<table>
<thead>
<tr>
<th>FALL SEMESTER FIRST YEAR</th>
<th>Credits</th>
<th>SPRING SEMESTER FIRST YEAR</th>
<th>Credits</th>
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<tbody>
<tr>
<td>CHEM 1035 General Chemistry</td>
<td>3</td>
<td>CHEM 1036 General Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>Pre: Eligible to enroll</td>
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<td>Pre: CHEM 1035 or 1055 or 105SH</td>
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<tr>
<td>CHEM 1045 General Chemistry Laboratory</td>
<td>1</td>
<td>ENGL 1106 First-Year Writing</td>
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<tr>
<td>Co: CHEM 1035</td>
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<td>Pre: ENGL 1105</td>
<td></td>
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<tr>
<td>ENGL 1105 First-Year Writing</td>
<td>3</td>
<td>MATH 1226 Calculus of a Single Variable</td>
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<td>Pre: MATH 1225 (C-)</td>
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<tr>
<td>MATH 1225 Calculus of a Single Variable (C-)</td>
<td>4</td>
<td>PHYS 2305 Foundations of Physics</td>
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<tr>
<td>Pre: Eligible to enroll</td>
<td></td>
<td>Pre: (MATH 1205 or MATH 1205H or MATH1225) or (MATH 1206 or MATH 1206H or MATH 1226); Co: 2325 or (MATH 1206 or MATH 1206H or MATH 1226)</td>
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<tr>
<td>ENGE 1215 Foundations of Engineering</td>
<td>2</td>
<td>ENGE 1216 Foundations of Engineering</td>
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<td>Pathways Core Concept 2, 3, 6a, or 7</td>
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<td><strong>TOTAL</strong></td>
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<td><strong>TOTAL</strong></td>
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<tr>
<th>FALL SEMESTER SECOND YEAR</th>
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<th>SPRING SEMESTER SECOND YEAR</th>
<th>Credits</th>
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<tbody>
<tr>
<td>BSE 2004 Introduction to Biological Systems Engineering</td>
<td>3</td>
<td>BSE 3144 Engineering Analysis for Biological Systems using Numerical Methods</td>
<td>2</td>
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<tr>
<td>Pre: ENGE 1215 or ENGE 1414</td>
<td>[P]</td>
<td>Co: MATH 2214</td>
<td>[P]</td>
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<tr>
<td>BIOL 1105 Principles of Biology</td>
<td>3</td>
<td>BIOL 1106 Principles of Biology</td>
<td>3</td>
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<td>[F,5,5]</td>
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<tr>
<td>MATH 2204 Introduction to Multivariable Calculus</td>
<td>3</td>
<td>Pathways Core Concept 2, 3, 6a, or 7</td>
<td>3</td>
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<tr>
<td>Pre: MATH 1226</td>
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<td></td>
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<tr>
<td>MATH 2114 Introduction to Linear Algebra</td>
<td>3</td>
<td>MATH 2214 Introduction to Differential Equations</td>
<td>3</td>
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<tr>
<td>Pre: MATH 1225 (B) or MATH 1226</td>
<td></td>
<td>Pre: (1114 or 2114 or 2114H or 2405H or ISC 2105), 1226</td>
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<tr>
<td>ESM 2104 Statics</td>
<td>3</td>
<td>PHYS 2306 Foundations of Physics</td>
<td>4</td>
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<tr>
<td>Pre: MATH 1226; Co: MATH 2204</td>
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<td>Pre: (MATH 1206 or MATH 1206H or MATH 1226), 2305</td>
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<tr>
<td>ISE 2014 Engineering Economy</td>
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<td><strong>TOTAL</strong></td>
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<td><strong>TOTAL</strong></td>
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<th>SPRING SEMESTER THIRD YEAR</th>
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<tr>
<td>BSE Fundamental Course or Technical Elective</td>
<td>3</td>
<td>BSE Fundamental Course or Technical Elective</td>
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<tr>
<td>BSE 3154 Thermodynamics of Biological Systems</td>
<td>3</td>
<td>BSE Fundamental Course</td>
<td>3</td>
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<tr>
<td>Pre: CHEM 1036, PHYS 2305, (MATH 2204 or MATH 2204H)</td>
<td>[F]</td>
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<td>[F]</td>
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<tr>
<td>ESM 3024 Introduction to Fluid Mechanics</td>
<td>3</td>
<td>BSE 3504 Transport Processes in Biological Systems</td>
<td>3</td>
</tr>
<tr>
<td>Pre: ESM 2104, PHYS 2305</td>
<td>[P]</td>
<td>Pre: 3154, ESM 3024</td>
<td>[P]</td>
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<tr>
<td>STAT 3704 Statistics for Engineering Applications</td>
<td>2</td>
<td>BIOL 2604 General Microbiology</td>
<td>3</td>
</tr>
<tr>
<td>Pre: MATH 2224 or MATH 2224H or MATH 2204 or MATH 2204H or MATH 2406H or CMDA 2005</td>
<td>[F,5,5]</td>
<td>Pre: (BIOL 1105 or ISC 2105), BIOL 1106, (CHEM 1036 or CHEM 1056 or CHEM 1056H or ISC 2105)</td>
<td>[F,5,5]</td>
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<tr>
<td>CHEM Elective</td>
<td>3</td>
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<tr>
<td>Pathways Core Concept 2, 3, 6a, or 7</td>
<td>3</td>
<td>ISE 3034 Technical Communication for Engineers</td>
<td>3</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td><strong>17</strong></td>
<td><strong>TOTAL</strong></td>
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<tr>
<th>FALL SEMESTER FOURTH YEAR</th>
<th>Credits</th>
<th>SPRING SEMESTER FOURTH YEAR</th>
<th>Credits</th>
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<tbody>
<tr>
<td>BSE 4125 Comprehensive Design Project</td>
<td>2</td>
<td>BSE 4126 Comprehensive Design Project</td>
<td>3</td>
</tr>
<tr>
<td>Pre: 3334 or 3524</td>
<td>[P]</td>
<td>Pre: 4125</td>
<td>[P]</td>
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<tr>
<td>BSE Elective</td>
<td>3</td>
<td>BSE Elective</td>
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<tr>
<td>BSE Elective</td>
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<td>Engineering Topics Elective</td>
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<tr>
<td>Engineering Topics Elective</td>
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<td>Technical Elective</td>
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<td>Engineering Topics Elective</td>
<td>3</td>
<td>Pathways Core Concept 2, 3, 6a, or 7</td>
<td>3</td>
</tr>
<tr>
<td>Pathways Core Concept 2, 3, 6a, or 7</td>
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<td></td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>17</strong></td>
<td><strong>TOTAL</strong></td>
<td><strong>15</strong></td>
</tr>
</tbody>
</table>
**General Information about Checksheet:** Superscripted annotation after the course number (1) indicates core course of the degree. Additionally, [F,S,Si,Sil] in credits column indicates terms when a course is expected to be offered. Course offerings are subject to change and the availability of sufficient resources. Students should confirm course offerings in advance with their department.

### Pathways General Education (Pathways)
Consult the pathway courses table: [https://www.pathways.prov.vt.edu/students-and-advisors/pathways-guides.html](https://www.pathways.prov.vt.edu/students-and-advisors/pathways-guides.html). Pathway courses need to be completed prior to graduation.

<table>
<thead>
<tr>
<th>Pathway Concept</th>
<th>Foundation: ENGL 1105 (3)</th>
<th>Foundation: ENGL 1106 (3)</th>
<th>Advanced: ISE 3034[5] (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pathway Concept 1:</strong> Discourse (6 hrs foundational, 3 hrs advanced)</td>
<td>Foundational: ENGL 1105 (3)</td>
<td>Foundational: ENGL 1106 (3)</td>
<td>Advanced: ISE 3034[5] (3)</td>
</tr>
<tr>
<td><strong>Pathway Concept 2:</strong> Critical Thinking in the Humanities (6 hrs)</td>
<td>(3)</td>
<td>(3)</td>
<td>(3)</td>
</tr>
<tr>
<td><strong>Pathway Concept 3:</strong> Reasoning in the Social Sciences (6 hrs)</td>
<td>(3)</td>
<td>(3)</td>
<td>(3)</td>
</tr>
<tr>
<td><strong>Pathway Concept 4:</strong> Reasoning in the Natural Sciences (8 hrs)</td>
<td>CHEM 1035 + CHEM 1045 (4)</td>
<td>PHYS 2305 (4)</td>
<td></td>
</tr>
<tr>
<td><strong>Pathway Concept 5:</strong> Quantitative and Computational Thinking (11 hrs)</td>
<td>Foundational: MATH 1225 (4)</td>
<td>Foundational: MATH 1226 (4)</td>
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<tr>
<td><strong>Pathway Concept 6:</strong> Critique and Practice in Design and the Arts (7 hrs)</td>
<td>Arts (6a):</td>
<td></td>
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</tr>
<tr>
<td><strong>Pathway Concept 7:</strong> Critical Analysis of Identity &amp; Equity in the US (3 hrs)</td>
<td>*Pathway 7 should be double-counted with either Pathways 2, 3, or 6a to avoid taking additional credit hours</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Electives:** BSE majors choose a focused 6 credits fundamental elective sequence, 9 credits of BSE electives (1 BSE elective must have 1-credit of lab), 3 credits of chemistry electives, 9 credits of engineering topics electives, and 6 credits of technical electives. Students choose from the courses listed under each respective requirement, noting that some courses are not available to all students because some courses have prerequisites and some are restricted to majors in the offering department. Courses with substantial duplication (as determined by the BSE Undergraduate Curriculum Committee) of courses previously taken will not qualify for credit.

**BSE Fundamental Elective Sequence:** There are 2 fundamental sequences to choose from (6 credits total):

**Change of Major Requirements:** Please see [https://eng.vt.edu/em](https://eng.vt.edu/em)

**Foreign Language Requirements:** Students must have had 2 years of a foreign language in high school or one year at the college level (6 credit hours) of the same language. College-level credits used to meet this requirement do not count towards the degree.

**Satisfactory Progress Towards Degree:** University Policy 91 outlines university-wide minimum criteria to determine if students are making satisfactory progress towards the completion of their degrees. The BSE Department fully supports this policy. Specific expectations for satisfactory progress for BSE majors are as follows:

- Maintain overall and in-major GPAs of at least 2.0 (in-major GPA based on all BSE-prefix courses taken); and,
- Be registered for at least one BSE-prefix course per semester, excluding BSE 2094, 2294, and 2484.

**Statement of Hidden Prerequisites:** Prerequisites for each course are listed after the course title. The (letter grade) notation, such as (C-), indicates the minimum grade students must earn in the prerequisite course. There are no hidden prerequisites in this program of study. Prerequisites may change from what is indicated. Be sure to consult the University Catalog or check with your advisor for the most current requirements. A student must obtain a C- or better in all BSE courses.

**Graduation Requirements:** Students must pass all required courses, with a minimum grade of C- in all BSE-prefix courses. Both the overall and in-major GPA must be at least 2.0, where in-major GPA is based on all BSE-prefix courses taken. Only free electives and courses only offered on a Pass/Fail basis may be taken Pass/Fail.

**Additional Checksheet Comments:**
1. ENGE 1414 (4 cr) may be substituted for ENGE 1215 (2 cr) + ENGE 1216 (2 cr)
2. MATH 2405H (5 cr) may be substituted for MATH 2114 (3 cr)
3. MATH 2405H (5 cr) + MATH 2406H (5 cr) may be substituted for MATH 2114 (3 cr) + MATH 2204 (3 cr) + MATH 2214 (3 cr)
4. Students are strongly encouraged to take CHEM 1036 first year Spring semester.
5. Students might also choose to take the BIOL 1105-1106 sequence during the first year if their schedule permits.
Biological Systems Engineering Electives

Courses with substantial duplication of courses taken previously will not qualify for credit.

Choose from the courses listed under each respective requirement, noting that some courses are not available to all students because some courses have prerequisites and some are restricted to majors in the offering department.

*# Biological Systems Engineering (BSE) Electives (9 credits, where 1 course must have a lab component, L):

- BSE 2304 Landscape Measurement and Modeling (L)
- BSE 4224 Field Methods in Hydrology (L)
- BSE 4304 Introduction to Watershed Modeling (L)
- BSE 4324 Applied Fluvial Geomorphology
- BSE 4344 Geographic Information Systems for Engineers (L)
- BSE 4524 Biological Process Plant Design
- BSE 4534 Bioprocess Engineering Lab (1) (L)
- BSE 4544/CHE 4544 Protein Separation Engineering
- BSE 4564 Metabolic Engineering
- BSE 4604 Food Process Engineering

*# Chemistry (CHEM) Electives (3 credits required):

- BCHM 2024 Concepts of Biochemistry
- CHEM 2114 Analytical Chemistry
- CHEM 2124 Analytical Chemistry Laboratory Techniques and Practice (1)
- CHEM 2514 Survey of Organic Chemistry
- CHEM 2535-2536 Organic Chemistry
- CHEM 2565-2566 Principles of Organic Chemistry
- CHEM 3615 Physical Chemistry
- CHEM 4615 Physical Chemistry for the Life Sciences
- ENSC 4314 Water Quality
- ENSC 4734 (CHEM 4734) Environmental Soil Chemistry
- GEOS 4634 Environmental Geochemistry

*# Engineering Topics Electives (9 credits required – students must request to be force-added to major-restricted courses):

All courses listed as Biological Systems Engineering electives, from top list, above

- BMES 2104 Introduction to Biomedical Engineering
- BMES 3124 Introduction to Biomechanics
- BMES 3134 Introduction to Biomedical Imaging
- BMES 3144 Biomedical Devices
- CEE 3104 Introduction to Environmental Engineering
- CEE 4104 Water and Wastewater Treatment Design
- CEE 4114 Fundamentals of Public Health Engineering
- CEE 4134 Environmental Sustainability - A Systems Approach
- CEE 4144 Air Resources Engineering
- CEE 4174 Solid and Hazardous Waste Management
- CEE 4314 Groundwater Resources
- CEE 4324 Open Channel Flow
- CEE 4334 Hydraulic Structures
- CEE 4344 Water Resources Planning
- ECE 3054 Electrical Theory
- ECE 4194 Engineering Principles of Remote Sensing
- ECE 4364 Alternate Energy Systems
- ENGR 3124 Introduction to Green Engineering
- ENGR 4134 Environmental Life Cycle Assessment
- ESM 2204 Mechanics of Deformable Bodies
- ESM 2304 Dynamics
- ESM 3054/MSE 3054 Mechanical Behavior of Materials
- ESM 3064/MSE 3064 Mechanical Behavior of Materials Laboratory (1)
- ESM 4044/CHE 4610 Mechanics of Composite Materials
- ESM 4105-4106 Engineering Analysis of Physiologic Systems
- ESM 4114/AOE 4514 Nonlinear Dynamics and Chaos
- ESM 4204 Musculoskeletal Biomechanics
- ISE 3204 Manufacturing Processes

* Prerequisites: Most of courses listed under the page 3 & 4 headers have pre/corequisites; please consult the University Course Catalog or check with your advisor.

# Unless otherwise designated (i.e., (1), (2), (4)), all courses listed under page 3 & 4 headers are 3-credit hour courses.
**Technical Electives (6 credits required – students must request to be force-added to major-restricted courses):**

- All BIOL 1XXX laboratories and all 2000, 3000, and 4000 level courses, except 3504.
- CHEM 1046 General Chemistry Laboratory and all CHEM 2000, 3000, and 4000 level courses except 4014.
- All 3000 and 4000 level MATH courses except 4044, 4625, 4626, 4644, 4664, 4754, 4964, 4974, 4984, 4994
- All 3000, 4000, or 5000 level engineering courses, with no more than 3 credits of undergraduate research and no more than 3 credits of independent study. Technical Elective courses cannot double-count for Engineering Topics Elective credit (and vice versa).

AAEC 3314 Environmental Law
ALS 3404 Ecological Agriculture: Theory and Practice
ALS 4614/WATR 4614 Watershed Assessment, Management, and Policy
BCHM 3114 Biochemistry for Biotechnology and the Life Sciences
BCHM 4115-4116 General Biochemistry
BIOL 4164/ENSC 4164 Environmental Microbiology
BMES 4064/BMVS 4064 Introduction to Medical Physiology
BSE 4394 Water Supply and Sanitation in Developing Countries
BSE 4554/FREC 4554/HORT 4554/LAR 4554/SPIA 4554 Creating the Ecological City
CS 1044 Introduction to Programming in C
CS 1054 Introduction to Programming in Java
CS 1064 Introduction to Programming in Python
CS 1114: Intro to Software Design
CS 2064: Intermediate Programming
CSES 3114/GEOS 3614 Soils
CSES 3124/GEOS 3624 Soils Laboratory (1)
CSES 3614 Soil Physical and Hydrological Properties
CSES 4854 Wetland Soils and Mitigation
ENSC 3634 Physics of Pollution
ENSC 3644 Plant Materials for Environmental Restoration
ECE 2164/AOE 2664 Exploration of the Space Environment
ENSC 3604 Fundamentals of Environmental Science
ENSC 4414 Monitoring and Analysis of the Environment (2)
ESM 4194/ME 4194 Sustainable Energy Solutions for a Global Society
FIW 4324/FREC 4324 Genetics of Natural and Managed Populations
FIW 4614 Fish Ecology
FIW 4624 Marine Ecology
FREC 4374 Forested Wetlands
FREC 4464/AAEC 4424/WATR 4464 Water Resource Policy & Economics
FREC 4784 Wetland Hydrology & Biogeochemistry
FST 2544 Functional Foods for Health
FST 3024 Principles of Sensory Evaluation
FST 3114/HORT 3114 Wines & Vines
FST 3124 Brewing Science and Technology
FST 3514 Food Analysis (4)
FST 3604/BIOL 3604 Food Microbiology (4)
FST 4104 Applied Malting and Brewing Science
FST 4504 Food Chemistry
GEOG 1514 Introduction to Meteorology
GEOG 3104 Environmental Problems, Population, and Development
GEOG 3304/GEOS 3304/CSES 3304 Geomorphology
GEOG 4354/GEOS 4354 Introduction to Remote Sensing
GEOS 2104 Elements of Geology
GEOS 3014 Environmental Geosciences
GEOS 3034 Oceanography
GEOS 4804 Groundwater Hydrology
ISE 4004 Theory of Organization
ISE 4304 Global Issues in Industrial Management
LAR 3044 Land Analysis and Site Planning
MINE 2504 Introduction to Mining Engineering
SBIO 2124 Structure and Properties of Sustainable Biomaterials
SBIO 2504 Circular Economy Analytics
SBIO 3434 Chemistry and Conversion of Sustainable Biomaterials
SBIO 3444 Sustainable Biomaterials and Bioenergy
SPES 2244 World Crops and Cropping Systems
SYSB 2024 Fundamentals of Systems Biology
SYSB 2034 Mathematical Methods in Systems Biology
SYSB 3115 Network Dynamics & Cell Physiology (4)
UAP 3354 Introduction to Environmental Policy and Planning
UAP 4344 Law of Critical Environmental Areas
UAP 4374 Land Use and Environment: Planning and Policy

*Prerequisites:* Most of courses listed under the page 3 & 4 headers have pre/corequisites; please consult the University Course Catalog or check with your advisor.

# Unless otherwise designated (i.e., (1), (2), (4)), all courses listed under page 3 & 4 headers are 3-credit hour courses.