<table>
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<tr>
<th><strong>FALL SEMESTER FIRST YEAR</strong></th>
<th><strong>Credits</strong></th>
<th><strong>SPRING SEMESTER FIRST YEAR</strong></th>
<th><strong>Credits</strong></th>
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<tbody>
<tr>
<td>CHEM 1035 General Chemistry Pre: Eligible to enroll</td>
<td>3</td>
<td>CHEM 1036 General Chemistry Pre: CHEM 1035 or 1055 or 1055H</td>
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<td>CHEM 1045 General Chemistry Laboratory Co: CHEM 1035</td>
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<td>ENGL 1106 First-Year Writing Pre: ENGL 1105</td>
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<td>ENGL 1105 First-Year Writing</td>
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<td>MATH 1226 Calculus of a Single Variable Pre: MATH 1225 (C-)</td>
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<td>MATH 1225 Calculus of a Single Variable (C-) Pre: Eligible to enroll</td>
<td>4</td>
<td>PHYS 2305 Foundations of Physics Pre: MATH 1225 or MATH 1226; Co: MATH 1226</td>
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<tr>
<td>ENGE 1215 Foundations of Engineering (C-)</td>
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<td>ENGE 1216 Foundations of Engineering (C-) Pre: ENGE 1215 (C-)</td>
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<td><strong>FALL SEMESTER SECOND YEAR</strong></td>
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<tr>
<td>BSE 2004 Introduction to Biological Systems Engineering Pre: ENGE 1215 or ENGE 1414</td>
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<td>BSE 3144 Engineering Analysis for Biological Systems using Numerical Methods Co: MATH 2214</td>
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<tr>
<td>BIOL 1105 Principles of Biology</td>
<td>3</td>
<td>BSE 3144 Engineering Analysis for Biological Systems using Numerical Methods Co: MATH 2214</td>
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<tr>
<td>MATH 2204 Introduction to Multivariable Calculus Pre: MATH 1226</td>
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<td>MATH 2214 Introduction to Differential Equations Pre: (MATH 1114 or MATH 2114 or MATH 2114H), MATH 1226</td>
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<tr>
<td>MATH 2114 Introduction to Linear Algebra Pre: MATH 1225 (B) or MATH 1226</td>
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<td>MATH 2214 Introduction to Differential Equations Pre: (MATH 1114 or MATH 2114 or MATH 2114H), MATH 1226</td>
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<tr>
<td>ESM 2104 Statics (C) Pre: MATH 1226; Co: MATH 2204 or MATH 2204H or MATH 2224 or MATH 2406H</td>
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<td>PHYS 2306 Foundations of Physics Pre: MATH 1226, PHYS 2305</td>
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<tr>
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<td>ISE 2014 Engineering Economy</td>
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<td><strong>TOTAL 17</strong></td>
<td><strong>TOTAL 17</strong></td>
<td><strong>FALL SEMESTER THIRD YEAR</strong></td>
<td><strong>Credits</strong></td>
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<td>BSE Fundamental Course or Technical Elective</td>
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<td>BSE Fundamental Course or Technical Elective</td>
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<tr>
<td>BSE 3154 Thermodynamics of Biological Systems Pre: ESM 2304, (MATH 2204 or MATH 2204H)</td>
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<td>ESM 3024 Introduction to Fluid Mechanics Pre: ESM 2304</td>
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<td>BSE 3504 Transport Processes in Biological Systems Pre: 3154, ESM 3024</td>
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<tr>
<td>STAT 3704 Statistics for Engineering Applications Pre: MATH 2204 or MATH 2204H or MATH 2406H</td>
<td>2</td>
<td>BIOL 2604 General Microbiology Pre: BIOL 1105, BIOL 1106, (CHEM 1036 or CHEM 1056 or CHEM 1036H or CHEM 1056H)</td>
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<td>CHEM Elective</td>
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<td>ISE 3034 Technical Communication for Engineers Pre: ENGL 1106</td>
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<td>ISE 3034 Technical Communication for Engineers Pre: ENGL 1106</td>
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<tr>
<td>BSE 4125 Comprehensive Design Project Pre: 3334 or 3524</td>
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<td>BSE 4126 Comprehensive Design Project Pre: 4125</td>
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<td>3</td>
<td>Technical Elective</td>
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<td>Pathways Core Concept 2, 3, 6a, or 7</td>
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<td>Pathways Core Concept 2, 3, 6a, or 7</td>
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<tr>
<td>Pathways Core Concept 2, 3, 6a, or 7</td>
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<td>Pathways Core Concept 2, 3, 6a, or 7</td>
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<tr>
<td><strong>TOTAL 17</strong></td>
<td><strong>TOTAL 17</strong></td>
<td><strong>FALL SEMESTER FOURTH YEAR</strong></td>
<td><strong>Credits</strong></td>
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<tr>
<td>BSE Elective</td>
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<td>Pathways Core Concept 2, 3, 6a, or 7</td>
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<tr>
<td>Engineering Topics Elective</td>
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<td>Pathways Core Concept 2, 3, 6a, or 7</td>
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<tr>
<td>Engineering Topics Elective</td>
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<td>Pathways Core Concept 2, 3, 6a, or 7</td>
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<td>Pathways Core Concept 2, 3, 6a, or 7</td>
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<td>Pathways Core Concept 2, 3, 6a, or 7</td>
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<td><strong>TOTAL 17</strong></td>
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<td><strong>SPRING SEMESTER FOURTH YEAR</strong></td>
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**Pathways to General Education (Pathways)**

Consult the pathways courses table: [https://www.pathways.prov.vt.edu/about/table.html](https://www.pathways.prov.vt.edu/about/table.html). Pathways courses need to be completed prior to graduation.

<table>
<thead>
<tr>
<th>Pathways Concept 1:</th>
<th>Foundational: ENGL 1105 (3)</th>
<th>Foundational: ENGL 1106 (3)</th>
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</thead>
<tbody>
<tr>
<td>Discourse (6 hrs foundational, 3 hrs advanced)</td>
<td>Advanced: ISE 3034(3)</td>
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<table>
<thead>
<tr>
<th>Pathways Concept 2:</th>
<th>(3)</th>
<th>(3)</th>
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<tbody>
<tr>
<td>Critical Thinking in the Humanities (6 hrs)</td>
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<table>
<thead>
<tr>
<th>Pathways Concept 3:</th>
<th>(3)</th>
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<tbody>
<tr>
<td>Reasoning in the Social Sciences (6 hrs)</td>
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</table>

<table>
<thead>
<tr>
<th>Pathways Concept 4:</th>
<th>CHEM 1035 + CHEM 1045 (4)</th>
<th>PHYS 2305 (4)</th>
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</thead>
<tbody>
<tr>
<td>Reasoning in the Natural Sciences (8 hrs)</td>
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</table>

<table>
<thead>
<tr>
<th>Pathways Concept 5:</th>
<th>Foundational: MATH 1225 (4)</th>
<th>Foundational: MATH 1226 (4)</th>
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<tbody>
<tr>
<td>Quantitative and Computational Thinking (11 hrs)</td>
<td>Advanced: MATH 2214</td>
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</table>

<table>
<thead>
<tr>
<th>Pathways Concept 6:</th>
<th>Arts (6a): (3)</th>
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<tbody>
<tr>
<td>Critique and Practice in Design and the Arts (7 hrs)</td>
<td>Design: ENGE 1215 + ENGE 1216 (4)</td>
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<thead>
<tr>
<th>Pathways Concept 7*:</th>
<th>(3)</th>
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<tbody>
<tr>
<td>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>
</tr>
</tbody>
</table>

**Electives:** BSE majors choose a focused 6 hour fundamental elective sequence, 6 hours of BSE electives, 3 hours of chemistry electives, 9 hours of engineering topics electives, and 6 hours 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. Independent study (BSE 4974) and undergraduate research (BSE 4994) courses cannot be used as electives.

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

- For *Watershed Science and Environmental Health*: BSE 3324 Small Watershed Hydrology(3) and BSE 3334(3) Nonpoint Source Pollution Assessment and Control.

- For *Biotechnology, Food Engineering, and Health Professions*: BSE 3524(3) Unit Operations in Biological Systems Engineering & BSE 3534(3) Bioprocess Engineering.

**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:

- Each student must meet the minimum University-wide criteria as described in Policy 91 and summarized in the Undergraduate Catalog (http://www.undergradcatalog.registrar.vt.edu/1617/academic-policies.html#22http://www.undergradcatalog.registrar.vt.edu/1617/academic-policies.html#22);
- 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, 2484, and 4994.

**Statement of Hidden Prerequisites:** Pre-requisites 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 pre-requisite 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.
Biological Systems Engineering Electives

Courses with substantial duplication of courses taken previously will not qualify for credit. Independent study (DEPT NAME 4974) and undergraduate research (DEPT NAME 4994) courses cannot be used as electives.

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 (6 credit hours required):

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

*# Chemistry (CHEM) Electives (3 credit hours 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  
CSES 4314/ENSC 4314 Water Quality  
CSES 4734/CHEM 4734/ENSC 4734 Environmental Soil Chemistry  
GEOS 4634 Environmental Geochemistry

*# Engineering Topics Electives (9 credit hours 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  
CE 3104 Introduction to Environmental Engineering  
CE 4104 Water and Wastewater Treatment Design  
CE 4114 Fundamentals of Public Health Engineering  
CE 4134 Environmental Sustainability - A Systems Approach  
CE 4144 Air Resources Engineering  
CE 4174 Solid and Hazardous Waste Management  
CE 4314 Groundwater Resources  
CE 4324 Open Channel Flow  
CE 4334 Hydraulic Structures  
CE 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 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

* Prerequisites: Most of courses listed under the page 3 & 4 headers have pre-/co-requisites; 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 credit hours required – students must request to be force-added to major-restricted courses):**

- All courses listed as Chemistry or Engineering Topics Electives, except 4754, 4964, 4974, 4984, 4994 in any department.
- 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 MATH 3000 and 4000 level courses except 4044, 4625, 4626, 4644, 4664, 4754, 4964, 4974, 4984, 4994

AAEC 3314 Environmental Law  
FREC 3604 Climate Science  
ALS 3404 Agricultural Ecology: Theory and Practice  
FREC 4374 Forested Wetlands  
ALS 4614/WATR 4614 Watershed Assessment, Management, and Policy  
FREC 4464/AAEC 4424/WATR 4464 Water Resource Policy & Economics  
BCHM 3114 Biochemistry for Biotechnology and the Life Sciences  
FREC 4784 Wetland Hydrology & Biogeochemistry  
BCHM 4115-4116 General Biochemistry  
FST 2544 Functional Foods for Health  
BIOL 4164/CSES 4164/ENSC 4164 Environmental Microbiology  
FST 3114/HORT 3114 Wines & Vines  
BMES 4064/BMVS 4064 Introduction to Medical Physiology  
FST 3124 Brewing Science and Technology  
BSE 4394 Water Supply and Sanitation in Developing Countries  
FST 3514 Food Analysis (4)  
BSE 4554/FREC 4554/HORT 4554/LAR 4554/SPIA 4554  
FST 3604/BIOL 3604 Food Microbiology (4)  
Creating the Ecological City  
FST 4104 Applied Malting and Brewing Science

CS 1044 Introduction to Programming in C  
FST 4504 Food Chemistry  
CS 1054 Introduction to Programming in Java  
GEOG 1514 Introduction to Meteorology  
CS 1064 Introduction to Programming in Python  
GEOG 3104 Environmental Problems, Population, and Development  
CSES 3114/ENSC 3114/GEOS 3614 Soils  
GEOG 4354/GEOS 4354 Introduction to Remote Sensing  
CSES 3124/ENSC 3124/GEOS 3624 Soils Laboratory (1)  
GEOS 2104 Elements of Geology  
CSES 3304/GEOG 3304/GEOS 3304 Geomorphology  
GEOS 3014 Environmental Geosciences  
CSES 3444/HORT 3444 World Crops and Cropping Systems  
GEOS 3034 Oceanoegy  
CSES 3614/ENSC 3614 Soil Physical and Hydrological Properties  
GEOS 4804 Groundwater Hydrology  
CSES 3634/ENSC 3634 Physics of Pollution  
ISE 4004 Theory of Organization  
CSES 3644/ENSC 3644 Plant Materials for Environmental Restoration  
ISE 4304 Global Issues in Industrial Management  
CSES 4764/ENSC 4764 Bioremediation  
LAR 3044 Land Analysis and Site Planning  
CSES 4774/ENSC 4774 Reclamation of Distracted Disturbed Lands  
MINE 2504 Introduction to Mining Engineering  
CSES 4854/ENSC 4854 Wetland Soils and Mitigation  
SBIO 2124 Structure and Properties of Sustainable Biomaterials  
ECE 2164/AOE 2164 Exploration of the Space Environment  
SBIO 2504 Circular Economy Analytics  
ENGR 2164/COS 2164 Introduction to Sciences (1)  
SBIO 3434 Chemistry and Conversion of Sustainable Biomaterials  
ENSC 3604 Fundamentals of Environmental Science  
SBIO 3444 Sustainable Biomaterials and Bioenergy  
ENSC 4414 Monitoring and Analysis of the Environment (2)  
SYSB 2025, 2026 Introduction to Systems Biology  
ESM 4194/ME 4194 Sustainable Energy Solutions for a Global Society  
SYSB 3115 Network Dynamics & Cell Physiology (4)  
FIW/FREC 4324 Genetics of Natural and Managed Populations  
UAP 3354 Introduction to Environmental Policy and Planning  
FIW 4614 Fish Ecology  
UAP 4344 Law of Critical Environmental Areas  
FIW 4624 Marine Ecology  
UAP 4374 Land Use and Environment: Planning and Policy

**Prerequisites:** Most of courses listed under the page 3 & 4 headers have pre-/co-requisites; 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.