

# BIOLOGICAL SYSTEMS ENGINEERING MAJOR

## Program Curriculum

Code	Title	Credits
<b>Degree Core Requirements</b>		
BIOL 2604	General Microbiology	3
BSE 2004	Introduction to Biological Systems Engineering (C-)	3
BSE 3144	Engineering Analysis for Biological Systems using Numerical Methods (C-)	2
BSE 3154	Thermodynamics of Biological Systems (C-)	3
BSE 3504	Transport Processes in Biological Systems (C-)	3
BSE 4125	Comprehensive Design Project (C-)	2
ESM 2104	Statics	3
ESM 3024	Introduction to Fluid Mechanics	3
ISE 2014	Engineering Economy	2
Subtotal		24
<b>Major Requirements</b>		
BIOL 1105	Principles of Biology	3
BIOL 1106	Principles of Biology	3
BSE 4126	Comprehensive Design Project (C-)	3
CHEM 1036	General Chemistry	3
MATH 2114	Introduction to Linear Algebra	3
MATH 2204	Introduction to Multivariable Calculus	3
PHYS 2306	Foundations of Physics	4
STAT 3704	Statistics for Engineering Applications	2
Subtotal		24
<b>Restricted Electives</b>		
Select 2 BSE Fundamental Courses		6
Select 1 CHEM Elective		3
Select 3 BSE Electives where 1 course must have a lab component.		9
Select 3 Engineering Topics Electives		9
Select 2 Technical Electives		6
Subtotal		33
<b>Pathways to General Education</b>		
<i>Pathways Concept 1 - Discourse</i>		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
ISE 3034	Technical Communication for Engineers (1A)	3
<i>Pathways Concept 2 - Critical Thinking in the Humanities</i>		
Select six hours in Pathway 2 ( <a href="https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02">https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02</a> )		6
<i>Pathways Concept 3 - Reasoning in the Social Sciences</i>		
Select six hours in Pathway 3 ( <a href="https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03">https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03</a> )		6
<i>Pathways Concept 4 - Reasoning in the Natural Sciences</i>		
CHEM 1035	General Chemistry	4
& CHEM 1045	and General Chemistry Laboratory	
PHYS 2305	Foundations of Physics	4
<i>Pathways Concept 5 - Quantitative and Computational Thinking</i>		
MATH 1225	Calculus of a Single Variable (5F ; C-)	4

MATH 1226	Calculus of a Single Variable (5F ;)	4
MATH 2214	Introduction to Differential Equations (5A)	3
<i>Pathways Concept 6 - Critique and Practice in Design and the Arts</i>		
Select three Arts credits in Pathway 6a ( <a href="https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A">https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A</a> )		3
ENGE 1215	Foundations of Engineering	4
& ENGE 1216	and Foundations of Engineering (6D ;)	
or ENGE 1414	Foundations of Engineering Practice	
<i>Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States</i>		
Pathway 7 should be double-counted with either Pathways 2, 3, or 6a to avoid taking additional credit hours.		
Subtotal		47
<b>Total Credits</b>		<b>128</b>

## 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 and BSE 3334 Nonpoint Source Pollution Assessment and Control.

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

## Restricted Electives

### Biological Systems Engineering (BSE) Electives

(9 credit hours required, where 1 course must have a lab component.)

Code	Title	Credits
BSE 2304	Landscape Measurements and Modeling	3
BSE 4224	Field Methods in Hydrology	3
BSE 4304	Introduction to Watershed Modeling	3
BSE 4324	Applied Fluvial Geomorphology	3
BSE 4344	Geographic Information Systems for Engineers	3
BSE 4524	Biological Process Plant Design	3
BSE 4534	Bioprocess Engineering Lab	1
BSE 4544	Protein Separation Engineering	3
BSE 4564	Metabolic Engineering	3
BSE 4604	Food Process Engineering	3

### Chemistry (CHEM) Electives

(3 credit hours required)

Code	Title	Credits
BCHM 2024	Concepts of Biochemistry	3
CHEM 2114	Analytical Chemistry	3
CHEM 2124	Analytical Chemistry Laboratory Techniques and Practice	1
CHEM 2514	Survey of Organic Chemistry	3
CHEM 2535	Organic Chemistry	3
CHEM 2565	Principles of Organic Chemistry	3
CHEM 3615	Physical Chemistry	3
CHEM 4615	Physical Chemistry for the Life Sciences	3
ENSC 4314	Water Quality	3

ENSC 4734	Environmental Soil Chemistry	3
GEOS 4634	Environmental Geochemistry	3

### Engineering Topics Electives

(9 credit hours required – students must request to be force-added to major-restricted courses)

Code	Title	Credits
BMES 2104	Introduction to Biomedical Engineering	3
BMES 3124	Introduction to Biomechanics	3
BMES 3134	Introduction to Biomedical Imaging	3
BMES 3144	Biomedical Devices	3
BMES 3154	Biosignal Processing and Classification	3
CEE 3104	Introduction to Environmental Engineering	3
CEE 4104	Water and Wastewater Treatment Design	3
CEE 4114	Fundamentals of Public Health Engineering	3
CEE 4134	Environmental Sustainability - A Systems Approach	3
CEE 4144	Air Resources Engineering	3
CEE 4174	Solid and Hazardous Waste Management	3
CEE 4314	Groundwater Resources	3
CEE 4324	Open Channel Flow	3
CEE 4334	Hydraulic Structures	3
CEE 4344	Water Resources Planning	3
ECE 3054	Electrical Theory	3
ECE 4194	Engineering Principles of Remote Sensing	3
ECE 4364	Alternate Energy for Climate Sustainability	3
ENGR 3124	Introduction to Green Engineering	3
ENGR 4134	Environmental Life Cycle Assessment	3
ESM 2204	Mechanics of Deformable Bodies	3
ESM 2304	Dynamics	3
ESM 3054	Mechanical Behavior of Materials	3
ESM 3064	Mechanical Behavior of Materials Laboratory	1
ESM 4044	Mechanics of Composite Materials	3
ESM 4105	Engineering Analysis of Physiologic Systems	3
ESM 4106	Engineering Analysis of Physiologic Systems	3
ESM 4114	Nonlinear Dynamics and Chaos	3
ESM 4194	Sustainable Energy Solutions for a Global Society	3
ESM 4204	Musculoskeletal Biomechanics	3
FST 4104	Applied Brewing Science and Engineering	3
ISE 2404	Deterministic Operations Research I	3
ISE 3204	Manufacturing Processes	3
ISE 4014	Introduction to Management Systems	3
ISE 4654	Principles of Industrial Hygiene	3
MSE 2034	Elements of Materials Engineering	3
MSE 2054	Fundamentals of Materials Science	3
MSE 3304	Physical Metallurgy	3
MSE 4584	Biomimetic Materials	3
MSE 4604	Composite Materials	3

### Technical Electives

(6 credit hours 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 MATH 3000 and 4000 level courses except 4044,4625,4626,4644,4664,4754,4964,4974, 4984,4994.
- All 3000, 4000, and 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.

Code	Title	Credits
AAEC 3314	Environmental Law	3
ALS 3404	Ecological Agriculture: Theory and Practice	3
ALS 4614	Watershed Assessment, Management, and Policy	2
BCHM 3114	Biochemistry for Biotechnology and the Life Sciences	3
BCHM 4115	General Biochemistry	4
BCHM 4116	General Biochemistry	3
BIOL 4164	Environmental Microbiology	3
BMES 4064	Introduction to Medical Physiology	3
BSE 4394	Water Supply and Sanitation in Developing Countries	3
BSE 4554	Creating the Ecological City	3
CS 1044	Introduction to Programming in C	3
CS 1054	Introduction to Programming in Java	3
CS 1064	Introduction to Programming in Python	3
CS 1114	Introduction to Software Design	3
CS 2064	Intermediate Programming in Python	3
CSES 3114	Soils	3
CSES 3124	Soils Laboratory	1
CSES 3614	Soil Physical and Hydrological Properties	3
CSES 4854	Wetland Soils and Mitigation	3
ECE 2164	Exploration of the Space Environment	3
ENSC 3604	Fundamentals of Environmental Science	3
ENSC 3634	Physics of Pollution	3
ENSC 3644	Plant Materials for Environmental Restoration	3
ENSC 4414	Monitoring and Analysis of the Environment	2
ENSC 4764	Bioremediation	3
ENSC 4774	Reclamation of Drastically Disturbed Lands	3
FIW 4324	Genetics of Natural and Mangaged Populations	3
FIW 4614	Fish Ecology	3
FIW 4624	Marine Ecology	3
FREC 4374	Forested Wetlands	3
FREC 4464	Water Resources Policy and Economics	3
FREC 4784	Wetland Hydrology and Biogeochemistry	3
FST 2544	Functional Foods for Health	3
FST 3024	Principles of Sensory Evaluation	3
FST 3114	Wines and Vines	3
FST 3124	Brewing Science and Technology	3
FST 3514	Food Analysis	4
FST 3604	Food Microbiology	4
FST 4504	Food Chemistry	3
GEOG 1514	Introduction to Meteorology	3

GEOG 3104	Environmental Justice	3
GEOG 3304	Geomorphology	3
GEOG 4354	Introduction to Remote Sensing	3
GEOS 2104	Elements of Geology	3
GEOS 3014	Environmental Geosciences	3
GEOS 3034	Oceanography	3
GEOS 4804	Groundwater Hydrology	3
ISE 4004	Theory of Organization	3
ISE 4304	Global Issues in Industrial Management	3
LAR 3044	Land Analysis and Site Planning	3
MINE 2504	Introduction to Mining Engineering	3
SBIO 2124	Structure and Properties of Sustainable Biomaterials	3
SBIO 2504	Circular Economy Analytics for Sustainable Systems	3
SBIO 3434	Chemistry and Conversion of Sustainable Biomaterials	3
SBIO 3444	Sustainable Biomaterials and Bioenergy	3
SPES 2244	World Crops: Food and Culture	3
SYSB 2024	Fundamentals of Systems Biology	3
SYSB 2034	Mathematical Methods in Systems Biology	3
SYSB 3115	Network Dynamics and Cell Physiology	4
SYSB 3116	Network Dynamics and Cell Physiology	4
UAP 3354	Introduction to Environmental Policy and Planning	3
UAP 4344	Law of Critical Environmental Areas	3
UAP 4374	Land Use and Environment: Planning and Policy	3

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 year

## Graduation Requirements

### Graduation Requirements:

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

### Additional Notes:

1. Students are strongly encouraged to take CHEM 1036 General Chemistry first year Spring semester.
2. Students are encouraged to take BIOL 1105 Principles of Biology and BIOL 1106 Principles of Biology during the first year if their schedule permits.

## Acceptable Substitutions

1. MATH 2405H Mathematics in a Computational Context may be substituted for MATH 2114 Introduction to Linear Algebra
2. MATH 2405H Mathematics in a Computational Context and MATH 2406H Mathematics in a Computational Context may be substituted for MATH 2114 Introduction to Linear Algebra and MATH 2204 Introduction to Multivariable Calculus and MATH 2214 Introduction to Differential Equations

## Foreign Language Requirement

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.

## Roadmap

First Year		Credits
<b>Fall Semester</b>		
CHEM 1035	General Chemistry	3
CHEM 1045	General Chemistry Laboratory	1
ENGL 1105	First-Year Writing	3
MATH 1225	Calculus of a Single Variable (C-)	4
ENGE 1215	Foundations of Engineering (C-)	2
Pathways 2 or 3 or 6A or 7		3
<b>Credits</b>		<b>16</b>
<b>Spring Semester</b>		
CHEM 1036	General Chemistry	3
ENGL 1106	First-Year Writing	3
MATH 1226	Calculus of a Single Variable	4
PHYS 2305	Foundations of Physics	4
ENGE 1216	Foundations of Engineering	2
<b>Credits</b>		<b>16</b>
<b>Second Year</b>		
<b>Fall Semester</b>		
BSE 2004	Introduction to Biological Systems Engineering	3
BIOL 1105	Principles of Biology	3
MATH 2204	Introduction to Multivariable Calculus	3
MATH 2114	Introduction to Linear Algebra	3
ESM 2104	Statics	3
ISE 2014	Engineering Economy	2
<b>Credits</b>		<b>17</b>
<b>Spring Semester</b>		
BSE 3144	Engineering Analysis for Biological Systems using Numerical Methods	2
BIOL 1106	Principles of Biology	3
Pathways Core Concept 2, 3, 6a, or 7		3
MATH 2214	Introduction to Differential Equations	3
PHYS 2306	Foundations of Physics	4
<b>Credits</b>		<b>15</b>
<b>Third Year</b>		
<b>Fall Semester</b>		
BSE Fundamental Course or Technical Elective		3
BSE 3154	Thermodynamics of Biological Systems	3
STAT 3704	Statistics for Engineering Applications	2
ESM 3024	Introduction to Fluid Mechanics	3
CHEM Elective		3
Pathways Core Concept 2, 3, 6a, or 7		3
<b>Credits</b>		<b>17</b>

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**Spring Semester**

BSE Fundamental Course or Technical Elective		3
BSE Fundamental Course		3
BSE 3504	Transport Processes in Biological Systems	3
BIOL 2604	General Microbiology	3
ISE 3034	Technical Communication for Engineers	3
<b>Credits</b>		<b>15</b>

**Fourth Year**

**Fall Semester**

BSE 4125	Comprehensive Design Project	2
BSE Elective		3
BSE Elective		3
Engineering Topics Elective		3
Engineering Topics Elective		3
Pathways Core Concept 2, 3, 6a, or 7		3
<b>Credits</b>		<b>17</b>

**Spring Semester**

BSE 4126	Comprehensive Design Project	3
BSE Elective		3
Engineering Topics Elective		3
Technical Elective		3
Pathways Core Concept 2, 3, 6a, or 7		3
<b>Credits</b>		<b>15</b>
<b>Total Credits</b>		<b>128</b>