

# Biological Engineering (BS)

To see more about what you will learn in this program, visit the Learning Outcomes website (<https://apps.oirp.ncsu.edu/pgas/>)!

The BE curriculum is jointly administered by the College of Agriculture and Life Sciences and the College of Engineering and combines the fields of engineering, biology and agriculture. The BE curriculum is accredited by the Engineering Accreditation Commission of ABET, <http://www.abet.org>. BE graduates are qualified to become registered professional engineers by passing the appropriate examinations and upon completing the engineering experience requirements. Specific curriculum requirements are available online.

BAE faculty, in concert with program constituencies, has developed the following undergraduate program objectives. Within the first five years following graduation, NC State's Biological Engineering graduates will:

- Excel in their careers or in graduate school by applying their knowledge of engineering principles, processes, and procedures;
- Practice engineering professionally and ethically;
- Communicate effectively in a professional environment; and
- Be engaged in life-long learning and professional development.

## Plan Requirements

### First Year

Fall Semester		Hours
CH 101	Chemistry - A Molecular Science <sup>1</sup>	3
CH 102	General Chemistry Laboratory <sup>1</sup>	1
E 101	Introduction to Engineering & Problem Solving <sup>2</sup>	1
E 115	Introduction to Computing Environments	1
ENG 101	Academic Writing and Research <sup>2</sup>	4
MA 141	Calculus I <sup>1</sup>	4
Hours		14

### Spring Semester

Select one of the following:		4
CH 201 & CH 202	Chemistry - A Quantitative Science and Quantitative Chemistry Laboratory	
CH 220 & CH 222	Introductory Organic Chemistry and Organic Chemistry I Lab	
CH 221 & CH 222	Organic Chemistry I and Organic Chemistry I Lab	
MA 241	Calculus II <sup>1</sup>	4
PY 205 & PY 206	Physics for Engineers and Scientists I and Physics for Engineers and Scientists I Laboratory <sup>1</sup>	4
Select one of the following:		3
ARE 201	Introduction to Agricultural & Resource Economics	
ARE 201A	Introduction to Agricultural & Resource Economics	
EC 201	Principles of Microeconomics	

EC 205	Fundamentals of Economics	
Hours		15

### Second Year

Fall Semester		
BAE 200	Computer Methods in Biological Engineering	2
CE 214 or MAE 206	Engineering Mechanics-Statics <sup>2</sup> or Engineering Statics	3
MA 242	Calculus III	4
PY 208 & PY 209	Physics for Engineers and Scientists II and Physics for Engineers and Scientists II Laboratory	4
BIO 181 or BIO 183	Introductory Biology: Ecology, Evolution, and Biodiversity or Introductory Biology: Cellular and Molecular Biology	4
Hours		17

### Spring Semester

Select one of the following:		4
BAE 202	Introduction to Biological and Agricultural Engineering Methods	
BAE 203 & BAE 204	Introduction to AutoCAD Civil 3D for Environmental & Ecological Engineers and Introduction to Environmental and Ecological Engineering	
CE 215 or MAE 208	Engineering Mechanics-Dynamics <sup>2</sup> or Engineering Dynamics	3
MA 341	Applied Differential Equations I	3
MAE 201	Engineering Thermodynamics I	3
Biological Science/Chemistry Elective (p. 2)		3
Hours		16

### Third Year

Fall Semester		
BAE 302	Transport Phenomena	3
Select one of the following:		3
BAE 322	Introduction to Food Process Engineering	
BAE 361	Analytical Methods in Engineering Design	
BAE 371	Fundamentals of Hydrology for Engineers	
BAE 481	Structures & Environment	
CE 282 or MAE 308	Hydraulics or Fluid Mechanics	
BAE 305	Biological Engineering Circuits	4
ENG 331 or ENG 333	Communication for Engineering and Technology or Communication for Science and Research	3
Hours		13

### Spring Semester

Select one of the following:		3
BAE 322	Introduction to Food Process Engineering	
BAE 361	Analytical Methods in Engineering Design	
BAE 371	Fundamentals of Hydrology for Engineers	
BAE 481	Structures & Environment	
CE 225 or MAE 214	Mechanics of Solids or Solid Mechanics	

ST 370	Probability and Statistics for Engineers	3
BAE 401	Sensors and Controls	3
Advanced Biology Elective (p. 3)		3
	Hours	12

**Fourth Year****Fall Semester**

Select one of the following:		3
BAE 322	Introduction to Food Process Engineering	
BAE 361	Analytical Methods in Engineering Design	
BAE 371	Fundamentals of Hydrology for Engineers	
BAE 481	Structures & Environment	
BAE 451	Engineering Design I	2
Engineering Elective (p. 3)		3
Engineering Elective (p. 3)		3
Select one of the following:		3
IDS 201	Environmental Ethics	
STS 301	Science and Civilization	
STS 304	Ethical Dimensions of Progress	
	Hours	14

**Spring Semester**

BAE 452	Engineering Design II	2
Select one of the following:		3
BAE 425	Industrial Microbiology and Bioprocessing	
BAE 474	Principles and Applications of Ecological Engineering	
BAE 488	Postharvest Engineering	
BAE 525	Industrial Microbiology and Bioprocessing	
	Hours	5
	Total Hours	106

<sup>1</sup> A grade of C or higher is required.

<sup>2</sup> A grade of C- or higher is required.

**GEP Courses**

Code	Title	Hours	Counts towards
GEP Humanities ( <a href="http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-humanities/">http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-humanities/</a> )		6	
GEP Social Sciences ( <a href="http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-social-sciences/">http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-social-sciences/</a> )		3	
GEP Health and Exercise Studies ( <a href="http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-health-exercise-studies/">http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-health-exercise-studies/</a> )		2	
GEP Additional Breadth ( <a href="http://catalog.ncsu.edu/undergraduate/gep-category-requirements/">http://catalog.ncsu.edu/undergraduate/gep-category-requirements/</a> ) (Humanities/Social Sciences/Visual and Performing Arts)		3	

GEP Interdisciplinary Perspectives (<http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-interdisciplinary-perspectives/>)

GEP U.S. Diversity (<http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-us-diversity/>) (verify requirement)

GEP Global Knowledge (<http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-global-knowledge/>) (verify requirement)

Foreign Language Proficiency (<http://catalog.ncsu.edu/undergraduate/gep-category-requirements/foreign-language-proficiency/>) (verify requirement)

Total Hours 16

**Biological Science/Chemistry Electives**

Code	Title	Hours	Counts towards
AEC 360	Ecology	4	
BIO 361	Developmental Biology	3	
BIO 414	Cell Biology	3	
CH 201	Chemistry - A Quantitative Science	3	
CH 202	Quantitative Chemistry Laboratory	1	
CH 220	Introductory Organic Chemistry	3	
CH 221	Organic Chemistry I	3	
CH 222	Organic Chemistry I Lab	1	
FS 462	Postharvest Physiology	3	
FS 562	Postharvest Physiology	3	
GN 311	Principles of Genetics	4	
HS 462	Postharvest Physiology	3	
HS 562	Postharvest Physiology	3	
MB 351	General Microbiology	3	
PB 321	Introduction to Whole Plant Physiology	3	
PB 360	Ecology	4	
SSC 200	Soil Science	3	

SSC 332	Environmental Soil Microbiology	3
---------	------------------------------------	---

## Advanced Biology Elective

Code	Title	Hours	Counts towards
AEC 360	Ecology	4	
BIO 361	Developmental Biology	3	
BIO 414	Cell Biology	3	
FS 462	Postharvest Physiology	3	
FS 562	Postharvest Physiology	3	
GN 311	Principles of Genetics	4	
HS 462	Postharvest Physiology	3	
HS 562	Postharvest Physiology	3	
MB 351	General Microbiology	3	
PB 321	Introduction to Whole Plant Physiology	3	
PB 360	Ecology	4	
SSC 332	Environmental Soil Microbiology	3	

## Engineering Electives

Code	Title	Hours	Counts towards
BAE 322	Introduction to Food Process Engineering	3	
BAE 361	Analytical Methods in Engineering Design	3	
BAE 371	Fundamentals of Hydrology for Engineers	3	
BAE 425	Industrial Microbiology and Bioprocessing	3	
BAE 462	Machinery Design and Applications	3	
BAE 472	Irrigation and Drainage	3	
BAE 473	Introduction to Hydrologic and Water Quality Modeling	3	
BAE 474	Principles and Applications of Ecological Engineering	3	

BAE 481	Structures & Environment	3
BAE 525	Industrial Microbiology and Bioprocessing	3
BAE 528	Biomass to Renewable Energy Processes	3
BAE 572	Irrigation and Drainage	3
BAE 573	Introduction to Hydrologic and Water Quality Modeling	3
CHE 435	Process Systems Analysis and Control	3
ISE 311	Engineering Economic Analysis	3
SSC 473	Introduction to Hydrologic and Water Quality Modeling	3
SSC 573	Introduction to Hydrologic and Water Quality Modeling	3
TE 435	Process Systems Analysis and Control	3

## Semester Sequence

To see more about what you will learn in this program, visit the Learning Outcomes website (<https://apps.oirp.ncsu.edu/pgas/>)!

### First Year

Fall Semester		Hours
CH 101	Chemistry - A Molecular Science <sup>1</sup>	3
CH 102	General Chemistry Laboratory <sup>1</sup>	1
E 101	Introduction to Engineering & Problem Solving <sup>1</sup>	1
E 115	Introduction to Computing Environments	1
ENG 101	Academic Writing and Research <sup>1</sup>	4
MA 141	Calculus I <sup>1</sup>	4
GEP Health and Exercise Studies ( <a href="http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-health-exercise-studies/">http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-health-exercise-studies/</a> )		1
Hours		15

### Spring Semester

Select one of the following:		4
CH 201 & CH 202	Chemistry - A Quantitative Science and Quantitative Chemistry Laboratory	
CH 220 & CH 222	Introductory Organic Chemistry and Organic Chemistry I Lab	

CH 221 & CH 222	Organic Chemistry I and Organic Chemistry I Lab	
MA 241	Calculus II <sup>1</sup>	4
PY 205	Physics for Engineers and Scientists I <sup>1</sup>	3
PY 206	Physics for Engineers and Scientists I Laboratory <sup>1</sup>	1
Select one of the following:		3
EC 205	Fundamentals of Economics	
ARE 201	Introduction to Agricultural & Resource Economics	
EC 201	Principles of Microeconomics	
Hours		15

**Second Year****Fall Semester**

BAE 200	Computer Methods in Biological Engineering	2
MAE 206 or CE 214	Engineering Statics <sup>1</sup> or Engineering Mechanics-Statics	3
MA 242	Calculus III	4
PY 208	Physics for Engineers and Scientists II	3
PY 209	Physics for Engineers and Scientists II Laboratory	1
BIO 181 or BIO 183	Introductory Biology: Ecology, Evolution, and Biodiversity or Introductory Biology: Cellular and Molecular Biology	4
Hours		17

**Spring Semester**

Select one of the following:		4
BAE 202	Introduction to Biological and Agricultural Engineering Methods	
BAE 203 & BAE 204	Introduction to AutoCAD Civil 3D for Environmental & Ecological Engineers and Introduction to Environmental and Ecological Engineering	
MAE 208	Engineering Dynamics	3
MA 341	Applied Differential Equations I	3
MAE 201	Engineering Thermodynamics I	3
Biological Science/Chemistry Elective (p. 2)		3
Hours		16

**Third Year****Fall Semester**

BAE 302	Transport Phenomena	3
Select one of the following:		3
BAE 361	Analytical Methods in Engineering Design	
BAE 322	Introduction to Food Process Engineering	
BAE 371	Fundamentals of Hydrology for Engineers	
BAE 481	Structures & Environment	
MAE 308 or CE 282	Fluid Mechanics <sup>1</sup> or Hydraulics	3
ENG 331 or ENG 333	Communication for Engineering and Technology or Communication for Science and Research	3

BAE 305	Biological Engineering Circuits	4
Hours		16

**Spring Semester**

Select one of the following:		3
BAE 361	Analytical Methods in Engineering Design	
BAE 322	Introduction to Food Process Engineering	
BAE 371	Fundamentals of Hydrology for Engineers	
BAE 481	Structures & Environment	
MAE 214 or CE 225	Solid Mechanics <sup>1</sup> or Mechanics of Solids	3
ST 370	Probability and Statistics for Engineers	3
BAE 401	Sensors and Controls	3
Advanced Biology Elective (p. 3)		3
Hours		15

**Fourth Year****Fall Semester**

BAE 451	Engineering Design I	2
Engineering Electives (p. 3)		6
Select one of the following:		3
BAE 361	Analytical Methods in Engineering Design	
BAE 322	Introduction to Food Process Engineering	
BAE 371	Fundamentals of Hydrology for Engineers	
BAE 481	Structures & Environment	
Select one of the following:		3
IDS 201	Environmental Ethics	
STS 302	Contemporary Science, Technology and Human Values	
STS 304	Ethical Dimensions of Progress	
GEP Humanities ( <a href="http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-humanities/">http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-humanities/</a> )		3
Hours		17

**Spring Semester**

BAE 452	Engineering Design II	2
Select one of the following:		3
BAE 425	Industrial Microbiology and Bioprocessing	
BAE 474	Principles and Applications of Ecological Engineering	
BAE 488	Postharvest Engineering	
GEP Social Sciences ( <a href="http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-social-sciences/">http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-social-sciences/</a> )		3
GEP Interdisciplinary Perspectives ( <a href="http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-interdisciplinary-perspectives/">http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-interdisciplinary-perspectives/</a> )		2
GEP Additional Breadth ( <a href="http://catalog.ncsu.edu/undergraduate/gep-category-requirements/">http://catalog.ncsu.edu/undergraduate/gep-category-requirements/</a> )		3
GEP Humanities ( <a href="http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-humanities/">http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-humanities/</a> )		3
GEP Health and Exercise Studies ( <a href="http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-health-exercise-studies/">http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-health-exercise-studies/</a> )		1
Hours		17
Total Hours		128

<sup>1</sup> A grade of C- or higher is required.

## Career Opportunities

BE students learn to solve a wide variety of engineering problems and will have opportunities for specialization through selection of a specific concentration. Scientific and engineering principles are applied: to conserve and manage air, energy, soil and water resources; to manage, protect and restore natural ecosystems; to understand and utilize biological, chemical and physical processes for the production and conversion of biomass to bio energy; to analyze, understand and utilize mechanical properties of biological materials; to design and develop machinery systems for all phases of agricultural and food production; to design and evaluate structures and environmental control systems for housing animals, plant growth, and biological product storage; to develop improved systems for processing and marketing food and agricultural products; and to design sensor-based instrumentation and control systems for biological and agricultural applications.

Graduates of the BE curriculum receive a Bachelor's of Engineering in Biological Engineering, qualifying them for positions in design, development, and research in industry, government and public institutions. The curriculum also prepares students for post-graduate work leading to advanced degrees. Typical positions filled by recent BE graduates include: stream and wetlands restoration project manager; product design; development and testing engineer; plant engineering and management; engineering analysis and inspection for federal and state agencies; engineering consultant and research engineer. Entry-level salary ranges for BE graduates are similar to those of Civil, Industrial, and Mechanical Engineering graduates.

The BAET curriculum provides graduates opportunities in technical analysis, application and evaluation of agricultural production systems and environmental systems. The curriculum's flexibility enables students to specialize technologically in agriculture, the environment, or business management. Careers include technical jobs in production agriculture, environmental systems, agribusiness sales and service, and agricultural extension.