

# Biological Engineering (BS): Bioprocessing Engineering Concentration

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, chemistry, and agriculture. The Biological Engineering program is accredited by the Engineering Accreditation Commission of ABET, <https://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 by applying their engineering knowledge, critical-thinking skills, systematic approach to problem solving, and innovation to improve biological and agricultural systems;
- Work effectively both independently and as part of professional teams and demonstrate leadership potential in project management;
- Display professionalism, ethics, equity, and inclusivity in the practice of engineering to safeguard life, health, and public welfare;
- 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
<b>Hours</b>		<b>14</b>

### Spring Semester

BAE 100	Introduction to Biological and Agricultural Engineering and Technology	1
CH 221	Organic Chemistry I	3
CH 222	Organic Chemistry I Lab	1
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 16**

### 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
CH 223	Organic Chemistry II	3
CH 224	Organic Chemistry II Lab	1

**Hours 17**

#### Spring Semester

BAE 202	Introduction to Biological and Agricultural Engineering Methods	4
CE 215 or MAE 208	<sup>2</sup> or Engineering Dynamics	3
MA 341	Applied Differential Equations I	3
MAE 201	Engineering Thermodynamics I	3
BIO 183	Introductory Biology: Cellular and Molecular Biology	4

**Hours 17**

### Third Year

#### Fall Semester

BAE 302	Transport Phenomena	3
BAE 321	Bioprocessing Engineering Fundamentals	3
MB 351	General Microbiology	3
MB 352 or MB 354	General Microbiology Laboratory or Inquiry-Guided Microbiology Lab	1
CE 282 or MAE 308	Hydraulics or Fluid Mechanics	3
BAE 305	Biological Engineering Circuits	4

**Hours 17**

#### Spring Semester

BAE 401	Sensors and Controls	3
BAE 322	Introduction to Food Process Engineering	3
CE 225 or MAE 214	Mechanics of Solids or Solid Mechanics	3
ST 370	Probability and Statistics for Engineers	3

**Hours 12**

### Fourth Year

#### Fall Semester

BAE 451	Engineering Design I	2
Bioprocessing Engineering Elective (p. 2)		3

Select one of the following: 3

IDS 201	Environmental Ethics	
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STS 301	Science and Civilization	
STS 304	Ethical Dimensions of Progress	
ENG 331 or ENG 333	Communication for Engineering and Technology or Communication for Science and Research	3
<b>Hours</b>		<b>11</b>
<b>Spring Semester</b>		
BAE 425	Industrial Microbiology and Bioprocessing	3
BAE 452	Engineering Design II	2
Select one of the following:		3
BAE 361	Analytical Methods in Engineering Design	
BAE 371	Fundamentals of Hydrology for Engineers	
BAE 481	Structures & Environment	
<b>Hours</b>		<b>8</b>
<b>Total Hours</b>		<b>112</b>

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

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

Code	Title	Hours	Counts towards
<b>GEP Courses</b>			
	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 US Diversity, Equity, and Inclusion ( <a href="http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-usdei/">http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-usdei/</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 Global Knowledge ( <a href="http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-global-knowledge/">http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-global-knowledge/</a> ) (verify requirement)		
	Foreign Language Proficiency ( <a href="http://catalog.ncsu.edu/undergraduate/gep-category-requirements/foreign-language-proficiency/">http://catalog.ncsu.edu/undergraduate/gep-category-requirements/foreign-language-proficiency/</a> ) (verify requirement)		
<b>Total Hours</b>		<b>16</b>	

## Bioprocessing Engineering Elective

Code	Title	Hours	Counts towards
BAE 528	Biomass to Renewable Energy Processes	3	
BEC 436	Introduction to Downstream Process Development	2	
BEC 463	Fermentation of Recombinant Microorganisms	2	
BEC 485	cGMP Downstream Operations	2	
BEC 488	Animal Cell Culture Engineering	2	
BEC 536	Introduction to Downstream Process Development	2	
BEC 563	Fermentation of Recombinant Microorganisms	2	
BEC 585	cGMP Downstream Operations	2	
BIT 463	Fermentation of Recombinant Microorganisms	2	
BIT 563	Fermentation of Recombinant Microorganisms	2	
CHE 435	Process Systems Analysis and Control	3	
CHE 463	Fermentation of Recombinant Microorganisms	2	
CHE 488	Animal Cell Culture Engineering	2	
CHE 563	Fermentation of Recombinant Microorganisms	2	
ISE 311	Engineering Economic Analysis	3	
TE 435	Process Systems Analysis and Control	3	

## Semester Sequence

This is a sample.

**First Year**

<b>Fall Semester</b>		<b>Hours</b>
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 <sup>1</sup>	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

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**Hours** **15**

**Spring Semester**

BAE 100	Introduction to Biological and Agricultural Engineering and Technology	1
CH 221	Organic Chemistry I	3
CH 222	Organic Chemistry I Lab	1
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	1
Select one of the following:		3
EC 201	Principles of Microeconomics	
EC 205	Fundamentals of Economics	
ARE 201	Introduction to Agricultural & Resource Economics	

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**Hours** **16**

**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
CH 223	Organic Chemistry II	3
CH 224	Organic Chemistry II Lab	1

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**Hours** **17**

**Spring Semester**

BAE 202	Introduction to Biological and Agricultural Engineering Methods	4
MAE 208	Engineering Dynamics <sup>1</sup>	3
MA 341	Applied Differential Equations I	3
MAE 201	Engineering Thermodynamics I	3
BIO 183	Introductory Biology: Cellular and Molecular Biology	4

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**Hours** **17**

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

BAE 302	Transport Phenomena	3
BAE 321	Bioprocessing Engineering Fundamentals	3

MB 351	General Microbiology	3
MB 352 or MB 354	General Microbiology Laboratory or Inquiry-Guided Microbiology Lab	1
MAE 308 or CE 282	Fluid Mechanics <sup>1</sup> or Hydraulics	3
BAE 305	Biological Engineering Circuits	4

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**Hours** **17**

**Spring Semester**

BAE 401	Sensors and Controls	3
BAE 322	Introduction to Food Process Engineering	3
MAE 214 or CE 225	Solid Mechanics <sup>1</sup> or Mechanics of Solids	3
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
ST 370	Probability and Statistics for Engineers	3

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**Hours** **15**

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

BAE 451	Engineering Design I	2
Bioprocessing Engineering Elective (p. 2)		3
Select one of the following:		3
IDS 201	Environmental Ethics	
STS 301	Science and Civilization	
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
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
ENG 331 or ENG 333	Communication for Engineering and Technology or Communication for Science and Research	3

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**Hours** **15**

**Spring Semester**

BAE 425	Industrial Microbiology and Bioprocessing	3
BAE 452	Engineering Design II	2
BAE Elective (p. 1)		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 US Diversity, Equity, and Inclusion ( <a href="http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-usdei/">http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-usdei/</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

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**Hours** **16**

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**Total Hours** **128**

<sup>1</sup> Must be completed with a grade of C- or higher.

## 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.