

Biological Engineering (BS): Bioprocessing Engineering Concentration

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 ¹	3
CH 102	General Chemistry Laboratory ¹	1
E 101	Introduction to Engineering & Problem Solving ²	1
E 115	Introduction to Computing Environments	1
ENG 101	Academic Writing and Research ²	4
MA 141	Calculus I ¹	4
Hours		14

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 ¹	4
PY 205 & PY 206	Physics for Engineers and Scientists I and Physics for Engineers and Scientists I Laboratory ¹	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		Hours
BAE 200	Computer Methods in Biological Engineering	2
CE 214 or MAE 206	Engineering Mechanics-Statics ² 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	² or Engineering Dynamics	3
MA 341	Applied Differential Equations I	3
MAE 201	Thermal-Fluid Sciences	3
BIO 183	Introductory Biology: Cellular and Molecular Biology	4
Hours		17

Third Year

Fall Semester		Hours
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		Hours
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	

ENG 331 or ENG 333	Communication for Engineering and Technology or Communication for Science and Research	3
Hours		11
Spring Semester		
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	
Hours		8
Total Hours		112

¹ A grade of C or higher is required.

² A grade of C- or higher is required.

Code	Title	Hours	Counts towards
GEP Courses			
GEP Humanities (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-humanities/)		6	
GEP Social Sciences (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-social-sciences/)		3	
GEP Health and Exercise Studies (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-health-exercise-studies/)		2	
GEP US Diversity, Equity, and Inclusion (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-usdei/)		3	
GEP Interdisciplinary Perspectives (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-interdisciplinary-perspectives/)		2	
GEP Global Knowledge (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-global-knowledge/) (verify requirement)			
World Language Proficiency (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/world-language-proficiency/) (verify requirement)			
Total Hours		16	

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

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

Hours	15
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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 ¹	4
PY 205	Physics for Engineers and Scientists I ¹	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	

Hours	16
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Second Year
Fall Semester

BAE 200	Computer Methods in Biological Engineering	2
MAE 206 or CE 214	Engineering Statics ¹ 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

Hours	17
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Spring Semester

BAE 202	Introduction to Biological and Agricultural Engineering Methods	4
MAE 208	Engineering Dynamics ¹	3
MA 341	Applied Differential Equations I	3
MAE 201	Thermal-Fluid Sciences	3
BIO 183	Introductory Biology: Cellular and Molecular Biology	4

Hours	17
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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 ¹ or Hydraulics	3
BAE 305	Biological Engineering Circuits	4

Hours	17
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Spring Semester

BAE 401	Sensors and Controls	3
BAE 322	Introduction to Food Process Engineering	3
MAE 214 or CE 225	Solid Mechanics ¹ or Mechanics of Solids	3
GEP Social Sciences (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-social-sciences/)		3
ST 370	Probability and Statistics for Engineers	3

Hours	15
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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	

Hours	15
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GEP Humanities (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-humanities/)	3
GEP Health and Exercise Studies (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-health-exercise-studies/)	1

ENG 331 or ENG 333	Communication for Engineering and Technology or Communication for Science and Research	3
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Hours	15
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Spring Semester

BAE 425	Industrial Microbiology and Bioprocessing	3
BAE 452	Engineering Design II	2
BAE Elective (p. 1)		3
GEP Interdisciplinary Perspectives (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-interdisciplinary-perspectives/)		2
GEP US Diversity, Equity, and Inclusion (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-usdei/)		3
GEP Humanities (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-humanities/)		3

Hours	16
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Total Hours	128
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¹ 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.

Career Titles

- Stream and wetlands restoration project manager
- Product designer
- Development and testing engineer
- Plant engineering and management
- Engineering analyst and inspector for federal and state agencies
- Engineering consultant
- Research engineer

Learn More About Careers

NCcareers.org (<https://nccareers.org/>)

Explore North Carolina's central online resource for students, parents, educators, job seekers and career counselors looking for high quality job and career information.

Occupational Outlook Handbook (<https://www.bls.gov/ooh/>)

Browse the Occupational Outlook Handbook published by the Bureau of Labor Statistics to view state and area employment and wage statistics. You can also identify and compare similar occupations based on your interests.

Career One Stop Videos (<https://www.careeronestop.org/>)

View videos that provide career details and information on wages, employment trends, skills needed, and more for any occupation. Sponsored by the U.S. Department of Labor.

Focus 2 Career Assessment (<https://careers.dasa.ncsu.edu/explore-careers/career-assessments/>) (NC State student email address required)

This career, major and education planning system is available to current NC State students to learn about how your values, interests, competencies, and personality fit into the NC State majors and your future career. An NC State email address is required to create an account. Make an appointment with your career counselor (<https://careers.dasa.ncsu.edu/about/hours-appointments/>) to discuss the results.

American Society of Agricultural and Biological Engineers (<https://www.asabe.org/>)

Career Cornerstone Center-Engineering (<https://www.careercornerstone.org/eng/eng.htm>)

National Society of Professional Engineers (<https://www.nspe.org/>)