

# BIOLOGICAL SYSTEMS ENGINEERING

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For the undergraduate curriculum in biological systems engineering leading to the degree bachelor of science. The Biological Systems Engineering program is accredited by the Engineering Accreditation Commission of ABET, <http://www.abet.org/>.

Biological Systems Engineering integrates life sciences with engineering to solve problems related to, or using, biological systems. These biological systems may include microbes, plants, animals, humans and/or ecosystems. Biological systems engineers have a worldview shaped by an understanding of fundamental principles of engineering and life-sciences. They use their understanding of engineering to analyze organisms or ecosystems, and their knowledge of biological systems to inspire and inform their designs. They approach engineering design from a biological systems perspective, appreciating the complexity of biological systems and developing solutions that accommodate and anticipate the adaptability of biological systems.

**Goal:** To educate students to solve problems related to biorenewables production and processing, water quality, environmental impacts of the bioeconomy, food processing, and biosensors, and in so doing to prepare students for professional practice and post-graduate educational opportunities.

**Student Learning Outcomes:** Graduates of the Biological Systems Engineering curriculum should have, at the time of graduation:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions

7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

**Program Educational Objectives:** Three to five years after graduation, our graduates will be using the knowledge, skills, and abilities from their biological systems engineering degree to improve the human condition through successful careers in a wide variety of fields. They will be effective leaders, collaborators, and innovators who address environmental, social, technical, and business challenges. They will be engaged in life-long learning and professional development through self-study, continuing education, or graduate/professional school.

Well-qualified juniors and seniors in biological systems engineering who are interested in graduate study may apply for concurrent enrollment in the Graduate College to simultaneously pursue a bachelor of science degree in biological systems engineering and a master of science degree in agricultural engineering. Under concurrent enrollment, students are eligible for assistantships and simultaneously take undergraduate and graduate courses.

A concurrent bachelor of science and master of business administration program is also offered by the department.

The department also offers a bachelor of science curriculum in agricultural engineering. See College of Engineering (<http://catalog.iastate.edu/previouscatalogs/2023-2024/collegeofengineering/>). Additionally, the department offers bachelor of science curricula in agricultural systems technology and in industrial technology. See College of Agriculture and Life Sciences (<http://catalog.iastate.edu/previouscatalogs/2023-2024/collegeofagricultureandlifesciences/>).

The department also participates in interdepartmental majors in environmental science, sustainable agriculture, human computer interaction, and toxicology (see Index (<http://catalog.iastate.edu/previouscatalogs/2023-2024/azindex/>)).

## Curriculum in Biological Systems Engineering

Administered by the Department of Agricultural and Biosystems Engineering.

Leading to the degree bachelor of science.

**Total credits required:****127.0 cr Ecological Engineering Option****128.0 cr Food & Bioprocess Engineering Option****128.0 cr Open Option.**

Any transfer credit courses applied to the degree program require a grade of C or better (but will not be calculated into the ISU cumulative GPA, Basic Program GPA or Core GPA). See also Basic Program and Special Programs. International Perspectives: 3 cr.<sup>1</sup>

U.S. Diversity: 3 cr.<sup>1</sup>**Communication Proficiency/Library requirement:**

ENGL 150	Critical Thinking and Communication (Must have a C or better in this course)	3
ENGL 250	Written, Oral, Visual, and Electronic Composition (Must have a C or better in this course)	3
LIB 160	Introduction to College Level Research	1
Communication Elective: One of the following (Must have a C or better in this course)		3
AGEDS 311	Presentation and Sales Strategies for Agricultural Audiences	
ENGL 309	Proposal and Report Writing	
ENGL 314	Technical Communication	
MKT 450	Advanced Professional Selling	
SP CM 212	Fundamentals of Public Speaking	
SP CM 312	Business and Professional Speaking	

**Social Sciences and Humanities: 12 cr.**<sup>1,2</sup>

3 credits from international perspectives-university approved list	3
3 credits from U.S. diversity-university approved list	3
6 credits from Social Sciences and Humanities courses-department approved list	6

**Total Credits** 12**Basic Program: 24 cr.**

A minimum GPA of 2.00 required for this set of courses (please note that transfer course grades will not be calculated into the Basic Program GPA). See Requirement for Entry into Professional Program in College of Engineering Overview section. Within the Biological Systems Engineering Basic Program, students are required to complete CHEM 167 and CHEM 167L or the sequence of CHEM 177, CHEM 177L, and CHEM 178.

This is a departmental requirement within the College of Engineering Basic Program requirements. The CHEM 178 course will show as completing the chemistry portion of the Basic Program and the credits will be applied towards a student's classification.

A B E 160	Systematic Problem Solving and Computer Programming <sup>3</sup>	3
CHEM 167	General Chemistry for Engineering Students or CHEM 177 and CHEM 178	4
ENGL 150	Critical Thinking and Communication (Must have a C or better in this course)	3

ENGR 101	Engineering Orientation	R
LIB 160	Introduction to College Level Research	1
MATH 165	Calculus I	4
MATH 166	Calculus II	4
PHYS 231	Introduction to Classical Physics I	4
PHYS 231L	Introduction to Classical Physics I Laboratory	1
<b>Total Credits</b>		<b>24</b>

**Biological, Math and Physical Science: 23 cr.**

BIOL 212	Principles of Biology II	3
CHEM 167L	Laboratory in General Chemistry for Engineering or CHEM 177L Laboratory in General Chemistry I	1
Chemistry Sequence I (select from list of lecture with corresponding lab)		4
CHEM 231	Elementary Organic Chemistry	
CHEM 231L	Laboratory in Elementary Organic Chemistry	
CHEM 331	Organic Chemistry I	
CHEM 331L	Laboratory in Organic Chemistry I	
MATH 267	Elementary Differential Equations and Laplace Transforms	4
MICRO 302	Biology of Microorganisms	3
MICRO 302L	Microbiology Laboratory	1
STAT 305	Engineering Statistics (Chemistry Sequence I)	3
Chemistry Sequence II (select from list of lecture with corresponding lab)		4
CHEM 211	Quantitative and Environmental Analysis	
CHEM 211L	Quantitative and Environmental Analysis Laboratory	
CHEM 332	Organic Chemistry II	
CHEM 332L	Laboratory in Organic Chemistry II	
FS HN 311	Food Chemistry	
FS HN 311L	Food Chemistry Laboratory	
<b>Total Credits</b>		<b>23</b>

**Biological Systems Engineering Core: 42 cr.**

(A minimum GPA of 2.00 required for this set of courses, including any transfer courses; please note that transfer course grades will not be calculated into the Core GPA).

A B E 216	Fundamentals of Agricultural and Biosystems Engineering	3
A B E 218	Project Management & Design in Agricultural and Biosystems Engineering	2
A B E 273	CAD for Process Facilities and Land Use Planning	1
A B E 316	Applied Numerical Methods for Agricultural and Biosystems Engineering	3

A B E 363	Agri-Industrial Applications of Electric Power and Electronics	4
A B E 378	Mechanics of Fluids	3
A B E 380	Principles of Biological Systems Engineering	3
A B E 404	Instrumentation for Agricultural and Biosystems Engineering	3
A B E 415	Agricultural & Biosystems Engineering Design I	2
A B E 416	Agricultural & Biosystems Engineering Design II	2
A B E 480	Engineering Analysis of Biological Systems	3
C E 274	Engineering Statics	3
E M 324	Mechanics of Materials	3
E M 327	Mechanics of Materials Laboratory	1
or A B E 378L	Mechanics of Fluids Laboratory	
I E 305	Engineering Economic Analysis	3
M E 231	Engineering Thermodynamics I	3
<b>Total Credits</b>		<b>42</b>

**Other Remaining Courses: 11 cr.**

A B E 110	Experiencing Agricultural and Biosystems Engineering	1
A B E 170	Engineering Graphics and Introductory Design	3
A B E 201	Preparing for Workplace Seminar	1
ENGL 250	Written, Oral, Visual, and Electronic Composition (Must have a C or better in this course)	3
Communication Elective: One of the following (Must have a C or better in this course)		3
AGEDS 311	Presentation and Sales Strategies for Agricultural Audiences	
ENGL 309	Proposal and Report Writing	
ENGL 314	Technical Communication	
MKT 450	Advanced Professional Selling	
SP CM 212	Fundamentals of Public Speaking	
SP CM 312	Business and Professional Speaking	
<b>Total Credits</b>		<b>11</b>

Complete remaining courses from one of the following options:

**Ecological Engineering Option: 15 cr.**

A B E 431	Design and Evaluation of Soil and Water Conservation Systems	3
A B E 434X	Ecosystem Restoration Engineering	3
C E 372	Engineering Hydrology and Hydraulics	3
Ecological Elective <sup>2</sup>		6
<b>Total Credits</b>		<b>15</b>

**Food & Bioprocess Engineering Option: 16 cr.**

A B E 451	Food and Bioprocess Engineering	3
A B E 450X	Emerging Technologies in Biomanufacturing	3
A B E 469	Engineering for Grain Storage, Preservation, Handling, and Processing Systems	3
M E 436	Heat Transfer	4
Food Elective (select 3 cr from the following):		3
A B E 325	Biorenewable Systems	
FS HN 420	Food Microbiology	
FS HN 471	Food Processing	
SCM 301	Supply Chain Management	
<b>Total Credits</b>		<b>16</b>

**Open Option: 16 cr.**

A B E 451	Food and Bioprocess Engineering	3
M E 436	Heat Transfer	4
Sequence I, II & III Elective <sup>2</sup>		9
<b>Total Credits</b>		<b>16</b>

**Co-op/Internships (Optional)**

- These university requirements will add to the minimum credits of the program unless the university-approved courses are also approved by the department to meet other course requirements within the degree program.  
U.S. Diversity, International Perspectives and Social Science/ Humanities courses may not be taken Pass/Not Pass.
- Choose from department approved list. (<http://www.abe.iastate.edu/undergraduate-students/biological-systems-engineering/bse-curricula/>)
- See Basic Program for Professional Engineering Curricula for accepted substitutions for curriculum designated courses in the Basic Program.

**TRANSFER CREDIT REQUIREMENTS**

Students graduating with a degree in A E or BSE are required to have a minimum of 18 credits of 300-level and 400-level ABE courses taken at Iowa State University (excluding 490, 415, and 416), and must complete the two-semester ABE Capstone sequence (ABE 415 & 416) at Iowa State University. The Department of Agricultural & Biosystems Engineering requires a grade of C or better for any transfer credit course that is applied to the degree program.

See also: A 4-year plan of study grid showing course template by semester for Biological Systems Engineering. (<http://catalog.iastate.edu/previouscatalogs/2023-2024/collegeofengineering/biologicalsystemsengineering/#fouryearplanstext>)

Biological Systems Engineering, B.S. - ecological engr option

First Year			First Year		
Fall	Credits Spring	Credits	Fall	Credits Spring	Credits
ENGR 101	R A B E 110	1	ENGR 101	R A B E 110	1
A B E 170	3 A B E 160	3	A B E 170	3 A B E 160	3
CHEM 167	4 MATH 166	4	MATH 165	4 MATH 166	4
CHEM 167L	1 PHYS 231	4	CHEM 167	4 PHYS 231	4
MATH 165	4 PHYS 231L	1	CHEM 167L	1 PHYS 231L	1
ENGL 150	3 ENGL 250	3	ENGL 150	3 ENGL 250	3
LIB 160	1		LIB 160	1	
	<b>16</b>	<b>16</b>		<b>16</b>	<b>16</b>
Second Year			Second Year		
Fall	Credits Spring	Credits	Fall	Credits Spring	Credits
A B E 216	3 A B E 218	2	A B E 216	3 A B E 218	2
C E 274	3 A B E 201	1	C E 274	3 A B E 201	1
BIOL 212	3 A B E 273	1	BIOL 212	3 A B E 273	1
CHEM 231	3 M E 231	3	CHEM 231	3 MATH 267	4
CHEM 231L	1 MATH 267	4	CHEM 231L	1 MICRO 302	3
US Diversity Elective	3 CHEM 211	2	US Diversity Elective	3 MICRO 302L	1
	CHEM 211L	2		M E 231	3
	<b>16</b>	<b>15</b>		<b>16</b>	<b>15</b>
Third Year			Third Year		
Fall	Credits Spring	Credits	Fall	Credits Spring	Credits
A B E 316	3 A B E 363	4	A B E 316	3 A B E 363	4
A B E 378	3 A B E 380	3	A B E 378	3 A B E 380	3
MICRO 302	3 C E 372	3	STAT 305	3 A B E 469	3
MICRO 302L	1 E M 324	3	FS HN 311	3 E M 324	3
STAT 305	3 I E 305	3	FS HN 311L	1 I E 305	3
Communication Elective	3		Communication Elective	3	
	<b>16</b>	<b>16</b>		<b>16</b>	<b>16</b>
Fourth Year			Fourth Year		
Fall	Credits Spring	Credits	Fall	Credits Spring	Credits
A B E 415	2 A B E 416	2	A B E 415	2 A B E 416	2
A B E 404	3 A B E 434X	3	A B E 404	3 A B E 451	3
A B E 431	3 E M 327 or A B E 378L	1	A B E 480	3 E M 327 or A B E 378L	1
A B E 480	3 Ecological Elective	3	A B E 450X Emerging	3 M E 436	4
Social Science or Humanities Elective	3 Ecological Elective	3	Technologies in Biomanufacturing		
International Perspectives Elective	3 Social Science or Humanities Elective	3	Option Elective	3 Social Science or Humanities Elective	3
	<b>17</b>	<b>15</b>	International Perspectives Elective	3 Social Science or Humanities Elective	3
				<b>17</b>	<b>16</b>

Biological Systems Engineering, B.S. - Open Option

**First Year**

Fall	Credits	Spring	Credits
ENGR 101	1	R A B E 110	1
A B E 170	3	3 A B E 160	3
CHEM 167	4	MATH 166	4
CHEM 167L	4	1 PHYS 231	4
MATH 165	1	4 PHYS 231L	1
ENGL 150	3	3 ENGL 250	3
LIB 160	1		
		<b>16</b>	<b>16</b>

**Second Year**

Fall	Credits	Spring	Credits
A B E 216	2	3 A B E 218	2
C E 274	1	3 A B E 201	1
BIOL 212	1	3 A B E 273	1
CHEM 331	3	CHEM 332	3
CHEM 331L	1	CHEM 332L	1
US Diversity Elective	4	3 MATH 267	4
		M E 231	3
		<b>16</b>	<b>15</b>

**Third Year**

Fall	Credits	Spring	Credits
A B E 316	4	3 A B E 363	4
A B E 378	3	3 A B E 380	3
MICRO 302	3	3 E M 324	3
MICRO 302L	3	1 I E 305	3
STAT 305	3	3 Sequence I Elective	3
Communication Elective	3		
		<b>16</b>	<b>16</b>

**Fourth Year**

Fall	Credits	Spring	Credits
A B E 415	2	2 A B E 416	2
A B E 404	3	3 A B E 451	3
A B E 480	1	3 E M 327 or A B E 378L	1
Sequence II Elective	4	3 M E 436	4
International Perspectives Elective	3	3 Sequence III Elective	3
Social Science or Humanities Elective	3	3 Social Science or Humanities Elective	3
		<b>17</b>	<b>16</b>

The Department of Agricultural and Biosystems Engineering has concurrent Bachelor of Science /Master of Science (BS/MS) programs designed especially for departmental seniors who wish to pursue advanced studies. Concurrent BS/MS programs are: agricultural engineering (BS) with agricultural and biosystems engineering (MS) and biological systems engineering (BS) with agricultural and biosystems engineering (MS).

The concurrent BS/MS program allows seniors to:

- Become eligible for a research assistantship during their senior year
- Complete an MS degree (with thesis) within 18 months of BS graduation

For more information about our concurrent undergraduate and graduate programs in Agricultural & Biosystems Engineering, visit: <https://www.abe.iastate.edu/graduate-students/abe-concurrent-degrees/>.

## Graduate Study

The department offers master of science, master of engineering, and doctor of philosophy degrees with a major in agricultural and biosystems engineering. Within the agricultural and biosystems engineering major the student may specialize in advanced machinery engineering, animal production systems engineering, biological and process engineering, occupational safety engineering, or water and environmental stewardship engineering. Details on current research programs available at <http://www.abe.iastate.edu/>.

For the master of science program, at least 30 credits of acceptable graduate work must be completed with a minimum of 22 credits of course work; corresponding numbers for the master of engineering program are 32 and 27. For the doctor of philosophy degree, at least 72 credits of acceptable graduate work must be completed with a minimum of 42 credits of course work. All Ph.D. students must complete a teaching/extension experience prior to graduation.

The department also offers both master of science and doctor of philosophy degrees in industrial and agricultural technology.