Biological Systems Engineering

Undergraduate Study

For the undergraduate curriculum in biological systems engineering leading to the degree bachelor of science.

Curriculum Educational Goal, Objectives, and Learning Outcomes

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.

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.

Student Outcomes: At graduation, students will have developed and demonstrated:

(a) an ability to apply knowledge of mathematics, science, and engineering;
(b) an ability to design and conduct experiments, as well as to analyze and interpret data;
(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability;
(d) an ability to function on multidisciplinary teams;
(e) an ability to identify, formulate, and solve engineering problems;
(f) an understanding of professional and ethical responsibility;
(g) an ability to communicate effectively;
(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context;
(i) a recognition of the need for, and an ability to engage in life-long learning;
(j) a knowledge of contemporary issues;
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

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, Curricula. Additionally, the department offers bachelor of science curricula in agricultural systems technology and in industrial technology. See College of Agriculture and Life Sciences, Curricula.

The department also participates in interdepartmental majors in environmental science, sustainable agriculture, biorenewable resources and technology, human computer interaction, and toxicology (see Index).

Graduate Study

The department offers master of science, master of engineering, and doctor of philosophy degrees with a major in agricultural engineering. Within the agricultural 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.

Curriculum in Biological Systems Engineering

Administered by the Department of Agricultural and Biosystems Engineering.

Leading to the degree bachelor of science.

Total credits required: 128 cr. Any transfer credit courses applied to the degree program require a grade of C or better. See also Basic Program and Special Programs.

International Perspectives: 3 cr. [1]

U.S. Diversity: 3 cr. [1]

Communication Proficiency/Library requirement:

ENGL 150	Critical Thinking and Communication *	3
ENGL 250	Written, Oral, Visual, and Electronic Composition *	3
LIB 160	Information Literacy	1
One of the following (minimum grade of C)		3
AGEDS 311	Presentation and Sales Strategies for Agricultural Audiences	
ENGL 309	Report and Proposal Writing	
MKT 343	Personal Sales	
ENGL 314	Technical Communication	
or SP CM 212	Fundamentals of Public Speaking	

* with a minimum grade of C in each course

** See Basic Program for credits

Social Sciences and Humanities: 12 cr. [2]

3 credits from international perspectives	3
3 credits from U.S. diversity university-approved list	3
6 credits from Social Sciences and Humanities courses	6
Total Credits	12

Basic Program: 27 cr. [4]

Complete with 2.00 GPA including transfer courses:

CHEM 167	General Chemistry for Engineering Students	4
or CHEM 177 and CHEM 178		
ENGL 150	Critical Thinking and Communication *	3
ENGL 250	Written, Oral, Visual, and Electronic Composition *	3
ENGR 101	Engineering Orientation	R
ENGR 160	Engineering Problems with Computer Applications Laboratory [3]	3
LIB 160	Information Literacy	1
MATH 165	Calculus I	4
MATH 166	Calculus II	4
PHYS 221	Introduction to Classical Physics I	5
Total Credits		27

* see above for grade requirements

Biological, Math and Physical Science: 20 cr.

BIOL 212	Principles of Biology II	3
CHEM 167L	Laboratory in General Chemistry for Engineering	1
or CHEM 177L	Laboratory in General Chemistry I	
MATH 267	Elementary Differential Equations and Laplace Transforms	4
PHYS 222	Introduction to Classical Physics II	5
MICRO 302	Biology of Microorganisms	3
MICRO 302L	Microbiology Laboratory	1
STAT 305	Engineering Statistics	3
Total Credits		20

Biological Systems Engineering Core: 35 cr. [4]

A E 363	Agri-Industrial Applications of Electric Power and Electronics	4
A E 404	Instrumentation for Agricultural and Biosystems Engineering	3
BSE 216	Fundamentals of Agricultural and Biosystems Engineering	3
BSE 218	Project Management & Design in Agricultural and Biosystems Engineering	2
BSE 316	Applied Numerical Methods for Agricultural and Biosystems Engineering	3
BSE 380	Principles of Biological Systems Engineering	3
BSE 415	Agricultural Engineering Design I	2
BSE 416	Agricultural Engineering Design II	2
BSE 480	Engineering Analysis of Biological Systems	3
E M 274	Statics of Engineering	3
E M 324	Mechanics of Materials	3
E M 327	Mechanics of Materials Laboratory	1
M E 231	Engineering Thermodynamics I	3
Total Credits		35

Other Remaining Courses: 14 cr.

BSE 110	Experiencing Biological Systems Engineering	1
BSE 201	Preparing for Workplace Seminar	1
CH E 356	Transport Phenomena I	3
CH E 357	Transport Phenomena II	3
BSE 170	Engineering Graphics and Introductory Design	3
One of the following (minimum grade of C)		3
AGEDS 311	Presentation and Sales Strategies for Agricultural Audiences	
ENGL 309	Report and Proposal Writing	
ENGL 314	Technical Communication	
MKT 343	Personal Sales	
SP CM 212	Fundamentals of Public Speaking	
Total Credits		14

Complete remaining courses from one of the following options:

Biorenewable Resources Engineering Option: 20 cr.

A E 388	Sustainable Engineering and International Development	3
BSE 403	Modeling and Controls for Agricultural Systems	3
CHEM 331	Organic Chemistry I	3
CHEM 331L	Laboratory in Organic Chemistry I	1
CHEM 332	Organic Chemistry II	3
Option Electives		7
Total Credits		20

Bioenvironmental Engineering Option: 20 cr.

A E 431	Design and Evaluation of Soil and Water Conservation Systems	3
C E 326	Principles of Environmental Engineering	3
CHEM 211	Quantitative and Environmental Analysis	2
CHEM 211L	Quantitative and Environmental Analysis Laboratory	2
CHEM 231	Elementary Organic Chemistry	3
CHEM 231L	Laboratory in Elementary Organic Chemistry	1
One of the following		3
A E 436	Design and Evaluation of Soil and Water Monitoring Systems	
C E 421	Environmental Biotechnology	
C E 428	Water and Wastewater Treatment Plant Design	
ENSCI 381	Environmental Systems I: Introduction to Environmental Systems	
Option Elective		3
Total Credits		20

Food Engineering Option: 20 cr.

A E 451	Food and Bioprocess Engineering	3
BSE 469	Grain Processing and Handling	3
CHEM 231	Elementary Organic Chemistry	3
CHEM 231L	Laboratory in Elementary Organic Chemistry	1
FS HN 311	Food Chemistry	3
FS HN 311L	Food Chemistry Laboratory	1
FS HN 420	Food Microbiology	3
FS HN 471	Food Processing I	3
Total Credits		20

Preprofessional and Pre-Graduate Option: 20 cr.

CHEM 331	Organic Chemistry I	3
CHEM 331L	Laboratory in Organic Chemistry I	1
CHEM 332	Organic Chemistry II	3
CHEM 332L	Laboratory in Organic Chemistry II	1
BSE 403	Modeling and Controls for Agricultural Systems	3
Option Electives		9
Total Credits		20

Co-op/Internships (Optional)

1. 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 and international perspectives courses may not be taken Pass/Not Pass.
2. Choose from department approved list.
3. See Basic Program for Professional Engineering Curricula for accepted substitutions for curriculum designated courses in the Basic Program.
4. 2.00 GPA required including transfer courses.

See also: A 4-year plan of study grid showing course template by semester for a bioenvironmental engineering option in Biological Systems Engineering. (https://nextcatalog.registrar.iastate.edu/planofstudy/engineering/#biologicalsystemsengineeringbs-bioenvironmentalengroption)

See also: A 4-year plan of study grid showing course template by semester for a food engineering option in Biological Systems Engineering. (https://nextcatalog.registrar.iastate.edu/planofstudy/engineering/#biologicalsystemsengineeringbsfoodengineeringoption)

See also: A 4-year plan of study grid showing course template by semester for a pre-professional and pre-graduate option in Biological Systems Engineering. (https://nextcatalog.registrar.iastate.edu/planofstudy/engineering/#biologicalsystemsengineeringbs-pre-profpre-graduateoption)

See also: A 4-year plan of study grid showing course template by semester for a biorenewable resources engineering option in Biological Systems Engineering. (https://nextcatalog.registrar.iastate.edu/planofstudy/engineering/#biologicalsystemsengineeringbs-biorenewableresourcesengroption)

Courses primarily for undergraduates:

BSE 110. Experiencing Biological Systems Engineering.
(0-2) Cr. 1. S.
Laboratory-based, team-oriented experiences in a spectrum of topics common to the practice of biological systems engineering. Report writing, co-ops, internships, careers, registration planning.

BSE 170. Engineering Graphics and Introductory Design.
(Cross-listed with A E). (2-2) Cr. 3. F.S. *Prereq: Satisfactory scores in math placement assessments; credit or enrollment in MATH 142.*
Applications of multi-view drawings and dimensioning. Techniques for visualizing, analyzing, and communicating 3-D geometries. Application of the design process including written and oral reports.

BSE 201. Preparing for Workplace Seminar.
(Cross-listed with A E, TSM). (1-0) Cr. 1. F.S. *Prereq: Sophomore classification in A E, AST, BSE or ITec*
8 week course. Professionalism in the context of the engineering/technical workplace. Development and demonstration of key workplace competencies: teamwork, initiative, communication, and engineering/technical knowledge. Resumes, interviewing, preparation for internship experiences, professional portfolios.

BSE 216. Fundamentals of Agricultural and Biosystems Engineering.
(Cross-listed with A E). (2-2) Cr. 3. F. *Prereq: A E 110, ENGR 160, credit or enrollment in MATH 166*
Application of mathematics and engineering sciences to mass and energy balances in agricultural and biological systems. Emphasis is on solving engineering problems in the areas of heat and mass transfer, air and water vapor systems; animal production systems, grain systems; food systems, hydrologic systems, and bioprocessing.

BSE 218. Project Management & Design in Agricultural and Biosystems Engineering.
(Cross-listed with A E). (1-2) Cr. 2. S. *Prereq: A E 216*
Project management - critical path, Gantt charts, resource allocations, basic project budgeting, and project management software. Engineering design approaches. Open-ended design projects to demonstrate the preceding principles through application of technical concepts taught in prerequisite coursework.

BSE 298. Cooperative Education.
Cr. R. F.S.SS. *Prereq: Permission of department and Engineering Career Services*
First professional work period in the cooperative education program. Students must register for this course before commencing work. Offered on a satisfactory-fail basis only.

BSE 316. Applied Numerical Methods for Agricultural and Biosystems Engineering.
(Cross-listed with A E). (2-2) Cr. 3. F. *Prereq: ENGR 160, Math 266*
Computer aided solution of agricultural engineering problems by use of numerical techniques and mathematical models. Systems analysis and optimization applicable to agricultural and biological systems.

BSE 325. Biorenewable Systems.
(Cross-listed with A E, AGRON, AN S, TSM, BUSAD, ECON). (3-0) Cr. 3. F. *Prereq: ECON 101, CHEM 163 or higher, MATH 140 or higher*
Converting biorenewable resources into bioenergy and biobased products. Biorenewable concepts as they relate to drivers of change, feedstock production, processes, products, co-products, economics, and transportation/logistics.

BSE 380. Principles of Biological Systems Engineering.
(3-0) Cr. 3. S. *Prereq: BSE 216, CH E 357 or M E 436*
Unit-operation analysis of biological systems, through the study of mass, energy, and information transport in bioresource production and conversion systems. Quantification and modeling of biomass production, ecological interactions, and bioreactor operations.

BSE 388. Sustainable Engineering and International Development.
(Cross-listed with A E, E E, M E, MAT E, C E). (2-2) Cr. 3. F. *Prereq: Junior classification in engineering*
Multi-disciplinary approach to sustainable engineering and international development, sustainable development, appropriate design and engineering, feasibility analysis, international aid, business development, philosophy and politics of technology, and ethics in engineering. Engineering-based projects from problem formulation through implementation. Interactions with partner community organizations or international partners such as nongovernment organizations (NGOs). Course readings, final project/design report.
Meets International Perspectives Requirement.

BSE 396. Summer Internship.
Cr. R. Repeatable. SS. *Prereq: Permission of department and Engineering Career Services*
Summer professional work period. Offered on a satisfactory-fail basis only.

BSE 397. Engineering Internship.
Cr. R. Repeatable. F.S. *Prereq: Permission of department and Engineering Career Services*
One semester maximum per academic year professional work period. Offered on a satisfactory-fail basis only.

BSE 398. Cooperative Education.
Cr. R. F.S.SS. *Prereq: BSE 298, permission of department and Engineering Career Services*
Second professional work period in the cooperative education program. Students must register for this course before commencing work. Offered on a satisfactory-fail basis only.

BSE 403. Modeling and Controls for Agricultural Systems.
(Dual-listed with BSE 503). (Cross-listed with A E). (2-2) Cr. 3. Alt. S., offered 2013. *Prereq: A E 363, MATH 266*
Modeling dynamic systems with ordinary differential equations. Introduction to state variable methods of system analysis. Analysis of mechanical, electrical, and fluid power systems. Analytical and numerical solutions of differential equations. Introduction to classical control theory. Feedback and stability examined in the s domain. Frequency response as an analytical and experimental tool. MATLAB will be used throughout the course for modeling.

BSE 411. Bioprocessing and Bioproducts.
(Dual-listed with BSE 511). (Cross-listed with A E, BIOE, C E). (3-0) Cr. 3. F. *Prereq: A E 216, C E 326 or equivalent, MATH 160 or MATH 165, CHEM 167 or higher, BIOL 173 or BIOL 211 or higher, senior or graduate classification*
Sustainability, cleaner production. Taxonomy, kinetics, metabolism, microbial cultivation, aerobic and anaerobic fermentation. Antibiotics, food supplements, fermented foods, vitamin production. Biofuels, bioenergy and coproducts. Mass/energy balances, process integration, pretreatment, separation. Membrane reactors, bioelectrolysis, microbial fuel cells, nanotechnology, genetic engineering, mutagenesis.

BSE 415. Agricultural Engineering Design I.
(Cross-listed with A E). (1-2) Cr. 2. F.S. *Prereq: A E 271 or A E 272, E M 324*
Identification of current design problems in agricultural engineering. Development of alternate solutions using creativity and engineering analysis and synthesis techniques. Nonmajor graduate credit.

BSE 416. Agricultural Engineering Design II.
(Cross-listed with A E). (1-2) Cr. 2. F.S. *Prereq: A E 415*
Selection of promising solutions to design problems identified in 415 for development by design teams. Presentation of designs through oral and written reports and prototypes. Nonmajor graduate credit.

BSE 469. Grain Processing and Handling.
(Dual-listed with BSE 569). (Cross-listed with A E). (2-3) Cr. 3. S. *Prereq: A E 216*
Cereal grain and oilseed properties, quality measurement, processing, and end-use value. Design of drying systems using computer simulation. Corn wet and dry milling. Soybean oil extraction. Grain handling systems.

BSE 480. Engineering Analysis of Biological Systems.
(Cross-listed with ENSCI). (2-2) Cr. 3. F. *Prereq: BSE 216; MATH 266; BIOL 211 or BIOL 212; M E 231*
Systems-level engineering analysis of biological systems. Economic and life-cycle analysis of bioresource production and conversion systems. Global energy and resource issues and the role of biologically derived materials in addressing these issues. Nonmajor graduate credit.

BSE 490. Biological Systems Engineering Independent Study.
Cr. 1-4. Repeatable. F.S.SS.
Faculty-guided independent study in topics relevant to biological systems engineering.

BSE 490B. Biological Systems Engineering Independent Study: Biorenewable Resources.
Cr. 1-4. Repeatable. F.S.SS.

BSE 490E. Biological Systems Engineering Independent Study: Environmental Bioprocessing.
Cr. 1-4. Repeatable. F.S.SS.

BSE 490F. Biological Systems Engineering Independent Study: Food Engineering.
Cr. 1-4. Repeatable. F.S.SS.

BSE 490G. Biological Systems Engineering Independent Study: General Topics.
Cr. 1-4. Repeatable. F.S.SS.

BSE 490H. Biological Systems Engineering Independent Study: Honors.
Cr. 1-4. Repeatable. F.S.SS.

BSE 496. Agricultural and Biosystems Engineering Travel Course.
(Cross-listed with A E). Cr. 1-4. Repeatable. F.S.SS. *Prereq: Permission of instructor*
Limited enrollment. Tour and study of international agricultural and biosystems engineering as applied to biorenewable and food systems. Location and duration of tours will vary. Travel expenses paid by students. Course requires completion of options A, B, and C or option D.
Meets International Perspectives Requirement.

BSE 496A. Agricultural and Biosystems Engineering Travel Course: Pre-departure.
(Cross-listed with A E). Cr. 1-4. Repeatable. F.S.SS. *Prereq: Permission of instructor*
Limited enrollment. Tour and study of international agricultural and biosystems engineering as applied to biorenewable and food systems. Location and duration of tours will vary. Travel expenses paid by students. Course requires completion of options A, B, and C or option D.
Meets International Perspectives Requirement.

BSE 496B. Agricultural and Biosystems Engineering Travel Course: Travel (R credit).
(Cross-listed with A E). Cr. 1-4. Repeatable. F.S.SS. *Prereq: Permission of instructor*
Limited enrollment. Tour and study of international agricultural and biosystems engineering as applied to biorenewable and food systems. Location and duration of tours will vary. Travel expenses paid by students. Course requires completion of options A, B, and C or option D.

BSE 496C. Agricultural and Biosystems Engineering Travel Course: Post-travel.
(Cross-listed with A E). Cr. 1-4. Repeatable. F.S.SS. *Prereq: Permission of instructor*
Limited enrollment. Tour and study of international agricultural and biosystems engineering as applied to biorenewable and food systems. Location and duration of tours will vary. Travel expenses paid by students. Course requires completion of options A, B, and C or option D.
Meets International Perspectives Requirement.

BSE 496D. Agricultural and Biosystems Engineering Travel Course: Combination (A/B/C).
(Cross-listed with A E). Cr. 1-4. Repeatable. F.S.SS. *Prereq: Permission of instructor*
Limited enrollment. Tour and study of international agricultural and biosystems engineering as applied to biorenewable and food systems. Location and duration of tours will vary. Travel expenses paid by students. Course requires completion of options A, B, and C or option D.
Meets International Perspectives Requirement.

BSE 498. Biological Systems Engineering Cooperative Education.
Cr. R. Repeatable. F.S.SS. *Prereq: BSE 398, permission of department and Engineering Career Services*
Third and subsequent professional work periods in the cooperative education program. Students must register for this course before commencing work. Offered on a satisfactory-fail basis only.