

BIOLOGICAL SYSTEMS ENGINEERING

For the undergraduate curriculum in biological systems engineering leading to the degree bachelor of science. This curriculum is accredited under the General Criteria and Program Criteria for Biological Systems Engineering Programs by the Engineering Accreditation Commission of ABET, <http://www.abet.org/>.

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 (<http://catalog.iastate.edu/previouscatalogs/2016-2017/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/2016-2017/collegeofagricultureandlifesciences>).

The department also participates in interdepartmental majors in environmental science, sustainable agriculture, biorenewable resources and technology, human computer interaction, and toxicology (see Index (<http://catalog.iastate.edu/previouscatalogs/2016-2017/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: 128 cr. 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.¹

U.S. Diversity: 3 cr.¹

Communication Proficiency/Library requirement:
(Minimum GPA of 2.00 in this set of courses.)

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	Information Literacy	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	
MKT 343	Personal Sales	
ENGL 314	Technical Communication	
SP CM 212	Fundamentals of Public Speaking	

Social Sciences and Humanities: 12 cr.^{1,2}

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: 27 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 Basic Program GPA). See Requirement for Entry into Professional Program in College of Engineering Overview section.

A B E 160	Systematic Problem Solving and Computer Programming ³	3
CHEM 167	General Chemistry for Engineering Students or CHEM 177 and CHEM 178	4
ENGL 150	Critical Thinking and Communication	3
ENGL 250	Written, Oral, Visual, and Electronic Composition	3
ENGR 101	Engineering Orientation	R
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

Biological, Math and Physical Science: 20 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
MATH 267	Elementary Differential Equations and Laplace Transforms	4
MICRO 302	Biology of Microorganisms	3
MICRO 302L	Microbiology Laboratory	1
PHYS 222	Introduction to Classical Physics II	5
STAT 305	Engineering Statistics	3
Total Credits		20

Biological Systems Engineering Core: 35 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 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 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
E M 274	Engineering Statics	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: 8 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
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 343	Personal Sales	
SP CM 212	Fundamentals of Public Speaking	
Total Credits		8

Complete remaining courses from one of the following options:

Biorenewable Resources Engineering Option: 26 cr.

A B E 325	Biorenewable Systems	3
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
Heat/Mass Transport Sequence (E M 378/M E 436 OR CH E 356/CH E 357)		6
Technical Elective ²		3
Biorenewable Electives I & II ²		6
Total Credits		26

Bioenvironmental Engineering Option: 26 cr.

A B 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
E M 378	Mechanics of Fluids	3
C E 372	Engineering Hydrology and Hydraulics	3
Bioenvironmental Elective I ²		3
Bioenvironmental Elective II ²		3
Total Credits		26

Food Engineering Option: 26 cr.

A B E 451	Food and Bioprocess Engineering	3
A B E 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

Heat/Mass Transport Sequence (E M 378/M E 436 OR CH E 356/
CH E 357) 6

Total Credits 26

Preprofessional and Pre-Graduate Option: 26 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

Heat/Mass Transport Sequence (E M 378/M E 436 OR CH E 356/
CH E 357) 6

Technical Elective ² 3

Sequence I, II & III Electives ² 9

Total Credits 26

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, International Perspectives and Social Science/
Humanities courses may not be taken Pass/Not Pass.

2. Choose from department approved list. (<http://www.abe.iastate.edu/undergraduate-students/biological-systems-engineering/bse-curricula>)

3. See Basic Program for Professional Engineering Curricula for accepted substitutions for curriculum designated courses in the Basic Program.

See also: A 4-year plan of study grid showing course template by semester for Biological Systems Engineering. (<http://catalog.iastate.edu/previouscatalogs/2016-2017/collegeofengineering/biologicalsystemsenineering/#fouryearplanstext>)

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

First Year

Fall	Credits Spring	Credits
ENGR 101	0 A B E 110	1
A B E 170	3 A B E 160	3
MATH 165	4 MATH 166	4
CHEM 167	4 PHYS 221	5
CHEM 167L	1 ENGL 250	3
ENGL 150	3	
LIB 160	1	
16		16

Second Year

Fall	Credits Spring	Credits
A B E 216	3 A B E 218	2
E M 274	3 A B E 201	1
PHYS 222	5 E M 324	3
BIOL 212	3 MATH 267	4
SSH Elective	3 CHEM 211	2
	CHEM 211L	2
	M E 231	3
17		17

Third Year

Fall	Credits Spring	Credits
A B E 316	3 A B E 380	3
A B E 363	4 C E 372	3
E M 378	3 MICRO 302	3
E M 327	1 MICRO 302L	1
CHEM 231	3 STAT 305	3
CHEM 231L	1 SS/H Elective	3
15		16

Fourth Year

Fall	Credits Spring	Credits
A B E 415	2 A B E 416	2
A B E 404	3 C E 326	3
A B E 431	3 Bioenvironmental Elective II	3
A B E 480	3 US Diversity Elective	3
Bioenvironmental Elective I	3 International Perspective Elective	3
	Communication Elective	3
14		17

Total Credits: 128

Biological Systems Engineering, B.S. - biorenewable resources engr option

First Year

Fall	Credits Spring	Credits
ENGR 101	0 A B E 110	1
A B E 170	3 A B E 160	3
MATH 165	4 MATH 166	4
CHEM 167	4 PHYS 221	5
CHEM 167L	1 SS/H Elective	3
ENGL 150	3	
LIB 160	1	
16		16

Second Year

Fall	Credits Spring	Credits
A B E 216	3 A B E 218	2
E M 274	3 A B E 201	1
STAT 305	3 E M 324	3
PHYS 222	5 MATH 267	4
ENGL 250	3 BIOL 212	3
	M E 231	3
17		16

Third Year

Fall	Credits Spring	Credits
A B E 316	3 A B E 380	3
A B E 325	3 Heat Mass Transport Sequence I	3
A B E 363	4 MICRO 302	3
E M 327	1 MICRO 302L	1
CHEM 331	3 CHEM 332	3
CHEM 331L	1 CHEM 332L	1

		SS/H Elective	3
		15	17
Fourth Year			
Fall	Credits	Spring	Credits
A B E 415	2	A B E 416	2
A B E 404	3	Biorenewable Elective II	3
A B E 480	3	Technical Elective	3
Heat Mass Transport Sequence II	3	US Diversity	3
Biorenewable Elective I	3	International Perspective Elective	3
		Communication Elective	3
		14	17
Total Credits: 128			

Biological Systems Engineering, B.S. - Pre-prof. and pre-graduate Option

First Year			
Fall	Credits	Spring	Credits
ENGR 101	1	A B E 110	1
A B E 170	3	A B E 160	3
MATH 165	4	MATH 166	4
CHEM 167	5	PHYS 221	5
CHEM 167L	3	ENGL 250	3
ENGL 150	3		
LIB 160	1		
		16	16

Second Year

Fall	Credits	Spring	Credits
A B E 216	2	A B E 218	2
E M 274	1	A B E 201	1
STAT 305	3	E M 324	3
PHYS 222	4	MATH 267	4
BIOL 212	3	M E 231	3
		SSH Elective	3
		17	16

Third Year

Fall	Credits	Spring	Credits
A B E 316	3	A B E 380	3
A B E 363	3	Heat Mass Transport Sequence I	3
E M 327	3	CHEM 332	3
CHEM 331	1	CHEM 332L	1
CHEM 331L	3	Sequence Course I	3
SSH Elective	1	MICRO 302L	1
		MICRO 302	3
		15	17

Fourth Year

Fall	Credits	Spring	Credits
A B E 415	2	A B E 416	2
A B E 404	3	Sequence Course III	3
A B E 480	3	Technical Elective	3

Heat Mass Transport Sequence II	3	US Diversity Elective	3
Sequence Course II	3	International Perspective Elective	3
		Communication Elective	3
		14	17

Total Credits: 128

Biological Systems Engineering, B.S. Food Engineering Option

First Year

Fall	Credits	Spring	Credits
ENGR 101	1	A B E 110	1
A B E 170	3	A B E 160	3
MATH 165	4	MATH 166	4
CHEM 167	5	PHYS 221	5
CHEM 167L	3	ENGL 250	3
ENGL 150	3		
LIB 160	1		
		16	16

Second Year

Fall	Credits	Spring	Credits
A B E 216	2	A B E 218	2
E M 274	1	A B E 201	1
STAT 305	3	E M 324	3
PHYS 222	4	MATH 267	4
BIOL 212	3	CHEM 231	3
		CHEM 231L	1
		M E 231	3
		17	17

Third Year

Fall	Credits	Spring	Credits
A B E 316	3	A B E 380	3
A B E 363	3	Heat Mass Transport Sequence I	3
A B E 451	3	MICRO 302	3
E M 327	1	MICRO 302L	1
FS HN 311	3	SS/H Elective	3
FS HN 311L	3	SS/H Elective	3
		15	16

Fourth Year

Fall	Credits	Spring	Credits
A B E 415	2	A B E 416	2
A B E 404	3	A B E 469	3
A B E 480	3	Heat Mass Transport Sequence II	3
FS HN 420	3	Communication Elective	3
FS HN 471	3	International Perspective Elective	3
		US Diversity Elective	3
		14	17

Total Credits: 128

Biological Systems Engineering, B.S. - biorenewable resources engr option

First Year

Fall	Credits	Spring	Credits
ENGR 101	0	A B E 110	1
A B E 170	3	A B E 160	3
MATH 165	4	MATH 166	4
CHEM 167	4	PHYS 221	5
CHEM 167L	1	SS/H Elective	3
ENGL 150	3		
LIB 160	1		
		16	16

Second Year

Fall	Credits	Spring	Credits
A B E 216	3	A B E 218	2
E M 274	3	A B E 201	1
STAT 305	3	E M 324	3
PHYS 222	5	MATH 267	4
ENGL 250	3	BIOL 212	3
		M E 231	3
		17	16

Third Year

Fall	Credits	Spring	Credits
A B E 316	3	A B E 380	3
A B E 325	3	Heat Mass Transport Sequence I	3
A B E 363	4	MICRO 302	3
E M 327	1	MICRO 302L	1
CHEM 331	3	CHEM 332	3
CHEM 331L	1	CHEM 332L	1
		SS/H Elective	3
		15	17

Fourth Year

Fall	Credits	Spring	Credits
A B E 415	2	A B E 416	2
A B E 404	3	Biorenewable Elective II	3
A B E 480	3	Technical Elective	3
Heat Mass Transport Sequence II	3	US Diversity	3
Biorenewable Elective I	3	International Perspective Elective	3
		Communication Elective	3
		14	17

Total Credits: 128

Biological Systems Engineering, B.S. - Pre-prof. and pre-graduate Option

First Year

Fall	Credits	Spring	Credits
ENGR 101	0	A B E 110	1
A B E 170	3	A B E 160	3
MATH 165	4	MATH 166	4
CHEM 167	4	PHYS 221	5

CHEM 167L	1	ENGL 250	3
ENGL 150	3		
LIB 160	1		
		16	16

Second Year

Fall	Credits	Spring	Credits
A B E 216	3	A B E 218	2
E M 274	3	A B E 201	1
STAT 305	3	E M 324	3
PHYS 222	5	MATH 267	4
BIOL 212	3	M E 231	3
		SSH Elective	3
		17	16

Third Year

Fall	Credits	Spring	Credits
A B E 316	3	A B E 380	3
A B E 363	4	Heat Mass Transport Sequence I	3
E M 327	1	CHEM 332	3
CHEM 331	3	CHEM 332L	1
CHEM 331L	1	Sequence Course I	3
SSH Elective	3	MICRO 302L	1
		MICRO 302	3
		15	17

Fourth Year

Fall	Credits	Spring	Credits
A B E 415	2	A B E 416	2
A B E 404	3	Sequence Course III	3
A B E 480	3	Technical Elective	3
Heat Mass Transport Sequence II	3	US Diversity Elective	3
Sequence Course II	3	International Perspective Elective	3
		Communication Elective	3
		14	17

Total Credits: 128

Biological Systems Engineering, B.S. Food Engineering Option

First Year

Fall	Credits	Spring	Credits
ENGR 101	0	A B E 110	1
A B E 170	3	A B E 160	3
MATH 165	4	MATH 166	4
CHEM 167	4	PHYS 221	5
CHEM 167L	1	ENGL 250	3
ENGL 150	3		
LIB 160	1		
		16	16

Second Year

Fall	Credits	Spring	Credits
A B E 216	3	A B E 218	2
E M 274	3	A B E 201	1

STAT 305	3 E M 324	3
PHYS 222	5 MATH 267	4
BIOL 212	3 CHEM 231	3
	CHEM 231L	1
	M E 231	3
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	17	17

Third Year

Fall	Credits Spring	Credits
A B E 316	3 A B E 380	3
A B E 363	4 Heat Mass Transport Sequence I	3
A B E 451	3 MICRO 302	3
E M 327	1 MICRO 302L	1
FS HN 311	3 SS/H Elective	3
FS HN 311L	1 SS/H Elective	3
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	15	16

Fourth Year

Fall	Credits Spring	Credits
A B E 415	2 A B E 416	2
A B E 404	3 A B E 469	3
A B E 480	3 Heat Mass Transport Sequence II	3
FS HN 420	3 Communication Elective	3
FS HN 471	3 International Perspectivte Elective	3
	US Diversity Elective	3
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	14	17

Total Credits: 128

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.

Courses primarily for undergraduates:**A B E 110: Experiencing Agricultural and Biosystems Engineering** (0-2) Cr. 1. S.

Laboratory-based, team-oriented experiences in a spectrum of topics common to the practice of agricultural and biosystems engineering. Report writing, co-ops, internships, careers, registration planning.

A B E 160: Systematic Problem Solving and Computer Programming (2-2) Cr. 3. S.

Prereq: Credit or enrollment in MATH 143 or MATH 165

Engineering approach to problem solution and presentation in the context of real world problems. Introduction to basic principles from statics, projectile motion, conservation of mass and energy and electricity and magnetism. Use of spreadsheet programs and computer programming language(s) to solve and present engineering problems. Introduction to interfacing computers to sensor systems for data collection.

A B E 170: Engineering Graphics and Introductory Design (2-2) Cr. 3.

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.

A B E 201: Preparing for Workplace Seminar

(Cross-listed with TSM). (1-0) Cr. 1. F.S.

Prereq: Prereq: Sophomore classification in AE, AST, BSE, or I TEC

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; Cover Letters; Behavioral Based Interviewing; Industry Speakers; Preparation for internships experiences.

A B E 216: Fundamentals of Agricultural and Biosystems Engineering (2-2) Cr. 3. F.

Prereq: A B E 160 or permission of the instructor

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.

A B E 218: Project Management & Design in Agricultural and Biosystems Engineering

(1-2) Cr. 2. S.

Prereq: A B 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.

A B E 271: Engineering Applications of Parametric Solid Modeling (1-2) Cr. 1. F.S.

Prereq: A B E 170 or TSM 116 or equivalent

8 week-course. Creating, editing, and documenting part and assembly models using Solidworks.

A B E 272: Parametric Solid Models, Drawings, and Assemblies Using Pro/ENGINEER

(1-2) Cr. 1. F.S.

Prereq: A B E 170 or TSM 116 or equivalent

8 week-course. Applications of Creo Parametric software. Create solid models of parts and assemblies. Utilize the solid models to create design documentation (standard drawing views, dimensions, and notes) and for the geometric analysis of parts and assemblies.

A B E 273: CAD for Process Facilities and Land Use Planning

(1-2) Cr. 1.

Prereq: ENGR 170 or TSM 116 or equivalent. 8-week course.

8-week course. Application of 2-D AutoCAD software to create and interpret 2-D drawings and 3-D models of facilities. Topics include geometric construction, design documentation: (using views, dimension, notes), and AutoCAD specific features (i.e. Layers, Blocks, Standards, Styles).

A B E 298: Cooperative Education

Cr. R. F.S.SS.

Prereq: A B E 218 and permission from Engineering Career Services

First professional work period in the cooperative education program. Students must register for this course before commencing work.

A B E 316: Applied Numerical Methods for Agricultural and Biosystems Engineering

(2-2) Cr. 3. F.S.

Prereq: A B E 160, A B E 218; MATH 266 or MATH 267

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.

A B E 325: Biorenewable Systems

(Cross-listed with TSM). (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.

A B E 340: Functional Analysis and Design of Agricultural Field Machinery

(2-2) Cr. 3. F.

Prereq: A B E 110, A B E 216

Principles of operation, design, selection, testing and evaluation of agricultural field machinery and systems. Functional and mechanical performances. Crop and soil interaction with machines. Machine systems, including land preparation, crop establishment, crop protection, harvesting and post-harvest, materials handling systems.

A B E 342: Agricultural Tractor Power

(2-3) Cr. 3. S.

Prereq: Ch E 381 or M E 211

Thermodynamic principles and construction of tractor engines. Fuels, combustion, and lubrication. Kinematics and dynamics of tractor power applications; drawbar, power take-off and traction mechanisms.

A B E 363: Agri-Industrial Applications of Electric Power and Electronics

(3-2) Cr. 4. F.S.

Prereq: PHYS 222

Single phase and three phase circuit design. Electrical safety. Electric motors and controls. Programmable logic controllers. Digital logic, instrumentation and sensors.

A B E 380: Principles of Biological Systems Engineering

(2-2) Cr. 3. S.

Prereq: A B E 316

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.

A B E 388: Sustainable Engineering and International Development

(Cross-listed with C E, E 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.

A B E 396: Summer Internship

Cr. R. Repeatable. SS.

Prereq: Permission of department and Engineering Career Services

Summer professional work period.

A B E 397: Engineering Internship

Cr. R. Repeatable. F.S.

Prereq: A B E 218 and permission of department and Engineering Career Services

One semester maximum per academic year professional work period.

A B E 398: Cooperative Education

Cr. R. F.S.SS.

Prereq: A B E 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.

A B E 403: Modeling, Simulation, and Controls for Agricultural and Biological Systems

(Dual-listed with A B E 503). (2-2) Cr. 3. Alt. S., offered odd-numbered years.

Prereq: A B E 316, and A B E 363, and MATH 266 or MATH 267

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. Individual and/or group projects required for graduate credit.

A B E 404: Instrumentation for Agricultural and Biosystems Engineering

(Dual-listed with A B E 504). (2-2) Cr. 3. F.

Prereq: A B E 316 and A B E 363 or CPR E 281

Interfacing techniques for computer-based data acquisition and control systems. Basic interfacing components including A/D and D/A conversion, signal filtering, multiplexing, and process control. Sensors and theory of operation applied to practical monitoring and control problems. Individual and group projects required for graduate credit.

A B E 408: GIS and Natural Resources Management

(Dual-listed with A B E 508). (Cross-listed with ENSCI). (2-2) Cr. 3. F.

Prereq: Working knowledge of computers and Windows environment

Introduction to fundamental concepts and applications of GIS in natural resources management with specific focus on watersheds. Topics include: basic GIS technology, data structures, database management, spatial analysis, and modeling; visualization and display of natural resource data. Case studies in watershed and natural resource management using ArcView GIS.

A B E 410: Electronic Systems Integration for Agricultural Machinery & Production Systems

(Dual-listed with A B E 510). Cr. 3. Alt. S., offered odd-numbered years.

Prereq: A B E 363

System architecture and design of electronics used in agricultural machinery and production systems. Emphasis on information technology and systems integration for automated agriculture processes. Design of Controller Area Network (CAN BUS) communication systems and discussion of relevant standards (ISO 11783 and SAE J1939). Application of technologies for sensing, distribution control, and automation of agricultural machinery will be emphasized.

A B E 413: Fluid Power Engineering

(Cross-listed with M E). (2-2) Cr. 3. F.

Prereq: Credit or enrollment in E M 378 or M E 335, A B E 216 or M E 270

Properties of hydraulic fluids. Performance parameters of fixed and variable displacement pumps and motors. Hydraulic circuits and systems. Hydrostatic transmissions. Characteristics of control valves. Analysis and design of hydraulic systems for power and control functions.

A B E 415: Agricultural & Biosystems Engineering Design I

(1-2) Cr. 2. F.S.

Prereq: A B E 316 (majors only)

Identification of current design problems in ag & biosystems engineering. Development of alternate solutions using creativity and engineering analysis and synthesis techniques.

A B E 416: Agricultural & Biosystems Engineering Design II

(1-2) Cr. 2. F.S.

Prereq: A B E 415 (majors only)

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.

A B E 418: Fundamentals of Engineering Review

(1-0) Cr. 1.

Prereq: senior classification.

8 week course. Review of core concepts covered in the Fundamentals of Engineering examination with emphasis on statics, dynamics, fluid mechanics, heat transfer, electric circuits, and engineering economics. Open to all College of Engineering seniors, however focus is on the general exam, not discipline specific exams.

A B E 424: Air Pollution

(Dual-listed with A B E 524). (Cross-listed with C E, ENSCI). (1-0) Cr. 1.

Prereq: Either PHYS 221 or CHEM 178 and either MATH 166 or 3 credits in statistics. Senior classification or above

1 cr. per module. Module A prereq for all modules; module B prereq for D and E.

A B E 424A: Air Pollution: Air quality and effects of pollutants

(Dual-listed with A B E 524A). (Cross-listed with C E, ENSCI). (1-0) Cr. 1.

Prereq: Either PHYS 221 or CHEM 178 and either MATH 166 or 3 credits in statistics. Senior classification or above

1 cr. per module. Module A prereq for all modules; module B prereq for D and E.

A B E 424B: Air Pollution: Climate change and causes

(Dual-listed with A B E 524B). (Cross-listed with C E, ENSCI). (1-0) Cr. 1.

Prereq: Either PHYS 221 or CHEM 178 and either MATH 166 or 3 credits in statistics. Senior classification or above

1 cr. per module. Module A prereq for all modules; module B prereq for D and E.

A B E 424C: Air Pollution: Transportation Air Quality

(Dual-listed with A B E 524C). (Cross-listed with C E, ENSCI). (1-0) Cr. 1.

Prereq: C E 524A; PHYS 221 or CHEM 178; MATH 166 or 3 credits in statistics. Senior classification or above.

A B E 424D: Air Pollution: Off-gas treatment technology

(Dual-listed with A B E 524D). (Cross-listed with C E, ENSCI). (1-0) Cr. 1.

Prereq: Either PHYS 221 or CHEM 178 and either MATH 166 or 3 credits in statistics. Senior classification or above

1 cr. per module. Module A prereq for all modules; module B prereq for D and E.

A B E 424E: Air Pollution: Agricultural sources of pollution

(Dual-listed with A B E 524E). (Cross-listed with C E, ENSCI). (1-0) Cr. 1.

Prereq: Either PHYS 221 or CHEM 178 and either MATH 166 or 3 credits in statistics. Senior classification or above

1 cr. per module. Module A prereq for all modules; module B prereq for D and E.

A B E 431: Design and Evaluation of Soil and Water Conservation Systems

(Dual-listed with A B E 531). (Cross-listed with ENSCI). (2-2) Cr. 3. F.

Prereq: E M 378 or CH E 356

Hydrology and hydraulics in agricultural and urbanizing watersheds. Design and evaluation of systems for the conservation and quality preservation of soil and water resources. Use and analysis of hydrologic data in engineering design; relationship of topography, soils, crops, climate, and cultural practices in conservation and quality preservation of soil and water for agriculture. Small watershed hydrology, water movement and utilization in the soil-plant-atmosphere system, agricultural water management, best management practices, and agricultural water quality.

A B E 432: Nonpoint Source Pollution and Control

(Dual-listed with A B E 532). (3-0) Cr. 3.

Prereq: A B E 431 or C E 372 or instructor permission

Characteristics and courses of non-point source (NPS) pollution in agricultural and urban watersheds, computer modeling and NPS pollution for terrestrial and aquatic systems, strategies to control and manage NPS pollution of water bodies, total maximum daily loads (TMDLs) and integrated watershed management. Graduate students are required to review research papers and develop/deliver lecture models on assigned topics.

A B E 436: Design and Evaluation of Soil and Water Monitoring Systems

(Dual-listed with A B E 536). (2-3) Cr. 3. Alt. S., offered even-numbered years.

Prereq: A B E 431/A B E 531

Development of monitoring systems that support effective planning, performance evaluation, modeling, or environmental impact assessment of soil-, water-, and waste-management systems. Typical soil and water pollutants and physical, chemical, and biological characteristics that affect sample location and timing. Sample collection, documentation, chain-of-custody, and quality assurance procedures. In addition to other assignments, graduate students will prepare several research literature reviews on topics covered in the class and develop monitoring plans.

A B E 451: Food and Bioprocess Engineering

(Dual-listed with A B E 551). (3-0) Cr. 3. F.

Prereq: A B E 216 and M E 436 or C H E 357, or F S H N 351 and MATH 266 or MATH 267

Application of engineering principles and mathematical modeling to the quantitative analysis of food and bioprocessing systems. Physical/chemical characteristics of foods and biological systems, flow processes, thermal processes and separation processes. Term paper required for graduate credit.

A B E 466: Multidisciplinary Engineering Design

(Cross-listed with A E R E, B M E, C P R E, E E, E N G R, I E, M E, M A T E). (1-4) Cr. 3. Repeatable. F.S.

Prereq: Student must be within two semesters of graduation and permission of instructor.

Application of team design concepts to projects of a multidisciplinary nature. Concurrent treatment of design, manufacturing and life cycle considerations. Application of design tools such as CAD, CAM and FEM. Design methodologies, project scheduling, cost estimating, quality control, manufacturing processes. Development of a prototype and appropriate documentation in the form of written reports, oral presentations, computer models and engineering drawings.

A B E 469: Grain Processing and Handling

(Dual-listed with A B E 569). (2-3) Cr. 3. S.

Prereq: A B 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.

A B E 472: Design of Environmental Modification Systems for Animal Housing

(Dual-listed with A B E 572). (3-0) Cr. 3. Alt. S., offered even-numbered years.

Prereq: A B E 216, M E 231

Principles and design of animal environmental control systems. Insulation, heat and mass transfer, fans, ventilation, air distribution, heating and cooling equipment, and controls. Individual and group projects required for graduate credit.

A B E 475: Design in Animal Production Systems Engineering

(2-0) Cr. 2. F.S.

Prereq: A B E 271 or A B E 272, E M 324 and enrollment in APSE option of AE program.

Application of engineering fundamentals to the independent solution of an animal production systems engineering problem with well defined criteria and constraints in either environmental control, structural design, manure management, or air quality/mitigation.

A B E 478: Wood Frame Structural Design

(Dual-listed with A B E 578). (3-0) Cr. 3. Alt. S., offered odd-numbered years.

Prereq: A B E 216, E M 324

Design of light-framed wood structures using LRFD and ASD design procedures. Includes analysis of wind, snow, dead, and live loads. Applications include animal housing and machine storage. Fasteners, laminated posts, truss design and use of National Design Specifications.

A B E 480: Engineering Analysis of Biological Systems

(Cross-listed with ENSCI). (2-2) Cr. 3. F.

Prereq: A B E 380 or permission of the instructor

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.

A B E 490: A B E Independent Study

Cr. 1-5. Repeatable.

Independent Study.

A B E 490A: A B E Independent Study: Animal Production Systems Engineering

Cr. 1-5. Repeatable.

Independent Study.

A B E 490B: A B E Independent Study: Biorenewable Resources

Cr. 1-5. Repeatable. F.S.SS.

Independent study.

A B E 490E: A B E Independent Study: Environmental Bioprocessing Engineering

Cr. 1-5. Repeatable. F.S.SS.

Independent study in environmental bioprocessing engineering.

A B E 490F: A B E Independent Study: Food Engineering

Cr. 1-5. Repeatable. F.S.SS.

Independent study in food engineering.

A B E 490G: A B E Independent Study: General Topics in A B E

Cr. 1-5. Repeatable. F.S.SS.

Independent study in general A B E topics.

A B E 490H: A B E Independent Study: Honors

Cr. 1-5. Repeatable.

Guided instructing in agricultural and biosystems engineering for honors students.

A B E 490L: A B E Independent Study: Land & Water Resources Engineering

Cr. 1-5. Repeatable.

Guided instruction in land and water resources engineering.

A B E 490M: A B E Independent Study: Advanced Machinery Systems Engineering

Cr. 1-5. Repeatable.

Guided instruction in advance machinery systems engineering.

A B E 495: Agricultural and Biosystems Engineering Department Study Abroad Preparation or Follow-up

(Cross-listed with TSM). Cr. 1-2. Repeatable. F.S.SS.

Prereq: Permission of instructor

Preparation for, or follow-up of, study abroad experience (496). For preparation, course focuses on understanding the tour destination through readings, discussions, and research on topics such as the regional industries, climate, crops, culture, economics, food, geography, government, history, natural resources, and public policies. For follow-up, course focuses on presentations by students, report writing, and reflection. Students enrolled in this course intend to register for 496 the following term or have had taken 496 the previous term. Meets International Perspectives Requirement.

A B E 496: Agricultural and Biosystems Engineering Department Study Abroad

(Cross-listed with TSM). Cr. 1-4. Repeatable. F.S.SS.

Prereq: Permission of instructor

Tour and study at international sites relevant to disciplines of industrial technology, biological systems engineering, agricultural systems technology, and agricultural engineering. Location and duration of tours will vary. Trip expenses paid by students. Pre-trip preparation and/or post-trip reflection and reports arranged through 495.

Meets International Perspectives Requirement.

A B E 498: Cooperative Education

Cr. R. Repeatable. F.S.SS.

Prereq: A B E 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.

Courses primarily for graduate students, open to qualified undergraduates:**A B E 501: Fundamentals of Biorenewable Resources**

(3-0) Cr. 3. S.

Prereq: Undergraduate training in an engineering or physical or biological discipline or degrees in agriculture or economics

Introduction to the science and engineering of converting biorenewable resources into bioenergy and biobased products. Survey of biorenewable resource base and properties; description of biobased products; methods of biorenewable resource production; processing technologies for fuels, chemicals, materials, and energy; environmental impacts; economics of biobased products and bioenergy.

A B E 503: Modeling, Simulation, and Controls for Agricultural and Biological Systems

(Dual-listed with A B E 403). (2-2) Cr. 3. Alt. S., offered odd-numbered years.

Prereq: A B E 316, and A B E 363, and MATH 266 or MATH 267

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. Individual and/or group projects required for graduate credit.

A B E 504: Instrumentation for Agricultural and Biosystems Engineering

(Dual-listed with A B E 404). (2-2) Cr. 3. F.

Prereq: A B E 316 and A B E 363 or CPR E 281

Interfacing techniques for computer-based data acquisition and control systems. Basic interfacing components including A/D and D/A conversion, signal filtering, multiplexing, and process control. Sensors and theory of operation applied to practical monitoring and control problems. Individual and group projects required for graduate credit.

A B E 506: Applied Computational Intelligence

(2-2) Cr. 3. Alt. F., offered even-numbered years.

Prereq: A B E 316 or equivalent, MATH 166, STAT 305

Applications of biologically inspired computational intelligence tools for data mining, system modeling, and optimization for agricultural, biological and other engineered systems. Introduction to Artificial Neural Networks, Support Vector Machines, Fuzzy Logic, Genetic Algorithms, Bayesian and Decision Tree learning. Fundamental Machine Vision techniques will be introduced in the first part of course and be integrated into the lab exercises for learning different computational intelligence techniques. MATLAB will be used throughout the course for algorithm implementation.

A B E 508: GIS and Natural Resources Management

(Dual-listed with A B E 408). (Cross-listed with ENSCI). (2-2) Cr. 3. F.

Prereq: Working knowledge of computers and Windows environment

Introduction to fundamental concepts and applications of GIS in natural resources management with specific focus on watersheds. Topics include: basic GIS technology, data structures, database management, spatial analysis, and modeling; visualization and display of natural resource data. Case studies in watershed and natural resource management using ArcView GIS.

A B E 510: Electronic Systems Integration for Agricultural Machinery & Production Systems

(Dual-listed with A B E 410). Cr. 3. Alt. S., offered odd-numbered years.

Prereq: A B E 363

System architecture and design of electronics used in agricultural machinery and production systems. Emphasis on information technology and systems integration for automated agriculture processes. Design of Controller Area Network (CAN BUS) communication systems and discussion of relevant standards (ISO 11783 and SAE J1939). Application of technologies for sensing, distribution control, and automation of agricultural machinery will be emphasized.

A B E 515: Integrated Crop and Livestock Production Systems

(Cross-listed with AGRON, AN S, SUSAG). (3-0) Cr. 3. Alt. F., offered odd-numbered years.

Prereq: SUSAG 509

Methods to maintain productivity and minimize the negative ecological effects of agricultural systems by understanding nutrient cycles, managing manure and crop residue, and utilizing multispecies interactions. Crop and livestock production within landscapes and watersheds is also considered. Course includes a significant field component, with student teams analyzing Iowa farms.

A B E 524: Air Pollution

(Dual-listed with A B E 424). (Cross-listed with C E, ENSCI). (1-0) Cr. 1.

Prereq: Either PHYS 221 or CHEM 178 and either MATH 166 or 3 credits in statistics. Senior classification or above

1 cr. per module. Module A prereq for all modules; module B prereq for D and E.

A B E 524A: Air Pollution: Air quality and effects of pollutants

(Dual-listed with A B E 424A). (Cross-listed with C E, ENSCI). (1-0) Cr. 1.

Prereq: Either PHYS 221 or CHEM 178 and either MATH 166 or 3 credits in statistics. Senior classification or above

A B E 524B: Air Pollution: Climate change and causes

(Dual-listed with A B E 424B). (Cross-listed with C E, ENSCI). (1-0) Cr. 1.

Prereq: C E 524A; Either PHYS 221 or CHEM 178 and either MATH 166 or 3 credits in statistics. Senior classification or above

A B E 524C: Air Pollution: Transportation Air Quality

(Dual-listed with A B E 424C). (Cross-listed with C E, ENSCI). (1-0) Cr. 1.
Prereq: C E 524A; PHYS 221 or CHEM 178; MATH 166 or 3 credits in statistics. Senior classification or above.

A B E 524D: Air Pollution: Off-gas treatment technology

(Dual-listed with A B E 424D). (Cross-listed with C E, ENSCI). (1-0) Cr. 1.
Prereq: C E 524A, C E 524B; Either PHYS 221 or CHEM 178 and either MATH 166 or 3 credits in statistics. Senior classification or above

A B E 524E: Air Pollution: Agricultural sources of pollution

(Dual-listed with A B E 424E). (Cross-listed with C E, ENSCI). (1-0) Cr. 1.
Prereq: C E 524A, C E 524B; Either PHYS 221 or CHEM 178 and either MATH 166 or 3 credits in statistics. Senior classification or above

A B E 531: Design and Evaluation of Soil and Water Conservation Systems

(Dual-listed with A B E 431). (Cross-listed with ENSCI). (2-2) Cr. 3. F.
Prereq: E M 378 or CH E 356

Hydrology and hydraulics in agricultural and urbanizing watersheds. Design and evaluation of systems for the conservation and quality preservation of soil and water resources. Use and analysis of hydrologic data in engineering design; relationship of topography, soils, crops, climate, and cultural practices in conservation and quality preservation of soil and water for agriculture. Small watershed hydrology, water movement and utilization in the soil-plant-atmosphere system, agricultural water management, best management practices, and agricultural water quality.

A B E 532: Nonpoint Source Pollution and Control

(Dual-listed with A B E 432). (Cross-listed with ENSCI). (3-0) Cr. 3.
Prereq: A B E 431 or C E 372 or instructor permission

Characteristics and courses of non-point source (NPS) pollution in agricultural and urban watersheds, computer modeling and NPS pollution for terrestrial and aquatic systems, strategies to control and manage NPS pollution of water bodies, total maximum daily loads (TMDLs) and integrated watershed management. Graduate students are required to review research papers and develop/deliver lecture models on assigned topics.

A B E 533: Erosion and Sediment Transport

(Cross-listed with ENSCI, NREM). (2-3) Cr. 3. F.

Prereq: C E 372 or GEOL/ENSCI/MTEOR 402, MATH 266 or equivalent

Soil erosion processes, soil loss equations and their application to conservation planning, sediment properties, initiation of sediment motion and over land flow, flow in alluvial channels and theory of sediment transport, channel stability, reservoir sedimentation, wind erosion, BMPs for controlling erosion.

A B E 536: Design and Evaluation of Soil and Water Monitoring Systems

(Dual-listed with A B E 436). (Cross-listed with ENSCI). (2-3) Cr. 3. Alt. S., offered even-numbered years.

Prereq: A B E 431/A B E 531

Development of monitoring systems that support effective planning, performance evaluation, modeling, or environmental impact assessment of soil-, water-, and waste-management systems. Typical soil and water pollutants and physical, chemical, and biological characteristics that affect sample location and timing. Sample collection, documentation, chain-of-custody, and quality assurance procedures. In addition to other assignments, graduate students will prepare several research literature reviews on topics covered in the class and develop monitoring plans.

A B E 537: Total Maximum Daily Load (TMDL) Development and Implementation

(Cross-listed with ENSCI). (2-2) Cr. 3. Alt. F., offered odd-numbered years.

Prereq: CE 372 or equivalent

A project-based course to develop a water quality improvement plan. The legislative and judicial basis of the Total Maximum Daily Load (TMDL) program, different approaches for TMDL development, data needs and sources, SWAT modeling, and principles and techniques for implementation of water quality improvement plans.

A B E 551: Food and Bioprocess Engineering

(Dual-listed with A B E 451). (3-0) Cr. 3. F.

Prereq: A B E 216 and M E 436 or CH E 357, or FS HN 351 and MATH 266 or MATH 267

Application of engineering principles and mathematical modeling to the quantitative analysis of food and bioprocessing systems. Physical/chemical characteristics of foods and biological systems, flow processes, thermal processes and separation processes. Term paper required for graduate credit.

A B E 569: Grain Processing and Handling

(Dual-listed with A B E 469). (2-3) Cr. 3. S.

Prereq: A B E 216

Cereal grain and oilseed preservation, quality measurement, and end-use value. Design of drying systems using computer simulation. Corn wet and dry milling. Soybean oil extraction. Grain handling systems. Individual and group projects required for graduate credit.

A B E 572: Design of Environmental Modification Systems for Animal Housing

(Dual-listed with A B E 472). (3-0) Cr. 3. Alt. S., offered even-numbered years.

Prereq: A B E 216, M E 231

Principles and design of animal environmental control systems. Insulation, heat and mass transfer, fans, ventilation, air distribution, heating and cooling equipment, and controls. Individual and group projects required for graduate credit.

A B E 578: Wood Frame Structural Design

(Dual-listed with A B E 478). (3-0) Cr. 3. Alt. S., offered odd-numbered years.

Prereq: A B E 216, E M 324

Design of light-framed wood structures using LRFD and ASD design procedures. Includes analysis of wind, snow, dead, and live loads. Applications include animal housing and machine storage. Fasteners, laminated posts, truss design and use of National Design Specifications.

A B E 580: Engineering Analysis of Biological Systems

(2-2) Cr. 3. F.

Prereq: A B E 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. Students enrolled in ABE 580 will be required to answer additional exam questions and report on two journal articles.

A B E 590: Special Topics in Agricultural & Biosystems Engineering

Cr. 1-3. Repeatable.

Guided instruction and self-study on special topics relevant to agricultural and biosystems engineering.

A B E 598: Technical Communications for a Master's Degree

(Cross-listed with TSM). Cr. 1. F.S.SS.

A technical paper draft based on the M.S. thesis or creative component is required of all master's students. This paper must be in a form that satisfies the requirements of some specific journal and be ready for submission. A technical presentation based on M.S. thesis or creative component is required of all master's students. This presentation must be in a form that satisfies the normal presentation requirements of a professional society. The presentation itself (oral or poster) may be made at a professional society meeting or at any international, regional, state, or university conference/event as long as the presentation content and form conforms to normal expectations. Offered on a satisfactory-fail basis only.

A B E 599: Creative Component

Cr. arr. Repeatable.

Creative Component.

Courses for graduate students:**A B E 601: Graduate Seminar**

(Cross-listed with TSM). (1-0) Cr. 1. F.

Keys to starting a good MS thesis or PhD dissertation project. Learning how to formulate research problems. Discussion of broader impact, review of literature, identifying knowledge gaps and needs, long-term goals, research hypotheses, objectives, rationale and significance, and approaches for accomplishing research objectives. Preparation and communication of research proposal and project in different formats. Using peer review and responding to feedback.

A B E 610: Foundations of Sustainable Agriculture

(Cross-listed with AGRON, ANTHR, SOC, SUSAG). (3-0) Cr. 3. F.

Prereq: Graduate classification, permission of instructor

Historical, biophysical, socioeconomic, and ethical dimensions of agricultural sustainability. Strategies for evaluating existing and emerging agricultural systems in terms of the core concepts of sustainability and their theoretical contexts.

A B E 690: Advanced Topics

Cr. arr. Repeatable.

Advanced topics.

A B E 694: Teaching Practicum

(Cross-listed with TSM). Cr. 1-3. Repeatable. F.S.SS.

Prereq: Graduate classification and permission of instructor

Graduate student experience in the agricultural and biosystems engineering departmental teaching program.

A B E 697: Engineering Internship

Cr. R. Repeatable.

Prereq: Permission of department chair, graduate classification

One semester and one summer maximum per academic year professional work period.

A B E 698: Technical Communications for a Doctoral Degree

(Cross-listed with TSM). Cr. 1. F.S.SS.

A technical paper draft based on the dissertation is required of all Ph.D. students. This paper must be in a form that satisfies the requirements of some specific journal and be ready for submission. A technical presentation based on the dissertation is required of all Ph.D. students. This presentation must be in a form that satisfies the normal presentation requirements of a professional society. The presentation itself (oral or poster) may be made at a professional society meeting or at any international, regional, state, or university conference/event as long as the presentation content and form conforms to normal expectations. Offered on a satisfactory-fail basis only.

A B E 699: Research

Cr. arr. Repeatable.

Research.

A B E 699B: Research: Biosystems Engineering

Cr. arr. Repeatable.

Guided graduate research in biosystems engineering.

A B E 699C: Research: Computer Aided Design

Cr. arr. Repeatable.

Guided graduate research in computer-aided design.

A B E 699E: Research: Environmental Systems

Cr. arr. Repeatable.

Guided graduate research in environmental systems.

A B E 699F: Research: Food Engineering

Cr. arr. Repeatable.

Guided graduate research in food engineering.

A B E 699O: Research: Occupational Safety

Cr. arr. Repeatable.

Guided graduate research in occupational safety.

A B E 699P: Research: Power and Machinery Engineering

Cr. arr. Repeatable.

Guided graduate research in power and machinery engineering.

A B E 699Q: Research: Structures

Cr. arr. Repeatable.

Guided graduate research in structures.

A B E 699R: Research: Process Engineering

Cr. arr. Repeatable.

Guided graduate research in process engineering.

A B E 699S: Research: Environment and Natural Resources

Cr. arr. Repeatable.

Guided graduate research in environment and natural resources.

A B E 699U: Research: Waste Management

Cr. arr. Repeatable.

Guided graduate research in waste management.