Agricultural Engineering

Administered by the Department of Agricultural and Biosystems Engineering

Undergraduate Study

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

Curriculum Educational Goal, Objectives, and Learning Outcomes:

Goal: To educate students in the analysis and design of machinery, animal housing, and environmental systems for the production, processing, storage, handling, distribution, and use of food, feed, fiber and other biomaterials, and the management of related natural resources, by integrating basic physical and biological sciences with engineering design principles.

Program Educational Objectives: Three to five years after graduation, our graduates will be using the knowledge, skills, and abilities from their agricultural 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 these outcomes:

(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.

Graduates find employment in diverse ag- and bio-related industries and government agencies dealing with agricultural machines and buildings, animal and environmental control, grain processing and handling, soil and water resources, food, biorenewables, and biotechnology. Their work involves engineering design, development, testing, research, manufacturing, consulting, sales, and service. Students are highly encouraged to participate in either cooperative education or internship programs.

The department also offers a bachelor of science curriculum in biological systems technology and in industrial technology.

Well-qualified juniors and seniors in agricultural 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 agricultural engineering and a master of science degree in agricultural engineering. A concurrent bachelor of science and master of business administration program is also offered by the department. Refer to Graduate Study for more information.

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.

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

Curriculum in Agricultural 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:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>ENGL 150</td>
<td>Critical Thinking and Communication (minimum grade of C)</td>
<td>3</td>
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<tr>
<td>ENGL 250</td>
<td>Written, Oral, Visual, and Electronic Composition (minimum grade of C)</td>
<td>3</td>
</tr>
<tr>
<td>LIB 160</td>
<td>Information Literacy</td>
<td>1</td>
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<tr>
<td>AGED 311</td>
<td>Presentation and Sales Strategies for Agricultural Audiences</td>
<td>3</td>
</tr>
<tr>
<td>ENGL 309</td>
<td>Report and Proposal Writing</td>
<td></td>
</tr>
<tr>
<td>ENGL 314</td>
<td>Technical Communication</td>
<td></td>
</tr>
<tr>
<td>SP CM 212</td>
<td>Fundamentals of Public Speaking</td>
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<tr>
<td>MKT 343</td>
<td>Personal Sales</td>
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Social Sciences and Humanities: 12 cr. 2

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<tr>
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<tbody>
<tr>
<td>ENGL 150</td>
<td>Critical Thinking and Communication (minimum grade of C)</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 167</td>
<td>General Chemistry for Engineering Students</td>
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<tr>
<td>CHEM 177</td>
<td>General Chemistry I</td>
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<tr>
<td>ENGL 150</td>
<td>Critical Thinking and Communication *</td>
<td>3</td>
</tr>
<tr>
<td>ENGL 250</td>
<td>Written, Oral, Visual, and Electronic Composition *</td>
<td>3</td>
</tr>
<tr>
<td>ENGR 101</td>
<td>Engineering Orientation</td>
<td>R</td>
</tr>
<tr>
<td>ENGR 160</td>
<td>Engineering Problems with Computer Applications</td>
<td>3</td>
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<tr>
<td>LIB 160</td>
<td>Information Literacy</td>
<td>1</td>
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<tr>
<td>MATH 165</td>
<td>Calculus I</td>
<td>4</td>
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<tr>
<td>MATH 166</td>
<td>Calculus II</td>
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<tr>
<td>PHYS 221</td>
<td>Introduction to Classical Physics I</td>
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TotalCredits: 27

* see above for grade requirements
### Math and Physical Science: 12 cr.

<table>
<thead>
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<th>Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>CHEM 167L</td>
<td>Laboratory in General Chemistry for Engineering</td>
<td>1</td>
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<tr>
<td>or CHEM 177L</td>
<td>Laboratory in General Chemistry I</td>
<td></td>
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<tr>
<td>MATH 266</td>
<td>Elementary Differential Equations</td>
<td>3</td>
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<tr>
<td>PHYS 222</td>
<td>Introduction to Classical Physics II</td>
<td>5</td>
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<tr>
<td>STAT 305</td>
<td>Engineering Statistics</td>
<td>3</td>
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Total Credits: 12

### Ag Engineering Core: 29 cr.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>A E 216</td>
<td>Fundamentals of Agricultural and Biosystems Engineering</td>
<td>3</td>
</tr>
<tr>
<td>A E 218</td>
<td>Project Management &amp; Design in Agricultural and Biosystems Engineering</td>
<td>2</td>
</tr>
<tr>
<td>A E 316</td>
<td>Applied Numerical Methods for Agricultural and Biosystems Engineering</td>
<td>3</td>
</tr>
<tr>
<td>A E 363</td>
<td>Agri-Industrial Applications of Electric Power and Electronics</td>
<td>4</td>
</tr>
<tr>
<td>A E 404</td>
<td>Instrumentation for Agricultural and Biosystems Engineering</td>
<td>3</td>
</tr>
<tr>
<td>A E 415</td>
<td>Agricultural Engineering Design I</td>
<td>2</td>
</tr>
<tr>
<td>A E 416</td>
<td>Agricultural Engineering Design II</td>
<td>2</td>
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<tr>
<td>E M 274</td>
<td>Statics of Engineering</td>
<td>3</td>
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<tr>
<td>E M 324</td>
<td>Mechanics of Materials</td>
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<tr>
<td>E M 327</td>
<td>Mechanics of Materials Laboratory</td>
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<tr>
<td>M E 231</td>
<td>Engineering Thermodynamics I</td>
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Total Credits: 29

### Other Remaining Courses: 8 cr.

<table>
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<th>Credits</th>
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<tbody>
<tr>
<td>A E 110</td>
<td>Experiencing Agricultural and Biosystems Engineering</td>
<td>1</td>
</tr>
<tr>
<td>A E 170</td>
<td>Engineering Graphics and Introductory Design</td>
<td>3</td>
</tr>
<tr>
<td>A E 201</td>
<td>Preparing for Workplace Seminar</td>
<td>1</td>
</tr>
<tr>
<td>AGEDS 311</td>
<td>Presentation and Sales Strategies for Agricultural Audiences</td>
<td>3</td>
</tr>
<tr>
<td>ENGL 309</td>
<td>Report and Proposal Writing</td>
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<tr>
<td>SP CM 212</td>
<td>Fundamentals of Public Speaking</td>
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<tr>
<td>MKT 343</td>
<td>Personal Sales</td>
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</table>

Total Credits: 8

Elect remaining courses from one of the following options:

### Land and Water Resources Engineering Option: 40 cr.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>BIOL 211</td>
<td>Principles of Biology I</td>
<td>3</td>
</tr>
<tr>
<td>GEOL 201</td>
<td>Geology for Engineers and Environmental Scientists</td>
<td>3</td>
</tr>
<tr>
<td>E M 378</td>
<td>Mechanics of Fluids</td>
<td>3</td>
</tr>
<tr>
<td>MICRO 201</td>
<td>Introduction to Microbiology</td>
<td>2</td>
</tr>
<tr>
<td>MICRO 201L</td>
<td>Introductory Microbiology Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>AGRON 154</td>
<td>Fundamentals of Soil Science</td>
<td>3</td>
</tr>
<tr>
<td>C E 326</td>
<td>Principles of Environmental Engineering (ABE Breadth Elective or SSH)</td>
<td>3</td>
</tr>
<tr>
<td>A E 431</td>
<td>Design and Evaluation of Soil and Water Conservation Systems</td>
<td>3</td>
</tr>
<tr>
<td>A E 408</td>
<td>GIS and Natural Resources Management</td>
<td>3</td>
</tr>
<tr>
<td>C E 372</td>
<td>Engineering Hydrology and Hydraulics</td>
<td>3</td>
</tr>
<tr>
<td>A E 271 or A E 272</td>
<td>Engineering Applications of Parametric Solid Modeling</td>
<td>1</td>
</tr>
<tr>
<td>A E 430</td>
<td>Design and Evaluation of Soil and Water Monitoring Systems</td>
<td>3</td>
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<tr>
<td>A E 432</td>
<td>Nonpoint Source Pollution and Control</td>
<td>3</td>
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<tr>
<td>A E 537</td>
<td>Total Maximum Daily Load (TMDL) Development and Implementation</td>
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Total Credits: 30

### AE Structures Elective

<table>
<thead>
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<th>Course</th>
<th>Title</th>
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<tbody>
<tr>
<td>A E 472</td>
<td>Design of Environmental Modification Systems for Animal Housing</td>
<td>3</td>
</tr>
<tr>
<td>A E 478</td>
<td>Wood Frame Structural Design</td>
<td>3</td>
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</table>

### AE Water Quality Elective

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>A E 436</td>
<td>Design and Evaluation of Soil and Water Monitoring Systems</td>
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Total Credits: 40

### Power and Machinery Engineering Option: 40 cr.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>A E 271</td>
<td>Engineering Applications of Parametric Solid Modeling</td>
<td>1</td>
</tr>
<tr>
<td>A E 272</td>
<td>Parametric Solid Models, Drawings, and Assemblies Using Pro/ENGINEER</td>
<td>3</td>
</tr>
<tr>
<td>A E 340</td>
<td>Functional Analysis and Design of Agricultural Field Machinery</td>
<td>3</td>
</tr>
<tr>
<td>A E 413</td>
<td>Fluid Power Engineering</td>
<td>3</td>
</tr>
<tr>
<td>AGRON 154</td>
<td>Fundamentals of Soil Science</td>
<td>3</td>
</tr>
<tr>
<td>BIOL 211</td>
<td>Principles of Biology I</td>
<td>3</td>
</tr>
<tr>
<td>E M 345</td>
<td>Dynamics</td>
<td>3</td>
</tr>
<tr>
<td>E M 378</td>
<td>Mechanics of Fluids</td>
<td>3</td>
</tr>
<tr>
<td>M E 324</td>
<td>Manufacturing Engineering</td>
<td>3</td>
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<tr>
<td>M E 324L</td>
<td>Manufacturing Engineering Laboratory</td>
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<td>M E 325</td>
<td>Machine Design</td>
<td>3</td>
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<tr>
<td>MAT E 273</td>
<td>Principles of Materials Science and Engineering</td>
<td>3</td>
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Total Credits: 30

### One of the following

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>A E 431</td>
<td>Design and Evaluation of Soil and Water Conservation Systems</td>
<td>3</td>
</tr>
<tr>
<td>A E 469</td>
<td>Grain Processing and Handling</td>
<td>3</td>
</tr>
<tr>
<td>A E 472</td>
<td>Design of Environmental Modification Systems for Animal Housing</td>
<td>3</td>
</tr>
<tr>
<td>A E 478</td>
<td>Wood Frame Structural Design</td>
<td>3</td>
</tr>
<tr>
<td>BSE 480</td>
<td>Engineering Analysis of Biological Systems</td>
<td>5</td>
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</table>

Total Credits: 40

### Animal Production Systems Engineering Option: 40 cr.

<table>
<thead>
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</thead>
<tbody>
<tr>
<td>BIOL 211</td>
<td>Principles of Biology I</td>
<td>3</td>
</tr>
<tr>
<td>A E 271</td>
<td>Engineering Applications of Parametric Solid Modeling</td>
<td>1</td>
</tr>
<tr>
<td>A E 272</td>
<td>Parametric Solid Models, Drawings, and Assemblies Using Pro/ENGINEER</td>
<td>3</td>
</tr>
<tr>
<td>A E 472</td>
<td>Design of Environmental Modification Systems for Animal Housing</td>
<td>3</td>
</tr>
<tr>
<td>A E 469</td>
<td>Grain Processing and Handling</td>
<td>3</td>
</tr>
<tr>
<td>E M 378</td>
<td>Mechanics of Fluids</td>
<td>3</td>
</tr>
<tr>
<td>A E 424A</td>
<td>Air Pollution: Air quality and effects of pollutants</td>
<td>1</td>
</tr>
<tr>
<td>A E 424B</td>
<td>Air Pollution: Climate change and causes</td>
<td>1</td>
</tr>
<tr>
<td>A E 424E</td>
<td>Air Pollution: Agricultural sources of pollution</td>
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<tr>
<td>C E 332</td>
<td>Structural Analysis I</td>
<td>3</td>
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<tr>
<td>C E 333</td>
<td>Structural Steel Design I</td>
<td>3</td>
</tr>
<tr>
<td>C E 334</td>
<td>Reinforced Concrete Design I</td>
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</tr>
<tr>
<td>M E 436</td>
<td>Heat Transfer</td>
<td>4</td>
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<tr>
<td>A E 478</td>
<td>Wood Frame Structural Design</td>
<td>3</td>
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</tbody>
</table>

Total Credits: 40
Courses primarily for undergraduates:

A 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 E 170. Engineering Graphics and Introductory Design. (Cross-listed with BSE), (2-3) Cr. 3. F.S. Prereq: Sophomore classification in A E, AST, BSE or ITeC.

A E 216. Fundamentals of Agricultural and Biosystems Engineering. (Cross-listed with BSE), (2-2) Cr. 3. F. Prereq: A E 110, ENGR 160, credit or enrollment in MATH 169.
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 E 216. Project Management & Design in Agricultural and Biosystems Engineering. (Cross-listed with BSE), (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.

A E 271. Engineering Applications of Parametric Solid Modeling. (1-2) Cr. 1. F.S. Prereq: ENGR 170 or TSM 116 or equivalent.
8 week-course. Creating, editing, and documenting part and assembly models using Solidworks.

A E 272. Parametric Solid Models, Drawings, and Assemblies Using Pro/ENGINEER. (1-2) Cr. 1. F.S. Prereq: ENGR 170 or TSM 116 or equivalent.
8 week-course. Applications of Pro/ENGINEER software. Create solid models of parts and assemblies. Utilize the solid models to create design documentation: standard drawing views, dimensions, and notes.
A E 404. Instrumentation for Agricultural and Biosystems Engineering. (Dual-listed with A E 504). (2-2) Cr. 3. F. Prereq: A 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.

A E 408. GIS and Natural Resources Management. (Dual-listed with A 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 E 410. Electronic Systems Integration for Agricultural Machinery & Production Systems. (Dual-listed with A E 510). Cr. 3. S. Prereq: A E 363 or equivalent. 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 11873 and SAE J1939). Application of technologies for sensing, distribution control, and automation of agricultural machinery will be emphasized.

A E 411. Bioprocessing and Bioproduts. (Dual-listed with A E 511). (Cross-listed with C E, BIOE, BSE). (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 coproduts. Mass/energy balances, process integration, pretreatment, separation. Membrane reactors, bioelectrolysis, microbial fuel cells, nanotechnology, genetic engineering, mutagenesis.


A E 416. Agricultural Engineering Design II. (Cross-listed with BSE). (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.

A E 424. Air Pollution. (Dual-listed with A E 524). (Cross-listed with ENSCI, C E), (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 E 424A. Air Pollution: Air quality and effects of pollutants. (Dual-listed with A E 524A). (Cross-listed with ENSCI, C E), (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 E 424B. Air Pollution: Climate change and causes. (Dual-listed with A E 524B). (Cross-listed with ENSCI, C E), (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 E 424C. Air Pollution: Transportation constraints. (Dual-listed with A E 524C). (Cross-listed with ENSCI, C E), (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 E 424D. Air Pollution: Off gas treatment technology. (Dual-listed with A E 524D). (Cross-listed with ENSCI, C E), (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 E 424E. Air Pollution: Agricultural sources of pollution. (Dual-listed with A E 524E). (Cross-listed with ENSCI, C E), (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 E 432. Nonpoint Source Pollution and Control. (Dual-listed with A E 532). (3-0) Cr. 3. E M 378 or CH E 356 or M E 335 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 E 451. Food and Bioprocess Engineering. (Dual-listed with A E 551). (3-0) Cr. 3. F. Prereq: A 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.

A E 466. Multidisciplinary Engineering Design. (Cross-listed with AER E, CPR E, ENGR, E E, E I, E M, MAT E), (1-4) Cr. 3. Repeatable. F. S. Prereq: Student must be within two semesters of graduation and receive permission of the 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 E 469. Grain Processing and Handling. (Dual-listed with A E 569). (Cross-listed with BSE). (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.

A E 478. Wood Frame Structural Design.  
(Dual-listed with A E 578). (3-0) Cr. 3. Alt. S., offered 2013. Prereq: A E 216, E M 324. 

A E 490. Agricultural Engineering Independent Study. 
Cr. 1-4. Repeatable.

A E 490C. Agricultural Engineering Independent Study: Computer-aided Design. 
Cr. 1-4. Repeatable. 
Guided instruction in computer-aided design.

Cr. 1-4. Repeatable. 
Guided instruction in agricultural engineering topics for honors students.

Cr. 1-4. Repeatable. 
Guided instruction in occupational safety.

A E 490P. Agricultural Engineering Independent Study: Power and Machinery Engineering. 
Cr. 1-4. Repeatable. 
Guided instruction in power and machinery engineering.

A E 490Q. Agricultural Engineering Independent Study: Structures. 
Cr. 1-4. Repeatable. 
Guided instruction in structures.

Cr. 1-4. Repeatable.

A E 490S. Agricultural Engineering Independent Study: Environmental and Natural Resources Systems. 
Cr. 1-4. Repeatable. 
Guided instruction in environmental and natural resources systems.

Cr. 1-4. Repeatable.

A E 496. Agricultural and Biosystems Engineering Travel Course. 
(Cross-listed with BSE). 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.

A E 496A. Agricultural and Biosystems Engineering Travel Course: Pre-departure. 
(Cross-listed with BSE). 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.

A E 496B. Agricultural and Biosystems Engineering Travel Course: Travel (R credit). 
(Cross-listed with BSE). 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.

A E 496C. Agricultural and Biosystems Engineering Travel Course: Post-travel. 
(Cross-listed with BSE). 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.

A E 496D. Agricultural and Biosystems Engineering Travel Course: Combination (A/B/C). 
(Cross-listed with BSE). 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.

A E 498. Cooperative Education. 
Cr. R. Repeatable. F.S.SS. Prereq: A 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: 
(Cross-listed with BRT). (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 biofuels 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 E 503. Modeling and Controls for Agricultural Systems. 
(Dual-listed with A E 403), (Cross-listed with BSE), (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.

A E 504. Instrumentation for Agricultural and Biosystems Engineering. 
(Dual-listed with A E 404), (2-2) Cr. 3. F. Prereq: A 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.

A E 506. Applied Computational Intelligence. 
(2-2) Cr. 3. Alt. F., offered 2012. Prereq: A 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 E 508. GIS and Natural Resources Management. 
(Dual-listed with A 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. In addition to other assignments, graduate students will prepare research literature reviews on topics covered in class and develop enterprise applications.

(Dual-listed with A E 410), Cr. 3. S. Prereq: A E 363 or equivalent. 
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 E 511. Bioprocessing and Bioproducts.
(Dual-listed with A E 411). (Cross-listed with C E, BIOE, BSE). (3-0) Cr. 3.
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.

(Cross-listed with SUSAG, AGRON, AN S). (3-0) Cr. 3. Alt. F., offered 2011.
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 E 524. Air Pollution.
(Dual-listed with A E 424). (Cross-listed with ENSCI, C E). (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 E 524A. Air Pollution: Air quality and effects of pollutants.
(Dual-listed with A E 424A). (Cross-listed with ENSCI, C E). (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 E 524B. Air Pollution: Climate change and causes.
(Dual-listed with A E 424B). (Cross-listed with ENSCI, C E). (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 E 524C. Air Pollution: Transportation constraints.
(Dual-listed with A E 424C). (Cross-listed with ENSCI, C E). (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 E 524D. Air Pollution: Off-gas treatment technology.
(Dual-listed with A E 424D). (Cross-listed with ENSCI, C E). (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 E 524E. Air Pollution: Agricultural sources of pollution.
(Dual-listed with A E 424E). (Cross-listed with ENSCI, C E). (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.

(Dual-listed with A E 431). (2-3) 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. Graduate students will prepare several research literature reviews on topics covered in the class in addition to the other assignments.

A E 532. Nonpoint Source Pollution and Control.
(Dual-listed with A E 432). (3-0) Cr. 3. Prereq: E M 378 or CH E 356 or M E 335
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.

(Cross-listed with ENSCI). (3-0) Cr. 3. F., offered 2012.
Prereq: A E 422 or C E 372, MATH 266
Soil erosion processes, modified universal soil loss equation and its 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, reserves sedimentation, wind erosion, BMPs for controlling erosion.

(Dual-listed with A E 436). (3-0) Cr. 3. Alt. S., offered 2014.
Prereq: A E 431 or permission of the instructor
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.

(2-2) Cr. 3. Alt. F., offered 2011.
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 E 551. Food and Bioprocess Engineering.
(Dual-listed with A E 451). (3-0) Cr. 3. F. Prereq: A 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.

A E 556. Pretreatment of Biomass.
(1-2) Cr. 2. S. Prereq: A E 216 or equivalent
Review of lignocellulosic chemistry; chemical and physical impacts of pretreatment; impact of pretreatment on downstream processing; pretreatment economics. Lab experiments using current and novel pretreatment methods.

A E 569. Grain Processing and Handling.
(Dual-listed with A E 469). (Cross-listed with BSE). (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.

(Dual-listed with A E 472). (3-0) Cr. 3. Alt. S., offered 2012.
Prereq: A 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, energy use, control strategies.

A E 578. Wood Frame Structural Design.
(Dual-listed with A E 478). (3-0) Cr. 3. Alt. S., offered 2013.
Prereq: A E 216, E M 324

A E 580. Engineering Analysis of Biological Systems.
(3-0) Cr. 3. F. Prereq: A 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 AE 580 will be required to answer additional exam questions and report on two journal articles.

A 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 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 E 599. Creative Component.
Cr. arr. Repeatable.

Courses for graduate students:
A E 601. Graduate Seminar.
(Cross-listed with TSM). (1-0) Cr. 1. F.
Keys to writing a good MS thesis or PhD dissertation. How to begin formulating research problems. Discussion of research problems and broader impacts, review of literature, identifying knowledge gaps and needs, long-term goals, research hypotheses, objectives, rationale and significance, methods, procedures, data analysis, and reporting results. Presentation of research proposal in different formats. Using peer review and responding to feedback.

A E 610. Foundations of Sustainable Agriculture.
(Cross-listed with AGRON, SUSAG, ANTHR, SOC). (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 E 690. Advanced Topics.
Cr. arr. Repeatable.

A 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 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 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.

Cr. arr. Repeatable.

A E 699B. Research: Biosystems Engineering.
Cr. arr. Repeatable.
Guided graduate research in biosystems engineering.

Cr. arr. Repeatable.
Guided graduate research in computer-aided design.

Cr. arr. Repeatable.
Guided graduate research in environmental systems.

A E 699F. Research: Food Engineering.
Cr. arr. Repeatable.
Guided graduate research in food engineering.

Cr. arr. Repeatable.
Guided graduate research in occupational safety.