

AGRICULTURAL AND BIOSYSTEMS ENGINEERING (A B E)

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.

A B E 170: Engineering Graphics and Introductory Design

(2-2) Cr. 3.

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. F.S.

Prereq: ENGR 170 or TSM 116 or equivalent.

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 316: Applied Numerical Methods for Agricultural and Biosystems Engineering

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

Prereq: A B E 160; 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: 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 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 231

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: A B E 216

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

Professional work period of at least 10 weeks during the summer. Students must register for this course prior to commencing work. Offered on a satisfactory-fail basis only.

A B E 398: Cooperative Education

Cr. R. Repeatable. F.S.

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

Professional work period. One semester per academic or calendar year. Students must register for this course before commencing work. Offered on a satisfactory-fail basis only.

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

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 410: Electronic Systems Integration for Agricultural Machinery & Production Systems

(Dual-listed with A B E 510). Cr. 3. S.

Prereq: A B E 363 or E E 230 or E E 442 or E E 448

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: 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 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). (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 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

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

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 437: Watershed Modeling and Policy

(Dual-listed with A B E 537). (Cross-listed with ENSCI). (2-2) Cr. 3. Alt. F., offered odd-numbered years.

Prereq: CE 372 or equivalent

A project-based course on watershed-scale models for improving water quality. Legislative and judicial basis of the Total Maximum Daily Load (TMDL) program; approaches to TMDL development; principles and techniques for implementation; stakeholder engagement strategies. Hands-on experiences with GIS-interfaced models, data sources, calibration/validation, statistical assessment of model results, and simulation using multiple tools. In addition to other assignments, graduate students will present case studies of TMDLs using different modeling tools.

A B E 451: Food and Bioprocess Engineering

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

Prereq: A B E 216 and credit or enrollment in 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 466: Multidisciplinary Engineering Design

(Cross-listed with AER E, B M E, CPR E, E E, ENGR, I E, M E, MAT E). (1-4) Cr. 3. Repeatable. F.S.

Prereq: Student must be within two semesters of graduation; 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 and computer models and engineering drawings.

A B E 469: Grain Processing and Handling

(Dual-listed with A B E 569). (Cross-listed with BSE). (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, A B E 272, or A B E 273; 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: M E 231, 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

(Dual-listed with A B E 580). (Cross-listed with ENSCI). (2-2) Cr. 3. F.

Prereq: A B E 380 or permission of the instructor

Systems-level quantitative analysis of biological systems, including applications in foods, feeds, biofuels, bioenergy, and other biological systems. Introduction to economic analysis and life-cycle assessment of these systems at multiple production scales. Applying these tools to evaluate and improve cost and sustainability performance of these biological systems. Students enrolled in ABE 580 will be required to answer additional exam questions and report on two journal articles.

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.

Courses primarily for graduate students, open to qualified undergraduates:**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

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 510: Electronic Systems Integration for Agricultural Machinery & Production Systems

(Dual-listed with A B E 410). Cr. 3. S.

Prereq: A B E 363 or E E 230 or E E 442 or E E 448

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 511: Bioprocessing and Bioproducts

(3-0) Cr. 3. F.

Prereq: A B E 216 or equivalent, MATH 160 or MATH 165, one of CHEM 167 or higher, BIOL 173 or BIOL 211 or higher or BRT 501, senior or graduate classification

Sustainability, cleaner production. Taxonomy, kinetics, metabolism, aerobic and anaerobic fermentation. Biofuels, bioenergy and coproducts. Mass/energy balances, process integration, pretreatment, separation. Membrane reactors, bioelectrolysis, microbial fuel cells, nanotechnology, genetic engineering, mutagenesis. Term paper for graduate level only.

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

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

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: 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 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: 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 531: Design and Evaluation of Soil and Water Conservation Systems

(Dual-listed with A B E 431). (Cross-listed with ENSCI). (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 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

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 166 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

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: Watershed Modeling and Policy

(Dual-listed with A B E 437). (Cross-listed with ENSCI). (2-2) Cr. 3. Alt. F., offered odd-numbered years.

Prereq: C E 372 or equivalent

A project-based course on watershed-scale models for improving water quality. Legislative and judicial basis of the Total Maximum Daily Load (TMDL) program; approaches to TMDL development; principles and techniques for implementation; stakeholder engagement strategies. Hands-on experiences with GIS-interfaced models, data sources, calibration/validation, statistical assessment of model results, and simulation using multiple tools. In addition to other assignments, graduate students will present case studies of TMDLs using different modeling tools.

A B E 551: Food and Bioprocess Engineering

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

Prereq: A B E 216 and credit or enrollment in 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 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: M E 231, 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

(Dual-listed with A B E 480). (2-2) Cr. 3. F.

Prereq: A B E 380 or permission of the instructor

Systems-level quantitative analysis of biological systems, including applications in foods, feeds, biofuels, bioenergy, and other biological systems. Introduction to economic analysis and life-cycle assessment of these systems at multiple production scales. Applying these tools to evaluate and improve cost and sustainability performance of these biological systems. 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.

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 begin formulating research questions. Review of literature, research hypotheses, objectives, methods, making figures and tables, and discussing results. Discussion of appropriate outlets including peer-reviewed journals, patents and intellectual property rights, responsible conduct, plagiarism, authorship, and reproducible research. Using peer review, conducting a peer review, and responding to feedback. Other topics may include on-campus library resources, data management, and time management.

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.

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.