

AGRICULTURAL AND BIOSYSTEMS ENGINEERING (A B E)

Any experimental courses offered by A B E can be found at:

registrar.iastate.edu/faculty-staff/courses/explistsings/ (<http://www.registrar.iastate.edu/faculty-staff/courses/explistsings/>)

Courses primarily for undergraduates:

A B E 102: Learning Communities

Cr. 0.5. F.

8 week learning communities course focusing on student success, engineering, and department curriculum. Building community within the ABE Department. Offered on a satisfactory-fail basis only.

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

Introduction to principles of dynamics, statics, and mass and energy conservation. Introduction to algorithmic thinking; use of spreadsheet programs and computer programming language(s) to solve engineering problems. Only one of ENGR 160, A B E 160, AER E 160, C E 160, CH E 160, CPR E 185, EE 185, IE 148, M E 160 and S E 185 may count towards graduation.

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 in agricultural and biosystems engineering. Emphasis is on solving engineering problems.

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

(1-2) Cr. 2. S.

Prereq: A B E 216

Engineering design process with emphasis on criteria and constraints, ideation, and analysis. Fundamental principles of project management including project management software. Open-ended project(s) to apply core principles using concepts from prerequisite courses.

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 Creo Parametric

(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 of Soil, Crop, and Machine Systems

(2-2) Cr. 3. F.

Prereq: A B E 216

Principles of machine systems operation (tillage, crop establishment, harvesting and crop protection). Principles of soil and crop interactions with machine systems. Experimental and simulation techniques for testing and evaluation of agricultural field machinery for equipment performance, functional analysis and crop production management.

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 378: Mechanics of Fluids

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

Prereq: C E 274

Properties of fluids. Fluid statics. Kinematics and kinetics of fluid flow. Mass, momentum, and energy conservation laws; dimensional analysis; flow in pipes and channels. Selected laboratory experiments.

A B E 380: Principles of Biological Systems Engineering

(2-2) Cr. 3. S.

Prereq: A B E 316

Engineering analysis of biological systems, through the study of mass, energy, and information transport. Quantification and modeling of biological interactions, biological activities and bioreactor operations. Includes laboratory experiences on biological materials characterization, unit operation for bioprocesses and fermentation for producing bioproducts.

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 and simulation of dynamic systems with modern software tools including Matlab Simulink and Modelica. Introduction to state variable methods of system analysis. Analysis of several engineering systems. Introduction to classical control theory. Term project 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

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

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, distributed 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

Fundamental fluid power principles, symbols and schematics. Hydraulic fluid properties. Function and performance of components such as connections and fittings, filtration, pumps, valves, actuators, hydrostatic transmissions. Hydraulic system dynamics. Modeling and simulation of circuits. Analysis and design of hydraulic systems. Hydrostatic transmission design. Hands-on construction of circuits, measurement of system variables, and electrohydraulic control.

A B E 415: Agricultural & Biosystems Engineering Design I

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

Prereq: A B E 316 (majors only)

Engineering design process with emphasis on team delivery of: clearly defined deliverables; criteria and constraints; wide-field ideation; discipline-appropriate analysis methods; identification and application of relevant standards.

A B E 416: Agricultural & Biosystems Engineering Design II

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

Prereq: A B E 415

Final execution of the engineering design process with emphasis on team delivery of: oral and written communication in completion of the client-agreed deliverables.

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 mechanisms of non-point source (NPS) pollution in agricultural and urban watersheds, modeling of NPS pollution for terrestrial and aquatic systems, statistical tools to assess environmental datasets, strategies to control and manage NPS pollution of water bodies, and integrated watershed management. Graduate students are required to develop/deliver lecture models on assigned topics and/or complete additional assignments.

A B E 437: Watershed Modeling and Policy

(Dual-listed with A B E 537). (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 transport phenomena in food and bioprocesses. Physical/chemical characteristics of foods and biological materials and systems, flow processes, thermal processes, cooling/freezing processes, dehydration processes and separation processes.

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: Engineering for Grain Storage, Preservation, Handling, and Processing Systems

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

Prereq: A B E 216

Cereal grain and oilseed production, properties, and quality assessment. Design of storage systems, drying systems, material handling, and size reduction systems. Design of cereal grain processing systems, including dry milling, wet milling, flour milling, feed milling, and fermentation facilities.

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: 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 various biological systems, including applications in foods, feeds, biofuels, bioenergy, and other bio-based systems. Introduction to techno-economic analysis and life-cycle assessment of these systems at multiple production scales. Applying these tools to evaluate and improve cost and sustainability performance. Students enrolled in ABE 580 will be required to conduct additional learning activities.

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 and simulation of dynamic systems with modern software tools including Matlab Simulink and Modelica. Introduction to state variable methods of system analysis. Analysis of several engineering systems. Introduction to classical control theory. Term project 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

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

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, distributed 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 mechanisms of non-point source (NPS) pollution in agricultural and urban watersheds, modeling of NPS pollution for terrestrial and aquatic systems, statistical tools to assess environmental datasets, strategies to control and manage NPS pollution of water bodies, and integrated watershed management. Graduate students are required to develop/deliver lecture models on assigned topics and/or complete additional assignments.

A B E 533: Erosion and Sediment Transport

(Cross-listed with ENSCI, NREM). (2-3) Cr. 3. Alt. F., offered even-numbered years.
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 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: 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 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 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 transport phenomena in food and bioprocesses. Physical/chemical characteristics of foods and biological materials and systems, flow processes, thermal processes, cooling/freezing processes, dehydration processes and separation processes.

A B E 556: GIS Programming and Automation

(Dual-listed with A B E 556). (Cross-listed with C R P). (3-0) Cr. 3. F.
Prereq: C R P 351 or equivalent or permission of instructor
 Introduction to automated geoprocessing in Geographic Information Systems using Python. Focus on learning scripting language and object-oriented programming, automation of custom-designed geoprocessing scripts, and application toward student research and/or interests.

A B E 569: Engineering for Grain Storage, Preservation, Handling, and Processing Systems

(Dual-listed with A B E 469). (2-3) Cr. 3. S.
Prereq: A B E 216
 Cereal grain and oilseed production, properties, and quality assessment. Design of storage systems, drying systems, material handling, and size reduction systems. Design of cereal grain processing systems, including dry milling, wet milling, flour milling, feed milling, and fermentation facilities.

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: 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 various biological systems, including applications in foods, feeds, biofuels, bioenergy, and other bio-based systems. Introduction to techno-economic analysis and life-cycle assessment of these systems at multiple production scales. Applying these tools to evaluate and improve cost and sustainability performance. Students enrolled in ABE 580 will be required to conduct additional learning activities.

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.

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

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

Keys to starting a successful graduate research project. Effective literature review, formulating research questions, and setting goals. Practicing effectively communicating research and science. Effective strategies for scholarly writing, professional development, responding to feedback, peer-reviewing, successful publishing in journals, and curating scholarly output.

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. 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 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.