AGRICULTURAL AND BIOLOGICAL ENGINEERING

ABE 5009 Control Methods in SmartAg Systems 3 Credits
Grading Scheme: Letter Grade
Design, analysis, simulation and programming modern control methods for applications in production agriculture, biological and food engineering, land and water resources. Students will learn theoretical concepts, application programming, and simulation techniques using classical and modern control approaches, fuzzy logic, neural networks and other intelligent learning algorithms.
Prerequisite: Elementary Differential Equations or equivalent, Physics with Calculus, Dynamics or equivalent; fluent in general programming language such as C, C++, or Visual Basic, and MATLAB; Engineering graduate student.

ABE 5038 Recent Developments and Applications in Biosensors 3 Credits
Grading Scheme: Letter Grade
Introduction to biosensors, design and performance analysis. Fundamental application of biosensor theory will be demonstrated, including recognition, transduction, signal acquisition, and post processing/data analysis.
Prerequisite: At least senior status in engineering and background in biology including biomolecules.

ABE 5152 Fluid Power Circuits and Control 3 Credits
Grading Scheme: Letter Grade
Engineering analysis, design, and experimentation of electro-hydraulic circuits and systems. Design of hydraulic circuits, fluid power system components, hydraulic actuator analysis, servo and proportional valve performance, and electro-hydraulic control theory and applications.
Prerequisite: EML 3100, EGM 3400, 3520

ABE 5310 Advanced Controlled Environment Agriculture Systems Design 3 Credits
Grading Scheme: Letter Grade
Targets engineering design of controlled environment agriculture systems, including glazing materials selection, fan sizing, lighting distribution, cooling, and heating systems design.
Prerequisite: MAC 1147 and any three-credit university-level course in physics.

ABE 5442 Advanced Agricultural Process Engineering 3 Credits
Grading Scheme: Letter Grade
Engineering principles, processes, and techniques for using biological agents for production of chemicals, food, biofuels, and pharmaceuticals, and waste treatment.

ABE 5643C Biological Systems Modeling 3 Credits
Grading Scheme: Letter Grade
Introduction to concepts and methods of process-based modeling of biological systems; physiological, populational, and agricultural applications.

ABE 5646 Biological and Agricultural Systems Simulation 3 Credits
Grading Scheme: Letter Grade
Basic concepts of systems analysis, modeling, and computer simulation of dynamic biological and agricultural systems. Methods for working with models, including sensitivity analysis, parameter estimation, and model evaluation. Applications of models in agricultural and biological systems.
Prerequisite: MAC 2312, STA 3032 or STA 4322.

ABE 5648 Modeling Coupled Natural-Human Systems 3 Credits
Grading Scheme: Letter Grade
Approaches to modeling coupled natural-human systems are explored, drawing from both natural and social sciences. Topics include regime shift from dynamical systems and basic concepts from game theory and social-ecological system literature. These are combined in models that operationalize a conceptual framework. Students develop models—with guidance—for final projects.
Prerequisite: basic calculus and college-level probability courses.

ABE 5653 Rheology and Mechanics of Agricultural and Biological Materials 3 Credits
Grading Scheme: Letter Grade
Relation of biophysical and biochemical structure to rheological and mechanical behavior of biological materials in solid, liquid, and granular form; methods for measuring material properties governing these behaviors.
Prerequisite: MAC 2313, PHY 2048, CHM 2045, or consent of instructor.

ABE 5663 Advanced Applied Microbial Biotechnology 3 Credits
Grading Scheme: Letter Grade
Principles of microbial biotechnology, emphasizing the application of microorganisms for industrial processes (e.g., energy, environmental, food, pharmaceutical, and chemical).
Prerequisite: general biology and organic chemistry, or consent of instructor.

ABE 5707C Agricultural Waste Management 3 Credits
Grading Scheme: Letter Grade
Engineering analysis and design of systems for the collection, storage, treatment, transport, and utilization of livestock and other agricultural organic wastes and wastewaters. Field trips to operating systems and laboratory evaluation of materials and processes.
Prerequisite: 4 or higher classification.

ABE 5805 Advanced Life Cycle Assessment in Water-Energy-Food Systems 3 Credits
Grading Scheme: Letter Grade
Introduction and application of life cycle assessment (LCA) to evaluate the environmental impacts of various products, processes, or services related to the water-energy-food nexus. Additional topics include planetary boundaries, systems thinking, circular economy, mass and energy balances, life-cycle costing, social LCA and sensitivity and uncertainty analysis. This is an interdisciplinary course open to students from any major.
Prerequisite: Knowledge of Calculus.

ABE 5815C Food and Bioprocess Engineering Design 4 Credits
Grading Scheme: Letter Grade
Engineering design of unit process operations employed in agro/food, pharmaceutical, and biological industries including sterilization/pasteurization, radiation, freezing, drying, evaporation, fermentation, distillation.

ABE 5936 Writing Grant Proposals for Scholarships and Fellowships 2 Credits
Grading Scheme: Letter Grade
Provides incoming graduate students in the ABE Department an introduction to acquire scholarships, fellowships, internships, and graduate assistantships from federal funding agencies. Students will be introduced to funding sources and opportunities, provided guidelines for proposal writing, and prepare a mock proposal for instructor and peer review.
Prerequisite: ENC3246 or equivalent technical writing course, and graduate status in the Agricultural and Biological Engineering Department.

ABE 6005 Applied Control for Automation and Robots 3 Credits
Grading Scheme: Letter Grade
Introduction to industrial controls, programmable logic controllers, and manipulator application programming in agricultural and biological engineering. Kinematics, dynamics, and control strategies for serial link manipulators in agricultural applications.
Prerequisite: EML 5311 .

ABE 6017 Stochastic Modeling in Ecology and Hydrology 3 Credits
Grading Scheme: Letter Grade
Stochastic modeling is introduced through a problem-based approach. Selected papers are studied in depth; derivation of their main results unpacked. Examples include stochastic models of biodiversity, soil moisture, and rainfall. Students pick stochastic models to study for final projects. Students enjoy deeper understanding from unpacking these otherwise seemingly mysterious results.
Prerequisite: MAC 2312 or equivalent.

ABE 6031 Instrumentation in Agricultural Engineering Research 3 Credits
Grading Scheme: Letter Grade
Principles and application of measuring instruments and devices for obtaining experimental data in agricultural engineering research.

ABE 6035 Advanced Remote Sensing: Science and Sensors 3 Credits
Grading Scheme: Letter Grade
Develops understanding of remote sensing theory and systems using information obtained from visible/near infrared, thermal infrared, and microwave regions of the EM spectrum.
Prerequisite: MAP 2302.

ABE 6037C Remote Sensing in Hydrology 3 Credits
Grading Scheme: Letter Grade
Develops practical understanding of remote sensing applications to hydrology using observations in different regions of the EM spectrum. Seminar style with emphasis on literature review and presentation.
Prerequisite: ABE 6035.

ABE 6165 Comp Vis Deep Learn Agri Sys 3 Credits
Grading Scheme: Letter Grade
The exploration of applied machine vision with a focus on modern deep learning techniques to solve problems in agricultural and food systems (AFS). Learn and apply the principles of machine vision, convolutional neural networks, and recurrent neural networks for image semantic understanding and processing to address challenges in AFS, such as visual navigation of agricultural robots, monitoring and managing crops and livestock, and food postharvest sorting.
Prerequisite: Permission of Instructor.

ABE 6252 Advanced Soil and Water Management Engineering 3 Credits
Grading Scheme: Letter Grade
Physical and mathematical analysis of problems in infiltration, drainage, and groundwater hydraulics.

ABE 6254 Simulation of Agricultural Watershed Systems 3 Credits
Grading Scheme: Letter Grade
Characterization and simulation of agricultural watershed systems including land and channel phase hydrologic processes and pollutant transport processes. Investigation of the structure and capabilities of current agricultural watershed computer models.
Prerequisite: CWR 4111 and working knowledge of FORTRAN.

ABE 6265 Vadose Zone Modeling 3 Credits
Grading Scheme: Letter Grade
Unsaturated zone modeling of water flow and solute transport processes. Comparative analysis of alternative mechanistic modeling approaches of different complexity.
Prerequisite: Recommended basic use of high level computer language or numerical computing environment (i.e., Matlab, Mathematica, etc.) that allows the student to test algorithms and read existing modeling source code.

ABE 6266 Nanotechnology in Water Research 3 Credits
Grading Scheme: Letter Grade
Applications of environmental nanotechnology to water quality control. Fate and transport of nanomaterials in hydrologic pathways.
Prerequisite: Basic knowledge of hydrology, environmental engineering, and water chemistry.

ABE 6615 Advanced Heat and Mass Transfer in Biological Systems 3 Credits
Grading Scheme: Letter Grade
Analytical and numerical technique solutions to problems of heat and mass transfer in biological systems. Emphasis on nonhomogeneous, irregularly shaped products with respiration and transpiration.
Prerequisite: COP 2271, ABE 3612C.

ABE 6644 Agricultural Decision Systems 3 Credits
Grading Scheme: Letter Grade
Computerized decision systems for agriculture. Expert systems, decision support systems, simulations, and types of applications in agriculture.

ABE 6645C Computer Simulation of Crop Growth and Management Responses 3 Credits
Grading Scheme: Letter Grade
Teaches the background of computer models for the dynamic simulation of crop growth, development, and yield, and soil and plant water, nutrient, and carbon dynamics, and the application of models to real-world problems. The course is based on a systems analysis approach using DSSAT as a platform.

ABE 6649C Advanced Biological Systems Modeling 3 Credits
Grading Scheme: Letter Grade
This course serves as an advanced graduate class for continued biological modeling and covers topics such as: (1) formulating, solving analytical and numerical problems with programming, (2) dynamic biological models; (3) object-oriented design and agent-based modeling, (4) High Performance Computing and Global Sensitivity and Uncertainty Analysis.
Prerequisite: ABE 5643C.

ABE 6654C Advanced Bio-Based Products from Renewable Resources 3 Credits
Grading Scheme: Letter Grade
Provides the knowledge for the production of fuels, chemicals and materials from renewable resources. The course includes the fundamental principles and practical applications of bio-based products: biorefinery and biobased products overview, fundamental concepts in understanding biorefinery and biobased products; materials, chemical platforms, and fuels from biomass.
Prerequisite: CHM2045 or equivalent, or instructor permission.

ABE 6840 Data Diagnostics 3 Credits
Grading Scheme: Letter Grade
Application of nonlinear time series analysis to detect, characterize, and model deterministic structure in real-world time series data. Topics include signal processing, phase space reconstruction, surrogate data testing, causal network analysis, and phenomenological modeling.
Prerequisite: Elementary statistics and Differential equations.

ABE 6905 Individual Work in Agricultural and Biological Engineering 1-4 Credits, Max 6 Credits
Grading Scheme: Letter Grade
Special problems in agricultural engineering.

ABE 6910 Supervised Research 1-5 Credits, Max 5 Credits
Grading Scheme: S/U
Supervised Research

ABE 6931 Seminar 1 Credit, Max 2 Credits
Grading Scheme: S/U
Preparation and presentation of reports on specialized aspects of research in agricultural engineering and agricultural operations management.

ABE 6933 Special Topics in Agricultural and Biological Engineering 1-4 Credits, Max 15 Credits
Grading Scheme: Letter Grade
Lectures, laboratory, and/or special projects.

ABE 6940 Supervised Teaching 1-5 Credits, Max 5 Credits
Grading Scheme: S/U
Supervised Teaching

ABE 6971 Research for Master's Thesis 1-15 Credits
Grading Scheme: S/U
Research for Master's Thesis

ABE 6972 Research for Engineer's Thesis 1-15 Credits
Grading Scheme: S/U
Research for Engineer's Thesis

ABE 6974 Nonthesis Project 1-6 Credits, Max 6 Credits
Grading Scheme: S/U
In-depth project.

ABE 6986 Applied Mathematics in Engineering and Agriculture 3 Credits
Grading Scheme: Letter Grade
Mathematical methods, including regression analysis, graphical techniques, and analytical and numerical solution of ordinary and partial differential equations, relevant to engineering in agriculture and the related sciences.

ABE 7979 Advanced Research 1-12 Credits
Grading Scheme: S/U
Research for doctoral students before admission to candidacy. Designed for students with a master's degree in the field of study or for students who have been accepted for a doctoral program. Not appropriate for students who have been admitted to candidacy.

ABE 7980 Research for Doctoral Dissertation 1-15 Credits
Grading Scheme: S/U
Research for Doctoral Dissertation

AGG 5607 Communicating in Academia 3 Credits
Grading Scheme: Letter Grade
Teaching graduate students about academic writing, specifically focused on research proposals, theses, dissertations, manuscripts, grant proposals, and CVs. Also teaching students about aspects of academic writing that are not normally part of graduate curriculum but are necessary to succeed.

AOM 5456 Applied Methods in SmartAg Systems 3 Credits
Grading Scheme: Letter Grade
Design, analysis, and evaluation of SmartAg methods for applications in production agriculture, biological and food engineering, forestry, land, and water resources. Students will learn hardware and software concepts used in SmartAg applications with real-world examples (e.g., UAV's, irrigation, controlled environments for plant and animals, crop modeling).

EGN 5949 Practicum/Internship/Cooperative Work Experience 1-6 Credits, Max 6 Credits
Grading Scheme: S/U
Practical cooperative engineering work under approved industrial and faculty supervision.
Prerequisite: graduate student.

EGN 6913 Engineering Graduate Research 0-3 Credits, Max 12 Credits
Grading Scheme: S/U
Course will provide the student with supervised research in a laboratory setting.

STA 6348 Bayesian Analysis for Machine Learning and Uncertainty Quantification 3 Credits
Grading Scheme: Letter Grade
This course emphasizes Bayesian methodology for modeling, inference and prediction using hierarchical/multilevel models, with particular emphasis on computation (Monte Carlo and its flavors) and applications (inference and prediction in models for regression and classification, potentially with various types of statistical dependence) as intended for Master's and doctoral students in data sciences and engineering.
Prerequisite: (i) mathematical statistics emphasizing inference (e.g., PHC6092 or STA6327) and regression (e.g., STA6207) or (ii) a graduate course in machine learning with emphasis on probability/statistics or (iii) permission of the instructor.

STA 6703 Statistical Machine Learning 3 Credits
Grading Scheme: Letter Grade
Methodology and application of tools of statistical (machine) learning targeted at graduate students in engineering, applied statistics/biostatistics and quantitative life sciences. Statistical approaches to machine learning are emphasized. Application and the intuition behind statistical methods rather than formal derivations and full mathematical proofs of the procedures are prioritized.
Prerequisite: Calculus-based probability and statistics (e.g., EGN6446 or PHC6092 or STA5328). Additionally, knowledge of scientific/statistical computing (e.g., in R or Python) and undergraduate mathematics (multivariate calculus and linear algebra).

STA 6709 Spatial Statistics & Hierarchical Modeling for Dependent Data 3 Credits

Grading Scheme: Letter Grade

This is a course on analytical and computational methods of spatial statistics for modeling, inference and prediction for dependent data, including point-referenced (geostatistical), areal and point process data. The methods (including uncertainty quantification using hierarchical Bayesian models) generalize to Gaussian process and GMRF models popular in machine learning and other areas of engineering. The course is targeted a students in data sciences, engineering and life sciences.

Prerequisite: Mathematical statistics emphasizing inference (e.g., PHC6092 or STA6327) and regression (e.g., STA6207). Knowledge of scientific/statistical computing and undergraduate mathematics (multivariate calculus and linear algebra).