Biosystems & Agricultural Engineering

College of Engineering

The Biosystems and Agricultural Engineering Department offers programs leading to the M.S. (Plan A and Plan B available) and the Ph.D. degree.

Admission Requirements
Admission into the M.S. graduate program of the Biosystems and Agricultural Engineering Department requires the concurrence of the Department Graduate Committee, and the Director of Graduate Studies, and the Department Chair and the availability of an advisor for the student. The Biosystems and Agricultural Engineering Graduate Committee reviews the applicant's three letters of recommendation, resume, statement of professional objective and transcripts with special emphasis given to the science and mathematics area. The department requires a minimum grade point average of 2.8 and a GRE score of at least 1500. An engineering B.S. degree from an ABET-accredited engineering program (or international equivalent) is generally required, however, non-engineering students may be admitted by agreeing to take additional undergraduate courses specified by the graduate committee. Exceptions to these requirements are considered on a case-by-case basis, taking into account the materials described above as well as GRE scores.

Admission into the Ph.D. graduate program of the Biosystems and Agricultural Engineering Department requires the concurrence of the Department Graduate Committee, the Director of Graduate Studies, and the Department Chair, and the availability of an advisor for the student. The Biosystems and Agricultural Engineering Graduate Committee reviews the applicant's previous graduate record, three letters of recommendation, resume, statement of professional objective, and transcripts with special emphasis given to the science and mathematics area. The department requires a minimum grade point average of 3.2 on all previous graduate work for unconditional admission. Exceptions to these requirements are considered on a case-by-case basis, taking into account the materials described above as well as GRE scores. Ph.D. students are admitted into candidacy after they have successfully completed the Qualifying Exam.

Degree Requirements
The objectives of the Biosystems and Agricultural Engineering graduate program are to develop and strengthen:

1. the ability to plan and conduct research and design involving the application of engineering science to biological and agricultural systems.
2. an understanding of mathematical, physical, and biological sciences that enables critical assessment of scientific literature in these and related fields.
3. the skills required to use precision instruments, techniques and computers in research and design.
4. the ability to make sound engineering and management decisions.
5. the ability to teach college level courses in Biosystems and Agricultural Engineering, particularly at the doctoral level.

Graduate students will combine courses in Biosystems and Agricultural Engineering, other engineering fields, the physical sciences, and the biological sciences to develop a program of study that facilitates these objectives. The advanced degrees, however, are primarily research degrees awarded for significant creative research accomplishment, not for the completion of a specified number of courses. Therefore, the program normally concentrates on a strong thesis or dissertation problem completed under the supervision of the graduate faculty of the department. A design-oriented, non-thesis option is also available for the master's degree.

Graduate Courses

BAE 502 MODELING OF BIOLOGICAL SYSTEMS. (3)
This course will introduce students to mathematical modeling of biological systems, both from a conceptual and methodological perspective. The art and science of developing a computer simulation model will be presented and supported by examples/exercises in MATLAB. Prereq: BAE 402.

BAE 503 FUNDAMENTALS OF BIORENEWABLE RESOURCE ENGINEERING. (3)
This course introduces students to the science and engineering of converting biorenewable resources into bioenergy and biobased products.
Topics include: Defining the resource base; physical and chemical properties of biorenewable resources; description of biobased products; methods of production for biorenewable resources.

BAE 504 BIOFUELS PRODUCTION AND PROPERTIES. (3)
This course introduces students to the science and engineering of liquid biofuels for transportation. Topics include: physical and chemical properties; engine performance; processing technologies; and environmental impact of biofuels. Prereq: BAE 503 or consent of instructor.

BAE 505 THERMOCHEMICAL PROCESSING OF BIOMASS. (3)
Introduction to thermal and catalytic processes for the conversion of biomass to biofuels and other biobased products. Topics include gasification, fast pyrolysis, hydrothermal processing, syngas to synfuels, and bio-oil upgrading. Prereq: BAE 503, BAE 504, or consent of instructor.

BAE 506 LIFE CYCLE ASSESSMENTS FOR BIORESOURCE ENGINEERING. (3)
Life Cycle Assessment (LCA) is a method in which the energy and raw material consumption, different types of emissions and other important factors related to a specific production or service are measured, analyzed and summarized over the entire life cycle. This course will cover the theory, practice and application of Life Cycle Assessment. Life Cycle Assessment is one tool in a large tool box of methods, such as Life Cycle Costing (LCC), Substance Flow Analysis (SFA), and Risk Assessment (RA), used to evaluate goods, services and systems. Prereq: Senior or graduate student standing.

BAE 513 SOIL DYNAMICS IN TILLAGE AND TRACTION.

BAE 514 COMPONENT DESIGN. (3)
This course is intended to give students practical experience in the design and analysis of components used in agricultural machinery. Major topics include material properties, stress/strain analysis, failure theory, and mechanical components. Students will learn how to use computer software to conduct simulations and design components. Rapid prototyping and traditional fabrication techniques will be explored. Prereq: EM 302; ME 205 or CE 106.

BAE 515 FLUID POWER SYSTEMS. (3)
Analysis and design of fluid power systems used in agricultural, industrial and processing equipment. Selected topics to include: positive displacement components, control devices, actuators, fluid transmission and system dynamics. Lecture, two hours; laboratory, two hours per week. Prereq: ME 330, ME 340 and engineering standing.

BAE 516 CONTROL OF OFF-ROAD VEHICLES. (3)
This course is intended to give students practical experience in the design and analysis of control and communication systems used in offroad vehicles. Additional emphasis will be placed on implementing

simple feedback control methods using an industrial embedded controller. Prereq: BAE 305.

BAE 517 OFF-ROAD VEHICLE DESIGN. (3)
Morphology, operational characteristics, and design considerations of off-road vehicles used in agriculture, forestry and construction. This course provides an introduction to conceptualization, analysis and design of these vehicles. Topics to be addressed include: engine performance and design, vehicle testing, turbo chargers and intercoolers, drivetrains, chassis mechanics, electronic systems, hydraulic systems, and human factors. Prereq: BAE 417.

BAE 532 INTRODUCTION TO STREAM RESTORATION. (3)
Introduction to principles of fluvial geomorphology for application in restoring impaired streams. Topics include channel formation processes (hydrology/hydraulics), stream assessment, sediment transport, in-stream structures, erosion control, habitat, and monitoring. Prereq: CE 341 (or equivalent) and engineering standing or consent of instructor. (Same as CE 542.)

BAE 535 ENVIRONMENTAL CONTROL SYSTEM DESIGN AND RECLAMATION. (3)
Introduction to the principles of sustainable mine planning with a focus on environmental control system design, reclamation and restoration design, and environmental monitoring systems. Topics will include culvert and diversion design, hydrologic inputs, catchment delineation and routing, sedimentologic inputs, erosion control and best management practice selection, sediment pond design, design of silt fences, grass filters, and sediment ditches, weep berm and vegetated filter strip design, reforestation, grassland/wildlife establishment, stream restoration, wetlands/vernal ponds, environmental monitoring system design, and community integration. Prereq: MNG 291, MNG 463, and engineering standing or consent of instructor. (Same as MNG 535.)

BAE 536 FLUVIAL HYDRAULICS. (3)
Rainfall physics, principles of erosion on upland areas and construction sites, stable channel design in alluvial material, mechanics of sediment transport, river mechanics, reservoir sedimentation. Prereq: CE 341 or ME 330 and engineering standing. (Same as CE 546.)

BAE 537 IRRIGATION AND DRAINAGE ENGINEERING. (3)
Planning and design of irrigation system; sprinkler, traveling gun, center pivot, trickle, subirrigation and residential and commercial irrigating; pumps; water quality treatment and supply; ponds and wells; principles of water movement and plant-soil relationships; surface and subsurface drainage. Prereq: ME 330 or CE 341 or consent of instructor.

BAE 538 GIS APPLICATIONS FOR WATER RESOURCES. (3)
This course studies the principles, methodology and analysis of geographic information systems and spatially-referenced data unique to water resources and hydrologic modeling. Lectures will explore the latest GIS concepts, hydrologic modeling relationships and data sources and be complimented with computer-based laboratory exercises. Prereq: BAE 437, CE 461G, or consent of instructor. (Same as CE 568.)

BAE 541 INTERMEDIATE FLUID MECHANICS. (3)
Application of basic fluid mechanics to problems of importance to civil engineering practice. This includes flow measuring, closed conduit flow and pipe networks, open channel flow, turbomachinery (pumps), hydraulic structures, culvert flow. Prereq: CE 341, CS programming course, and engineering standing or consent of instructor. (Same as CE 541.)

BAE 543 SOLAR CELL DEVICES AND SYSTEMS FOR ELECTRICAL ENERGY GENERATION. (3)
Physics of photovoltaic (PV) devices, emerging technologies, design of PV cells and systems, electronic components for signal conditioning, integration, installation, performance evaluation and economic issues related to PV systems. Prereq: EE 211 or EE 305 and Engineering Standing, or consent of instructor. (Same as EE 543/EGR 543.)

BAE 545 ENGINEERING HYDRAULICS. (3)
Analysis and Design of flow in closed conduits and natural and artificial open channels. Design of hydraulic structures. Prereq: CE 461G and engineering standing, or consent of instructor. (Same as CE 549.)

BAE 547 WATERSHED SEDIMENTATION. (3)
The course objective is to gain an understanding of watershed sedimentation including: (1) erosion and sediment transport processes in a watershed and the mechanisms by which the processes are initiated, developed, and worked towards equilibrium; (2) measurement of the sediment budget for a watershed using sediment fingerprinting and sediment loading data; and (3) prediction of sediment loading in watersheds with different human disturbances using hydrologic-based modeling tools. Specific emphasis will be placed on the use of natural carbon and nitrogen isotopic tracer measurements within sediment fingerprinting as a data-driven approach to measure sediment loading from different sources in a watershed. In order to fulfill the course objective, the instructor will use traditional classroom learning as well as field and laboratory components of the course in order that students can participate in hands-on learning. Prereq: CE 461G (Pre- or Co-requisite or equivalent). (Same as CE 547.)

BAE 549 BIOLOGICAL PROCESS ENGINEERING. (3)
An analysis of processing operations for the conversion or generation of biological materials. The course material applies thermodynamics, heat transfer, mass and energy balances, and reaction kinetics to biological process operations such as sterilization, fermentation, product recovery, freezing, drying, evaporation, and refrigeration. Applications include biomedical, food processing, and biochemical and biofuel production from biomass. Prereq: BAE 447 or consent of instructor.

BAE 556 SOLID AND HAZARDOUS WASTE MANAGEMENT. (3)
Study of the generation and management of solid and hazardous wastes. Application of engineering principles to the collection, transport, processing, resource recovery and ultimate disposal of these wastes. Prereq: CE 471G, CE 521 or consent of instructor and engineering standing. (Same as CE 556.)

BAE 580 HEATING, VENTILATING AND AIR CONDITIONING. (3)
A course emphasizing the use of thermodynamics, fluid mechanics, and heat transfer principles in thermal environmental design. Building energy requirements will be computed and thermal comfort criteria will be studied. Prereq: BAE 427 or ME 321, or consent of instructor. This course is open only to graduate students or undergraduates with engineering standing. (Same as ME 580.)

BAE 581 PHYSICS OF PLANT AND ANIMAL ENVIRONMENTS. (3)
A study of the thermal, moisture, light, and gaseous components of plant and animal environments with emphasis on interactions between these biological systems and their environments. Prereq: BAE 427 or consent of instructor.

BAE 599 TOPICS IN BIOSYSTEMS ENGINEERING. (2-3)
A detailed investigation of a topic of current significance in biosystems engineering such as: design of small earth dams, vacuum dehydration systems, small particle mechanics, biofuels, environmental control in green houses, sprinkler irrigation, energy conversion in agriculture,bio-simulation. May be repeated to a

maximum of six credits, but only three credits can be earned under the same title. A particular topic may be offered at most twice under the BAE 599 number. Prereq: Variable; given when topic identified.

BAE 625 TOPICS IN ADVANCED ENVIRONMENT CONTROL AND ANALYSIS (Subtitle required). (3)
A study of current research in environment control and analysis of agricultural, commercial and residential structures. May be repeated three times for a maximum of nine credits, but not more than three credits may be earned under a particular topic. Prereq: Senior course in environment control and HVAC, BAE/ME 580, or consent of instructor.

BAE 642 OPEN CHANNEL FLOW. (3)
The study of open channel flow fundamentals and concepts. Topics include uniform flow, varied flow, steady and unsteady flow, energy dissipators, flow transitions, controls, analytical and numerical solutions in 1D and 2D applications. Prereq: CE 541 or consent of instructor. (Same as CE 642.)

BAE 643 MECHANICS OF SEDIMENT TRANSPORT. (3)
Fundamentals of turbulence in rivers and sediment transport will be taught including recent theory, derivation of governing equations, experimental methods, modeling, and design based on sediment thresholds. Prereq: CE 341 or consent of instructor. (Same as CE 643.)

BAE 647 SYSTEM OPTIMIZATION I. (3)
Introduction to linear and nonlinear optimization and their use in engineering design. Emphasis on numerical approaches and use of optimization methods for engineering systems (e.g. biological, mechanical, structural). Prereq: CS 221 or equivalent; one mathematics course beyond MA 214 or equivalent. (Same as ME 647.)

BAE 648 ENERGY AND MASS TRANSFER IN BIOSYSTEMS PROCESSING. (3)
A comprehensive and in-depth study of the principles of energy and mass transfer as they apply to the processing of agricultural and biological materials. Prereq: BAE 549 or consent of instructor.

BAE 652 BIOLOGICAL PROCESSES FOR WATER QUALITY CONTROL. (3)
Principles and applications of environmental biotechnology for water quality control. Process microbiology and kinetics for various water and wastewater treatment processes. Prereq: CE 351 or consent of instructor. (Same as CE 652.)

BAE 653 WATER QUALITY IN SURFACE WATERS. (3)
Principles of surface water quality modeling and control. Analysis of dispersion, advection, natural aeration, biological oxidation and photosynthesis; their effects on the physical, chemical, and biological quality of waters in streams, lakes, reservoirs, estuaries and other surface waters. Prereq: CE 351 or consent of instructor. (Same as CE 653.)

BAE 658 INSTRUMENTATION FOR ENGINEERING RESEARCH. (3)
Instrumentation and measuring system characteristics; transducers for engineering measurements; and data acquisition and analysis. Lecture, two hours; laboratory, two hours per week. Prereq: Consent of instructor.

BAE 660 SIMILITUDE IN ENGINEERING.

BAE 662 STOCHASTIC HYDROLOGY. (3)

Hydrologic random variables and probability distributions. Statistical measures, development and use of Monte Carlo simulations in the generation of precipitation fields. Statistical tests of hydrologic data. Point frequency and regional frequency analysis. Analysis of hydrologic time series. Long-term trend, harmonic analysis of periodicity, autocorrelation, spectral analysis. Correlation and regression analysis. Linear stochastic models. Introduction to stochastic processes in hydrology, real-time hydrologic forecast (Kalman filter), pattern recognition, and stochastic differential equations. Prereq: MA 214, CE 461G or equivalent. (Same as CE 662.)

#BAE 664 WATERSHED MANAGEMENT. (3)
This course provides an overview of the scientific principles and management strategies used to effectively manage the physical, chemical,
biological and social resources within a watershed so as to improve and sustain the integrity of the watershed system. The course will examine watershed management from both a scientific/engineering perspective as well as from a social science/policy perspective. Examples of effective watershed management will be drawn from cases studies in Kentucky and the United States. Students will be provided with an introduction to those spatial data sets, computer software, and methods currently used in watershed management practice. Prereq: BAE 437 or CE 461G or an equivalent course in hydrology, or consent of instructor. (Same as CE 664.)

BAE 665 WATER RESOURCES SYSTEMS. (3)
Application of systems analysis, mathematic modeling, and optimization in water resources management and design. Solution of engineering problems found in water supply, water quality, urban drainage, and river basin development and management by use of linear, nonlinear, and dynamic programming models. Prereq: Consent of instructor. (Same as CE 665.)

BAE 667 STORMWATER MODELING. (3)
Introduction to deterministic and parametric modeling approaches for mathematically simulating stormwater runoff and quality. Emphasis on modeling concepts and model formulation. Analysis of deterministic component models and their linkage. Formulation of existing parametric models. Presentation of methods for parameter optimization and regionalization. Demonstration of linkage between the two approaches with illustrative examples. Prereq: CE 341 and CE 461G, or consent of instructor. (Same as CE 667.)

BAE 672 LANDFILL DESIGN. (3)
This course deals with the geotechnical aspects of the design of landfills for the disposal of municipal solid waste. Since landfill design is driven by state and federal regulations, time is taken to review these regulations. Landfills are evaluated as engineered systems consisting of multiple components. Each component is investigated individually, and methods are developed to predict and quantify the performance of these components so that appropriate materials, design criteria, and construction methods can be selected to assure that the landfill will function with minimal environmental impact. Prereq: CE 471G. (Same as CE 672.)

BAE 680 BIOCHEMICAL ENGINEERING. (3)
Principles and design of processes involving biochemical reactions, including aerobic and anaerobic respirations and fermentations, and involving pure and mixed cultures. Energy considerations, heat and mass transfer, biochemical kinetics, and application to biological waste treatment. Prereq: CME 550, CME 630, CHE 440G or consent of instructor. (Same as CME 680.)

BAE 748 MASTER'S THESIS RESEARCH. (0)
Half-time to full-time work on thesis. May be repeated to a maximum of six semesters. Prereq: All course

work toward the degree must be completed.

BAE 749 DISSERTATION RESEARCH. (0)
Half-time to full-time work on dissertation. May be repeated to a maximum of six semesters. Prereq: Registration for two full-time semesters of 769 residence credit following the successful completion of the qualifying exams.

BAE 750 SPECIAL PROBLEMS IN BIOSYSTEMS ENGINEERING. (1-3)
Independent work on selected research problems in one of the various fields of biosystems and agricultural engineering. Consultation and laboratory by appointment. May be repeated three times for a maximum of nine credits. Prereq: Approval of chairperson of department.
BAE 767 DISSERTATION RESIDENCY CREDIT. (2)
Residency credit for dissertation research after the qualifying examination. Students may register for this course in the semester of the qualifying examination. A minimum of two semesters are required as well as continuous enrollment (Fall and Spring) until the dissertation is completed and defended.

BAE 768 RESIDENCE CREDIT FOR MASTER'S DEGREE. (1-6)
May be repeated to a maximum of 12 hours.

BAE 769 RESIDENCE CREDIT FOR DOCTOR'S DEGREE. (0-12)
May be repeated indefinitely.

BAE 775 PROFESSIONAL PRACTICES SEMINAR. (2)
Review of current research topics, methods, management tools and communications techniques with applications. Required of all departmental graduate students. May be repeated once for credit. Lecture, two hours per week. Prereq: Graduate standing.

BAE 795 THESIS. (0)
May be repeated twice