101 Introduction to Biosystems Engineering
Fall. 1(0-2) P: (MTH 116 or concurrently) or (MTH 132 or concurrently) or (MTH 152H or concurrently) or (LB 118 or concurrently) SA: BE 130
Introduction to the profession of biosystems engineering. Case studies of engineering design problems with a biological component. Exploration of career opportunities and ethical framework for the profession.

230 Engineering Analysis of Biological Systems
Spring. 3(3-0) P: (MTH 132 or MTH 152H or LB 118) and (BS 162 or concurrently) or (BS 182H or concurrently) and (EGR 102 or concurrently) Biosystems modeling of growth and dynamic interactions. Conservation of mass, and sustainability. Steady-state and stability analysis. Ecological concepts. Life-cycle analysis. Design for environment. Application of engineering and biological principles to the analysis of microbial systems. Kinetic analyses and modeling of microbial growth, survival, and inactivation for engineering applications.

385 Engineering Design and Optimization for Biological Systems
Spring. 3(2-2) P: (BE 101 and (BE 230 or concurrently)) and (MTH 235 or MTH 265H or LB 220) R: Open to juniors or seniors in the College of Engineering. SA: BE 431 Design and optimization techniques applied to engineering problems with biological constraints. Project management. Engineering economics. Linear programming.

402 Agricultural Climatology
Fall of even years. 3(3-0) Interdepartmental with Geography. Administered by Geography. P: MTH 110 or MTH 116 R: Not open to freshmen or sophomores. Relationships between climate and agriculture in resource assessment, water budget analysis, meteorological hazards, pests, crop-yield modeling, and impacts of global climate change.

418 Animal Agriculture and the Environment
Fall. 3(2-2) Interdepartmental with Animal Science. Administered by Animal Science. P: (BS 161 or LB 145 or BS 181H) and (CEM 143 or CEM 251) RB: CSS 210 Comprehensive nutrient management plans (CNMP) for animal feeding operations. Trends in animal production, environmental issues, and diet formulation and their impact on manure production. Development of CNMP for a specific animal feeding operation.

419 Applications of Geographic Information Systems to Natural Resources Management
Spring. 4(2-2) Interdepartmental with Forestry and Fisheries and Wildlife. Administered by Fisheries and Wildlife. RB: GEO 221 Application of geographic information systems, remote sensing, and global positioning systems to integrated planning and management for fish, wildlife, and related resources.

429 Fundamentals of Food Engineering
Spring. 3(3-0) Interdepartmental with Food Science. Administered by Biosystems Engineering. P: FSC 325 and MTH 124 and PHY 231 RB: FSC 211 R: Not open to students in the College of Engineering. SA: BE 329 Definition and measurement of food properties, thermodynamics, fluid mechanics, heat transfer, and mass transfer.

431 Controls for Biological Systems
Fall. 3(3-0) P: (BE 101 or concurrently) and (MTH 235 or MTH 255H or LB 220) and ((ICE 321 or concurrently) or (CHE 311 or concurrently) or (ME 332 or concurrently) and (CIF 143 or concurrently) or (CEM 251 or concurrently) or (CEM 351 or concurrently)) R: Open to students in the College of Engineering. Not open to students with credit in ME 410. Steady state and transient heat transfer. Radiation and convection heat transfer. Heat exchangers. Mass transfer application problems in biosystems engineering.

435 Thermodynamics for Biological Engineering
Fall. 3(3-0) P: (BE 101 or concurrently) and (MTH 235 or MTH 255H or LB 220) and (BS 161 or BS 181H or LB 145) R: Open to juniors or seniors in the College of Engineering. Thermodynamics of biological systems. First and second laws of thermodynamics. Power and refrigeration cycles. Water relations and psychrometry. Chemical and phase equilibria.

456 Electric Power and Control
Spring. 3(2-2) P: BE 334 SA: AE 356 Alternating current circuits, power distribution, electrical machines, protection, and programmable motor controllers. Design project related to food and agricultural industries.

457 Bioenergy Feedstock Systems Analysis
Fall. 3(2-2) Interdepartmental with Forestry. Administered by Biosystems Engineering. P: FOR 404 or approval of department R: Open to juniors or seniors. Equipment used for harvesting, pre-processing, and transporting woody biomass from natural forests and energy wood plantations; control and system optimization in woody biomass supply chain; environmental impact of woody biomass recovery.

461 Seminar in Plant, Animal and Microbial Biotechnology
Spring. 1(1-0) Interdepartmental with Animal Science and Crop and Soil Sciences and Horticulture. Administered by Horticulture. P: (ANS 425 or concurrently) or (BE 360 or concurrently) or (CSS 451 or concurrently) or (MMG 445 or concurrently) Current applications of plant and microbial biotechnology in agriculture and related industries. Technologies under development and factors associated with moving from laboratory to product development. Field trips required.

467 BioEnergy Feedstock Production
Fall. 3(3-0) Interdepartmental with Crop and Soil Sciences and Forestry. Administered by Crop and Soil Sciences. P: MTH 103 or MTH 116 or MTH 124 or MTH 132 or LB 118 or MTH 152H or MTH 133 or MTH 153H or LB 119 RB: CSS 101 and CSS 210 Agronomic, economic, technological, and environmental principles involved in bioenergy feedstock production. Cultivation, harvest, transportation, and storage of agricultural and forest biomass.
Biosystems Engineering—BE

468  Biomass Conversion Engineering  
Fall; 3(3-0) Interdepartmental with Chemical Engineering. Administered by Chemical Engineering. P: (BE 351 or CHE 321) and (BE 360 or CHE 431)  
Physical, chemical, and biological pretreatment. Biomass conversion to alcohols, biodiesel, bio-oil, syngas, and other value-added products using advanced biological, chemical, and thermochemical treatments.

469  Sustainable Bioenergy Systems  
Spring; 3(3-0) Interdepartmental with Chemical Engineering. Administered by Biosystems Engineering. P: BE 230 or CHE 201  
Biomass conversion to biofuels, biogas, and other value-added products using advanced physical, chemical, and biological pretreatment. Bioenergy systems engineering design process. Problem identification, analysis, design, modeling, materials, cost estimation, and final specifications. Safety, environmental, and ethical considerations.

475  International Studies in Biosystems Engineering  
Fall, Spring, Summer. 1 to 6 credits. Fall: Abroad; Spring: Abroad. Summer: Abroad. A student may earn a maximum of 6 credits in all enrollments for this course. R: Approval of department; application required.
Study abroad emphasizing biosystems and agricultural engineering issues affecting agriculture and natural resources in world, national, and local communities.

478  Food Engineering: Fluids  
Fall; 3(2-2) Interdepartmental with Food Science. Administered by Biosystems Engineering. P: BE 350 and BE 351 and BE 360  
Unit operations, process engineering, equipment, and industrial practices of the food industry. Manufactured dairy products: thermal processing, pipeline design, heat exchange, evaporation, dehydration, aseptic processing, membrane separation, cleaning, and sanitation.

479  Food Engineering: Solids  
Spring; 3(2-2) P: BE 350 and BE 351 and BE 360  
Analysis and design of unit operations and complete systems for handling, processing, and manufacturing bulk, granular, and solid food products. Material variability and microbial, chemical, and physical hazards.

481  Water Resources Systems Analysis and Modeling  
Fall; 3(2-2) P: CE 321 or CHE 311 or ME 332  
Hydrology of natural systems. Quantifying runoff, infiltration, and evapotranspiration. Geophysical data collection at watershed scale. Geographical information system application in hydrology and ecosystems engineering. Watershed modeling and applications in engineering design and decision-making.

482  Diffuse-Source Pollution Engineering  
Spring; 3(2-2) P: BE 350 or ENE 483 and (BE 360 or ENE 487)  
Identification, estimation, and control of diffuse source pollution from agricultural and urban sources. Analysis of diffuse source pollutants in biological systems. Engineering design of practices and structures to prevent, mitigate, and treat diffuse source pollution, including low impact development (LID) strategies.

485  Biosystems Design Techniques  
Fall; 3(2-2) P: BE 332, and BE 334 and BE 350 and BE 351 and BE 360 and BE 385 or approval of department  
Open to juniors or seniors in the Biosystems Engineering major. SA: BE 486  
Engineering design process. Problem identification, analysis, design, modeling, materials, cost estimation, and final specifications. Safety, environmental, and ethical considerations.

487  Biosystems Design Project (W)  
Spring; 3(0-6) P: (BE 485) and completion of Tier I Writing requirement  
Open to seniors in Biosystems Engineering major. SA: AE 488  
Individual or team design project selected in BE 485. Information expansion, development of alternatives, and evaluation, selection, and completion of a design project.

490  Independent Study  
Fall, Spring, Summer. 1 to 5 credits. A student may earn a maximum of 5 credits in all enrollments for this course. R: Approval of department; application required.
Supervised individual student research and study in biosystems engineering.

491  Special Topics in Biosystems Engineering  
Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 12 credits in all enrollments for this course. R: Approval of department.
Special topics in biosystems engineering.

815  Experimentation and Instrumentation in Biosystems Engineering  
Spring; 3(2-2) R: Open to graduate students in the College of Agriculture and Natural Resources or in the College of Engineering. SA: AE 815  
Establish generalized experimental study planning, measurement, data collection and execution skills, which are applicable to individual topics/projects/areas in biological systems.

820  Research Methods in Biosystems Engineering  
Fall; 1(1-0) R: Open only to graduate students in the College of Agriculture and Natural Resources or College of Engineering. SA: AE 820  
Procedures and methods for designing and executing research projects.

835  Modeling Methods in Biosystems Engineering  
Fall; 3(2-2) RB: Undergraduate degree in an engineering discipline, and one year of biological science. R: Open to graduate students in the College of Agriculture and Natural Resources or in the College of Engineering. SA: AE 890  
Establish general model planning and execution skills, which are applicable to individual topics/projects/areas in biological systems.

844  Biosensor Principles and Applications  
Spring; 3(3-0) Interdepartmental with Biomedical Engineering. Administered by Biosystems Engineering. R: Knowledge of biology, chemistry, and electronics. SA: BE 845  
Biotechnology-based biosensors, their components, desirable properties, and associated electronics. Applications related to healthcare, biodefense, food and water safety, agriculture, bio-production, and environment. Multidisciplinary interactions necessary for biosensor development.

849  Quantitative Human Health Risk Modeling and Analysis for Microbial Stressors  
Fall of even years. 3(2-2) P: STT 421 or STT 464 or (STT 814 or concurrently)  

869  Life Cycle Assessment for Bioenergy and Bioproduct Systems  
Spring; 3(3-0) Interdepartmental with Chemical Engineering. Administered by Biosystems Engineering. R: Open to graduate students in the College of Engineering or in the Department of Biosystems and Agricultural Engineering or approval of department. Not open to students with credit in BE 469.
Life cycle assessment to evaluate the environmental impacts of biological and chemical conversion processes. Biomass supply chain economics and technoeconomics for biomass conversion. Current policy considerations impacting the adoption of bioenergy and bioproduct systems.

881  Ecohydrology  
Fall of odd years. 3(3-0) RB: BE 481 or ENE 421 or FW 454  
Identify and quantify the critical linkages between ecological processes and the hydrological cycle.

882  Advanced Topics in Ecological Engineering  
Fall; 3(3-0) RB: Undergraduate course or equivalent experience on biological and chemical process design and hydraulics. SA: BE 891  
Rural and suburban water quality challenges. Science and design of rural and suburban water treatment and resource recovery systems.

890  Special Problems  
Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 6 credits in all enrollments for this course. R: Approval of department; application required. SA: AE 890  
Individual study in biosystems engineering.

891  Advanced Topics in Biosystems Engineering  
Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 6 credits in all enrollments for this course. R: Open only to seniors and graduate students. SA: AE 891  
Biosystems engineering topics not covered in regular courses.
BE—Biosystems Engineering

892  Biosystems Engineering Seminar
     Spring. 1(1-0) R: Open only to graduate stu-
     dents in the College of Agriculture and Natu-
     ral Resources or College of Engineering. SA: 
     AE 892
     Current topics in biosystems engineering.

899  Master's Thesis Research
     Fall, Spring, Summer. 1 to 10 credits. A stu-
     dent may earn a maximum of 99 credits in all 
     enrollments for this course. R: Open only to 
     master's students in the Biosystems Engi-
     neering major. SA: AE 899
     Master's thesis research.

999  Doctoral Dissertation Research
     Fall, Spring, Summer. 1 to 24 credits. A stu-
     dent may earn a maximum of 36 credits in all 
     enrollments for this course. R: Open to doc-
     toral students in the Biosystems Engineering 
     Major. SA: AE 999
     Doctoral dissertation research.