

## BIOSYSTEMS ENGINEERING

BE

### Department of Biosystems and Agricultural Engineering College of Agriculture and Natural Resources

- 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) or (LB 144 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.

- 332 Engineering Properties of Biological Materials**  
Fall. 3(3-0) P: (BE 101 or concurrently) and (BS 161 or BS 181H or LB 145) and CE 221  
R: Open to juniors or seniors in the Department of Biosystems and Agricultural Engineering. C: BE 333 concurrently.

Physical, thermal, and electromagnetic properties of biological materials necessary for the design and analysis of processes and equipment in biosystems.

- 334 Biosystems Engineering Laboratory Practice**  
Fall. 3(2-2) P: (BE 101 or concurrently) and (BS 171 or BS 172) and PHY 184 R: Open to juniors or seniors in the Department of Biosystems and Agricultural Engineering. C: BE 332 concurrently.

Sensors and instrumentation for measuring and analyzing properties of biological materials and systems.

- 350 Heat and Mass Transfer in Biosystems**  
Spring. 3(3-0) P: (BE 101 or concurrently) and (MTH 235 or MTH 255H or LB 220) and ((CE 321 or concurrently) or (CHE 311 or concurrently) or (ME 332 or concurrently)) and ((CEM 143 or concurrently) or (CEM 251 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 conduction. Radiation and convection heat transfer. Heat exchangers. Mass transfer application problems in biosystems engineering.

- 351 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. Not open to students with credit in CHE 321 or ME 201.

Thermodynamics of biological systems. First and second laws of thermodynamics. Power and refrigeration cycles. Water relations and psychrometry. Chemical and phase equilibria.

- 360 Microbial Systems Engineering**  
Spring. 3(3-0) P: (BE 230 or concurrently) and MTH 235 R: Open to juniors or seniors in the College of Engineering.

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 255H 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 104 or 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 Comprehensive Nutrient Management Planning**  
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(2-4) Interdepartmental with Community, Agriculture, Recreation and Resource Studies and Forestry and Fisheries and Wildlife and Geography. Administered by Fisheries and Wildlife. P: 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 126 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.

- 443 Restoration Ecology**  
Spring. 3(2-2) Interdepartmental with Fisheries and Wildlife and Zoology. Administered by Fisheries and Wildlife. RB: (CSS 210 or BE 230) and (FOR 404 or FW 364 or ZOL 355)

Principles of ecological restoration of disturbed or damaged ecosystems. Design, implementation, and presentation of restoration plans. Field trips required.

- 445 Biosensors for Medical Diagnostics**  
Spring. 3(3-0) P: (BS 161 or BS 181H or LB 145) and (CEM 141 or CEM 151) and (ECE 302 or ECE 345 or BE 334) RB: Biology, chemistry, and electronics R: Open to juniors or seniors or graduate students in the College of Engineering. Not open to students with credit in BE 845.

Biosensors, their components, properties, and associated electronics for applications in medical diagnostics.

- 452 Watershed Concepts**  
Fall, Spring, Summer. 3(3-0) Interdepartmental with Crop and Soil Sciences and Environmental Studies and Agriscience and Forestry and Fisheries and Wildlife. Administered by Environmental Studies and Agriscience. P: ESA 324 and ZOL 355 RB: organic chemistry SA: RD 452

Watershed hydrology and management. The hydrologic cycle, water quality, aquatic ecosystems, and social systems. Laws and institutions for managing water resources.

- 456 Electric Power and Control**  
Spring. 3(2-2) P: ECE 201 or ECE 345 SA: AE 356

Alternating current circuits, power distribution, electrical machines, protection, and programmable motor controllers. Design project related to food and agricultural industries.

- 460 Natural Resource Economics**  
Spring. 3(3-0) Interdepartmental with Environmental Economics and Policy and Environmental Studies and Applications and Park, Recreation and Tourism Resources. Administered by Environmental Studies and Applications. P: EC 201 and (ESA 302 or EEP 255) SA: RD 460

Economic framework for analyzing natural resource management decisions. Spatial and inter-temporal allocation of renewable and nonrenewable resources. Special emphasis on institutions, externalities, and public interests in resource management.

- 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 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.

- 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)

Physicochemical and biological pretreatment. Biomass conversion to alcohols, biodiesel, bio-oil, syngas, and other value-added products using advanced biological, chemical, and thermochemical treatments.

## Biosystems and Engineering—BE

- 469 Sustainable Bioenergy Systems**  
Spring. 3(3-0) Interdepartmental with Chemical Engineering. Administered by Biosystems Engineering. P: BE 230 or CHE 201 RB: CSS 467 and CHE 468 R: Open to juniors or seniors in the College of Engineering. Biorefinery analysis and system design. Life cycle assessment to evaluate sustainability of bioenergy systems. Current policy regulating the bioeconomy and system economics. Product commercialization.
- 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.
- 477 Food Engineering: Fluids**  
Fall. 3(2-2) Interdepartmental with Food Science. Administered by Biosystems Engineering. P: BE 350 and BE 351 and BE 360 SA: FE 465  
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.
- 478 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 R: Open to juniors or seniors in the College of Engineering. SA: AE 481  
Hydrology of natural systems. Quantifying runoff, infiltration, and evapotranspiration. Geospatial 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 CE 483) and (BE 360 or CE 487) R: Open to juniors or seniors in the College of Engineering.  
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 R: 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 R: 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. P: (BE 230 or BE 350) R: Approval of department; application required. SA: AE 490  
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. P: (BE 230 or BE 331 or BE 350) R: Approval of department. SA: AE 491  
Special topics in biosystems engineering.
- 815 Instrumentation for Biosystems Engineering**  
Spring. 3(3-0) SA: AE 815  
Theory and techniques of measuring temperature, pressure, flow, humidity, and moisture in biological materials.
- 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.
- 825 Properties of Biological Materials**  
Fall. 3(3-0)  
Determination, analysis, and modeling of engineering properties of materials encountered in biological engineering.
- 835 Engineering Analysis and Optimization of Biological Systems**  
Fall. 3(3-0) RB: Undergraduate degree in an engineering discipline, and one year of biological science.  
Application of quantitative modeling methods to the description, analysis, design, and operation of biological systems. Dimensional analysis. Theory of models. Network design. Life-cycle assessment. Multi-criteria optimization.
- 845 Biosensor Principles and Applications**  
Spring. 3(3-0) RB: Knowledge of biology, chemistry, and electronics.  
Nanotechnology-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.
- 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.
- 892 Biosystems Engineering Seminar**  
Spring. 1(1-0) R: Open only to graduate students in the College of Agriculture and Natural 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 student may earn a maximum of 99 credits in all enrollments for this course. R: Open only to master's students in the Biosystems Engineering major. SA: AE 899  
Master's thesis research.
- 999 Doctoral Dissertation Research**  
Fall, Spring, Summer. 1 to 24 credits. A student may earn a maximum of 99 credits in all enrollments for this course. R: Open only to doctoral students in the Biosystems Engineering major. SA: AE 999  
Doctoral dissertation research.