BIOLOGICAL SYSTEMS ENGINEERING (BSEN)

BSEN 814 Medical Imaging Systems
Crosslisted with: BSEN 414
Prerequisites: BSEN 311 or ELEC 304.
Description: Underlying physics, instrumentation, and signal analysis of biomedical and biological imaging modalities. MRI, X-ray, CT, ultrasound, nuclear medicine, and the human visual system. Energy-tissue interactions. Resolution, point spread function, contrast, diffraction, comparisons. Information content in images for biological systems.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

BSEN 815 Introduction to Magnetic Resonance Imaging
Prerequisites: Familiarity with linear systems theory (e.g. BSEN 311 or ELEC 304) and MATLAB programming preferred, however, these topics are reviewed for clinicians and bio science students wishing to take the class.
Description: Introduction to the physics, techniques, and biomedical applications of magnetic resonance imaging (MRI) in basic sciences and the clinic. Fundamentals of nuclear magnetic resonance physics, Fourier transforms, MRI hardware, and MRI principles including signal generation, detection and spatial localization techniques. Applications of MRI including tissue relaxometry and diffusion weighted imaging applications to diseases, traumatic brain injury, and cancer.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

BSEN 816 Introduction to Biomaterials
Crosslisted with: BSEN 416
Prerequisites: BSEN/AGEN 225; BIOC 321 or BIOC/BIOS/CHEM 431/831.
Notes: BSEN 416/816 requires the evaluation of current primary literature in the field.
Description: Introduction to all types of bio-materials, metals, ceramics, polymers, and natural materials. Characterization of biomaterials, mechanical and physical properties, cell-biomaterials interactions, degradation, and host reaction to biomaterials. FDA testing and applications of biomaterials, implants, tissue engineering scaffolds, artificial organs, drug delivery, and adhesives.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
Prerequisite for: BSEN 418, BSEN 818

BSEN 818 Tissue Engineering
Crosslisted with: BSEN 418
Prerequisites: BSEN 416/816 or equivalent
Notes: BSEN 418/818 uses case studies to demonstrate clinical implementation of engineered tissues.
Description: Introduction to engineering biological substitutes that can restore, maintain or improve organ function in therapy of diseases. Engineering methods and principles to design tissues and organs, cell and tissue biology, tissue growth and development, biomaterial scaffolds, growth factor and drug delivery, scaffold-cell interactions, and bioreactors.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

BSEN 822 Pollution Prevention: Principles and Practices
Crosslisted with: BSEN 422, CIVE 422, CIVE 822
Prerequisites: Permission.
Description: Introduction to pollution prevention (P2) and waste minimization methods. Practical applications to small businesses and industries. Legislative and historical development of P2 systems analysis, waste estimation, P2 methods, P2 economics, and sources of P2 information.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

BSEN 841 Animal Waste Management
Crosslisted with: AGEN 441, AGEN 841, BSEN 441
Prerequisites: Senior standing.
Description: Characterization of wastes from animal production. Specification and design of collection, transport, storage, treatment, and land application systems. Air and water pollution, regulatory and management aspects.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

BSEN 844 Biomass and Bioenergy Engineering
Crosslisted with: BSEN 444
Prerequisites: Senior/graduate standing in engineering; BIOC 321 or 431; or permission.
Description: Engineering processes for biomass conversion and bioenergy production. Topics include biomass chemistry, conversion reactions, current and emerging bioenergy technologies, feedstock logistics, life cycle assessment. Analysis of primary research literature required for graduate credit.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
### BSEN 846 Unit Operations of Biological Processing
**Crosslisted with:** BSEN 446, AGEN 446, AGEN 846  
**Prerequisites:** AGEN 225 or BSEN 225 and CHEM 332 or equivalent.  
**Description:** Application of heat, mass, and moment transport in analysis and design of unit operations for biological and agricultural materials.Evaporation, drying, distillation, extraction, leaching, thermal processing, membrane separation, centrifugation, and filtration.  
**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
**Format:** LEC

### BSEN 853 Irrigation and Drainage Systems Engineering  
**Crosslisted with:** AGEN 453, AGEN 853, BSEN 453  
**Prerequisites:** CIVE 310 or MECH 310; AGEN 344 or BSEN 344; or permission.  
**Description:** Analytical and design consideration of evapotranspiration, soil moisture, and water movement as related to irrigation and drainage systems; analysis and design of components of irrigation and drainage systems including water supplies, pumping plants, sprinkler systems, and center pivots.  
**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
**Format:** LEC

### BSEN 855 Nonpoint Source Pollution Control Engineering  
**Crosslisted with:** BSEN 455, CIVE 455, CIVE 855  
**Prerequisites:** BSEN 326 or CIVE 326; BSEN 350 or AGEN 350 or CIVE 352.  
**Description:** Identification, characterization, and assessment of nonpoint source pollutants; transport mechanisms and remediation technologies; design methodologies and case studies.  
**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
**Format:** LEC

### BSEN 858 Groundwater Engineering  
**Crosslisted with:** BSEN 458, CIVE 458, CIVE 858  
**Prerequisites:** CIVE 352 or AGEN 350 or BSEN 350 or CIVE 352.  
**Description:** Application of engineering principles to the movement of groundwater. Analysis and design of wells, well fields, and artificial recharge. Analysis of pollutant movement.  
**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
**Format:** LEC

### BSEN 860 Instrumentation and Controls  
**Crosslisted with:** AGEN 460, AGEN 860, BSEN 460  
**Prerequisites:** ELEC 211 or ELEC 215; or permission.  
**Description:** Analysis and design of instrumentation and controls for agricultural and biological production, management and processing. Theory of basic sensors and transducers, analog and digital electrical control circuits, and the interfacing of computers with instruments and controls. Emphasis on signal analysis and interpretation for improving system performance.  
**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
**Format:** LEC

### BSEN 879 Hydroclimatology  
**Crosslisted with:** NRES 479, METR 479, WATS 479, BSEN 479, NRES 879, METR 879  
**Prerequisites:** NRES 208 or METR 100 or METR/NRES 370.  
**Notes:** Offered spring semester of even-numbered calendar years.  
**Description:** Interaction between earth's climate and the hydrologic cycle. Energy and water fluxes at the land-atmosphere interface. Atmospheric moisture transport, precipitation, evaporation, snowmelt, and runoff. Impacts of climate variability and change on the hydrologic cycle.  
**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
**Format:** LEC

### BSEN 889 Seminar I  
**Crosslisted with:** AGEN 889  
**Description:** Introduction into departmental and campus resources, professionalism, preparation and delivery of presentations, technical writing, and additional topics as arranged by enrolled students.  
**Credit Hours:** 1  
**Max credits per semester:** 1  
**Max credits per degree:** 1  
**Format:** LEC

### BSEN 892 Special Topics  
**Crosslisted with:** BSEN 492  
**Prerequisites:** Permission  
**Description:** Subject matter in emerging areas of Biological Systems Engineering not covered in other courses within the curriculum. Topics, activities, and delivery methods vary.  
**Credit Hours:** 1-6  
**Min credits per semester:** 1  
**Max credits per semester:** 6  
**Max credits per degree:** 6  
**Format:** LEC

### BSEN 896 Special Problems  
**Crosslisted with:** AGEN 896  
**Prerequisites:** Permission  
**Description:** Investigation and written report on engineering problems not covered in sufficient depth through existing courses. Topic varies by semester.  
**Credit Hours:** 1-6  
**Min credits per semester:** 1  
**Max credits per semester:** 6  
**Max credits per degree:** 6  
**Format:** IND
BSEN 898 Internship
Crosslisted with: AGEN 898
Prerequisites: Permission
Notes: Students required to write an internship report of their creative accomplishments after completion of the internship. Students may spend up to nine months at the cooperating partner’s workplace.
Description: Solution of engineering or management problems through a non-academic experience within the private sector or a government agency. The experience entails all or some of the following: research, design, analysis, and testing on an engineering problem. A plan, which documents how the individual will demonstrate creativity during the internship must be approved prior to the internship.
Credit Hours: 1-6
Min credits per semester: 1
Max credits per semester: 6
Max credits per degree: 6
Format: FL

BSEN 899 Masters Thesis
Prerequisites: Admission to masters degree program and permission of major adviser
Credit Hours: 1-10
Min credits per semester: 1
Max credits per semester: 10
Max credits per degree: 99
Format: IND

BSEN 912 Advanced Ultrasound Imaging
Prerequisites: BSEN 311 or ELEC 304 Engineering design and analysis of medical ultrasound applications
Description: Beamforming, diffraction, wave space, scattering, imaging. Interactions of mechanical energy and tissue. Linear and phased arrays. Doppler estimation of blood flow velocity. Tumor and cyst characterization. Other modern research topics in medical ultrasound.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

BSEN 935 Analysis of Engineering Properties of Biological Materials
Prerequisites: BSEN 846 or equivalent
Description: Current and relevant mechanical, rheological, thermal, electrical, and optical properties as related to the engineering of processing, storage, handling, and utilization systems for biological materials are selected for analysis.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

BSEN 941 Agricultural Waste Management
Crosslisted with: AGEN 941
Prerequisites: Permission
Description: Aerobic, anaerobic, and physical-chemical treatment, energy recovery and protein synthesis processes for high-strength organic materials; agricultural applications including composting, ammonia stripping, nitrification, denitrification, and land disposal of organic and chemically treated materials.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

BSEN 943 Bioenvironmental Engineering
Prerequisites: MATH 821
Description: An engineer analysis of livestock, their environment and the interaction between the two; mathematical models, heat transfer, energy balances, environmental measurements, physiological measurements, calorimetry.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

BSEN 951 Advanced Mathematical Modeling in Biological Engineering
Description: Advanced mathematical modeling techniques and applications. Specific topics from current literature and vary depending on research interests.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

BSEN 954 Turbulent Transfer in the Atmospheric Surface Layer
Crosslisted with: NRES 954
Prerequisites: MATH 821; MECH 310 or NRES 808 or BIOS 857; or equivalent or permission
Notes: Offered spring semester of odd-numbered calendar years.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3

BSEN 957 Modeling Vadose Zone Hydrology
Crosslisted with: AGN 957, CIVE 957, GEOL 957
Prerequisites: MATH 821; CIVE 957; GEOL 957; or MATH 221/821 or equivalent. AGEN/BSEN 350 or NRES 453/853 or equivalent.
Notes: Typically offered spring semester in even years.
Description: Principles and modeling of fluid flow and solute transport in the vadose zone. Topics include hydraulic properties of variably saturated media, application of Darcy’s Law in variably saturated media, hydrologic and transport processes in the vadose zone, and solution of steady and unsteady flow problems using numerical techniques including finite element methods. Contemporary vadose zone models will be applied to engineering flow and transport problems. Review and synthesis of classic and contemporary research literature on vadose zone hydrology will be embedded in the course.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

BSEN 989 Seminar II
Crosslisted with: AGEN 989
Description: Developing a graduate program, orientation to research, grant and research proposal preparation, experimental design and analysis, manuscript preparation and review, preparations and delivery of technical presentations, and research management.
Credit Hours: 1
Max credits per semester: 1
Max credits per degree: 1
Format: LEC
BSEN 998 Advanced Topics
Crosslisted with: AGEN 998
Prerequisites: Permission
Description: Individual study in advanced engineering topics that are not covered in regular course work or thesis. Topic varies by term.
Credit Hours: 1-6
Min credits per semester: 1
Max credits per semester: 6
Max credits per degree: 6
Format: IND

BSEN 999 Doctoral Dissertation
Prerequisites: Admission to doctoral degree program and permission of supervisory committee chair
Credit Hours: 1-24
Min credits per semester: 1
Max credits per semester: 24
Max credits per degree: 99
Format: IND