

BIOLOGICAL SYSTEMS ENGINEERING (BSEN)

BSEN 812 Rehabilitation Engineering

Crosslisted with: BSEN 412

Description: Application of engineering methods to the development of assistive technology for people with injuries and disabilities. Characterization of the physical and mental capabilities of people with impairment, universal design, assistive technologies associated with seating, transportation, communication, and recreation. Integration of engineering design principles in a rehabilitation design project.

Credit Hours: 3

Max credits per semester: 3

Max credits per degree: 3

Grading Option: Graded

BSEN 814 Medical Imaging Systems

Crosslisted with: BSEN 414

Prerequisites: BSEN 311 or ECEN 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

Grading Option: Grade Pass/No Pass Option

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

Grading Option: Grade Pass/No Pass Option

BSEN 816 Introduction to Biomaterials

Crosslisted with: BSEN 416

Prerequisites: BSEN/AGEN 225 or MECH 325; BIOC 401 or BIOC 431

Notes: 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

Grading Option: Grade Pass/No Pass Option

Prerequisite for: BSEN 418, BSEN 818

BSEN 818 Tissue Engineering

Crosslisted with: BSEN 418

Prerequisites: BSEN 416/816 or equivalent

Notes: 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

Grading Option: Grade Pass/No Pass Option

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

Grading Option: Grade Pass/No Pass Option

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

Grading Option: Grade Pass/No Pass Option

BSEN 844 Biomass and Bioenergy Engineering

Crosslisted with: BSEN 444

Prerequisites: Senior/graduate standing in engineering; BIOC 401 or 431

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

Grading Option: Grade Pass/No Pass Option

BSEN 845 Bioprocess Engineering

Crosslisted with: BSEN 445

Prerequisites: BSEN 344 or CHME 333

Description: Engineering topics related to processing of biological materials into valuable products. Enzyme kinetics, microbial kinetics, application of enzymes in industrial processes, bioreactor design, equipment scale-up, gas transfer in reactors and bioseparations.

Credit Hours: 3

Max credits per semester: 3

Max credits per degree: 3

Grading Option: Graded

Offered: FALL

BSEN 846 Unit Operations of Biological Processing

Crosslisted with: BSEN 446, AGEN 446, AGEN 846

Prerequisites: AGEN/BSEN 225; and AGEN/BSEN 344

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

Grading Option: Grade Pass/No Pass Option

Offered: SPRING

Prerequisite for: BSEN 935

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.

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

Grading Option: Grade Pass/No Pass Option

Prerequisite for: AGEN 854, AGST 854; AGEN 953; AGST 855

BSEN 855 Nonpoint Source Pollution Control Engineering

Crosslisted with: BSEN 455, CIVE 455, CIVE 855

Prerequisites: BSEN 321/CIVE 321 or BSEN 355; AGEN/BSEN 350 or CIVE 351 as prerequisite or parallel.

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

Grading Option: Grade Pass/No Pass Option

Offered: FALL

BSEN 856 GIS and Ecohydrological Modeling for Natural Resources

Crosslisted with: BSEN 456, AGEN 456, AGEN 856

Prerequisites: AGEN/BSEN 350 or CIVE 351 or AGST 354 or NRES 453

Description: Use of GIS to create inputs to models such as HEC-HMS and SWAT. Processes to simulate hydrology and erosion in models. Development and calibration of models based on student's area of interest.

Credit Hours: 3

Max credits per semester: 3

Max credits per degree: 3

Grading Option: Grade Pass/No Pass Option

Offered: SPRING

BSEN 858 Groundwater Engineering

Crosslisted with: BSEN 458, CIVE 458, CIVE 858

Prerequisites: CIVE 351 or AGEN 350 or BSEN 350

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

Grading Option: Grade Pass/No Pass Option

BSEN 860 Instrumentation and Controls

Crosslisted with: AGEN 460, AGEN 860, BSEN 460

Prerequisites: ECEN 211 or ECEN 215 or AGEN/BSEN 260

Description: Analysis and design of instrumentation and controls for agricultural, biological, and biomedical applications. Theory of basic sensors and transducers, analog and digital electrical control circuits, and the interfacing of computers with instruments and controls. LabVIEW Programming. Emphasis on signal analysis and interpretation for improving system performance.

Credit Hours: 3

Max credits per semester: 3

Max credits per degree: 3

Grading Option: Grade Pass/No Pass Option

Offered: FALL

BSEN 868 Wetlands

Crosslisted with: BIOS 458, NRES 468, NRES 868, BSEN 468

Prerequisites: CHEM 109A and 109L and CHEM 110A and 110L, or CHEM 105A and 105L and CHEM 106A and 106L; Junior or Senior Standing.

Notes: Offered even-numbered calendar years.

Description: Physical, chemical and biological processes that occur in wetlands; the hydrology and soils of wetland systems; organisms occurring in wetlands and their ecology wetland creation, delineation, management and ecotoxicology.

Credit Hours: 4

Max credits per semester: 4

Max credits per degree: 4

Grading Option: Grade Pass/No Pass Option

Course and Laboratory Fee: \$40

BSEN 879 Hydroclimatology

Crosslisted with: NRES 479, METR 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

Grading Option: Grade Pass/No Pass Option

BSEN 889 Graduate Foundations 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

Grading Option: Grade Pass/No Pass Option

Prerequisite for: AGEN 989, BSEN 989

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

Grading Option: Graded

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

Grading Option: Grade Pass/No Pass Option

BSEN 897 Masters Project

Crosslisted with: AGEN 897, AGST 897

Prerequisites: Admission to M.S. in Agricultural and Biological Systems Engineering or M.S. in Agricultural Systems Technology or M.S. in Mechanized Systems Management, and permission of major advisor

Notes: Intended for students who are pursuing an option B master's degree in Agricultural and Biological Systems Engineering, or Agricultural Systems Technology or Mechanized Systems Management.

Description: Conception, design, development, and completion of a project that requires data collection, synthesis, analysis of results, and the development of a final written report that will be defended in the final oral examination.

Credit Hours: 1-6

Min credits per semester: 1

Max credits per semester: 6

Max credits per degree: 6

Grading Option: Pass No-Pass

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

Grading Option: Grade Pass/No Pass Option

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

Grading Option: Pass No-Pass

BSEN 910 Delivery of Nucleic Acids

Prerequisites: Graduate Standing

Description: Engineering methods and principles to design delivery systems that can transfer nucleic acids to mammalian cells, including viral, non-viral and physical techniques, and review of applications including vaccines and gene therapies.

Credit Hours: 3

Max credits per semester: 3

Max credits per degree: 3

Grading Option: Graded

Offered: FALL

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

Grading Option: Grade Pass/No Pass Option

BSEN 930 Conservation Agriculture Systems

Crosslisted with: AGRI 930, NRES 930, AGEN 930

Prerequisites: Graduate student status.

Notes: Students entering the course should have a contextual understanding or background on the ecology of managed landscapes. The course is designed to build on students' scientific knowledge about the ecological functioning of agricultural landscapes by addressing the parallel influences of social, economic, and civil structures on agricultural system functioning, food security, cultural sovereignty, and environmental health.

Description: Aims to equip with an in-depth knowledge of conservation agriculture systems. Builds on scientific knowledge about the ecological functioning of agricultural landscapes by addressing the parallel influences of social, economic, and civil structures on agricultural system functioning, food security, cultural sovereignty, and environmental health. Explores the historical foundations, motivations, advances, and outcomes in global and local agricultural systems across time. Topics will focus on discovering ways scientific knowledge is correlated with historical occurrences and modern social perceptions. Content is selected to assist in developing multifaceted connections and clarity between their scientific understanding, the organization of agricultural systems, and the historical events that have influenced the development of modern food systems. Emphasis will be placed on harnessing individuals experiences and building discipline-based knowledge to prepare informed and perceptive agriculture science professionals with skills needed to strategically tackle modern agricultural production issues.

Credit Hours: 3

Max credits per semester: 3

Max credits per degree: 3

Grading Option: Graded

Offered: FALL

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

Grading Option: Grade Pass/No Pass Option

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

Grading Option: Grade Pass/No Pass Option

BSEN 942 Antimicrobial Resistance from a One Health Perspective

Prerequisites: Graduate Standing

Description: Covers the fundamentals of antimicrobial resistant development, transmission, and risks to humans, animals and the environment delivered by experts in One Health fields (interconnection between people, animals, and their shared environment). Exposed to a variety of perspectives on the highly complex problem of AMR and the spectrum of the challenges and the opportunities of multidisciplinary efforts to address it. Expected to work together with their peers across the country to review and develop research-based resources and methods for communicating scientific information about AMR to non-academic audiences.

Credit Hours: 1

Max credits per semester: 1

Max credits per degree: 1

Grading Option: Graded

Offered: SPRING

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

Grading Option: Grade Pass/No Pass Option

BSEN 945 Resilience Design in Agriculture**Crosslisted with:** AGRI 945, NRES 945, AGEN 945**Prerequisites:** Graduate student status.

Description: This 3-credit, graduate-level course teaches practical approaches in designing, or redesigning, food systems to optimize resource use and enhance agriculture system resilience. Transdisciplinary approaches are applied in solution development by combining concepts of conservation agriculture, agroecology, biodynamic farming, biogeochemistry, permaculture, and biosystems engineering to plan, mediate, and regenerate food systems. Topics center on land mitigation and adaptation methods that protect and conserve natural resources, regenerate and advance agroecosystems, promote land investment, adapt infrastructure, reduce disaster risks and climate vulnerability, and promote value-added incentives for controlling waste and pollution. Investigative analyses focus on ways food production and consumption patterns affect social and environmental sustainability and modern agrifood supply chain influences the economic concepts of circularity and solidarity.

Credit Hours: 3**Max credits per semester:** 3**Max credits per degree:** 3**Grading Option:** Graded**Offered:** FALL**BSEN 950 International Applications of Conservation Agriculture****Crosslisted with:** AGRI 950, NRES 950, AGEN 950**Prerequisites:** Graduate student status or approval by the instructor.

Description: This 3-credit, graduate-level course examines agricultural systems located in diverse geographical locations across the globe. Select agriculture production systems will be individually investigated to understand the environmental history of the area, creation of active production practices, viability of current methods, and value-added benefits from adding enhanced conservation practices. Science-based development plans will be created for the agriculture systems explored, which will have targeted goals, project objectives, theories to change (opportunities, barriers, planned interventions), implementation strategies, and assessment indicators. Improvement plans for each agriculture system will prioritize conservation practices and reflect on economic strengths and limitations of the region, community considerations, and dietary needs of the local population. Agriculture systems examined will include a diverse grouping of large-scale and small-holder food and fiber systems in Africa, Asia, Australia, Europe, North America, and South America.

Credit Hours: 3**Max credits per semester:** 3**Max credits per degree:** 3**Grading Option:** Graded**Offered:** SPRING**BSEN 951 Data-driven Modeling****Prerequisites:** Graduate standing**Notes:** Knowledge of linear algebra, computer programming, and nonlinear optimization are recommended prerequisites.

Description: Introduction of fundamental mathematical techniques and theories for data-driven modeling, with a focus on applications to agricultural sciences, biological systems engineering, and related areas. Topics include dimensionality reduction and coordinate transformation, sparse modeling, modeling time-series data, and machine learning. Common application areas encompass pattern extraction from spatiotemporal data profiles, determination of optimal sensor displacement, robust image reconstruction, reduced-order modeling, and more.

Credit Hours: 3**Max credits per semester:** 3**Max credits per degree:** 3**Grading Option:** Grade Pass/No Pass Option**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**Notes:** Offered spring semester of odd-numbered calendar years.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Grading Option:** Grade Pass/No Pass Option**BSEN 957 Modeling Vadose Zone Hydrology****Crosslisted with:** AGEN 957, CIVE 957, GEOL 957**Prerequisites:** 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**Grading Option:** Grade Pass/No Pass Option**Offered:** SPRING**BSEN 989 Graduate Foundations II****Crosslisted with:** AGEN 989**Prerequisites:** AGEN/BSEN 889

Description: Explore BSE career paths; identify necessary knowledge, skills, and abilities; and plan an aligned graduate experience. Become familiar with the professional norms and ethical principles and practices related to research. Build foundational skills for conducting a literature review. Develop oral communication skills appropriate for BSE. Develop reflexive ability to make meaning of graduate experiences.

Credit Hours: 1**Max credits per semester:** 1**Max credits per degree:** 1**Grading Option:** Grade Pass/No Pass Option

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

Grading Option: Grade Pass/No Pass Option

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

Grading Option: Pass No-Pass