Biological Engineering (BENG)

Courses

BENG 26302. Biological Engineering Design Studio. 2 Hours.
Application of the engineering design process to projects involving living systems. Projects are team-based open-ended design with hands-on construction and testing of design prototypes. Emphasis is placed on understanding, quantifying and controlling complex interacting living systems involving humans, animals, plants and microbes with the goal of creating economically and ecologically sustainable systems. 4 hours of design studio per week. Pre- or Corequisite: PHYS 20304 and BIOL 10103 and BIOL 10101, and (GNEG 11101 or GNEG 11003). (Typically offered: Fall)

BENG 26403. Biological Engineering Methods I. 3 Hours.
Introduction to software techniques for the graphical and geo-spatial representation of processes, structures, devices, landscapes and watersheds in biological engineering. Process layout and process flow diagrams. Two-dimensional and three-dimensional scale drawings and models. Elements of engineering drawings and plans. Mapping and introduction to geographic information systems. Surface topography, digital elevation modeling, spatial land use, soils and other GIS data sources. Stream networks, watershed delineation, grade planning and introductory runoff modeling. Introductory land surveying. Geo-referencing and integrating designed hydrologic structures with GIS-based site maps. Communicating complex designed systems. Two hours of lecture plus one 3-hour lab per week. Corequisite: Lab component. Prerequisite: PHYS 20304. (Typically offered: Spring)

BENG 31103. Measurement and Control for Biological Systems. 3 Hours.
Principles of sensors, instruments, measurements, controls, and data acquisition systems, with emphasis on applications for biological systems; including basic circuit analysis, sensor calibration and hardware selection. Basic process monitoring and control methods, including hardware and software. Lecture 2 hours, laboratory 3 hours per week. Corequisite: Lab component. Prerequisite: PHYS 20404. (Typically offered: Spring)

BENG 311H3. Honors Measurement and Control for Biological Systems. 3 Hours.
Principles of sensors, instruments, measurements, controls, and data acquisition systems, with emphasis on applications for biological systems; including basic circuit analysis, sensor calibration and hardware selection. Basic process monitoring and control methods, including hardware and software. Lecture 2 hours, laboratory 3 hours per week. Corequisite: Lab component. Prerequisite: PHYS 20404 and honors candidacy. (Typically offered: Spring)
This course is equivalent to BENG 31103.

BENG 36503. Global Bio-Energy Engineering. 3 Hours.
Global energy sources with a focus on renewable energy, solar and biomass derived fuels. Biomass energy production from crops and organic residues or waste products. Conversion of biomass to usable fuels. Utilization of renewable energy in society. Includes detailed systems analyses to examine inputs, efficiencies, usable outputs and by-products. Systems design to select and integrate components which meet client needs while maximizing sustainable global impacts. Three hours of lecture per week. Pre- or Corequisite: MEEG 24003 or CHEG 23103. (Typically offered: Fall)

BENG 365H3. Honors Global Bio-Energy Engineering. 3 Hours.
Global energy sources with a focus on renewable energy, solar and biomass derived fuels. Biomass energy production from crops and organic residues or waste products. Conversion of biomass to usable fuels. Utilization of renewable energy in society. Includes detailed systems analyses to examine inputs, efficiencies, usable outputs and by-products. Systems design to select and integrate components which meet client needs while maximizing sustainable global impacts. Three hours of lecture per week. Prerequisite: Honors standing. Pre- or corequisite: MEEG 24003 or CHEG 23103. (Typically offered: Fall)
This course is equivalent to BENG 36503.

BENG 36603. Biological Engineering Methods II. 3 Hours.
Modeling biological processes to predict system behavior as part of the design process. Development and use of spreadsheets and script programming code to represent biological phenomena and processes. Introduction to experimental design as applied to biological processes, including data collection and analysis, and elementary statistics. Use of engineering economics to aid comparisons of alternatives. Analysis of engineering designs and management practices to best meet the needs of society and the client in areas of sustainable water, food and energy systems. Lecture 2 hours and lab 3 hours per week. Corequisite: Lab component. Prerequisite: PHYS 20304 and MATH 25004. (Typically offered: Fall)

BENG 37203. Unit Operations in Biological Engineering. 3 Hours.
Design of basic unit operations typical of biological engineering practice; unit operations include pump-pipe, fan-duct, moist air (psychrometric) processes (cool/heater/humidifier/dryer), air mixing, aeration, and refrigeration; unit operations design will account for unique constraints imposed by biological systems. Lecture 2 hours and lab 3 hours per week. Corequisite: Lab component. Prerequisite: (MEEG 24003 or CHEG 23103) and (CVEG 32103 or CHEG 21303 or MEEG 35003). (Typically offered: Spring)

BENG 37303. Transport Phenomena in Biological Systems. 3 Hours.
Basic principles governing transport of energy and mass. Estimating transfer of energy (heat) through solid bodies and liquid/gas boundary layers through conduction, convection, and radiation. Modeling the rates at which biological reactions occur (kinetics). Estimating the transfer of diffusing mass (gas or liquid) through solid bodies and liquid/gas boundary layers, including processes such as drying and oxygen diffusion. Three hours lecture per week. Pre- or Corequisite: (CVEG 32103 or MEEG 35003 or CHEG 21303) and MATH 25804. Prerequisite: (MEEG 24003 or CHEG 23103). (Typically offered: Fall)

BENG 41203. Biosensors & Bioinstrumentation. 3 Hours.
Principles of biologically based sensing elements and interfacing techniques. Design and analysis methods of biosensing and transducing components in bioinstrumentation. Applications of biosensors and bioinstrumentation in bioprocessing, bioenvironmental, biomechanical and biomedical engineering. Lecture 2 hours, laboratory 3 hours per week. Corequisite: Lab component. Prerequisite: BIOL 20003 or BIOL 25473 and BENG 31103. (Typically offered: Spring Odd Years)

BENG 4500V. Special Problems. 1-4 Hour.
Problems in biological engineering are pursued in detail. Prerequisite: Instructor consent. (Typically offered: Fall, Spring and Summer) May be repeated for up to 4 hours of degree credit.

BENG 450HV. Honors Special Problems. 1-4 Hour.
Problems in biological engineering are pursued in detail. Prerequisite: Instructor consent and honors standing. (Typically offered: Fall, Spring and Summer) May be repeated for up to 4 hours of degree credit.
This course is equivalent to BENG 4500V.

BENG 451HV. Honors Thesis. 1-6 Hour.
Honors thesis. Prerequisite: Honors candidacy. (Typically offered: Fall, Spring and Summer)

BENG 4520V. Special Topics in Biological Engineering. 1-6 Hour.
Special topics in biological engineering not covered in other courses. Prerequisite: Engineering student. (Typically offered: Irregular) May be repeated for up to 8 hours of degree credit.

BENG 46603. Sustainable Biosystems Designs. 3 Hours.
Process and methodologies associated with measuring, assessing, and designing sustainable systems in water, energy and food. Quantitatively rigorous methodology for life cycle analysis (LCA) for inventory, assessment and impact analyses. Use of other systems analyses and process control theory to evaluate and design sustainable systems. Application of the methods to a project to gain experience in defining, quantifying and utilizing sustainable metrics. Three hours of lecture per week. Prerequisite: BENG 36503. (Typically offered: Spring)

BENG 47403. Food and Bio-Product Systems Engineering. 3 Hours.
Sustainable bio-product engineering through biosystem design, analysis, modeling, control, and optimization. Life cycle phases for bio-products (food, fiber, feed, and fuel). System analysis of inputs and outputs of energy, water and mass for the purpose of producing and processing biomass for human uses. Advanced bio-process design topics to utilize enzymes, cells, tissues and organisms to create bio-products and methods for deactivating biological agents to preserve the quality and safety of food and other bio-products. Three hours lecture per week. Pre- or corequisite: BENG 37303. Prerequisite: BENG 37203. (Typically offered: Fall)

BENG 474H3. Honors Food and Bio-Product Systems Engineering. 3 Hours.
Sustainable bio-product engineering through biosystem design, analysis, modeling, control, and optimization. Life cycle phases for bio-products (food, fiber, feed, and fuel). System analysis of inputs and outputs of energy, water and mass for the purpose of producing and processing biomass for human uses. Advanced bio-process design topics to utilize enzymes, cells, tissues and organisms to create bio-products and methods for deactivating biological agents to preserve the quality and safety of food and other bio-products. Three hours lecture per week. Prerequisite: BENG 37203 and honors standing. Pre- or corequisite: BENG 37303. (Typically offered: Fall)
This course is equivalent to BENG 47403.

BENG 48102. Senior Biological Engineering Design I. 2 Hours.
Initiation of comprehensive two-semester team-design projects to design processes, devices and systems to meet needs of clients in sustainable water, food and energy. Practice in following the design process, including the definition of design objectives and constraints, establishing functions and performance criteria, generating alternatives and evaluating alternatives through analysis, modeling and prototype testing; exploring relevant design considerations including performance, efficiency, costs, environmental impacts, sustainability and stewardship, safety and ethics. Developing analytic capability; and practicing design optimization to find best alternative for the client. Lecture 1 hour, laboratory 3 hours per week. Corequisite: Lab component. Pre- or corequisite: (BENG 47403 and BENG 49303) or Instructor consent. (Typically offered: Fall)

BENG 48203. Senior Biological Engineering Design II. 3 Hours.
Completion of comprehensive two-semester team-design projects to design processes, devices and systems to meet needs of clients in sustainable water, food and energy. Focus on building of prototypes or models, system optimization, evaluation and improvement. Final design details packaged to meet the needs of the client. Interaction with appropriate persons from other disciplines. Written and oral reporting. Communications with peers, supervisor, clients and the public. Lecture 1 hour per week, two 2-hour lab periods per week. Prerequisite: BENG 48102. Corequisite: Lab component. (Typically offered: Spring)

BENG 48301. Biological Engineering Professionalism. 1 Hour.
Preparation to be job-ready, employable and successful in transition to a professional career and further study in Biological Engineering. Introduction to job and graduate study searches. Professional and ethical responsibilities; professional registration. Conflict, change and project management. Effective communications and interactions with supervisors, peers, clients, and stakeholders. Two hour discussion section per week. Prerequisite: Senior standing. (Typically offered: Fall)

BENG 49303. Sustainable Watershed Engineering. 3 Hours.
Provides students with expertise in using advanced tools in watershed monitoring, assessment, and design. Builds on core competencies in hydrology and hydraulics to allow student to evaluate water used by sector in water management regions; evaluate and quantify water demands by sector with emphasis on irrigation; develop risk-based simulations of hydrologic processes, including precipitation, evapo-transportation, infiltration, runoff, and stream flow; quantify and simulate constituent loading to watersheds using GIS-based models, and understand the applications of these methods in water resource management policy. Three hours lecture per week. Prerequisite: CVEG 32203. (Typically offered: Fall)

BENG 493H3. Honors Sustainable Watershed Engineering. 3 Hours.
Provides students with expertise in using advanced tools in watershed monitoring, assessment, and design. Builds on core competencies in hydrology and hydraulics to allow student to evaluate water used by sector in water management regions; evaluate and quantify water demands by sector with emphasis on irrigation; develop risk-based simulations of hydrologic processes, including precipitation, evapo-transportation, infiltration, runoff, and stream flow; quantify and simulate constituent loading to watersheds using GIS-based models, and understand the applications of these methods in water resource management policy. Three hours lecture per week. Prerequisite: CVEG 32203. (Typically offered: Fall)
This course is equivalent to BENG 49303.

BENG 49603. Modeling Environmental Biophysics. 3 Hours.
Interactions between the biosphere and the atmosphere. Connecting the physical environment of solar energy, wind, soil, and hydrology to the biosphere through plant ecophysiology. Boundary layer meteorology, photosynthesis and boundary layer modeling strategies, and the soil-plant-atmosphere continuum. Instrumentation, measurement and modeling strategies for understanding leaf-, landscape- and regional behaviors; and, the transfer, kinetics, and balance of momentum, energy, water vapor, CO2, and other atmospheric trace gases between the landscape (vegetation and soil) and the atmosphere. Applications in sustainable agriculture, irrigation, land and water resources, and modeling plant water use and carbon uptake strategies. Three hours of lecture per week. Prerequisite: MATH 25004 and (BENG 49303 or CVEG 32203). (Typically offered: Spring Even Years)

BENG 49703. Practice in Water Quality Monitoring and Analysis. 3 Hours.
Application of water quality principles to a real world problem. Team project experience developing quality assurance project plans, designing monitoring systems, selecting chemical analysis methods, estimating loads, performing trend analysis, basic model calibration and validation, and technical report writing and oral presentations. Working with various clientele to analyze water quality data in the context of evaluating real-world problems and issues. Technical course intended for students in engineering, environmental sciences, agriculture and biology. Three hours of lecture per week. Prerequisite: CVEG 32103 or instructor's consent to allow interdisciplinary student teams. (Typically offered: Spring Odd Years)

BENG 5000V. Advanced Topics in Biological Engineering. 1-6 Hour.
Special problems in fundamental and applied research. Prerequisite: Graduate standing. (Typically offered: Irregular) May be repeated for up to 6 hours of degree credit.

BENG 51003. Advanced Instrumentation in Biological Engineering. 3 Hours.
Applications of advanced instrumentation in biological systems. Emphasis on updated sensing and transducing technologies, data acquisition and analytical instruments. Lecture 2 hours, lab 3 hours per week. Corequisite: Lab component. Prerequisite: BENG 31103. (Typically offered: Spring Even Years)

BENG 52503. Bio-Mems. 3 Hours.
Topics include the fundamental principles of microfluidics, Navier-Stokes Equation, bio/abio interfacing technology, bio/abio hybrid integration of microfabrication technology, and various biomedical and biological problems that can be addressed with microfabrication technology and the engineering challenges associated with it. Lecture 3 hour per week. Prerequisite: MEEG 35003 or CVEG 32103 or CHEG 21303. (Typically offered: Irregular)
This course is cross-listed with MEEG 52503.

BENG 56103. Simulation Modeling of Biological Systems. 3 Hours.
Application of computer modeling and simulation of discrete-event and continuous-time systems to solve biological and agricultural engineering problems. Philosophy and ethics of representing complex processes in simplified form. Deterministic and stochastic modeling of complex systems, algorithm development, application limits, and simulation interpretation. Emphasis on calibration, validation and testing of biological systems models for the purposes of system optimization, resource allocation, real-time control and/or conceptual understanding. Prerequisite: AGST 50203 or (STAT 30043 or STAT 50133) or INEG 23104. (Typically offered: Irregular)

BENG 56203. Life Cycle Assessment. 3 Hours.
This course will examine the process and methodologies associated with life cycle analysis (LCA). The course will explore the quantitatively rigorous methodology for life cycle inventory (LCI), LCA and life cycle impact assessment (LCIA). This course is offered on-line. The principal instructor will be a UA faculty member. (Typically offered: Spring)

BENG 56303. Linkages Among Technology, Economics and Societal Values. 3 Hours.
Addresses how macro-level change is influenced by the linkages among technology, economics and societal values. Three major course initiatives: 1) Developing a conceptual model for understanding how macro-level change has occurred over history; 2) Examining recorded history in order to develop a contextual appreciation for Society's current situation; and 3) Using statistical data to identify six overriding world trends that are likely to greatly impact society's goal of achieving sustainable prosperity and well-being in the foreseeable future. Prerequisite: Graduate standing or instructor permission. (Typically offered: Fall and Spring)

BENG 57003. Design and Analysis of Experiments for Engineering Research. 3 Hours.
Principles of planning and design of experiments for engineering research. Propagation of experimental error. Improving precision of experiments. Analysis of experimental data for optimal design and control of engineering systems using computer techniques. Students must have an introductory background in statistics. Lecture 2 hours, laboratory 3 hours per week. Corequisite: Lab component. (Typically offered: Irregular)

BENG 58001. Graduate Seminar. 1 Hour.
Reports presented by graduate students on topics dealing with current research in biological engineering. Prerequisite: Graduate standing. (Typically offered: Spring)

BENG 59203. Nonpoint Source Pollution Control and Modeling. 3 Hours.
Control of hydrologic, meteorologic, and land use factors on nonpoint source (NPS) pollution in urban and agricultural watersheds. Discussion of water quality models to develop NPS pollution control plans and total maximum daily loads (TMDLs), with consideration of model calibration, validation, and uncertainty analysis. Prerequisite: CVEG 32203. (Typically offered: Irregular)

BENG 59303. Environmental and Ecological Risk Assessment. 3 Hours.
Process and methodologies associated with human-environmental and ecological risk assessments. Environmental risk assessments based on human receptors as endpoints, addressing predominantly abiotic processes. Ecological risk assessments based on non-human receptors as endpoints. Approach using hazard definition, effects assessment, risk estimation, and risk management. Application of methods to student projects to gain experience in defining and quantifying uncertainty associated with human perturbation, management and restoration of environmental and ecological processes. (Typically offered: Spring)

BENG 59603. Modeling Environmental Biophysics. 3 Hours.
Interactions between the biosphere and the atmosphere. Connecting the physical environment of solar energy, wind, soil, and hydrology to the biosphere through plant ecophysiology. Boundary layer meteorology, photosynthesis and boundary layer modeling strategies, and the soil-plant-atmosphere continuum. Instrumentation, measurement and modeling strategies for understanding leaf-, landscape- and regional behaviors; and, the transfer, kinetics, and balance of momentum, energy, water vapor, CO2, and other atmospheric trace gases between the landscape (vegetation and soil) and the atmosphere. Applications in sustainable agriculture, irrigation, land and water resources, and modeling plant water use and carbon uptake strategies. A working knowledge of calculus and a discipline related to the course is expected. Three hours of lecture per week. Students may not earn degree credit for both BENG 49603 and BENG 59603. Prerequisite: Instructor consent. (Typically offered: Spring Even Years)

BENG 59703. Advanced Practice in Water Quality Monitoring and Analysis. 3 Hours.
Application of water quality principles to a real world problem. Team project experience leading and developing quality assurance project plans, designing monitoring systems, selecting chemical analysis methods, estimating loads, performing trend analysis, basic model calibration and validation, team management, and technical report writing and oral presentations. Working with various clientele to analyze water quality data in the context of evaluating real-world problems and issues. Three hours of lecture per week. Prerequisite: Graduate standing. (Typically offered: Spring Odd Years)

BENG 6000V. Master's Thesis. 1-6 Hour.
Graduate standing required for enrollment. (Typically offered: Fall, Spring and Summer) May be repeated for degree credit.

BENG 7000V. Doctoral Dissertation. 1-18 Hour.
Candidacy is required for enrollment. (Typically offered: Fall, Spring and Summer) May be repeated for degree credit.