BIOLOGICAL ENGINEERING (BE)

BE 1420 Introduction to Biological Engineering (2 credits)
An introduction to the biological engineering discipline, focusing on creatively integrating engineering principles and modern technologies to solve biological problems. Students will explore fields of study within biological engineering such as medical, environmental, and energy. Students will also develop hands-on skills and conduct a team-based project. The course includes one lecture and a lab each week. Typically Offered: Spring.

BE 2040 (s) Special Topics (1-16 credits, max 99)
Credit arranged

BE 2420 Biological Engineering Analysis and Design (3 credits)
Methods of analyzing and solving engineering problems; introduction to elements of biological engineering design; use of computers in engineering problem solving.
Prereqs: MATH 1170
Coreqs: MATH 1750

BE 2990 (s) Directed Study (1-16 credits, max 99)
Credit arranged

BE 3410 Electronics in Biological Engineering (3 credits)
This course will give students an understanding of electrical systems and electronics applied to biological engineering. It covers analysis of DC and polyphase AC circuits, basic electronics such as diode, transistor, up to op-amp, characteristics and selection of various types of electric motors, and control of motors using microcontroller. Two 1-hour lectures and one 3-hour lab per week. Typically Offered: Spring.
Prereqs: PHYS 2120 and MATH 2750

BE 3610 Biotransport Processes (3 credits)
The course will familiarize students with transport phenomena processes involved in bio-related fields spanning from agricultural to environmental and medical to pharmaceutical. Typically Offered: Varies.
Prereqs: ENGR 3350
Coreqs: ENGR 3200

BE 3980 (s) Engineering Cooperative Internship (1-16 credits, max 99)
Credit arranged. Supervised internship in professional engineering settings, integrating academic study with work experience; details of the co-op to be arranged with supervising professor before the start of the co-op; requires written report. Cannot be used for technical elective. Graded Pass/Fail.
Prereqs: Permission

BE 4040 (s) Special Topics (1-16 credits, max 99)
Credit arranged

BE 4110 Energy and Environmental Auditing (3 credits)
Joint-listed with BE 5110
This course provides an understanding of energy usage, energy management, and impact of industrial processes on environment. The course covers instrumentation for measuring energy and emissions, diagnostics for energy wastage, environmental life cycle analysis, assessment tools, and writing recommendations. The graduate version of the course includes a case study and in-depth analysis of uncommon energy saving recommendations.
Prereqs: ENGR 2400 and (ENGR 3200 or ME 3220), or Permission

BE 4210 Image Processing and Computer Vision (3 credits)
Joint-listed with BE 5210
Fundamentals of digital image processing, analysis, feature recognition, and computer vision applied to areas of Biological Engineering including agricultural, environmental and biomedical applications. This course covers camera model, digital image processing and image analysis techniques for computer vision. Additional project components required for graduate credit.
Prereqs: BE 2420 and MATH 2750 or permission

BE 4220 Tissue Biomechanics (3 credits)
Joint-listed with BE 5220
This course explores the structure and mechanical properties of hard and soft tissues. The main focus will be on musculoskeletal tissues and may include topics in bone, skin, cartilage, muscle, tendon and ligament. Structure-function relationships at a range of anatomical levels, from the cell to the whole tissue, will be examined. Journal articles will be used to discuss current research in tissue biomechanics. Additional projects/assignments are required for graduate credit. Recommended Preparation: Mechanics of Materials
Prereqs: Junior or Senior standing; or Instructor Permission

BE 4230 Tissue Engineering and Regenerative Medicine (3 credits)
Joint-listed with BE 5230
This course explores the principles, strategies, and tools used in the field of tissue engineering and regenerative medicine. Topics may include the application of biomaterials, stem cells, and bioreactors for restoring, maintaining and improving tissue function. Journal articles will be used to discuss current research in tissue engineering and regenerative medicine. Additional projects/assignments are required for graduate credit.
Prereqs: Junior or Senior standing; or Instructor Permission

BE 4330 Bioremediation (3 credits)
Joint-listed with BE 5330
Theory and practice of bioremediation as applied to toxic and hazardous wastes, including reaction kinetics, reaction stoichiometry, microbiology, and design of ex- and in-situ processes. Graduate credit requires additional design project. One or two field trips.
Prereqs: BIOL 1150, BIOL 1150L, and MATH 1170, or Permission

BE 4410 Instrumentation and Controls (4 credits)
Joint-listed with BE 5410
This course provides a solid foundation on instrumentation for measurements and controls. Topics include principles of sensing elements, noise sources and mitigation techniques, analog domain signal conditioning, analog to digital conversion, signal filtering in the frequency domain, statistical inferences of measurements, feedback controls, optimum control, and modern controller hardware programming. Students will design, fabricate, and test a complete instrumentation and control system related to biological engineering. Additional work will be required for graduate credit. Typically Offered: Fall.
Prereqs: PHYS 2120, BE 3410, or ENGR 2400, or Permission
Coreqs: STAT 3010 Cooperative: open to WSU degree-seeking students

BE 4500 Environmental Hydrology (3 credits)
Carries no credit after CE 3250. The objective of this course is to provide a comprehensive understanding of the hydrologic processes associated with the environmental processes. Includes components of the hydrologic cycle, analysis of precipitation and run off, evapotranspiration, routing, peak flow, infiltration, soil and water relationships, snowmelt, and frequency analysis. Typically Offered: Spring.
Prereqs: MATH 1170

BE 4530 Northwest Climate and Water Resources Change (3 credits)
Joint-listed with BE 5530
Examines the relationship between climate and water resources in the Northwest, including historical and potential changes, and comparisons with other US regions. Scientific literature is read and discussed. Quantitative tools are developed for modeling the process physics and conducting statistical analyses. Historical data are analyzed. Additional project components required for graduate credit.
Prereqs: STAT 3010 or permission

BE 4610 Bioprocess Engineering (3 credits)
Joint-listed with BE 5610
This course covers advanced applications of biological sciences, processing principles applied to the analysis and design of handling, processing, and separation of bioproducts. Students complete several hands-on laboratory modules in addition to a bioprocess design project. Additional work required for graduate credit.
Prereqs: Permission

BE 4620 Electric Power and Controls (3 credits)
Design, selection, and use of electrical equipment and electric power systems for application to biological systems; design and use of electrical, electronic, and other feedback control systems for use with biological systems. Course includes advanced biological sciences applications. Two lectures and one 3-hour lab per week. Typically Offered: Spring.
Coreqs: MATH 3100 and PHYS 2120

BE 4780 Engineering Design I (3 credits)
General Education: Capstone Experience
The capstone design sequence for biological and agricultural engineering majors. Course topics include research, design, experimental methods, specifications, prototyping, and verification; report writing, documentation and oral presentations. Topics, from industrial sponsorship, are considered in the context of a major design project involving a team of students. Projects incorporate realistic engineering constraints including environmental concerns, sustainability, ethical, safety, manufacturability, social and political considerations.
Prereqs: BE 2420, ENGR 3200, ENGR 3350, and ENGR 3500

BE 4790 Engineering Design II (3 credits)
General Education: Capstone Experience
Continuation of the capstone design sequence for biological and agricultural engineering majors. Course topics include research, design, experimental methods, specifications, prototyping, verification, report writing, documentation and oral presentations. Topics, from industrial sponsorship, are considered in the context of a major design project involving a team of students. Projects incorporate realistic engineering constraints including environmental concerns, sustainability, ethical, safety, manufacturability, social and political considerations
Prereqs: BE 4780

BE 4850 Fundamentals of Bioenergy and Bioproducts (3 credits)
Joint-listed with BE 5850
Review of current technology for producing energy and products from biological materials. Discussion of economic, social, and political aspects and future prospects for petroleum displacement. Additional projects/assignments required for graduate credit. Recommended Preparation: Organic Chemistry.
Prereqs: CHEM 1111, CHEM 1111L
Coreqs: ENGR 3200 or Permission

BE 4910 Senior Seminar (1 credit)
General Education: Capstone Experience
Cross-listed with CHE 4910
Professional aspects of the field, employment opportunities, and preparation of occupational inventories. Graded Pass/Fail. Typically Offered: Varies.
Prereqs: Senior standing.

BE 4920 Biofuels (3 credits)
Joint-listed with BE 5920
Basic principles for the production and utilization of biobased fuels; processing techniques and chemistry; fuel properties and utilization. Additional projects/assignments required for graduate credit. Recommended Preparation: Organic Chemistry.
Prereqs: CHEM 1111, CHEM 1111L
Coreqs: ENGR 3200 or Permission

BE 4940 Thermochemical Technologies for Biomass Conversion (3 credits)
Joint-listed with BE 5940
Introduce the fundamentals of biomass conversion technologies for biofuels and bioenergy. Specific topics include biomass preparation/pretreatment, pyrolysis, gasification, direct liquefaction, and economic factors in thermochemical conversion of biomass. Advances of the technologies will be brought to current through literature reviews. A semester-long course project is required if taken as a graduate-level course. Recommended Preparation: Organic Chemistry, Chemical Reaction Engineering, Engineering Thermodynamics.
Prereqs: CHEM 2770 and CHEM 2780
Coreqs: ENGR 3200 or Permission

BE 4990 (s) Directed Study (1-16 credits, max 99)
Credit arranged

BE 5000 Master's Research and Thesis (1-16 credits, max 99)
Credit arranged

BE 5010 (s) Seminar (1 credit, max 99)
Cross-listed with CHE 5010
Graded Pass/Fail. Typically Offered: unknown.
Prereqs: Permission

BE 5020 (s) Directed Study (1-16 credits, max 99)
Credit arranged

BE 5040 (s) Special Topics (1-16 credits, max 99)
Credit arranged

BE 5110 Energy and Environmental Auditing (3 credits)
Joint-listed with BE 4110
This course provides an understanding of energy usage, energy management, and impact of industrial processes on environment. The course covers instrumentation for measuring energy and emissions, diagnostics for energy wastage, environmental life cycle analysis, assessment tools, and writing recommendations. The graduate version of the course includes a case study and in-depth analysis of uncommon energy saving recommendations.

BE 5210 Image Processing and Computer Vision (3 credits)
Joint-listed with BE 4210
Fundamentals of digital image processing, analysis, feature recognition, and computer vision applied to areas of Biological Engineering including agricultural, environmental and biomedical applications. This course covers camera model, digital image processing and image analysis techniques for computer vision. Additional project components required for graduate credit.

BE 5220 Tissue Biomechanics (3 credits)
Joint-listed with BE 4220
This course explores the structure and mechanical properties of hard and soft tissues. The main focus will be on musculoskeletal tissues and may include topics in bone, skin, cartilage, muscle, tendon and ligament. Structure-function relationships at a range of anatomical levels, from the cell to the whole tissue, will be examined. Journal articles will be used to discuss current research in tissue biomechanics. Additional projects/assignments are required for graduate credit. Recommended Preparation: Mechanics of Materials

BE 5230 Tissue Engineering and Regenerative Medicine (3 credits)
Joint-listed with BE 4230
This course explores the principles, strategies, and tools used in the field of tissue engineering and regenerative medicine. Topics may include the application of biomaterials, stem cells, and bioreactors for restoring, maintaining and improving tissue function. Journal articles will be used to discuss current research in tissue engineering and regenerative medicine. Additional projects/assignments are required for graduate credit.

BE 5240 Sustainable Food-Energy-Water Systems (3 credits)
Cross-listed with ME 5240
This course covers sustainability analysis, life cycle assessment, and applications of sustainability across design and manufacturing processes, as well as food-energy-water systems, which establishes the concept of sustainability, and sustainable engineering. This course introduces the intersection of sustainability and food-energy-water systems through sustainable development, sustainability principles, and environmental analysis. Foundational knowledge in physics, chemistry, calculus, engineering materials; engineering design and manufacturing; foundational knowledge in business operations and supply chain. Typically Offered: Spring.

BE 5330 Bioremediation (3 credits)
Joint-listed with BE 4330
Theory and practice of bioremediation as applied to toxic and hazardous wastes, including reaction kinetics, reaction stoichiometry, microbiology, and design of ex- and in-situ processes. Graduate credit requires additional design project. One or two field trips.

BE 5410 Instrumentation and Controls (4 credits)
Joint-listed with BE 4410
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Coreqs: STAT 3010 Cooperative: open to WSU degree-seeking students

BE 5530 Northwest Climate and Water Resources Change (3 credits)
Joint-listed with BE 4530
Examines the relationship between climate and water resources in the Northwest, including historical and potential changes, and comparisons with other US regions. Scientific literature is read and discussed. Quantitative tools are developed for modeling the process physics and conducting statistical analyses. Historical data are analyzed. Additional project components required for graduate credit.

BE 5610 Bioprocess Engineering (3 credits)
Joint-listed with BE 4610
This course covers advanced applications of biological sciences, processing principles applied to the analysis and design of handling, processing, and separation of bioproducts. Students complete several hands-on laboratory modules in addition to a bioprocess design project. Additional work required for graduate credit.

BE 5850 Fundamentals of Bioenergy and Bioproducts (3 credits)
Joint-listed with BE 4850
Review of current technology for producing energy and products from biological materials. Discussion of economic, social, and political aspects and future prospects for petroleum displacement. Additional projects/assignments required for graduate credit. Recommended Preparation: Organic Chemistry.
Coreqs: ENGR 3200 or Permission

BE 5920 Biofuels (3 credits)
Joint-listed with BE 4920
Basic principles for the production and utilization of biobased fuels; processing techniques and chemistry; fuel properties and utilization. Additional projects/assignments required for graduate credit. Recommended Preparation: Organic Chemistry.
Coreqs: ENGR 3200 or Permission

BE 5940 Thermochemical Technologies for Biomass Conversion (3 credits)
Joint-listed with BE 4940
Introduce the fundamentals of biomass conversion technologies for biofuels and bioenergy. Specific topics include biomass preparation/pretreatment, pyrolysis, gasification, direct liquefaction, and economic factors in thermochemical conversion of biomass. Advances of the technologies will be brought to current through literature reviews. A semester-long course project is required if taken as a graduate-level course. Recommended Preparation: Organic Chemistry, Chemical Reaction Engineering, Engineering Thermodynamics.
Coreqs: ENGR 3200 or Permission

BE 5980 (s) Internship (1-16 credits, max 99)
Credit arranged

BE 5990 (s) Non-thesis Master's Research (1-16 credits, max 99)
Credit arranged. Research not directly related to a thesis or dissertation.
Prereqs: Permission

BE 6000 Doctoral Research and Dissertation (1-45 credits, max 99)
Credit arranged