BIOLOGICAL ENGINEERING (BE)

BE 142 Introduction to Biological Engineering (2 credits)
An introduction to biological engineering and the engineering principles used to solve biological engineering problems. Fields of study within biological engineering will be discussed including agricultural, bioenergy, biomedical, bioprocess, ecohydrological and environmental engineering. Students will work on a team-based engineering project. One lecture and one 3-hour lab per week.

BE 204 (s) Special Topics (1-16 credits)
Credit arranged

BE 242 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 170
Coreqs: MATH 175

BE 299 (s) Directed Study (1-16 credits)
Credit arranged

BE 341 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 212, Math 275

BE 361 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 335
Coreqs: ENGR 320

BE 398 (s) Engineering Cooperative Internship (1-16 credits)
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. Graded P/F. Cannot be used for technical elective.
Prereqs: Permission

BE 404 (s) Special Topics (1-16 credits)
Credit arranged

BE 411 Energy and Environmental Auditing (3 credits)
Joint-listed with BE 511
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 240 and (ENGR 320 or ME 322), or Permission

BE 421 Image Processing and Computer Vision (3 credits)
Joint-listed with BE 521
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 242 and MATH 275) or permission

BE 422 Tissue Biomechanics (3 credits)
Joint-listed with BE 522
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 423 Tissue Engineering and Regenerative Medicine (3 credits)
Joint-listed with BE 523
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 433 Bioremediation (3 credits)
Joint-listed with BE 533
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 115, BIOL 115L, and MATH 170, or Permission

BE 441 Instrumentation and Controls (4 credits)
Joint-listed with BE 541
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 212, BE 341
Coreqs: STAT 301 Cooperative: open to WSU degree-seeking students

BE 450 Environmental Hydrology (3 credits)
Carries no credit after BE 355 or CE 325. 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. (Spring only)
Prereqs: MATH 170

BE 453 Northwest Climate and Water Resources Change (3 credits)
Joint-listed with BE 553
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 301 or permission

BE 461 Bioprocess Engineering (3 credits)
Joint-listed with BE 561
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 462 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 310 and PHYS 212

BE 478 Engineering Design I (3 credits)
General Education: Senior 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 242, ENGR 320, ENGR 335, and ENGR 350

BE 479 Engineering Design II (3 credits)
General Education: Senior Experience
Continuation of 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 478

BE 485 Fundamentals of Bioenergy and Bioproducts (3 credits)
Joint-listed with BE 585
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 111, CHEM 111L
Coreqs: ENGR 320 or Permission

BE 491 Senior Seminar (1 credit)
General Education: Senior Experience
Professional aspects of the field, employment opportunities, and preparation of occupational inventories. Graded P/F.
Prereqs: Senior standing.

BE 492 Biofuels (3 credits)
Joint-listed with BE 592
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 111, CHEM 111L
Coreqs: ENGR 320 or Permission

BE 494 Thermochemical Technologies for Biomass Conversion (3 credits)
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 277 and CHEM 278.
Coreqs: ENGR 320 or Permission

BE 499 (s) Directed Study (1-16 credits)
Credit arranged

BE 500 Master's Research and Thesis (1-16 credits)
Credit arranged

BE 501 (s) Seminar (1 credit, max 2)
Cross-listed with CHE 501
Graded P/F.
Prereqs: Permission

BE 502 (s) Directed Study (1-16 credits)
Credit arranged

BE 504 (s) Special Topics (1-16 credits)
Credit arranged

BE 511 Energy and Environmental Auditing (3 credits)
Joint-listed with BE 411
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 240 and (ENGR 320 or ME 322), or Permission

BE 521 Image Processing and Computer Vision (3 credits)
Joint-listed with BE 421
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 242 and MATH 275) or permission

BE 522 Tissue Biomechanics (3 credits)
Joint-listed with BE 422
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 required for graduate credit. Recommended Preparation: Mechanics of Materials

BE 523 Tissue Engineering and Regenerative Medicine (3 credits)
Joint-listed with BE 423
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 required for graduate credit.

BE 524 Sustainable Food-Energy-Water Systems (3 credits)
Cross-listed with ME 524
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 533 Bioremediation (3 credits)
Joint-listed with BE 433
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 115, BIOL 115L and MATH 170, or Permission

BE 541 Instrumentation and Controls (4 credits)
Joint-listed with BE 441
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.
Coreqs: STAT 301 Cooperative: open to WSU degree-seeking students

BE 552 Environmental Water Quality (3 credits)
Joint-listed with BE 452
Engineering design to monitor, evaluate, and minimize non-point pollution from agriculture, environmentally acceptable disposal of wastes, bioremediation. Graduate credit requires an additional project and report. Two lectures and one 3-hour lab per week.

BE 553 Northwest Climate and Water Resources Change (3 credits)
Joint-listed with BE 453
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 301 or permission

BE 561 Bioprocess Engineering (3 credits)
Joint-listed with BE 461
This course covers advanced applications of biological sciences, processing principles applied to the analysis and design of handling, processing, and separation of biomaterials. Students complete several hands-on laboratory modules, in addition to a bioprocess design project. Additional work is required for graduate credit.
Prereqs: Permission

BE 585 Fundamentals of Bioenergy and Bioproducts (3 credits)
Joint-listed with BE 485
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 111, CHEM 111L
Coreqs: ENGR 320 or Permission

BE 592 Biofuels (3 credits)
Joint-listed with BE 492
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 111, CHEM 111L
Coreqs: ENGR 320 or Permission

BE 594 Thermochemical Technologies for Biomass Conversion (3 credits)
Joint-listed with BE 494
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 277 and CHEM 278
Coreqs: ENGR 320 or Permission

BE 598 (s) Internship (1-16 credits)
Credit arranged

BE 599 (s) Non-thesis Master's Research (1-16 credits)
Credit arranged. Research not directly related to a thesis or dissertation.
Prereqs: Permission

BE 600 Doctoral Research and Dissertation (1-45 credits)
Credit arranged