BE (EES, FOR) 4510* Newman Seminar and Lecture Series in Natural Resources Engineering 1(2) Topics dealing with development and protection of land, air, water, and related resources are covered by seminar with instructor and invited lecturers. Current environmental and/or resource conservation issues are addressed. Includes Honors sections. May also be offered as EES 4510 or FOR 4510. Prep: Senior standing.

BE 4640* Non-Point Source Management in Engineered Ecosystems 3(2) Fundamentals of non-point source pollution, including quantification of environmental impact and ecosystem management related to contaminants and nutrients and to planning and design of ecological systems. Prep: MICR 3050 and Senior standing in engineering. Coreq: BE 4641.

BE 4641* Non-Point Source Management in Engineered Ecosystems Laboratory 0(3) Non-credit laboratory to accompany BE 4640. Coreq: BE 4640.

BE 4730 Special Topics in Biosystems Engineering 13(3-1) Comprehensive study of special topics not covered in other courses. Emphasizes independent pursuit of detailed investigations. May be repeated for a maximum of six credits, but only if different topics are covered. Prep: Consent of instructor.

BE 4740 Biosystems Engineering Design/Project Management 2(1) Study of biological systems design using hydrology principles, fluid mechanics, bioprocessing, heat/mass transfer, instrumentation, mechanical unit operations, and structural principles for project design, scheduling, and cost estimation. Topics also include engineering ethics, professional development, written and oral communication, and job skills. Senior portfolios are also developed. Prep: Senior standing in Biosystems Engineering. Coreq: BE 4741.

BE 4741 Biosystems Engineering Design/Project Management Laboratory 0(3) Non-credit laboratory to accompany BE 4740. Coreq: BE 4740.

BE 4750 Biosystems Engineering Capstone Design 2 (4) Applications of hydrology, fluid mechanics, bioprocessing, heat/mass transfer, instrumentation, mechanical unit operations, and structural principles in design; project scheduling, cost estimation; ethics; environmental and social impacts; design drawings; and report documentation. Prep: Senior standing in Biosystems Engineering.

BE (EES) 4840* Municipal Solid Waste Management 3(3) Introduction to the problems, regulations, collection, handling, recycling, and disposal of municipal solid wastes in the urban and rural sectors. Emphasizes an integrated waste-management system with resource recovery, composting, incineration, landfill disposals, and their costs. May also be offered as EES 4840. Preq: EES 2020 or EES 4010.

BE 4990 Creative Inquiry - Biosystems Engineering IV 1(3-1) In consultation with and under the direction of a faculty member, students pursue scholarly activities individually or in teams. These creative inquiry projects may be interdisciplinary. Arrangements with mentors must be established prior to registration. May be taken twice for a maximum of six credits. To be taken Pass/No Pass only.

BIOENGINEERING


BIOE 1010 Biology for Bioengineers 1(1) Provides basic introduction to fundamental principles of molecular and cellular biology. Prep: CH 1010.

BIOE 2000 Bioengineering Professional Development 0(1) Provides an introduction to the professional opportunities available for bioengineering students. Students learn best practices and prepare for a bioengineering career. To be taken Pass/No Pass only. Prep: Sophomore standing in bioengineering.

BIOE 2010 Introduction to Biomedical Engineering 3(3) Provides engineering, biological, and physical science students with an overview of the replacement of human body parts and the problems related to artificial devices. Prep: CH 1020; and one of BIOE 1010 or BIOL 1030 or BIOL 1100.

BIOE 3000 Bioengineering Ethics and Entrepreneurship 0(1) Introduction to the ethical considerations of performing human and animal research in support of medical technology development. Students are exposed to fundamental business concepts related to translating technology to the marketplace. To be taken Pass/No Pass only. Prep: BIOE 2000.

BIOE 3020 Biomaterials 3(2) Study of metallic, ceramic, and polymer materials used for surgical and dental implants; materials selection, implant design, physical and mechanical testing corrosion and wear in the body. In addition, physical and mechanical properties of tissue as related to microstructure are studied. Prep: BIOE 2010 and MSE 2100; and either both CH 1010 and CH 2240, or both CH 2230 and CH 2270. Coreq: BIOE 3021.

BIOE 3021 Biomaterials Laboratory 0(3) Non-credit laboratory to accompany BIOE 3020. Coreq: BIOE 3020.

BIOE 3200 Biomechanics 3(3) Study of relation between biological and mechanical functions of musculoskeletal tissues such as bone, ligaments, muscles, cartilage, etc.; mechanics of human joints; analysis of implants and implant failure. Prep: CE 2010 and MATH 2080.

BIOE 3210 Biofluid Mechanics 3(3) Introduces mechanics of biological fluids (e.g., blood, synovial fluid and physiological solutions) with an emphasis on the formation of biological problems within the context of (1) kinematics, (2) the concept of stress, (3) linear momentum balance, (4) constitutive relations and (5) boundary conditions. Prep: CE 2010 and MATH 2080.

BIOE 3700 Biotechnology and Bioimaging 3(2) Introduction of fundamental topics in bioinstrumentation and bioimaging focused on the acquisition and monitoring of vital signals. Basic principles for the selection and appropriate use of instruments for solving bioengineering and medical problems such as microscopy, magnetic resonance imaging, and ultrasounds, among others, are addressed. Prep: MATH 2080; and ECE 2020 or ECE 2070. Coreq: BIOE 3701.

BIOE 3701 Biotechnology and Bioimaging Laboratory 0(3) Non-credit laboratory to accompany BIOE 3700. Coreq: BIOE 3700.

BIOE 4000 Bioengineering Leadership and MedTech Commercialization 1(1) Introduction to common leadership techniques and management approaches. Students are exposed to various product/technology valuation techniques that contribute to how business decisions are made in the MedTech sector. To be taken Pass/No Pass only. Prep: BIOE 3000.

BIOE 4010 Bioengineering Design Theory 3(3) Introduces principles of engineering design and applies them to the design of medical devices. Covers materials selection, fabrication processes, performance standards, cost analysis, and design optimization. Students defend a design project proposal in written and oral form before a faculty jury. Prep: BIOE 3020 or BIOE 3200 or BIOE 3700.

BIOE 4020 Biocompatibility 3(2) Guides students through the theory and practice of determining compatibility of biomaterials and medical devices as required by the FDA. Hands-on experiments emphasize host-implant interactions such as toxicity towards tissues using specific techniques, including cell culture, implantation of biomaterials in experimental animals and histopathology. Prep: BIOE 3020 and BIOL 4610. Coreq: BIOE 4021.

BIOE 4021 Biocompatibility Laboratory 0(3) Non-credit laboratory to accompany BIOE 4020. Coreq: BIOE 4020.

BIOE 4030 Applied Biomedical Design 3(1) Creative applications of bioengineering and design principles to solving clinically relevant design problems. Team-based development, construction and evaluation of design prototypes in accordance with design theory. Students present results to a faculty jury and external collaborators through written reports and oral presentations. Prep: BIOE 4010. Coreq: BIOE 4031.

BIOE 4031 Applied Biomedical Design Laboratory 0(6) Non-credit laboratory to accompany BIOE 4030. Coreq: BIOE 4030.

BIOE 4120 Orthopaedic Engineering and Pathology 3(3) Interdisciplinary study of clinical orthopaedic cases (bone growth, bone remodeling, osteoarthritis, implant fixation and joint replacements); biomechanical, biomaterials, tribology and clinical diagnosis of failed implants (joint replacements, fracture fixation and spinal instrumentation); basic concepts of orthopaedic pathology for engineers. Prep: BIOE 3020 and BIOE 3200; Prep or concurrent enrollment: BIOL 3150.
BIOE 4150* Research Principles and Concepts 1(1)  
Introduces seniors and graduate students to principles and practices of scientific research. Topics include developing scientific concepts, developing projects, pursuing research, collaborating in multidisciplinary teams, patenting and publishing technical and scientific information, and reviewing professional and ethical standards of performance. Includes Honors sections.

BIOE 4200* Sports Engineering 3(3)  

BIOE 4230* Cardiovascular Engineering and Pathology 3(3)  
Medical and bioengineering aspects of artificial cardiovascular and vascular devices; physiology and pathological aspects of patients with need for such devices; diagnostic techniques and surgical management of diseases and pathology; design aspects of current devices and selection; state of the art in experiments and human clinical trials. Preq: BIOE 3020 and BIOI 3150; and either BIOE 3200 or BIO E 3210.

BIOE 4310* Medical Imaging 3(2)  
Introduction to the history, physics, and basis of medical imaging devices; including X-ray, Computed Tomography, Magnetic Resonance Imaging, and Ultrasound. Students will understand imaging from both an engineering and clinical prospective. Students will have the opportunity to work with real medical images, to understand the tradeoffs between modali- ties. Preq: MATH 2080; and one of ECE 2020 or ECE 2070. Preq or concurrent enrollment: BIOE 3700. Coreq: BIOE 4311.

BIOE 4311* Medical Imaging Laboratory 0(2)  
Non-credit laboratory to accompany BIOE 4310. Coreq: BIOE 4310.

BIOE 4350* Computer Modeling of Multiphysics Problems 3(3)  
This course will introduce students to a holistic way to deal with complicated engineering problems using a computer modeling approach. For a real-world problem governed by combined mechanical, electrical, thermal, electro-chemical and mass-transport phenomena will be dealt with in an integrated and multidisciplinary way rather than the conventional piecewise single-discipline way. Preq: MATH 2080.

BIOE 4400* Biopharmaceutical Engineering 3(3)  
This course examines the design principles necessary to use bacteria, fungi, and mammalian cells in bioengineering applications, including molecular techniques, fermentation, process scaleup, purification processes, and FDA regulations. The production of biopharmaceuticals derives from recombinant systems, including uses in medical systems, in emphasized. Preq: BCHM 3050.

BIOE 4480 Tissue Engineering 3(2)  
Explores the application of engineering principles toward the development of biologically based substitutes that restore, maintain, or improve tissue function. Topics include biodegradable scaffolds, wound healing and tissue repair, cell-matrix interactions, immunology and biocompatibility, stem cells. Preq: BIOE 3020 and BIOI 3150. Preq or concurrent enrollment: BIOI 4610. Coreq: BIOE 4481.

BIOE 4481 Tissue Engineering Laboratory 0(3)  
Non-credit laboratory to accompany BIOE 4480. Coreq: BIOE 4480.

BIOE 4490 Drug Delivery 3(3)  
Fundamental principles of controlled drug delivery including drug release mechanisms, physiological barriers, and various types of delivery routes. Specific emphasis is placed on understanding drug delivery technologies and processes to scale up the fabrication of drug delivery systems. Preq: BIOE 3020.

BIOE 4500 Special Topics in Bioengineering 1-4(1-4)  
Comprehensive study of a topic of current interest in the field of biomedical engineering under the direct supervision and guidance of a faculty member. May be repeated for a maximum of six credits, but only if different topics are covered. Includes Honors sections. Preq: Consent of instructor.

BIOE 4510 Creative Inquiry in Bioengineering 1-3(1-3)  
Disciplinary and multidisciplinary team research projects with the goal of developing the students’ skills in literature research, engineering design, and data analysis. May be repeated. Preq: Consent of instructor.

BIOE 4600 International Bioengineering Research Topics 1-6(1-6)  
Comprehensive study and research exposure relating to bioengineering research topics at an international institution through the Bioengineering study abroad program. Students are exposed to laboratory and research methods while under the direct supervision and guidance of approved international mentors. May be repeated for a maximum of six credits. Includes Honors sections. Preq: Consent of instructor.

BIOE 4610 International Study in Bioengineering 3(3)  
Introduction to selected bioengineering topics through participation in international study abroad summer programs. Offers an international study experience to undergraduates through lectures, guest speakers, tours, and/or laboratory exposure on a selected bioengineering topic chosen annually by the department. Preq: Consent of instructor.

BIOE 4690 International Bioengineering Internship 1-3(1-3)  
Observation and assignment in an international medical school, dental school, hospital, regulatory agency, or industrial department. Course is affiliated with the bioengineering study abroad program and students are under the direct supervision and guidance of approved international mentors. May be repeated for a maximum of six credits. Preq: Consent of instructor.

BIOE 4710* Biophotonics 3(3)  
Biophotonics is an interdisciplinary subject of applying photonics to study biological samples from individual cells to the entire body. Introduces fundamental and frontier topics in optical imaging aspects of biophotonics for senior-level undergraduates and graduate students to gain the ability to solve bioimaging-related biomedical problems. Preq: MATH 2080; and PHYS 2210; and either ECE 2070 or ECE 3200.

BIOE 4760 Biosurface Engineering 3(2)  
Study of how surface design influences the interactions of biomolecules with biomaterials and how this in turn influences implant biocompatibility. Laboratory addresses both the theory and application of various analytical instruments commonly used in bioengineering to characterize biomaterial surfaces and investigate biomolecular surface interactions. Preq: Senior standing in Bioengineering and BCHM 3050. Coreq: BIOE 4761.

BIOE 4761 Biosurface Engineering Laboratory 0(3)  
Non-credit laboratory to accompany BIOE 4760. Coreq: BIOE 4760.

BIOE 4820* Biomaterial Implantology 3(2)  
Provides training in the planning and conduct of experimental surgery, including laws and regulations; institutional requirements; selection of animal models; ethical considerations of animal research; preparation of animals for surgery; general and special surgical techniques; aseptic surgical techniques; and basic and applied instrumentation. Preq: Junior standing in Bioengineering. Coreq: BIOE 4821.

BIOE 4821* Biomaterial Implantology Laboratory 0(3)  
Non-credit laboratory to accompany BIOE 4820. Coreq: BIOE 4820.

BIOE 4900 Internship 1(1)  
Observation and assignment in a medical school, dental school, hospital, regulatory agency, or industrial department. May be repeated for a maximum of two credits. To be taken Pass/No Pass only. Preq: Senior standing in Bioengineering and consent of department chair.

BIOE 4910 Internship in Bioengineering 1-6(1-6)  
Mentored research training for undergraduate students working with a faculty advisor, including literature review, experimental design, research documentation, and presentation of results. May be repeated. Honors students must take six credits under a single advisor and write an honors thesis. Includes Honors sections. Preq: Consent of instructor.

BIOLOGY  

BIOL 1010 Frontiers in Biology I 1(1)  
Introduces Biological Sciences majors to the Biological Sciences Advising Center, curriculum, preprofessional health advisors, university career services, and the department's faculty. Preq or concurrent enrollment: BIOL 1030 and BIOL 1050; or BIOL 1100.