

BIOMEDICAL ENGINEERING (BME)

Courses

BME 1600. BME Design 0. 0 or 2 Credits.

Introduction to the biodesign methodology. Hands-on design experiences that emphasize inter-disciplinary teamwork, technical communication, and engineering ethics.

BME 1605. Design 1: Intro to Design. 3 Credits.

Introduces design methodologies for biomedical engineers in a lecture format with studio-style integrated project-based learning. Integrates crucial design skills, including user-based design principles and engineering judgment, required for successful design in healthcare. Covers scientific (e.g., anatomy), engineering fundamentals (e.g., physics), and hands-on prototyping skills (e.g., 3D printing, soldering, electronics prototyping, coding, etc.) relevant to the semester project. Design experiences emphasize critical thinking, interdisciplinary teamwork, technical communication, and engineering ethics. Prerequisites: Biomedical Engineering major.

BME 1990. Special Topics. 1-18 Credits.

See Schedule of Courses for specific titles.

BME 1991. Internship. 1-3 Credits.

On-site supervised work experience combined with a structured academic learning plan directed by a faculty member or a faculty-staff team in which a faculty member is the instructor of record, for which academic credit is awarded. Offered at department discretion.

BME 1993. Independent Study. 1-18 Credits.

A course which is tailored to fit the interests of a specific student, which occurs outside the traditional classroom/laboratory setting under the supervision of a faculty member, for which credit is awarded. Offered at department discretion.

BME 2000. Core 1: Biomechanics & Sensing. 6 Credits.

Studio-style course that fuses lecture with project-based learning and laboratory exercises. Covers force and torque vectors, systems in equilibrium, physical properties of human body segments and biological systems, kinematics and kinetics of particles and rigid bodies, stress and strain of solid materials, circuits and instrumentation. Prerequisites: C- or better in MATH 1248, and PHYS 1500.

BME 2050. Core 2: Materials & Transport. 6 Credits.

Studio-style course that fuses lecture with project-based learning and laboratory exercises. Covers materials related to medical devices, the biological reaction to implanted medical devices, and associated failure mechanisms. Diffusive and convective mass transport in biochemical interactions, oxygen transport, cell adhesion/signaling, drug and macromolecule transport. Prerequisites: BME 2000, BHSC 1340.

BME 2170. Biomechanics. 3 Credits.

Introduces biomechanics with applications to human body dynamics and mechanics of tissues. Covers force and torque vectors, joint moments, physical properties of human body segments and biological systems, kinematics and kinetics of particles and rigid bodies, reaction loads, stress and strain of solid materials. Prerequisites: CEE 1100, ANPS 1190.

BME 2600. BME Design 1. 1 Credit.

Introduction to ISO standards, FDA, quality control, and regulatory processes. Case studies of BME Capstone Design I teams. Prerequisite: BME 1600 or equivalent.

BME 2605. Design 2: Regulatory & Testing. 3 Credits.

Introduces the regulatory, technical, and ethical contexts in which biomedical solutions are developed, tested, and approved or licensed for use in the United States, including content related to the regulatory landscape in the U.S. (e.g., regulatory history, Food and Drug Administration, regulatory pathways, design controls), technical engineering requirements (engineering specifications, risk management), testing (verification, validation, animal studies, clinical trials), and ethics. Prerequisite: BME 1605. Catamount Core: GC2.

BME 2650. BME Design 2. 1 Credit.

Introduction to verification/validation testing. Case studies of BME Capstone Design II teams. Prerequisite: BME 2600.

BME 2990. Special Topics. 1-18 Credits.

See Schedule of Courses for specific titles.

BME 2991. Internship. 1-18 Credits.

On-site supervised work experience combined with a structured academic learning plan directed by a faculty member or a faculty-staff team in which a faculty member is the instructor of record, for which academic credit is awarded. Offered at department discretion.

BME 2993. Independent Study. 1-18 Credits.

A course which is tailored to fit the interests of a specific student, which occurs outside the traditional classroom/laboratory setting under the supervision of a faculty member, for which credit is awarded. Offered at department discretion.

BME 2994. Teaching Assistantship. 1-3 Credits.

Undergraduate student service as a teaching assistant, usually in an introductory-level course in the discipline, for which credit is awarded. Offered at department discretion.

BME 2995. Undergraduate Research. 1-18 Credits.

Undergraduate student work on individual or small team research projects under the supervision of a faculty member, for which credit is awarded. Offered at department discretion.

BME 2996. College Honors. 1-6 Credits.

Honors studies leading to a thesis.

BME 3000. Core 3: Systems & Signals. 6 Credits.

Studio-style course that fuses lecture with project-based learning and Python programming. Covers continuous/discrete-time descriptions of signals, visualization and analysis of linear systems, Fourier analysis and filtering, and the collection and processing of biomedical signals. These concepts are applied to mathematical problem sets and Python programming assignments. Prerequisite: CS 1210, BME 2050. Pre/Co-requisite: MATH 3201.

BME 3130. Biomaterials. 3 Credits.

Introduces materials engineering and the biological reaction to materials in a lecture format with integrated active and project-based learning. Covers materials related to medical devices (e.g., metals, ceramics, polymers, and composites), the biological reaction to implanted medical devices (e.g., protein adsorption, wound healing, immune system reaction, failure mechanisms). Prerequisites: BHSC 1340; CHEM 1152 or CHEM 2580.

BME 3150. Biotransport. 3 Credits.

Covers fundamental topics in mass transport and fluid mechanics while focusing on applications in biomedicine. Lecture format with integrated active and project-based learning. Specific topics covered will include diffusive and convective mass transport in relation to biochemical interactions, oxygen transport, circulation, and transport of drugs and macromolecules. Prerequisites: MATH 3201, ANPS 1200.

BME 3175. Biomed Data & Signal Analysis. 4 Credits.

Introduces signal processing and system modeling for the purposes of biomedical signal and system analysis. Python programming is used to explore and apply these techniques. Covers continuous/discrete-time representations of signals, visualization and analysis of linear systems, Fourier analysis and filtering, and the collection and processing of biomedical signals. These concepts are applied in mathematical problem sets and Python programming assignments. Prerequisites: CS 1210; BME 2155 or EE 2155. Pre/co-requisite: MATH 3201.

BME 3205. Biomechanics Lab. 3 Credits.

Introduces laboratory techniques and analyses in biomechanics, focusing on human movement analysis and tissue mechanics. Covers hands-on data collection, analyses, and laboratory report writing. Prerequisite: BME 2170.

BME 3255. Biomaterials & Transport Lab. 3 Credits.

Hands-on, advanced biomedical engineering laboratory focused on applications of biomaterials and biotransport including diffusion, bioprinting, drug delivery, cell culture, protein engineering, and microfluidics. Focuses on providing students with experience and instruction in interdisciplinary teamwork, technical communication, data analysis, and experimental design. Prerequisites: BME 3130, BME 3150. Pre/Co-requisite: STAT 2430.

BME 3310. Multi-scale Biomedical Systems. 3 Credits.

Examines tissues to organs as complex systems operating at multiple levels of length and time scale. A particular focus is on how system behavior emerges in non-trivial ways from the ensemble behavior of components at lower levels of scale. Prerequisite: BME 3000.

BME 3340. Computational Systems Biology. 3 Credits.

Covers foundational mathematical models in systems biology, and their computational implementation, describing biological processes from the molecular to the ecological scale. Prerequisite: Beginner knowledge of Python programming is recommended.

BME 3370. Medical Imaging. 3 Credits.

Describes the physics behind signal acquisition and image generation for the major medical imaging modalities. Covers radiography (including diagnostic X-ray and computed tomography), magnetic resonance imaging (MRI), ultrasound, and nuclear medicine. Includes applications with image data and image processing. Prerequisites: BME 2000, BME 3000, EE 2125, or EE 2145.

BME 3410. Biomaterials Engineering. 3 Credits.

A materials science and engineering approach is used to explore the structure-function relationships of natural and bio-inspired materials for various engineering applications. The emphasis is on mechanical design and function. The medical applications of biomaterials will be discussed. Prerequisites: ME 2110 or BME 3600. Cross-listed with: ME 3410.

BME 3460. Biomechanics of Human Motion. 3 Credits.

Biomechanics of Human Motion will describe the typical processes-from small scale protein interactions to large scale joint torques-that result in human locomotion. Clinical problems and athletic performance will be discussed. Students will learn about musculoskeletal tissues related to force generation/transmission and will perform kinematic/kinetic analyses. Prerequisite: BME 2000 or ME 1120. Pre/Co-requisites: ME 2110, ME 2120, or BME 3000. Cross-listed with: ME 3460.

BME 3480. Biomechanics: Tissue Engr. 3 Credits.

Solid biomechanics including structure, function and mechanical properties of biological tissues. Tissue engineering involving cell mechanics, scaffold materials, and signaling. Current literature topics are covered. Prerequisites: ME 2110 or BME 3600. Cross-listed with: ME 3480.

BME 3600. BME Design 3. 2 Credits.

Industry-standard biodesign and project management processes. Application of principles to small-scale team-based design projects in collaboration with existing BME Capstone Design teams and to identify future Capstone projects. Shop training. Prerequisite: BME 2650.

BME 3605. Design 3: BME Capstone I. 3 Credits.

Focuses on the development of projects and prototypes in preparation for BME Capstone II in a project-based learning environment. Covers design topics (prior art, concept generation, early-stage prototyping, etc.), professional skills (project management, technical communication), and ethical design (sustainability, health equity). Prerequisite: BME 2605. Catamount Core: SU.

BME 3710. Biomedical Instrumentation. 3 Credits.

Measurement techniques for biomedical engineering research and industry, and health care institutions. Integrated biomedical monitoring, diagnostic, and therapeutic instrumentation. Prerequisite: EE 2145, EE 2175, or EE 2135. Co-requisite: EE 3110, ANPS 1200, or Instructor permission. Cross-listed with: EE 3710.

BME 3720. Biosignal Decoding. 3 Credits.

Overview of biomedical measurement techniques; development of Python software to visualize, denoise, and decode biomedical signals. Prerequisites: CS 1210; (BME 3000 or EE 3150) or (ME 2120 and EE 2845) or Instructor permission. Pre/Co-requisites: Beginner knowledge of Python programming is strongly suggested. Cross-listed with: EE 3720.

BME 3740. Wearable Sensing. 3 Credits.

Covers current state-of-the-art in wearable sensors and the biomechanical and physiological phenomena they are being used to measure. Emphasis will be given to applications related to human health and medicine. Prerequisite: EE 3150, BME 3000, or equivalent with Instructor permission.

BME 3810. Clinical Devices & Instruments. 3 Credits.

Focuses on the development, design and adaptation of biomedical devices and instruments. Team-taught by faculty in the Larner College of Medicine and UVM Medical Center and focuses on exciting active areas of biomedical device development and applications at UVM and the UVM Medical Center. Credit not awarded for both BME 3810 and BME 5800. Prerequisites: ANPS 1190, ANPS 1200; or Instructor permission.

BME 3990. Special Topics. 1-18 Credits.

See Schedule of Courses for specific titles.

BME 3991. Internship. 1-18 Credits.

On-site supervised work experience combined with a structured academic learning plan directed by a faculty member or a faculty-staff team in which a faculty member is the instructor of record, for which academic credit is awarded. Offered at department discretion.

BME 3993. Independent Study. 1-18 Credits.

A course which is tailored to fit the interests of a specific student, which occurs outside the traditional classroom/laboratory setting under the supervision of a faculty member, for which credit is awarded. Offered at department discretion.

BME 3994. Teaching Assistantship. 1-3 Credits.

Undergraduate student service as a teaching assistant, usually in an introductory-level course in the discipline, for which credit is awarded. Offered at department discretion.

BME 3995. Undergraduate Research. 1-18 Credits.

Undergraduate student work on individual or small team research projects under the supervision of a faculty member, for which credit is awarded. Offered at department discretion.

BME 4600. BME Capstone Design I. 3 Credits.

Teams apply industry-standard biodesign and project management processes to design, build, and test a functional prototype that meets their client's requirements. Prerequisite: BME 3600. Catamount Core: OC.

BME 4605. Design 4: BME Capstone II. 3 Credits.

Focuses on the development and testing of functional biomedical solutions that satisfy medical needs. Covers design topics (fabrication, verification, validation etc.), professional skills (project management, technical communication), and ethical design (sustainability, health equity). Prerequisite: BME 3605. Catamount Core: OC.

BME 4650. BME Capstone Design II. 3 Credits.

Teams refine their functional prototype from BME Capstone Design 1 and explore approaches for manufacturing at scale, regulatory strategy, clinical strategy, IP strategy, health-economics and reimbursement. Prerequisite: BME 4600.

BME 4990. Special Topics. 1-18 Credits.

See Schedule of Courses for specific titles.