Biomedical Engineering Courses (BME)

BME Courses

This is a list of courses with the subject code BME. For more information, see Roy J. Carver Department of Biomedical Engineering (College of Engineering) in the catalog.

BME:1010 First-Year Forum 1 s.h.
Presentations by faculty, graduate students, collaborators from the Carver College of Medicine, and Colleges of Dentistry and Law; may include visits to laboratories and industries.

BME:2010 Professional Seminar: Biomedical Engineering 1 s.h.
Professional aspects of biomedical engineering presented through lectures and discussions by guest speakers, field trips, films, panel discussions. Requirements: sophomore or higher standing.

BME:2200 Systems, Instrumentation, and Data Acquisition 4 s.h.
Introduction to engineering art and science of modeling, acquisition, and analysis of data collected from living systems; modeling of physiological and biological systems; concepts of analog circuit design, with emphasis on circuits for collecting data for biomedical applications using operational amplifiers, active filters, conversion, and interface to microcomputers; patient safety; clinical circuits; analysis of data using time domain and Fourier domain techniques and models; time domain sampling, and Nyquist sampling theorem. Prerequisites: ENGR:2120. Corequisites: HHP:3500, and BIOS:4120 or STAT:3510.

BME:2210 Bioimaging and Bioinformatics 4 s.h.
Introduction to bioinformatics and biomedical imaging; computer algorithms, machine learning, databases and SQL, the web and web servers, ethics, computer security, genome technology, public warehouses of biological data; medical imaging hardware and software for acquisition and analysis of medical images, especially those collected from X-ray, CT, MR, and ultrasound systems; medical imaging system physics, including interaction of energy with tissue, concepts of image spatial and temporal resolution; applications of filtering, enhancement, and image processing for analysis of medical images. Prerequisites: ENGR:1300 and BIOL:1411. Corequisites: BIOS:4120 or STAT:3510.

BME:2260 Quantitative Physiology 3 s.h.
Introduction to core concepts in human physiology, homeostatic regulation, and structure-function relationships across cellular and organ systems; emphasis on analytical and quantitative methods including topics from dynamical systems, systems analysis, feedback, and control; students use mathematical modeling and computational simulation (MATLAB) to explore sensitivity analysis and emergent phenomena in complex physiological systems. Prerequisites: CHEM:1120 and BIOL:1411 and MATH:2560 and ENGR:1300.

BME:2400 Cell Biology for Engineers 3 s.h.
Introduction to fundamental concepts in quantitative cell biology from an engineering perspective. Prerequisites: BIOL:1411. Corequisites: BIOS:4120 or STAT:3510.

BME:2500 Biomaterials and Biomechanics 4 s.h.
Introduction to mechanics and materials in biological systems; principles of mechanics (stress, strain, motion, fluid flow) presented and used to characterize behavior of biological entities (tendon/ligament, bone and cartilage, blood, blood vessels, heart); principles of material science; role of biomaterials (metals, polymers, ceramics) in medical devices. Prerequisites: ENGR:2110. Corequisites: HHP:3500, and BIOS:4120 or STAT:3510.

BME:2710 Engineering Drawing, Design, and Solid Modeling 3 s.h.
Introduction to methods and principles used by engineers to define and describe geometry and topology of engineered components; use of Parametric Technology's Creo Pro (formerly ProEngineer) 3D computer-aided design software; emphasis on elements of design; basic commands used in parametric design to develop spatial visualization skills and the ability to create and understand 3D solid parametric design for assembly and 3D drawing documentation; creation of 3D assemblies and detailed drawings from art of design to part utilization of solid modeling techniques.

BME:3710 Medical Device Design: The Fundamentals 3 s.h.
Introduction to medical device design process; project-based; development of prototyping and fabrication skills needed for engineering design projects, safety, communication, and teamwork; focus on physical rehabilitation science and assistive technologies; preparation for senior design course sequence. Prerequisites: BME:2500 and BME:2710. Requirements: junior standing.

BME:3998 Individual Investigations: Biomedical Engineering arr.
Individual projects for biomedical engineering undergraduate students, such as laboratory study, engineering design projects, analysis and simulation of an engineering system, computer software development, research.

BME:4310 Computational Biochemistry 3 s.h.
Introduction to biomolecular modeling and computer simulation techniques; biomolecular structure and molecular driving forces; principles of structural optimization and conformational sampling; applications to biomolecular phenotypes; scripting and molecular visualization in PyMol, setting up and running molecular dynamics simulations using VMD and NAMD, performing refinement of X-ray diffraction data sets using Phenix, and executing Poisson-Boltzmann electrostatic calculations using APBS. Prerequisites: (MATH:1560 or MATH:1860) and CHEM:1120. Recommendations: BMB:3110 or BMB:3120. Same as BMB:4310.

BME:4314 Introduction to Synthetic Biology in the Lab 4 s.h.
Introduction to theory and practice of large-scale design goals of synthetic biology in which various types of DNA instructions, known from decades of research and discovery on specific biological systems, are taken out of context and used to execute various novel tasks designed to solve real-world problems; basic laboratory instruction in standardized construction techniques for stringing together off-the-shelf DNA components that are then introduced into organisms capable of executing the instructional set; controlled experiments to investigate the degree of variability exhibited by engineered genetic constructs. Prerequisites: BIOL:1411. Same as BIOL:4314.
BME:4710 Medical Device Design Studio 3 s.h.
Intermediate medical device design geared towards electro-
mechanical design and techniques; builds on foundational
knowledge acquired in BME:3710 and BME:2200; focus
on advanced prototyping skills including solid modeling,
proper electrical component selection, integrating electrical
components into hardware design, and testing electro-
mechanical device against industry standards. Prerequisites:
BME:2200 and BME:2500 and BME:2710 and BME:3710.

BME:4910 Biomedical Engineering Senior Design I 4 s.h.
Individual or group work on a creative design project involving
current problems in biomedical engineering; interdisciplinary
projects involving biomedical engineering and health
sciences faculty members; first semester of a year-long
senior capstone design project. Prerequisites: BIOS:4120 or
STAT:3510. Requirements: senior standing.

BME:4920 Biomedical Engineering Senior Design II 4 s.h.
Second semester of a year-long senior capstone design
project begun in BME:4910. Prerequisites: BME:4910.

BME:5010 Seminar in Biomedical Engineering 0 s.h.
Presentation of recent advances in biomedical engineering.
Requirements: graduate standing.

BME:5101 Biomaterials and Implant Design 3 s.h.
Introduction to material and mechanical considerations
underlying a broad range of medical implants; emphasis
on understanding factors involved in orthopedic device
design; major classes of biomaterials; considerations that
underlie implant design, use, failure; contemporary areas
of biomaterials and implant development. Prerequisites:
ENGR:2750 and BME:2500.

BME:5200 Biomedical Signal Processing 3 s.h.
Application of signal processing methods (e.g., Fourier,
Laplace, z-transforms) to biomedical problems, such as
analysis of cardiac signals, circadian rhythm, the breathing
cycle; computer simulation lab. Same as IGPI:5212.

BME:5210 Medical Imaging Physics 3 s.h.
Physics and data acquisition techniques of major medical
imaging modalities (X-ray, CT, MR, ultrasound, PET, SPECT);
physical interactions of energy with living tissue; principles
and methods for acquiring imaging data and subsequent
image construction; how individual modalities influence image
quality; MATLAB programming required. Second in a medical
imaging sequence. Prerequisites: BME:2200 and BME:2210.
Same as ECE:5470, IGPI:5206.

BME:5251 Advanced Biosystems 3 s.h.
Biological systems unique to systems analysis; operation
under nonequilibrium conditions; tools for systems
analysis developed from models of systems at equilibrium
(i.e., mechanical systems); fundamental difference between
biological and mechanical systems that impact systems
analysis; expand knowledge of linear systems and begin
work with nonlinear systems; various modeling and analysis
approaches useful in biomedical and biomedical engineering
research. Prerequisites: BME:2200. Same as IGPI:5251.

BME:5335 Computational Bioinformatics 3 s.h.
Introduction to computational methods used in genomics,
genome analysis, biological sequence analysis, sequence
database search, expression analysis, and biological network
analysis; in-depth coverage of principal genome science
challenges and contemporary solutions. Prerequisites:
(BIOS:4120 or STAT:2020 or STAT:3510) and (CS:5110 or
ENGR:1300).

BME:5340 Contemporary Topics in Biomedical Engineering 3 s.h.
New and emerging areas of biomedical engineering and
related fields; specific content varies.

BME:5421 Cell Material Interactions 3 s.h.
Current thought and techniques in the engineering and
assessment of biomaterials. Prerequisites: BME:2400.

BME:5430 Biotransport 3 s.h.
Energy, mass, and momentum transport in living systems;
processes essential for understanding how physiological
systems function from molecular level through scale of
tissues and organs; fluid mechanics and physiological flows,
mass transport, biochemical kinetics and reactions, bioheat
transfer; conservation laws; various biological applications.
Prerequisites: BME:2500.

BME:5431 Biofabrication for Tissue Engineering 3 s.h.
Understanding the principles and approaches of advanced
biofabrication for tissue engineering and regenerative
medicine. Biofabrication relies on the use of biological
materials and cells to create bioengineered tissue to
regenerate or repair diseased or injured tissues and organs,
such as respiratory bioengineering. Emphasis is on the
fundamental mechanisms, processing conditions, and
bioinspired strategies of biofabrication, additive approaches,
the integration of molecular sciences, and tissue-level
micro-physiological systems. Prerequisites: ENGR:2110 and
BME:2400 and BME:2500.

BME:5435 Systems Biology for Biomedical Engineering 3 s.h.
Although systems biology is comprised of both experimental
and computational aspects, focus is on computational
aspects; introduction to deterministic models of biochemical
reaction networks; development and application of
mathematical models of reaction networks using systems
of nonlinear ordinary differential equations; numerical
techniques employed to study system stability and perform
simulations in realistic biological contexts. Prerequisites:
BME:2400 and BME:2200.

BME:5441 Numerical and Statistical Methods for Bioengineering 3 s.h.
Mathematics and computation as indispensable tools needed
to model and explain complex phenomena relevant to
biomedical engineering problems; introduction to concepts
from linear algebra, differential equations, probability and
statistics, nonlinear model regression, optimization, numerical
integration, and other numerical methods, all using Matlab.
Prerequisites: MATH:2560 and MATH:2550.

BME:5445 Stem Cells in Regenerative Engineering 3 s.h.
Discovery and history of stem cells, how they are defined and
grouped, and various techniques for their isolation, creation,
culture, and characterization; focus on current state of stem
cells in medical research and treatment of human disease,
as well as future outlook of their use; particular emphasis
placed on practical knowledge that students may find useful
as they pursue careers in cellular and tissue engineering.
Prerequisites: BME:2400 or BIOL:2723.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BME:5451</td>
<td>Research Methods in Cellular Engineering</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Statistical approaches and principles of assays routinely used in cell engineering; design of experiments and statistical approaches commonly used to analyze biological data including t-tests and one- and two-way ANOVAs, taking into consideration the constraints of cellular engineering research; students design, execute, and analyze data collected from actual experiments; review of recently published literature and analysis of public data sets to understand how each assay and test contributes to understanding of cellular phenotype. Prerequisites: BIOL:1411 and (STAT:3510 or BIOS:4120).</td>
<td></td>
</tr>
<tr>
<td>BME:5460</td>
<td>Principles of Microfluidics</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Microfluidics (i.e., lab-on-a-chip) has become a powerful tool for biomedical research; examination of history, theory, design, fabrication, and function of microfluidic systems; state-of-the-art technologies and real-life biomedical applications; microfluidic-related career opportunities in academia and industry; hands-on fabrication and operation of microfluidic devices. Prerequisites: BME:2500.</td>
<td></td>
</tr>
<tr>
<td>BME:5510</td>
<td>Cardiovascular Engineering</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Mechanics—forces and motion—at the heart of the cardiovascular system; fluid and solid mechanics inherent to the motion of the heart, valves, arteries, and veins, and how they facilitate the flow of blood; how to use mechanics to understand and diagnose the severity of cardiovascular disease states and to design implants and devices. Prerequisites: BME:2500.</td>
<td></td>
</tr>
<tr>
<td>BME:5525</td>
<td>Cardiopulmonary Design and Modeling</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Cardiac and pulmonary systems central to all aspects of human health and diseases that affect these systems can have deadly consequences; physiologic fluid mechanics critical to tissue/organ function, transport, homeostasis, and disease progression; diseases that afflict cardiopulmonary system; focus on role of fluid mechanics in how diseases develop, progress, and are treated; use of computational modeling tools to simulate disease conditions and understand challenges of designing devices and interventions. Prerequisites: ENGR:2510 and BME:2500.</td>
<td></td>
</tr>
<tr>
<td>BME:5540</td>
<td>Quantitative Studies of Respiratory and Cardiovascular Systems</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Quantitative physiological aspects of respiratory and cardiovascular systems; classical models of these systems are considered including lumped element models, branching tree structures, and distributed parameter models to predict wave propagation in compliant walled tubes filled with compressible or incompressible fluids; development of extensive computer models to simulate the behavior of these systems in frequency- and time-domains, under various conditions of health and disease. Prerequisites: BME:2200 and HHP:3500.</td>
<td></td>
</tr>
<tr>
<td>BME:5610</td>
<td>Musculoskeletal Biomechanics</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Principles of solid mechanics applied to analytical, experimental investigation of biological systems; emphasis on applications in kinesiology of human musculoskeletal system. Prerequisites: BME:2500 and ENGR:2750.</td>
<td></td>
</tr>
<tr>
<td>BME:5620</td>
<td>Introduction to Applied Biomedical Finite Element Modeling</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Introduction to finite element modeling as applied to biomechanics-related applications. Prerequisites: ENGR:2750 and BME:2500.</td>
<td></td>
</tr>
<tr>
<td>BME:5630</td>
<td>Kinetics of Musculoskeletal Systems</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Principles of kinematics; kinetics applied to analytical and experimental investigation of musculoskeletal systems; mathematical foundations for kinematic and kinetic analyses; examples of mathematical modeling of human movements. Prerequisites: ENGR:2710.</td>
<td></td>
</tr>
<tr>
<td>BME:5640</td>
<td>Ergonomics of Occupational Injuries</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Epidemiology, surveillance systems, ergonomics, biomechanics, physiology, psychology, legal aspects, and cost control. Prerequisites: BME:2500. Corequisites: ENGR:2750.</td>
<td></td>
</tr>
<tr>
<td>BME:5715</td>
<td>Advanced Medical Device Design Studio</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Continuation of BME:3710 and BME:4710; biomedical engineering project based; focus on advanced prototyping and manufacturing techniques of mechanical and electromechanical medical devices; implementation of design controls and testing to medical industry standards for quality and safety; development of project management skills and communication within a team; final course in medical device design sequence. Prerequisites: BME:2200 and BME:2500 and BME:2710 and BME:3710 and BME:4710.</td>
<td></td>
</tr>
<tr>
<td>BME:5720</td>
<td>Optimization of Structural Systems</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Advanced topics; optimization of structural topology, shape, and material; finite dimensional dynamic response optimization, sensitivity analysis, distributed parameter systems; projects. Same as CEE:5236.</td>
<td></td>
</tr>
<tr>
<td>BME:5998</td>
<td>Individual Investigations: Biomedical Engineering</td>
<td>arr.</td>
</tr>
<tr>
<td></td>
<td>Individual projects for biomedical engineering graduate students, such as laboratory study, engineering design project, analysis and simulation of an engineering system, computer software development, research. Requirements: graduate standing.</td>
<td></td>
</tr>
<tr>
<td>BME:5999</td>
<td>Research: Biomedical Engineering MS Thesis</td>
<td>arr.</td>
</tr>
<tr>
<td></td>
<td>Experimental and/or analytical investigation of an approved topic for partial fulfillment of the requirements for the MS with thesis in biomedical engineering. Requirements: graduate standing.</td>
<td></td>
</tr>
<tr>
<td>BME:6225</td>
<td>Communicating Science</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Writing and speaking about biomedical engineering and science research; key principles of writing with clarity and cohesion; practice applying these principles on a piece of research writing students are currently working on; review of best practices for presenting research to peers and at conferences; students share their work with peers through writing and presentations.</td>
<td></td>
</tr>
<tr>
<td>BME:6230</td>
<td>Principles of Magnetic Resonance Imaging</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>MRI is a powerful and versatile imaging modality capable of providing a wide variety of contrast mechanisms and visualizing soft tissues in detail; principles of MRI from a signal processing perspective; MATLAB programming, literature readings, final project, visits to MRI research scanner facility, guest lectures from leading MRI experts; MRI concepts, interpretation of commonly used pulse sequences in clinical MRI, and emerging trends in MRI. Prerequisites: BME:5210 or BME:5200 or ECE:5460. Recommendations: familiarity with digital signal processing.</td>
<td></td>
</tr>
<tr>
<td>BME:6415</td>
<td>Advanced Biomechanics and Modeling of Soft Tissues</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Application of continuum mechanics and modeling to study of biological tissues and biomaterials.</td>
<td></td>
</tr>
</tbody>
</table>
BME:6610 Spine Mechanics  3 s.h.
Biomechanics applied to mechanics of the human spine; clinical aspects; state-of-the-art in spine research; basic engineering principles for biomechanical analysis. Prerequisites: BME:5610.

BME:7999 Research: Biomedical Engineering PhD Dissertation  arr.
Experimental and/or analytical investigation of an approved topic for partial fulfillment of requirements for PhD with thesis in biomedical engineering.