BIOMEDICAL ENGINEERING

http://www.miami.edu/bme

Dept. Code: BME

The Department of Biomedical Engineering offers a four-year undergraduate program leading to the Bachelors of Science degree in Biomedical Engineering. Biomedical Engineering (BME) is a multidisciplinary field that addresses problems at the interface of engineering, medicine, and the life sciences. Biomedical engineers have an impact on all fields of medicine. They design medical devices, implants and prostheses, they develop new biomaterials or drug delivery systems, they use engineering principles to develop cures by modifying cells and tissues.

The BME program at the University of Miami was the first of its kind in Florida, with the first class of B.S.B.E. students graduating in 1993. It has been continuously accredited by the Engineering Accreditation Commission (EAC) of the Accreditation Board of Engineering and Technology (ABET) since 1997. Graduates of the biomedical engineering undergraduate program find employment in industry or continue their studies either in graduate school or in a professional school in medicine and other health-related disciplines (such as dentistry, optometry, orthotics), law or business.

Some special features of the program include the small class size and open-door policy of the faculty, which facilitates student-faculty interaction. The Department has very strong ties with the University of Miami Miller School of Medicine and with industry. Undergraduate students have a wide range of research and internship opportunities in some of the leading research laboratories in their respective field. The Department strongly encourages undergraduate student participation in research and professional activities.

Advanced Writing and Communication Skills

Biomedical Engineering students satisfy the University's Advanced Writing and Communication Skills requirement by completing a set of classroom courses, laboratory courses and design courses where they learn effective oral, graphical and technical writing skills. Biomedical Engineering students acquire Advanced Writing and Communication skills in the following core courses:

Code	Title	Credit Hours
EGN 114	Global Challenges Addressed by Engineering and Technology	3
BME 112	Introduction to Biomedical Engineering	2
BME 335	Biomaterials	3
BME 336	Living Systems Engineering	3
BME 340	Medical Instrumentation I	4
BME 341	Medical Instrumentation II	3
BME 360	Applied Biotransport	3
BME 420	Capstone Project I	3
BME 421	Capstone Project II	3

Design Experience

The biomedical engineering design experience is integrated in the curriculum throughout the four years of study, starting in the freshman year with the Global Challenges in Engineering and Introduction to Biomedical Engineering courses. Each semester includes a hand-on design or project course which provide students with strong experimental and prototyping skills and cover the principles of biomedical engineering design, from problem identification and design conception to implementation and testing, including regulatory aspects. The design experience culminates in the senior year with a yearlong Capstone Project. The Capstone Project is typically completed by teams of two to four students who build on their knowledge and previous design experience to solve one major design problem which integrates the various components of the curriculum..

Dual Major

The College of Engineering offers a dual major in Biomedical Engineering for students that are majoring in another engineering Department. In order to obtain the dual major in Biomedical Engineering, the student will have to obtain, in parallel, a major in one of the fundamental engineering programs, plus 24 credit hours of course work, including 20 credit hours of required course work and 4 credit hours of elective course work from the lists given below.

The requirements for the dual major are:

Code	Title	Credit Hours
Required Courses		
BME 267	Medical Systems Physiology with Lab	4
BME 335	Biomaterials	3
BME 340	Medical Instrumentation I	4

BME 341	Medical Instrumentation II	3
BME 375	Fundamentals of Biomechanics	3
BME 370	Biomedical Signal Analysis	3
BME Electives (chosen from the BME course list)		**4**
Total Credit Hours		**24**

Departmental Honors

Upon request departmental honor is noted in a student's diploma and transcript upon fulfillment of the requirements specified in the College Bulletin.

BME 100. Introduction to Biomedical Engineering for Summer Scholars. 3 Credit Hours.
This introductory course is designed to expose high school students to biomedic al engineering. The program is designed for the exemplary high school student interested in applied mathematics and science. The students will be provided w ith an understanding and some hands-on experience on topics relative to the dis cipline of Biomedical Engineering. The course content changes throughout the 3 -week duration and includes topics on lasers, medical imaging, biomaterials, bi oelectricity and biomechanics. The students will be able to understand the cah llenges associated with the desing, testing and FDA clearance of biomedical dev ices and the importance of the scientific methods in engineering.. The laborato ry and field trip experiences will deal with the desingn and thesting of a bio electric device. Summer Scholar Students only.
Components: LEC.
Grading: GRD.
Typically Offered: Summer.

BME 110. Introduction to Innovation: Learning About Innovation by Innovating. 3 Credit Hours.
Introduction to diverse methods and tools that promote and nurture student creativity, entrepreneurship, team-work, and skills for creating business plans that consider ethical, global and financial issues. Students will learn to use the Maker Space facility to implement their design ideas.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

BME 111. Introduction to Engineering I. 3 Credit Hours.
Use of engineering tools for problem solving are discussed. Topics include the use of computer techniques for data acquisition, analysis, presentation, software design, computer aided drafting, and development of design skills through several design and building competitions. Introduction to professional ethics and intellectual property rights, the use of MATLAB, AutoCAD, and programming in C++.
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

BME 112. Introduction to Biomedical Engineering. 2 Credit Hours.
Introduction to Engineering II provides an introduction to biomedical engineering analysis, design, and manufacturing processes. Ethics, Regulatory Factors, and Biomedical Design Tools (mechanical, electrical, and computer tools) are introduced. · Students will also be given lectures from both Biomedical Engineering researchers and industrial professionals concerning their experiences and the current trends within the field. Hands on experience is provided.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

BME 123. Explorations in Engineering. 3 Credit Hours.
Introduction to engineering for non-engineers with emphasis on real-world engineering systems and services which are changing the way we live, communicate, learn, play, and care for ourselves, our communities and our planet. Students will learn how to use modern tools to observe and design simple engineering systems.
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

BME 211. Introduction to Programming for Biomedical Engineers. 3 Credit Hours.
This course will provide a comprehensive introduction to programming using MATLAB. The students will learn MATLAB functions for importing, analyzing, visualizing and exporting data, numerical computation, modeling and solving biomedical engineering problems.
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

BME 221. Biomedical Design I. 1 Credit Hour.
First course in the 2nd year design sequences for undergraduate biomedical engineering students. Course will introduce the BioDesign framework. Focus will be on need identification. The course will be taught using problem-based methodology with emphasis on student driven enquiry.
Pre-requisite: BME 112 or Equivalent.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

BME 222. Biomedical Project I. 2 Credit Hours.
Second course in the 2nd year design sequences for undergraduate biomedical engineering students. Student teams will make physical and simulated prototypes based on the concepts created in BME221. The focus is on project identification and conceptual design. The course will introduce the students to relevant techniques and processes. The students, working in teams, will develop three projects that focus on mechanical, electronics and tissue aspects.
Pre/Co-requisite: BME221.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

BME 265. Medical Systems Physiology. 3 Credit Hours.
Human physiological processes from a bioengineering and medical point of view. Pertinent aspects of anatomy, biophysics, biochemistry, and disease mechanisms are also included.
Pre-requisites: BIL 150 and CHM 121.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

BME 266. Human Physiology Laboratory. 1 Credit Hour.
This course provides a series of laboratory experiments to assist students to learn human physiology through noninvasive measurements by using the Powerlab Physiology Data Acquisition station. Following introductory lectures in the lab, students will assemble measurement probes, connect different devices, collect data under normal and stimulating conditions, and perform data analysis. Lab report is required for each experiment.
Prerequisite: Or Corequisite: BME 265.
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

BME 267. Medical Systems Physiology with Lab. 4 Credit Hours.
This course is designed to provide a generalized overview of human physiology for engineering students. It is patterned after similar instructional material that is part of the 1st year medical school physiology course. Pertinent aspects of anatomy, biochemistry and mechanisms of disease are also included. A series of laboratory experiments are provided to assist students in learning human physiology through noninvasive measurements by using the PowerLab physiology data acquisition station. Students will assemble measurement probes, connect different adaptors, collect data under normal and stimulating conditions, and perform data analysis. A report is required for each laboratory.
Pre-requisites: BIL 150 or permission of the instructor.
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

BME 302. Cellular Engineering. 3 Credit Hours.
Cellular engineering addresses issues related to understanding and manipulating cell structure-function relationships. This course is intended to bridge between cell biologists and engineers, to understand quantitatively cell biological aspects. Central to biomaterial and tissue engineering is our use of cells and our understanding of their interactions with their environment. It is important to understand how cells respond to external signals from their substrata or their milieu, how they move, and what they need in order to perform their desired function. Students are provided with an introduction to engineering principles and modeling at the cellular level. Of particular interest are cytomechanics, receptor/ligand binding, genetic engineering, enzyme kinetics, and metabolic pathway engineering.
Pre-requisites: BIL 150 and CHM 121.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

BME 303. Cell Engineering Lab. 1 Credit Hour.
The principles of cell engineering will be presented in a hands-on laboratory experience. General techniques learned will include sterile methods, cell culture techniques, cell imaging, DNA cloning and cell transfection, microcontact printing. Cell engineering topics include cell cycle/metabolism, adhesion, signal transduction, and assessment and fabrication of 2D culture substrates.
Prerequisite: BIL 150 and BIL 151.
Components: LAB.
Grading: GRD.
Typically Offered: Fall & Spring.

BME 305. Biomedical Technology. 3 Credit Hours.
Non-mathematical introduction to technical and clinical aspects of biomedical e ngineering. Biomedical signals and instrumentation, sensors, transducers, physi ological measurements, laboratory instrumentation, implants, cardiac assist dev ices, radiology, ultrasound, CT, MRI, transmission, and scanning electron microscopy. Field trips to clinical and research laboratories are included. Open only to non-BME students.
Prerequisite: BIL 150 and CHM 121.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

BME 310. Mathematical Analysis in Biomedical Engineering. 3 Credit Hours.
Mathematical modeling of physiological and other biomedical engineering systems and devices. Basic engineering principles and mathematical tools are covered for rigorous understanding of physiological regulation and control in biosystems.
Prerequisite: MTH 311.
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

BME 312. Biomedical Statistics and Data Analysis. 3 Credit Hours.
The course will provide a comprehensive introduction to biostatistical models and methods, with applications in clinical trials research, observational studies, physiology, genomics and public health. Various examples will be solved using statistical software and the results will be compared and discussed.
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

BME 320. The Evolution of Technology. 3 Credit Hours.
Organized and taught by an intedisciplinary team, this innovative course is designed for juniors and seniors. An experimental elective, the course uses multimedia to explore the ways in which innovation is driven by the needs of society and individuals, and nurtured by improvements in tools and production. Five broad subject areas will receive special attention: survival, communication, transportation, entertainment and medicine.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

BME 321. Biomedical Design II. 1 Credit Hour.
First course in the 3nd year design sequences for undergraduate biomedical engineering students. Course will review BioDesign framework and dive into lower-level design requirements. Focus will be on translating need criteria into experiments and test protocols. The use of engineering standards and electronic datasheets as resources for experimental design will also be covered. The course will be taught using problem-based methodology with emphasis on student driven enquiry.
Pre-requisite: BME 112 or Equivalent.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

BME 322. Biomedical Project II. 2 Credit Hours.
Second course in the 3nd year design sequences for undergraduate biomedical engineering students. Student teams will make physical and simulated prototypes based on the concepts created in BME321. The focus is on design thinking, experimentation, and testing. The course will emphasize prototypes that include a project with combined mechanical, electrical and cell-tissue aspects.
Pre/Corequisite: BME 321, BME 340, BME 375.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

BME 330. Foundations of Medical Imaging. 3 Credit Hours.
Physical and biological principles of medical imaging, including ultrasound, X-ray, nuclear, magnetic resonance, electrical impedance and optical imaging. Propagation and interaction of ultrasonic waves, light waves, X-ray photons, and nuclear radiation in hard and soft biological tissue.
Corequisite: BME 310.
Prerequisite: (PHY 222 and PHY 223) or PHY 230 or (PHY 201 and PHY 202).
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

BME 335. Biomaterials. 3 Credit Hours.
Introduction to the field of Biomaterials. Review of materials science for four main types of biomaterials: ceramics, metals, polymers, and composites. Lectures on special topics given by guest lecturers who are active in their specific areas, under supervision of the instructor.
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

BME 336. Living Systems Engineering. 3 Credit Hours.
Living systems engineering addresses issues related to understanding and manipulating the cell structure-function relationship. This course will serve as a bridge between biologists and engineers by applying biomedical concepts, including cellular engineering, tissue engineering, biomaterials, and mechanobiology, to foundational cell biology and human physiology knowledge. Students are provided with a practical and theoretical introduction to engineering principles and modeling at the cellular, tissue, and system level.
Pre-requisites: BIL 150 and CHM 121.
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

BME 340. Medical Instrumentation I. 4 Credit Hours.
Introduction to electrical circuit analysis used for biomedical applications. Network analysis theorems applied to transducers, associated circuits, and related static/dynamic responses are discussed. Measurement principles and parameters for biomedical signals and systems are discussed. Laboratory experiments are conducted in parallel with the course.
Pre-requisites: PHY 201, PHY 202, BME 211, BME 310.
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

BME 341. Medical Instrumentation II. 3 Credit Hours.
Modeling and simulation of medical electronic systems including vital signs measurement, electrophysiology, and imaging. The functional principles, operation, clinical context, and technological trends of systems commonly used in clinical applications will be discussed
Pre-requisite: BME 340.
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

BME 360. Applied Biotransport. 3 Credit Hours.
Fundamentals of transport phenomena in biological systems including diffusion, fluid mechanics, heat transfer. Applications in biomedical engineering – tissue engineering, transport in physiological tissues, blood flow. Use of COMSOL Multiphysics software to solve biomedical application problems in transport.
Prerequisite: BME 310.
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

BME 370. Biomedical Signal Analysis. 3 Credit Hours.
Course topics include quantitative description, analysis, and processing of biological (neural, muscular) signals using computers. Survey of time-frequency representations, correlation, convolution, filtering, and averaging is also included.
Pre-requisite: BME 211.
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

BME 375. Fundamentals of Biomechanics. 3 Credit Hours.
Application of solid and fluid mechanics to describe the mechanical behavior of human motion, mechanical behavior of soft and hard biological tissues, cells and biofluids. Review of fundamental concepts and techniques of mechanics (stress, strain, constitutive relations). Focus on mechanical properties of specific tissues, including tendon, skin, smooth muscle, heart muscle, cartilage, and bone. Cellular and biofluid mechanics will be presented.
Prerequisite: MTH 311 And (PHY 221 OR PHY 201).
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

BME 399. Cooperative Education. 1 Credit Hour.
Practical application of classroom theory through alternating semester or summe r employment with firms offering positions consistent with the student's field of study. May be repeated.
Components: THI.
Grading: GRD.
Typically Offered: Fall, Spring, & Summer.

BME 401. Biomedical Design. 3 Credit Hours.
Introduction to the clinical problem-based design for undergraduate biomedical engineering students. Focus will be on need identification, concept generation, prototype development and testing.
Pre-Requisite: Junior Standing.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

BME 402. Senior Design I. 2 Credit Hours.
This course deals with the introduction phase of an individual or group project for seniors. Need identification, screening, technical and economic feasibility, proof of concept development and killer experiment will be performed by students working on teams. Scheduled individual or group report presentations are required.
Prerequisite: BME 401 And Senior standing.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

BME 403. Senior Design II. 1 Credit Hour.
This course deals with the completion phase of an individual or group project for seniors. Concepts on projects related to the hypotheses/testing protocols, design limitations (constraints), and validation of the design in Biomedical Engineering will be discussed. Scheduled individual or group report presentations are required
Prerequisite: BME 402.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

BME 420. Capstone Project I. 3 Credit Hours.
First course in the clinical problem-based design series for undergraduate biomedical engineering students. Focus will be on need identification, concept generation, prototype development and testing.
Senior Standing.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

BME 421. Capstone Project II. 3 Credit Hours.
Completion phase of an individual or group project for seniors. Basic concepts on projects related to the design of devices, instrumentation, and experiments in Biomedical Engineering will be discussed. Scheduled individual or group report presentations are required.
Pre-requisite: BME 420.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

BME 440. Biomedical Measurements. 4 Credit Hours.
Introduction to the principles of measurements in physiological and biological systems, as well as a discussion of measurable parameters, transducers, sensors, signal conditioning, and processing. Laboratory experiments are conducted in parallel with the course.
Prerequisite: ECE 201.
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

BME 450. Biomedical Transport Phenomena. 3 Credit Hours.
Fundamentals of transport phenomena in biological systems including diffusion, osmosis, convection, electrophoresis, and transport with binding. Applications to cell electrophysiology and drug delivery. Introduction to physiological fluid flow in tissues.
Prerequisite: BME 310.
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

BME 460. Introduction to Physiological Fluid Mechanics. 3 Credit Hours.
The role of transport processes in biological systems, mathematical modeling of physiological fluid transport, conservation of mass and momentum rheology of blood flow in large and small vessels, approximation methods for the analysis of complex physiological flow, fluid flow in the circulation and tissue. Basic engineering principles and mathematical tools are covered for rigorous understanding of physiological fluid flow.
Prerequisite: PHY 222 or PHY 230 or (PHY 201 and PHY 202).
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

BME 470. Biomedical Signal Analysis. 3 Credit Hours.
Time and frequency description, analysis and processing of biophysical and physiological signals. This course covers analytical and computational tools for measuring, manipulating and interpreting signals fundamental to biomedical engineering. Fourier analysis, Fourier transform, data acquisition, averaging, digital filter design, discrete Fourier transform, correlation, convolution, coherence are discussed.
Pre-requisite: BME 211.
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

BME 480. Biomedical Instrumentation. 3 Credit Hours.
Analysis and design of systems and electronic circuits in biomedical instrumentation including modeling and simulation of dynamic measurement systems and implementation of analog signal processing. The functional principles, operation, clinical context and technological trends of medical instrumentation systems used in clinical and research applications will be discussed.
Prerequisite Or Corequisite: BME 440.
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

BME 495. Undergraduate Research in Biomedical Engineering. 1-3 Credit Hours.
Research and/or design projects consisting of an individual investigation of current problems under the mentorship of a faculty member. Requires department approval.
Components: THI.
Grading: GRD.
Typically Offered: Fall, Spring, & Summer.

BME 506. Computer Aided Design in Biomedical Engineering. 1 Credit Hour.
Laboratory course for computer based two and three dimensional drawing and design based on ProEngineer. Parametric design, parts, features, assemblies for complex modeling. Applications in biomedical engineering design.
Prerequisite: BME 112. And BME 211.
Components: LAB.
Grading: GRD.
Typically Offered: Fall & Spring.

BME 507. LabView Applications for Biomedical Engineering. 1 Credit Hour.
Laboratory course for computer based instrumentation and design based on Labview. Virtual instrumentation, data acquisition and display, GPIB instrument control, biomedical applications in biosignal recording, and monitoring are discussed.
Prerequisite: BME 112. And BME 211.
Components: LAB.
Grading: GRD.
Typically Offered: Fall & Spring.

BME 510. Introduction to Medical Robotics. 3 Credit Hours.
This course will discuss the basic principles of robotics and focus on its medical applications. The course integrates previously learned math, programming and imaging knowledge into an application platform to enable students to understand fundamentals of robotics methods in biology and medicine and to train students to build a robotics prototype through hands-on projects.
Prerequisite: BME 211. And BME 310. And BME 330.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

BME 512. Regulatory Control of Biomedical Devices. 3 Credit Hours.
Regulatory agencies and requirements, Food and Drug Administration, 510(k) and premarket approval (PMA), international regulatory requirements, ISO 9000 series, CE, UL, product and process validation, quality engineering, quality improvement programs, rapid prototyping, packaging and sterilization, and project management are discussed.
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

BME 513. Biomedical Systems Engineering. 3 Credit Hours.
This course provides students with an understanding and appreciation of Biomedical Systems Engineering with emphasis on current day industrial project management and product development processes. The components of Systems Engineering to be presented include: functional system analysis, requirements analysis, translation of functions and requirements into a system and product architecture, and, finally, testing methods to verify the biomedical product meets all design requirements. Decision methodology, alternative concept analysis, trade-off studies, integration of human factors, manufacturability, reliability, maintainability, feasibility demonstration, and safety are all addressed as part of the product design system. The entire product development life cycle will be analyzed with relevant concepts from initial market evaluation, to requirement development, through final product manufacturing and product launch. The regulatory environment for biomedical devices will also be presented for both US FDA and international compliance. The lectures will provide detailed notes on the subjects; other articles as handouts or additional readings will also be assigned.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

BME 515. Current Trends in Neural Engineering. 3 Credit Hours.
In this course students will learn from lectures, literature review, and hands-on experimentation to apply engineering principles in neuroscience including such diverse areas as neural tissue engineering, models of neural function, neural interface technology and rehabilitation. The course material will focus in the context of neural interfaces and prosthetics, from basic neural physiology and models of neural mechanisms to advanced neural interfaces currently in research.
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

BME 516. Applied Machine Learning for Medical Devices. 3 Credit Hours.
This course will provide a comprehensive introduction to machine learning with a special emphasis on its use in medical device applications (and the associated regulatory considerations). Students will learn how to approach fundamental machine learning problems and implement solutions using MATLAB. Example concepts covered: feature selection, dimensionality reduction, clustering, supervised & unsupervised decoding, model optimization, clinically relevant machine learning interpretability, medical device design processes, and graphical user interfaces integrating medically relevant machine learning tools.
Pre-requisite: BME 211.
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

BME 520. Medical Imaging Systems: X-ray and CT. 3 Credit Hours.
Engineering and scientific principles of medical imaging systems. The physics concepts and engineering implementations for different medical imaging modalities are discussed. Topics include imaging fundamentals, radiographic imaging (X-ray) system, and computed tomography (CT) system.
Prerequisite: ECE 201. And BME 211. And BME 330.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

BME 521. Medical Imaging Systems: MRI, NMI and Ultrasound. 3 Credit Hours.
Engineering and scientific principles of medical imaging systems. The physics concepts and engineering implementations for different medical imaging modalities are discussed. Topics include magnetic resonance imaging (MRI) system, nuclear medicine imaging (NMI) system, and ultrasound imaging system.
Prerequisite: ECE 201. And BME 211. And BME 330.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

BME 522. Scanning Electron Microscopy for Engineers. 3 Credit Hours.
Physics of transmission and scanning electron microscopy including x-ray spectroscopic analysis. Students will learn to independently operate and use the SEM for imaging in its role in research and engineering. Each student will be responsible for several imaging assignments and an independent research project related to their field of interest.
Components: LAB.
Grading: GRD.
Typically Offered: Fall & Spring.

BME 523. Neurosensory Engineering. 3 Credit Hours.
Biophysics of neural communication, quantitative electroencephalography and evoked potentials, sleep, seizure, anesthesia and intraoperative monitoring, neural stimulation, neural signal processing, cochlear and visual implants.
Prerequisite: BME 265 and BME 470.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

BME 524. Neuromotor Engineering. 3 Credit Hours.
Advances in Neural Engineering have led to improved medical-device designs with novel functions. This course focuses on the fundamental engineering approaches, technical principles, neurophysiology, and applications of neuroprosthetics. We will cover Neural Engineering theory and applications from the perspectives of electronics design, neural signal analysis, and neurophysiology.
Prerequisite: BME 265 and BME 470.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

BME 525. Special Topics. 1-3 Credit Hours.
Subject matter offerings based upon student demand and availability of faculty. Subtitles describing the topics to be offered will be shown in the printed class schedule, following the title "Special Topics".
Components: LEC.
Grading: GRD.
Typically Offered: Fall, Spring, & Summer.

BME 526. Special Topics. 1-3 Credit Hours.
Subject matter offerings based upon student demand and availability of faculty. Subtitles describing the topics to be offered will be shown in the printed class schedule, following the title "Special Topics".
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

BME 535. Advanced Biomaterials. 3 Credit Hours.
Applications of biomaterials in different tissue and organ systems. Relationshi p between physical and chemical structure of materials and biological system re sponse are discussed as well as choosing, fabricating, and modifying materials for specific biomedical applications.
Prerequisite: BME 335.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

BME 540. Microcomputer-Based Medical Instrumentation. 3 Credit Hours.
Principles and design of microcomputer-based biomedical instruments, analog and digital signal conversion, microcomputer hardware and software design, algorithm development for medical applications, medical signal processing with microcomputers, software safety in life support systems, and current applications are discussed.
Prerequisite: ECE 315. And ECE 304. Or ECE 211.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

BME 541. Medical Electronic Systems Laboratory. 2 Credit Hours.
Laboratory course for BME 540/640. Design of medical instruments integrated with microcomputers and telemetry devices.
Pre/Corequisite: BME 540. Or BME 640.
Components: LAB.
Grading: GRD.
Typically Offered: Spring.

BME 545. Biomedical Optical Instruments. 3 Credit Hours.
Introduction to geometrical optics, light sources, detectors, and fiber optics with an emphasis on engineering aspects and medical applications. Fiber-optic d elivery systems for medical applications, optics of the eye and visual instrume nts, and optical instruments used in medicine (microscopes, endoscopes, ophthalmic instruments) are discussed. Hands-on sessions in the laboratory are included.
Prerequisite: PHY 222. And PHY 223. And MTH 311.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

BME 546. Medical Applications of Lasers. 3 Credit Hours.
Review of geometrical optics, fiber optics, wave optics, laser physics, and technology. Medical laser systems, optical properties of tissue, light propagat ion in tissue, laser-tissue interactions, and surgical applications of lasers are also covered. Hands-on sessions in the laboratory are included.
Prerequisite: PHY 222. And PHY 223. And MTH 311.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

BME 555. Fundamentals of Computational Neuroscience. 3 Credit Hours.
Major concepts include neural signaling and communication from the single neuro n to system of neural ensembles and the role of neural computation in engineeri ng applications. Theory and principles of information processing in the brain are presented. Experimental data and computer simulations are used to provide real examples for students experimentation.
Prerequisite: BME 265 and Corequisite: BME 470.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

BME 565. Principles of Cellular and Tissue Engineering. 3 Credit Hours.
Introduction to cellular and tissue engineering. Current therapeutic approaches for lost/damaged tissue or organ function, tissue engineering strategies to replace/repair tissue or function: infusion of cells, production and delivery of tissue-inducing substances, cells placed on or within biomaterial scaffolds, examples of tissue engineering applications: skin, heart muscle, blood vessels, and blood.
Prerequisite: BME 302 or BME 336, BME 335.
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

BME 567. Tissue Engineering Lab. 1 Credit Hour.
The principles of tissue engineering will be presented in a hands-on laboratory experience. General techniques learned will include hydrogel spectroscopy analysis, swelling tests, permeability tests, rheological tests, cell culture techniques, cell imaging, cell culture in hydrogels. Cell & Tissue engineering topics include cell cycle/metabolism, adhesion, biomaterials synthesis and characterization, biocompatibility.
Prerequisite: BME 302 and BME 303. And Corequisite: BME 335 or BME 565.
Components: LAB.
Grading: GRD.
Typically Offered: Fall & Spring.

BME 570. Advanced Biomedical Signal Processing. 3 Credit Hours.
This course provides an overview of advanced topics in biomedical signal processing with an emphasis on practical applications. Topics include quantitative description, analysis, on-line and real-time processing of biophysical and physiological signals (cardiovascular, neural, sensory, muscular, respiratory and other) using adaptive, learning, pattern recognition and data dimension reduction methods.
Prerequisite: BME 470.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

BME 571. Introduction to Biosignal Processing Lab. 1 Credit Hour.
Laboratory course in conjunction with BME 570 course. Corequisite: BME 570.
Prerequisite: BME 570. Or Corequisite: BME 570.
Components: LAB.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

BME 575. Tissue Mechanics. 3 Credit Hours.
Applications of linear and nonlinear viscoelastic concepts to the biomedical characteristics of biological tissues and structures at small and large deformations of blood flow, experimental methods of analysis, artificial organs, and life-support systems.
Prerequisite: BME 375. And BME 310.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

BME 581. Radiation Biology and Physics. 3 Credit Hours.
The principles, methods, and results of radiation biology with physics applications in radiation therapy will be introduced in the course. The course will focus on mechanisms of radiation and biological system interaction, biological aspects of the foundation of radiation therapy, and mathematical models for radiobiological analysis.
Prerequisite: BME 265.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

BME 582. Radiation Therapy Physics. 3 Credit Hours.
The principles and instrumentation of radiation dosimetry with focus on the applications in radiation therapy will be introduced in this course. The course will emphasize radiation dose computation algorithms and applications in treatment dose planning. The course will also cover a catagorized dosimetric analysis of radiation therapy to different clinical conditions.
Prerequisite: BME 310. Or Pre/Corequisite: BME 581.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

BME 583. Radiation Protection. 3 Credit Hours.
This course covers radiation safety principles for all areas of clinical medical physics, including regulatory requirements for personnel, equipment and facilities and detailed structural shielding design requirements for medical facilities. The student will become proficient in practical aspects of radiation safety objectives and regulatory requirements in clinical practice, including those for patients, members of the general public and staff. Students will learn the principles for designing and installing structural shielding in clinical facilities that satisfies both regulatory requirements and clinical needs.
Prerequisite: BME 581. Or Pre/Corequisite: BME 582.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

BME 585. Immunoengineering. 3 Credit Hours.
Immunoengineering is a novel interdisciplinary field that combines biomaterial science and bioengineering design with immunology to develop cutting edge technology for the prevention, rapid diagnosis and treatment of infectious diseases, cancer, autoimmune and inflammatory diseases. The goal of this course is to provide a basic background in immunology that will allow understanding the need for immunoengineering and providing the tools to be able to design novel immunotherapy. Application of biomaterials for immunoengineering applications will be reviewed through lectures, reading assignments and group projects (design and journal clubs). This course will provide valuable knowledge of an emerging field that will impact both the academic and industrial world.
Prerequisite: BME 335.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

BME 587. Finite Element Analysis for Engineers. 3 Credit Hours.
Introduction to the finite-element method. Hands-on applications of FEM software to the analysis of structural, thermal, chemical, electro-magnetic, optical, and fluid flow problems.
Prerequisite: MTH 311 or EGN 319.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

BME 595. Current Trends in Regenerative Medicine. 3 Credit Hours.
This team-taught course provides background, clinically-relevant applications and ethical aspects of regenerative medicine as it applies to multiple types of cell, tissues and organs. The course is divided into modules focused on one application of regenerative medicine and taught by an expert in that specific topic area. The course includes hands-on demonstrations of key techniques and problem-based group projects.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

BME 599. Cooperative Education.. 1 Credit Hour.
Practical application of classroom theory through alternating semester or summe r employment with firms offering positions consistent with the student's field of study. Course may be repeated. Periodic reports and conferences are require d.
Components: THI.
Grading: GRD.
Typically Offered: Offered by Announcement Only.