BIOMEDICAL ENGINEERING

http://www.miami.edu/bme

Dept. Code: BME

Introduction

Biomedical engineering is a multidisciplinary field at the interface of traditional engineering disciplines and biological sciences. Biomedical engineers apply engineering principles and techniques to solve problems in medicine and biology. Applications include the design of medical devices, implants and prostheses, the development of new biomaterials or drug delivery systems, cellular or tissue engineering, medical applications of optics and lasers, or the acquisition and interpretation of physiological signals and medical images for diagnostic and monitoring purposes. Biomedical engineering has an impact on virtually all fields of medicine.

The Department of Biomedical Engineering at the University of Miami was formally established in 1979 as a graduate program. The four-year undergraduate program leading to the B.S degree in BME was created approximately ten years later to address the growing importance of the field and the need for professional biomedical engineers. The undergraduate 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 Accredited by the Engineering Accreditation Commission (EAC) of the Accreditation Board of Engineering and Technology (ABET) since 1997. The Department of Biomedical Engineering also offers graduate courses leading to the Master of Science and Doctor of Philosophy degrees. In addition, qualified undergraduate students may apply for the combined BS/MS program (details are provided following the curricula for the BS degrees).

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. 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.

Mission Statement

The mission of the biomedical engineering program is to prepare students to become knowledgeable and skilled engineers with an understanding of the ethical and other professional aspects of biomedical engineering. Design skills and an ability to work both independently and as part of a team are emphasized.

Educational Objectives

The educational objectives of the program are to graduate engineers who will apply their knowledge, technical skills, and ability to solve problems at the interface of engineering and life sciences. Within a few years after graduation they will be:

1. Working as professionals in biomedical engineering or related fields.

2. Continuing their education to advance their careers through professional development activities or through the pursuit of advanced degrees.

Program Description

Curriculum

The two educational objectives of the Biomedical Engineering program are achieved via the implementation of a curriculum with four parallel concentrations which include a common core and concentration-specific courses. The core curriculum is designed to provide a broad foundation in the basic sciences and in engineering. Concentration-specific courses provide the depth required to be proficient engineers.

The four concentrations are:

• Electrical (E),
• Mechanical (M),
• Biomaterials and Tissue (B) and
• Premedical (P).

The Premed concentration provides training in biomedical engineering and allows for students to take courses that are commonly required for admission to medical school. The Biomaterials and Tissue concentration provides training in the fundamental aspects of cell and tissue biology, design of biomaterial scaffolds and implants, and the application of tissue engineered constructs toward repair, restoration, and regeneration of damaged cells, tissues and organs. The Electrical concentration provides training in the fundamental aspects of electronics and signal processing, design of instrumentation, sensors, imaging systems and neural interfaces, and the application of biomedical technology toward measurement, control and rehabilitation of tissue and organ function. The Mechanical concentration provides training in the fundamental aspects of solid, fluid, and computational mechanics, design and modeling of biomedical devices such as artificial implants, and prostheses and the application of biomechanical principles toward assessment and restoration of tissue and organ function. The curriculum is designed to provide all graduates with the analytical and design skills required to formulate and solve problems at the interface of engineering and life sciences. Outstanding students are prepared for graduate studies or medical school.

Required courses in the humanities and social sciences provide students with an awareness of social, ethical and environmental issues related to their profession. The curriculum has been carefully designed with the prerequisite structure in mind so that students have to draw from previously acquired knowledge to complete the upper level course requirements successfully. The curriculum includes two or three technical electives selected by the student based on their individual professional interests.

The curriculum places a special emphasis on written and oral communication skills. Many of the Biomedical Engineering courses, as well as the capstone design project, include a requirement for a written term paper and oral presentation on a course-related topic related to the class.

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:

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<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credit Hours</th>
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<tbody>
<tr>
<td>BME 111</td>
<td>Introduction to Engineering I</td>
<td>3</td>
</tr>
<tr>
<td>BME 112</td>
<td>Introduction to Biomedical Engineering</td>
<td>2</td>
</tr>
<tr>
<td>BME 330</td>
<td>Foundations of Medical Imaging</td>
<td>3</td>
</tr>
<tr>
<td>BME 335</td>
<td>Biomaterials</td>
<td>3</td>
</tr>
<tr>
<td>BME 402</td>
<td>Senior Design I</td>
<td>2</td>
</tr>
<tr>
<td>BME 403</td>
<td>Senior Design II</td>
<td>1</td>
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<tr>
<td>BME 440</td>
<td>Biomedical Measurements</td>
<td>4</td>
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<tr>
<td>BME 450</td>
<td>Biomedical Transport</td>
<td>3</td>
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<tr>
<td>BME 480</td>
<td>Biomedical Instrumentation</td>
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**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 Introduction to Biomedical Engineering course. Each semester includes classroom or laboratory courses which place a heavy emphasis on theoretical and practical biomedical engineering design concepts. In the second semester of the junior year, students complete a 3 credit-hour course which covers 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 Senior Design Project. The Senior Design 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.

**Teaching and Design Laboratories**

Biomedical Engineering students have open access to several teaching laboratories which are used for the laboratory courses and design projects. The laboratory equipment and instructional modules are geared towards instruction in the areas of tissue mechanics, instrumentation, measurements, biomedical optics, physiological signals, tissue engineering, among others. In particular, the Department houses a scanning electron microscope and a state-of-the-art 3D printer that are used by students in their design projects.

**Undergraduate Research and Internships**

Biomedical Engineering students are strongly encouraged to gain research or professional experience through internships. Many undergraduate students conduct research in laboratories at the Department of Biomedical Engineering and at the School of Medicine, or are hired as interns by the local biomedical industry.

**Degree Programs**

The department offers one degree program with four concentrations: Electrical, Mechanical, Biomaterials and Tissue, and Premed. A list of the core science and engineering courses common to all four concentrations is provided below, followed by a tabular listing of the course requirements for the degree Bachelor of Science in Biomedical Engineering for each concentration.

**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 19 credit hours of required course work and 5 credit hours of elective course work from the lists given below. Of this total of 24 credit hours, at least 12 have to be at the level of 400 and above.

The required courses for the dual major are:

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<thead>
<tr>
<th>Code</th>
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<th>Credit Hours</th>
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<tbody>
<tr>
<td>BME 265</td>
<td>Medical Systems Physiology</td>
<td>3</td>
</tr>
<tr>
<td>BME 335</td>
<td>Biomaterials</td>
<td>3</td>
</tr>
<tr>
<td>BME 375</td>
<td>Fundamentals of Biomchanics</td>
<td>3</td>
</tr>
<tr>
<td>BME 440</td>
<td>Biomedical Measurements</td>
<td>4</td>
</tr>
<tr>
<td>BME 470</td>
<td>Biomedical Signal Analysis</td>
<td>3</td>
</tr>
<tr>
<td>BME 480</td>
<td>Biomedical Instrumentation</td>
<td>3</td>
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The electives are to be chosen from the BME course list.

**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 biomedical engineering. The program is designed for the exemplary high school student interested in applied mathematics and science. The students will be provided with an understanding and some hands-on experience on topics relative to the discipline of Biomedical Engineering. The course content changes throughout the 3-week duration and includes topics on lasers, medical imaging, biomaterials, bioelectricity and biomechanics. The students will be able to understand the challenges associated with the desing, testing and FDA clearance of biomedical devices and the importance of the scientific methods in engineering. The laboratory and field trip experiences will deal with the design and testing of a bioelectric device. Summer Scholar Students only.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Summer.

**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.
Prerequisite: BME 111.
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 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.
Prerequisite: BIL 150. And CHM 111.
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 PowerlabPhysiology 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 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.
Prerequisite: BIL 150. And CHM 111.
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

BME 305. Biomedical Technology. 3 Credit Hours.
Non-mathematical introduction to technical and clinical aspects of biomedical engineering. Biomedical signals and instrumentation, sensors, transducers, physiological measurements, laboratory instrumentation, implants, cardiac assist devices, 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 111.
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 311. MATLAB for Biomedical Engineers. 1 Credit Hour.
Laboratory course for applications of MATLAB in biomedical engineering. Upon the completion of this course, students will be able to write MATLAB scripts to solve engineering problems and perform basic analysis and processing of biomedical signals. The course includes MATLAB programming environment, MATLAB variables, FOR, IF and WHILE statements, plotting and advance graphics, user defined functions, symbolic computation, data file management and graphical user interfaces. The course concludes with a final project focused in biomedical application.
Prerequisites: ECE 118, BME 310. Or Corequisite: BME 310.
Components: LAB.
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 MATLAB and the results will be compared and discussed. A brief introduction to R will be provided.
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

BME 320. The Evolution of Technology. 3 Credit Hours.
Organized and taught by an interdisciplinary 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: 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 206. And PHY 207. Or Pre/Corequisite: BME 310.
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 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 205.
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

BME 395. Undergraduate Research in Biomedical Engineering. 1-3 Credit Hours.
Research and/or design projects consisting of an individual investigation of current problems. Offered by special arrangement only.
Components: THI.
Grading: GRD.
Typically Offered: Fall, Spring, & Summer.

BME 399. Cooperative Education. 1 Credit Hour.
Practical application of classroom theory through alternating semester or summer 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.
Components: LEC.
Grading: GRD.
Typically Offered: Fall & 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.
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

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: Fall & Spring.

BME 440. Biomedical Measurements. 4.00 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. And ECE 204.
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 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: ECE 201. And ECE 204.
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: BME 310 and PHY 206.
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. Prerequisite: 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 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: Offered by Announcement Only.

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. Prerequisite: BME 112. And BME 211. And BME 330. Or Corequisite: BME 470.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

BME 520. Medical Imaging System. 3 Credit Hours.
Engineering and scientific principles of medical imaging systems. The concepts of instrumentation and diagnostic applications of different techniques and systems are presented. Demonstrations or exhibitions of medical systems are given in the visits to clinical and research laboratories. Topics include digital image and image processing fundamentals, radiographic (X-ray, CT), magnetic resonance (MRI) and radio-isotopic (PET) systems, and associated image reconstruction techniques. Basic concepts and simulation of imaging systems are emphasized. Prerequisite: ECE 201. And BME 211. And BME 330. Or Corequisite: BME 470.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

BME 521. Medical Imaging Applications. 3 Credit Hours.
Medical applications of imaging systems and image processing techniques. Topics include image fundamentals (resolution, format, and storage), image processing fundamentals (transformation, compression, enhancement, segmentation, registration, and reconstruction), and image analysis fundamentals (calibration, quantification, correlation, linearity and depiction). Course includes dedicated computer laboratory projects and demonstrations given in clinical and research laboratories at the medical campus. Corequisite: BME 570 or equivalent. Prerequisite: BME 211. And BME 330. Or Corequisite: BME 470.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

BME 522. Scanning Electron Microscopy for Engineers. 3 Credit Hours.
Physics of transmission and scanning electron microscopy including x-rayspectroscopic 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. Prerequisite: ECE 201. Or Corequisite: BME 570.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

BME 525. Special Problems. 1-3 Credit Hours.
Research and/or design projects consisting of an individual investigation of current problems. Offered by special arrangement only. Prerequisite: BME 112. And BME 211. And BME 330.
Components: THI.
Grading: GRD.
Typically Offered: Spring.

BME 526. Special Problems. 1-3 Credit Hours.
Research and/or design projects consisting of an individual investigation of current problems. Offered by special arrangement only. Prerequisite: BME 112. And BME 211. And BME 330.
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.
BME 531. Technical Entrepreneurship I. 1 Credit Hour.
The first half of a two-semester sequence that simulates the work of a product development team to gain experience in technical entrepreneurship. The students propose product ideas, assess those collectively, select a few, form teams, define the product, and perform market analysis. The course is concluded with a business and technical development plan for the team’s project. Lectures are presented on a variety of entrepreneurial topics.
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

BME 532. Technical Entrepreneurship II. 2 Credit Hours.
The second half of a two-semester sequence that simulates the work of a product development team to gain experience in technical entrepreneurship. The students complete the development of a working prototype and refine their marketing and business plan based on experience gained during the development phase. Lectures are presented on relevant entrepreneurial topics.
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

BME 535. Advanced Biomaterials. 3 Credit Hours.
Applications of biomaterials in different tissue and organ systems. Relationships between physical and chemical structure of materials and biological system response 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: Offered by Announcement Only.

BME 541. Medical Electronic Systems Laboratory. 2 Credit Hours.
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 delivery systems for medical applications, optics of the eye and visual instruments, and optical instruments used in medicine (microscopes, endoscopes, ophthalmic instruments) are discussed. Hands-on sessions in the laboratory are included. Prerequisite: PHY 206. And PHY 207. And MTH 311.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

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 propagation in tissue, laser-tissue interactions, and surgical applications of lasers are also covered. Hands-on sessions in the laboratory are included. Prerequisite: PHY 206. And PHY 207. And MTH 311.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

BME 555. Fundamentals of Computational Neuroscience. 3 Credit Hours.
Major concepts include neural signaling and communication from the single neuron to system of neural ensembles and the role of neural computation in engineering 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. Corequisite: BME 470.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

BME 560. 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.
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

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. And BME 335.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

BME 566. Cell and Tissue Engineering Laboratory. 1 Credit Hour.
The principles of cell and tissue engineering will be presented in a hands-on laboratory experience. General techniques learned will include sterile methods, cell culture techniques and integration of cells within biomaterials. Cell engineering topics include cell cycle/metabolism, adhesion, signal transduction, and assessment. Tissue engineering topics include fabrication, biomaterials/scaffolds and cell integration, and functional assessment. Pre/Corequisite: BME 565 Or BME 302.
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: Spring.

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: Fall & Spring.

BME 575. Biomechanics II. 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: Offered by Announcement Only.

BME 578. 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: Fall.

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

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