MS IN BIOMEDICAL ENGINEERING
Online Curriculum

To complete the online program in two years, students typically take two courses per semester, each lasting 14 weeks. Our online program requires a total of 27 credits of coursework.

The curriculum is organized as follows:

BIOMEDICAL ENGINEERING CORE COURSES

EBME 401D: Biomedical Instrumentation and Signal Processing (required)

Graduate students with various undergraduate backgrounds will learn the fundamental principles of biomedical measurements that integrate instrumentation and signal processing with problem-based hands-on experience.

(Choose one of the following:)

EBME 451: Cellular and Molecular Physiology

This course covers the important fundamentals and applications of polymers in medicine, and consists of three major components: (i) the blood and soft-tissue reactions to polymer implants; (ii) the structure, characterization and modification of biomedical polymers; and (iii) the application of polymers in a broad range of cardiovascular and extravascular devices. The chemical and physical characteristics of biomedical polymers and the properties required to meet the needs of the intended biological function will be presented. Course offers clinical evaluation, including recent advances and current problems associated with different polymer implants.

EBME 432: Quantitative Analysis of Physiological Systems

Mathematical modeling and simulation of cellular, tissue, and organ systems: respiratory, renal, liver, cardiovascular, neural, and muscular. Dynamic mass transport and reaction processes. Cellular metabolism. Cardiac electrophysiology and regulation. Excitable cells and tissue. Neural system integration, feedback, and control.
Recommended preparation: differential equations, linear algebra, and MATLAB.

ENGINEERING CORE COURSES

(Choose one of the following:)

EPOM 405: Applied Engineering Statistics

This course provides an intensive introduction to fundamental concepts, applications and the practice of contemporary engineering statistics. Each topic is introduced through realistic sample problems to be solved first by using standard spreadsheet programs and then using more sophisticated software packages. Primary attention is given to teaching the fundamental concepts underlying standard analysis methods.

EPOM 407: Engineering Economics & Financial Analysis

In this course, money and profit as measures of "goodness" in engineering design are studied. Methods for economic analysis of capital investments are developed and the financial evaluation of machinery, manufacturing processes, buildings, research and development, personnel development, and other long-lived investments is emphasized. Optimization methods and decision analysis techniques are examined to identify economically attractive alternatives. Basic concepts of cost accounting are also covered.

BIOMEDICAL ENGINEERING SPECIALTY COURSES

(Choose two of the following:)

EBME 406: Polymers in Medicine (Materials)

This course covers the important fundamentals and applications of polymers in medicine, and consists of three major components: (i) the blood and soft-tissue reactions to polymer implants; (ii) the structure, characterization and modification of biomedical polymers; and (iii) the application of polymers in a broad range of cardiovascular and extravascular devices. The chemical and physical characteristics of biomedical polymers and the properties required to meet the needs of the intended biological function will be presented. Course offers clinical evaluation, including recent advances and current problems associated with different polymer implants.

EBME 410: Medical Imaging Fundamentals (Imaging)

Physical principles of medical imaging. Imaging devices for x-ray, ultrasound, magnetic resonance, etc. Image quality descriptions. Patient risk.

EBME 421: Bioelectric Phenomena (Neural Engineering)

The goal of this course is to provide working knowledge of the theoretical methods that are used in the fields of electrophysiology and bioelectricity for both neural and cardiac systems. These methods will be applied to describe, from a theoretical and quantitative perspective, the electrical behavior of excitable cells, the methods for recording their activity and the effect of applied electrical and magnetic fields on excitable issues.

TRANSLATIONAL COURSES

EBME 440: Translational Research for BME

Translation of laboratory developments to improve biomedical and clinical research and patient care. Interdisciplinary and team communication. Evaluation of technology and research planning with clinical and engineering perspectives. Discussing clinical situations, shadowing clinicians, attending Grand Rounds and Morbidity-Mortality conferences. Validation study design. Regulatory/oversight organization. Protocol design and informed consent for Institutional Review Board (IRB) approval. NIH requirements for human subject research. Special project reports to produce IRB protocol or NIH-style proposal.

EBME 471: Principles of Medical Device Design and Innovation

Translational research leading to medical device innovation is highly interdisciplinary, requiring a systematic, structured approach to bringing new medical technologies to market. This course provides the fundamental principles of the biodesign innovation process, providing the student the essential tools to (A) identify unmet clinical needs, (B) create innovative medical device concepts that respond to a primary unmet need, and (C) understand the process for translating these concepts into the market. In short, the student learns the fundamental principles for the process of "identify, invent, implement" in the field of biodesign.

MS IN BIOMEDICAL ENGINEERING
Online Curriculum

TECHNICAL ELECTIVES

(Choose two of the following:)

EMAE 456: Micro-Electro-Mechanical Systems and Biomanufacturing

Microscale technologies have enabled advanced capabilities for researchers in unexplored territories of cells in biology and medicine. Biological (or Biomedical) Micro-Electro-Mechanical Systems (BioMEMS) involve the fundamentals of mechanics, electronics and advanced microfabrication technologies with specific emphasis on biological applications. BioMEMS is an interdisciplinary research area, which brings together multiple disciplines, including mechanical engineering, biomedical engineering, chemical engineering, materials science, electrical engineering, clinical sciences, medicine, and biology. BioMEMS-based technologies have found real-world applications in tissue engineering, implantable microdevices, proteomics, genomics, molecular biology, and point-of-care platforms. This course aims to: (1) introduce the need for miniaturized systems in biology and medicine and the fundamental design and microfabrication concepts, (2) introduce the basics of microscale manipulation of cells and biological agents employing the fundamentals of microscale behaviors of fluids and mechanical systems, and (3) expose the students to applications of BioMEMS and on-chip technologies in biology and medicine with clinical impact.

EPOM 401: Introduction to Business for Engineers

This course provides an introduction to the business environment for practicing engineers. The course emphasizes the interplay between business and engineering in the context of the competitive marketplace (economics), how engineering proposals are evaluated (finance), the relationship between product and customer (marketing), making effective use of micro-disciplinary teams (organizational behavior), and the manufacturing and production process (operations).

EBME 601: Research Projects

This is a capstone course for the Master of Science in Biomedical Engineering, which provides students with the opportunity to integrate the various components of the program. In particular the core knowledge will be combined with the Principles of Medical Device Design and Innovation concepts to guide the student through the analysis and design of the product or device for the solution of a health care related problem.