# Biomedical Engineering

## BIOMEDICAL ENGINEERING

**Note:** Text highlighted in red indicates that a change has been made to the course listing. The red text indicates the current, updated information.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Instructor</th>
<th>Credits</th>
<th>Prerequisites</th>
<th>Units</th>
<th>Sections</th>
<th>Days</th>
<th>Time</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>580.111 (E,N)</td>
<td>BME MODELING &amp; DESIGN (2) <strong>Allen, Haase</strong></td>
<td></td>
<td>2</td>
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<td>Lec.</td>
<td>Th 12</td>
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<tr>
<td></td>
<td>Limit 6 per section BME Freshmen only (Formerly BME Design Group) Working in teams with upperclassmen this course (1) introduces biomedical engineering freshmen to an orderly method for analyzing and modeling biological systems and (2) introduces engineering principles to solve design problems that are biological, physiological, and/or medical. Freshmen are expected to use the informational content being taught in calculus, physics and chemistry and to apply this knowledge to the solution of practical problems encountered in biomedical engineering.</td>
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<td>Lab</td>
<td>Th 8:30-10:20 &amp; 10:30-12</td>
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<td></td>
<td>Sections 13-26 added 7/10/06</td>
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<td></td>
<td></td>
<td>01,02,03,04</td>
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<td></td>
<td>Sections 15,19,22,24 canceled 8/22/06</td>
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<td></td>
<td>Th 1-3</td>
<td>05,06,07,08</td>
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<td>Th 3-5</td>
<td>09,10,11,12</td>
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<td>13,14,15,16</td>
<td>13-16, 7pm</td>
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<td>F 8:30-10:20</td>
<td>17,18,19,20</td>
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<td>F 12-2</td>
<td>21,22,23,24</td>
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<td>F 2-4</td>
<td>25,26</td>
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<tr>
<td>580.211 (E,N)</td>
<td>BME DESIGN GROUP (3) <strong>Allen</strong></td>
<td></td>
<td>3</td>
<td>Permission of course director required.</td>
<td></td>
<td></td>
<td>Sec.</td>
<td>Th 12</td>
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<td></td>
<td>Sophomore-level version of 580.111</td>
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<td>Sec. 01</td>
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<tr>
<td>580.221 (E,N)</td>
<td>MOLECULES AND CELLS (4) <strong>Kuo</strong></td>
<td></td>
<td>4</td>
<td>Prereq: 030.101, 030.104</td>
<td></td>
<td></td>
<td>Lec.</td>
<td>TTh 4-5:30</td>
<td>F 9</td>
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<td></td>
<td>Limit 35 per section</td>
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<td>02</td>
<td>F 10</td>
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<td>An introduction to modern molecular and cellular biology in the context of potential biomedical engineering applications. Topics covered: reactions between molecules, including receptor-ligand and antigen-antibody specificity, protein structure, enzyme catalysis, genetic information, protein processing and secretion, cell physiology and cell functions. Advanced quantitative treatment including multi-state kinetics, Monte Carlo simulations of biochemical reactions, and transport phenomena.</td>
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<td>Sec.</td>
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<td>03</td>
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<td></td>
<td>Secs. 01 &amp; 06 canceled 9/14/06</td>
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<td>04</td>
<td>F 12</td>
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<td>06</td>
<td>F 2</td>
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<tr>
<td>580.228 (N)</td>
<td>INTRODUCTION TO HUMAN PHYSIOLOGY (3) <strong>Goldberg, Allen</strong></td>
<td></td>
<td>3</td>
<td>Freshmen and Sophomores only</td>
<td></td>
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<td>Sec.</td>
<td>MWF 1</td>
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<td>This course will provide students with an understanding of the structure and function relationships of the human body. The associations that exist between cells, tissues, and organs will be presented and discussed from multiple perspectives: from the molecular level to studies of human pathology through the use of clinical correlations. The course structure will include lectures and seminar style discussions of the primary literature.</td>
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<td>Sec. 01</td>
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<tr>
<td>580.311 (E,N)</td>
<td>BME DESIGN GROUP (3) <strong>Allen</strong> Perm. Req</td>
<td></td>
<td>3</td>
<td>A two-semester course sequence where juniors and seniors work with a team leader and a group of BME freshmen and sophomores, to solve open-ended problems in biomedical engineering. Upperclassmen are expected to apply their general knowledge and experience, and their knowledge in their concentration area, to teach lower classmen and to generate the solution to practical problems encountered in biomedical engineering.</td>
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<td>Sec.</td>
<td>TBA</td>
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<tr>
<td>580.410</td>
<td>BME TEACHING PRACTICUM (2) <strong>Haase</strong></td>
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<td>Senior biomedical engineering students will assist the BME Modeling &amp; Design course instructor in managing the laboratory component of the class.</td>
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<td>Course Code</td>
<td>Course Title</td>
<td>Instructor(s)</td>
<td>Credits</td>
<td>Description</td>
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<tr>
<td>580.411 (E,N)</td>
<td>BME DESIGN GROUP (3)</td>
<td>Allen</td>
<td>3</td>
<td>Perm. Req. Senior-level version of 580.311-312.</td>
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<tr>
<td>580.413</td>
<td>DESIGN TEAM - TEAM LEADER (4)</td>
<td>Allen</td>
<td>4</td>
<td>Perm. Req. A two-semester sequence where leaders direct a team of undergraduate biomedical engineering students in a series of design problems. Prior design team experience and permission of course director required.</td>
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<td>580.421 (E,N)</td>
<td>SYSTEMS BIOENGINEERING I (4)</td>
<td>Yue</td>
<td>4</td>
<td>Prereq. 580.221 &amp; 580.222. Limit 25 per section. A quantitative, model-oriented investigation of the cardiovascular system. Topics are organized in three segments: (1) Molecular/cellular physiology, including electrical signaling and muscle contraction. (2) Systems cardiovascular physiology, emphasizing circuit-diagram analysis of hemodynamics. (3) Cardio-vascular horizons and challenges for biomedical engineers, including heart failure and its investigation/treatment by computer simulation, by gene-array analysis, by stem-cell technology, and by mechanical devices (left-ventricular assist and total-heart replacement). <strong>Section 04 canceled 10/30/06</strong> <strong>Section 05 added 10/30/06</strong></td>
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<tr>
<td>580.423 (N)</td>
<td>SYSTEMS BIOENGINEERING LAB I (2)</td>
<td>Allen</td>
<td>2</td>
<td>Prereq. 580.421. Priority to Junior BME majors. A two-semester laboratory course in which various physiological preparations are used as examples of problems of applying technology in biological systems. The emphasis in this course is on the design of experimental measurements and on physical models of biological systems.</td>
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<td>580.435 (E,N)</td>
<td>BIOELECTROMAGNETIC PHENOMENA (3)</td>
<td>Tung</td>
<td>3</td>
<td>Prereq. 110.202, 110.302 or 550.291, 520.213, 520.214, 520.219, 580.421 or equivalent. This course reviews theoretical concepts and experimental approaches used to characterize electric, magnetic and electromagnetic phenomena that arise in biological tissues. Topics include the passive and active behavior of cell membranes, volume conductor models of cells and tissues, the bidomain model, bioelectric and biomagnetic measurements, electric and magnetic stimulation, and impedance plethysmography abnd tomography.</td>
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<td>580.439 (E,N)</td>
<td>MODELS OF THE NEURON (4)</td>
<td>Young</td>
<td>4</td>
<td>Prereq. 110.301, 580.421 or equivalent. Single-neuron modeling, emphasizing the use of computational models as links between the properties of neurons at several levels of detail. Topics include thermodynamics of ion flow in aqueous environments, biology and biophysics of ion channels, gating, nonlinear dynamics as a way of studying the collective properties of channels in a membrane, synaptic transmission, integration of electrical activity in multi-compartment dendritic tree models, and properties of neural networks. Students will study the properties of computational models of neurons; graduate students will develop a neuron model using data from the literature.</td>
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<td>580.440 (E)</td>
<td>CELLULAR AND TISSUE ENGINEERING (3)</td>
<td>Elisseef, Yarema</td>
<td>3</td>
<td>Prereq. 580.422-424. Junior, Senior and Graduate students only. Lectures provide an overview of molecular biology fundamentals, an extensiveview on extracellular matrix and basics of receptors, followed by topics on cell-cell and cell-matrix interactions at both the theoretical and experimental levels. Subsequent lectures will cover the effects of physical (shear, stress, strain), chemical (cytokins, growth factors), and electrical stimuli on cell function, emphasizing topics on gene regulation and signal transduction processes. Material on cell-cycle, apoptosis, metabolic engineering and gene therapy will also be incorporated into the course.</td>
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</table>
| 580.451 (E,N) | CELLULAR AND TISSUE ENGINEERING LAB (2) | Haase | 2 | Limit 8 Senior and Graduate students only; others Perm. Req. Lab Fee: $100.00. Cell and tissue engineering is a field that relies heavily on experimental techniques. This laboratory course will consist of three six experiments that will provide students with valuable hands-on experience in cell and tissue engineering. Students will learn basic cell culture procedures and specialized techniques related to faculty expertise in cell engineering, microfluidics, gene therapy, microfabrication and cell encapsulation. Experiments include the basics of cell culture techniques, gene transfection and metabolic engineering, basics of cell-substrate interactions I, cell-substrate interactions II, and...
cell encapsulation and gel contraction.

**ADVANCED TOPICS IN COMPUTER VISION (3) Vidal**  
Prereq: 600.461 and linear algebra or instructor's permission. State-of-the-art methods in dynamic vision, with an emphasis on segmentation, reconstruction and recognition of static and dynamic scenes. Topics include: reconstruction of static scenes (tracking and correspondence, multiple view geometry, self calibration), reconstruction of dynamic scenes (2-D and 3-D motion segmentation, nonrigid motion analysis), recognition of visual dynamics (dynamic textures, face and hand gestures, human gaits, crowd motion analysis), as well as geometric and statistical methods for clustering and unsupervised learning, such as K-means, Expectation Maximization, and Generalized Principal Component Analysis. Applications in robotics and biomedical imaging are also included.  
*Co-listed with 600.462 Course added 4/05/06*

**PRINCIPLES OF DESIGN OF BIOMEDICAL INSTRUMENTATION (4) Thakor**  
Prereq: 520.213-214, electronics lab or 580.470  
Lab Fee:$100.00  
This core design course will cover lectures and hands-on labs. The material covered will include fundamentals of biomedical sensors and instrumentation, FDA regulations, designing with electronics, biopotentials and ECG amplifier design, recording from heart, muscle, brain, etc., diagnostic and therapeutic devices (including pacemakers and defibrillators), applications in prosthetics and rehabilitation, and safety. The course includes extensive laboratory work involving circuits, electronics, sensor design and interface, and building complete biomedical instrumentation. The students will also carry out design challenge projects, individually or in teams (examples include smart cane for blind, computer interface for quadriplegic).  
*Sec. 01 Lec. Th 4-6pm  
Sec. 01 Lec. Th 4-6pm  
Sec. 02 Lec. F 9-11  
Sec. 02 Lec. F 1-5  
Sec. 03 Lec. F 8-12  
Sec. 04 Lec. F 1-5  
Sec. 05 Lec. Th 8-11*

**MICROFABRICATION LAB (4) Wang/Andreou**  
Prereq: d. This laboratory course introduces the principles used in the construction of microelectronic devices, sensors, and micromechanical structures. Students will work in the laboratory on the fabrication and testing of a device. Accompanying lecture material covers basic processing steps, design and analysis CAD tools, and national foundry services.  
*Co-listed with 530.495 and 520.495 Secs. 04 & 05 added 9/20/06*

**MICRO/NANOSCIENCE AND BIOTECHNOLOGY (3) Wang**  
An introduction to the physical and chemical principles important to MEMS, BioMEMS, and Bionanotechnology. Topics include scaling laws, colloids and surfaces, micro and nanofluidics, thermal forces and diffusion, chemical forces, electrokinetics, electric aspects of surface chemistry, capillary forces and surface tension, and top-down and bottom-up nanofabrication.  
*Sec. 01 Lec. MW 2-3:30  
Sec. 01 Lec. MW 2-3:30*

**FRESHMAN-SOPHOMORE RESEARCH OR PRACTICUM IN BIOMEDICAL ENGINEERING**  
TBA

**FRESHMAN - SOPHOMORE INDEPENDENT STUDY IN BIOMEDICAL ENGINEERING**  
TBA

**JUNIOR - SENIOR RESEARCH OR PRACTICUM IN BIOMEDICAL ENGINEERING**  
TBA

**JUNIOR - SENIOR INDEPENDENT STUDY IN BIOMEDICAL ENGINEERING**  
TBA

**BME INTERNSHIP**  
TBA

**HONORS INSTRUMENTATION (2) Thakor**  
Coreq: Enrollment in 580.471 Students enrolled jointly in 580.471 and 580.571 will not be required to take exams. Instead, students will develop a term paper and patent application and carry out a hands-on individual or team project throughout the semester and the intersession. Previous projects include design of EEG amplifier, voltage clamp and patch clamp, vision aid of blind, pacemaker/defibrillator, sleep detection and alert device, glucose sensor and regulation, temperature controller, eye movement detection and device control, ultrasound ranging and tissue properties, impedance plethysmography, lie detector, blood alcohol detector, pulse oximeter, etc.  
*Sec. 01 TBA*

**SENIOR DESIGN PROJECT (3) Allen**  
Perm.  
Independent or team design project to design and evaluate a system. The design should demonstrate creative thinking and experimental skills, and must draw upon advanced topics of biomedical and traditional engineering.  
*Project proposals must be submitted by September 15, 2006*

**HORIZONS IN SYSTEMS BIOENGINEERING I Yue**  
Limit 30 Open to doctoral students in BME  
Advanced papers and topics in systems bioengineering will be surveyed in a three-semester sequence. Topics are thematically related to those covered in the Systems Bioengineering course. Topics, as they relate to the ongoing
research in the Whitaker Biomedical Engineering Institute, will be introduced by WBMEI faculty. Students are required to present an original research proposal based on one of the topics covered in the course. This course is required of all BME first-year PhD students. **Course added 9/12/06**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Instructor(s)</th>
<th>Prerequisites/Notes</th>
<th>Section</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>580.625</td>
<td>STRUCTURE AND FUNCTION OF THE AUDITORY AND VESTIBULAR SYSTEMS</td>
<td>May / Staff</td>
<td>Prereq: 580.421-422 or equivalent. Recommend: 110.302, 520.214 (taught at Medical Campus)</td>
<td>Sec. 01</td>
<td>TTh 8:30-10</td>
</tr>
<tr>
<td>580.628</td>
<td>TOPICS IN SYSTEM NEUROSCIENCE</td>
<td>Wang</td>
<td>Prereq: Intro. to Neuroscience, 110.302, 520.214, 580.421 or equivalent This course consists of weekly discussions of current literature in systems neuroscience. The selected readings will focus on neural mechanisms for perception, attention, motor behavior, learning, and memory, as studied using physiological, psychophysical, computational, and imaging techniques. Students are expected to give presentations and participate in discussions.</td>
<td>Sec. 01</td>
<td>W 5</td>
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<tr>
<td>580.639</td>
<td>MODELS OF THE NEURON</td>
<td>Young</td>
<td>Prereq: 110.301-302, 580.421-422 or equivalent. See description for 580.439.</td>
<td>Sec. 01</td>
<td>MW 8:30-10 T 9</td>
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<tr>
<td>580.640</td>
<td>CELLULAR AND TISSUE ENGINEERING</td>
<td>Yarema</td>
<td>See 580.440 for full description.</td>
<td>Sec. 01</td>
<td>MW 8:30-10 2-3:30</td>
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<tr>
<td>580.651</td>
<td>INTRODUCTION TO NONLINEAR DYNAMICS</td>
<td>Shelhamer</td>
<td>Prereq: Knowledge of signals and systems or Perm Req'd. Organizational Meeting: Thursday, September 7, 2006 @ 2pm Traylor Bldg 709 (School of Medicine) Course canceled 9/06/06</td>
<td>Sec. 01</td>
<td>TBA</td>
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<tr>
<td>580.671</td>
<td>STATISTICAL MECHANICAL BIO SYSTEMS</td>
<td>Sun</td>
<td>See 580.440 for full description.</td>
<td>Sec. 01</td>
<td>MW 11-12:30</td>
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<tr>
<td>580.692</td>
<td>LEARNING THEORY II: MODELING AND SEGMENTATION OF MULTIVARIATE MIXED DATA</td>
<td>Vidal</td>
<td>Limit 10 Prereq: 580.691 or Perm. Req'd. The aim of this two semester course is to describe the foundations of computational methods for the statistical and dynamical modeling of multivariate data. The emphasis of the second semester is to use methods from algebraic geometry, probability theory and dynamical systems theory to build models of data. Topics include nonlinear dimensionality reduction (PCA, LLE), unsupervised learning (central clustering, subspace clustering, GPCA), and estimation and identification of dynamical systems (Kalman filtering, subspace identification, hybrid system identification). We will apply these tools to model data from computer vision, biomedical imaging, neuroscience, and computational biology. Course added 8/03/06</td>
<td>Sec. 01</td>
<td>TTh 4:30-6pm</td>
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<td>580.703</td>
<td>SEMINAR IN NEUROENGINEERING</td>
<td>Thakor</td>
<td>Weekly seminar in which faculty, staff, graduate students, and outside speakers discuss topics of current research interest in the area of neuroengineering.</td>
<td>Sec. 01</td>
<td>Th 2</td>
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<td>580.771</td>
<td>PRINCIPLES OF BME INSTRUMENTATION</td>
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<td>Sec. 01</td>
<td>Th 4-6pm Lab F 6-9pm</td>
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<tr>
<td>580.801</td>
<td>RESEARCH IN BIOMEDICAL ENGINEERING</td>
<td></td>
<td>Graduate Students only</td>
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