

# BME - BIOMEDICAL ENGINEERING

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## **BME 1910 Biomedical Engineering Design Lab I Cr. 1**

Application of engineering principles to biomedical engineering problems through laboratory and design exercises. First of a six-semester sequence; work on a biomedical engineering team; basics of biomedical engineering design. Offered Fall.

**Prerequisites:** (May be taken concurrently: [BE 1500 with a minimum grade of C-])

**Restriction(s):** Enrollment is limited to students with a major in Biomedical Engineering, Biomedical Engg Honors or Pre-Biomedical Engineering; enrollment limited to students in the BS in Biomedical Engineering or UG Undeclared/Non-Degree (EN) programs; enrollment is limited to Undergraduate level students.

**Course Material Fees:** \$25

## **BME 1920 Biomedical Engineering Design Lab II Cr. 1**

Application of engineering principles to biomedical engineering problems through laboratory and design exercises. Second of a six-semester sequence; basic analysis of biomaterials and design importance of materials. Offered Winter.

**Prerequisite:** BE 1300 (may be taken concurrently) with a minimum grade of D-

**Restriction(s):** Enrollment is limited to students with a major in Biomedical Engineering, Biomedical Engg Honors or Pre-Biomedical Engineering; enrollment limited to students in the BS in Biomedical Engineering or UG Undeclared/Non-Degree (EN) programs; enrollment is limited to Undergraduate level students.

**Course Material Fees:** \$100

## **BME 1925 Biomedical Engineering Design Laboratory: Jump Start I Cr. 2**

Laboratory and design exercises focusing on fundamental design processes for biomedical engineering and the application of materials science to BME. This course replaces the BME 1910-BME 1920 sequence for students who transfer into the program in the second or third curricular year. Offered Spring/Summer.

**Restriction(s):** Enrollment is limited to students with a major in Biomedical Engineering, Biomedical Engg Honors or Pre-Biomedical Engineering; enrollment limited to students in the BS in Biomedical Engineering program; enrollment limited to students in the College of Engineering.

**Course Material Fees:** \$43

## **BME 2010 Introduction to Physiology for Engineers Cr. 2**

Introduction to human physiological and pathophysiological processes. Offered Yearly.

**Prerequisite:** BIO 1510 with a minimum grade of C- and CHM 1240 with a minimum grade of C-

**Restriction(s):** Enrollment is limited to students with a major, minor, or concentration in Biomedical Engineering or Biomedical Engg Honors; enrollment limited to students in the College of Engineering.

## **BME 2070 Introduction to Anatomy for Engineers Cr. 2**

A text and models based anatomy course for undergraduate students in biomedical engineering. This course is intended to give the students an introductory experience of the study of human anatomy in relation to engineering principles. Offered Fall.

**Prerequisites:** ([BIO 1510 with a minimum grade of D-])

**Restriction(s):** Enrollment limited to students in a BS in Biomedical Engg degree.

**Course Material Fees:** \$25

## **BME 2910 Biomedical Engineering Design Lab III Cr. 1**

Application of engineering principles to biomedical engineering problems through laboratory and design exercises. Third of a six-semester sequence; analysis of musculoskeletal forces biomechanics. Offered Fall.

**Prerequisite:** (BME 1920 with a minimum grade of C- or BME 1925 with a minimum grade of C-) and ME 2410 (may be taken concurrently) with a minimum grade of C-

**Restriction(s):** Enrollment is limited to students with a major in Biomedical Engineering or Biomedical Engg Honors; enrollment limited to students in the BS in Biomedical Engineering program; enrollment is limited to Undergraduate level students; enrollment limited to students in the College of Engineering.

**Course Material Fees:** \$25

## **BME 2920 Biomedical Engineering Design Lab IV Cr. 1**

Application of engineering principles to biomedical engineering problems through laboratory and design exercises involving tissue biomechanics. Introduction to finite element modeling. Fourth of a six-semester sequence. Offered Winter.

**Prerequisite:** BE 2100 (may be taken concurrently) with a minimum grade of C- and BME 2010 (may be taken concurrently) with a minimum grade of C- and ME 2420 (may be taken concurrently) with a minimum grade of C-

**Restriction(s):** Enrollment is limited to students with a major in Biomedical Engineering or Biomedical Engg Honors; enrollment limited to students in the BS in Biomedical Engineering program; enrollment is limited to Undergraduate level students; enrollment limited to students in the College of Engineering.

**Course Material Fees:** \$25

## **BME 3470 Biomedical Signals and Systems Cr. 3**

Mathematical, engineering and computer techniques for describing and analyzing biomedical signals, including ECG, EEG, EMG, blood pressure, and tomographic images. Offered Fall.

**Prerequisites:** (May be taken concurrently: [BME 3910 with a minimum grade of C-]) AND ([ECE 3320 with a minimum grade of C-])

**Restriction(s):** Enrollment is limited to students with a major in Biomedical Engineering or Biomedical Engg Honors; enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment is limited to Undergraduate level students; enrollment limited to students in the College of Engineering.

**Course Material Fees:** \$50

## **BME 3910 Biomedical Engineering Design Lab V Cr. 1**

Application of engineering principles to biomedical engineering problems through laboratory and design exercises. Focus on measurement, analysis, modeling, and interaction with biomedical signals from living systems. Fifth of a six-semester sequence. Offered Fall.

**Prerequisite:** BE 1500 with a minimum grade of C- and MAT 2150 with a minimum grade of C- and ENG 3050 with a minimum grade of C- and BME 3470 (may be taken concurrently) with a minimum grade of C-

**Restriction(s):** Enrollment is limited to students with a major in Biomedical Engineering or Biomedical Engg Honors; enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment is limited to Undergraduate level students; enrollment limited to students in the College of Engineering.

**Course Material Fees:** \$25

**BME 3920 Biomedical Engineering Design Lab VI Cr. 2**

Application of engineering principles to biomedical engineering problems through laboratory and design exercises. Introduction to the capstone design process. Integration of the design process with the complete government regulation system for medical device design. Use of advanced CAE tools for analysis. Sixth of a six-semester sequence. Offered Winter.

**Restriction(s):** Enrollment is limited to students with a major in Biomedical Engineering or Biomedical Engg Honors; enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment is limited to Undergraduate level students; enrollment limited to students in the College of Engineering.

**Course Material Fees:** \$100

**BME 4010 Engineering Physiology Laboratory Cr. 1**

Measurement and analysis of physiological signals on living systems, with focus on neural, cardiovascular, respiratory and muscular systems. Includes a student-designed experiment on a physiological system. Offered Winter.

**Prerequisites:** ([BME 2010 with a minimum grade of C-])

**Restriction(s):** Enrollment is limited to students with a major in Biomedical Engineering or Biomedical Engg Honors; enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment is limited to Undergraduate level students; enrollment limited to students in the College of Engineering.

**Course Material Fees:** \$30

**BME 4210 Introduction to Biomechanics Cr. 3**

Broad introduction to the application of mechanical engineering principles to biomedical engineering, including motion analysis, injury and forensic biomechanics, cardiovascular and pulmonary mechanics, and design of implants with mechanical functions. Offered Winter.

**Prerequisite:** CHE 3200 with a minimum grade of C- and ME 2420 with a minimum grade of C-

**Restriction(s):** Enrollment is limited to students with a major in Biomedical Engineering or Biomedical Engg Honors; enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment is limited to Undergraduate level students; enrollment limited to students in the College of Engineering.

**BME 4310 Introduction to Biomaterials Cr. 3**

Broad introduction to the field of biomaterials and its application to tissue engineering, implant design, controlled drug delivery, and designer materials for therapeutic use. Offered Winter.

**Prerequisite:** CHE 3200 with a minimum grade of C- and ME 2420 with a minimum grade of C-

**Restriction(s):** Enrollment is limited to students with a major in Biomedical Engineering or Biomedical Engg Honors; enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment is limited to Undergraduate level students; enrollment limited to students in the College of Engineering.

**BME 4410 Introduction to Biomedical Instrumentation Cr. 3**

Broad introduction to the use and design of instrumentation for biomedical applications, in both clinical and research use; includes filtering techniques, safety issues, and special concerns for implanted and external systems. Offered Winter.

**Prerequisites:** ([BME 3470 with a minimum grade of D-]) AND ([ECE 3300 with a minimum grade of D-])

**Restriction(s):** Enrollment is limited to students with a major in Biomedical Engineering or Biomedical Engg Honors; enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment is limited to Undergraduate level students; enrollment limited to students in the College of Engineering.

**Course Material Fees:** \$25

**BME 4910 (WI) Biomedical Engineering Capstone Design I Cr. 3**

First in a two-semester sequence during which student teams develop a design to address a biomedical engineering challenge; includes discussions with clinical faculty, analysis of current solutions, and finalization of conceptual design. Offered Fall.

**Prerequisite:** BME 3920 with a minimum grade of C-

**Restriction(s):** Enrollment is limited to students with a major in Biomedical Engineering or Biomedical Engg Honors; enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment is limited to Undergraduate level students; enrollment limited to students in the College of Engineering.

**Course Material Fees:** \$50

**BME 4920 Biomedical Engineering Capstone Design II Cr. 3**

Second of a two-semester sequence. Students develop and test a prototype of their biomedical engineering design; culminates in a public design expo to exhibit student designs. Offered Winter.

**Prerequisite:** BME 4910 with a minimum grade of C-

**Restriction(s):** Enrollment is limited to students with a major in Biomedical Engineering or Biomedical Engg Honors; enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment is limited to Undergraduate level students; enrollment limited to students in the College of Engineering.

**Course Material Fees:** \$50

**BME 5005 Intro:Cell Biol&Physol:Engrs Cr. 2**

Offered Every Term.

**BME 5010 Quantitative Physiology Cr. 4**

Basic principles of human physiology presented from the engineering perspective. Bodily functions, their regulation and control discussed in quantitative terms and illustrated by mathematical models where feasible. Offered Fall, Winter.

**Prerequisites:** ([BME 5005 with a minimum grade of C] OR [BME 2010 with a minimum grade of C])

**Equivalent:** CHE 5100, ECE 5100, IE 5100, ME 5100

**BME 5020 Computer and Mathematical Applications in Biomedical Engineering Cr. 4**

Application of numerical methods in biomedical engineering. Data acquisition, reduction, and analysis using numerical methods and computer programming for such tasks. Offered Winter.

**BME 5040 Fundamentals of Engineering Analysis Cr. 2**

Intended to train biomedical engineering students, who have no engineering background, with fundamental principles of engineering and basics of an engineering programming language. It includes Matlab programming language and basics of engineering statics, dynamics, strength of materials, and electrical circuits. Offered Fall.

**BME 5070 Engineering Anatomy Cr. 4**

A cadaver based anatomy course for undergraduate students and MS-level students in biomedical engineering. This hands-on course is intended to give the students directed experience of the study of human anatomy in relation to engineering principles. The histological study of tissues in relation to mechanical function of the organism is included in this study. Offered Winter.

**Prerequisites:** ([BME 2070 with a minimum grade of D-])

**Restriction(s):** Enrollment is limited to Graduate or Undergraduate level students; enrollment limited to students in a BS in Biomedical Engg degree.

**Course Material Fees:** \$225

**BME 5130 Vehicle Safety Engineering Cr. 4**

Role of vehicle in road safety, occupation and pedestrian injury mechanisms, measures of vehicle safety performance, driver behavior and vehicle interface. Use of new technology to improve vehicle safety. Offered Irregularly.

**BME 5210 Musculoskeletal Biomechanics Cr. 4**

Structure and properties of the major tissue components of the musculoskeletal system and evaluation of how tissues combine to provide support and motion to the body. Offered Fall.

**Prerequisite:** BME 5010 with a minimum grade of C or BMS 6550 with a minimum grade of C

**Equivalent:** ME 5160

**BME 5310 Device and Drug Approval and the FDA Cr. 3**

Government regulations and industrial procedures that lead to device/drug approval. Offered Spring/Summer.

**Prerequisite:** BME 5010 with a minimum grade of C

**BME 5350 Regenerative Biology & Medicine for Biomedical Engineers Cr. 4**

Introduces students specializing in biomedical engineering and premedical students to the conceptual and methodological principles of modern regenerative biology and medicine. Includes a review of research methods and achievements in this field and the translational applications of regenerative biology to tissue engineering and the development of regenerative therapies. Offered Winter, Spring/Summer.

**Prerequisites:** ([BME 2070 with a minimum grade of C-])

**BME 5360 Histology and Embryology Cr. 4**

Examines the normal structure and development of human tissues and organisms and the applications of this knowledge to biomedical engineering. Working with microscopes, students will study the molecular and cellular characteristics of different tissues and the lab procedures used for the analysis of tissue specimens. Particular attention is focused on technical principles of tissue engineering of human organs in experimental and clinical settings. Offered Fall, Spring/Summer.

**Prerequisites:** ([BME 2070 with a minimum grade of C-])

**BME 5370 Introduction to Biomaterials Cr. 4**

Introduction to study of both biological materials (bone, muscle, etc.) and materials for medical applications. Topics include tissue properties and effects of pathology, biocompatibility, and design considerations. Offered Winter.

**Prerequisite:** BE 1300 with a minimum grade of C- or BME 5010 with a minimum grade of C or BMS 6550 with a minimum grade of C

**Equivalent:** ME 5180

**BME 5380 Biocompatibility Cr. 4**

Wound healing and the tissue response to foreign materials. The organization, activation, and mechanisms of the immune system. Bioactive materials and the molecular basis for surface recognition and masking. Offered Irregularly.

**Prerequisite:** BME 5010 with a minimum grade of C or BMS 6550 with a minimum grade of C

**Equivalent:** MSE 5385

**BME 5450 Microscopic Analysis: Methods & Instrumentation Cr. 4**

Provides the students specializing in biomedical engineering with a basis for understanding the modern methods of microscopic analysis and the design of different types of instrumentation used for microscopic analysis and imaging. Offered Winter, Spring/Summer.

**Prerequisites:** ([BME 2070 with a minimum grade of C-])

**BME 5510 Introduction to Clinical Engineering and Technology Cr. 2**

Fundamental topics, including evolution of clinical engineering, medical technology, risk management, patient safety, medical equipment planning. Offered Winter.

**Prerequisite:** BME 5010 with a minimum grade of C

**BME 5530 Mechatronic System Design I Cr. 4**

Students work in small groups to design and build "smart" devices or systems, which will integrate sensors, digital logic and/or microprocessors, and user interfacing; products will be requested by "clients" and the student will work in a cross-disciplinary team. Offered Fall.

**Prerequisites:** ([ECE 4600])

**Equivalent:** ECE 5370

**BME 5540 Mechatronic System Design II Cr. 4**

Continuation of BME 5530. Offered Winter.

**Prerequisites:** ([ECE 4600])

**Equivalent:** ECE 5380

**BME 5990 Directed Study Cr. 1-4**

Independent projects on subjects in the field of biomedical engineering. Offered Every Term.

**Repeatable for 998.99 Credits**

**BME 5995 Special Topics in Biomedical Engineering I Cr. 1-4**

Topics as announced in Schedule of Classes. Offered Irregularly.

**BME 6130 Accident Reconstruction Cr. 3**

Passenger car and light truck behavior in collisions; recognition of roadway markings and vehicle damage used to analyze vehicle accidents and to use that evidence to reconstruct driver, vehicle and occupant dynamics at the time of the collision. Offered Spring/Summer.

**Prerequisite:** BME 5040 with a minimum grade of C

**BME 6470 Smart Sensor Technology I: Design Cr. 4**

Introduction to various types of sensors and the design of basic analog VLSI circuit building blocks. Offered Fall.

**Equivalent:** ECE 6570, PHY 6570

**BME 6480 Biomedical Instrumentation Cr. 4**

Engineering principles of physiological measurements. Signal conditioning equipment, amplifiers, recorders and transducers. Recent advances. Offered Winter.

**Prerequisites:** ([BME 5020]) AND ([ECE 3300] OR [BME 5010] OR [BMS 6550])

**Equivalent:** ECE 6180, IE 6180, ME 6180

**BME 6500 Enabling Technology Cr. 3,4**

Principles of application of enabling technology: across life stages, for differing ethnic and cultural backgrounds, for individuals with varying functional abilities. Offered Irregularly.

**Equivalent:** ECE 6100

**BME 6991 Internship in Industry Cr. 1-4**

Industrial internship in biomedical engineering. Offered Every Term.

**Repeatable for 99 Credits**

**BME 7010 Functional Anatomy Cr. 4**

Gross dissection-based course designed to introduce students to the anatomical structures associated with major physiological functions important to biomedical engineering. Offered Spring/Summer.

**Prerequisite:** BME 5010 with a minimum grade of C

**Restriction(s):** Enrollment is limited to Graduate level students.

**Course Material Fees:** \$100

**BME 7020 Cardiovascular Systems Modeling Cr. 4**

Application of engineering principals and mathematical and computational techniques to cardiovascular systems. Partial differential equations, signal transduction pathway and biotransport modeling, and introduction to systems biology approaches. Offered Winter.

**Restriction(s):** Enrollment is limited to Graduate level students.

**BME 7030 Mechanisms and Models of Cellular Regulation for Engineering Cr. 3**

Basic concepts of intracellular signaling pathways in response to environmental stimuli such as biomaterials and mechanical forces. Offered Winter.

**Restriction(s):** Enrollment is limited to Graduate level students.

**BME 7100 Mathematical Modeling in Impact Biomechanics Cr. 4**

Review of models created for impact simulations. Regional impact simulation models. Human and dummy models subject to various restraint systems. Offered Winter.

**Prerequisite:** BME 5010 with a minimum grade of C or BMS 6550 with a minimum grade of C

**Restriction(s):** Enrollment is limited to Graduate level students.

**Equivalent:** ECE 7100, IE 7100, ME 7100

**BME 7120 Applied Finite Element Methods in Biomechanical Analysis Cr. 4**

Structural, stress, and strain analysis of the human body and/or artificial implants, using realistic biomechanical data for relevant tissues and material. Theoretical background and applied analysis. Offered Irregularly.

**Prerequisite:** BME 5040 with a minimum grade of C

**Restriction(s):** Enrollment is limited to Graduate level students.

**BME 7130 Computational Methods in Biology Cr. 3**

Theory and computational methods for modeling the dynamic and thermodynamic properties of biomolecular systems. Methods for modeling biological systems involving biofluid dynamics. Offered Irregularly.

**Restriction(s):** Enrollment is limited to Graduate level students.

**BME 7150 Biomechanics of Blast-Related Injuries Cr. 3**

This course covers new and old information developed by military researchers on injuries sustained by military personnel due to explosions or blasts caused by a variety of weapon systems. Injuries to body regions from head to foot are discussed. Particular emphasis is placed on injuries to the spine and lower extremities for the mounted soldier and on brain injury for both the mounted and dismounted soldier. The course includes the modeling of blast and blast-related effects on selected body regions. Offered Fall.

**Prerequisite:** BME 7100 with a minimum grade of C

**Restriction(s):** Enrollment is limited to Graduate level students.

**BME 7160 Impact Biomechanics Cr. 4**

Biomechanical response of the body regions and the whole body to impact. Mechanisms of injury in blunt impact. Effects of restraints on injury reduction. Development of test surrogates such as dummies. Offered Fall.

**Prerequisite:** BME 5010 with a minimum grade of C or BMS 6550 with a minimum grade of C

**Restriction(s):** Enrollment is limited to Graduate level students.

**Course Material Fees:** \$10

**Equivalent:** ECE 7160, ME 7160

**BME 7170 Experimental Methods in Impact Biomechanics Cr. 4**

Lecture and laboratory combined; principles of impact testing; hands-on experience in use of impact-test equipment, including sled, pendulum, other types of impactors, and drop-test techniques. Offered Biannually (Winter).

**Prerequisite:** BME 6480 with a minimum grade of C and BME 7160 with a minimum grade of C

**Restriction(s):** Enrollment is limited to Graduate level students.

**Course Material Fees:** \$100

**BME 7210 Tissue Biomechanics Cr. 4**

Tissue-level mechanical properties. Analytical models of hard and soft tissue mechanics. Soft tissue viscoelasticity, quasilinear viscoelasticity and biphasic theory. Wolff's law and bone remodeling, bone fatigue and microfracture. Form and function relationships from microstructure to macrostructure. Application of theoretical models to experimental data sets. Offered Irregularly.

**Prerequisites:** ([BME 5010 with a minimum grade of C] OR [BMS 6550 with a minimum grade of C]) AND ([BME 5020 with a minimum grade of C]) AND ([BME 5210 with a minimum grade of C])

**Restriction(s):** Enrollment is limited to Graduate level students.

**Equivalent:** ME 7195

**BME 7300 Advanced Topics in Biomaterials and Tissue Biomechanics Cr. 4**

Seminar format: advanced topics presented to the class; lectures by the instructor and by the participants based on literature reviews. Topics determined by student interest. Offered Biannually (Fall).

**Prerequisite:** BME 5210 with a minimum grade of C or BME 5370 with a minimum grade of C

**Restriction(s):** Enrollment is limited to Graduate level students.

**Equivalent:** ME 7180, MSE 7180

**BME 7370 Biomaterial Interfaces Cr. 4**

Effects of topography and texture on the performance of biomaterials. Self-organization of biomembranes and supramolecular systems. Offered Winter.

**Prerequisite:** BME 5370 with a minimum grade of C

**Restriction(s):** Enrollment is limited to Graduate level students.

**BME 7390 Tissue Engineering and Hybrid Systems Cr. 4**

Seminar and project based approach to the design, development, analysis and application of organ and tissue replacement systems which incorporate processed materials and living cells. Offered Fall.

**Prerequisites:** ([BME 5370 with a minimum grade of C]) AND ([CHE 7100 with a minimum grade of C] OR [BME 5020 with a minimum grade of C])

**Restriction(s):** Enrollment is limited to Graduate level students.

**Equivalent:** CHE 7390

**BME 7400 Medical Robotics and Systems Cr. 4**

Technology that interfaces computer engineering and electronics with surgery; introduction of key concepts in the field, including medical robotics, image-guided surgery, segmentation/3D modeling, medical simulation, and medical sensors. Offered Winter.

**Prerequisite:** ECE 5020 with a minimum grade of C

**Restriction(s):** Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.

**Equivalent:** ECE 7400

**BME 7470 Smart Sensor Technology II: Characterization and Fabrication Cr. 4**

Integration of ongoing research in integrated technology of smart sensors. Design of smart sensor devices using computer simulation. Fabrication of smart sensor. Offered Winter.

**Prerequisite:** BME 6570 with a minimum grade of C

**Restriction(s):** Enrollment is limited to Graduate level students.

**Course Material Fees:** \$50

**Equivalent:** ECE 7570, PHY 7580

**BME 7490 Biomedical Microsystems Cr. 4**

Biomedical microsystems, with a focus on microfluidics and lab-on-a-chip technologies for medical diagnostics and biological research. Broad coverage of microscale physics; microfabrication methods; separation, purification, and other on-chip processes; biosensing. Offered Fall.

**Prerequisite:** ECE 5575 with a minimum grade of C or ECE 6570 with a minimum grade of C or BME 6470 with a minimum grade of C

**Restriction(s):** Enrollment is limited to Graduate level students.

**Equivalent:** CHE 7490, ECE 7590

**BME 7670 Experimental Methods in Physiology Cr. 3**

Basic principles and techniques for monitoring and reading EMGs, EEGs, ECGs, respiratory cycle, pulmonary function, galvanic skin response and polygraph, human acceleration response. Designing and carrying out a project involving human body acceleration measures and EMG responses; a second project will be designed and carried out using measurement techniques chosen by the students. Offered Spring/Summer.

**Prerequisite:** BME 5010 with a minimum grade of C

**Restriction(s):** Enrollment is limited to Graduate level students.

**Course Material Fees:** \$40

**BME 7710 Magnetic Resonance Imaging Cr. 4**

Science and engineering of magnetic resonance imaging; relaxation times, signal concepts, Fourier imaging, sampling, filtering, and sequence design. Offered Biannually (Fall).

**Restriction(s):** Enrollment is limited to Graduate level students.

**BME 7720 MR Imaging of Neurovascular Disease Cr. 3**

Recent advances in MRI technology applied to human brain vascular diseases. Methods include: 3D anatomical imaging, diffusion tensor imaging, functional brain imaging, perfusion imaging, and susceptibility weighted imaging. Offered Biannually (Fall).

**Prerequisite:** BME 5010 with a minimum grade of C

**Restriction(s):** Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.

**Equivalent:** PYC 7320

**BME 7730 Medical Imaging Systems Cr. 3**

Exposes students to the world of medical and biomedical imaging with emphasis on principles, approaches and applications of each modern imaging modality. Basic knowledge of MATLAB programming language is required. Offered Fall.

**Restriction(s):** Enrollment is limited to Graduate level students.

**Equivalent:** ECE 7740

**BME 7990 Directed Study Cr. 1-4**

Independent projects on subjects of interest in the field of biomedical engineering. Offered Every Term.

**Restriction(s):** Enrollment is limited to Graduate level students.

**Repeatable for 998.99 Credits**

**BME 7995 Special Topics in Biomedical Engineering II Cr. 1-4**

Topics as announced in Schedule of Classes. Offered Irregularly.

**Restriction(s):** Enrollment is limited to Graduate level students.

**BME 7996 Research Cr. 1-4**

Combined experimental and analytical study of a problem in the field of biomedical engineering. Offered Every Term.

**Restriction(s):** Enrollment is limited to Graduate level students.

**Repeatable for 998.99 Credits**

**BME 8070 Seminar in Biomedical Engineering Cr. 1**

Lectures on biomedical engineering and related fields by guest speakers, faculty, and students. M. S. and Ph.D. students are required to take one semester. Offered Fall, Winter.

**Restriction(s):** Enrollment is limited to Graduate level students.

**BME 8080 Doctoral Seminar in Biomedical Engineering Cr. 1**

Seminar and research discussion based on research projects of BME doctoral students. Offered Every Term.

**Restriction(s):** Enrollment is limited to Graduate level students.

**BME 8470 Smart Sensor Technology Seminar Cr. 1**

Technological advances. Interaction of research experience in smart sensors and integrated devices. Offered Winter.

**Restriction(s):** Enrollment is limited to Graduate level students.

**Equivalent:** ECE 8570

**BME 8999 Master's Thesis Research and Direction Cr. 1-8**

Offered Every Term.

**Restriction(s):** Enrollment limited to students with a class of Candidate Masters; enrollment is limited to Graduate level students.

**Repeatable for 8 Credits**

**BME 9990 Pre-Doctoral Candidacy Research Cr. 1-8**

Research in preparation for doctoral dissertation. Offered Every Term.

**Restriction(s):** Enrollment is limited to Graduate level students.

**Repeatable for 12 Credits**

**BME 9991 Doctoral Candidate Status I: Dissertation Research and Direction Cr. 7.5**

Offered Every Term.

**Restriction(s):** Enrollment is limited to Graduate level students.

**BME 9992 Doctoral Candidate Status II: Dissertation Research and Direction Cr. 7.5**

Offered Every Term.

**Prerequisite:** BME 9991 with a minimum grade of S

**Restriction(s):** Enrollment is limited to Graduate level students.

**BME 9993 Doctoral Candidate Status III: Dissertation Research and Direction Cr. 7.5**

Offered Every Term.

**Prerequisite:** BME 9992 with a minimum grade of S

**Restriction(s):** Enrollment is limited to Graduate level students.

**BME 9994 Doctoral Candidate Status IV: Dissertation Research and Direction Cr. 7.5**

Offered Every Term.

**Prerequisite:** BME 9993 with a minimum grade of S

**Restriction(s):** Enrollment is limited to Graduate level students.

**BME 9995 Candidate Maintenance Status: Doctoral Dissertation Research and Direction Cr. 0**

Offered Every Term.

**Restriction(s):** Enrollment is limited to Graduate level students.

**Course Material Fees:** \$348.67

**Repeatable for 0 Credits**