Contents

The School of Biomedical Engineering, Science and Health Systems

2011-2012 Graduate Course Descriptions

Biomedical Engineering & Science Courses

BMES 501 - Medical Sciences I
First course in a three-course sequence designed to acquaint students with the fundamentals of biology and physiology from an engineering perspective. This first course covers evolution, genetics, molecular biology and basic cellular physiology.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Repeat Status: Not repeatable for credit

BMES 502 - Medical Sciences II
Second course in a three-course sequence designed to acquaint students with the fundamentals of biology and physiology from an engineering perspective. This second course covers tissues, muscle and nerve function, cardiovascular systems and respiration.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Pre-Requisites: BMES 501 Minimum Grade: C
Repeat Status: Not repeatable for credit

BMES 503 - Medical Sciences III
Third course in a three-course sequence designed to acquaint students with the fundamentals of biology and physiology from an engineering perspective. This third course covers renal and digestive systems. However, the major emphasis is on biological control systems ? nervous, endocrine and immune system structure and function.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Pre-Requisites: BMES 502 Minimum Grade: C
Repeat Status: Not repeatable for credit

BMES 504 - Medical Sciences IV
Mechanical, physical, electrical, and mathematical models of living systems, including feedback control systems. The laboratory part includes computer simulation so that data obtained from laboratory experiments may be compared with those predicted from models.
Credits: 4.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Repeat Status: Not repeatable for credit

BMES 505 - Math for Biomedical Sciences I
This course is for students of biology and related medical fields aimed at bridging the gap between qualitative and quantitative approaches in the study of biological processes. Topics include single and multivariable calculus infinite series, etc.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
May not be enrolled in one of the following Program Level(s):
Continuing Education
Repeat Status: Not repeatable for credit

BMES 506 - Math for Biomedical Sciences II
This course for students of biomedical science or biomedical engineering is designed to permit the student to go on to advanced studies in engineering and science in which differential equations are needed. Biological applications are emphasized.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
May not be enrolled in one of the following Program Level(s):
Continuing Education
Pre-Requisites: BMES 505 Minimum Grade: C
Repeat Status: Not repeatable for credit

BMES 507 - Math for Biomedical Sciences III
This course covers topics in Fourier series and orthogobnal functions, partial differential equations, and boundary value problems Applications are made to problems in neuro-physiology, cellular transport, and biological oscillations.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
May not be enrolled in one of the following Program Level(s):
Continuing Education
Pre-Requisites: BMES 506 Minimum Grade: C
Repeat Status: Not repeatable for credit

BMES 508 - Cardiovascular Engineering
This course emphasizes engineering approaches to the analysis of the cardiovascular system focusing on fundamental mechanics and emerging technologies.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter

Pre-Requisites: BMES 501 Minimum Grade: B and BMES 502 Minimum Grade: B and BMES 503 Minimum Grade: B
Repeat Status: Not repeatable for credit

BMES 509 - Entrepreneurship for BMES
This course serves as the foundation course in entrepreneurship and is designed to provide students with a complete working knowledge of the modern entrepreneurial and business planning process.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Repeat Status: Not repeatable for credit

BMES 510 - Biomedical Statistics
This course introduces the graduate student to the fundamentals of inferential statistics with biomedical applications. It covers topics in data presentation, sampling, experimental design, probability and probability distributions, significance tests, and clinical trials.
Credits: 4.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
May not be enrolled in one of the following Program Level(s):
Continuing Education
Repeat Status: Not repeatable for credit

BMES 511 - Prin Sys Anl App Biomed I
Covers formulation of biological problems by rigorous mathematical techniques, including application of conservation laws, network theorems, and mesh and nodal analysis.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Repeat Status: Not repeatable for credit

BMES 512 - Princ Sys Analy Biomed II
Continues BMES 511. Emphasizes input/output transfer function problems, linear systems and linear operations, and impulse response.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Repeat Status: Not repeatable for credit

BMES 513 - Biomedical Electronics
Physical principles in the operation of both integrated circuits and discrete components. Analysis and design of transducers, amplifiers, oscillators, logic circuits, etc., with particular application to biomedical problems. (BMS)
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Repeat Status: Not repeatable for credit

BMES 514 - Computer Applications in Biomedical Research
This course is intended to familiarize students with at least one computer language and to demonstrate computer applications in diagnosis, monitoring, and biomedical signal processing. (BMS)
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Repeat Status: Not repeatable for credit

BMES 515 - Experimental Design in Biomedical Research
This course is designed to introduce students to the fundamental principles of experimental design and statistical analysis as applied to biomedical research with animals and humans. Topics to be covered include experimental design, clinical design, and protocol submission and review.
Credits: 4.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Pre-Requisites: BMES 510 Minimum Grade: B
Repeat Status: Not repeatable for credit

BMES 517 - Intermediate Biostatistics
The purpose of this course is to acquaint students with some of the statistical tools commonly used in biomedical and health sciences research. The course will provide the student with a basic theoretical background on the procedures of repeated measures ANOVA and selected multivariate statistical tests. It will familiarize students with the use of computer-based statistical analyses.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Pre-Requisites: BMES 510 Minimum Grade: C
Repeat Status: Not repeatable for credit

BMES 518 - Interpretation of Biomedical Data

The focus of this course is on understanding the methods used to analyze and interpret the results of quantitative data analyses in the biomedical and health sciences and determine their meaningfulness (clinical significance). Fundamental to this process is an understanding of the interrelatedness of statistical power, effect size, sample size and alpha.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Pre-Requisites: BMES 510 Minimum Grade: C
Repeat Status: Not repeatable for credit

BMES 521 - Principles of Bioengineering
Principles of transduction and measurement, including characterization of the measurements systems, and invasive vs. noninvasive methods. (BME)
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Repeat Status: Not repeatable for credit

BMES 522 - Principles of Bioengineering II
In-depth analysis of selected electromechanical transducer principles; review of important transduction methods in bioengineering; biopotential electrodes and chemical electrodes. (BME)
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Repeat Status: Not repeatable for credit

BMES 523 - Principles of Bioengineering III
Microprocessor applications in biomedical engineering, including interfacing, data processing, display, and storage. (BME)
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Repeat Status: Not repeatable for credit

BMES 524 - Introduction to Biosensors
An introductory course in the general area of microsensors covering basic sensing mechanisms and various types of conductometric, acoustic, silicon, optical and MEMS microsensors. Two case studies involving biosensors and acoustics sensors allow students to acquire in-depth knowledge in the theory and design of microsensors.
Credits: 4.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Repeat Status: Not repeatable for credit

BMES 525 - Advanced Biosensors
The second course in a two-course sequence, this course covers aspects of modern biosensor design methods and addresses challenges associated with fabrication technologies and instrumentation techniques. Topics covered include the theory and modeling of biosensors, fabrication steps, and testing methods.
Credits: 4.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Repeat Status: Not repeatable for credit

BMES 531 - Chronobioengineering I
This course advances the student's knowledge of biological time-keeping and adaptive functions of biological clocks. It includes such topics as biochemical and physiological models of biological blocks, adjustment to environmental cycles and rhythms in behavior and models.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
May not be enrolled in one of the following Program Level(s):
Continuing Education
Pre-Requisites: BMES 503 Minimum Grade: C
Repeat Status: Not repeatable for credit

BMES 532 - Chronobioengineering II
This course continues BMES 531. It covers topics in the patterns, rhythms, evolution, neurology, psychology and overall functions of sleep.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
May not be enrolled in one of the following Program Level(s):
Continuing Education
Pre-Requisites: BMES 531 Minimum Grade: C
Repeat Status: Not repeatable for credit

BMES 534 - Design Thinking for BMEs

This course is a studio-seminar exploring principles and theories of product design, systematic design process, problem-solving, decision-making and design as authorship. The course uses design research methods and topical design issues to explore and experience design thinking.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Repeat Status: Not repeatable for credit

BMES 535 - Intro to Product Design for BMEs
This course introduces students to basic product design techniques. It combines lectures, demonstrations, discussions and problem solving exercises exploring product design as a creative process in the production of simple objects. Students develop a command of product development, skills in modeling and communication of their novel solutions.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Pre-Requisites: BMES 534 Minimum Grade: D or PROD 101 Minimum Grade: C
Repeat Status: Not repeatable for credit

BMES 538 - Biomedical Ethics and Law
Introduces a wide spectrum of ethical, regulatory, and legal issues facing health care practitioners and biomedical researchers. The course helps students become aware of the ethical and legal issues involved in their work while increasing the student's understanding of how legal and ethical decisions should be made in biomedical research, as well as what sources of help and guidance are available.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Repeat Status: Not repeatable for credit

BMES 543 - Quantitative Systems Biology
This course uses a systems engineering approach to provide a foundation in systems biology and pathology informatics. Topics covered include the robust complex network of genes and proteins; cell as basic units of life; communication of cells with other cells and the environment; and gene circuits governing development.
Credits: 4.50
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Pre-Requisites:
Repeat Status: Not repeatable for credit

BMES 544 - Genome Information Engineering
This course is designed to provide students with hands-on experience in the application of genomic, proteomic, and other large-scale information to biomedical engineering. The underlying goal is to develop an understanding of highthrough experimental technologies, biological challenges, and key mathematical and computational methods relevant to biomedical engineering.
Credits: 4.50
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Pre-Requisites: BMES 543 Minimum Grade: B
Repeat Status: Not repeatable for credit

BMES 545 - Biosystems Modeling
This course provides hands-on experience in advanced computational methods used in systems biology: pathway and circuitry, feedback and control, cellular automata, sets of partial differential equations, stochastic analysis, and biostatistics.
Credits: 4.50
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Pre-Requisites: BMES 503 Minimum Grade: C and (BMES 512 Minimum Grade: C or BMES 561 Minimum Grade: C)
Repeat Status: Not repeatable for credit

BMES 546 - Biocomputational Languages
This course provides hands-on education in C/C++, MATLAB, Java, and Perl languages used in biomedical applications. The principle application areas to be investigated include image analysis, feedback and control systems, algorithms on strings and sequences, database interactions, Web interactions, and biostatistics.
Credits: 4.50
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Repeat Status: Not repeatable for credit

BMES 551 - Biomedical Signal Processing
Introduces discrete time signals and systems; origin and classification of biomedical signals; data acquisition, filtering, and spectral estimation of medical signals; compression of medical signals; new processing approaches and time-frequency representation and wavelets.

Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
May not be enrolled in one of the following Program Level(s):
Continuing Education
Repeat Status: Not repeatable for credit

BMES 552 - Intro to Bioacoustics
This course covers essential materials for anyone who is interested in the application of acoustical waves in biomedical and material science. The main objective is to familiarize students with the propagation of acoustic waves in different media, with particular emphasis on biomedical applications.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Repeat Status: Not repeatable for credit

BMES 561 - Introduction to Systems Analysis in BMES
This course acquaints students with the methods of dynamical systems analysis as used to understand biological phenomena. Uses mathematical/engineering models from several areas of biological/medical research to describe the function of systems.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
May not be enrolled in one of the following Program Level(s):
Continuing Education
Repeat Status: Not repeatable for credit

BMES 563 - Robotics in Medicine I
This course provides an introduction to the use of haptics (the use of somtaosensory information) in the design of robotic devices in surgery. Topics covered include actuators, sensors, nonportable feedback, portable force feedback, tactile feedback interfaces, haptic sensing and control systems.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Repeat Status: Not repeatable for credit

BMES 565 - Robotics in Medicine II
This course covers the use of robots in surgery and included aspects of safety, robot kinematics, analysis of surgical performance using robotic devices, inverse kinematics, velocity analysis and acceleration analysis. Various types of surgeries in which robotic devices are or could be used are presented on a case study basis.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Pre-Requisites: BMES 563 Minimum Grade: B
Repeat Status: Not repeatable for credit

BMES 566 - Robotics in Medicine III
This course covers topics in the design of medical robotic systems, including force and movement analysis for robotic arms, dynamics, computer vision and vision-based control. Thus use of haptics, vision systems and robot dynamics are examined in a cohesive framework.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Pre-Requisites: BMES 565 Minimum Grade: B
Repeat Status: Not repeatable for credit

BMES 571 - Applied Evolution
This course is designed to provide students with an evolutionary perspective on health and disease. The focus is on humans as products of evolution by natural selection and as such, subject to the same relationships and historical precedents that govern the rest of the natural world. Topics to be covered include ecological damage and emerging diseases, sociobiological perspectives on behavioral disorders, the development of resistance in pathogens, and adaptation and maladaptation of humans to urban environments.
Credits: 4.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
May not be enrolled in one of the following Program Level(s):
Continuing Education
Repeat Status: Not repeatable for credit

BMES 588 - Medical Device Development
Medical device product development must take into account a diverse set of disciplines to achieve a safe and successful product. This course exposes the student to several of these disciplines with the objective of raising the student's awareness of safety throughout the product development life cycle. Students will learn to appreciate the complex engineering decisions that support development of a safe medical device through an examination of risk management, regulatory processes, human factors and clinical studies.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter

Pre-Requisites: BMES 821 Minimum Grade: C-
Repeat Status: Not repeatable for credit

BMES 590 - Clinical Rotation
Students are exposed to the problems and issues surrounding the practice of medicine in a modern hospital. Every 2 weeks students will be paired with a medical professional and observe clinical applications and procedures as well as other administrative functions. Actual topics covered vary from offering to offering. Course is run off campus at local hospitals.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Repeat Status: Course can be repeated 2 time(s) for 6.00 credit(s)

BMES 594 - Clinical Practicum I
This course provides biomedical engineering students with an extensive exposure to live clinical cardiology procedures, including cardiac catheterization, electrophysiology, echocardiography and nuclear stress testing. Emphasis is placed on identifying important interfaces between engineering and clinical medicine, particularly in areas where clinical needs may be addressed by advances in biomedical engineering.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Must be enrolled in one of the following College(s)/School(s):
Sch.of Biomed Engr,Sci & Hlth
Repeat Status: Not repeatable for credit

BMES 595 - Clinical Practicum II
This course provides biomedical engineering students with an extensive exposure to live operations in an emergency department an intensive care until. The students are expected to analyze specific operations within these environments and develop a solution to a process problem within one of these environments. System analysis, design and evaluation are emphasized
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Must be enrolled in one of the following College(s)/School(s):
Sch.of Biomed Engr,Sci & Hlth
Repeat Status: Not repeatable for credit

BMES 596 - Clinical Practicum III
This course provides biomedical engineering students with an opportunity to observe basic operative and postoperative procedures with the idea of both learning about such procedures and identifying the role of biomedical engineering in these clinical settings.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Must be enrolled in one of the following College(s)/School(s):
Sch.of Biomed Engr,Sci & Hlth
Repeat Status: Not repeatable for credit

BMES 601 - Anatomy I
The anatomy sequence surveys the gross and microscopic structure of the human body with emphasis on the structure-function relationship. This course is concerned with cell structure, histology, and tissues.
Credits: 2.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Repeat Status: Not repeatable for credit

BMES 602 - Anatomy II
Continues BMES 601. Functional gross anatomy.
Credits: 2.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Repeat Status: Not repeatable for credit

BMES 603 - Anatomy III
Continues BMES 602. Neuroanatomy.
Credits: 2.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Repeat Status: Not repeatable for credit

BMES 604 - Pharmacogenomics
Covers the interaction between chemical agents and biological systems at all levels of integration. Discusses general classes of drugs, with particular emphasis on general concepts and problems of medical importance.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Repeat Status: Not repeatable for credit

Sophomore
Repeat Status: Not repeatable for credit

BMES 611 - Biological Control Systems I
Introduces the basic concepts of feedback control systems, including characterization in terms of prescribed constraints, study of input and output relationship for various types of biological systems, and stability and time delay problems in the pupillary reflex/eye-hand coordination system.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Repeat Status: Not repeatable for credit

BMES 612 - Biological Control Systems II
Covers receptors, skeletal-muscle control systems, vestibular feedback, and sampled-data models.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Repeat Status: Not repeatable for credit

BMES 613 - Biological Control Systems III
Covers mathematical models of biological systems, with emphasis on non-linear and adaptive systems study.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Repeat Status: Not repeatable for credit

BMES 621 - Medical Imaging Systems I
Provides an overview of the field of medical imaging. Covers aspects of light imaging; systems theory, convolutions, and transforms; photometry, lenses, and depth of field; image perception and roc theory; three-dimensional imaging; image acquisition and display; and image processing operations, including scanning and segmentation.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Undergraduate Quarter
May not have the following Classification(s):
Freshman
Junior
Pre-Junior

BMES 622 - Medical Imaging Systems II
Introduces medical visualization techniques based on ultrasound propagation in biological tissues. Includes generation and reception of ultrasound, imaging techniques (A-mode, B-mode, M-mode, and Doppler), typical and emerging diagnostic applications, elements of ultrasound exposimetry, and safety aspects from the clinical point of view.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Pre-Requisites: BMES 621 Minimum Grade: C
Repeat Status: Not repeatable for credit

BMES 623 - Medical Imaging Systems III
Introduces elements of wave imaging, including wave propagation, Fourier optics and acoustics, limitations on resolution, ultrasound transducer characterization, and synthetic aperture systems. Examines MRI imaging in detail, including physical principles and scanning methodologies. Includes aspects of the psychophysics of human vision.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Pre-Requisites: BMES 622 Minimum Grade: C
Repeat Status: Not repeatable for credit

BMES 625 - Biomedical Ultrasound I
Focuses on the propagation of ultrasound in inhomogeneous media such as tissue, and discusses imaging principles and basics of tissue characterization. Discusses ultrasound instrumentation, including A-and B-mode scanners. Presents simple tissue models based on ultrasound wave absorption and scattering, and examines properties of tissue-mimicking materials and tissue phantoms. Covers ultrasound transducer models and discusses advantages and disadvantages of various transducer configurations. Outlines the principles of acoustic output measurements and discusses instrumentation requirements. Includes ultrasound exposimetry and biological effects of ultrasound.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Repeat Status: Not repeatable for credit

BMES 626 - Biomedical Ultrasound II

Covers the theory and construction of array transducers for imaging, Doppler ultrasound systems and their application to the study of blood flow, and continuous wave and pulsed systems and Doppler imaging. Discusses the mechanisms for biological effects of ultrasound, including thermal and mechanical interaction of ultrasound energy and tissue.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Repeat Status: Not repeatable for credit

BMES 628 - Ultrasound Wave Motion in Solids/Piezoelectronics
This course provides an introduction to the physics of wave propagation in solids, acquainting the student along the way with the necessary tensor formalism. The origin and behavior of longitudinal and shear bulk waves, surface waves, and plate waves are derived. The ultrasound behavior of piezoelectrics is analyzed and the results are applied to the analysis of piezoelectric transducers and ultrasound signal-processing devices.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Repeat Status: Not repeatable for credit

BMES 631 - Tissue Engineering I
This course is designed to familiarize students with advanced concepts of cellular and molecular biology relevant to tissue engineering. This is the initial course in a three-course sequence combining materials from life science, engineering design and biomaterials to educate students in the principles, methods and technology of tissue engineering.
Credits: 4.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Pre-Requisites: BMES 503 Minimum Grade: B
Repeat Status: Not repeatable for credit

BMES 632 - Tissue Engineering II
This course familiarizes students with advanced concepts of developmental and evolutionary biology relevant to tissue engineering. The second part of a three-course sequence combines materials from cellular/molecular biology, evolutionary design, and biomaterials to education students in the principles and methods of tissue engineering.
Credits: 4.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Co-Requisites: BMES 661
Pre-Requisites: BMES 631 Minimum Grade: B
Repeat Status: Not repeatable for credit

BMES 641 - Biomedical Mechanics I
Designed to acquaint students with the response of biological tissues to mechanical loads and with the mechanical properties of living systems. Covers topics in musculoskeletal anatomy and functional mechanics; a review of mechanical principles, statics, dynamics, and materials; soft and hard tissue mechanics; mechano-pathological conditions in biological tissues and their correction; and prosthetics.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Repeat Status: Not repeatable for credit

BMES 642 - Biomedical Mechanics II
Continues BMES 641.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Repeat Status: Not repeatable for credit

BMES 643 - Biomedical Mechanics III
Continues BMES 642.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Repeat Status: Not repeatable for credit

BMES 644 - Cellular Biomechanics
This course of cellular bioengineering focuses on mechanics and transport. Material builds upon undergraduate engineering education to place engineering mechanics into the context of biological function at the cellular level.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Must be enrolled in one of the following College(s)/School(s):
Sch.of Biomed Engr,Sci & Hlth
Repeat Status: Not repeatable for credit

BMES 651 - Transport Phenomena in Living Systems I
Covers physical principles of momentum, energy, and mass transport phenomena in blood and other biological fluids; diffusion and convection at the microcirculatory level; physiology of arteries and veins; and local and systemic blood flow regulation and vascular disease.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Pre-Requisites: BMES 503 Minimum Grade: C and BMES 681 Minimum Grade: C
Repeat Status: Not repeatable for credit

BMES 660 - Biomaterials I
First course in a three-quarter sequence designed to acquaint students with the behavior of materials used in biomedical application under load (i.e., mechanical properties), their modes of failure and as a function of their environment. This course provides students with the fundamentals needed to proceed with Biomaterials II
Credits: 4.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Repeat Status: Not repeatable for credit

BMES 661 - Biomaterials II
Second course in a three-quarter sequence in biomaterials. The goal of this course is with an understanding of, and ability to select, appropriate materials for specific applications taking into account mechanical, thermal, and rheological properties taught in Biomaterials I and combining them with the biocompatibility issues covered in the present course.
Credits: 4.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
May not have the following Classification(s):
Freshman
Junior
Pre-Junior
Sophomore
Repeat Status: Not repeatable for credit

BMES 672 - Biosimulation I
This course focuses upon the mathematical analysis of biomedical engineering systems. As the first course in the biosimulation sequence, the course is a blend of analytical and numerical methods with strong emphasis on analytical approaches. The class concentrates on the application of mathematical concepts to biomedical problems drawn from physiological systems, cellular and molecular systems, bioimaging and biomedical device design.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Repeat Status: Not repeatable for credit

BMES 673 - Biosimulation II
The second in a two-course sequence, this course focuses upon the mathematical modeling and subsequent computational analysis of complex biological systems. Specific examples are drawn physiological systems, cellular and molecular systems, bioimaging and biomedical device design and analysis. Topics covered include: modeling of complex bioengineering systems; parameter estimation and optimization of such models; and application of probability and statistical approaches as required.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Pre-Requisites: BMES 672 Minimum Grade: C
Repeat Status: Not repeatable for credit

BMES 675 - Biomaterials and Tissue Engineering III
This course provides students with in-depth knowledge of factor-mediated tissue engineering and regenerative medicine. Students learn about fundamental repair and regenerative processes and gain an understanding of specific biomaterials being used to mimic and/or enhance such processes. Students also learn about the delivery methods of agents which promote the proper functional development of specialized tissues.
Credits: 4.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Pre-Requisites: BMES 660 Minimum Grade: C- and BMES 661 Minimum Grade: C- and BMES 631 Minimum Grade: C- and BMES 632 Minimum Grade: C-
Repeat Status: Not repeatable for credit

BMES 676 - Software Development for Health Science Instruction
This course presents the planning, development and evaluation of computer software for instruction and clinical decision support in the area of health care. Particular emphasis is given to the Macintosh computer and the preparation of compiled "stand-alone" programs
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:

Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Repeat Status: Not repeatable for credit

BMES 680 - Special Topics
Covers topics of particular interest that may not be offered every term or every year. Also included in this category are courses under development.
Credits: 9.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Repeat Status: Course can be repeated 99 time(s) for 998.90 credit(s)

BMES 681 - Physics of Living Systems I
Designed for the biomedical science student with a background in life sciences. Reviews and expands on basic concepts in physics as applied in biological systems. Topics include mechanics, exponential growth and decay, thermodynamics, and diffusion and membrane transport.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Repeat Status: Not repeatable for credit

BMES 682 - Physics of Living Systems II
Covers advanced topics in biophysics for both biomedical science and biomedical engineering students.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Repeat Status: Not repeatable for credit

BMES 683 - Physics of Living Systems III
Covers advanced topics of current interest in biomedical engineering.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Repeat Status: Not repeatable for credit

BMES 710 - Neural Signals
This course covers aspects of neural signaling, including fundamentals of action potential generation, generator potentials, synaptic potentials, and second messenger signals. Students learn Hodgkin-Huxeley descriptions, equivalent circuit representations and be able to derive and integrate descriptive equations and generate computer simulations.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Pre-Requisites:
Repeat Status: Not repeatable for credit

BMES 711 - Principles in Neuroengineering
This course is an in-depth student of some of the cutting-edge technologies in neuroengineering. The course draws on faculty in the College of Medicine and School of Biomedical Engineering, Science and Health Systems to present and investigate three topics in neuroengineering.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Pre-Requisites: BMES 710 Minimum Grade: B
Repeat Status: Not repeatable for credit

BMES 722 - Neural Aspects of Posture & Locomotion I
Studies physiology of sensory/motor systems, with emphasis on modeling of neural systems and biomechanical aspects of functional tasks. Begins with an analysis of the transportation of materials in and out of cells, followed by an examination of the origin and maintenance of membrane potentials. Discusses intra-and extracellular and surface measurement of potentials, generation and transmission of action potentials, synaptic processes, and the structure/function of muscle. Combines these elements to study reflex systems as well as vestibular and ocular effects on posture. Culminates in the study of the control of motor systems with respect to bipedal locomotion.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Repeat Status: Not repeatable for credit

BMES 725 - Neural Networks
Explores the mathematical and biological bases for neurocomputing. Involves construction by students of computer simulations of important models and learning algorithms. Discusses applications to pattern recognition, vision, speech, control, and psychological modeling.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth

Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Pre-Requisites: MATH 210 Minimum Grade: C
Repeat Status: Not repeatable for credit

BMES 731 - Advanced Topics in Ultrasound Research I
Explores subjects of current interest through review of the literature by faculty, students, or invited lecturers.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Repeat Status: Course can be repeated 99 time(s) for 998.90 credit(s)

BMES 732 - Advanced Topics in Ultrasound Research II
Continues BMES 731. Discusses current developments and research in medical and industrial ultrasound, and geophysical and underwater signal processing.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Pre-Requisites: BMES 731 Minimum Grade: C
Repeat Status: Course can be repeated 99 time(s) for 998.90 credit(s)

BMES 799 - Independent & Supervised Study
Course and credits arranged with individual advisers.
Credits: 9.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Repeat Status: Course can be repeated 99 time(s) for 998.90 credit(s)

BMES 821 - Medical Instrumentation
Provides a broad overview of the applications of health care technology in diagnosis and therapy. Reflects the persuasiveness of biomedical engineering in medicine by describing medical instrumentation and engineering technology used in most of the main areas of specialization in medicine.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Repeat Status: Not repeatable for credit

BMES 822 - Medical Instrumentation II
The objective of this course is to prepare the student for following an industry-accepted standard for designing a medical device. Students will work in teams to identify and design a response to medical need. The resulting design will either address an unmet medical need or present an improved approach to an existing solution. After identifying a particular project, the students will learn and implement particular processes for both design and documentation.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Pre-Requisites: BMES 821 Minimum Grade: C or (BMES 391 Minimum Grade: C and BMES 392 Minimum Grade: C)
Repeat Status: Course can be repeated 2 time(s) for 6.00 credit(s)

BMES 823 - Medical Instrument Laboratory
Provides laboratory exercises, including pulmonary function testing, stress testing, EKG, electrosurgery, and x-ray.
Credits: 2.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Pre-Requisites: BMES 821 Minimum Grade: C
Repeat Status: Not repeatable for credit

BMES 825 - Hospital Administration
Provides an analysis of the administrative process, including planning, organization, design, decision-making, leadership, and control. Presents methodologies and techniques that can contribute to the effective performance of administrative responsibilities examined in the light of significant and unique factors in hospital health care administration.
Credits: 3.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Pre-Requisites:
Repeat Status: Not repeatable for credit

BMES 826 - Hospital Engineering Management
Covers the wide range of responsibilities of a clinical engineer, including managing a clinical engineering department, setting up an electrical safety program, establishing an equipment maintenance program, approaches for equipment acquisition, pre-purchase evaluation, and incoming inspection. Includes medical legislation, liability, and risk management.
Credits: 3.00

College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Pre-Requisites: BMES 825 Minimum Grade: C
Repeat Status: Not repeatable for credit

BMES 864 - Seminar
An invitation seminar for discussion of research topics in biomedical engineering and science. Attendance of all graduate students in the institute is required. (None may be repeated for credit.)
Credits:
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Repeat Status: Not repeatable for credit

BMES 866 - Seminar II
Continues BMES 865.
Credits: 2.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Repeat Status: Not repeatable for credit

BMES 867 - Seminar III
Continues BMES 866.
Credits: 2.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Repeat Status: Not repeatable for credit

BMES 897 - Research
Requires investigation of a biomedical problem under the direction of a faculty adviser.
Credits: 1.00 to 12.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Repeat Status: Course can be repeated 98 time(s) for 998.00 credit(s)

BMES 898 - Master's Thesis
Requires the study and investigation of a research or development problem. Requires results to be reported in a thesis under the direction of a faculty adviser. No credit granted until the thesis is completed and approved.
Credits: .50 to 20.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Repeat Status: Not repeatable for credit

BMES 998 - Ph.D. Dissertation
Requires the study and investigation of a research or development problem. Requires results to be reported in a dissertation under the direction of a faculty adviser. No credit granted until the dissertation is completed and approved.
Credits: 1.00 to 12.00
College: Sch.of Biomed Engr,Sci & Hlth
Department: Sch of Biomedical Engineering
Restrictions:
Must be enrolled in one of the following Program Level(s):
Graduate Quarter
Repeat Status: Course can be repeated 98 time(s) for 998.00 credit(s)