BIOENGINEERING (BE-GY)

BE-GY 871X Guided Studies in Biomedical Engineering (3-6 Credits)
Typically offered Fall, Spring, and Summer terms
Under faculty supervision, students study selections, analyses, solutions and presentations of biomedical engineering reports for problems in products, processes or equipment design, or other fields of biomedical-engineering practices. Conferences are scheduled. Master's degree candidates are required to submit three unbound copies of their reports to advisers one week before the last day of classes. | Prerequisite: degree status.
Grading: Grad Poly Graded
Repeatable for additional credit: Yes

BE-GY 873X Research in Biomedical Engineering (3-6 Credits)
Typically offered Fall, Spring, and Summer terms
Supervised by faculty, this course examines engineering fundamental or applied research in biomedical engineering. Conferences are scheduled. Master's degree candidates are required to submit three unbound copies of their reports to advisers one week before the last day of classes. | Prerequisite: Degree status.
Grading: Grad Poly Graded
Repeatable for additional credit: Yes

BE-GY 997X MS Thesis in Biomedical Engineering (3-9 Credits)
Typically offered Fall, Spring, and Summer terms
The thesis for the master's degree in biomedical engineering should report the results of an original investigation of problems in biomedical engineering or application of physical, chemical or other scientific principles to biomedical engineering. The thesis may involve experimental research, theoretical analyses or process designs, or combinations of them. Master's degree candidates are required to submit four unbound copies to advisers before the seventh Wednesday before commencement. | Prerequisite: Degree status.
Grading: Satisfactory/Unsatisfactory
Repeatable for additional credit: Yes

BE-GY 999X PhD Dissertation in Biomedical Engineering (3-9 Credits)
Typically offered Fall, Spring, and Summer terms
Theses for the PhD degree must give results of independent investigations of problems in biomedical engineering and may involve experimental or theoretical work. Theses must show ability to do creative work and must show that original contributions, worthy of publication in recognized journals, are made to biomedical engineering. Candidates are required to take oral examinations on thesis subjects and related topics. Doctoral-degree candidates must submit five unbound thesis copies to advisers before or on the seventh Wednesday before commencement. | Prerequisite: Passing grade in RE-GY 9990 Phd Qualifying Exam, and Adviser's approval
Grading: Satisfactory/Unsatisfactory
Repeatable for additional credit: Yes
Prerequisites: RE-GY 9990 AND PhD Biomedical Engineering.

BE-GY 5000 BME Recitation (0 Credits)
Typically offered Fall and Spring
BME Recitation
Grading: Class does not print on the transcript
Repeatable for additional credit: Yes

BE-GY 6103 Anatomy, Physiology, & Biophysics I (3 Credits)
Typically offered Fall
Anatomy and Physiology are the sciences that identify body structures and how they function and interact, respectively. Therefore, academic training for biomedical engineering must include a sound, comprehensive knowledge of human anatomy and physiology. While the course emphasizes normal functions, it also considers the consequences of disease and injury and deals with the body's potential for recovery and compensation. The Biophysics' component examines the underlying physical principles of organ function. Part I of this two-part sequence focuses on Cell Physiology and Homeostasis, Cardiac, Nervous, and Respiratory systems. The course will be taught using a "systems engineering" approach and introduce the design considerations for artificial organs. The material includes hands-on demonstration of technology to measure EEGs, EKG and respiratory function.
Grading: Grad Poly Graded
Repeatable for additional credit: No

BE-GY 6113 Anatomy, Physiology, & Biophysics II (3 Credits)
Typically offered Spring
Part II of this sequence focuses on the muscular, skeletal, renal and endocrine systems and includes discussions on skin and basic oncology. This part is taught using a "systems" approach and link concepts from BE-GY 6013. The material includes hands-on demonstration of technology to measure EMG. | Prerequisites: BE-GY 6013.
Grading: Grad Poly Graded
Repeatable for additional credit: No

BE-GY 6203 Biomedical Imaging I (3 Credits)
Typically offered Fall
This course introduces the physics, instrumentation and signal-processing methods used in X-ray imaging (projection radiography), X-ray computed tomography, nuclear medicine (SPECT/PET), ultrasound imaging and magnetic resonance imaging. Also listed under: EL-GY 6813 Prerequisites: Undergraduate level courses in multivariable calculus (MA-UY 2112 & MA-UY 2122 or MA-UY 2114), physics (PH-UY 2033), probability (MA-UY 3012), signals and systems (EE-UY 3054). Students who do not have prior courses in signals ans systems must take EL-GY 6113 / BE-GY 6403 - Digital Signal Processing I as a prerequisite or must obtain instructor's approval; EL-GY 6123 - Image and Video Processing is also recommended but not required.
Grading: Grad Poly Graded
Repeatable for additional credit: No

BE-GY 6303 Bio-optics (3 Credits)
Typically offered Fall
Recent growth in using optics technology for biomedical research and health care has been explosive. New applications are made possible by emerging technologies in lasers, optoelectronic devices, fiber optics, physical and chemical sensors and imaging—all of which are now applied to medical research, diagnostics and therapy. This sequence course on optics for biomedical students combines fundamental knowledge of the generation and interaction of electromagnetic waves with applications to the biomedical field. The goal is for this approach is to provide tools for researchers in bio-physics and to familiarize researchers, technologists and premed students with cutting-edge approaches. | Prerequisite(s): An undergraduate course in physics that includes electricity, magnetism and waves such as PH-UY 2023, an undergraduate course in physics that includes electricity, magnetism and waves such as PH-UY 2023 and multivariable calculus such as MA-UY 2122 and MA-UY 2122.
Grading: Grad Poly Graded
Repeatable for additional credit: No

BE-GY 6353 Special Topics in Biomedical Engineering (3 Credits)
Typically offered occasionally
Topics of special interest in Biomedical Engineering are announced before the semester in which they are offered. | Prerequisite: adviser's approval.
Grading: Grad Poly Graded
Repeatable for additional credit: No

BE-GY 6403 Digital Signal Processing I (3 Credits)
Typically offered Fall and Spring
Discrete and continuous-time linear systems. Z-transform. Fourier transforms. Sampling. Discrete Fourier transform (DFT). Fast Fourier transform (FFT). Digital filtering. Design of FIR and IIR filters. Windowing. Least squares in signal processing. Minimum-phase and all-pass systems. Digital filter realizations. Matlab programming exercises.
Grading: Grad Poly Graded
Repeatable for additional credit: No

BE-GY 6453 Probability and Stochastic Processes (3 Credits)
Typically offered Fall and Spring
Continuous and discrete random variables and their joint probability distribution and density functions; Functions of one random variable and their distributions; Independent random variables and conditional distributions; One function of one and two random variables; Two functions of two random variables and their joint density functions; Jointly distributed discrete random variables and their functions; Characteristic functions and higher order moments; Covariance, correlation, orthogonality; Jointly Gaussian random variables; Linear functions of Gaussian random variables and their joint density functions. Stochastic processes and the concept of Stationarity; Strict sense stationary (SSS) and wide sense stationary (WSS) processes; Auto correlation function and its properties; Poisson processes and Wiener processes; Stochastic inputs to linear time-invariant (LTI) systems and their input-output autocorrelations; Input-output power spectrum for linear systems with stochastic inputs; Minimum mean square error estimation (MMSE) and orthogonality principle; Auto regressive moving average (ARMA) processes and their power spectra. Co-listed as EL-GY 6303. | Prerequisites: Graduate status
Grading: Grad Poly Graded
Repeatable for additional credit: No

BE-GY 6463 Statistics for Biomedical Engineers (3 Credits)
Typically offered Fall and Spring
This course reviews various methods of analysis for biomedical data. Contents: population and sample, confidence interval, hypothesis test, Bayesian logic, correlation, regression, design of studies, t test, chi-square test, analysis of variance, multiple regression, survival curves. Multivariable Calculus knowledge required; Probability Theory knowledge is preferred.
Grading: Grad Poly Graded
Repeatable for additional credit: No

BE-GY 6473 Applied Mathematics and Statistics for Biomedical Engineering (3 Credits)
Typically offered Fall
This course introduces applied mathematics and advanced statistical methods commonly encountered in biomedical engineering, while covering probability theory to bridge between mathematics and statistics. The topics include: generalized linear mixed models, discrete-time models, stochastic processes, elements of information theory, time-series analysis, causality analysis, and rudiments of probability theory. Beyond structured learning in class, students will work on the analysis of real datasets from the biomedical fields. | Prerequisite: Basic knowledge of calculus
Grading: Grad Poly Graded
Repeatable for additional credit: No

BE-GY 6503 Biomedical Instrumentation (3 Credits)
Typically offered Spring
This course gives an overview on the theory, design and application of biomedical instrumentation used for dagnosis, monitoring, treatment and scientific study of physiological systems. The objective of this course is to enable students to design, build and test useful circuits, and to interface them with a computer using a data acquisition system for further signal analysis and processing. Cross-listed with BE-GY 6503. | Prerequisite: EE-UY 2024 or equivalent course in circuits, programming experience.
Grading: Grad Poly Graded
Repeatable for additional credit: No

BE-GY 6513 Biomedical Device Design and Development (3 Credits)
Typically offered Fall
This course aims to provide the essential knowledge in the biomedical product development (e.g. material properties, fabrication processes and design techniques for different applications) in order to provide ways to speed up the product development cycle. This course is multidisciplinary and covers the principles in mechanical, chemical, biological, and physiological aspects. Students can learn the techniques to apply the acquired knowledge of biomedical device design, prototyping, and manufacturing for particular applications they are interested. | Prerequisite: Advisor's Approval
Grading: Grad Poly Graded
Repeatable for additional credit: No

BE-GY 6523 Biomems and Microfluidics (3 Credits)
Typically offered Fall
This course targets to: (1) introduce fundamental design and microfabrication concepts of BioMEMS, microfluidics and lab-on-chip systems, (2) expose students to the relevant biomedical and biological applications. The course is divided into four main sections: (i) BioMEMS/Microfluidic materials and microfabrication, (ii) Statistics and modeling for BioMEMS, (iil) BioMEMS sensors and actuators, and (iv) Microfluidic and Lab-on-chip systems. | Prerequisites: Adviser's approval
Grading: Grad Poly Graded
Repeatable for additional credit: No

BE-GY 6723 Natural Polymers and Materials (3 Credits)
Typically offered occasionally
The course introduces natural and biomimetic polymers. It is taught with an interdisciplinary view of biology, chemistry and macromolecular science. Topics covered include natural building blocks and methods by which nature carries out polymer synthesis and modification reactions, DNA, structural proteins, plant proteins, polysaccharides, polyesters, biosurfactants, polymers built from natural monomers and a wide variety of renewable resources, uses of these polymers as fibers, films, rheological modifiers, flocculants, foams, adhesives and membranes, and special applications of natural polymers in medicine and as biodegradable plastics. | Co-listed as CM-GY 7923. Prerequisite: CM-UY 1004 and BMS-UY 1004.
Grading: Grad Poly Graded
Repeatable for additional credit: No

BE-GY 6763 Rehabilitation Engineering (3 Credits)
Typically offered Spring
This course will provide the student with fundamental knowledge of theory and practice in rehabilitation engineering. Based on an understanding of the pathophysiological processes that lead to disability, students will be introduced to medical, physiological, and psychological considerations in the design of rehabilitative interventions and learn to implement analytical methods for the evaluation of human performance in rehabilitation medicine applications. | Prerequisites: Basic knowledge of human anatomy, physiology, statics and dynamics, and adviser's approval
Grading: Grad Poly Graded
Repeatable for additional credit: No

BE-GY 6783 Biomechanics for Biomedical Engineers (3 Credits)
Typically offered Spring
Biomechanics offers contemporary topics on applications of linear and nonlinear solid mechanics to biological tissues, biomedical device design and intervention. The course will be composed of two parts: (1) theoretical aspects of biomechanics including kinematics, stress, and elastic material models that are related to modeling of biological tissue behavior; 2) review and discussion of clinical and engineering journal papers related to disease treatment and modeling. | Prerequisites: Undergraduate biomechanics course or instructor's consent
Grading: Grad Poly Graded
Repeatable for additional credit: No

BE-GY 6803 Biomaterials: Engineering Principles and Design Consideration (3 Credits)
Typically offered Fall
This course will provide the student with an overview of the techniques used to evaluate and design with materials used in biomedicine in the context of reconstructing, repairing, replacing or augmenting diseased or injured tissue or organs in the human body. | Prerequisites: Calculus I, Calculus II and Ordinary Differential Equations. Course objective: 1. Introduce the concepts of CAD/FEA used with the design of non-orthopedic devices that interface to the neurologic and cardiovascular systems. 2. To present the various classes of biomaterials such as metals, ceramics, man-made polymers and those derived from nature. 3. To simulate and identify the pertinent interactions between materials and composites with living tissue and their durability. 4. To give specific examples for the design of an artificial organ, i.e. artificial heart.
Grading: Grad Poly Graded
Repeatable for additional credit: No

BE-GY 6813 Computer Aided Design for Biomedical Engineering (3 Credits)
Typically offered Spring
This course teaches Computer Aided Design, basic mechanical design and manufacturability with focus on Biomedical Engineering applications. Topics include Computer aided drafting, tolerancing and dimensioning drawings, Geometric dimensioning and tolerancing. Course teaches design and drafting for basic mechanical elements like threads, gears, cams and splines with focus on biomedical applications. Course theory is complemented with a project designing biomedical device.
Grading: Grad Poly Graded
Repeatable for additional credit: No

BE-GY 8103 Systems & Computational Simulation for Biomedical Engineering (3 Credits)
This course provides an introduction to numerical methods commonly used in biomedical engineering to simulate various systems and processes. Students will learn to apply computational methods to solve problems encountered in various areas, such as biomechanics, computational physiology, drug delivery, tissue engineering, medical imaging, and biomedical signal processing. The course emphasizes hands-on implementation and practical applications to solve real-world biomedical engineering problems.
Grading: Grad Poly Graded
Repeatable for additional credit: No

BE-GY 8203 Biomedical Modeling, Estimation and Control (3 Credits)
Typically offered Spring
The introductory course provides the mathematical basis for modeling biomedical systems using state-space methods for analysis and design of biomedical systems with feedback loops. Mathematical tools will be developed to analyze and design biomedical systems expressed as coupled ordinary linear differential equations. State-space methods enable us to analyze and design multi- input/multi-output systems in time domain. The focus will be on the properties of state-space equations for stability analysis, estimator, and control design to be utilized for biomedical applications and brain-machine interfaces. The course will mostly concentrate on linear systems. This is a graduate class and knowledge of Probability theory, Signal processing (ECE-UY 3054: Signals and Systems or equivalent), linear algebra, and MATLAB are prerequisites. | Prerequisites: Graduate students; Adviser's approval
Grading: Grad Poly Graded
Repeatable for additional credit: No

BE-GY 9443 Tissue Engineering (3 Credits)
Typically offered Fall
This courses teaches basic biological processes that occur during blood contact with artificial surfaces; how to critically read and review literature on tissue engineering; how to anticipate biocompatibility issues with a variety of implant devices students may later encounter; current approaches directed toward the engineering of cell-based replacements for various tissue types. | Prerequisite: Adviser's approval.
Grading: Grad Poly Graded
Repeatable for additional credit: No

BE-GY 9453 Engineering Tissue Regeneration (3 Credits)
Typically offered Spring
This course presents engineering design principles for stimulation and control of tissue repair through regenerative mechanisms. Based on approaches for control of cell differentiation and growth, the application of engineering to the modeling and design of systems, agents, and processes to stimulate regenerative repair of tissues will be discussed. Example topics such as stem cell delivery and microenvironment design; drug and gene delivery; role of signaling pathway modulation; extracellular vesicle-mediated communication; signaling via electrical, mechanical, and fluid transport control will be discussed. | Prerequisites: Biochemistry highly recommended and adviser's approval
Grading: Grad Poly Graded
Repeatable for additional credit: No

BE-GY 9603 Neural and Physiological Signal Processing (3 Credits)
Typically offered Fall
This advanced-topic course will present signal processing and statistical methods used to study neural systems and analyze pulsatile physiological signals. Core topics include state-space modeling, state-space estimation, Kalman filtering, theory of point processes, estimation of point processes, maximum likelihood estimation, expectation maximization, point process filtering and smoothing, and sparse signal processing. Emphasis on developing a firm conceptual understanding of advanced signal processing and statistical methods primarily through analysis of experimental data in form of a course project. Applications of these theoretical techniques include dynamic analyses of neural encoding, neural spike train decoding, and pulsatile physiological data analysis. This is an advanced graduate class and knowledge of Probability theory, Signal processing, and MATLAB are prerequisites. | Prerequisites: Graduate Students, advisor's approval
Grading: Grad Poly Graded
Repeatable for additional credit: No
Prerequisites: Graduate Students, advisor's approval.

BE-GY 9730 Colloquium in Biomedical Engineering (0 Credits)
Typically offered Fall and Spring
Engineers and scientists from industry and academia present recent developments in biomedical engineering. MS students are required to take this course twice, while PhD students have to register for this course four times during the time of their studies in their respective programs.
Grading: Grad Poly Pass/Fail
Repeatable for additional credit: Yes

BE-GY 9740 Seminar in Biomedical Engineering (0 Credits)
Typically offered Fall and Spring
Students present research findings if engaged in MS or PhD thesis research, or make presentations from their critical analysis of recent biomedical-engineering publications. The seminar gives students the opportunity to prepare a scientific presentation on a biomedical-engineering topic of interest and to speak before their peers, who will question them. Two and four semesters are required for master's and PhD students, respectively.
Grading: Grad Poly Pass/Fail
Repeatable for additional credit: Yes

BE-GY 9753 Bioethics Seminar (3 Credits)
Typically offered Spring
This graduate-level seminar course discusses the ethical issues relevant to today's bioengineers and molecular and cell biologists. Topics include: Darwin's theory of evolution; science and religion in twentieth-century America; Intelligent Design Theory; social Darwinism and the concomitant rise of eugenics in Europe and the U.S., the ways in which molecular genetics has challenged historical categories of race; the ethical, social, and legal implications of the Human Genome Project (specifically genetic privacy and testing, human genes and intellectual property); argo-biotechnology and the science, ethics, and politics of genetically modified organisms (GMOs); and the science, politics, and ethics of human-embryonic-stem-cell research. The student is encouraged to think about the way in which debates concerning "nature versus nurture" have been framed historically, in order to understand current controversies over that distinction.
Grading: Grad Poly Graded
Repeatable for additional credit: No

BE-GY 9763 Regulatory Issues Surrounding Medical Devices (3 Credits)
Typically offered Fall and Spring
Medical devices are developed, manufactured, and distributed in a highly regulated environment. This course primarily concerns the processes for obtaining FDA marketing approval or clearance for biomedical devices. Prior to marketing a medical device in the US, a specific governmental approval or clearance is required depending on the type of device and the risk associated with the device. | Prerequisite: Instructor and adviser's approval.
Grading: Grad Poly Graded
Repeatable for additional credit: No