

BME

Biomedical Engineering

BME 501: Engineering Principles in Cell Biology

Course content is directed toward describing the physico-chemical and biological interactions within cells, and between cells and their environment. The course has two main objectives: 1) to equip students with essential knowledge and stimulate intuitive understanding of molecular and cell biology; 2) to introduce and develop common engineering concepts and approaches for quantitative analysis of physical-chemical systems in context of cell biology. The long-term goal is to help apply their knowledge of molecular and cellular phenomena and the analytical techniques learned in this course to design and development of products and processed for improving help and/or medical care. Therefore, a major component of this course will be an individual project requiring the development of a patent for a biomedical device or process, which relies on one or more of the biological (cell and molecular level) and engineering principles covered in class.

Fall, 3 credits, Letter graded (A, A-, B+, etc.)

BME 502: Advanced Numerical & Computation Analysis Applied to Biological Systems

Numerical analyses of Biological Data. A unified mathematical/time series framework for modeling and mining biological data. Applications range from cardio-respiratory, renal blood pressure/flow and sequence (DNA, RNA, proteins) to gene expression data. Tools of data analysis include linear algebra, interpolation and extrapolation, parametric and nonparametric spectral estimation with the FFT and singular value decomposition, statistical description of data and integration of ordinary differential equations. Special focus will be placed on the use of linear and nonlinear numerical methods for the identification of physiological system dynamics and the development of computer simulation techniques to study dynamic response of physiological systems. Cannot be repeated for credit.

Spring, 3 credits, Letter graded (A, A-, B+, etc.)

BME 503: Cell and Molecular Imaging

This course will cover basics of optics, microscopy, spectroscopy and fluorescence in the context of imaging at the cellular and molecular level. Recently developed advanced imaging techniques for probing

protein interactions and live cell functions are also discussed. The course is organized in 3 modules:

3 credits, Letter graded (A, A-, B+, etc.)

May be repeated 2 times FOR credit.

BME 504: Biomaterials Science and Analysis

Course content is directed toward providing an introductory treatment of the engineering issues implicit in understanding living tissue interactions with processed materials. Emphasis on identifying and eliminating surface contamination, corrosion, and optimizing material surface properties and compatibility.

Spring, 3 credits, Letter graded (A, A-, B+, etc.)

BME 505: Principles and Practice of Biomedical Engineering

Introduces first year students to the basic and clinical research at the cutting edge of biomedical engineering. The course has two key components: the first is a seminar series presented by internationally renowned bioengineers. An interactive discussion of topic-specific scientific literature precedes the formal presentation. The second component of the course is teaming up with a physician, in rounds, the operating theater, clinics, etc., to get exposure to the real-life problems which face the medical community. It is hoped that the mix of science and clinic will move students towards determining how they can make contributions to health and society.

2 credits, Letter graded (A, A-, B+, etc.)

BME 508: Molecular and Cellular Biomechanics

Course content revolves around the effects and interactions of mechanical forces at the cellular and molecular level. The topics range from describing the molecular and cellular basis of the adaptation of tissues to physical signals, to prescribing specific mechanical environments for improved tissue engineering, to delineating relevant molecular, cellular, and biomechanical techniques, to issues involved in the development and approval of diagnostics and therapeutics in molecular engineering. Course format is based on lectures and discussion of the current literature. For a deeper understanding of the scientific literature, this course will contain a module on the design and analysis of experiments (i.e., applied biostatistics).

Fall and Spring, 3 credits, Letter graded (A, A-, B+, etc.)

May be repeated 2 times FOR credit.

BME 509: Fundamentals of the Bioscience Industry

A 4-module course set up to provide students with a comprehensive introduction to the complexities of the bioscience business environment.

Prerequisite: Must be either a BME or MBA graduate student (West Campus). All other students must obtain permission from the instructor.

Spring, 3 credits, Letter graded (A, A-, B+, etc.)

BME 510: Biomechanics

This course emphasizes the application of continuum mechanics to living tissues and organs in order to describe the material properties and their behavior under loading and stress. The interrelationship between biomechanics and physiology is examined in normal function and in disease processes. This course focuses on the physiology of tissue and organ systems in the context of mechanics, stress, strain, viscoelasticity and material behavior, and the constitutive equations and the field equations governing fluids and fluid flow, with an emphasis on the cardiovascular and musculoskeletal systems. Emphasis is placed on the utilization of engineering principles to analyze processes at the tissue and organ levels, covering soft and hard tissues and organs (blood, cardiovascular system, bone, cartilage, etc.) and to understand how these principles could be applied towards the design and development of prosthetic devices.

3 credits, Letter graded (A, A-, B+, etc.)

May be repeated 2 times FOR credit.

BME 515: Biomedical Optical Imaging

An introduction to the principles and applications of biomedical optical imaging, with an emphasis on high-resolution imaging and spectroscopy. This course provides a conceptual overview, along with basic mathematical theory (assignments), of some of the key concepts that are relevant to biomedical optical imaging, including Gaussian beams, refraction, total internal reflection, and fluorescence. Cannot be repeated for credit.

3 credits, Letter graded (A, A-, B+, etc.)

May be repeated 1 times FOR credit.

BME 517: Radiation Physics

This graduate offering provides an initial physical background required for the study of the Medical Physics. Sources of ionizing radiation including radioactivity (natural and manmade) and x-ray producing devices are studied as well as sources of nonionizing radiation such as radiofrequency and ultrasound. The physical aspects of these radiations are characterized by their interaction

with matter and methods for their detection. Each student will select and present a proposal for solving a clinical medical physics problem.

Prerequisites: Modern Physics or equivalent Fall, 3 credits, Letter graded (A, A-, B+, etc.)

BME 518: Radiobiology

The biological consequences of irradiation (ionizing, ultrasound, laser, RF, etc.) will be examined. Interaction mechanisms will first be examined followed by examination of the radiation impact at the molecular and cellular level. The use of radiation for therapeutic gain will be considered. As well, models will be developed for risk estimates. Topics to be covered will include: target theory, biological response, NSD and risk estimates.

Spring, 3 credits, Letter graded (A, A-, B+, etc.)

BME 519: Medical Health Physics

This course discusses the health physics and safety issues associated with radiological devices, facilities and procedures.

Prerequisite: BME 517.

Spring, 3 credits, Letter graded (A, A-, B+, etc.)

May be repeated 2 times FOR credit.

BME 520: Lab Rotation I

BME 521: Lab Rotation II

BME 525: Tissue Engineering

Course deals with basics of biomaterial formulation that are relevant to tissue engineering, leading to the principles and practice of designing an engineered tissue, which will be facilitated by a design project.

Spring, 3 credits, Letter graded (A, A-, B+, etc.)

May be repeated 2 times FOR credit.

BME 526: Biological Systems Engineering

This course is a hands-on study of systems engineering in biology, using computer modeling to conceptualize and simulate a wide variety of applications. All skills taught in class. Appropriate and applicable to all BME tracks. May not be repeated for credit.

Fall, 3 credits, Letter graded (A, A-, B+, etc.)

BME 530: Medical Image Formation

This course covers the physical aspects of medical image formation. Image receptor design/optimization, reconstruction techniques, device hardware and performance characteristics are considered.

Fall, 3 credits, Letter graded (A, A-, B+, etc.)

May be repeated 2 times FOR credit.

BME 531: Biosensing and Bioimaging

Basic concepts of biosensing and bioimaging, which include the elements of biological systems and bioimmobilizers, traditional electrode and novel optical transducers, and advanced biomedical optical imaging systems.

Fall, 3 credits, Letter graded (A, A-, B+, etc.)

May be repeated 2 times FOR credit.

BME 532: Time Series Modeling of Biological Systems

A unified mathematical/time series framework for modeling and mining biological data. Applications range from cardio-respiratory, renal blood pressure/flow and sequence (DNA, RNA, proteins) to gene expression data. Tools of analysis include neural networks, time-invariant and time-varying spectral methods, fractal and nonlinear dynamics techniques, hidden Markov Model, clustering analysis, and various system identification techniques.

Spring, 3 credits, Letter graded (A, A-, B+, etc.)

BME 534: Functional Genomics

Course provides foundation in concepts of functional genomics and proteomics. Topics include organization and complexity of the mammalian genome and mechanisms of expression of genes, gene expression analysis technologies with a strong focus on construction and utilization of DNA microarrays, and tools for determining gene function by perturbation of gene expression.

Spring, 3 credits, Letter graded (A, A-, B+, etc.)

May be repeated 2 times FOR credit.

BME 540: Radiation Oncology Physics

This course provides a background in therapeutic instrumentation, dosimetry and treatment planning.

Prerequisite: BME 517

Fall, 3 credits, Letter graded (A, A-, B+, etc.)

May be repeated 2 times FOR credit.

BME 546: Statistical Analysis of Physiological Data

Statistical methods useful in analyzing common types of physiological data. Topics include probability, data distributions, hypothesis testing, with parametric and non-parametric methods, ANOVA, regression and correlation and power analysis. Emphasis is on experimental design and appropriate, efficient use of statistical software.

1 credit, Letter graded (A, A-, B+, etc.)

BME 547: Model-Based Analysis of Physiological Data

The analysis of common biochemical and physiological data by non-linear regression of data models and biophysical models of physiological and biochemical processes. Examples include binding kinetics, compartmental mass transfer and spectral analysis.

1 credit, Letter graded (A, A-, B+, etc.)

BME 548: Measurement and Analysis in Physiological Research

The acquisition and analysis of data arising from common biochemical and physiological measurements. Topics include computer-based data acquisition and processing, densitometry, microscopy, and image analysis and processing. Emphasis is on experimental design and strategies for optimizing signal to noise ratio of measurements.

1 credit, Letter graded (A, A-, B+, etc.)

BME 549: Experimental Techniques in Systems Physiology

A series of lectures and laboratory exercises designed to introduce students to invitro experimental techniques used in systems physiology. Emphasis will be placed on the ethical use of rodents in biomedical research and the measurement of physiological variables. Data acquisition and analysis procedures used in cardio-vascular, respiratory, neural and renal physiology will also be covered.

1 credit, Letter graded (A, A-, B+, etc.)

BME 550: Mathematical Models of Physiologic & Biophysical Systems

An introduction to mathematical modeling of cell and tissue function. Topics include the derivation and numerical solution of models of cell homeostasis, membrane transport and excitability, and cell signaling and metabolism. Grading is based on problems, student presentation, and completion of a modeling project.

3 credits, Letter graded (A, A-, B+, etc.)

BME 571: Microfluids in Biological Systems

This course will outline theory and applications of special fluid handling conditions associated with living systems.

Fall, 3 credits, Letter graded (A, A-, B+, etc.)

May be repeated 2 times FOR credit.

BME 572: Biomolecular Analysis

This interdisciplinary course is intended for graduate students and advanced undergraduates in departments such as

Biomedical Engineering, Chemistry, Physics, Biology and Chemical Engineering. This course will give an introduction to single molecule experiments using fluorescence, optical traps, AFM cantilevers, microneedles, magnetic microbeads as well as micro and nanofluidic devices.

Prerequisites: BME 501 and 502, or instructor approval.

*Fall, 3 credits, Letter graded (A, A-, B+, etc.)
May be repeated 2 times FOR credit.*

BME 573: iPhone Programming for Medical Applications

iPhone Programming for Medical Applications.

3 credits, Letter graded (A, A-, B+, etc.)

BME 599: Biomedical Engineering Research

Research to be supported by a faculty member of the Department of Biomedical Engineering. Students must have permission of instructor to enroll in appropriate section. Faculty to be identified by the student.

*Fall and Spring, 1-9 credits, S/U grading
May be repeated for credit.*

BME 601: Cardiovascular Fluid Mechanics

The course will cover the application of fluid mechanics principles to the analysis of blood flow in the cardiovascular system under normal and pathological conditions. It will follow an historical time line by beginning with the most basic models of arterial blood flow, and proceed to the most advanced theories related to physiology and pathology flow phenomena, including an examination of the most up to date research in the area and the development of devices and implants.

Spring, alternate years, 3 credits, Letter graded (A, A-, B+, etc.)

BME 602: Topics in Biomedical Applications of Neural Networks

This is a project based course which includes weekly seminars discussing advanced topics in fuzzy logic and neural networks and their applications, in biomedical devices. Applications include drug delivery, diagnostics, management information handling. Students utilize simulation software to develop algorithms to deal successfully with training data sets of their own choosing.

Fall, alternate years, 3 credits, Letter graded (A, A-, B+, etc.)

BME 604: Finite Element Modeling in Biology and Medicine

Both finite difference and FEM are applied to solve the equations of incompressible and compressible fluid flow in porous media with emphasis on flows in skeletal tissues, i.e., bone and cartilage. Steady-state, transient flow, permeability and surface boundary conditions are discussed. Practical and recent studies in the field are also discussed. Programming using FORTRAN or C languages will be required. The student is also introduced to commercially available software packages.

Spring, alternate years, 3 credits, Letter graded (A, A-, B+, etc.)

BME 605: Biomechanics of Tactile Sensory Systems

Detailed study of the biomechanics of tactile neurophysiology for engineers entering the field of haptics and robotics manipulations. Anatomy and electrophysiology of transducer cells and neurons starting at the fingertips and extending to the somatosensory cortex. Characteristics of the external stimulus and its peripheral transformation. Relations of these topics to perceptual and/or behavioral responses.

Spring, alternate years, 3 credits, Letter graded (A, A-, B+, etc.)

BME 606: Drug Gene Delivery

Applications of biodegradable and biocompatible polymers in the design of drug and gene delivery systems for site-specific applications. A broad overview on the origin and development of controlled release therapeutic devices will be provided. Existing and proven commercial products will be examined. The second half of the course will be devoted to the use of DNA as a therapeutic entity and issues relevant to DNA delivery will be explored. An assessment of the most up-to-date DNA delivery technologies will be presented. Students are required to write a term paper on a drug or gene delivery topics of their choice. Students are also expected to give presentations on drug delivery and gene therapy related topics during the course.

Fall, alternate years, 3 credits, Letter graded (A, A-, B+, etc.)

BME 608: Contemporary Biotechnology

General discussion on the nature of biotechnology and its historical development, applications, impact, consequences, and some of the social and ethical considerations.

*Co-scheduled with BME 402
Fall, 3 credits, Letter graded (A, A-, B+, etc.)*

BME 610: Magnetic Resonance

This course provides a comprehensive study of magnetic resonance and its applications in medical imaging. An introduction of NMR is followed with development of the hardware and processing aspects required for MR image formation. An overview of basic and advanced MR imaging techniques is provided. Each student will select a topic in MR imaging for presentation at the conclusion of the course.

Fall, 3 credits, Letter graded (A, A-, B+, etc.)

BME 611: Positron Emission Tomography

Positron emission tomography (PET) is a unique and powerful functional imaging method used in the clinic and in medical research. It is a multidisciplinary endeavor involving the fields of chemistry, physics, mathematics and medicine. This course addresses the disparate areas of science underlying PET imaging, including radioisotope production, radiotracer synthesis, the physics of the imaging process, quantitative data processing, image reconstruction approaches, data analysis, and tracer kinetic modeling to extract quantitative physiological parameters. Radioactive validation and applications of PET will also be covered including the area of drug addiction. There is a hands-on component in which students will visit an active PET research center and acquire and manipulate PET data.

*3 credits, Letter graded (A, A-, B+, etc.)
May be repeated 1 times FOR credit.*

BME 612: Biomedical Engineering Aspects for the Use of Radiation in Medicine

This course provides a comprehensive study of the use of radiation in medicine. Physical aspects of the interaction of radiation with matter and for the radiation production are initially considered. The underlying principles of current radiation based medical imaging is considered next. Topics include radiography, fluoroscopy, radionuclide imaging and computed tomography. The use of radiation for the treatment of malignancy is considered with the focus on required technology. Finally advanced applications of radiation are considered with focus on imaging and treatment. Each student will select a topic examining the engineering or technical application of radiation in medicine for presentation at the conclusion of the course.

Spring, 3 credits, Letter graded (A, A-, B+, etc.)

BME 615: Clinical Nuclear Imaging

This course is designed to prepare the Medical Physics graduate student in the area of clinical

Medical Imaging. In this clinical rotation, medical physics methods for: planar film, DR, CR, mamography, fluoroscopy, CT, ultrasound and MRI performance evaluations will be introduced. In addition, basic medical ethics, radiographic anatomy and radiation safety will be covered. A total of 200 clinical hours will be completed in this program

Prerequisites: BME 517; BME 518; BME 519; BME 530 or BME 540.

Fall, 4 credits, S/U grading

May be repeated 2 times FOR credit.

BME 616: Clinical Nuclear Medicine Imaging

This course is designed to prepare the Medical Physics graduate student in the area of clinical Nuclear Medicine Imaging. In this clinical rotation, the students will be exposed to radionuclide processes, radiopharmaceuticals including radioactive gases and aerosols-particulate, characteristics and radiation dosimetry, in vitro and in vivo radiation detection systems, imaging systems and their performance evaluations. In addition, basic medical ethics, clinical interpretations and radiation safety will be covered. A total of 150 clinical hours will be completed in this program.

Fall, 4 credits, S/U grading

May be repeated 2 times FOR credit.

BME 617: Clinical Radiation Oncology Physics

This course is designed to prepare the Medical Physics graduate student in the area of clinical radiation oncology physics. In this clinical rotation, the student will learn by observation and participation some of a selection of the following medical physics procedures: LINAC Beam Dosimetry (ion chamber measurement techniques, film dosimetry (radiographic and radiochromic), diode dosimetry, TLD dosimetry, water phantom scanning), implementation of photon and electron beam calibration protocols (AAPM TG51), LINAC beam data measurement and tabulation, commissioning a TPS system, LINAC, acceptance testing, LINAC monthly QA, HDR QA and planning, and IMRT inverse planning and IMRT clinical QA. A total of 120 clinical hours will be completed in this program. Prerequisite: BME 517 and BME 540 with a B+ or better.

Spring, 4 credits, S/U grading

BME 620: Space Radiation Biology

An extensive series of lectures, training sessions and laboratory activities sponsored by the NASA's Radiation Health Program in collaboration with BNL. The material is oriented to cover basic and state of the art

concepts in space radiation environment, physics and radiobiology. Content includes basic concepts in physics, dosimetry, radiobiology, space radiation problems and accelerator operations. Concurrent sessions are provided to complete specific BNL training and plan and prepare experiments for low- and high-LET radiation exposures. Students are trained in NSRL operations and are able to run control experiments using gamma rays in preparation for NSRL runs, and subsequently experiments at the NSRL using heavy ions. Data are obtained from different endpoints are discussed and analyzed with the instructors. Homework are used to test the student's level of comprehension of the lectures and laboratory activities. The write up of a full BNL beam time request proposal is required of each student.

4 credits, Letter graded (A, A-, B+, etc.)

BME 690: Biomedical Engineering Research

Biomedical Engineering research for doctoral students who have already received their M.S. degree, but have not yet advanced to candidacy.

Fall and Spring, 1-9 credits, Letter graded (A, A-, B+, etc.)

May be repeated for credit.

BME 698: Practicum in Teaching

Undergraduate teaching to be supervised by a faculty member of the Program in Biomedical Engineering. Course to be identified by the student and graduate studies director.

Fall and Spring, 1 credit, Letter graded (A, A-, B+, etc.)

May be repeated for credit.

BME 699: Dissertation Research on Campus

Prerequisite: Students must be advanced to candidacy (G5); permission of instructor and enroll in appropriate section. Major portion of research must take place on SBU campus, at Cold Spring Harbor, or at the Brookhaven National Lab.

Fall, Spring, and Summer, 1-9 credits, Letter graded (A, A-, B+, etc.)

May be repeated for credit.

BME 700: Dissertation Research off Campus - Domestic

Prerequisite: Must be advanced to candidacy (G5). Major portion of research will take place off-campus, but in the United States and/or U.S. provinces. Please note, Brookhaven National Labs and the Cold Spring Harbor Lab are considered on-campus. All international students must enroll in one of the graduate

student insurance plans and should be advised by an International Advisor.

*Fall, Spring, 1-9 credits, S/U grading
May be repeated for credit.*

BME 701: Dissertation Research off Campus - International

Prerequisite: Must be advanced to candidacy (G5). Major portion of research will take place outside of the United States and/or U.S. provinces. Domestic students have the option of the health plan and may also enroll in MEDEX. International students who are in their home country are not covered by mandatory health plan and must contact the Insurance Office for the insurance charge to be removed. International students who are not in their home country are charged for the mandatory health insurance. If they are to be covered by another insurance plan they must file a waiver by second week of classes. The charge will only be removed if other plan is deemed comparable.

*All international students must received clearance from an International Advisor.
Fall, Spring, 1-9 credits, S/U grading
May be repeated for credit.*

BME 800: BME RESEARCH

Full-time summer research.

S/U grading

May be repeated for credit.