BME

Biomedical Engineering

BME 100 Introduction to Biomedical Engineering
A rigorous introduction to biomedical engineering that provides the historical and social context of BME though the lens of emerging areas within BME. Specific areas covered in depth include: bioelectricity and biosensors (action potentials to signal processing), bioimaging (invasive and non-invasive), genetic engineering (with ethical discussions), and biostatistics. Hands-on computational modeling introduces the physiological concept of positive and negative feedback loops in the body. Emphasis is placed on ways engineers view the living system by using design based approaches and computation.
Prerequisites: BME Major, BNG Minor or Departmental Consent
3 credits

BME 120 Programming Fundamentals for Biomedical Engineering
This course will introduce the theory and fundamen- tals of computer programming specifically designed for the applications in biomedical engineering. Students will learn the basic computer architecture and the interaction between the computer hardware, operating system and application software. The course focus will be on the programming control logic and style critical to all programming languages including C and MATLAB. Several core and elective courses in biomedical engineering use MATLAB as a key pro- gramming language, and therefore MATLAB will be the primary language used to teach the abovedemen- tioned programming principles. This course will also serve as the foundation where the students can pursue further advanced programming skills.
Prerequisites: BME Majors only
3 credits

BME 201-H Biomedical Engineering and Society
How engineers interact with others in the develop- ment of solutions to societal problems, with emphasis on engineering problems arising in the biological realm. In-depth study of both successful and unsuccessful technologies illuminate the role of biomedical engi- neers in supporting the well-being of urban and rural populations throughout the world, through develop- ments in medical engineering, biotechnology, environ- mental engineering, and ergonomic design. Not for credit in addition to BME 100.
Prerequisite: One D.E.C. category E course
3 credits

BME 212 Biomedical Engineering Research Fundamentals
Introduction to data collection and analysis in the con- text of biophysical measurements commonly used by biomedical engineers. Statistical measures, hypothesis testing, linear regression, and analysis of variance are intro- duced in an application-oriented manner. Data collec- tion methods using various instruments, A/D boards, and PC as well as LabVIEW, a powerful data collection computer package. Not for credit in addition to the dis- continued BME 309.
Prerequisites: BME major, BME 100
Pre-or Corequisite: MEC 296; BIO 202 or 203
3 credits

BME 213 Studies in Nanotechnology
The emerging field of nanotechnology develops solu- tions to engineering problems by taking advantage of the unique physical and chemical properties of nanoscale materials. This interdisciplinary, co-taught course introduces materials and nano-fabrication methods with applications to electronics, biomed- ical, mechanical and environmental engineering. Guest speakers and a semester project involve ethics, tox- cology, economic and business implications of nanotechnology. Basic concepts in research and design methodology and characterization techniques will be demonstrated. Course is cross-listed as BME 213, MEC 213, and EST 213 and is required for the Minor in Nanotechnology Studies (NTS).
Prerequisites: PHY 171 or PHY 125; CHE 171 or ESG 198
3 credits

BME 300 Writing in Biomedical Engineering
See Requirements for the Major in Biomedical Engineering, Upper-Division Writing Requirement.
Prerequisites: WRT 102; US or UE standing; BME major; Corequisite: Any upper division BME course and permission of the course instructor or Undergraduate Program Director
S/U grading

BME 301 Bioelectricity
Theoretical concepts and experimental approaches used to characterize electric phenomena that arise in live cells and tissues. Topics include, ionic channels, mem- branes and action potential generation, cable theory, equivalent dipoles and volume conductor fields, bio- electric measurements, electrodes and electric stimu- lation of cells and tissues.
Prerequisites: BME 212; ESE 271; ESG 111 (or ESE 124); BIO 202 or 203
3 credits

BME 303 Biomechanics
Illuminates the principles of mechanics and dynamics that apply to living organisms, from cells to humans to Sequoia trees. The behavior of organisms is examined to observe how they are constrained by the physical properties of biological materials. Locomotion strate- gies (or the lack thereof) are investigated for the forces and range of motions required and energy expenditures. Includes the relationship between form and function to illustrate how form dominates behavior. Presents the physiological effects of mechanical stresses on organs, pathologies that develop from abnormal stress, and how biological growth and adaptation arise as a natural response to the mechanics of living.
Prerequisite: MEC 260; MEC 212
Pre or Corequisite: BIO 202 or 203
3 credits

BME 304-H Genetic Engineering
An introduction to the realm of molecular bioengin- eering with a focus on genetic engineering. Includes the structure and function of DNA, the flow of genetic information in a cell, genetic mechanisms, the methodology involved in recombinant DNA technol- ogy and its application in society in terms of cloning and genetic modification of plants and animals (trans- genics), biotechnology (pharmaceutical, genomics, bioprocessing (production and process engineering focusing on the production of genetically engineered products.), and gene therapy. Production factors such as time, rate, cost, efficiency, safety, and desired prod- uct quality are also covered.
Prerequisites: MEC 260; BME 212
Pre or Corequisite: MEC 296
3 credits

BME 305 Biofluids
The fundamentals of heat transfer, mass transfer, and fluid mechanics in the context of physiological sys- tems. Techniques for formulating and solving biofluid and mass transfer problems with emphasis on the spe- cial features and the different scales encountered in physiological systems, from the organ and the tissue level down to the molecular transport level.
Prerequisites: AMS 261 (or MAT 203 or MAT 205); AMS 361 (or MAT 303 or MAT 305); BME 212; MEC 260 and MEC 282
Pre or Corequisite: BIO 202 or 203
3 credits

BME 311 Fundamentals of Macro to Molecular Bioimaging
This course will cover the fundamentals of modern imaging technologies, including techniques and appli- cations within medicine and biomedical research. The course will also introduce concepts in molecular imag- ing with the emphasis on the relations between imag- ing technologies and the design of target specific probes as well as unique challenges in the design of probes of each modality: specificity, delivery, and amplification strategies. The course includes visits to clinical sites.
Prerequisites: BME 212
3 credits

BME 313 Bioinstrumentation
Basic concepts of biomedical instrumentation and medical devices with a focus on the virtual instrumen- tation in biomedical engineering using the latest com- puter technology. Topics include basic sensors in biomedical engineering, biomedical signal measure- ment, conditioning, digitalizing, and analysis. Advanced applications of LabVIEW, a graphics programming tool for virtual instrumentation. Helps students develop skills to build virtual instruments for laboratory research and prototyping medical devices.
Prerequisite: BME 212
3 credits

BME 381 Nanofabrication in Biomedical Applications
Theory and applications of nanofabrication. Reviews aspects of nanomachines in nature with special atten- tion to the role of self-lubrication, intracellular or inter- stitial viscosity, and protein-guided adhesion. Discusses current nanofabricated machines to per- form the same tasks and considers the problems of lubrication, compliance, and adhesion. Self-assembly mechanisms of nanofabrication with emphasis on cutting-edge discovery to overcome current challenges associated with nanofabricated machines.
Prerequisites: CHE 132; BME 100
Pre or Corequisite: BIO 202 or 203
3 credits

BME 400 Research and Nanotechnology
This is the capstone course for the minor in Nanotechnology Studies (NTS). Students learn pri- mary aspects of the professional research enterprise through writing a journal-quality manuscript and mak- ing professional presentations on their independent research (499) projects in a formal symposium setting. Students will also learn how to construct a grant pro- posal (a typical NSF graduate fellowship proposal), methods to search for research/fellowship funding, and key factors in being a research mentor.
Prerequisites: BME 213; at least one semester of inde- pendent research (499) course
3 credits

BME 404 Essentials of Tissue Engineering
Topics covered are: developmental biology (nature’s tissue engineering), mechanisms of cell-cell and cell- matrix interactions, biomaterial formulation, charac- terization of biomaterial properties, evaluation of cell interactions with biomaterials, principles of designing an engineered tissue. Considers manufacturing parameters such as time, rate, cost, efficiency, safety and desired product quality as well as regulatory issues.
Prerequisites: BIO 202 or 203; CHE 132
3 credits

BME 420 Computational Biomechanics
Introduces the concepts of skeletal biology; mechan- ics of bone, ligament, and tendon; and linear and non- linear properties of biological tissues. Principles of
finite differences method (FDM) and finite elements method (FEM) to solve biological problems. Both FDM and FEM are applied to solve equations and problems in solid and porous media. Requires knowledge of Fortran or C programming.

**Prerequisites:** BME 303; BIO 203

3 credits

**BME 430 Engineering Approaches to Drug Delivery**

Introduction to the application of engineering principles and biological considerations in designing drug delivery systems for medical uses. The concept of biocompatibility and its implications in formulating controlled release devices are illustrated. Emphasis on the use of biodegradable materials to design drug delivery systems for site-specific applications.

**Prerequisites:** AMS 161 or MAT 132 or 142 or 171; BIO 202 or 203; BME 304

3 credits

**BME 440 Biomedical Engineering Design**

Introduction to product development from the perspective of solving biomedical, biotechnological, environmental, and ergonomic problems. Teamwork in design, establishing customer needs, writing specifications, and legal and financial issues are covered in the context of design as a decision-based process. A semester-long team design project follows and provides the opportunity to apply concepts covered in class.

**Prerequisites:** BME major; U4 standing; BME 301 and 305

3 credits

**BME 441 Senior Design Project in Biomedical Engineering**

Formulation of optimal design problems in biomedical and physiological settings. Introduces optimization techniques for engineering design and modeling for compact and rapid optimization of realistic biomedical engineering problems. Necessary conditions for constrained local optimum with special consideration for the constraints in which the product designed should function in terms of the settings (corporal, ex-corporal, biological, etc.) and the safety considerations involved which are unique to biomedical engineering. Students carry out the detailed design of projects chosen early in the semester. A final design report is required.

**Prerequisite:** BME 440

3 credits

**BME 461 Biosystems Analysis**

Fundamentals of the linear time series analyses framework for modeling and mining biological data. Applications range from cardiorespiratory; renal blood pressure, flow, and sequence; to gene expression data. Tools of data analysis include Laplace and Z transforms, convolution, correlation, Fourier transform, transfer function, coherence function, various filtering techniques, and time-invariant and time-varying spectral techniques.

**Prerequisites:** BME 212 and 301

3 credits

**BME 475 Undergraduate Teaching Practicum**

Students assist the faculty in teaching by conducting recitation or laboratory sections that supplement a lecture course. The student receives regularly scheduled supervision by the faculty instructor. May be used as an open elective and repeated once.

**Prerequisites:** BME major; U4 standing; a minimum g.p.a. of 3.00 in all Stony Brook courses and a grade of B or better in the course in which the student is to assist; or permission of the department

3 credits

**BME 481 Biosensors**

A comprehensive introduction to the basic features of biosensors. Discusses types of most common biological agents (e.g. chromophores, fluorescence dyes) and the ways in which they can be connected to a variety of transducers to create complete biosensors for biomedical applications. Focus on optical biosensors and systems (e.g. fluorescence spectroscopy, microscopy), and fiberoptically-based biosensing techniques. New technologies such as molecular beacons, Q-dots, bioMEMs, confocal microscopy and multi-photon microscopy, and OCT will be referenced.

**Prerequisites:** BIO 202 or 203; ESE 271

3 credits

**BME 488 Biomedical Engineering Internship**

Participation in off-campus biomedical engineering practice. Students are required to submit a proposal to the undergraduate program director at the time of registration that includes the location, immediate supervisor, nature of the project, and hours per week for the project. One mid-semester report and one end of semester report are required. May be repeated up to a limit of 12 credits.

**Prerequisites:** BME 212 and permission of undergraduate program director

3-6 credits, S/U grading

**BME 499 Research in Biomedical Engineering**

An independent research project with faculty supervision.

**Prerequisites:** Permission of instructor

0-3 credits