Biomedical Engineering (BME)

Major in Biomedical Engineering

Department of Biomedical Engineering, College of Engineering and Applied Sciences

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Minors of particular interest to students majoring in Biomedical Engineering: Applied Math and Statistics (AMS), Biochemistry (BCH), Nanotechnology (NTS)

Department Information - Biomedical Engineering (BME)

The Department of Biomedical Engineering offers the major in Biomedical Engineering, leading to the Bachelor of Engineering (B.E.) degree. The Department also offers a minor in Bioengineering approved for Biology or Biochemistry majors. (See the entry in the alphabetical listings of Approved Majors, Minors, and Programs for the requirements for the minor in Bioengineering.) In a rigorous, cross-disciplinary training and research environment, the major program provides an engineering education along with a strong background in the biological and physical sciences. It is designed to enhance the development of creativity and collaboration through study of a specialization within the field of biomedical engineering. Teamwork, communication skills, and hands-on laboratory and research experience are emphasized. The curriculum provides students with the underlying engineering principles required to understand how biological organisms are formed and how they respond to their environment. The Biomedical Engineering program is accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org.

Core courses provide depth within the broad field of biomedical engineering. These are integrated with, and rely upon, course offerings from both the College of Engineering and Applied Sciences and the College of Arts and Sciences. To achieve the breadth of engineering experience expected of Biomedical Engineering graduates, additional elective courses from the College of Engineering and Applied Sciences are required of all Biomedical Engineering students.

The Department also offers a five-year accelerated B.E./M.S. degree, which can be completed within one additional year of studies beyond the Bachelor's degree.

The accelerated B.E./M.S. is intended to prepare high-achieving and highly-motivated undergraduate BME students for either doctoral studies or a variety of advanced professional positions. The program is highly selective with admission based on academic performance as well as undergraduate research. Juniors can be admitted into the accelerated degree program if they satisfy the requirements outlined in the Graduate Bulletin. The requirements for the accelerated program are the same as the requirements for the B.E. and M.S. degree, except that two graduate 500-level courses replace two 300-level electives, so that six graduate credits are counted toward the undergraduate degree.

Graduates are prepared for entry into professions in biomedical engineering, biotechnology, pharmaceuticals, and medical technology, as well as careers in academia and government. Potential employers include colleges and universities, hospitals, government, research institutes and laboratories, and private industry.
Program Educational Objectives
The undergraduate program in biomedical engineering has the following four specific program educational objectives:

- Our graduates will apply skills and insight gained from a curriculum integrating engineering and biology to biomedically related fields in sectors including academia, industry, medicine, law, and/or government.
- Our graduates will strive to become inspirational leaders who make socially and ethically responsible decisions that beneficially impact health and society from local communities to the global population.
- Our graduates will use scientific research and collaborations to develop biomedical technologies that can be translated into cost-effective clinical solutions to enhance diagnosis, prevention, and treatment of health issues.
- Our graduates will remain lifelong learners, continue to grow professionally and personally throughout their careers, and be partners to grow future generations of biomedical engineers.
Student Outcomes

The students will demonstrate the following:

A. an ability to apply knowledge of mathematics, science, and engineering
B. an ability to design and conduct experiments, as well as to analyze and interpret data
C. an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
D. an ability to function on multidisciplinary teams
E. an ability to identify, formulate, and solve engineering problems
F. an understanding of professional and ethical responsibility
G. an ability to communicate effectively
H. the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
I. a recognition of the need for, and an ability to engage in life-long learning
J. a knowledge of contemporary issues
K. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

Requirements for the Major in Biomedical Engineering

Acceptance into the Major

Qualified freshman and transfer students who have indicated their interest in the major on their applications may be admitted directly as a degree major or as a pre-major. Pre-majors are placed into the Area of Interest (AOI) program and to be eligible for the degree, they must be admitted to and declare the major. The requirements and application process for matriculation are detailed below. Students admitted to other programs within the College of Engineering and Applied Science (CEAS) follow the same admissions process as students in the AOI program. Students in programs outside of CEAS (non-CEAS students) and double major applicants may apply for admission to the degree program following a separate process, outlined below.

Area of Interest and Other CEAS Students (excluding double major applicants)

Applications for major admission from AOI and other CEAS students are reviewed twice per year and must be received by January 5 for Spring admission and June 5 for Fall admission. Students who submit their application on time will be admitted if they meet the following requirements:

• Completed AMS 161 and PHY 132/134 or equivalents;
• Earn 10 or more credits of mathematics, physics and engineering courses that are taken at Stony Brook and satisfy the major’s requirements;
• Obtain a grade point average of at least 3.2 in major courses with no more than one grade below B-;
• No courses required for the major have been repeated;
• Completion of course evaluations for all transferred courses that are to be used to meet requirements of the major.

Students must complete these requirements no later than one year after they enroll in the first course that applies towards major entry. Students must apply for admission by the application deadline immediately following completion of the above requirements, but no later than the one year limit. Admission of AOI students and other CEAS students who apply late will follow the process of Non-CEAS Students and Double Major Applicants below.

Non-CEAS Students and Double Major Applicants

Applications for major admission from non-CEAS students and double major applicants are reviewed twice per year and must be received by January 5 for Spring admission and June 5 for Fall admission. Students who do not meet the requirements for AOI admission above will not be considered. Fulfilling the requirements does not guarantee acceptance. Admission is competitive and contingent upon program capacity.

Requirements for the Major

The curriculum begins with a focus on basic mathematics and the natural sciences followed by courses that emphasize engineering science and bridging courses that combine engineering science and design. The sequence of courses culminates with a one-year design experience that integrates the science, engineering, and communication knowledge acquired. The technical electives and additional courses are chosen in consultation with a faculty advisor, taking into consideration the particular interest of the student.

Completion of the major requires approximately 128 credits.

1. Mathematics
a. AMS 151, AMS 161 Calculus I, II
b. AMS 261 or MAT 203 Calculus III
c. AMS 361 or MAT 303 Calculus IV
d. AMS 210 Matrix Methods and Models
e. AMS 310 Survey of Probability and Statistics

Note: The following alternate calculus course sequences may be substituted for AMS 151, AMS 161: MAT 125, MAT 126, MAT 127 or MAT 131, MAT 132 or MAT 141, MAT 142 or MAT 171

2. Natural Sciences
a. BIO 202 Fundamentals of Biology: Molecular and Cellular Biology and BIO 204 Fundamentals of Scientific Inquiry in the Biological Sciences I
b. CHE 131, CHE 132 General Chemistry I, II or CHE 152 Molecular Science I
c. PHY 131/PHY 133, PHY 132/PHY 134 Classical Physics I, II with labs

Note: The following alternate physics course sequences may be substituted for PHY 131/PHY 133, PHY 132/PHY 134; PHY 125, PHY 126, PHY 127, PHY 133, PHY 134 Classical Physics A, B, C and Laboratories or PHY 141, PHY 142, PHY 133, PHY 134 Classical Physics I, II: Honors

3. Computers and Programming
a. BME 120 Programming Fundamentals in Biomedical Engineering

4. Engineering
a. MEC 203 Engineering Graphics and CAD

5. Biomedical Engineering
a. BME 100 Introduction to Biomedical Engineering
b. BME 212 Laboratory Methods in Biomedical Engineering
c. BME 260 Statics and Dynamics in Biological Systems
d. BME 271 Introduction to Bio-electricity and Bio-photonics
e. BME 301 Biophotonics
f. BME 303 Biomechanics
g. BME 304 Genetic Engineering
h. BME 305 Biofluids
i. BME 440 Biomedical Engineering Design
j. BME 441 Senior Design Project in Biomedical Engineering

6. Biomedical Engineering Specializations and Technical Electives

Biomedical engineering students must complete a specialization, composed of at least 30 credits in one of three areas, including at least two 3- to 4-credit design technical elective courses with a BME designation. Five technical elective courses must be 300- or 400-level BME courses (not BME 499). BME 499 may be taken as an additional technical elective for a total of 6 credits. (See below for the three specializations with course options.) The specialization must be declared in writing by the end of the sophomore year and is selected in consultation with the faculty advisor to ensure a cohesive curriculum with depth at the upper level.

7. Upper-Division Writing Requirement: BME 300 Writing in Biomedical Engineering

All degree candidates must demonstrate skill in written English at a level acceptable for engineering majors. All Biomedical Engineering students must complete the writing course BME 300 concurrently with a selected 300- or 400-level BME course (excluding BME 440, 441, and 499). The quality of writing in technical reports submitted for the course is evaluated, and students whose writing does not meet the required standard are referred for remedial help. Satisfactory writing warrants an S grade for BME 300, thereby satisfying the requirement.

Grading

All courses taken to satisfy 1 through 6 above must be taken for a letter grade. The grade point average for all required BME courses and all technical electives must be at least a 2.5 to graduate. A grade of C or higher is required in the following courses: AMS 151, AMS 161 or equivalent; BIO 202; CHE 131, CHE 132 or equivalent; PHY 131/PHY 133, PHY 132/PHY 134 or equivalent; BME 271 or ESE 271; all BME courses.

Specializations

To complete the specialization, students choose from the technical elective course list for one of the three specializations. Other courses may be used towards this requirement with the permission of the undergraduate program director. A total of 30 credits in technical electives are required. Fifteen credits or more must be engineering designations. Fifteen credits must be BME (not BME 499), however six additional credits may be BME 499. Although any BME technical elective courses will be accepted within any of the three tracks, below are recommended courses for each track. Non-BME technical elective courses are entirely track specific. BME courses with significant design content are marked by (*).
a. Biomechanics and Biomaterials

Courses that focus on developing an understanding of mechanical structures and dynamics of biological systems, and material properties of those structures. This specialization is appropriate for students interested in the areas of biofluid mechanics, hard and soft tissue biomechanics, biomaterials, biocompatibility, medical prosthetics, or bioinstrumentation.

**Recommended courses:**

- BME 353 Introduction to Biomaterials
- BME 354 Advanced Biomaterials (*)
- BME 371 Biological Microfluidics
- BME 381 Nanofabrication in Biomedical Applications (*)
- BME 404 Essentials of Tissue Engineering (*)
- BME 420 Computational Biomechanics
- BME 430 Quantitative Human Physiology
- ESG 302 Thermodynamics of Materials
- ESG 332 Materials Science I
- ESM 335 Strength of Materials
- ESM 353 Biomaterials
- ESM 369 Polymers
- MEC 363 Mechanics of Solids

**Alternative courses:**

- AMS 315 Data Analysis
- AMS 333 Mathematical Biology
- BME 311 Fundamentals of Bio-imaging (*)
- BME 312 LabVIEW Programming in Engineering (*)
- BME 313 Bioinstrumentation (*)
- BME 402 Contemporary Biotechnology
- BME 481 Biosensors (*)
- CHE 321 Organic Chemistry I
- CHE 322 Organic Chemistry II
- CHE 327 Organic Chemistry Laboratory
- CSE 332 Introduction to Scientific Visualization
- ESE 315 Control System Design
- ESG 281 Engineering Intro to Solid State
- ESG 316 Engineering Science Design II
- ESM 325 Diffraction Techniques and Structure of Solids
- ESM 335 Strength of Materials
- ESM 369 Polymer Engineering
- ESM 450 Phase Changes and Mechanical Properties of Materials
- MEC 310 Introduction to Machine Design
- MEC 320 Engineering Design Methodology and Optimization
- MEC 402 Mechanical Vibrations
- MEC 410 Design of Machine Elements
- MEC 411 Control System Analysis and Design
- MEC 455 Applied Stress Analysis

b. Bioelectricity and Bioimaging

Courses focusing on the description of biological cells, tissues, and organisms as complex systems. This specialization is appropriate for students interested in the areas of bioinstrumentation, medical imaging, electrical prosthetics, electromagnetic compatibility, tissue engineering, or bioinformatics.

**Recommended courses:**

- BME 311 Fundamentals of Macro to Molecular Bioimaging (*)
- BME 312 LabVIEW Programming in Engineering (*)
- BME 313 Bioinstrumentation (*)
- BME 381 Nanofabrication in Biomedical Applications (*)
- BME 430 Quantitative Human Physiology
- BME 481 Biosensors (*)
- CSE 377 Introduction to Medical Imaging
- ESE 211 Electronics Laboratory A
- ESE 218 Digital System Design
- ESE 306 Random Signals and Systems
- ESE 314 Electronics Laboratory B
- ESE 315 Control System Design
ESE 372 Electronics

Alternative courses:
AMS 311 Probability Theory
CHE 321 Organic Chemistry I
CHE 322 Organic Chemistry II
CHE 327 Organic Chemistry Laboratory
ESE 305 Deterministic Signals and Systems
ESE 324 Electronics Laboratory
EST 421 Starting the High-Technology Venture

c. Molecular and Cellular Biomedical Engineering

Courses focus on the application of biochemistry, cell biology, and molecular biology (i.e., recombinant DNA methodology) to the broad fields of genetic engineering, biotechnology, bionano-technology, and biosensors. Includes the specific engineering principles that are applied to problems involving structure and function of molecules and cells in areas such as tissue engineering, gene therapy, microarray, drug design and delivery, structural biology computational methods, and bioinformatics.

Recommended courses:
BIO 317 Principles of Cellular Signaling
BME 311 Bioimaging (*)
BME 353 Introduction to Biomaterials
BME 354 Advanced Biomaterials (*)
BME 371 Biological Microfluidics
BME 381 Nanofabrication in Biomedical Applications (*)
BME 402 Contemporary Biotechnology
BME 404 Essentials of Tissue Engineering (*)
BME 420 Computational Biomechanics
BME 430 Quantitative Physiology
BME 481 Biosensors(*)
CHE 321 Organic Chemistry I
CHE 322 Organic Chemistry II
CHE 327 Organic Chemistry Laboratory

Alternative courses:
BIO 310 Cell Biology
BIO 311 Techniques in Molecular and Cellular Biology
BIO 320 General Genetics
BIO 325 Animal Development
BIO 328 Mammalian Physiology
BIO 361 Biochemistry I
BIO 362 Biochemistry II
BIO 365 Biochemistry Laboratory
BME 312 LabVIEW Programming in Engineering (*)
BME 313 Bioinstrumentation (*)
CHE 312 Physical Chemistry
CHE 346 Biomolecular Structure and Reactivity
CHE 353 Chemical Thermodynamics
EBH 302 Human Genetics
ESG 332 Materials Science I
ESM 353 Biomaterials: Manufacture, Properties and Applications
ESM 369 Polymer Engineering

Honors Program in Biomedical Engineering

The purpose of the honors program in Biomedical Engineering is to give high achieving students an opportunity to receive validation for a meaningful research experience and for a distinguished academic career. A student interested in becoming a candidate for the honors program in Biomedical Engineering may apply to the program at the end of the sophomore year. To be admitted to the honors program, students need a minimum cumulative grade point average of 3.50 and a B or better in all major required courses (including math and physics). Transfer students who enter Stony Brook University in the junior year need a minimum cumulative grade point average of 3.50 and a B or better in all required major courses (including math and physics) in their first semester at Stony Brook University.

Graduation with departmental honors in Biomedical Engineering requires the following:

1. A cumulative grade point average of 3.50 or higher and a B or better in all major required courses (including math and physics) upon graduation.
2. Completion of BME 494, a 1 credit seminar on research techniques, with a B or better during the junior year.

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3. Completion of BME 495, a 3-credit honors research project, with a B or better.
4. Presentation of an honors thesis (written in the format of an engineering technical paper) under the supervision of a BME faculty member. The thesis must be presented to and approved by a committee of two faculty members including the student’s advisor.

For students who qualify, this honor is indicated on their diploma and on their permanent academic record.

BE/MS Degree

BME undergraduate students may be eligible to enroll in the BE/MS degree starting in their senior year and pursue a Bachelor’s Degree along with a MS in Biomedical Engineering. Important features of this accelerated degree program are that students must apply to the program through the BME Graduate Program Director during their junior year.

**Sample Course Sequence for the Major in Biomedical Engineering**

A course planning guide for this major may be found here. The major course planning guides are not part of the official Undergraduate Bulletin, and are only updated periodically for use as an advising tool. The Undergraduate Bulletin supersedes any errors or omissions in the major course planning guides.

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*Note: This course partially satisfies the following: ESI, CER, SPK, WRTD, SBS+, STEM+, EXP+. For more information contact the CEAS Undergraduate Student Office.
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 contemporary 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 or BNG minor or departmental consent
SBC: SNW, TECH
3 credits

BME 120: Programming Fundamentals
in Biomedical Engineering
This course will introduce the theory and fundamentals 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 programming language, and therefore MATLAB will be the primary language used to teach the above mentioned programming principles. This course will also serve as the foundation where the students can pursue further advanced programming skills.

Prerequisite: BME Major or BNG Minor
3 credits

BME 200: Bioengineering in Extreme Environments
Technology at the human-engineering interface that enables human life in harsh environments, including high temperatures, high altitude, deep sea and outer space. Emphasis on the technical design requirements of the bio-engineering interface that will enable life to thrive. Physiological limits to survival will be examined within the context of when the bio-engineering technology is required. This course may not be taken for major credit.

SBC: SNW, TECH
3 credits

BME 205: Clinical Challenges of the 21st Century
Technology used by current medical practice, focusing on weekly topics associated with a specific disease state. Technology used to diagnose and treat these disease states will be rigorously examined. Weekly topics will include: cancer, cardiovascular disease, Alzheimer's, obesity, diabetes, osteoporosis, osteoarthritis, and organ transplant. Key disease states will be presented in physiological and cellular depth. This course may not be taken for major credit.

SBC: SNW, TECH
3 credits

BME 212: Biomedical Engineering Research Fundamentals
Introduction to data collection and analysis in the context of biophysical measurements commonly used by bioengineers. Statistical measures, hypothesis testing, linear regression, and analysis of variance are introduced in an application-oriented manner. Data collection methods using various instruments, A/D boards, and PCs as well as LabView, a powerful data collection computer package. Not for credit in addition to the discontinued BME 309. This course has an associated fee. Please see www.stonybrook.edu/coursefees for more information.

Prerequisites: BME major; BME 100
Pre- or Corequisite: BIO 202 or 203
3 credits

BME 260: Statics and Dynamics in Biological Systems
Fundamentals of engineering statics and dynamics on biological systems will be covered using vector methods. Covered topics will include free body diagrams, equilibrium of systems, rectilinear kinetics and kinematics, angular kinetics and kinematics, work, energy and momentum of biological systems. In parallel, the necessary anatomy and physiology of the organ systems including the musculoskeletal system, the nervous system and the cardiovascular system will be covered. This material will lead to a discussion on kinesiology.

Prerequisites: BME 100; AMS 161; PHY 125 or 131 or 141
3 credits

BME 271: Introduction to Bio-electricity and Bio-photons
An introductory course to two key areas of the modern biomedical engineering discipline: bioelectricity and bio-photons. The first part of the class begins with fundamental theory of circuit analysis, including lumped time-invariant models of resistors, capacitors, inductors, Ohm's Law, Kirchoff's Laws, nodal and mesh analysis for electric circuits, two-port equivalent circuits, steady-state AC circuits, phasor and transient analysis using Laplace Transform. The applications of basic circuit analysis techniques in biological circuitry will be discussed throughout the first part of the class. In the second part of the course, the principles of cell electrophysiology, bio-potentials and electrical interactions with tissue will be studied. Finally, the third part of the course will cover ray optics, including reflection, refraction, lenses and image formation, and wave optics for introduction to bio-photons. Not for credit in addition to ESE 271.

Prerequisites: AMS 161 or MAT 127 or 132 or 142 or 171; PHY 127/134 or PHY 132/134 or PHY 142
4 credits

BME 300: Writing in Biomedical Engineering
See Requirements for the Major in Biomedical Engineering, Upper-Division Writing Requirement.

Prerequisites: WRT 102; U3 or U4 standing; BME major
Corequisite: Any upper division BME course; perm. of instructor or Undergraduate Director
0 credit, S/U grading

BME 301: Biophotonics
Introduction to basic concepts of optics and optical applications in biomedical research. Physical optics, ray and wave optics, image formation, Fourier optics and holography, basic electromagnetic optics, optical microscopy, optical force are introduced in an application-oriented manner. Quantitative methods and data analysis are used in the course.

Prerequisites: BME 120; BME 271 or ESE 271; BIO 202
Pre or Corequisite: BME 212
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
This course will cover the fundamentals of modern imaging technologies, including techniques and applications within medicine and biomedical research. The course will also introduce concepts in molecular imaging with the emphasis on the relations between imaging 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.

Prerequisite: BME 212

3 credits

BME 312: LabVIEW Programming in Engineering

LabVIEW is the leading software development platform that enables engineers and scientists to create and deploy powerful measurement and control applications and prototypes with minimal time. This course will systematically teach LabVIEW programming with the focus on the data flow model. The highlighted course topics are basic programming logics, graphic user interface design and parallel programming. It will also teach hardware integration using LabVIEW built-in functions for data acquisition, instrument control, measurement analysis and data presentation.

Hands-on projects and demonstrations will be implemented throughout the course to enhance the knowledge learned in classroom. At the end of the course, students will be offered the free exam for Certified LabVIEW Associated Developer provided by National Instruments for future career development.

3 credits

BME 313: Bioinstrumentation

Basic concepts of biomedical instrumentation and medical devices with a focus on the virtual instrumentation in biomedical engineering using the latest computer technology. Topics include basic sensors in biomedical engineering, biological signal measurement, conditioning, digitizing, and analysis. Advanced applications of LabVIEW, a graphics programming tool for virtual instrumentation. Helps students develop skills to build virtual instrumentation for laboratory research and prototyping medical devices. This course has an associated fee. Please see www.stonybrook.edu/coursefees for more information.

Prerequisite: BME 212

Pre- or Corequisite: BME 271 or ESE 271

3 credits

BME 353: Advanced Biomaterials

This course is an overview of the applications of biomaterials. Here the emphasis is on the unique challenges in the design, fabrication, and evaluation of biomaterials for a particular application/field. Since biomaterials applications entail their direct or indirect contact with humans, the various practical aspects associated with biomaterials such as sterilization, packaging, evaluating device failures as well as regulatory guidelines will be covered.

Prerequisite: BME 353 or ESM 353

3 credits

BME 354: Advanced Microfluidics

This one semester course will outline theory and applications of special fluid handling conditions associated with living systems. Microfluids will be examined with respect to aquaporin channels (single file molecular water movement), intercellular fluid transport mechanisms, microvascular convective fluid movement (2 phase flow), and transvascular fluid movement (3 pore theory) with reference to the similarity of each to flow in fabricated microchannels.

Prerequisite: BME 305

3 credits

BME 381: Nanofabrication in Biomedical Applications

Theory and applications of nanofabrication. Reviews aspects of nanomachines in nature with special attention to the role of self-lubrication, intracellular or interstitial viscosity, and protein-guided adhesion. Discusses current nanofabricated machines to perform 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 402: Contemporary Biotechnology
This course will provide an introduction into the realm of modern biotechnology and its applications. This course introduces the historical development of biotechnology and its contemporary applications, including, bioproducts and biofuels, microbial fermentation/bioprocessing, aerobic bioreactors, modeling and simulation, metabolism and enzyme kinetics, metabolic engineering, bioremediation and environmental sustainability and human medicine. Further, societal issues involving ethical and moral implications, perceptions and fears, intellectual property, safety, risks and regulatory issues, as well as economics of biotechnology will be discussed.
Prerequisite: BME 304
3 credits

BME 404: Essentials of Tissue Engineering
Topics covered are: developmental biology (nature's tissue engineering), mechanisms of cel-cell and cell-matrix interactions, biomaterial formulation, characterization 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
Advisory Prerequisites: CHE 321 and 322
3 credits

BME 420: Computational Biomechanics
Introduces the concepts of skeletal biology; mechanics of bone, ligament, and tendon; and linear and nonlinear 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
3 credits

BME 430: Quantitative Human Physiology
This course will provide an introduction to the study of quantitative physiology. This course will introduce the physical, chemical and mathematical foundation of physiology. That knowledge will then be applied to membranes, transport, metabolisms, excitable cells and various organ systems.
Prerequisites: BIO 202 and AMS 261 or MAT 203 or MAT 205

BME 440: Biomedical Engineering Design
Introduction to product development from the perspective of solving biomedical, biotechnological, environmental, and ergonomic problems incorporating appropriate engineering standards and multiple realistic constraints. 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 multiple realistic constraints in which the product designed should function in terms of the settings (corporal, ex-corporal, biological, etc.), the engineering standards, 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. This course has an associated fee. Please see www.stonybrook.edu/coursefees for more information.
Prerequisite: BME 440
3 credits

BME 444: Experiential Learning
This course is designed for students who engage in a substantial, structured experiential learning activity in conjunction with another class. Experiential learning occurs when knowledge acquired through formal learning and past experience are applied to a "real-world" setting or problem to create new knowledge through a process of reflection, critical analysis, feedback and synthesis. Beyond-the-classroom experiences that knowledge acquired through formal learning and past experience are applied to a "real-world" setting or problem to create new knowledge through a process of reflection, critical analysis, feedback and synthesis. Beyond-the-classroom experiences that support experiential learning may include: service learning, mentored research, field work, or an internship.
Prerequisite: WRT 102 or equivalent; permission of the instructor and approval of the EXP+ contract (http://www.stonybrook.edu/bulletin/current/policiesandregulations/degree_requirements/EXPplus.php)
SBC: EXP+
0 credit, S/U grading

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
SBC: EXP+
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 multiphoton microscopy, and OCT will be referenced.
Prerequisites: BIO 202; BME 271 or 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

SBC:  EXP+
3-6 credits, S/U grading

**BME 494: Honors Seminar on Research**
The course outlines components of biomedical research vs design that includes experimental design, data recording, analysis and presentation at scientific meetings, as well as engineering design schematics, patents, and presentations to angel investors. The course culminates with an Honors Thesis Proposal that follows either a research (hypothesis testing) or design (prototype construction) pathway.

Prerequisite: U3 standing and acceptance into the BME Honors program.

1 credit

**BME 495: Honors Independent Research**
The course involves research (hypothesis testing) or engineering design (prototype construction) that the student completes under the supervision of the faculty member. The course culminates with an Honors Thesis draft (Fall semester) or Honors Thesis that is orally defended (Spring semester). Both BME 494 and BME 495 must be taken to qualify to graduate with Honors in BME.

Prerequisite: BME 494

3 credits

**BME 499: Research in Biomedical Engineering**
An independent research project with faculty supervision.

Prerequisites: Permission of instructor

0-3 credits