Biomedical Engineering (BME)

BME 2000: Professional Development in Engineering
(same as BIOL_EN 2000). A review of professional opportunities, registration, ethics, and societies. Graded on A-F basis only.

Credit Hours: 2
Prerequisites: Sophomore standing

BME 2007: World of Neuroscience
(same as BIOL_EN 2007, CMP_SC 2007, ECE 2007). This in-class course will introduce undergraduates to the growing area of neuroscience from the perspectives of three disciplines: engineering, biology and psychology. Topics in the course will span multiple levels of neuroscience including genomic, genetic, molecular, cellular, systems, behavioral and clinical levels. Due to the interdisciplinary nature of the neuroscience, the classes will cover diverse topics. The topics will range from overviews of the key neurobiology areas, to lab sessions involving how to analyze your own brain signals (EEG), and to visits to brain imaging center and EEG lab. The overall goal is to provide a broad exposure to the fascinating world of interdisciplinary neuroscience. Graded on A-F basis.

Credit Hour: 1

BME 2080: Introduction to Programming for Engineers
(same as BIOL_EN 2080). This course teaches how to write scientific programs for analysis of data and simulation of physical phenomena using MATLAB. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: MATH 1500

BME 2180: Engineering Analysis of Bioprocesses
(same as BIOL_EN 2180). Material and Energy Balances. Integrating principles of physics, chemistry and mathematics to analyze steady state and transient biological/biomedical processes. Graded on A-F basis only.

Credit Hours: 3
Recommended: MATH 1700, CHEM 1320, PHYSCS 2750

BME 3070: Biological Fluid Mechanics
(same as BIOL_EN 3070). Basic principles of fluid mechanics applied to transport processes in biological systems. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: PHYSCS 2750 and MATH 1700

BME 3075: Introduction to Materials Engineering
(same as BIOL_EN 3075,CH_ENG 3075). Course covers concepts and techniques in materials engineering from an engineering design perspective, materials requirements for design, and fundamentals; intended for undergraduate engineering students. Graded on A-F basis only.

Credit Hours: 3
Prerequisites or Corequisites: One of the following BIOL_EN 3180, CH_ENG 3234, MAE 4231, MAE 4300, or instructor consent
Prerequisites: MATH 2300, ENGINR 1200, ENGINR 2200, or instructor's consent

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BME 3170: Biomaterials
(same as BIOL_EN 3170). Engineering sciences and design will be leverage for the study and design of biomaterials. Understanding the structure-property relationship between biomaterials and tissue will be addressed for implant design. Graded on A-F basis only.

Credit Hours: 3
Prerequisites or Corequisites: BIOL_EN 2180, ENGINR 2200, or instructor's consent
Prerequisites: BIOL_EN 3075 or BME 3075

BME 3170W: Biomaterials - Writing Intensive
(same as BIOL_EN 3170W). Engineering sciences and design will be leverage for the study and design of biomaterials. Understanding the structure-property relationship between biomaterials and tissue will be addressed for implant design. Graded on A-F basis only.

Credit Hours: 3
Prerequisites or Corequisites: BIOL_EN 2180, ENGINR 2200, or instructor's consent
Prerequisites: BIOL_EN 3075 or BME 3075

BME 3180: Heat and Mass Transfer in Biological Systems
(same as BIOL_EN 3180). Principles of heat and mass transfer and their applications in biomedical, bioenvironmental, and bioprocessing engineering. Graded on A-F basis only.

Credit Hours: 3
Prerequisites or Corequisites: ENGINR 2300 or CH_ENG 3261
Prerequisites: BIOL_EN 2180 or CH_ENG 2225

BME 4001: Topics in Biomedical Engineering
Current and new technical developments in biomedical engineering.

Credit Hour: 3-9

BME 4002: Scientific Discovery Leading to Life Science Innovations
The overarching goal of this course is to introduce the concept of biomedical innovation and the pathways to succeed in drug or device product development. The importance of identifying appropriate unmet clinical needs, understanding stake holder perspectives, recording and protecting their ideas, and the commercialization potential of a product will be explained. The recent, innovation-based, life science research that is carried out in academic institutions, as well as the pathways involved in translating those fundamental discoveries into products and services that affect healthcare, will be explained. We will provide an outline about drug-discovery, device development, intellectual property protection, conflict of interests, ethical perspectives, and regulatory issues, as well as the transitions from initial discovery concepts to product development. An introduction to essential disciplines and interactions that enable scientific discoveries to move forward into novel drug and device development will be provided. Graded on A-F basis only.

Credit Hours: 3

BME 4003: Design and Development of Biomedical Innovation
The overarching goal of this course is to help participants understand the design and development (drug or device) process in biomedical

innovation. This course will help participants to understand the process of choosing unmet clinical needs, articulate a need statement without integrating solution, design and develop a solution. Participants will learn to assess the commercial potential of clinical needs by performing market analysis and valuing customer needs. A conceptual understanding about development of a prototype for a device and also drug development by different brainstorming process will be provided. Details of regulatory, reimbursement, patenting process required for product development will be explained with examples. An overview about how to evaluate preliminary designs, define product specifications, comply with manufacturing principles and methods, costs, cGMP requirements will be explained. Quality control and Quality assurance necessities for drug/device will be elucidated with case studies. Participants will gain knowledge about different business models for drug and devices, estimate market penetration and how to make profitable, patient-driven products. Graded on A-F basis only.

Credit Hours: 3

BME 4004: Regulatory Issues in Clinical Trials
The overarching goal of this course is to help participants understand the essentials of compliance issues as it is related to conducting clinical trials using drugs and devices that have been or yet to be approved by FDA. This course will also help biomedical innovators recognize the importance of Human Subject Protection (HSP) and abide by the FDA regulations to conduct clinical trials with the new drugs/devices that are being designed to advance patient-care. The course will describe regulatory standpoints for human subject protection, how to obtain approvals and develop clinical protocols for conducting clinical trials. An overview about clinical epidemiology, biostatistics and data management and analysis will be provided. Graded on A-F basis only.

Credit Hours: 3

BME 4075: Brain Signals and Brain Machine Interfaces
(same as BIOL_EN 4075; cross-leveled with BIOL_EN 7075). The course introduces state-of-the-art technologies for monitoring and manipulating brain activity, as well as the design principles of modern brain-machine interfaces (BMIs) for interacting with the brain in health and disease. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: BIOL_EN 4070 or instructor's consent

BME 4085: Problems in Biomedical Engineering
Supervised independent study at the undergraduate level.

Credit Hour: 1-5
Prerequisites: instructor's consent

BME 4170: Biomaterials Interfaces of Implantable Devices
(same as BIOL_EN 4170; cross-leveled with BIOL_EN 7170). This course introduces students to implantable devices and tissue engineering and the effects of biocompatibility of the performance of the devices and tissue engineered scaffolds. A number of implantable devices will be studied including VADs (ventricular assist devices), drug delivery systems and tissue engineered constructs/scaffolds. Special emphasis is placed on investigating the techniques to enhance biocompatibility of the devices/scaffolds and integration of host tissue. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: BIOL_EN 3170

BME 4360: Biomanufacturing Technologies
(same as BIOL_EN 4360). This course is an introduction to biomanufacturing technologies and processes for manufacturing biological products (e.g., vaccine, antibodies, and therapeutic proteins). It mainly covers process development, unit operations, product evaluation, facilities, and regulatory compliance. It is an interdisciplinary course of biochemistry, microbiology, and engineering. The purpose of this course is to help the students acquire the knowledge of modern biomanufacturing and prepare them for rapidly growing fields in biomanufacturing. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: BIOL_EN 2180 and BIOL_EN 3180 (for biological engineering students) -or- CH_ENG 2225 and CH_ENG 3234 (for chemical engineering students) -or- Consent of instructor

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BME 4370: Orthopaedic Biomechanics
(same as BIOL_EN 4370; cross-leveled with BIOL_EN 7370). Engineering sciences will be leveraged to create a comprehensive study of orthopaedic biomechanics. The tissue mechanics of bone and soft tissue will be studied along with applying structural analysis of the musculoskeletal system. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: BIOL_EN 3170, ENGINR 1200, or instructor's consent

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BME 4380: Applied Electronic Instrumentation
(same as BIOL_EN 4380; cross-leveled with BIOL_EN 7380). Fundamental concepts and theories, basic electronics, analog and digital circuits, signal conditioning, computer interfacing, measurement principles and techniques used in developing computer-based instrumentation systems. Graded on A-F basis only.

Credit Hours: 4
Prerequisites: PHYSCS 2750

BME 4420: Introduction to Biomedical Imaging
(same as BIOL_EN 4420, PHYSCS 4420; cross-leveled with BIOL_EN 7420, PHYSCS 7420). This course offers a broad introduction to medical imaging. Topics to be covered include the physics basics and instrumentation of X-ray CT, PET , SPECT, ultrasound, MRI and Optical Imaging, as well as recent developments in biomedical imaging.

Credit Hours: 3
Prerequisites: PHYSCS 2760

BME 4470: Biomolecular Engineering and Nanbiotechnology
(same as BIOL_EN 4470; cross-leveled with BIOL_EN 7470). Generation of biotechnological products, devices through integration of engineering approaches with contemporary biology, chemistry and nanotechnology starting at the molecular level. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: MATH 1700, PHYSCS 2760, CHEM 2100
Recommended: Senior/graduate standing or instructor's consent

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BME 4470H: Biomolecular Engineering and Nanobiotechnology - Honors
(same as BIOL_EN 4470H; cross-leveled with BIOL_EN 7470). Generation of biotechnological products, devices through integration of engineering approaches with contemporary biology, chemistry and nanotechnology starting at the molecular level. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: MATH 1700, PHYSCS 2760, CHEM 2100. Honors eligibility required
Recommended: Senior/graduate standing or instructor's consent

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BME 4480: Physics and Chemistry of Materials
(same as BIOL_EN 4480, PHYSCS 4190, NU_ENG 4319, CHEM 4490; cross-leveled with BIOL_EN 7480, PHYSCS 7190, CHEM 7490, NU_ENG 7319). Physics and Chemistry of Materials is a 3 credit hours course offered every spring semester for students from Physics, Chemistry, Engineering and Medical Departments and consists of lectures, laboratory demonstrations, two mid-term and one final exam. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: PHYSCS 2750, CHEM 1320 or equivalent, or instructor's consent

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BME 4540: Neural Models and Machine Learning
(same as ECE 4540, CMP_SC 4540, BIOL_EN 4540; cross-leveled with ECE 7540, BIOL_EN 7540, CMP_SC 7540). The projects-based course has three inter-linked components: (I) math models of neurons and neural networks, (II) machine learning in neuroscience, after a brief introduction to python and (III) software automation and cyberinfrastructure to support neuroscience. Extensive projects focusing on software automation and machine learning components, with brief in-class presentations. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: MATH 1500 or consent of instructor
Recommended: Introductory software programming, and introductory cell biology or consent of instructor

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BME 4570: Fluorescent Imaging
(same as BIOL_EN 4570; cross-leveled with BIOL_EN 7570). Principles and applications of the modern technology of fluorescent imaging. The course covers image formation in microscope; Fundamentals of fluorescence and fluorescent microscopy; Fluorescent probe and applications of molecular and cellular fluorescent imaging in life science research. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: BIO_SC 1500, BIO_SC 2180

BME 4590: Computational Neuroscience
(same as BIOL_EN 4590, BIO_SC 4590, ECE 4590; cross-leveled with BIOL_EN 7590, BIO_SC 7590, ECE 7590). An interdisciplinary course with a strong foundation in quantitative science for students in biological-behavioral sciences. Graded on A-F basis only.

Credit Hours: 4
Prerequisites: BIO_SC 1010, BIO_SC 1500; MATH 1500

BME 4770: Biomedical Optics
(same as BIOL_EN 4770; cross-leveled with BIOL_EN 7770). Essential concepts and methods for applying optical techniques to biomedical diagnosis and therapy will be covered with major application examples being discussed.

Credit Hours: 3
Prerequisites: PHYSCS 2760
Recommended: BIOL_EN 3180

BME 4940: Engineering Internship
(same as BIOL_EN 4940). Problem course following prior approved work experience. Problem selected by internship company representative, faculty problem adviser and student. Supervised by faculty problem advisor and presented in engineering report form. Graded on S/U basis only.

Credit Hour: 1-3
Prerequisites: advisor's consent

BME 4970: Nuclear Magnetic Resonance and Magnetic Resonance Imaging
(same as BIOL_EN 4970). Nuclear Magnetic Resonance (NMR) is one of the most powerful methods of investigating the structure, composition, and dynamics of atoms and molecules. It is now ubiquitous in chemistry and engineering labs, and has blossomed into one of the most successful medical imaging modalities - Magnetic Resonance Imaging (MRI). This course is an in-depth examination of the relevant physical principles behind this technology: basic spin physics, spectrometer design and implementation, what it can be used to measure, and how it is currently being used in laboratory and clinical settings. In particular, students will gain a working knowledge of basic nuclear physics, spin precession, T1 and T2 weighting mechanisms, the pulse/acquire NMR experiment, the influence of magnetic field gradients, Fourier theory and k-space, imaging principles, and the many pulse sequences currently employed in NMR/MRI research labs around the world.

Credit Hours: 3
Prerequisites: Senior Standing or instructor consent

BME 4980: Biomedical Engineering Design
(same as BIOL_EN 4980). Capstone design course for the biomedical engineering major. Design of biomedical devices or processes. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: ENGINR 1100 or MAE 1100, and ENGINR 2200, and BIOL_EN 3180 or BME 3180, or instructor's consent
Corequisites: BIOL_EN 4380 or BME 4380

BME 4980W: Biomedical Engineering Design - Writing Intensive
(same as BIOL_EN 4980W). Capstone design course for the biomedical engineering major. Design of biomedical devices or processes. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: ENGINR 1100 or MAE 1100, and ENGINR 2200, and BIOL_EN 3180 or BME 3180, or instructor's consent
Corequisites: BIOL_EN 4380 or BME 4380

BME 4985: Bioengineering Design II
(same as BIOL_EN 4985). This course is intended to serve as the second term of our capstone, or senior design experience, for the Bachelor of Science in Biological Engineering or Biomedical Engineering degree programs. During this term, students will be expected to continue the design project begun by their team in the fall semester, carrying it through to prototyping, testing, and redesign. Students will continue their project under the advisement of the same faculty mentor and industrial cooperator who led their first term capstone experience. Graded on A-F basis only.

Credit Hour: 1-5
Prerequisites: BIOL_EN 4980 or BME 4980

BME 4990: Undergraduate Research in Biomedical Engineering
Supervised independent study at the undergraduate level. Graded on A-F basis only.

Credit Hour: 1-6
Prerequisites: Department consent

BME 4995H: Undergraduate Honors Research in Biomedical Engineering
(same as BIOL_EN 4995H). Open only to honor students in Biological Engineering and Biomedical Engineering. Independent investigation in biological engineering to be presented as a thesis.

Credit Hour: 1-5
Prerequisites: Instructor consent, Honors eligibility required

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