BME - Biomedical Engineering

BIOMEDICAL ENGINEERING Courses

BME 403. Introduction to Mathematical Modeling in Physiology. 3 Credits.
This course introduces model development and model formulation with differential equations in physiology. Students will learn how to use Matlab to solve differential equations and visualize their results. The physiological focus will be on cellular physiology, particularly ion channel dynamics and homeostasis. Prerequisites: BIOL 240 or BIOL 250 and MATH 200 or MATH 205 or MATH 211.

BME 404. Introduction to Biomaterials. 3 Credits.
This course will introduce the properties of biomedical materials used as implants, prostheses, orthosis, and tissue-engineered materials as medical devices in contact with tissues and organs. Biocompatibility, immunological responses, wound healing, clotting cascade, surface compatibility and characterization of materials used for implantable medical devices will be introduced. Other topics such as ethical considerations and medical device regulatory mechanisms will be presented. Prerequisites: BIOL 240 or BIOL 250 and MATH 200 or MATH 205 or MATH 211.

BME 406. Transport Phenomena in Biomedical Systems. 3 Credits.
The course focuses on basic principles of mass transport and biochemical reactions in biological systems. Topics include phase and reaction equilibrium, conservation relations, physiological transport in tissue-organ systems, transport of gases between blood and tissue, and designing of bioreactors and devices for biomedical engineering applications. Prerequisites: BIOL 240 or BIOL 250 and MATH 200 or MATH 205 or MATH 211.

BME 454/554. Introduction to Bioelectrics. 3 Credits.
This course covers the electrical properties of cells and tissues as well as the use of electrical and magnetic signals and stimuli in the diagnosis and treatment of disease. Typical topics to be covered include basic cell physiology, endogenous electric fields in the body, electrocardiography, cardiac pacing defibrillation, electrotherapy, electroporation, electrotherapy in wound healing. In addition ultra-short electrical pulses for intracellular manipulation and the application of plasmas to biological systems will be covered. Prerequisites: PHYS 111N or higher and MATH 200 or higher.

BME 462/562. Introduction to Medical Image Analysis. 3 Credits.
Introduction to basic concepts in medical image analysis. Medical image registration, segmentation, feature extraction, and classification are discussed. Basic psychophysics, fundamental ROC analysis and FROC methodologies are covered. Cross-listed with ECE 462/MSIM 462. Prerequisites: a grade of C or better in MATH 212.

BME 464/564. Biomedical Applications of Low Temperature Plasmas. 3 Credits.
This course is cross listed between ECE and Biology. It is designed to be taken by senior undergraduate students and first year graduate students. The course contents are multidisciplinary, combining materials from engineering and the biological sciences. The course covers an introduction to the fundamentals of non-equilibrium plasmas, low temperature plasma sources, and cell biology. This is followed by a detailed discussion of the interaction of low temperature plasma with biological cells, both prokaryotes and eukaryotes. Potential applications in medicine such as wound healing, blood coagulation, sterilization, and the killing of various types of cancer cells will be covered. Prerequisites: Senior standing.

BME 612. Digital Signal Processing I. 3 Credits.
This course will present the fundamentals of digital signal processing. Topics will include frequency domain analysis of discrete-time linear systems, sampling and reconstruction of signals, the Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT), and digital filter design and implementations. Practical applications and examples will be discussed. Problem solving using MATLAB is required. Cross-listed with ECE 612. Prerequisite: ECE 381 or equivalent.

BME 630. Advanced Bioelectrics. 3 Credits.
A one-semester course covering advanced topics in bioelectrics. The course will cover advanced applications of pulsed power and plasma in the medical, biological and environmental fields. (Cross listed with ENGN 630.)

BME 695. Topics in Biomedical Engineering. 3 Credits.
This course will be offered as needed, depending upon the need to introduce special subjects to target specific areas of master’s-level specializations in biomedical engineering.

BME 699. Master’s Thesis. 1-9 Credits.
Directed research for the master’s thesis. Prerequisite: departmental approval.

BME 720. Modern Biomedical Instrumentation. 3 Credits.
This course covers the design of modern biomedical instruments including select diagnostic, assistive, therapeutic, prosthetic, imaging, and virtual devices and systems. Techniques for mechanical, electrical, and chemical sensor and transducer design; stimulation and measurement; data acquisition; digital signal processing; and data visualization will be examined.

BME 721. Mathematical Modeling in Physiology. 3 Credits.
This course on mathematical modeling in human physiology emphasizes the development of mathematical models, their implementation, and the interpretation of simulation data. The course focuses on cellular physiology, including membrane channels, excitability, and calcium dynamics; it also covers intercellular communication and spatially distributed systems.

BME 724. Neural Engineering. 3 Credits.
This course presents engineering techniques for the restoration and augmentation of human function via direct interactions between the nervous system and artificial devices, with particular emphasis on brain-computer interfaces. Novel interfaces, hardware and computational issues, and practical and ethical considerations will also be covered.

BME 726. Biomaterials. 3 Credits.
This course covers fundamental principles and properties of biomedical materials used as implants, prostheses, orthosis, and tissue-engineered materials as medical devices in contact with tissues and organs. Advanced concepts of biocompatibility and material characterization will be discussed. Physiological response factors associated with materials and implanted devices used in the human body will be presented, including immunological responses, wound healing, clotting cascade and surface compatibility. Other topics such as ethical considerations and medical device regulatory mechanisms will be discussed.
BME 727. Advanced Transport Phenomena in Biomedical Systems. 3 Credits.
The course focuses on fundamental principles of mass transport and biochemical reactions applied to the study of metabolic and physiological systems, drug delivery, hemodialysis, blood oxygenators, immobilized enzyme reactors and bioartificial organs.

BME 751. Computational and Statistical Methods in Biomedical Engineering. 3 Credits.
This course covers the theoretical foundation and application of commonly used techniques in biomedical engineering. Topics include linear algebra, partial differential equations, regression analysis, applied probabilities, multivariate distributions, Bayesian statistics, hypothesis tests, multiple comparisons, ANOVA, solution of non-linear equations, numerical methods and optimization. Programming software will be used to perform simulations and analyze biomedical data. Prerequisites: Graduate status.

BME 755. Biomembranes and Ion Channels. 3 Credits.
This course will give an overview of the structure and dynamics of biomembranes, the ion channels that are embedded in them, and the electrical properties of biomembranes. Topics include molecular dynamics modeling of biomembranes, membrane damage and repair, ion channel dynamics and their experimental assessment using patch clamping, and excitability in neurons and cardiomyocytes. Prerequisite: ECE 454 or ECE 554 or BIOL 523.

BME 762. Applied Medical Image Analysis. 3 Credits.
Course explores hands-on exposure to state-of-the-art algorithms in medical image analysis, which builds on open-source software (Insight Segmentation and Registration Toolkit - ITK), as well as the principles of medical image acquisition in the modalities of clinical interest. Medical imaging modalities - X-rays, CT, and MR/ITK image pipeline; image enhancement, feature detection; segmentation - basic techniques, feature-based classification and clustering, graph cuts, active contour and surface models; surface and volume meshing; registration - transformations, similarity criteria; shape and appearance models are all explored and discussed in this course. Prerequisites: Knowledge of C++ and object-oriented programming.

BME 783. Digital Image Processing. 3 Credits.
Principles and techniques of two-dimensional processing of images. Concepts of scale and spatial frequency. Image filtering in spatial and transform domains. Applications include image enhancement and restoration, image compressing, biomedical imaging for diagnosis of disease, and image segmentation for computer vision. Prerequisites: ECE 782 or ECE 882.

BME 795. Special Topics in Biomedical Engineering. 1-3 Credits.
Special courses covering selected graduate-level topics in biomedical engineering.

BME 797. Independent Study. 1-3 Credits.
This course allows students to develop specialized expertise by independent study (supervised by a faculty member). Prerequisites: departmental approval.

BME 820. Modern Biomedical Instrumentation. 3 Credits.
This course covers the design of modern biomedical instruments including select diagnostic, assistive, therapeutic, prosthetic, imaging, and virtual devices and systems. Techniques for mechanical, electrical, and chemical sensor and transducer design; stimulation and measurement; data acquisition; digital signal processing; and data visualization will be examined.

BME 821. Mathematical Modeling in Physiology. 3 Credits.
This course on mathematical modeling in human physiology emphasizes the development of mathematical models, their implementation, and the interpretation of simulation data. The course focuses on cellular physiology, including membrane channels, excitability, and calcium dynamics; it also covers intercellular communication and spatially distributed systems.

BME 824. Neural Engineering. 3 Credits.
This course presents engineering techniques for the restoration and augmentation of human function via direct interactions between the nervous system and artificial devices, with particular emphasis on brain-computer interfaces. Novel interfaces, hardware and computational issues, and practical and ethical considerations will also be covered.

BME 826. Biomaterials. 3 Credits.
This course covers fundamental principles and properties of biomedical materials used as implants, prostheses, orthosis, and tissue-engineered materials as medical devices in contact with tissues and organs. Advanced concepts of biocompatibility and material characterization will be discussed. Physiological response factors associated with materials and implanted devices used in the human body will be presented, including immunological responses, wound healing, clotting cascade and surface compatibility. Other topics such as ethical considerations and medical device regulatory mechanisms will be discussed.

BME 827. Advanced Transport Phenomena in Biomedical Systems. 3 Credits.
The course focuses on fundamental principles of mass transport and biochemical reactions applied to the study metabolic and physiological systems, drug delivery, hemodialysis, blood oxygenators, immobilized enzyme reactors and bioartificial organs.

BME 851. Computational and Statistical Methods in Biomedical Engineering. 3 Credits.
This course covers the theoretical foundation and application of commonly used techniques in biomedical engineering. Topics include linear algebra, partial differential equations, regression analysis, applied probabilities, multivariate distributions, Bayesian statistics, hypothesis tests, multiple comparisons, ANOVA, solution of non-linear equations, numerical methods and optimization. Programming software will be used to perform simulations and analyze biomedical data. Prerequisites: Graduate status.

BME 855. Biomembranes and Ion Channels. 3 Credits.
This course will give an overview of the structure and dynamics of biomembranes, the ion channels that are embedded in them, and the electrical properties of biomembranes. Topics include molecular dynamics modeling of biomembranes, membrane damage and repair, ion channel dynamics and their experimental assessment using patch clamping, and excitability in neurons and cardiomyocytes. Prerequisite: ECE 454 or ECE 554 or BIOL 523.

BME 858. Applied Medical Image Analysis. 3 Credits.
Course explores hands-on exposure to state-of-the-art algorithms in medical image analysis, which builds on open-source software (Insight Segmentation and Registration Toolkit - ITK), as well as the principles of medical image acquisition in the modalities of clinical interest. Medical imaging modalities - X-rays, CT, and MR/ITK image pipeline; image enhancement, feature detection; segmentation - basic techniques, feature-based classification and clustering, graph cuts, active contour and surface models; surface and volume meshing; registration - transformations, similarity criteria; shape and appearance models are all explored and discussed in this course. Prerequisites: Knowledge of C++ and object-oriented programming.

BME 883. Digital Image Processing. 3 Credits.
Principles and techniques of two-dimensional processing of images. Concepts of scale and spatial frequency. Image filtering in spatial and transform domains. Applications include image enhancement and restoration, image compressing, biomedical imaging for diagnosis of disease, and image segmentation for computer vision. Prerequisites: ECE 783 and ECE 883.

BME 885. Biomembranes and Ion Channels. 3 Credits.
This course will give an overview of the structure and dynamics of biomembranes, the ion channels that are embedded in them, and the electrical properties of biomembranes. Topics include molecular dynamics modeling of biomembranes, membrane damage and repair, ion channel dynamics and their experimental assessment using patch clamping, and excitability in neurons and cardiomyocytes. Prerequisite: ECE 454 or ECE 554 or BIOL 523.

BME 886. Applied Medical Image Analysis. 3 Credits.
Course explores hands-on exposure to state-of-the-art algorithms in medical image analysis, which builds on open-source software (Insight Segmentation and Registration Toolkit - ITK), as well as the principles of medical image acquisition in the modalities of clinical interest. Medical imaging modalities - X-rays, CT, and MR/ITK image pipeline; image enhancement, feature detection; segmentation - basic techniques, feature-based classification and clustering, graph cuts, active contour and surface models; surface and volume meshing; registration - transformations, similarity criteria; shape and appearance models are all explored and discussed in this course. Prerequisites: Knowledge of C++ and object-oriented programming.

BME 888. Modern Biomedical Instrumentation. 3 Credits.
This course covers the design of modern biomedical instruments including select diagnostic, assistive, therapeutic, prosthetic, imaging, and virtual devices and systems. Techniques for mechanical, electrical, and chemical sensor and transducer design; stimulation and measurement; data acquisition; digital signal processing; and data visualization will be examined.

BME 895. Special Topics in Biomedical Engineering. 1-3 Credits.
Special courses covering selected graduate-level topics in biomedical engineering.

BME 897. Independent Study. 1-3 Credits.
This course allows students to develop specialized expertise by independent study (supervised by a faculty member). Prerequisites: departmental approval.

BME 899. PHD Dissertation Research. 1-9 Credits.
Directed research for the doctoral dissertation.
BME 999. Doctoral Graduate Credit. 1 Credit.
This course is a pass/fail course doctoral students may take to maintain active status after successfully passing the candidacy examination. All doctoral students are required to be registered for at least one graduate credit hour every semester until their graduation.