BIOMEDICAL ENGINEERING

OVERVIEW

Mission
The mission of the Department of Biomedical Engineering is to motivate and inspire students by providing high-caliber, fully integrated programs to prepare them to lead and participate in advancing the state of the art in health care technologies. In addition, graduates earn advanced degrees and further knowledge in the discipline by actively pursuing scholarly research for publication and dissemination.

Biomedical Engineering Program Educational Objectives
The biomedical engineering program prepares graduates who achieve employment in biomedical and related industry, government, or organizational fields using skills and knowledge learned while an undergraduate student as evidenced by:

• Employment history and/or career advancement
• Professional visibility (e.g., patents, invention disclosures, honors or awards, refereed journal articles, conference papers and other publications, involvement in professional associations)
• Entrepreneurial activities

Student Outcomes
The Department of Biomedical Engineering aims to produce graduates who have the ability to:

• Apply knowledge of mathematics, science, and engineering
• Design and conduct experiments, as well as to analyze and interpret data
• 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
• Function on multidisciplinary teams
• Identify, formulate, and solve engineering problems
• Understand professional and ethical responsibility
• Communicate effectively
• Understand the impact of engineering solutions in a global, economic environment
• Engage in life-long learning necessary to thrive in the profession
• Keep abreast of contemporary issues while maintaining breadth and depth of knowledge
• Use the techniques, skills, and modern engineering tools necessary for engineering practice

UNDERGRADUATE

Bachelor's program
• Bachelor of Science with a major in biomedical engineering (http://bulletin.gwu.edu/engineering-applied-science/biomedical-engineering/bs)

GRADUATE

Master's program
• Master of Science in the field of biomedical engineering (http://bulletin.gwu.edu/engineering-applied-science/biomedical-engineering/ms)

Doctoral program
• Doctor of Philosophy in the field of biomedical engineering (http://bulletin.gwu.edu/engineering-applied-science/biomedical-engineering/phd)

FACULTY

Professors I. Efimov (Chair), M. Kay, Z. Li, M. Loew, J. Zara, V. Zderic

COURSES

Explanation of Course Numbers
• Courses in the 1000s are primarily introductory undergraduate courses
• Those in the 2000-4000s are upper-division undergraduate courses that can also be taken for graduate credit with permission and additional work
• Those in the 6000s and 8000s are for master's, doctoral, and professional-level students
• The 6000s are open to advanced undergraduate students with approval of the instructor and the dean or advising office

BME 1010. Introduction to Biomedical Engineering. 1 Credit.
Basic and emerging concepts in electrical, computer, and biomedical engineering. Hands-on experiments and projects. Introduction to the professional literature and available resources and to technical writing, speaking, and presentation skills. (Fall).

BME 1020. Introduction to Biomedical Engineering. 1 Credit.
Continuation of BME 1010. Basic and emerging concepts in electrical, computer, and biomedical engineering. Hands-on experiments and projects. Introduction to the professional literature and available resources and to technical writing, speaking, and presentation skills. (Spring).
BME 2810. Biomedical Engineering Seminar I. 1 Credit.
BME 2810 and BME 2815 are taken in sequence by students in the biomedical engineering major. Overview of the field of biomedical engineering, including biomechanics, bioinformatics, telemedicine, instrumentation, and medical imaging. (Fall).

BME 2815. Biomedical Engineering Seminar II. 1 Credit.
BME 2810 and BME 2815 are taken in sequence by students in the biomedical engineering major. Overview of the field of biomedical engineering, including biomechanics, bioinformatics, telemedicine, instrumentation, and medical imaging. (Fall and spring).

BME 3820. Principles and Practice of Biomedical Engineering. 4 Credits.
Introduction to engineering principles applicable to medicine; medical measurements for clinical use and research; anatomy and physiology of the human body from system and cellular approaches. Principles of biomedical engineering are reinforced by determining and analyzing physiological measurements in laboratory exercises. Prerequisites: ECE 2110 and APSC 2113. (Fall).

BME 3907. Special Topics in Biomechanical Engineering. 3 Credits.
Topics vary by semester. May be repeated for credit if topic differs. See the Schedule of Classes for more details. (Fall, spring, and summer).

BME 3910. Capstone Design Preparation. 1 Credit.
Elements of project design; formulation of project ideas. Prerequisites: BME 2810, BME 2815. (Same as ECE 3910) (Fall).

BME 3915W. Biomedical Engineering Capstone Project Lab I. 1 Credit.
BME 3915, BME 4920, and BME 4925 are taken in sequence by departmental majors beginning in the second semester of the junior year. After an introduction to the formal design process, the student plans, refines, designs, and constructs a one-year project. (Spring).

BME 4825. Biomedical Properties Laboratory. 1 Credit.
Introduction to biophysical concepts in a laboratory setting. Experiments are included from the random walk model of diffusion, macroscopic diffusion processes, optical extinction in tissue, carrier-mediated transport (CMT), spectroscopy, hearing measurement, DNA identification, bioinformatics, and data mining. (Spring).

BME 4830. Introduction to Medical Imaging Methods. 3 Credits.
Common imaging modalities, including ultrasound, X-ray, MRI, CT, SPECT, and PET. Overview of linear systems, basic properties of an imaging system, the physics and instrumentation behind each modality, and their respective advantages, disadvantages, and applications. May be taken for graduate credit. Prerequisites: ECE 3220, BME 3820. (Spring).

BME 4920W. Biomedical Engineering Capstone Project Lab II. 3 Credits.
BME 3915, BME 4920, and BME 4925 are taken in sequence by departmental majors beginning in the second semester of the junior year. After an introduction to the formal design process, the student plans, refines, designs, and constructs a one-year project. (Fall).

BME 4925W. Biomedical Engineering Capstone Project Lab III. 2 Credits.
BME 3915, BME 4920, and BME 4925 are taken in sequence by departmental majors beginning in the second semester of the junior year. After an introduction to the formal design process, the student plans, refines, designs, and constructs a one-year project. (Spring).

BME 4990. Research. 1-3 Credits.
Applied research and experimentation projects, as arranged. Prerequisites: junior or senior status. (Fall and spring).

BME 6045. Special Topics. 1-3 Credits.
Topics to be announced in the Schedule of Classes. (Fall and spring).

BME 6050. Research. 1-12 Credits.
Applied research and experimentation projects, as arranged. May be repeated for credit.

BME 6065. Colloquium. 0 Credits.
Lectures by outstanding authorities in biomedical engineering. Topics to be announced each semester. (Fall and spring).

BME 6482. Medical Measurements. 3 Credits.
Theory of measurements in biological areas and techniques for electronic measurements on biological specimens. Experiments in acquisition, processing, and measurement of physiological signals, ECG, EEG, and EMG. (Fall).

BME 6483. Medical Instrumentation Design. 3 Credits.
The medical device design process and many of its key aspects, including needs assessment, regulatory processes and concerns, intellectual property, patient safety, and market analysis. Prerequisites: BME 6482. (Spring).

BME 6484. Biomedical Signal Analysis. 3 Credits.
Origin, acquisition, and analysis of physiological signals. Deterministic and probabilistic modeling; fitting models; sequences and time series. Feature extraction from EEG and ECG; Fourier analysis and filtering; modeling. Noise and artifact removal and signal compensation. Prerequisites: BME 6482. (Spring).

BME 6485. Medical Imaging I. 3 Credits.
Principles of projection radiography, fluoroscopy, tomography, ultrasound and nuclear sources; biomagnetic imaging. Source and object; recorder resolution and noise; scatter and attenuation. Ultrasound techniques and instrumentation, including physics of ultrasound, transducers, ultrasound imaging, hemodynamics, Doppler techniques. Prerequisite: BME 4830. (Fall).
BME 6486. Clinical Medicine for Engineers. 3 Credits.
Overview of clinical medicine with emphasis on those areas most affected by engineering and technology. Prerequisites: BME 6482. (Spring, even years).

BME 6487. Rehabilitation Medicine Engineering. 3 Credits.
Cross-sectional view of those areas of medicine most involved with the treatment of handicapped individuals. Application of engineering theory and techniques to the rehabilitation of handicapped individuals. Major problem areas and general solutions, solutions to some specific problems. Prerequisites: BME 6482. (Spring, odd years).

BME 6840. Digital Image Processing. 3 Credits.
Properties of images and visual systems. Image acquisition, sampling, quantization. One- and two-dimensional image transform techniques; enhancement and restoration. Image coding and data compression. Segmentation, representation, boundary and shape, texture, matching. Image understanding. Prerequisites: ECE 6800. (Same as ECE 6840) (Spring, odd years).

BME 6842. Image Engineering. 3 Credits.
Sensor/camera design and analysis as a system. Detection and noise processes underlying the sensing of optical radiation; the engineering and physics of image formation. Topics covered include radiometry/photometry, optics and image formation, device and camera characterization, and image quality metrics and system design trades. Prerequisites: ECE 6010, ECE 6015. (Same as ECE 6842) (Fall).

BME 6850. Pattern Recognition. 3 Credits.
Random vectors, transformations. Hypothesis testing, error probability: bias, variance, and sample size, resampling; sequential methods. Bayes, other linear classifiers. Discriminant functions, support vector machines, maximum-likelihood and parameter estimation, dimensionality reduction. Nonparametric methods; unsupervised learning and clustering; feature selection and ordering. Applications in industry and medicine. Student projects. Learning is reinforced by homework problems and in-class and at-home computer examples. Prerequisites: ECE 6015. (Same as ECE 6850) (Fall, spring, and summer).

BME 6885. Computer Vision. 3 Credits.
Image processing; edge detection, segmentation, local features, shape and region description in 2D and 3D. Insights from human vision studies. Representation for vision: object models, synthetic images, matching, gaps, algorithms. Interference, production system, syntactic networks. Planning spatial reasoning for robot vision. Prerequisites: BME 6840 or ECE 6840 or equivalent. (Same as ECE 6855) (Fall, spring, and summer).

BME 6998. Thesis Research. 3 Credits.
Thesis research. (Fall and spring).

BME 6999. Thesis Research. 3 Credits.
Thesis research. (Fall and spring).

BME 8999. Dissertation Research. 0-12 Credits.
Limited to Doctor of Philosophy candidates. May be repeated for credit. (Fall, spring, and summer).