Bioengineering (BIOE)

Course information contained within the Bulletin is accurate at the time of publication in June 2025 but is subject to change. For the most up-to-date course information, please refer to the Course Catalog.

BIOE 5278. Cardiac Devices. 3 Credit Hours.
This course will describe the structure, function and control of the cardiovascular system and its quantitative modeling. We will cover the functional organization of main elements within cardiovascular system including and interfacing systems, such as renal and respiratory systems. We will go through the major electrical signals, neurological and endocrine controls, which regulate function of the cardiovascular systems. Students will learn about pacing signals generated naturally in the heart and synthesized by electronics. Design considerations and indications for use of various devices to directly or indirectly affect heart function.

Repeatability: This course may not be repeated for additional credits.

BIOE 5301. Biosignals. 3 Credit Hours.
This course offers a deep overview of the signals in the Biomedical fields. Signals are studied in several modalities, including time frame, frequency frame, and statistical frame. A deep analysis of filters and analysis tools is included together with some basic techniques of storing and pattern interpretation techniques. Furthermore, the course gives to the student the necessary knowledge to realize a complete Data Acquisition, Analysis and Logging using LabView as a tool. The laboratory activities include the development of a complete system to do acquisition, analysis, report and logging of data incoming from sensors.

Repeatability: This course may not be repeated for additional credits.

BIOE 5311. The Entrepreneurial Bioengineer. 3 Credit Hours.
This course provides a practical overview of all stages of development of medical devices in regenerative medicine, from idea to launch of a company and commercialization of the product into international markets to address unmet medical needs. We will review the initial idea, based on an unmet medical need, review issues of intellectual property creation, determination of target markets, pre-clinical and clinical development, and different regulatory pathways leading to product approval and market introduction. We will discuss issues of company formation, financing and management, as well as target markets and avenues towards revenue generation. Note: Prior to fall 2017, the course title was "Entrepreneurial Studies in Regenerative Medicine - From Idea to Medical Practice".

Repeatability: This course may not be repeated for additional credits.

BIOE 5321. Biosensors. 3 Credit Hours.
This course offers an in-depth overview of several sensors used in the Biomedical Fields. The sensors are analyzed from an engineering point of view going from the physical principles to the necessary filtering and linearization studying the characteristics of output signals. The course also gives the student the necessary basis for Data Acquisition using LabView as a tool. The laboratory activities include the connection of sensors, the study of amplification, linearization and interpretation of data.

Repeatability: This course may not be repeated for additional credits.

BIOE 5333. Applied Biospectroscopy. 3 Credit Hours.
This course introduces the basics of light propagation in tissue and other turbid media, vibrational spectroscopy, absorption and fluorescence, and emerging spectroscopic applications. Emphasis is on applications for assessment of biomolecules, engineered tissues and clinically-relevant analyses including musculoskeletal disease and cancer diagnosis. Multivariate analyses for complex spectral data sets will also be introduced.

Repeatability: This course may not be repeated for additional credits.

BIOE 5421. Capstone Elective: Bionanotechnology. 3 Credit Hours.
This course is intended for graduate students interested in acquiring knowledge involving nanometer-sized objects frequently utilized within the biomedical sciences and engineering areas. The aim of the class is to introduce fundamental concepts critical in the design, preparation, analysis, and usage of bionanotechnology (or nanobiotechnology) and its multiple bottom-up and top-down approaches. Multiple nanomaterials categories, such as nanoparticles, nanotubes, biomacromolecules, synthetic polymers, and self-assembled structures, will be covered in detail along with their applications.

Repeatability: This course may not be repeated for additional credits.

BIOE 5431. Neuroengineering. 3 Credit Hours.
This course will teach students how signals are generated and propagated in neurons and neuronal circuits, and how this knowledge can be utilized to engineer devices to assist people with neurologic disease or injury. The functions of neurons as discrete elements and as parts of neuronal assembles will be examined; generator and action potentials; conduction in nerve fibers and across synaptic junctions; analysis of sensory and neuromuscular systems; EEG and EKG waveforms. At the completion of the course, students will have gained a fundamental understanding of neural interface/prosthetics design parameters from basic neural physiology to models of neural mechanisms. We will also review advanced neural interfaces currently being developed. The course will end with coverage of selected frontiers of neuroscience, including neurogenetic techniques, viral methods, and optogenetics.

Repeatability: This course may not be repeated for additional credits.

BIOE 5441. Biomechanics. 3 Credit Hours.
This course will provide an integrative and multi-scale understanding of biomechanics that spans from tissues, to organs, to the dynamics of an intact, running body. Foundational topics will include muscle mechanics, skeletal mechanics, gait and whole body dynamics. The course will then move on to cover selected topics at the forefront of applied biomechanics including clinical biomechanics and the design and optimization of prosthetic limbs. Finally, frontiers in neural-interfacing for prostheses and rehabilitation, including optogenetics and other emerging areas affecting biomechanics, including robotics and robotic exoskeletons, will be covered.

Repeatability: This course may not be repeated for additional credits.

BIOE 5451. Biomedical Imaging. 3 Credit Hours.
This course focuses on principles of diagnostic radiological imaging physics, including X-ray, computed tomography, and nuclear medicine, as well as optical imaging, ultrasound and magnetic resonance imaging modalities. The interaction of these modalities with tissues and detectors to produce useful image contrast will be presented, and students will gain an understanding of the basic physics of image acquisition and algorithms for image generation. Signal and noise characteristics, image quality and image reconstruction algorithms will also be covered. Image processing through MATLAB programming will be covered in class and in assignments.

Repeatability: This course may not be repeated for additional credits.

BIOE 5461. Principles of Tissue Engineering. 3 Credit Hours.
This course will introduce fundamental concepts of tissue engineering and regenerative medicine, focusing biomaterials used for scaffolds, mechanisms of cell-biomaterial interactions, biocompatibility and foreign body response, cellular engineering, and tissue biomechanics. Principles of cell/developmental and stem cell biology will be introduced, which will enable the students to apply a multidisciplinary approach to engineering select tissues and organs, such as the musculoskeletal system, cardiovascular tissues, the nervous system, and to design artificial organs. These topics will also be discussed in the context of scale-up, manufacturing, ethical and regulatory concerns. Note: Prior to fall 2017, the course title was "Principles of Tissue and Regenerative Engineering."

Repeatability: This course may not be repeated for additional credits.

BIOE 5471. Mechanobiology. 3 Credit Hours.
Mechanobiology is an emerging interdisciplinary field that focuses on the role of mechanical cues in governing cellular behavior. This course will address how a cell utilizes its adhesions to neighboring cells and to the surrounding extracellular matrix to sense external forces and furthermore, how these forces are transduced within the cell to alter cellular behavior and regulate tissue architecture. This course will also discuss how the extracellular matrix influences cellular behavior during development, health, and disease. Additionally, this course will also discuss the various tools and techniques developed to probe cytoskeletal structures, molecular motors, plasma membranes, cellular adhesion structures, and matrix proteins that pushed the field of mechanobiology forward. This course will culminate in integrating all new foundational knowledge in mechanobiology to propose new studies manipulating molecular, cellular, or tissue-level behavior for applications in diverse fields such as regenerative engineering, wound healing, or cancer diagnostics.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of B- in BIOE 5721 (may be taken concurrently)

BIOE 5500. Special Topics in Bioengineering. 3 Credit Hours.
An emerging or advanced area of bioengineering research will be covered. Topics vary by semester.

Repeatability: This course may be repeated for additional credit.

BIOE 5501. Regenerative Engineering. 3 Credit Hours.
This course is a continuation of fundamental concepts introduced in Principles of Tissue and Regenerative Engineering focusing on developmental biology used in tissue engineering and regenerative medicine. Principles of cell development/biology, cell-cell interactions, signal transduction, and stem cell biology will be discussed with applications to regenerative medicine. These topics will also be discussed in the context of scale-up, manufacturing, ethical and regulatory concerns.

Repeatability: This course may not be repeated for additional credits.

BIOE 5555. Biophotonics: Seeing is Believing. 3 Credit Hours.
Only a small portion of the world around us is visible to the human eye. With revolutionary microscopy developments, nowadays there are ways to visualize drug effects, forces, viral infection or cancer metastasis, or use light to control biological processes. Once we see biology happen, the result is not just a pretty image. We can use machine learning and artificial intelligence (AI) to improve resolution and quantify the imaging data. In this course students will learn how light can be used to visualize and manipulate biomaterials at molecular, cellular and tissue scale. The first part of the course will provide a review of light and optics. We will cover typical hardware used for imaging in biology, such as light sources, objectives and detectors used to generate images. The second part of the course will include hands-on fluorescent microscopy, the main tool for imaging in life sciences, and it will include imaging of cell cultures in 2D and 3D and tissue sections. We will use typical image processing tools, including Fiji, Matlab and selected Python plugins, and learn how to implement AI tools to improve images and imaging data. Final sessions will include presentations on specialized techniques by students.

Repeatability: This course may not be repeated for additional credits.

BIOE 5600. Bioengineering Graduate Seminar. 0 Credit Hours.
Required seminar for bioengineering graduate students. These seminars include speakers from academic and professional backgrounds for both scientific development and professional development. Students will be graded on participation of at least 70% of the bi-weekly seminars throughout the duration of the semester.

Repeatability: This course may be repeated for additional credit.

BIOE 5719. Introduction to Bioengineering. 3 Credit Hours.
This course offers an introduction to biomedical engineering, a diverse and evolving field that integrates engineering principles, life sciences, clinical medicine, research and engineering design, with the overall goal of improving health care and quality of life. Professors with expertise in specific fields of biomedical engineering will present lectures and discussions on a broad range of topics, including tissue engineering and regenerative medicine, biomaterials, biomechanics, bioinstrumentation, biomedical imaging and optics, and signal processing.

Repeatability: This course may not be repeated for additional credits.

BIOE 5721. Cell Biology for Engineers. 3 Credit Hours.
This course introduces biological concepts in modern cellular and molecular biology to engineering students. Topics will include the chemical composition of cells, bioenergetics and metabolism, structure and function of the plasma membrane, transport across membranes, the cytoplasmic membrane system, the extracellular matrix, interactions between cells and their environment, the cytoskeleton and cell motility, sensory systems, and cell signaling. In addition, an introduction to basic anatomy and physiology of vertebrates will include the skeletal system, muscle system, cardiovascular system, and nervous system.

Repeatability: This course may not be repeated for additional credits.

BIOE 5737. Systems Physiology for Engineers. 3 Credit Hours.
Systems Physiology is designed for graduate students majoring in engineering and for others interested in studying physiological processes from the molecular level to the organ/systems level. Among the topics covered are: scaling, respiration, circulation, cardiac process, renal function, muscle function, neuromuscular junction, neural processes, and temperature regulation. The course stresses the application of energetic and informational principles to the study of the body.

Repeatability: This course may not be repeated for additional credits.

BIOE 5741. Biomaterials for Engineers. 3 Credit Hours.
This course introduces engineering students to materials as they interact with biological systems, primarily in medicine. Topics will include a review of properties of materials, the classes of materials, tissues that come into contact with materials, the degradation of materials in the biological environment, the application of materials for specific uses, tissue engineering, and biomaterials standards and regulations.

Repeatability: This course may not be repeated for additional credits.

BIOE 5999. Research Experience in Bioengineering. 0 Credit Hours.
Research Experience provides graduate students laboratory experiences/research practices prior to undertaking independent, directed, master project, master's thesis, or dissertation research. This course allows graduate students the opportunity to learn to use laboratory equipment, designing and carrying out an experiment(s), collecting preliminary data, field experiences, and participation in laboratory meeting, etc. with faculty which may lead to identifying a faculty mentor. The course will be graded as Pass or Fail. The Research Experience is a non-repeatable course. After the completion of this Research Experience course, students will need to be enrolled in independent study, directed research, master's research, master's thesis, dissertation proposal, or dissertation if they continue in an active research program.

Repeatability: This course may not be repeated for additional credits.

BIOE 9182. Independent Study. 1 to 6 Credit Hour.
Repeatability: This course may be repeated for additional credit.

BIOE 9282. Independent Study II. 3 Credit Hours.
Special study in a particular aspect of engineering under the direct supervision of a graduate faculty member. May be taken once by Ph.D. students.

Repeatability: This course may be repeated for additional credit.

BIOE 9991. Directed Research. 1 to 6 Credit Hour.
Under the guidance of a faculty member, the student will conduct independent research on a selected topic in bioengineering.

Repeatability: This course may be repeated for additional credit.

BIOE 9994. BioEngineering Preliminary Examination Preparation. 1 to 6 Credit Hour.
Repeatability: This course may be repeated for additional credit.

BIOE 9995. BioEngineering Project Research. 1 to 6 Credit Hour.
Repeatability: This course may be repeated for additional credit.

BIOE 9996. BioEngineering Thesis Research. 1 to 6 Credit Hour.
Repeatability: This course may be repeated for additional credit.

BIOE 9998. Bioengineering Pre-Dissertation Research. 1 to 6 Credit Hour.
Repeatability: This course may be repeated for additional credit.

BIOE 9999. BioEngineering Dissertation Research. 1 to 6 Credit Hour.
Repeatability: This course may be repeated for additional credit.