BIOMEDICAL ENGINEERING (BMED)

BMED1000 INTRODUCTION TO BIOMEDICAL ENGINEERING
The course introduces the field of biomedical engineering with class activities that expose students to biomedical engineering careers, devices and systems related to medical diagnosis, treatment and rehabilitation. The course will include guest lectures by professional experts such as practicing biomedical engineers, physicians, and healthcare industry representatives. (2 credits)

BMED1599 QUANTITATIVE PHYSIOLOGY FOR ENGINEERS
Physiology of humans is explored from cells and tissues to organs and systems. Understanding of physiology is sought from the aspects of functional and control systems, and quantitative relationships. Topics include cell structure and function, mechanisms of homeostasis, membrane transport and biopotentials, skeletal muscle and motor control, nervous system, cardiovascular system, respiratory system, integrative physiology, and applications of engineered designs interacting with physiological systems. The course is intended to prepare students who are not in the Biomedical Engineering (BBME) program, and wish to work on interdisciplinary engineering projects involving biomedical applications. ***Prerequisite:*** *MATH1750 or MATH1775;* ***Corequisite:*** *PHYS1750 (4 credits)*

BMED2099 PHYSIOLOGY FOR ENGINEERS I
Provides the foundations of biochemistry, cell metabolism, reproduction and genetics, microorganisms, cells as organ subsystems, cells' interaction with the environment. Will include laboratory projects and simulations. ***Prerequisites:*** *CHEM1100 and PHYS1250; and MATH1750 or MATH1775 (4 credits)*

BMED2500 BIOMEDICAL ELECTRONICS & INSTRUMENTATION
This course is an introduction to biomedical electronics and instrumentation for clinical applications. Topics include sensors for measurement of biomedical signals, bioelectric phenomena, nerve and muscle potentials, electrodes and amplifiers, electrocardiography, blood pressure, heart sounds, respiratory pressure, gas concentration. blood-gases, electromyography, electroencephalography, therapeutic and prosthetic devices, electrical safety of medical devices, and advances in medical instrumentation.***Corequisites:*** *ELEC2699 and BIOL1750 (4 credits) spring*

BMED3099 PHYSIOLOGY FOR ENGINEERS II
Covers human physiology and anatomy, comparative physiology, the mechanism, types and prevention of diseases, and the environmental effects on human physiology. Will include laboratory projects and simulations. ***Prerequisite:*** *BMED2099 (4 credits)*

BMED3100 CLINICAL ENGINEERING PRACTICE
This course covers the basic models of clinical engineering practices and the role of clinical engineers in health care delivery organizations such as hospitals and clinics. Topics include clinical engineering department operations, managing safety programs, technology assessment, medical equipment planning, acquisition, commissioning, and management, selection of equipment in the design of clinical facilities, safe, effective and ethical use of medical devices in compliance with applicable regulatory standards and a clinical engineering design project. ***Prerequisite:*** *BMED2500;* ***Corequisite:*** *MATH2750 (4 credits)*

BMED3200 MEDICAL DEVICES AND SYSTEMS
This course covers various types of medical devices and systems. The topics include biosensors, signal processing and analysis, cardiac diagnostic and therapeutic devices involving electrophysiology and hemodynamics, respiratory, renal and neural devices and systems in clinical practice, life support and life saving devices, implants and artificial organs, imaging systems, anesthesia machines, electrosurgical units, clinical laboratory equipment, Q.A., standards, regulatory affairs, FDA approval and medical device design. ***Prerequisite:*** *BMED2500;* ***Corequisite:*** *MATH2750 (4 credits)*

BMED3800 SPECIAL TOPICS IN BIOMEDICAL ENGINEERING
Presents topics that are not covered by existing courses and are likely to change from semester to semester. Refer to the Class Schedule for a specific semester for details of offerings for the semester. (1 - 4 credits)

BMED4099 BIOMEDICAL SYSTEMS ENGINEERING
Covers biomedical modeling, design, applications: instrumentation, clinical experiments, biostatistics, ethics, biomechanics, biomaterials, bio-fluids, bioelectricity, bio-signal and image processing, physiological control systems. Will include laboratory projects and simulations. ***Prerequisites:*** *Fifth-year status in BELM; BMED3099 (4 credits)*

BMED4200 BIOMATERIALS & TISSUE ENGINEERING
This course covers the usage of biomaterials in biomedical engineering. Topics include the chemical structures, physical and mechanical properties of biomaterials, biomaterial degradation and processing, surface properties, protein and cell interactions with biomaterials, biomaterials implantation and acute inflammation, wound healing, immune response to biomaterials, biomaterials and thrombosis as well as infection, tumorigenesis and calcification of biomaterials. An overview of biomaterials applications and tissue engineering is provided and a biomaterials design project is required. ***Prerequisites:*** *BIOL1100 and CHEM1100 and MECH3599 (3 credits)*

BMED4300 SIGNALS AND SYSTEMS FOR BIOMEDICAL ENGINEERING
This course covers bioengineering signals and systems, signal processing, Fourier and Laplace transforms, transfer function, frequency selective filters, real time processing, adaptive filters, time-frequency and time-scale analysis, linear system identification, optimization, fuzzy models, compartment models and control systems. Selected biomedical applications include pulse oximetry, defibrillator output, blood pressure monitoring and closed-loop drug infusion control. ***Prerequisites:*** *BMED2500 and MATH2750 (3 credits) spring*

BMED4400 BIOMECHANICS
The overall objective of this course is to train students on problem-posing and problem-solving skills and illustrating how the fundamentals of mechanics are applied to biological problems. This course offers insight into the mechanics of hard tissue, musculoskeletal soft tissue, joint articulating surface motion, analysis of gait, mechanics of head and neck, biomechanics of chest and abdomen impact, cardiac biomechanics, heart and valve dynamics, molecular transport and regulation in microcirculation, modeling in cellular biomechanics and introduction to sports biomechanics. ***Prerequisites:*** *MECH3599 and MATH2750 (4 credits) spring*

BMED4450 DESIGN OF PROSTHETICS & IMPLANTS
This course covers the design process of prosthetic devices and implants from concept development to launch from technical perspective to regulatory approvals. The students will learn how to use the engineering principles to develop prosthetic devices and implants for treatment of different disorders. Topics include concept development, design for manufacturing, design optimization and validation, material selection and regulatory approval. ***Corequisites:*** *BMED4200 and BMED4400 (4 credits) summer*

BMED4500 ENGINEERING IN BIOMEDICINE
This course includes lectures by practicing professionals from medical devices research and development, manufacturing, hospitals, and regulatory agencies. It also includes presentations on ongoing biomedical research projects on campus and student co-operative work experiences. The course will also address current trends and emerging challenges in the biomedical engineering field. ***Prerequisite:*** *junior status (1 credit) summer*

BMED4550 MEDICAL ROBOTICS & ASSISTIVE TECHNOLOGY
This course covers the design, control and application of medical robotics and assistive technologies. The course includes surgical navigation, image guided interventions, robot assisted surgeries, as well as other medical robotic applications. The course will also cover assisted technologies, identifying the needs of disabled people, and the design and application of assistive devices. ***Prerequisites:*** *BMED2500, BMED4400 and Senior Standing. (4 credits) summer*

BMED4600 BIOSTATISTICS
This course, intended primarily for biomedical engineering students, covers topics including descriptive statistics, probability, sampling, sampling distribution, estimation, linear regression, hypothesis testing, analysis of variance, Baye's theorem, probability distributions, multiple regressions, chi square distribution and other statistical methods to analyze biomedical data. Lab modules complement theoretical coverage and involve software applications and a group design project for medical applications. ***Prerequisites:*** *BIOL1100 and COMP1000 and MATH2025 (4 credits) summer*

BMED4700 BIOMEDICAL ETHICS & REGULATORY AFFAIRS
This course provides an overview of the ethical and regulatory affairs applied to biomedical engineering. The course covers ethics and Biomedical engineering practice and research, theories and principles of ethics, the code of ethics, ethical considerations in areas including clinical engineering, human enhancement, and implants. This course also covers medical devices and FDA regulatory requirements including medical device design control, review, testing, pre- and post-marketing and compliance. ***Prerequisite:*** *BMED4500 (2 credits)*

BMED4750 Rehabilitation Engineering and Therapeutic Applications
This course focuses on how to design and evaluate devices and systems that assist in the rehabilitation and therapy of individuals with physical or cognitive impairments. Through lectures and laboratory activities, students in the course explore how mobility aids, augmentative communications systems, and sensory aids, as well as digital therapeutic devices, are designed and implemented. Clinical applications covered in the course include therapies for rehabilitation from musculoskeletal sports injuries, stroke, and dementia. Assistive and virtual therapies to guide and motivate patients in their rehabilitation are also addressed and evaluated. (4 credits)

BMED4800 MEDICAL INFORMATICS & TELEMEDICINE
This course will expose the student to the fields of telemedicine and medical informatics. Topics include telemedicine technologies, telemedicine consultations, the importance of internet in telemedicine, mobile technology, healthcare data storage, healthcare data analytics, electronic health records and health information exchange, medical coding, health information privacy and security, and ethics in health informatics. ***Prerequisites:*** *COMP1000 and BMED2500 (4 credits)*

BMED4850 MEDICAL IMAGING & OPTICS
This course covers principles, operations and applications of diagnostic medical imaging systems including ultrasound, x-rays, computer tomography, and magnetic resonance imaging. The course also covers diagnostic applications of optics in medicine including microscopy, spectroscopy, and endoscopy. ***Prerequisite:*** *BMED2500 (4 credits)*

BMED5000 BIOMEDICAL ENGINEERING SENIOR DESIGN I
This is a course for seniors that allows them to work in a group or as an individual to further their studies in a project-oriented style. Students in this course will work on their area of focus by taking an interdisciplinary approach to solve a technological problem in the biomedical field. The work done in this course will be performed under the supervision of one or more faculty advisors. Oral and written progress reports are reviewed and iteratively refined throughout the semester. The technical report of the work at the end of the semester is coupled with a formal presentation to the class. This course is followed by BME Senior Design II. ***Prerequisites:*** *senior status and completion of one co-op in a medical organization or academic research (3 credits)*

BMED5050 ARTIFICIAL INTELLIGENCE & ANALYTICS IN HEALTHCARE
The Artificial Intelligence (AI) and Analytics in Healthcare course covers applications of AI theory in disease diagnosis and health data analytics. Topics include Artificial Neural Networks, Fuzzy Logic, Application of AI and Analytics in diagnosis of disease such as cancer, genetic programming for knowledge discovery in chest-pain diagnosis. Lab experiments will include development of AI models and algorithms that solve selected real-world medical and healthcare decision making problems. ***Prerequisites:*** *MATH2750;* ***Corequisites:*** *BMED4300 and BMED4600 (4 credits) summer*

BMED5500 BIOMEDICAL ENGINEERING SENIOR DESIGN II
This course is a continuation of BME Senior Design I. Students are expected to continue with their design and development activities from the previous course and focus on design improvements and applications of the product. Supervising faculty and invited industry professionals will review the student's prototypes and make recommendations. Students will submit a report on the designed product and make a presentation to the class, supervisors, invited faculty, alumni and other interested parties. ***Prerequisite:*** *BMED5000 (3 credits)*