CATOLOG DESCRIPTION OF COURSES

BME 202 Molecular Biology and Genetics (3 Credits)

This is an introductory course in cell biology and genetics. Students will learn the nomenclature and current knowledge about the cell and its structures. Topics include chemical bonds; macromolecules; protein structure and function; enzymes; cell structure and function; cellular respiration; cell signaling; cellular reproduction and life cycle; cellular communication; structure and nature of DNA and genetics.

Prerequisite(s): Chem 142

BME 204 Anatomy and Physiology I (3 Credits)

The objective of this course is to present the concepts of human anatomy and physiology that are most pertinent to the field of biomedical engineering. Concepts from the following topics will be covered: homeostasis; cell membrane potentials and transport mechanisms; nerves; muscular, cardiovascular and circulatory systems. Modeling of living systems will be covered as well.
Prerequisite(s): BME 202

BME 220 Biomaterials (3 Credits)

This course introduces the science of materials with emphasis on materials used in biomedical applications such as surgical implants, medical devices, dental restoration, drug delivery systems…etc. Students shall learn the classes of biomaterials and their properties, characteristics, biological response, and clinical applications. Other topics include biocompatibility, biodegradation, and performance and design requirements of materials for medical applications.
Prerequisite(s): None

BME 304 Anatomy and Physiology II (3 Credits)

The objective of this course is to present the concepts of human anatomy and physiology that are most pertinent to the field of biomedical engineering. It is a continuation of Anatomy and Physiology I course. Concepts from the following topics will be covered: autonomic nervous system; blood; lymphatic and immunity; respiratory, urinary, endocrine and digestive systems.
Prerequisite(s): BME 204

BME 310 Biomedical Electronics I (3 Credits)

Diodes characteristics, models and applications (rectification, clipping, regulation …etc); Bipolar Junction Transistors (BJT) and Field Effect Transistors (FET): states and modes of operation of these devices; BJT and FET amplifiers; multistage amplifiers; frequency response of amplifiers.

Prerequisite(s): Engr 206

BME 312 Biomedical Electronics II (3 Credits)

Operational amplifiers, power amplifiers, differential & multistage amplifiers and their medical applications; passive and active filters; comparators; oscillator circuits and applications; functional integrated circuits (*V/f* converters, *A/D* converters… etc); frequency response; control systems; analysis and design of feedback control systems and applying these principles to solve biological feedback control problems.
Prerequisite(s): BME 310

*BME 313 Biomedical Electronics LAB (1 Credit***)**

The goal of this laboratory is to study electronics through experimentation. Upon completion of this lab course, students should be able to use standard laboratory equipments to analyze the behavior of basic electronic devices and to design and construct simple circuits containing these devices.

Corequisite(s): BME 312

BME 314 Biomedical Signals and Systems (3 Credit)

Biosignals and their Non-deterministic properties. Models for Biomedical systems. System response and Stability, Fundamentals of continuous-time signal processing as applied to biomedical instrumentation. Random noise and signal processes. Time Domain and Frequency Domain Analysis of Signals and System, Sampling theory, Applications of Fourier transforms and Laplace transforms, Transfer functions. Analog filter design methods for biomedical instrumentations. Discrete-time signal processing and Digital filter design will be introduced in this course. Projects and software will be used.

Prerequisite(s): Math 240, Engr 206

BME 316 Logic Design and Microprocessors for BME (3 Credits)

This is an introductory course in digital logic design and microprocessor systems. The course shall include introduction to digital systems; Boolean algebra; Combinational circuit analysis; Sequential circuit analysis and design that includes counters, registers and timers… etc. The fundamental principles of digital logic design shall be applied to understand Microprocessor organization and architecture; assembly language programming; CPU; Memory, I/O, and parallel processing. Biomedical Engineering applications shall be discussed wherever applicable.
Prerequisite(s): CS 204

BME 320 Biomechanics (3 Credits)

This course applies the principles of solid mechanics to musculoskeletal system. Topics include kinematics, kinetics, and biomechanics of locomotion. Students will learn the microstructure and mechanical properties of biological tissues such as bones, joints, blood vessels, muscle, heart…etc. The learned concepts of biomechanics will be applied to those body tissues. Design and analysis projects will be assigned.
Prerequisite(s): Engr 223, BME 220

BME 322 Biomedical Transport Phenomena (3 Credits)

Topics include reaction-diffusion processes; transport across membranes; fluid flow in the circulatory system and other tissues; oxygen transport in lungs and tissues; pharmacokinetics; biomedical engineering applications and devices: extracorporeal devices (e.g. hemodialysis, blood oxygenators…etc) and artificial organs.

Prerequisite(s): Math 240, Engr 303

BME 330 Biomedical Imaging Systems (3 Credits)

This course covers the fundamentals of different types of medical imaging modalities. Topics include the physics, mathematics, instrumentation and clinical applications of different imaging modalities including X-rays, Computed Tomography (CT), Fluoroscopy, Ultrasound Imaging, Optical Imaging, Nuclear Imaging (SPECT, PET) and Magnetic Resonance Imaging (MRI).

Prerequisite(s): Phys 141, Math 240

BME 331 Biomedical Imaging Systems Lab (1 Credit)

This laboratory focuses on the main medical imaging modalities in BME 330, and provides a hands-on experience for students to practically apply the knowledge they

have learned in BME 330. Medical images will be acquired using different modalities, analyzed, reconstructed, and archived.

Corequisite(s): BME 330

BME 410 Biomedical Instrumentation I (3 Credits)

This is the first course in bioinstrumentation covering clinical measurements. Topics include the origin of Biopotentials: cell, nerve, and muscle potentials; Biopotential electrodes; Biosensors and Transducers; Basic Theories of Measurements and concepts of Medical Instrumentation; Modular Block and System Integration; electrocardiogram (ECG); electroneurogram; electromyogram (EMG); electroretinogram; electroencephalogram (EEG); Cardiovascular system and associated measurements; Blood pressure and Blood flow Measurements; Measurements of the respiratory System; Pulmonary Function Analyzers; Audiometery; Introduction to Biomedical Virtual instrumentation. The Course shall explore the design, operation, safety aspects and calibration of the respective instrumentations.
Prerequisite(s): BME 312, Engr 105

BME 411 Biomedical Instrumentation I Lab (1 Credit)

This laboratory-based course is designed to develop hands-on experimental skills to the selection and application of various sensors and transducers, and develop practical experience to designing, using and testing analog instrumentation used to acquire and process biomedical signals. Students shall develop skills in writing Matlab programs and employing LabView to perform signal processing on biomedical signals such as ECG, and testing electrical equipment against safety standards. It will inculcate the safety issues involved in bioelectrical measurement and medical instrumentation.
Team work and written communication skills are emphasized through laboratory report organization, documentation of results, error analysis and interpretation of findings.
Co-requisite(s): BME 410

BME 412 Biomedical instrumentation II (3 Credits)

Students shall explore the design, operation, safety aspects and calibration of the respective instrumentation: Patient Monitoring Systems, Bedside Monitors and Central Monitors, Arrhythmia and Ambulatory Monitoring, Biomedical Wireless Telemetry, Introduction to networking concepts in Medical Devices. Clinical Laboratory Instrumentation (types and principle of operation): Electrophoresis, ELISA, Hematology,

Chromatography, Spectroscopy and Spectrophotometry, Blood gas analyzers, Electrolytes analyzers. Therapeutic and Prosthetic Devices: pacemakers and defibrillators, Pacemaker analyzers cardiac assist devices, Hemodialysis, Lithotripsy, Ventilators, Anesthesia Machines, Infant Incubators, Drug Delivery Devices, Instruments for Surgery. Prerequisite(s): BME 410

BME 413 Biomedical Instrumentation II Lab (1 Credit)

This laboratory-based course is designed to develop hands-on experimental skills relevant to the design and construction of biomedical instrumentation commonly used to acquire biomedical signals including aspects of signal processing, micro-computer interfacing, and simple software development. Team work and written communication skills are emphasized through laboratory report organization, documentation of results, error analysis and interpretation of findings.
Prerequisite(s): BME 316; Co-requisite(s): BME 412

*BME 414 Biomedical Digital Signal Processing **Elective** (3 Credits)*

This course is designed for senior level students. The objective of this course is to introduce the main techniques for the analysis of continuous and discrete signals including Laplace, Fourier and *Z* Transforms and apply them to analyze biological signals. Topics covered include signal acquisition and sampling; Nyquist rate; signal averaging; noise removal and signal compensation; discrete-time system analysis; *Z* transform; discrete and fast Fourier transform; transfer functions and digital filtering; Infinite Impulse Response (IIR) and Finite Impulse Response (FIR) systems. Computer programming softwares such as Matlab will be used for the course assignments to analyze biological systems and design different types of filters.
Prerequisite(s): Engr 105, BME 314

*BME 416 Introduction to BioMEMS and Bionanotechnology **Elective** (3 Credits)*

The objective of the course is to expose students to biomedical MicroElectroMechanical Systems (MEMS) and Nanotechnology, and to teach them fundamental principles of MEMS applications in biology and medicine. Topics covered include MEMS and nanotechnology, its application to biotechnology/biomedicine. Introduction to scaling laws as applied toward living systems and artificial devices; micro- and nanofabrication; biosensors and actuator principles; drug delivery; implantable systems; micro-total-analysis systems and lab-on-a-chip devices; minimally invasive surgery; detection and measuring systems; DNA, and protein microarrays; emerging applications in medicine.
Prerequisite(s): BME 202; Corequisite(s): BME 410

BME 420 Prosthetic Systems for Biomedical Engineering Elective (3 Credits)

Applying biomechanics of human movement to design and evaluate artificial devices intended to restore or improve movement loss due to disease or injury. Topics include motion analysis; gait analysis and electromyogram (EMG) and their measurement techniques. Artificial limbs; joint replacement & models of muscle and tension will be covered as well with the biomaterials used and their biocompatibility. Matlab projects will be assigned to demonstrate the concepts learned in this course.
Prerequisite(s): BME 320, BME 304, Engr 105.

BME 430 Biomedical Image Processing (2 Credits)

Medical image processing and analysis techniques: image enhancement and filtering in spatial and frequency domains, image restoration, image compression and archiving, segmentation, and registration. Common image characteristics such as Signal-to-Noise Ratio (SNR), resolution, contrast and Contrast-to-Noise ratio (CNR) will be covered as well. Concepts learned in this course will be demonstrated throughout projects and assignments utilizing computer programs such as Matlab.
Prerequisite(s): BME 330, BME 314

*BME 432 Biomedical Data Processing, Archiving, and Communication **Elective** (3 Credits)*

Data acquisition, digitization, storage and recovery. Review of image digitization, compression, enhancement and storage (archiving). Introduction to Picture archiving and communication System; Components of PACS; PACS Infrastructure; Network terminology; types of workstations; the relationship of a Radiology Information System (RIS) and/or a Hospital Information System (HIS) to PACS; interfaces and languages such as DICOM and HL-7 will be addressed.
Prerequisite(s): BME430

BME 440 Management of Healthcare Technology (3 Credits)

Driven by ever-evolving technological advancements, healthcare institutions must continuously adapt them in order to provide optimal patient care. The proliferation of cutting edge procedures in the Hospital call for the development of expertise in the management of Healthcare Technology. Management of Healthcare Technology ensures that the equipment and systems used in patient care are safe, operational, and properly configured to meet the mission of the healthcare; that the equipment is used in an effective way consistent with the highest standards of care.

***Description*:** Management concepts of Healthcare Technology; Introduction to the codes, standards, ethical issues and regulations governing Healthcare Technology

practices; Implications of Safe Medical Device Act (SMDA); Impact of regulatory agencies' (SFDA, JC etc) requirements on the operations of the Healthcare Technology Management (HTM) program; Development of related policies and procedures govern activities such as the selection, planning, and acquisition of medical devices for their safe use; Patient Safety and Safety programs; infection control; Types of Contracts and contract negotiation; Development and operation of a Healthcare Technology Management/Clinical Engineering Department in a Hospital.
Prerequisite(s): Senior Standing in BME

BME 442 Information Technology for Biomedical Engineer ***Elective*** *(3 Credits)*

Integration of Information technology and Biomedical Engineering. Introduction to networking, communications, and information infrastructures in medical environment. Exposure to basic concepts related to networking at several levels: low-level (TCP/IP, services), medium-level (network topologies), and high-level (distributed computing, Web-based services) implementations. Commonly used medical communication protocols (HL7, DICOM) and current medical information systems (HIS, RIS, PACS). Advances in networking, such as wireless health systems, peer-to-peer topologies, grid/cloud computing. Introduction to security and encryption in networked environments.
Prerequisite(s): Engr 105

BME 444 Medical Device Innovation and Entrepreneurship ***Elective*** *(3 Credits)*

This course provides a foundation course for those interested in developing medical devices and associated technologies. Topics include: innovation models, risks, costs and rewards; product development and new product management; product failure; introduction to medical devices and their classification and nomenclature; healthcare needs assessment; new medical devices and healthcare delivery: industry, government, hospital and user perspectives; medical device innovation including funding and IP issues and design guidance for manufacturers; medical device regulations including harmonization; essential principles of safety and performance of medical devices; Council Directive 93/42/EC on Medical Devices; ISO13485 and ISO14971 standards; FDA's 510(k) review procedure for medical devices; product liability and non-conformance; reliability and the product development process; biotechnology innovation; engineering entrepreneurship.
Prerequisite(s): Senior Standing in BME

BME 450 Senior Design I (2 Credits)

This is the first course of a two-semester sequence of senior capstone design. It provides students with experience in the process and practice of biomedical component/system design from concept through final design. Project management techniques, SFDA requirements for medical device design, intellectual property, ethical and human research subject considerations will also be covered. Emphasis will be on teamwork, project management, testing through simulation or prototype, oral and written communications

Prerequisite(s): Senior Standing in BME

BME 452 Senior Design II (2 Credits)

Continuation of BME 450 – Senior Design I
Prerequisite(s): BME450

BME 460 Special Topics in Biomedical Engineering ***Elective*** *(3 Credits)*

Topics determined by the course instructor in consultation with the department chair.
Prerequisite(s): Senior Standing in BME

BME 462 Undergraduate Research in Biomedical Engineering ***Elective*** *(3 Credits)*

Individual research projects for students with honors classification. It requires prior approval of, and arrangement with, a faculty research advisor.
Prerequisite(s): Senior Standing in BME

Other Engineering Courses Required as Core for Biomedical Engineering Program:

Engr 206 Electric Circuits (3 Credits)

Resistors, capacitors, inductors, currents; voltages; power and energy; circuit analysis techniques; DC and AC Analysis: magnetic Circuits and Transformers; Introduction to DC and AC machines. Prerequisite: Phys 141

EE 247 Electric Circuit Lab (1 Credit)

Lab experiments using resistors, inductors, capacitors, function generators, DC supplies Multimeters, and Oscilloscopes. Focus will be on DC inputs. Software circuit simulations will be used.

Prerequisite(s): Engr 206

Engr 223 Engineering Mechanics (3 credits)

Engineering mechanics covering both statics and dynamics. Topics include vector algebra, force systems, free-body diagrams, equilibrium of particles and rigid bodies, kinematics of particles and rigid bodies, Newton's laws applied to particles and rigid bodies, friction. Three lectures per week. *Prerequisite: Math 145 and Physics 140.*

Engr 303 Thermofluids (3 credits)

Basic concepts of thermodynamics, properties of pure substances, energy transfer by heat, work, and mass, first and second laws of thermodynamics, basic principles and concepts of fluid mechanics including fluid statics, momentum analysis of flow structures, Bernoulli and energy equations, flow in pipes, basic principles of heat transfer including modes of heat transfer, steady heat transfer. Three one-hour lectures per week
Prerequisite: Phys 141, Chem 142

Engr 340 Probability and Statistics for Engineers (3 credits)

This course provides a comprehensive introduction to those models and methods most likely to be encountered and used by students in their careers in engineering and the natural sciences. Some homework requires use of computers. The course will cover: Introduction to Statistics and Data Analysis, Probability, Random Variables and Probability Distributions, Mathematical Expectations, Some Discrete Probability Distributions, Functions of Random Variables, Fundamental Distributions and Data Description, Simple Linear Regression, Multiple Linear Regression, and Bayesian Statistics**.** The students can use Microsoft Excel or any other statistical software in their projects. Three lecture hours per week. Prerequisite: Math 145.