

B.Sc. in Biomedical Engineering Study Plan

■ University Compulsory Courses 16 C.H *Pages (64)*

■ University Elective Courses 9 C.H *Pages (64 & 65)*

■ Faculty Compulsory Courses 32 C.H

Line No.	Code	Course	
224000	CHE400CH	PROFESSIONAL ETHICS FOR ENGINEERS	1
242020	EE202EE	COMMUNICATION SKILLS FOR ENGINEERS	2
901010	MATH101	CALCULUS(I)	3
901020	MATH102	CALCULUS (2)	3
902010	MATH201	INTERMEDIATE ANALYSIS	3
902030	MATH203	ORDINARY DIFFERENTIAL EQUATIONS	3
911010	CHEM101	GENERAL CHEMISTRY (I)	3
911020	CHEM102	GENERAL CHEMISTRY (2)	3
911072	CHEM107	GENERAL CHEMISTRY LAB	1
921010	PHY101	GENERAL PHYSICS (1)	3
921020	PHY102	GENERAL PHYSICS (2)	3
921072	PHY107B	GENERAL PHYSICS (LAB)	1
1731150	CS115	C++ PROGRAMMING LANGUAGES	3

■ Department Compulsory Courses 90 C.H

Line No.	Code	Course	
102362	MED236B	PHYSIOLOGY (I)	3
102363	MED236B	PHYSIOLOGY (LAB)	1
223400	CHE340	THERMODYNAMICS	3
242121	EE212A	ELECTRIC CIRCUIT ANALYSIS	3
242130	EE213	ELECTRICAL CIRCUITS LAB	1
242401	EE240	INTRODUCTION TO LINEAR	3
243051	EE305	NUMERICAL METHODS FOR ENGINEERS	3
244402	EE440B	COTROL SYSTEMS	3
244422	EE442B	CONTROL SYSTEMS LAB	1
251010	ME101	ENGINEERING WORKSHOPS	2
251011	ME101A	ENGINEERING WORKSHOP (LAB)	0
252000	ME200	ENGINEERING DRAWING (A)	1
252150	ME215	ENGINEERING MECHANICS	3
253433	ME343C	FLUID MECHANICS	3
283021	BME302A	STATISTICS FOR BIOMEDICAL ENGINEERS	3
283111	BME311A	MEDICAL ELECTRONICS (1)	3
283121	BME312A	MEDICAL ELECTRONICS (2)	3
283171	BME317A	MEDICAL ELECTRONICS LAB	1
283211	BME321A	ANALYSIS OF BIOMEDICAL	3
284111	BME411A	BIOMEDICAL INSTRUMENTATION	3
284121	BME412A	BIOMEDICAL INSTRUMENTATION	3
284181	BME418A	BIOMEDICAL INSTRUMENTATION LAB (1)	1
284211	BME421A	DIGITAL SIGNAL PROCESSING	3
284381	BME438A	DIGITAL LOGIC DESIGN AND COMPUTER ARCHITECTURE LAB	1
284421	BME442A	INTRODUCTION TO BIOMEDICAL MATERIALS	3
284521	BME452A	BIOMEDICAL TRANSPORT	3
284901	BME490A	ENGINEERING TRAINING	3
285171	BME517A	BIOMEDICAL INSTRUMENTATION LAB (2)	1

285311	BME531A	PHYSIOLOGICAL MODELING	3
285910	BME591	BIOMEDICAL GRADUATION	1
285920	BME592	BIOMEDICAL GRADUATION	3
285941	BME594A	SEMINAR IN BIOMEDICAL ENGINEERING	0
293410	IE341	ENGINEERING ECONOMY	2
912170	CHEM217	ORGANIC CHEMISTRY	3
913620	CHEM362	BIOCHEMISTRY	3
931030	BIO103	GENERAL BIOLOGY	3
931070	BIO107	GENERAL BIOLOGY (PRACTICAL)	1
1712540	CPE254	DIGITAL LOGIC DESIGN AND COMPUTER ARCHITECTURE (NON-CIE STUDENTS)	3
1713530	CPE353	MICROPROCESSOR SYSTEMS (Non CPE students)	3

■ Department Elective Courses 12 C.H

Line No.	Code	Course	
285101	BME510A	BIOMEDICAL SENSORS AND TRANSDUCERS	3
285211	BME521A	DIGITAL IMAGE PROCESSING	3
285421	BME542A	PROSTHETICS AND ORTHOTICS	3
285441	BME544A	BIOMECHANICS	3
285501	BME550A	BIO MEMS AND	3
285521	BME552A	PHYSIOLOGICAL FLUID	3
285541	BME554A	ARTIFICIAL ORGANS	3
285561	BME556A	CELL AND MOLECULAR	3
285581	BME558A	TISSUE ENGINEERING	3
285601	BME560A	BIOMEDICAL ENGINEERING	3
285611	BME561A	MEDICAL IMAGING SYSTEMS	3
285621	BME562A	CONTROL AND COMMUNICATION IN THE NERVOUS SYSTEM	3
285631	BME563A	DIAGNOSTIC AND THERAPEUTIC ULTRASOUND	3
285641	BME564A	BIOINFORMATICS	3
285651	BME565A	MAGNETIC RESONANCE IMAGING	3
285671	BME567A	THERAPEUTIC DEVICES	3
285803	BME580C	MEDICAL INFORMATICS AND CLINICAL ENGINEERING	3
285811	BME581A	HEALTHCARE MANAGEMENT	3
285901	BME590A	SPECIAL TOPICS	3

TOTAL 159 C.H

*** For prerequisite & equivalent courses see the Courses' Description.**

B.Sc. in Biomedical Engineering

Courses' Description

I. Compulsory courses

BME 302 Statistics for Biomedical Engineers 3 C.H

Basic concepts of probability; conditional probability, statistical independence, total probability and Baye's Theorem; Random variables: introduction, discrete and continuous, probability mass and density functions, cumulative distribution function, and moments; Common discrete and continuous distributions; Functions of random variables; Descriptive Statistics: Describing and summarizing data sets, Histogram, Statistical distributions; Inferential statistics: hypothesis testing, significance levels, and t-test; Analysis of variances (ANOVA) and Linear regression.

Prerequisite: --- , Co-requisite: BME 321A

BME 311 Medical Electronics I 3 C.H

Introduction to Semiconductors, Diode types, circuits and applications, Bipolar Junction Transistors (BJT) types and biasing circuits, Field effect transistors (FET), Small-signal BJT and FET amplifiers, Multistage amplifiers, Frequency response of amplifiers, Introduction to differential amplifiers, Medical applications of diode circuits and transistor amplifiers. *Prerequisite: EE 212, Co-requisite: --*

BME 312 Medical Electronics II 3 C.H

Operational amplifiers and medical applications, Oscillator types and applications, switching modes of transistor, TTL logic family, MOSFET logic circuits, logic translators, Regenerative logic circuits, Digital to analog and analog to digital data converters, Medical applications of regenerative circuits and data converters.

Prerequisite: BME 411, Co-requisite: --

BME 317 Electronics Lab 1 C.H

The electronics lab focuses on experiments that cover the following topics: diode circuits and applications, biasing circuits of BJT and FET, small signal BJT and FET amplifiers, frequency response of amplifiers, differential amplifiers, operational amplifiers and applications, TTL logic circuits, CMOS logic circuits, multivibrators, A/D and D/A converters. *Prerequisite: EE 213, Co-requisite: BME 312*

BME 321A Analysis of Biomedical Signals & Systems 3 C.H

Concepts of linear time invariant systems; discrete and continuous time systems; application of Laplace and Fourier transforms to linear systems; Z-transform; system function; frequency response and simulation in the frequency domain; discrete Fourier series and fast Fourier transform; computer applications.

Prerequisite: EE 240, Co-requisite: ---

BME 411 Biomedical Instrumentation I 3 C.H

Introduces the principles of medical instrumentation. Covers biomedical sensors and transducers; temperature, displacement, acoustical and radiation measurements; bio-potential amplifiers and signal processing; origin of bio-potentials; bio-potential electrodes; measurement of bio-potentials such as ECG, EEG and EMG; blood pressure measurements; electrical safety.

Prerequisite: BME 312, MED 236A, Co-requisite: ---

BME 412 Biomedical Instrumentation II 3 C.H

Principles, modeling, applications and the design of Biomedical instruments most commonly used in hospitals: Measurement of flow and blood volume; Respiratory system measurements; Medical imaging systems; Laboratory instrumentation; Therapeutic and prosthetic devices. *Prerequisite: BME 411, Co-requisite: --*

BME 418 Biomedical Instrumentation Lab I 1 C.H

Measurements errors and noise, signal conditioning, amplification, filtration, processing, interfacing with digital computers; Biomedical measurement devices (ECG, EMG and EEG); Respiratory and temperature measurements.

Prerequisite: BME 411, Co-requisite: BME 412

BME 421 Digital Signal Processing 3 C.H

The basics of discrete sequences, studying the terms Linearity, Time-invariance, Causality, and Stability, Fourier transform theorems, Z-transform, the sampling theorem and the Nyquist rate, complete (A/D – DSP – D/A) system in both time and the frequency domains, frequency response of linear time invariant systems, frequency selective filters and Phase Distortion and Delay, IIR and FIR systems, design of different types of digital filters, bilinear transformation, and MATLAB use in designing different types of analog and digital filters.

Prerequisite: BME 321A, Co-requisite: BME 302

BME 438 Digital Logic Design and Computer Architecture Lab 1 C.H

Experiments in digital logic and computer design and implementation using TTL integrated circuits including SSI, MSI and LSI ALUs. Design and implementation of several interfacing tasks; interfacing with simple I/O devices using latches, buffers, and parallel adapters; parallel and serial interfacing to printers and scanners. Timer programming (wave generation, frequency meters, and real time clocks); host-to-host communication through parallel and serial links and modems.

Prerequisite: CPE 353, Co-requisite: ---

BME 442A Introduction to Biomedical Materials 3 C.H

Survey of materials intended for biological applications; Materials for both medical implants and dental restoration and appliances will be covered. Discussions of various aspects pertaining to the selection, processing, testing (in vitro and in vivo) and performance of biomedical materials. The biocompatibility and surgical applicability of metallic, polymeric, ceramic, and other implants and prosthetic devices are discussed.

Prerequisite: CHEM 262, ME 215, Co-requisite: ---

BME 452 Biomedical Transport Phenomenon 3 C.H

Concepts and biomedical applications in fluid mechanics and mass transport. The effect of transport processes upon biochemical interactions. Protein diffusion and transport across endothelium. Biomedical transport across the glomerulus, blood flow in organs and organism level (e.g. pharmacokinetic models). Analytical and numerical solutions of transport problems. Extracorporeal devices: renal dialysis and oxygenators; Bioartificial organs: Bioartificial Kidney and Bioartificial Pancreas.

Prerequisite: BME 302, MED 236A, EE 305, ChE 340 Co-requisite: ---

BME 490 Engineering Training 3 C.H

Eight weeks of practical training in an institution (university, company, hospital, ...etc) that is accredited by the BME department and faculty of engineering at JUST for training purposes in the field of biomedical engineering. *Prerequisite: Completion of 117 C.H., Co-requisite: ---*

BME 517 Biomedical Instrumentation Lab. II 1 C.H

The lab is dedicated to measuring and analyzing biosignals; ECG, pulse plethysmography, breathing volumes and parameters, in addition to gait analysis, audiometry, telemetry and biomedical equipment safety analysis. *Prerequisite: BME 418, Co-requisite: ---*

BME 531A Physiological Modeling 3 C.H

Basic concepts of modeling: lumped and distributed parameter modeling; Compartmental modeling; applications include compartmental modeling of pharmacokinetics, modeling of cardiovascular and respiratory system: pressure-flow and transport; thermoregulation, and prosthetic systems. Numerical solutions are analyzed using MATLAB/Simulink software packages.

Prerequisite: BME 452, Co-requisite: ---

BME 591 Graduation Project I 1 C.H

Provides students the opportunity to individually explore a BME problem or issue within their field of study and apply their education to solving the problem for the benefit of the local community and society as a whole. Students produce a short report that documents the application of previous learning, experience and knowledge to the problem at hand, and evaluates the results.

Prerequisite: Completion of 114 C.H., BME 412 Co-requisite: ---

BME 592 Graduation Project II 3 C.H

Students perform the experimental and practical phases associated with solving the BME problem addressed in Senior Capstone Project I. Students produce a full technical report that documents the research, design, results, analysis, and recommendations of the study, followed by a final presentation and defense.

Prerequisite: BME 591, Co-requisite: ---

BME 594 Seminar in Biomedical Engineering 3 C.H

Professional seminars presented through lectures and discussions by invited speakers focusing on recent developments and research or methodologies in biomedical engineering or related studies.

Prerequisite: ---, Co-requisite: BME 59

II. Elective courses

a) Track one: Biomedical Instrumentation and Imaging

BME 510A Biomedical Sensors and Transducers 3 C.H

Introduction to biomedical sensors: definition, classification, calibration, requirements, errors and uncertainty, static and dynamic parameters, requirements and design aspects of signal conditioning circuits, temperature sensors: types, and signal processing circuits, Pressure sensors: types, operating principle, calibration techniques, medical applications and conditioning procedures, Electrochemical sensors, Ion-selective sensors, Biosensors, Ion-sensitive field effect chemo-sensors, Optical sensors, Ultrasound transducers, Intelligent biomedical sensors, Manufacturing of biomedical sensors. *Prerequisite: BME 412, Co-requisite: ---*

BME 521 Digital Image Processing 3 C.H

A practical introduction to biomedical image processing using examples from various branches of medical imaging. Topics include: point operators, filtering in the spatial and frequency domains image enhancement, image restoration techniques, image segmentation, image compression, and morphological image processing. *Prerequisite: BME 412, BME 421 Co-requisite: ---*

BME 550A BioMEMS and Nanotechnology 3 C.H

Topics include the fundamental principles of micro-fluidics, bio-interfacing technology, bio-integration into micro-fabrication technology, as well as entertaining various biomedical and biological problems that can be addressed with micro-fabrication and nanotechnology. *Prerequisite: BME 442A, Co-requisite: ---*

BME 560 Biomedical Engineering Design 3 C.H

Introduces detailed description of the engineering design process and relevant information necessary for designing biomedical devices. The primary focus of the course is student design projects with applications in biomedical engineering. Covers presentation skills, communication skills, group dynamics, concept generation, product analysis, specifications, evaluation, design validation, clinical trials, regulation, liability, ethics, and case studies. *Prerequisite: BME 412, Co-requisite: ---*

BME 561 Medical Imaging Systems 3 C.H

The course describes four medical imaging systems; X-ray imaging, Radionuclide imaging, Magnetic resonance imaging (MRI), and Ultrasound imaging. For each system the course describes the fundamentals of the wave, the generation and detection of the wave, the diagnostic methods, image characteristics, and the biological effects of the given wave. *Prerequisite: BME 412, Co-requisite: ---*

BME 563 Diagnostic and Therapeutic Ultrasound 3 C.H

This course covers the fundamentals of acoustic propagation, the plane wave and the specific acoustic impedance, how the ultrasound wave propagates between two different mediums in both normal and oblique cases, the reflection and transmission coefficients, the Doppler Effect, the circular piston and its nearfield and farfield approximations, the piezoelectric effect, the electrical tuning matching circuit for a certain ultrasound transducer, the axial and lateral resolutions, the different types of ultrasound arrays, the pulse-echo methods, the biological effects of ultrasound, the wave distortion, and the design of a complete ultrasound transducer for either medical imaging ultrasound or therapeutic ultrasound. *Prerequisite: BME 412, Co-requisite: ---*

BME 565 Magnetic Resonance Imaging 3 C.H

Introduces physics of magnetic resonance. Covers magnetic field modalities, relaxation times, gradient and RF coils, pulse sequences, hardware, imaging techniques, artifacts, and spectroscopy. *Prerequisite: BME 412, Co-requisite: ---*

BME 567 Therapeutic Devices 3 C.H

Introduces principles of therapy and function of medical therapeutic devices. Covers Pacemakers, defibrillators, pump oxygenators, total artificial heart, lithotripsy, artificial kidney, anesthesia machine, ventilators, electrosurgical units, physical therapy equipment, radiotherapy equipment, ultrasound therapy, laser therapy, electrical stimulators, aids for the blind, cochlear implants, infant incubators and intelligent drug delivery systems. *Prerequisite: BME 412, Co-requisite: ---*

BME 580 Medical Informatics and Clinical Engineering 3 C.H

Architecture of medical information systems, data and process modeling, medical information extraction and representations, information retrieval and visualization, medical networking, medical communication protocols, security and encryption in networked healthcare environment, biotelemetry systems, clinical applications of information systems. *Prerequisite: BME 412, Co-requisite: ---*

BME 581 Healthcare Management Systems 3 C.H

Healthcare environment, medical technology management, healthcare care strategic planning utilizing technology assessment and evaluation, healthcare replacement planning, management styles and human resource development, safety management programs, risk management, information systems management, healthcare management systems, wireless management systems, medical equipments management programs, computerized maintenance management systems. *Prerequisite: BME 411, Co-requisite: ---*

BME 590 Special Topics 3 C.H

Covers a recent topic in biomedical Engineering as well as related current literature. *Prerequisite: BME 411, Co-requisite: ---*

b) Track two: Biomedical materials and Prosthetics

BME 510 Biomedical Sensors and Transducers 3 C.H

Introduction to biomedical sensors: definition, classification, calibration, requirements, errors and uncertainty, static and dynamic parameters, requirements and design aspects of signal conditioning circuits, temperature sensors: types, and signal processing circuits, Pressure sensors: types, operating principle, calibration techniques, medical applications and conditioning procedures, Electrochemical sensors, Ion-selective sensors, Biosensors, Ion-sensitive field effect chemo- sensors, Optical sensors, Ultrasound transducers, Intelligent biomedical sensors, Manufacturing of biomedical sensors. *Prerequisite: BME 412, Co-requisite: ---*

BME 542 Prosthetics and Orthotics 3 C.H

Introduction to upper and lower limb anatomy and amputations. Design, fabrication and fitting of prosthetic devices, general prosthetic replacement in human skeletal joints and limbs with reference to the associated mechanical design and biomechanical considerations will be examined. *Prerequisite: BME 442A, MED 236A, Co-requisite: ---*

BME 544 Biomechanics 3 C.H

Application of statics and dynamics to simple force analyses of the musculoskeletal system. Introduction to the fundamentals of strength of materials. Biomechanics of soft and hard tissues: microstructure and mechanical properties of biological tissues (Bones, joints, cartilage, blood vessels, connective tissue, muscle, and heart).

Prerequisite: ME 215, MED 236A Co-requisite: ---

BME 550A BioMEMS and Nanotechnology 3 C.H

Topics include the fundamental principles of micro-fluidics, bio-interfacing technology, bio-integration into micro-fabrication technology, as well as entertaining various biomedical and biological problems that can be addressed with micro-fabrication and nanotechnology.

Prerequisite: BME 442A, Co-requisite: ---

BME 552 Physiological Fluid Mechanics 3 C.H

Basic concepts and problems of fluid and solid mechanics and rheology are introduced and applied to the analysis of blood flow in the macro- and microcirculation, and to other physiological flows. Analysis of mathematical models is combined with discussions of physiological mechanisms.

Prerequisite: BME 411, ME 343 Co-requisite: ---

BME 554 Artificial Organs 3 C.H

Classification of biomaterials, biocompatibility, tissue engineering fundamentals and applications, bioartificial tissue, tissue function and dynamics, tissue microenvironment, cellular communications, cellular therapies, surface analysis techniques, design and function of artificial organs: artificial heart valves, total artificial heart, artificial lungs, artificial pancreas, artificial kidney, hearing aids, artificial cochlea, bioartificial liver, and artificial nose, ethics of organ replacement. *Prerequisite: BME 531A, BME 442A Co-requisite: ---*

BME 556 Cell and Molecular Biotechnology 3 C.H

This course will provide students with an introduction to biotechnology in an engineering context. Topics to be covered include nucleic acid structure and function, DNA replication, transcription, translation, chromosome

structure and remodeling, and regulation of gene expression. Extended topics to be covered include methods in recombinant DNA technology, micro-arrays and micro-RNA. *Prerequisite: BME 411, CHEM 262 Co-requisite: ---*

BME 558 Tissue Engineering 3 C.H

Cell-material interactions and interfaces; effect of construct architecture on tissue growth; and transport through engineered tissues. Examples of engineering tissues for replacing cartilage, bone, tendons, ligaments, skin and liver will be presented. *Prerequisite: BME 411, CHEM 262, MED 236A Co-requisite: ---*

BME 560 Biomedical Engineering Design 3 C.H

Introduces detailed description of the engineering design process and relevant information necessary for designing biomedical devices. The primary focus of the course is student design projects with applications in biomedical engineering. Covers presentation skills, communication skills, group dynamics, concept generation, product analysis, specifications, evaluation, design validation, clinical trials, regulation, liability, ethics, and case studies.

Prerequisite: BME 412, Co-requisite: ---

BME 562 Control and Communication in the Nervous System 3 C.H

An introduction to the structural and functional elements common to nervous systems, with emphasis on cellular dynamics, interneuronal communication, sensory and effector systems. *Prerequisite: BME 302, MED 236A, Co-requisite: ---*

BME 564 Bioinformatics 3 C.H

An interdisciplinary effort between molecular biology and computer science aimed at extracting the relevant biological information from the genome, and understanding not only the DNA itself, but the RNA and protein sequences that it encodes. Generally an overview of data mining, data analysis and computational methods of DNA/RNA and proteins as well as major applications and research areas.

Prerequisite: BME 531A, CHEM 262, Co-requisite: ---

BME 580 Medical Informatics and Clinical Engineering 3 C.H

Architecture of medical information systems, data and process modeling, medical information extraction and representations, information retrieval and visualization, medical networking, medical communication protocols, security and encryption in networked healthcare environment, biotelemetry systems, medical expert systems, clinical applications of information systems.

Prerequisite: BME 412, Co-requisite: ---

BME 590 Special Topics 3 C.H

Covers a recent topic in biomedical Engineering as well as related current literature.

Prerequisite: BME 411, Co-requisite: ---