DESCRIPTION OF B.Sc. COURSES FOR MEDICAL ENGINEERING

311102 Mathematics (1) [3][3-3]
Differentiation and application; complex numbers; analytical geometry; method of integration; infinite series; power series; vectors in three dimension; equations of line and plane in 3 dimension; complex power series; complex integration.
Prerequisite: None

311303 Physics for Engineers [3][3-3]
Physics and measurements; vectors; motions in one and two dimensions; laws of motion; circular motion; Newton's laws; work and energy; law of gravity linear momentum; and collisions; rotation of a rigid object about a fixed axis; rolling motion; angular momentum and torque; static equilibrium and elasticity; oscillatory motion. Electric charge and Coulomb’s law; Electric fields; Gauss law; electric potential, capacitance and dielectrics; current and resistance; direct current circuits; magnetic fields; sources of magnetic field; Faraday’s law; inductance; alternating current circuits; electromagnetic waves.
Prerequisite: None

311304 Physics Lab for Engineers [1] [1-3]
Measurement and errors; vectors; rectilinear motion; projectile motion; Newton’s second law; friction; collisions; circular motion; rotational motion; simple harmonic motion. Electric field mapping; Ohm’s construction law; Wheatstone bridge; electric power; potentiometer; Kirchhoff’s laws; Ammeter and Voltmeter construction; charging and discharging circuits (R-C circuits); electric magnetic field; Faraday’s laws of magnetic induction; resonance in R-L-C circuits.
Concurrent: 311303 Physics for Engineers

312104 Mathematics (2) [3][3-3]
Partial derivatives; optimization and applications; Lagrange Multiplier; double and triple integrals; solutions of higher linear ordinary differential Equations ODE's; series solution of linear ODE's; partial differential equations; wave and heat equations; Laplace transform; Fourier series; methods of separation of variables.
Prerequisite: 311102 Mathematics (1)

812003 Engineering Statistics [3][3-3]
Randomness; introduction to probability theory and probability distributions; discrete and continuous probability distributions; univariate analysis; decision theory (Bays’ theorem); hypothesis testing; confidence intervals and tolerance limits; correlation; regression analysis; analysis of variance; time series; nonparametric methods.
Prerequisite: 312104 Mathematics (2)

712206 Communication Skills and Ethics [2][2-2]
This course will teach students the established basics for effective written composition in the business world and introduce them to such types of communication as processes, description of mechanisms, proposals, and reports. Students utilize usage exercises, quizzes, and a final usage exam to reinforce sentence clarity and effectiveness. Each student will receive skill-appropriate, personal feedback and instruction from an experienced, qualified writing instructor.
Prerequisite: 771103 Communication Skills in English(1)
814006 Engineering Economy and Management {3}[3-3]
Engineering project development; decision making; basic concepts of capital investment, formulas and applications; rates of return; economic feasibility of projects (net future value, net present value, and equivalent uniform cash flow); comparison of mutually exclusive proposals; benefit-cost ratio method; depreciation; corporate taxation; resource allocation, optimization process, linear programming.
Prerequisite: 812003 Engineering Statistics

831001 Engineering Workshops {1} [1-2]
Workplace Safety and Use of Tools; Basic Skills of Machining; Basic Skills of Welding; Household Electric Circuit Installation; Basics of Carpentry and its Tools.
Prerequisite: None

831002 Engineering Drawing {2} [1-3]
Prerequisite: None

832004 Engineering Analysis(1) {3} [3-3]
Ordinary Differential Equations and Mathematical Modeling; First, Second and Higher Order Equations; Differential Equation Solving Using Infinite Series; Differential Equation Solving Using Laplace Transform; Applications in Electric Circuits.
Prerequisite: 312104 Mathematics (2)

832005 Engineering Analysis (2) {3} [3-3]
Linear Algebra: Matrices, Vectors, Determinants, Solution of Linear Systems of Equations, Inverse of a Matrix; Matrix Eigenvalue Problems: Eigenvalues, Eigenvectors, and Diagonalization; Complex Analysis: Complex Numbers and Functions, Analytic and Harmonic Complex Functions, Exponential, Trigonometric and Logarithmic Complex Functions.
Prerequisite: 832004 Engineering Analysis (1)

832101 Anatomy and Physiology for BME (1) {3} [3-3]
Medical Terminology; Introduction to the Levels of Organization of the Human Body: Chemical, Cells, Tissues, and Organs Levels; Skeletal System; Muscular System; Cardiovascular System; Nervous System.
Prerequisite: 771103 Communication Skills in English language (1)

832201 Biomechanics (1) {3} [3-3]
General Introduction: Statics, Dynamics, Elasticity, and Vector Analysis; Fundamentals of Mechanics: Deformations, Stress, and Strain; Applications of Mechanics in Biological Structures; Function and Engineering Analysis of Bone; Mechanics of Muscular System: Muscles, Skin, Tendons, and Ligaments.
Prerequisite: 311303 Physics for Engineering

833006 Numerical Analysis {3} [3-3]
General Numerical Methods: Equation Solving Via Iteration, Interpolation; Numerical Integration, and Numerical Differentiation; Numerical Methods in Linear Algebra;
Numerical Methods for Differential Equations; Multi-Step Methods; Optimization and Unconstrained Optimization.

**Prerequisite:** 832005 Engineering Analysis (2)

833103 Anatomy and Physiology for BME (2) [3-3]
Special Senses; Renal System; Digestive System; Respiratory System; Integumentary System

**Prerequisite:** 832101 Anatomy and physiology for BME (1)

833202 Biomechanics (2) [3] [3-3]
Introduction to Dynamics; Types and Degrees of Freedom in Joints; Functional Electrical Stimulation for Skeletal Muscles; Introduction to Vibration Theory; Free and Forced Vibrations; Vibration Isolator Design; Vibration Analysis of Biomedical Systems.

**Prerequisite:** 832201 Biomechanics (1)

833203 Biomaterials [2] [2-2]
General Introduction: Properties of Biological Materials, and Structure-Function Relationship; Engineered Biomaterials: Metallic, Ceramics, Polymeric, Composites, and Their Use in Implant Technology; Viscoelastic Materials; Biocompatibility; Smart Materials.

**Prerequisite:** 832201 Biomechanics (1)

833301 Medical Electronics [3] [3-3]
Amplifiers in Medical Electronics: Isolation Amplifiers, Low Noise Instrumentation Amplifiers, Biopotential Amplifiers, Applications of Operational Amplifiers; Active Filters; Wave Shaping Circuits; Oscillators; Bridge Circuits; Alarm Systems.

**Prerequisite:** 832301 Electronics 2

833308 Simulation Lab for Medical Engineering [1] [1-3]
MultiSim (Electronic Circuits) and ANSYS (Mechanics) for the design and analyse Medical Electronic and Biomechanical Systems respectively.

**Prerequisite:** 833301 Medical Electronics

834206 Fluid Mechanics for BME [3] [3-3]

**Prerequisite:** 833202 Biomechanics (2)

834302 Optoelectronics and Medical Lasers [3] [3-3]
Physics of Lasers; Fiber Optics; Biomedical Laser Sources and Applications; Types of Lasers: Continuous Wave and Pulsed Lasers, Surgical and Therapeutic Lasers; Laser-Tissue Interactions.

**Prerequisite:** 832301 Electronics (1)

834501 Biomedical Instrumentation I [3] [3-3]
Electrical Measuremets and Instrumentation; Analog Data Acquisition Systems; Basic Concepts of Biomedical Instrumentation; Biopotential Electrodes and Instrumentation (ECG, EEG, EMG and ENG); Blood Pressure and Flow Measurements and Instrumentation; Cardiac Output Measurement Techniques.

**Prerequisites:** 833103 Anatomy and Physiology for BME (2) & 833301 Medical Electronics
834502 Medical Sensors and Biotelemetry {3} [3-3]
Prerequisite: 833301 Medical Electronics

834503 Biomedical Instrumentation (2) {3} [3-3]
Microprocessor Interfacing and Computer Based Instrumentation; Respiratory System Instrumentation; Temperature Measurements; Audiometry; Electronic Patient Monitoring Systems; Therapeutic and Prosthetic Devices; Electrosurgery and Operating Room Equipment, Sterilization; Clinical Laboratory Equipment.
Prerequisite: 834501 Biomedical Instrumentation (1)

834508 Medical Sensors and Biotelemetry Lab {1} [1-2]
Introduction to The Practical Use of Biomedical Sensors and Biotelemetry; Experiments Include: Pulse Photoplethysmography, Galvanic Skin Resistance Measurement, Temperature Measurement; Respiratory Rate Measurement; Life Signs Meter S101 (Strain Gauge and Thermistor Sensors); Modulation and Demodulation Techniques, Transmitter and Receiver Circuits.
Concurrent: 834502 Medical Sensors and Biotelemetry

834509 Biomedical Instrumentation Lab {1} [1-3]
Experiments include: Signal Conditioning, Amplification, Filtration, and Processing; Medical Measuring Devices for Flow, Force, Pressure, Heart Rate, Biopotentials and Vital Signs Such As ECG, EEG, and EMG; Simulation of Biosignals; A/D and D/A Converters; Interfacing with Computers.
Prerequisite: 834501 Biomedical Instrumentation (1)
Concurrent: 834503 Biomedical Instrumentation (2)

835204 Rehabilitation Engineering {3} [3-3]
Prerequisite: 833203 Biomaterials

835205 Prosthetic and Artificial Organs {2} [2-2]
Biomechanics of the Upper and Lower Extremities; Analysis of the Aftermath of Various Injuries to the Human Body; Methodology and Requirements for the Reconstruction of an Injured or Diseased System in the Human Body; Overview of Various Prosthetic Systems for the Upper and Lower Extremities; Neuromuscular and Retinal Replacements; Osseointegration.
Prerequisite: 833203 Biomaterials

835207 Biomedical Transport Phenomena {3} [3-3]
This course covers: Body Fluids, Capillary Tubes, Osmosis and Protein Retention, Formation of Interstitial Fluids, Solute Transport in Biological Systems, Flow Properties of Blood, Oxygen Transport and Oxygen Level in Biological Systems, Factors Affecting Drug

**Prerequisite:** 833202 Biomechanics (2)

835208 Biomechanics and Rehabilitation Lab {1} [1-3]

**Concurrent:** 835204 Rehabilitation Engineering

835401 Computer Applications in BME {3} [3-3]
Programming in MATLAB and LabVIEW; Biomedical Engineering Related Applications; Data Acquisition; Biomedical Signal Processing; Image Acquisition; Medical Image Processing.

**Prerequisite:** 812401 Digital Logic Circuits

835402 Modeling Of Biocontrol Systems {3} [3-3]
This course introduces Methods for Analyzing and Designing Biomedical and Physiological Control Systems; Topics Include: Techniques for Generating Mathematical Models of Biomedical and Physiological Systems; Behavior of Physiological Control Systems Using Both Time and Frequency Domain Methods; Concept of Closed-Loop Real-Time Control of Biomedical Systems.

**Concurrent:** 874702 Control Systems

835403 Biomedical Informatics {3} [3-3]
This course focuses on the use of Computers and Information Management in Health Care; Topics Include: Organization of Medical Information; Effective Management of Information Using Computer Technology; Techniques for Assessing Current Information Practices, and Determining Information Needs of Health Care Providers and Patients; Introduction to Biomedical Imaging Informatics, Picture Archiving and Communication Systems (PACS).

**Prerequisite:** 835504 Clinical Engineering

835504 Clinical Engineering {3} [3-3]
This course introduces Basic Concepts of The Management of Medical Technology and Clinical Settings Including: Methods, Codes, Standards, Regulations, and Procedures in Biomedical Engineering Practices in Clinical Engineering Departments and Healthcare Facilities.

**Prerequisite:** 834503 Biomedical Instrumentation (2)

835505 Laboratory Instrumentation {3} [3-3]
This course covers Basic Principles of Laboratory Analytical Concepts and Instrumentation; Topics Include: Blood Cold Chain Equipment, Centrifugation; Histology Equipments, Microscopy; Spectrophotometry, Fluorometry; Blood Test Equipments, Flow Cytometry; Electro-Analytical Chemistry Autoanalyzers; Chromatography, and Electrophoresis; Drug Control Laboratory Systems.

**Prerequisite:** 834503 Biomedical Instrumentation (2)

835601 Medical Imaging Systems {3} [3-3]
Fundamental Principles and Applications of Noninvasive Imaging Modalities in Medicine; Information Content of an Image; Diagnostic X-rays; X-Ray Fluoroscopy; Computerized
Tomography (CT); Magnetic Resonance Imaging (MRI); Ultrasonic Medical Imaging; Nuclear Medicine Imaging; Thermography.

**Prerequisite:** 834503 Biomedical Instrumentation (2)

835602 Nuclear Medicine and Radiotherapy Systems [3] [3-3]
Nuclear Physics Fundamentals: Production of Radio-Nuclides, Radiation Detectors, Radiation Protection; Nuclear Imaging: Positron Emission Tomography (PET); Single-Photon Emission Computed Tomography (SPECT); Bone Densitometer; Thyroid Scan; Hot Lab Equipment; Radiotherapy Equipment; Linear Accelerators; Radiotherapy Simulators; and 3D Treatment Planning Systems.

**Prerequisite:** 834503 Biomedical Instrumentation (2)

835901 Graduation Project (1)
Each student (or a team of students) may choose from a list of research projects, and is/are supervised by a faculty member in the department. Project (1), which represents the first phase of the graduation project, requires gathering the practical and theoretical resources needed for the completion of graduation project (2).

**Prerequisite:** Completion of 120 Cr.H

835903 Graduation Project (2)
The student implements and finalizes the work described in project (1). After full implementation of the project’s goals, the student must present a comprehensive report on the entire graduation project to an examining committee.

**Prerequisite:** 835901

835908 Practical Engineering Training
Practical experience to be gained through working for eight continuous weeks in an accredited establishment.

**Prerequisite:** Completion of 110 Cr.H

812401 Digital Logic Circuit [3] [3-3]
Digital Numbering System and Information Representation: Arithmetic Operations, Decimal and Alphanumeric Codes, Binary Logic; Boolean Algebra: Identities, Functions and Manipulation, Standard Forms, Simplification, Logic Gates, Switch-Level and Logic CMOS Implementation, Integrated Circuits; Combinational Logic Design: Circuits (Gate Level), Design Hierarchy and Procedures, Computer-Aided Design, Combinational Two-Level and Multi-Level Implementations, Arithmetic (Add, Subtract, Multiply) and Other Popular Modules (Multiplexers, Encoders, Decoders); Programmable Logic Design: ROMs, PLAs, PALs, FPGAs, Language-Directed Combinational Design (VHDL); Sequential Logic Design: Latches, Flip-Flops, State Machine Design and Minimization (Mealy and Moore Models); Design Problems.

**Prerequisite:** 312104 Calculus (2)

812408 Digital Logic Lab [1] [1-2]
Combinational Logic Circuits; Storage Elements; Hazards (Malfunctions); Circuit Characteristics: Loads, Delays, Etc.; Simple Combinational Networks: Adders, Multiplexers, Etc.; Simple Sequential Networks: Counters, Shift Registers; Synchronous and Asynchronous Sequential Machines; Processor and Controller; Project Using a Microprocessor as a Control.

**Concurrent:** 812401 Digital Logic Circuits

813403 Microprocessors [3] [3-3]
Introduction to the Microprocessor and Microcomputer; The Microprocessor and its Architecture; Addressing Modes; Instruction Set; Programming the Microprocessor using Assembly Languages;
8086 and 8088 Hardware Specifications: Memory Interface, Basic I/O Interface, Interrupts, Keyboard and Printer Interface, PPI 82C55, ADC, DAC and DMA Interface.

Prerequisite: 812401 Digital Logic Circuits

813408 Microprocessor Lab (1) [1-3]
Explain the 8086/8088 Instructions Set; Developing Program and Programming Techniques Using the TASM Turbo Assembler Program; DOS Function Call and the BIOS Function Call.

Concurrent: 813403 Microprocessors

814404 Embedded Systems (3) [3-3]
Introduction to Embedded System: Understanding the Requirements, Constraints and Tools Associated with the Design and Implementation of Software Systems That Govern the Operation of Physical Hardware Since Such Systems are Often Combinations of Electrical, Mechanical and Software Components; Specific Topics Will Include: Microcontrollers and Embedded Development; Communication Protocols; Data Acquisition; Actuators; Sensors; Signal Processing; Basic Control Theory; and Real-Time Embedded Operating Systems.

Prerequisite: 813403 Microprocessors

814408 Embedded Systems Lab (1) [1-2]
Basic Introduction to Microcontroller-Based Embedded Systems Development; PIC Microcontroller Assembly Programming; C Language Programming; Peripheral Interfacing; Interrupt Management; Structured Programming and Task Scheduling; Applications on Digital Signal Processing (DSP); Mechanical and Electrical Sensors; and Other Related Topics;

Concurrent: 814404 Embedded Systems

815805 Digital Image Processing (3) [3-3]
Image Representation; Restoration; Transformation; Classification; Compression; Enhancement; Segmentation; Image Filters; Design; Histogram Techniques; Sampling and Quantization; Fast Fourier Transform; Image Data Structures; Parallel/Distributed Processing; Illumination Models and Surface-Rendering Methods; A Number of Applications Will Be Presented as Case Studies.

Prerequisite: 823007 Signals and Systems

872104 Electric circuit (1) [3] [3-3]

Prerequisite: 311303 Physics for Engineers

872106 Electric circuit (2) [3] [3-3]

Prerequisite: 872104 Electric circuits (1)
872108 Electric circuits Lab. {1} {1-3}
DC Circuits: Kirchoff’s Voltage and Current Laws, Network theorems, Maximum Power Transfer; Transient Circuits: RL, RC, RLC; Resonant Circuits; Magnetically Coupled Circuits; Two-Port Networks.
Concurrent: 872106 Electric circuits (2)

822201 Electronics (1) {3} {3-3}
Prerequisite: 822104 Electric circuits (1)

822208 Electronics Lab (1) {1} {1-3}
Diode characteristics; Clipping and Clamping Circuits: Half-Wave and Full-Wave Rectification; Zener - Diode and Voltage Regulation; BJT Characteristics and Biasing Circuits; FET Characteristics and Biasing circuits; BJT Amplifiers.
Concurrent: 822201 Electronics (1)

823007 Signals and Systems {3} {3-3}
Prerequisite: 872106 Electric circuits (1)

823201 Electronics (2) {3} {3-3}
Amplification; Biasing of Transistor (BJT and FET); Single-Stage Amplifier; Cascaded BJT and FET Amplifiers; Composite Transistor Stages; Operational Amplifiers and Applications; Differential Amplifier; Operational Amplifier Architectures; Gain with Active Load; DC Level Shifting; Output stage; Offset Voltages and Currents; Frequency Response of Amplifiers; The High-frequency Response of all Amplifier Configurations; The Low-Frequency Response of all Amplifier Configurations; The Frequency Response of Cascaded Stages; Feedback Amplifiers; Properties of Negative-Feedback Amplifiers; Properties of Feedback Amplifier Topologies; Analysis of Feedback Amplifiers.
Prerequisite: 822201 Electronics (1)

823208 Electronics Lab (2) {1} {1-3}
Amplifier and its Configurations; BJT Amplifier; Characteristic of JFET; Measurement of H-Parameters of BJT; Frequency Response of Single and Multi-Stage Amplifier; Transfer Characteristics of Cascade Amplifier; Differential Amplifier; Op-Amps and Application; Oscillators
Concurrent: 823201 Electronics (2)
823203 Digital Electronics {3} {3-3}
Applications of BJT as a Switch: RTL, DTL, TTL, ECL, MOS and CMOS Logic Gates; Timing Circuits: Bistable, Monostable, Astable Circuits and 555-timers; Wave-Shaping Circuits; Digital/Analog and Analog/Digital Converters; Sample and hold Circuits.
Prerequisite: 823201 Electronics (2)

823209 Digital Electronics Lab {1} {1-3}
Characteristics of Switching Devices; Characteristics of Logic Gates: RTL, TTL, and COMS; Analysis and Design of Multivibrators; Timing Circuits; Waveform Shaping Circuits; Applications of A/D and D/A Circuits; Interfacing of TTL & CMOS Gates.
Concurrent: 823203 Digital Electronics

874204 Power Electronics {3} {3-3}
General introduction; Power semiconductor Switches: Features, Characteristics and Classification of Diodes, Transistor, Thyristor and others; Quality Assessment and Parameters of AC & DC Waveform; Single-Phase and Three-Phase Rectifier Circuit; Uncontrolled, Fully-Controlled, and Semi-Controlled Converters; AC/AC Converters (AC Voltage Regulators); DC/DC Converters (DC Choppers); DC/AC Converters (Inverters); Applications of Power Electronics.
Prerequisite: 823201 Electronics (2) & 823007 Signals and Systems

824801 Digital Signals Processing [3] [3-3]
Discrete-Time Signals and Systems; Z-Transform; Frequency Analysis of Discrete-Time Signals and Systems; Fast Fourier Transform (FFT); DSP Systems; Design of Digital Filters: FIR, IIR Recursive and Non Recursive; Introduction to Image Processing; Computer Aided Design and Analysis homework using MATLAB software should be given to the students.
Prerequisite: 823007 Signals and Systems

874702 Control Systems [3] [3-3]
Concept of Control Systems; Open-loop and Closed-loop Systems; Mathematical Modeling of Physical Systems; Transfer Function and System Modeling Diagrams; Response Characteristics of Control Systems; Specifications of System Performance; Stability Analysis of Linear Control Systems; Routh’s Stability Criterion; Time-domain Analysis of Control Systems; Design of Controllers and Compensators.
Prerequisite: 823007 Signals and Systems

874708 Control Systems Lab. {1} {1-3}
Open-Loop and Closed-Loop Systems; Servomechanism Principles; Transient Response; Closed-Loop Position and Velocity Control Systems; The Effect of Gain, PI, PD, and PID Controls on System Performance; Frequency Response Measurements; Analogue Computer Simulation of Control Systems; System Analysis and Simulation using Software Packages; Introduction to Computer Control Systems.
Prerequisite: 874702 Control Systems