B.E.

BIOMEDICAL ENGINEERING

Curriculum and Syllabus
(Based on Choice Based Credit System)
Effective from the Academic year
2015-2016

Department of Biomedical Engineering

School of Bio-Engineering
Syllabus
Core Courses
Course Objective: To learn the basics of Ultrasonics, Lasers, Fibre optics and applications, Quantum physics and crystal physics etc., and to apply these fundamental principles to solve practical problems related to materials used for engineering applications.

UNIT- I
ULTRASONICS

UNIT - II
LASERS

UNIT- III
FIBRE OPTICS AND APPLICATIONS

UNIT- IV
QUANTUM PHYSICS
UNIT -V
CRYSTAL PHYSICS

Lattice – Unit cell – Bravais lattice – Lattice planes – Miller indices – d spacing in cubic lattice – Calculation of number of atoms per unit cell – Atomic radius – Coordination number – Packing factor for SC, BCC, FCC and HCP structures – NaCl, ZnS, diamond and graphite structures – Polymorphism and allotropy – Crystal defects – point, line and surface defects – Burger vector.

TOTAL: 45 h

TEXT BOOKS:

REFERENCE BOOKS:

15GBE 006 ENGINEERING PHYSICS LABORATORY 0 0 3 2

LIST OF EXPERIMENTS
1. Determination of Young’s modulus of the material – Non uniform bending.
2. Determination of Band Gap of a semiconductor material.
3. Determination of specific resistance of a given coil of wire – Carey Foster Bridge.
5. Spectrometer – Dispersive power of a prism.
6. Determination of Young’s modulus of the material – Uniform bending.
8. Ultrasonic Interferometer – Velocity of ultrasonic waves and compressibility of liquids.

TOTAL: 45 PERIODS

I Year/Semester II

15 EBM 001 HUMAN PHYSIOLOGY 3003

Course Objectives: To give an idea to the student about various mechanisms involved in the normal functioning of human body, underlining the basic working principles of different biological processes with engineering tools.

UNIT-I
Evolutionary aspects of biological systems, Thermodynamics of biological systems, Digital and analog molecules, Patterning of activity, Active and Passive process, Molecular homeostasis (molecular plasticity), Endogenous feed forward circuitry, Development and consolidation, stratified stabilities, Homogenous and Heterogeneous integration of Bio-molecules, Organelles, Integration of Organelles, Cells, Membrane Physiology, Transport across cell membrane, genesis of membrane potentials, Nernst equation, Resting membrane potential, Goldmann-Hodgkin-Katz equation, Cable properties (Local signaling-Analog Potentials(Digital mode), Hodgkin-Huxley model, Differential equations of action potentials, Voltage-Clamp and Patch-clamp methods, Signal Processing-Synapse, signal Transduction, Neuro transmitters, Biological amplification and filtration, Signal Integration(Input-sensory), Centers of Integration-Spinal Cord, Brain Stem, Cerebral Cortex, Motor System(Output)-Organization-Cortical, Sub cortical and spinal, Reflex process, NMJ, Smooth muscle, Cardiac Muscle, Skeletal muscle, Excitation-Contraction coupling, Sarcomere-Contractile Unit, Motor Unit, Frequency and Intensity related summation (temporal and Multi motor unit Summation), Tetanus, Load, Fatigue, EMG.

UNIT-II
CARDOI

CARDIOVASCULAR SYSTEM 10
Conducting system of the Heart, ECG, Blood as Non-Newtonian fluid, Dynamics of peripheral circulation, Resistance and Impedance, Streamline and Turbulent flow, Raynold’s Number, Poïsulle equation, Bernoulli equation, B.P., Control systems- Neurohumoral regulation, applied aspects.

UNIT-III
RESPIRATORY SYSTEM 10
Biophysics of Transport Across Respiratory Membrane, Perfusion and Diffusion limited process, Ventilation, Alveolar, Shunt and Dead space equations, Ventilation-perfusion inequalities, Physiological and anatomical shunts and dead spaces, Biophysics of transport of gasses in the blood, hemoglobin-oxygen association and dissociation curve, Haldane and Bohr effect, Applied aspects, Ventilators.

UNIT-IV
RENA SYSTEM 10
Regulation of volume and composition of Body fluids, Clearance equations, Biophysics of Filtration, Re-absorption and secretion, Counter current Multiplication and Exchange, Acid-Base Balance, regulation of Body Temperature-Physical and Physiological process, applied aspects, Dialysis, etc. Hormonal regulation of Body functions, Overview of Reproductive Physiology.

UNIT-V
NERVOUS SYSTEM 5
Higher functions of Brain(Perception, Rule of special senses, Learning and memory), Cybernetics of living systems, Neuro-Endocrine Control System, Servo mechanism, Posture and equilibrium, Motor skills, Neural Network related to the cognitive functions of the brain, near field(EEG) and Far Field Potentials(Evoked Potentials).
TOTAL: 45 PERIODS

TEXTBOOKS:

2. Best and Taylor, *Physiological basis of Medical Practice*.

REFERENCES:


15EBM002 BIOCHEMISTRY 3104

Course Objectives: To develop understanding and provide scientific basics of the life processes at the molecular level and explain the structure, function and inter-relationships of biomolecules and their deviation from normal and their consequences for interpreting and solving clinical problems.

Unit- I
BIOCHEMICAL ORGANIZATION AND BIOENERGETICS 10
Scope of clinical biochemistry, component of the cell, structure and biochemical functions, membrane structure and functions, transport through biological cell membrane, the concept of free energy, determination of change in free energy from equilibrium constant and reduction potential, bioenergetics and biological oxidation – general concept of oxidation and reduction, electron transport chain, oxidative phosphorylation, uncouplers and theories of biological oxidation and oxidative phosphorylation

Unit - II
BIOMOLECULES 12

Unit - III
BIOENERGETICS 5
High energy compounds, electronegative potential of compounds, respiratory chain, ATP cycle, Calculation of ATP during oxidation of glucose and fatty acids.

Unit - IV
MACROMOLECULES, VITAMINS, HORMONES, ENZYMES  
Physical and chemical properties, structure of haemoglobin, immunoglobulins and nucleoprotein, classification and their properties, occurrence, functions, requirements, deficiency manifestations and role of vitamins as coenzyme, chemical nature and properties, hormones, Nomenclature, enzyme kinetics, classification and their properties, mechanism of action, enzyme induction and inhibition, coenzyme significance and enzymes of clinical importance.

Unit -V
BIOCHEMISTRY OF CLINICAL DISEASES  
Diabetes mellitus, atherosclerosis, fatty liver, and obesity, hormonal disorders, aging, inborn errors of metabolism organ function tests

TOTAL: 45 L + 15T = 60 PERIODS

TEXTBOOKS:

REFERENCES:

15 EBM003  BIOCHEMISTRY AND HUMAN PHYSIOLOGY LABORATORY  0 0 3 2

Course Objectives:
To provide practice in:
• Estimation and quantification of biomolecules, Separation of macromolecules and their clinical importance. Study of the different physiological parameters and their clinical abnormalities.

LIST OF EXPERIMENTS:
1. General tests for carbohydrates, proteins and lipids.
2. Preparation of serum and plasma from blood.
3. Estimation of blood glucose.
4. Estimation of creatinine
5. Estimation of urea
6. Estimation of cholesterol
7. Assay of SGOT/SGPT
8. Separation of proteins by SDS electrophoresis
9. ESR, PCV, MCH, MC, MCHC, total count of RBCs and hemoglobin estimation.
10. Test of vision:
   a) Acuity of vision b) Colour vision, c) Ophthalmoscopy, d) Error of refraction
11. Examination of sensory system.
12. Examination of motor system. Recording of action potential and its display on oscilloscope (Demonstration).

LAB REQUIREMENT FOR A BATCH OF 30 STUDENTS:

- Spectrophotometer 1 No
- Colorimeter 2 Nos.
- pH meter 1 No
- Weighing balance 1 No
- Refrigerator 1 No
- Vortex Shaker 2 Nos.
- SDS gel electrophoresis 1 No
- Wintrobe’s tube 2 Nos.
- Centrifuge Normal 1 No
- Centrifuge Cooling 1 No
- Microslides 2 packets
- Lancet 5 boxes
- Microscope 1 No
- Neubaur’s Chamber 2 Nos.
- Heparinized Syringe 1 box
- Haemoglobinometer 1 No
- Capillary tubes 1 box
- Ophthalmoscope (direct & Indirect) 1 No
- Blood grouping kit 1 No

TOTAL: 45 PERIODS

II Year/Semester III

15 EBM004 MEDICAL PHYSICS 3 1 0 4

Course Objectives: To study effects of sound and light in human body, effects of radiation in matter and how isotopes are produced

UNIT- I
NON IONIZING RADIATION AND ITS MEDICAL APPLICATION 9

UNIT- II
SOUND IN MEDICINE
Physics of sound, Normal sound levels –ultrasound fundamentals – Generation of ultrasound (Ultrasound Transducer) - Interaction of Ultrasound with matter; Cavitations, Reflection, Transmission- Scanning systems – Artefacts- Ultrasound- Doppler-Double Doppler shift-Clinical Applications

UNIT- III
PRINCIPLES OF RADIOACTIVE NUCLIDES

UNIT- IV
INTERACTION OF RADIATION WITH MATTER

UNIT -V
BASIC RADIATION QUANTITIES
Introduction -exposure- Inverse square law-KERMA-Kerma and absorbed dose –stopping power - relationship between the dosimetric quantities - Bremsstrahlung radiation, Bragg’s curve-concept of LD 50- Stochastic and Non-stochastic effects, Different radiation Unit, Roentgen, gray, Sievert.

TOTAL: 45 + 15T = PERIODS

TEXT BOOKS:

REFERENCES:
3. J.P.Woodcock, Ultrasonic,Medical Physics Handbook series 1, Adam Hilger, Bristol, 2002
Course Objectives: The enable students to understand electrical and non-electrical physiological measurements and bioamplifiers.

UNIT- I
BIO POTENTIAL ELECTRODES 9

UNIT- II
ELECTRODE CONFIGURATIONS 9
Biosignals characteristics – frequency and amplitude ranges. ECG – Einthoven’s triangle, standard 12 lead system. EEG – 10-20 electrode system, unipolar, bipolar and average mode. EMG—unipolar and bipolar mode.

UNIT -III
BIO AMPLIFIER 8

UNIT- IV
MEASUREMENT OF NON-ELECTRICAL PARAMETERS 10

UNIT- V
BIO-CHEMICAL MEASUREMENT 9
Biochemical sensors - pH, pO₂ and pCO₂, Ion selective Field effect Transistor (ISFET), Immunologically sensitive FET (IMFET), Blood glucose sensors - Blood gas analyzers, colorimeter, flame photometer, spectrophotometer, blood cell counter, auto analyzer (simplified schematic description).

TOTAL: 45 PERIODS

TEXT BOOKS:

REFERENCES:

TOTAL: 45 + 15T = 60 PERIODS

15EBM006 BIO MEDICAL INSTRUMENTATION LABORATORY 0 0 3 2

Course Objectives: To provide hands on training on the measurement of different physiological and biochemical parameters, measurement and biosignal analysis.

LIST OF EXPERIMENTS:
1. Design and analysis of biological pre amplifiers
2. Recording of ECG signal and analysis
3. Recording of EMG-Signal
4. Recording of EEG-Signal
5. Recording of various physiological parameters using patient monitoring system and telemetry units.
7. Measurement and recording of peripheral blood flow
9. Study of characteristics of optical Isolation amplifier
10. Galvanic skin resistance (GSR) measurement.

TOTAL: 45 PERIODS

LAB REQUIREMENTS FOR A BATCH OF 30 STUDENTS:
- Multiparameter patient monitoring system: 1 No.
- EEG recorder with accessories for evoked studies: 1 No.
- ECG recorder: 1 No.
- EMG recorder: 1 No.
- pH meter, conductivity meter: 1 No.
- Blood flow measurement system using ultrasound transducer: 1 No.
- GSR measurement setup: 1 No.
- Function Generators
- DSOs
- Regulated Power supplies
OBJECTIVES: To introduce the basics of various electronic components used for the construction of medical devices and make them understand the basics of semiconductor diode, various special purpose diodes, characteristics of various transistor configuration and to educate concepts of IC fabrication technique.

UNIT- I INTRODUCTION TO SEMICONDUCTOR DIODES 9
p-n junction Energy band diagram of PN diode, PN diode operation- forward bias and reverse bias , Volt-ampere characteristics of p-n diode, Temperature dependence of VI characteristics, current components in p-n diode, Diode equation, Transition and Diffusion capacitances, Step graded junction, Breakdown Mechanisms in Semi Conductor diodes.

UNIT- II SPECIAL PURPOSE DIODES & TRANSISTORS 8
Zener diode characteristics, Characteristics of Tunnel Diode, LED, LDR, Varactor Diode, photo diode, PIN diode, Medical Application of LED & PIN Photodiode, LASER diode, Junction transistor-construction, Transistor current components.

UNIT- III TRANSISTORS - CHARACTERISTICS, HYBRID MODEL 10

UNIT- IV FIELD EFFECT TRANSISTOR (FET) 10
Junction field effect transistor-Theory & its V-I Characteristics, JFET small signal model, VVR operation of a FET, MOSFET and its classification, V-I Characteristics, Power MOSFET, MOS as a charge transferring Device – CCD, Uni-junction transistor, UJT as a relaxation oscillator. Medical application of MOSFET

UNIT - V THYRISTORS AND IC FABRICATION 8
Working, V-I characteristics and features of Silicon Controlled Rectifier, DIAC, TRIAC, GTO – Device Technology, Basic Planar processes, Thick film and thin film Technology.

TEXTBOOKS:
REFERENCES:

TOTAL: 45 + 15T = 60 PERIODS

15 EBM008 MEDICAL ELECTRONIC DEVICES LABORATORY 0 0 3 2

Course Objectives: To study and analyze the theoretical and practical characteristics of the fundamental electronic devices. To study the characteristics of diodes, transistors, FET and special purpose diodes and to analyze the applicability of the basic devices in various biomedical applications.

LIST OF EXPERIMENTS
1. Characteristics of semiconductor Diode
2. Characteristics of Zener Diode
3. Characteristics of Transistor under Common Emitter configuration
4. Characteristics of Transistor under Common Base Configuration
5. Characteristics of Transistor under Common Collector configuration
6. Characteristics of UJT
7. Characteristics of FET
8. Characteristics of SCR
9. Characteristics of DIAC
10. Characteristics of TRIAC
11. Characteristics of LDR
12. Characteristics of PHOTO DIODE
13. Case study: Biomedical application in electron device.

LABORATORY REQUIREMENTS FOR A BATCH OF 30 STUDENTS

- NI ELVIS Circuit Prototyping Hardware
- NI LabVIEW System Design Software
- NI Multisim Circuit Simulation Software
- NI Ultiboard PCB Design Software

TOTAL: 45 PERIODS

II Year/Semester IV

15 EBM 009 PATHOLOGY AND MICROBIOLOGY 3 0 0 3
Course Objectives: To help the student gain a knowledge on the structural and functional aspects of living organisms, know the etiology and remedy in treating the pathological diseases and empower them with knowledge of the importance of public health.

UNIT I CELL DEGENERATION, REPAIR AND NEOPLASIA 9
Cell injury and Necrosis, Apoptosis, Intracellular accumulations, Pathological calcification, cellular adaptations of growth and differentiation, Inflammation and Repair including fracture healing, Neoplasia, Classification, Benign and Malignant tumours, carcinogenesis, spread of tumours. Autopsy and biopsy.

UNIT II FLUID AND HEMODYNAMIC DERRANGEMENTS 9

UNIT III MICROSCOPES 9

UNIT IV MICROBIAL CULTURES 9
Morphological features and structural organization of bacteria, growth curve, identification of bacteria, culture media and its types, culture techniques and observation of culture.

UNIT V IMMUNOLOGY 9
Natural and artificial immunity, opsonization, phagocytosis, inflammation, Immune deficiency syndrome, antibodies and its types, antigen and antibody reactions, immunological techniques: immune diffusion, immuno electrophoresis, RIA and ELISA, monoclonal antibodies. Disease caused by bacteria, fungi, protozoal, virus and helminthes.

TEXT BOOKS:

REFERENCES:

15EBM010 PATHOLOGY AND MICROBIOLOGY LABORATORY 0 0 3 2

Course Objectives: The student should learn how to use Compound microscope, Practice on chemical examinations, Cryoprocessing, Histopathological examinations etc.
LIST OF EXPERIMENTS:
1. Urine physical and chemical examination (protein, reducing substances, ketones, bilirubin and blood)
2. Study of parts of compound microscope
3. Histopathological slides of benign and malignant tumours.
4. Manual paraffin tissue processing and section cutting (demonstration)
5. Cryo processing of tissue and cryosectioning (demonstration)
6. Basic staining – Hematoxylin and eosin staining.
7. Special stains – cresyl fast Blue (CFV)- Trichrome – oil red O – PAS
8. Simple stain.
10. AFB stain.
11. Slides of malarial parasites, micro filaria and leishmania donovani.
13. Bleeding time and clotting time.

TOTAL : 45 PERIODS

LAB EQUIPMENTS FOR 30 STUDENTS:
• Wax dispenser 1 No
• Slide warming 1 No
• Microtome 1 No
• Microscope
• Microphotographic unit 1 No
• Slides 1 box
• Coverslip 1 box
• Distillation Unit 1 No
• Water bath normal 1 No
• Incubator 1 No
• Autoclave 1 No
• Oven 1 No

15EBM 011                      SENSORS AND MEASUREMENTS                     3 0 0 3

Course Objectives: To teach the students the purpose of measurement, the methods of measurements, errors associated with measurements. Know the principle of transduction, classifications and the characteristics of different transducers and study its Biomedical applications and know the different display and recording devices.

UNIT- I
SCIENCE OF MEASUREMENT

UNIT- II
DISPLACEMENT, PRESSURE, TEMPERATURE SENSORS

Strain Gauge: Gauge factor, sensing elements, configuration, unbounded strain gage, biomedical applications; strain gauge as displacement & pressure transducers: Capacitive transducer, Inductive transducer, LVDT, Passive types: RTD materials & range, relative resistance vs. Temperature characteristics, thermistor characteristics, biomedical applications of Temperature sensors. Active type: Thermocouple – characteristics.

UNIT - III
PHOTOELECTRIC AND PIEZOELECTRIC SENSORS

Phototube, scintillation counter, Photo Multiplier Tube (PMT), photovoltaic, Photo conductive cells, photo diodes, phototransistor, comparison of photoelectric transducers, pectro photometric applications of photoelectric transducers. Piezoelectric active transducer and biomedical applications as pressure & Ultrasound transducer.

UNIT- IV
SIGNAL CONDITIONING & SIGNAL ANALYSER


UNIT-V
DISPLAY AND RECORDING DEVICES

Digital voltmeter – Multi meter – CRO – block diagram, CRT – vertical & horizontal deflection system, DSO, LCD monitor, PMMC writing systems, servo recorders, photographic recorder, magnetic tape recorder, Inkjet recorder, thermal recorder.

TOTAL: 45L = 45 PERIODS

TEXT BOOK:

REFERENCES:

15 EBM012 SENSORS AND MEASUREMENTS LABORATORY 0 0 3 2
**Course Objectives:** To study and analyze the theory and practical characteristics of the various transducers for the measurement of the vital physiological signals. To get familiar with the various types of transducers and to study the compatibility for any clinical measurements

**LIST OF EXPERIMENTS:**
1. Characteristics of pressure transducer
2. Measurement of displacement capacitive transducer, LVDT and Inductive transducer
3. Characteristics of optical transducer for SpO2 measurement
4. Measurement of skin temperature by both contact and non-contact method
5. Study of the characteristics of capacitor level sensor for saline level measurement in an I-V set.
6. Data acquisition of physiological signals
7. Study of hot-wire anemometry
8. Study of amperometric sensor for blood glucose measurement
9. Electronic weighing machine for the measurement of chemical compounds

**REFERENCE**

1. Biomedical Sensor and Measurements Laboratory Manual

**TOTAL: 45 PERIODS**

15EBM013 ANALOG AND DIGITAL ICs 3 1 0 4

**Course Objectives:** To teach the students the basic of the Digital systems, application of analog ICs in the designing circuit, study the applications of these Digital ICs,

**UNIT - I**

**NUMBER SYSTEMS AND LOGIC GATES**


**UNIT - II**

**REGISTERS AND COUNTERS**

UNIT- III
OPERATIONAL AMPLIFIERS

UNIT - IV
ACTIVE FILTERS AND SIGNAL GENERATOR
Active filters (first and second order) – Low pass, high pass, band pass filters, band reject filters (notch filters). Oscillators - RC Phase shift and Wein-bridge. Waveform generators - Square, triangular and saw tooth.

UNIT- V
TIMER, PLL, A/D AND D/A CONVERTERS
555 Timer (internal diagram) and its applications – monostable multivibrator, astable multivibrator. Phase locked Loop (565 - block diagram approach) and its applications - Frequency multiplication, Frequency translation, voltage to frequency and frequency to voltage converters. DAC – Binary weighted DAC and R-2R DAC. ADC – single slope and dual slope ADCs, successive approximation ADC

TOTAL: 45 L + 15T= 60 PERIODS

TEXT BOOKS:

REFERENCES:

EBM 014 Is Industrial Internship /Inplant Training to be completed at the end of II year
Course Objectives: To study the concept and different mathematical techniques applied in analyzing any given system, to learn the analysis of a given system in time domain and frequency domain.

UNIT-I
MODELING OF SYSTEMS
Terminology and basic structure of control system, example of a closed loop system, transfer functions, modeling of electrical systems, translational and rotational mechanical systems, and electro mechanical systems, block diagram and signal flow graph representation of systems, conversion of block diagram to signal flow graph, reduction of block diagram and signal flow graph.

UNIT-II
TIME RESPONSE ANALYSIS
Step and impulse responses of first order and second order systems, determination of time domain specifications of first and second order systems from its output responses, definition of steady state error constants and its computations.

UNIT-III
STABILITY ANALYSIS
Definition of stability, Routh- Hurwitz criteria of stability, root locus technique, construction of root locus and study of stability, definition of dominant poles and relative stability.

UNIT-IV
FREQUENCY RESPONSE ANALYSIS
Frequency response, Nyquist stability criterion, Nyquist plot and determination of closed loop stability, definition of gain margin and phase margin, Bode plot, determination of gain margin and phase margin using Bode plot, use of Nichol’s chart to compute response frequency and bandwidth.

UNIT-V
PHYSIOLOGICAL CONTROL SYSTEM
Example of physiological control system, difference between engineering and physiological control systems, generalized system properties, models with combination of system elements, linear models of physiological systems-Examples, introduction to simulation.

TOTAL: 45L + 15T=60 PERIODS

TEXT BOOKS:
REFERENCES:

15EBM 0016 BIOMATERIALS AND ARTIFICIAL ORGANS 3 0 0 3

Course Objectives: The student should be made to learn characteristics and classification of Biomaterials, Understand different metals and ceramics used as biomaterials, learn polymeric materials and combinations that could be used as a tissue replacement implants and know artificial organ developed using these materials

UNIT - I
STRUCTURE OF BIO-MATERIALS AND BIO-COMPATIBILITY 9
Definition and classification of bio-materials, mechanical properties, visco elasticity, wound healing process, body response to implants, blood compatibility.

UNIT- II
IMPLANT MATERIALS 9
Metallic implant materials, stainless steels, co-based alloys, Ti-based alloys, ceramic implant materials, aluminum oxides, hydroxyapatite, glass ceramics, carbons, medical applications.

UNIT- III
POLYMERIC IMPLANT MATERIALS 9

UNIT- IV
TISSUE REPLACEMENT IMPLANTS 9
Small intestinal submucosa and other decullarized matrix biomaterials for tissue repair. Softtissue replacements, sutures, surgical tapes, adhesive, Percutaneous and skin implants, maxillofacial augmentation, Vascular grafts, hard tissue replacement Implants, joint replacements, Pancreas replacement.

UNIT - V ARTIFICIAL ORGANS 9
Artificial blood, Artificial skin, Artificial Heart, Prosthetic Cardiac Valves, Artificial lung (oxygenator), Artificial Kidney (Dialyser membrane), Dental Implants.

TOTAL: 45 PERIODS

TEXT BOOK:
REFERENCES:

15 EBM 017 MEDICAL OPTICS 3003

Course Objectives: To study about the optical properties of the tissues and the applications of laser in diagnosis and therapy.

UNIT- I
OPTICAL PROPERTIES OF THE TISSUES 9
Refraction, Scattering, Absorption, Light transport inside the tissue, Tissue properties, Laser Characteristics as applied to medicine and biology-Laser tissue Interaction-Chemical-Thermal-Electromechanical – Photoabalative processes.

UNIT- II
INSTRUMENTATION IN PHOTONICS 9
Instrumentation for absorption, Scattering and emission measurements, excitation light sources – high pressure arc lamp, LEDs, Lasers, Optical filters, - optical detectors – Time resolved and phase resolved detectors.

UNIT - III
SURGICAL APPLICATIONS OF LASERS 9

UNIT - IV
NON THERMAL DIAGNOSTIC APPLICATIONS 9
Optical coherence tomography, Elastography, Laser Induced Fluorescence (LIF)-Imaging, FLIM Raman Spectroscopy and Imaging, FLIM – Holographic and speckle application of lasers in biology and medicine.

UNIT- V THERAPEUTIC APPLICATIONS 9
Phototherapy, Photodynamic therapy (PDT) - Principle and mechanism - Oncological and nononcological applications of PDT - Biostimulation effect – applications-Laser Safety Procedures.

TOTAL: 45 PERIODS
15EBM018 BIOMEDICAL DIAGNOSTIC AND THERAPEUTIC EQUIPMENT

Course Objectives: To enable the students to understand the medical devices applied in measurement of parameters related to cardiology, neurology and the methods of continuous monitoring and transmitting them, learn some of the cardiac assist devices, measure the signals generated by muscles and understand the need and use of some of the extracorporeal devices.

UNIT- I CARDIAC EQUIPMENT
Electrocardiograph, Normal and Abnormal Waves, Heart rate monitor, Holter Monitor, Phonocardiography, Plethysmography. Cardiac Pacemaker- Internal and External Pacemaker– Batteries, AC and DC Defibrillator- Internal and External

UNIT- II NEUROLOGICAL EQUIPMENT
Clinical significance of EEG, Multi channel EEG recording system, Epilepsy, Evoked Potential– Visual,Auditory and Somatosensory, MEG (Magneto Encephalo Graph). EEG Bio Feedback Instrumentation.

UNIT- III SKELETAL MUSCULAR EQUIPMENT
Generation of EMG, recording and analysis of EMG waveforms, fatigue characteristics, Muscle stimulators, nerve stimulators, Nerve conduction velocity measurement, EMG Bio Feedback Instrumentation.

UNIT- IV PATIENT MONITORING AND BIOTELEMETRY
Patient monitoring systems, ICU/CCU Equipments, Infusion pumps, bed side monitors, Central consoling controls. Radio Telemetry (single, multi), Portable and Landline Telemetry unit, Applications in ECG and EEG Transmission.

UNIT- V EXTRA CORPOREAL DEVICES AND SPECIAL DIAGNOSTIC TECHNIQUES

**TOTAL: 45 PERIODS**

**TEXT BOOK:**

**REFERENCES:**

**Course Objectives:** To provide practice on recording and analysis of different bio potentials, study the function of different therapeutic equipments.

**LIST OF EXPERIMENTS:**
1. Simulation of ECG – detection of QRS complex and heart rate
2. Study of shortwave and ultrasonic diathermy
3. Study of biotelemetry
4. Electrical safety measurements.
7. Study of ESU – cutting and coagulation modes
8. Recording of Audiogram
9. Design of ECG amplifier, recording and analysis using Lab View

**TOTAL: 45 PERIODS**
LAB REQUIREMENTS FOR 30 STUDENTS

- Multioutput power supply (+15v, -15v, +30V variable, +5V, 2A) 2 Nos.
- Short wave Diathermy 1 No.
- Ultrasound diathermy 1 No.
- Single parameter biotelemetry system 1 No.
- Electrical Safety Analyser 1 No.
- Spirometry with associated analysis system 1 No.
- ECG Simulator 1 No.
- Medical stimulator 1 No
- Surgical diathermy with analyzer 1 No
- Audiometer 1No
- Lab View.

III Year/Semester VI
15 EBM020 RADIOLOGICAL EQUIPMENT 3 1 0 4

Course Objectives: To teach the students and make them understand generation of x-rays and its uses in imaging, different types of radio diagnostic techniques. To enable them to learn techniques used for visualizing different sections of the body, learn radiation therapy methodologies and the radiation safety.

UNIT- I
MEDICAL X-RAY EQUIPMENT 9

UNIT- II
COMPUTED TOMOGRAPHY 9

UNIT- III
MAGNETIC RESONANCE IMAGING 9
Fundamentals of magnetic resonance- Interaction of Nuclei with static magnetic field and Radio frequency wave- rotation and precession – Induction of magnetic resonance signals – bulk magnetization – Relaxation processes T1 and T2. Block Diagram approach of MRI system-system magnet (Permanent, Electromagnet and Super conductors), generations of gradient magnetic fields, Radio Frequency coils (sending and receiving), shim coils, Electronic components, fMRI.

UNIT- IV
NUCLEAR MEDICINE SYSTEM

UNIT- V
RADIATION THERAPY AND RADIATION SAFETY

TOTAL: 45 PERIODS

TEXT BOOKS:

REFERENCES:

TOTAL 45 L + 15T = 60 PERIODS

15 EBM021 BIOMECHANICS 3 1 0 4

Course Objectives: The student will be exposed to principles of mechanics, learn the mechanics of physiological systems, be familiar with the mathematical models used in the analysis of biomechanical systems.

UNIT- I
INTRODUCTION TO MECHANICS

UNIT -II
BIOFLUID MECHANICS
Introduction, viscosity and capillary viscometer, Rheological properties of blood, laminar flow, Couette flow and Hagen-poiseuille equation, turbulent flow. Cardiovascular system - biological and mechanical valves development, artificial heart valves testing of valves, Structure, functions, material properties and modeling of Blood vessels.

UNIT- III
BIOSOLID MECHANICS

Hard Tissues: Bone structure & composition mechanical properties of bone, cortical and cancellous bones, viscoelastic properties, Maxwell & Voight models – anisotropy.


UNIT- IV
BIOMECHANICS OF JOINTS AND IMPLANTS

Skeletal joints, forces and stresses in human joints, Analysis of rigid bodies in equilibrium, free body diagrams, types of joint, biomechanical analysis of elbow, shoulder, spinal column, hip knee and ankle. Design of orthopedic implant, specifications for a prosthetic joint, biocompatibility, requirement of a biomaterial, characteristics of different types of biomaterials, manufacturing process of implants, fixation of implants.

UNIT- V
MODELLING AND ERGONOMICS


TEXT BOOKS:

REFERENCES:

TOTAL 45 L + 15T = 60 PERIODS

15 EBM022 MEDICAL IMAGE PROCESSING AND ANALYSIS 3 0 0 3

Course Objectives: To learn the fundamental concepts of medical image acquisition and understand how to apply the image processing techniques for various medical images. To learn the image fundamentals and mathematical transforms necessary for image processing, study the
various image enhancement techniques, apply various image restoration procedures in Medical images. To gain knowledge about the basic concepts of image compression procedures and study about the various segmentation techniques applied to Medical Images.

UNIT I - FUNDAMENTALS OF DIGITAL IMAGE AND TRANSFORMS 9
Elements of Visual perception, Image sampling and quantization, Neighborhood pixel Relationships – Basic Image operations – Arithmetic, Geometric and Morphological, Image transform: 2D DFT- Discrete cosine-, Sine-, Haar-, and Hadamard- transform

UNIT II - IMAGE ENHANCEMENT 9
Basic gray level transformation, Histogram processing ,Smoothening by spatial filters - Sharpening by spatial filters ,Smoothening- frequency domain filters, Sharpening- frequency domain filters ,Color image Processing- color models- Pseudo color image processing– Color Image Transformation – Smoothening - Sharpening.

UNIT III - IMAGE SEGMENTATION AND OBJECT RECOGNITION 9
Edge detection- Marr Hidreth edge detector - Canny edge detector, Thresholding foundation - Basic global thresholding - Basic Adaptive thresholding, Region Based segmentation, Watershed segmentation algorithm, Patterns and pattern classes, Recognition based on decision theoretic methods-matching, Optimum statistical classifiers.

UNIT IV - IMAGE COMPRESSION 9

UNIT V - IMAGE RESTORATION AND RECONSTRUCTION OF MEDICAL IMAGES 9
Image degradation models, Algebraic approach to restoration, inverse filtering. Least mean square filter, Image reconstruction from projections – Radon transforms - Filter back projection algorithm – Fourier reconstruction of MRI Images

TEXTBOOKS:

REFERENCES:

15 EBM 23 MEDICAL IMAGE PROCESSING AND ANALYSIS 0 0 3 2
LABORATORY
Course Objectives: To gain the practical knowledge about the processing of medical images, understand the fundamentals of digital image and its properties. To enhance the medical images by applying various filters and segment the region of interest using various image processing Algorithms.
LIST OF EXPERIMENTS:
1. Digital image Fundamentals.
2. Image Enhancement
4. Image Transformation in spatial domain and frequency domain.
5. Edge detection and boundary tracing techniques.
6. Region based processing
7. Color image processing
8. Statistical Image Analysis.
10. Image segmentation by thresholding.

TOTAL = 45 PERIODS

REFERENCES:
1. Medical Image Processing and Analysis Lab Manual

15 EBM 024 Minor Project: At the end of the VI Semester the students will execute a minor project.

IV Year/ Semester VII

15 EBM 025 PATTERN RECOGNITION AND NEURAL NETWORKS 3 1 0 4

Course Objectives: The course will introduce the student to the fundamentals of pattern recognition and its application, discuss several supervised and unsupervised algorithms suitable for pattern classification. Particular emphasis will be given to computational methods such as linear discriminant functions and nearest neighbor rule. The course will also cover basic neural network architectures and learning algorithms, for applications in pattern recognition, image processing, and computer vision.

UNIT - I
INTRODUCTION AND SUPERVISED LEARNING 9
Overview of Pattern recognition, Types of Pattern recognition, Parametric and Nonparametric approach, Bayesian classifier, Discriminant function, non parametric density estimation, histograms, kernels, window estimators, k- nearest neighbor classifier, estimation of error rates.

UNIT- II
UNSUPERVISED LEARNING AND CLUSTERING ANALYSIS 9
Unsupervised learning- Hierarchical clustering- Single-linkage Algorithm, Complete – linkage Algorithm, Average-linkage algorithm and Ward’s method. Partitional clustering- Forgy’s Algorithm, k-means algorithm and Isodata Algorithm

UNIT - III
INTRODUCTION AND SIMPLE NEURAL NET 9
Elementary neurophysiology and biological neural network- Artificial neural network-
Architecture, biases and thresholds, Hebb net, Perceptron, Adaline and Madaline.

UNIT- IV
BACK PROPAGATION AND ASSOCIATIVE MEMORY
Back propagation network, generalized delta rule, Bidirectional Associative memory Hopfield
Network

UNIT - V
NEURAL NETWORKS BASED ON COMPETITION
Kohonen Self organizing map, Learning Vector Quantisation, Counter Propagation network.

TOTAL: 45 L + 15 T= 60 PERIODS

TEXT BOOKS:
Delhi, 2002.

REFERENCES:
2. Earl Gose, Richard Johnsonbaugh Steve Jost, “Pattern Recognition and Image Analysis”,
Prentice Hall of India Pvt Ltd., New Delhi, 1999.
4. Laurene Fausett, “Fundamentals of neural networks- Architectures, algorithms and

15 EBM026 MEDICAL INFORMATICS 3 1 0 4

Course Objectives: The student will learn ICT applications in medicine with an introduction to
health informatics., understand the theories and practices adopted in Hospital Information
Systems in the light of medical standards, medical data formats and recent trends in Hospital
Information Systems.

UNIT-I
MEDICAL INFORMATICS
Introduction – Medical Informatics – Bioinformatics – Health Informatics - Structure of Medical
Informatics – Functional capabilities of Hospital Information System - On-line services and Off –
line services - Dialogue with the computer.

UNIT- II
MEDICAL STANDARDS
Patient Records – Healthcare Standard Organizations – JCAHO (Joint Commission on Accreditation of Healthcare Organization) - JCIA (Joint Commission International Accreditation) - Evidence Based Medicine - Bioethics.

UNIT - III MEDICAL DATA STORAGE AND AUTOMATION
Representation of Data, Data modeling Techniques, Relational Hierarchical and network Approach, Normalization techniques for Data handling - Plug-in Data Acquisition and Control Boards – Data Acquisition using Serial Interface – Medical Data formats – Signal, Image and Video Formats – Medical Databases - Automation in clinical laboratories - Intelligent Laboratory Information System – PACS.

UNIT- IV HEALTH INFORMATICS
Bioinformatics Databases, Bio-information technologies, Semantic web and Bioinformatics, Genome projects, Clinical informatics, Nursing informatics, Public health informatics, Education and Training

UNIT- V
RECENT TRENDS IN MEDICAL INFORMATICS

TOTAL: 45 L + 15 T = 60 PERIODS

TEXT BOOKS:

REFERENCES:

15 EBM 027 PROSTHETIC ENGINEERING

OBJECTIVES: To enable students to help extend knowledge of the amputee, of lost and remaining functions affecting locomotion, and to collect information on the best possible medical treatment. To improve fitting techniques and practices, including training, so that
existing devices might be used with greater comfort and function. To develop improved lower-
limb devices.

UNIT – I  9
Engineering Concepts in Sensory Rehabilitation, Motor Rehabilitation, Communication Disor-
ders, Computer-Aided Engineering in customized component design. Intelligent prosthetic
knee, Hierarchically controlled prosthetic hand, Self-aligning orthotic knee joint. Externally
powered and controlled orthotics and prosthetics: FES systems: Restoration of hand function,
Myoelectric hand and arm prostheses.

UNIT – II  9
Transportation. Auxiliary devices and systems.

UNIT – III  9
Sensory augmentation and substitution: Visual system: Visual augmentation. Tactual vision
substitution, Auditory vision substitution; Auditory system: Auditory augmentation. Cochlear
implantation, Visual auditory substitution, Tactual auditory substitution, Tactual system: Tactual
augmentation. Tactual substitution, Augmentative communication, Control and Computer
Access: User Interface, Cost-Effectiveness of High – Verses Low – technology Approaches,
Intervention and other Issues.

UNIT – IV  9
Measurement tools and processes: Subjective and Objective measurement methods,
Measurements and assessments; measurement Objectives and Approaches; Characterising the
Characterizing overall systems in high-level-task situations. Decision-Making process: Current
Limitations: Quality of measurements, Standards. Rehabilitation service delivery.

UNIT – V  9
Computer applications in Rehabilitation Engineering: Interfaces in Compensation for visual
perception. Improvement of orientation and mobility. Computer-assisted lip reading. Brain-
computer interfaces.

TOTAL PERIODS: 45

TEXTBOOKS:

15 EBM 028 VIRTUAL INSTRUMENTATION DESIGN 3 0 0 3
FOR MEDICAL SYSTEMS
Course Objectives: To impart adequate knowledge on Virtual Instrumentation for acquisition and analysis of signals in medical system, to educate about the Basic concepts of VI, programming concepts of VI and enable them to implement VI in medical systems.

UNIT- I
INTRODUCTION TO VIRTUAL INSTRUMENTATION (VI) 8
Virtual instrumentation (VI): Evolution, Definition, Architecture- Conventional-, and Distributed- VI, Comparison of VI with traditional Instruments, Need of VI, advantages, block diagram, data flow techniques, graphical programming, Comparison between graphical programming and conventional programming, VI in engineering process.

UNIT- II
PROGRAMMING MODES IN VI 10
VI: front panel, Block diagram, LABVIEW Environment: Startup-, Shortcut-, and Pull down menu, Palletes, Control structures: FOR loop, WHILE loop, Shift Registers, feedback nodes, Selection Structures: Case and sequence structures, Formulae nodes, Arrays, Clusters, Waveform Chart and graph, XY Graph, Strings, Tables, File I/O functions.

UNIT- III
HARDWARE ASPECTS OF VI SYSTEM 9
Digital I/O Techniques: pull-up and pull down resistors, TTL to solid state Relays, Voltage dividers, data acquisition in LABVIEW, hardware installation and configuration, Data acquisition (DAQ): Components, Accessories, Hardware, and Software.

UNIT- IV
COMMON INSTRUMENT INTERFACE 10
Current loop: 4-20mA, 60mA, RS232, RS422, RS485, General purpose interface bus(GIPB), Virtual Instrument Software Architecture (VISA), Universal serial port bus(USB), Peripheral computer interface (PCI), VME extensions for instrumentation (VXI), PCI extensions for Instrumentation (PXI), Personal Computer Memory Card International Association (PCMCIA), Signal conditioning extension for instrumentation (SCXI).

UNIT – V
ANALYSIS TOOLS AND APPLICATIONS OF VI 8
Fourier transform, Power spectrum, Correlation, Windowing, filtering, Oscilloscope, Waveform generator, Multi-channel data acquisition using LABVIEW, ECG acquisition for long term monitoring of heart rate using VI.

TEXTBOOKS

REFERENCES
2 Technical Manuals for DAS Modules of Advantech and National Instruments

15 EBM029 VIRTUAL INSTRUMENTATION DESIGN 0 0 3 2
FOR MEDICAL SYSTEMS

Course Objectives: To impart adequate knowledge on programming in Virtual Instrumentation for acquisition and analysis of signals in medical system and to impart knowledge on various analysis tools

LIST OF EXPERIMENTS
1. Basic arithmetic operations
2. Boolean operations
3. Sum of ‘n’ numbers using ‘for’ loop
4. Factorial of a given number using for loop
5. Sum of ‘n’ natural numbers using while loop
6. Factorial of a given number using while loop
7. Sorting even numbers using while loop in an array
8. Array maximum and minimum
9. Bundle and unbundle cluster
10. Flat and stacked sequence
11. Application using formula node
12. Median filter
13. Discrete cosine transform
14. Convolution of two signals
15. Windowing technique
16. Instrumentation of an amplifier to acquire an ECG signal using NI vision acquisition software
17. To measure BP, heart rate, temperature, ECG using vernier biomedical sensor kit
18. Acquire, analyse and present an EEG instrumentation using NI ELVIS hardware

REFERENCE
1. Virtual instrumentation lab manual

IV Year/Semester VIII

Major Project:
MATHEMATICS-I

**Course Objectives:** To develop the skills in the areas of Matrices, Three dimensional Analytical Geometry, Differential calculus, Functions of several Variables and Multiple Integrals. To serve as a pre-requisite mathematics course for post graduate courses, specialized studies and research.

**UNIT - I**
**MATRICES**

**UNIT - II**
**THREE DIMENSIONAL ANALYTICAL GEOMETRY**

**UNIT - III**
**DIFFERENTIAL CALCULUS**
Curvature in Cartesian co-ordinates – Centre and radius of curvature – Circle of curvature – Evolutes – Envelopes – Evolute as envelope of normals.

**UNIT - IV**
**FUNCTIONS OF SEVERAL VARIABLES**

**UNIT - V**
**MULTIPLE INTEGRALS**
Double integration – Cartesian and polar coordinates – Change of order of integration – Change of variables between Cartesian and polar coordinates – Triple integrals – Area as double integral

**TEXT BOOKS:**

REFERENCE BOOKS:


UNIT- IV
PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES

12
Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes by rotating object method and auxiliary plane method.

UNIT- V
ISOMETRIC AND PERSPECTIVE PROJECTIONS

12
Principles of isometric projection – isometric scale – Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions and miscellaneous problems. Perspective projection of simple solids-Prisms, pyramids and cylinders by visual ray method. COMPUTER AIDED DRAFTING (Demonstration Only). Introduction to drafting packages and demonstration of their use.

TOTAL: 60 h