

**Autonomy Curriculum & Syllabus of B.Tech (BME) Programme
Implemented From The Academic Year 2016**

First Year - First Semester

Subject Type	Subject Code	Subject Name	Contact Hours L:T:P	Total Credits	Contact Hours/Week
THEORY:					
BS	M 101	MATHEMATICS-I	3:1:0	4	4
BS	CH 101	CHEMISTRY	3:1:0	4	4
ES	EE101	BASIC ELECTRICAL ENGINEERING	3:1:0	4	4
HS	HU 101	COMMUNICATIVE ENGLISH	2:0:0	2	2
ES	ME 101	ENGINEERING MECHANICS	3:1:0	4	4
PRACTICAL:					
BS	CH191	CHEMISTRY LAB	0:0:3	2	3
ES	EE 191	BASIC ELECTRICAL ENGINEERING LAB	0:0:3	2	3
HS	HU191	LANGUAGE LAB & SEMINAR PRESENTATION	0:0:2	1	2
ES	ME 191	ENGINEERING DRAWING & GRAPHICS LAB	0:0:3	2	3
SESSIONAL:					
HS	XC 181	EXTRA CURRICULAR ACTIVITY (NSS/NCC)	0:0:2	1	2
		TOTAL: TEN	14:4:13	26	31

First Year – Second Semester

Subject Type	Subject Code	Subject Name	Contact Hours L:T:P	Total Credits	Contact Hours/Week
THEORY:					
BS	M 201	MATHEMATICS-II	3:1:0	4	4
BS	PH 201	PHYSICS-I	3:1:0	4	4
ES	EC 201	BASIC ELECTRONICS ENGINEERING	3:1:0	4	4
ES	CS 201	COMPUTER FUNDAMENTALS & PRINCIPLE OF COMPUTER PROGRAMMING	3:1:0	4	4
ES	ME 201	ENGINEERING THERMODYNAMICS & FLUID MECHANICS	3:1:0	4	4
PRACTICAL:					
BS	PH 291	PHYSICS LAB-I	0:0:3	2	3
ES	EC 291	BASIC ELECTRONICS ENGINEERING LAB	0:0:3	2	3
ES	CS 291	COMPUTER PROGRAMING LAB	0:0:3	2	3
ES	ME 291	WORKSHOP LAB	0:0:3	2	3
SESSIONAL:					
MC	MC281	SOFT SKILL DEVELOPMENT	0:0:2	0	2 units
		TOTAL: TEN	15:5:14	28	34

BME-Semester III

Subject Type	Subject Code	Subject Name	Contact hrs/week				Credits
			L	T	P	Total	
		THEORY					
BS	M(BME) 301	MATHEMATICS-III	3	1	0	4	4
PC	BME 301	ENGINEERING PHYSIOLOGY & ANATOMY	3	1	0	4	4
PC	BME 302	BIOPHYSICAL SIGNALS & SYSTEMS	3	1	0	4	4
ES	EE(BME) 303	CIRCUIT THEORY & NETWORKS	2	0	0	2	2
ES	EC(BME) 304	ANALOG ELECTRONIC CIRCUITS	2	0	0	2	2
		PRACTICAL					
PC	BME 391	ENGINEERING PHYSIOLOGY & ANATOMY LABORATORY	0	0	3	3	2
PC	BME 392	BIOPHYSICAL SIGNALS & SYSTEMS LABORATORY	0	0	3	3	2
ES	EE(BME) 393	CIRCUITS & NETWORKS LABORATORY	0	0	2	2	1
ES	EC(BME) 394	ANALOG ELECTRONIC CIRCUITS LABORATORY	0	0	2	2	1
		SESSIONAL					
MC	MC381	TECHNICAL SKILL DEVELOPMENT	0	0	2 Units	2 Units	0
		TOTAL	13	3	12	28	22

BME-Semester IV

Subject Type	Subject Code	Subject Name	Contact hrs/week				Credits
			L	T	P	Total	
		THEORY					
HS	HU (BME) 401	ENVIRONMENTAL SCIENCE	2	0	0	2	2
BS	PH(BME) 401	PHYSICS-II	3	1	0	4	4
ES	EC(BME) 401	DIGITAL ELECTRONIC CIRCUITS	2	0	0	2	2
PC	BME 402	BIOMECHANICS	3	1	0	4	4
PC	BME 403	BIOMATERIALS	3	1	0	4	4
		PRACTICAL					
BS	PH(BME) 491	PHYSICS-II LABORATORY	0	0	3	3	2
ES	EC(BME) 491	DIGITAL ELECTRONIC CIRCUITS LABORATORY	0	0	2	2	1
PC	BME 492	BIOMECHANICS & BIOMATERIALS LABORATORY	0	0	3	3	2
		SESSIONAL					
HS	HU 481	TECHNICAL REPORT WRITING LANGUAGE PRACTICE	0	0	2	2	1
		TOTAL	13	3	10	26	22

BME-Semester V

Subject Type	Subject Code	Subject Name	Contact hrs/week				Credits
			L	T	P	Total	
		THEORY					
PC	BME 501	BIOMEDICAL INSTRUMENTATION	3	1	0	4	4
PC	BME 502	BIOMEDICAL DIGITAL SIGNAL PROCESSING	3	1	0	4	4
PC	BME 503	BIOSENSORS & TRANSDUCERS	3	0	0	3	3
PC	BME 504	MEDICAL IMAGING TECHNIQUES	3	1	0	4	4
PE-I	BME 505A	HOSPITAL ENGINEERING & MANAGEMENT	3	0	0	3	3
	BME 505B	BIOHEAT AND MASS TRANSFER					
	BME 505C	BIONANOTECHNOLOGY					
OE-I	CS(BME) 506A	DATA STRUCTURE & ALGORITHM	3	0	0	3	3
	CS(BME) 506B	DATA BASE MANAGEMENT SYSTEM					
	EE(BME) 506C	CONTROL ENGINEERING					
		PRACTICAL					
PC	BME 591	BIOMEDICAL INSTRUMENTATION LABORATORY	0	0	3	3	2
PC	BME 592	BIOMEDICAL DIGITAL SIGNAL PROCESSING LABORATORY	0	0	3	3	2
PC	BME 593	BIOSENSORS & TRANSDUCERS LABORATORY	0	0	3	3	2
OE-I	CS(BME) 596A	DATA STRUCTURE & ALGORITHM LABORATORY	0	0	3	3	2
	CS(BME) 596B	DATA BASE MANAGEMENT SYSTEM LABORATORY					
	EE(BME) 596C	CONTROL ENGINEERING LABORATORY					
		SESSIONAL					
PW	BME 582	MINI PROJECT	0	0	3	3	2
MC	MC 581	GROUP DISCUSSION PRACTICE	0	0	2 Units	2 Units	0
		TOTAL	18	3	17	38	31

BME-Semester VI

Subject Type	Subject Code	Subject Name	Contact hrs/week				Credits
			L	T	P	Total	
	THEORY						
PC	BME 601	ANALYTICAL & DIAGNOSTIC EQUIPMENTS	3	1	0	4	4
PC	BME 602	BIOPHYSICS & BIOCHEMISTRY	3	1	0	4	4
PC	BME 603	MODELLING OF PHYSIOLOGICAL SYSTEMS	3	0	0	3	3
PC	BME 604	ADVANCED IMAGING SYSTEMS	3	1	0	4	4
PE-II	BME 605A	COMMUNICATION SYSTEMS & BIOTELEMETRY	3	0	0	3	3
	BME 605B	DRUG DELIVERY SYSTEM					
	BME 605C	BIOINFORMATICS					
OE-II	EI(BME) 606A	MICROPROCESSORS & MICROCONTROLLERS	3	0	0	3	3
	EC(BME) 606B	VLSI & EMBEDDED SYSTEM					
	IT(BME) 606C	SOFT-COMPUTING					
	PRACTICAL						
PC	BME 691	BIOMEDICAL EQUIPMENT LABORATORY	0	0	3	3	2
PE-II	BME 695A	COMMUNICATION SYSTEMS & BIOTELEMETRY LABORATORY	0	0	3	3	2
	BME 695B	DRUG DELIVERY SYSTEM LABORATORY					
	BME 695C	BIOINFORMATICS LABORATORY					
OE-II	EI(BME) 696A	MICROPROCESSORS & MICROCONTROLLERS LABORATORY	0	0	3	3	2
	EC(BME) 696B	VLSI & EMBEDDED SYSTEM LABORATORY					
	IT(BME) 696C	SOFT-COMPUTING LABORATORY					
	SESSIONAL						
PW	BME 681	DESIGN LAB	0	0	6	6	3
PW	BME 682	HOSPITAL TRAINING (3 Weeks)	0	0	0	0	2
		TOTAL	18	3	15	36	32

BME-Semester VII

Subject Type	Subject Code	Subject Name	Contact hrs/week				Credits
			L	T	P	Total	
	THEORY						
HS	HU 703	ECONOMICS FOR ENGINEERS	2	0	0	2	2
PC	BME 701	THERAPEUTIC EQUIPMENTS	3	1	0	4	4
PE-III	BME 702A	MEDICAL IMAGE PROCESSING	3	0	0	3	3
	BME 702B	TISSUE ENGINEERING					
	BME 702C	MEDICAL ROBOTICS & AUTOMATION					
PE-IV	BME 703A	BIOLOGICAL CONTROL SYSTEMS	3	0	0	3	3
	BME 703B	BIOMEMS & BIOMICROFLUIDICS					
	BME 703C	BIOENERGY & BIOFUELS ENGINEERING					
	PRACTICAL						
PC	BME 791	MEDICAL INSTRUMENTS & SYSTEMS LABORATORY	0	0	3	3	2
PE-III	BME 792A	MEDICAL IMAGE PROCESSING LABORATORY	0	0	3	3	2
	BME 792B	TISSUE ENGINEERING LABORATORY					
	BME 792C	MEDICAL ROBOTICS & AUTOMATION LABORATORY					
	SESSIONAL						
PW	BME 781	PROJECT I	0	0	6	6	3
PW	BME 782	INDUSTRIAL TRAINING (4 WEEKS)	0	0	0	0	2
MC	MC 781	TECHNICAL SEMINAR PRESENTATION	0	0	3	3	0
		TOTAL	11	1	15	27	21

BME-Semester VIII

Subject Type	Subject Code	Subject Name	Contact hrs/week				Credits
			L	T	P	Total	
	THEORY						
HS	HU 802	VALUES & ETHICS IN PROFESSION	2	0	0	2	2
PE-V	BME 801A	ARTIFICIAL ORGAN & REHABILITATION ENGINEERING	3	0	0	3	3
	BME 801B	BIOMEDICAL HAZARDS & SAFETY					
	BME 801C	TELEMEDICINE					
PE-VI	BME 802A	RADIOTHERAPY & NUCLEAR MEDICINE	3	0	0	3	3
	BME 802B	LASERS & OPTICS IN MEDICINE					
	BME 802C	BIOMEDICAL EQUIPMENT MANAGEMENT					
	SESSIONAL						
PW	BME 881	PROJECT II	0	0	12	12	6
PW	BME 882	GRAND VIVA	0	0	0	0	2
		TOTAL	8	0	12	20	16

HS	Humanities and Social Sciences	PC	Professional -Core
BS	Basic Sciences	PE	Professional -Electives
ES	Engineering Sciences	OE	Open Electives
PW	Projects, Seminar, Industrial Training		

Group A (ECE , EE , AEIE , BME)		Group B (CSE , IT , FT ,ME,CE)	
1 st Semester	2 nd Semester	1 st Semester	2 nd Semester
Chemistry	Physics - I	Physics - I	Chemistry
Basic Electrical Engineering	Basic Electronics Engineering	Basic Electronics Engineering	Basic Electrical Engineering
Engg Drawing & Graphics	Workshop Practice	Workshop Practice	Engg Drawing & Graphics

Credit points evaluation for B.Tech (BME) Programme

Total Credit: 198

Humanities and Social Sciences including Management (HS)					
Course Code	Credits	Total Credits	Range of Total credits (%) as per AICTE Min. Max.		Assigned Credits (for Total=198) for Autonomy syllabus(%)
HU191	1	11	5	10	5.6
XC181	1				
HU101	2				
HU(BME)401	2				
HU 481	1				
HU 703	2				
HU 802	2				

Basic Sciences including Mathematics, Physics, Chemistry, Biology (BS)					
Course Code	Credits	Total Credits	Range of Total credits (%) as per AICTE		Assigned Credits (for Total=198) for Autonomy syllabus(%)
			Min.	Max.	
M 101	4	30	15	20	15.2
CH 101	4				
CH191	2				
M 201	4				
PH 201	4				
PH 291	2				
M(BME) 301	4				
PH(BME) 401	4				
PH(BME) 491	2				

Engineering Sciences (ES)					
Course Code	Credits	Total Credits	Range of Total credits (%) as per AICTE norms		Assigned Credits (for Total=198) for Autonomy syllabus(%)
			Min.	Max.	
EE101	4	39	15	20	19.7
ME 101	4				
EE 191	2				
ME 191	2				
EC 201	4				
CS 201	4				
ME 201	4				
EC 291	2				
ME 291	2				
CS 291	2				
EE(BME) 303	2				
EC(BME) 304	2				
EE(BME) 393	1				
EC(BME) 394	1				
EC(BME) 401	2				
EC(BME) 491	1				

Professional Subjects-Core (PC)					
Course Code	Credits	Total Credits	Range of Total credits (%) as per AICTE norms		Assigned Credits (for Total=198) for Autonomy syllabus(%)
			Min.	Max.	
BME 301	4	66	30	40	33.33
BME 391	2				

BME 302	4				
BME 392	2				
BME 402	4				
BME 403	4				
BME 492	2				
BME 501	4				
BME 502	4				
BME 503	3				
BME 504	4				
BME 591	2				
BME 592	2				
BME 593	2				
BME 601	4				
BME 602	4				
BME 603	3				
BME 604	4				
BME 691	2				
BME 701	4				
BME 791	2				
Professional Subjects – Electives (PE)					
Course Code	Credits	Total Credits	Range of Total credits (%) as per AICTE norms Min. Max.		Assigned Credits (for Total=198) for Autonomy syllabus(%)
BME 505A	3	22	10	15	11.11
BME 505B					
BME 505C					
BME 605A	3				
BME 605B					
BME 605C					
BME 695A	2				
BME 695B					
BME 695C					
BME 702A	3				
BME 702B					
BME 702C					
BME 703A	3				
BME 703B					
BME 703C					
BME 792A	2				
BME 792B					
BME 792C					

BME 801A	3			
BME 801B				
BME 801C				
BME 802A	3			
BME 802B				
BME 802C				

Open Subjects- Electives (OE)				
Course Code	Credits	Total Credits	Range of Total credits (%) as per AICTE norms Min. Max.	Assigned Credits (for Total=198) for Autonomy syllabus(%)
CS(BME) 506A	3	10	5 10	5.05
CS(BME) 506B				
EE(BME) 506C				
CS(BME) 596A	2			
CS(BME) 596B				
EE(BME) 596C				
EI(BME) 606A	3			
EC(BME) 606B				
IT(BME) 606C				
EI(BME) 696A	2			
EC(BME) 696B				
IT(BME) 696C				

Project Work, Seminar and/or Internship in Industry				
Course Code	Credits	Total Credits	Range of Total credits (%) as per AICTE norms Min. Max.	Assigned Credits (for Total=198) for Autonomy syllabus(%)
BME 582	2	20	10 15	10.1
BME 681	3			
BME 682	2			
BME 781	3			
BME 782	2			
BME 881	6			
BME 882	2			

**Detailed Syllabus of B.Tech in Biomedical Engineering Programme
(First Year - First Semester)**

Group A: ECE, EE, BME, AEIE/EIE

Curriculum:

THEORY							
Sl o	Paper Code	Theory	Contact Hours /Week				Credit Points
			L	T	P	Total	
1	M 101	Mathematics -I	3	1	0	4	4
2	CH 101	Chemistry	3	1	0	4	4
3	EE 101	Basic Electrical Engineering	3	1	0	4	4
4	HU 101	Communicative English	2	0	0	2	2
5	ME 101	Engineering Mechanics	3	1	0	4	4
Total no. of Theory						18	18
PRACTICAL							
6	CH191	CHEMISTRY LAB	0	0	3	3	2
7	EE 191	BASIC ELECTRICAL ENGINEERING LAB	0	0	3	3	2
8	HU191	LANGUAGE LAB & SEMINAR PRESENTATION	0	0	2	2	1
9	ME 191	ENGINEERING DRAWING & GRAPHICS LAB	0	0	3	3	2
SESSIONAL							
10	XC181	Extra Curricular Activity (NSS/ NCC)	0	0	2	2	1
Total no. of Practical & Sessional						13	08

Syllabus:

Theory

Paper Name: Mathematics –I

Paper Code: M101

Total Contact Hours: 40

Credit: 4

Prerequisite: Any introductory course on matrix algebra, calculus, geometry.

Course Objective: The purpose of this course is to provide fundamental concepts matrix algebra, Calculus of Single and Several Variables and Vector Analysis.

Course outcome:

On successful completion of the learning sessions of the course, the learner will be able to:

M 101.1: Recall the distinctive characteristics of Matrix Algebra, Calculus of Single and Several Variables and Vector Analysis.

M 101.2: Understand the theoretical concept of Matrix Algebra, Calculus of Single and Several Variables and Vector Analysis.

M 101.3: Apply the principles of Matrix Algebra, Calculus of Single and Several Variables and Vector Analysis to solve various problems.

Course contents:

MODULE I [10L]

Matrix Algebra: Elementary row and column operations on a matrix, Rank of matrix, Normal form, Inverse of a matrix using elementary operations, Consistency and solutions of systems of linear equations using elementary operations, Linear dependence and independence of vectors, Concept & Properties of different matrices (unitary, orthogonal, symmetric, skew-symmetric, hermitian, skew-hermitian), Eigen values and Eigen vectors of a square matrix (of order 2 or 3), Characteristic polynomials, Caley-Hamilton theorem and its applications, Reduction to diagonal form (upto 3rd order).

MODULE II [10L]

Calculus-I (Functions of single variable): Rolle's theorem, Mean value theorem- Lagrange & Cauchy, Taylor's and Maclaurin's theorems, Expansion of simple functions by Taylor's and Maclaurin's Theorems, Fundamental theorem of integral calculus, Evaluation of plane areas, volume and surface area of a solid of revolution and lengths, Convergence of Improper integrals, Beta and Gamma Integrals - Elementary properties and the Inter relations.

Paper Name: Chemistry
Paper Code: CH 101
Total Contact Hours: 40
Credit: 4

Pre requisites: 10+2 science with chemistry

Course Objective

Understanding of the fundamental theories and applications of thermodynamics, electrochemical principles in modern electrochemical cells and to get an insight into electronic structure of crystals and nanomaterials. Learning about the Synthesis, properties and applications of polymers, fuels and alternative energy sources & their significance in petrochemical industries. Analyzing water quality for its various parameters & its significance in industries.

Course Outcome

CH101.1: Able to apply fundamental concepts of thermodynamics in different engineering applications.

CH101.2: Able to analyze & design simple and technologically advanced electrical and energy storage devices.

CH101.3: Able to synthesize nanomaterials, composites, polymers.

CH101.4: Able to apply the basic concept of Organic Chemistry and knowledge of chemical reactions to industries, and technical fields.

CH101.5: Able to apply the knowledge of different fuels and corrosion to different industries

CH101.6: Able to analyse water quality parameter for its various parameters & its significance in industries.

Course contents

Module 1 [8L]

Chemical Thermodynamics –I

1.1 Concept of Thermodynamic system: Definition with example of diathermal wall, adiabatic wall, isolated system, closed system, open system, extensive property, intensive property.

Introduction to first law of thermodynamics: Different statements, mathematical form.

Internal energy: Definition, Example, Characteristics, Physical significance, Mathematical expression for change in internal Energy, Expression for change in internal energy for ideal gas. **2L**

1.2 Enthalpy: Definition, Characteristics, Physical significance, Mathematical expression for change in Enthalpy, Expression for change in enthalpy for ideal gas.

Heat Capacity: Definition, Classification of Heat Capacity (C_p and C_V): Definition and General expression of $C_p - C_V$. Expression of $C_p - C_V$ for ideal gas.

Reversible and Irreversible processes: Definition, Work done in Isothermal Reversible and Isothermal Irreversible process for Ideal gas, Adiabatic changes: Work done in adiabatic process, Interrelation between thermodynamic parameters (P , V and T), slope of P - V curve in adiabatic and isothermal process.

Application of first law of thermodynamics to chemical processes: exothermic, endothermic processes, law of Lavoisier and Laplace, Hess's law of constant heat summation. **3L**

1.3 2nd law of thermodynamics: Statement, Mathematical form of 2nd law of thermodynamics (Carnot cycle). Joule Thomson and throttling processes; Joule Thomson coefficient for Ideal gas, Concept of inversion temperature (brief).

Evaluation of entropy: characteristics and expression, physical significance. Work function and free energy: Definition, characteristics, physical significance, mathematical expression of ΔA and ΔG for ideal gas, standard free energy and chemical potential, Condition of spontaneity and equilibrium reaction. **3L**

Module 2 [7L]

2.1 Reaction Dynamics

Reaction laws: rate and order; molecularity; zero and first order kinetics, second order kinetics (same reactant concentration), Pseudounimolecular reaction, Arrhenius equation. **3L**

Mechanism and theories of reaction rates (Content beyond the syllabus)

2.2 Solid state Chemistry

Introduction to stoichiometric defects (Schottky & Frenkel) and non – stoichiometric defects (Metal excess and metal deficiency).

Role of silicon and germanium in the field of semiconductor, n-type, p-type semiconductor, photo voltaic cell, fabrication of integrated circuits. **4L**

Module 3 [8L]

Electrochemistry

3.1 Conductance

Conductance of electrolytic solutions, specific conductance, equivalent conductance, molar conductance and ion conductance, effect of temperature and concentration (Strong and Weak electrolyte). **1L**

3.2 Electrochemical cell

Cell EMF and its Thermodynamic derivation of the EMF of a Galvanic cell (Nernst equation), single electrode potentials, hydrogen half cell, calomel half cell (representation, cell reaction, expression of potential, Discussion, Application). **3L**

3.3 Concept of battery

Battery and Commercial electrochemical cell: Dry cell, acid storage cell, alkaline storage cell, fuel cell (construction, representation, cell reaction, expression of potential, discussion, application). **2L**

3.4 Corrosion and its control

Introduction, cause and effect of corrosion, types of corrosion: dry, wet and other: Electrochemical corrosion, galvanic corrosion, passivation and protective measure. **2L**

Module 4 [12L]

4.1 Structure and reactivity of Organic molecule

Electronegativity, electron affinity, hybridisation, Inductive effect, resonance, hyperconjugation, electromeric effect, carbocation, carbanion and free radicals. Brief study of some addition, eliminations and substitution reactions. **3L**

4.2 Polymers

Concepts, classifications and industrial applications. Polymer molecular weight (number avg. weight avg.: Theory and mathematical expression only), Poly dispersity index (PDI).

Polymerization processes: addition and condensation polymerization (mechanism not required), degree of polymerization, Copolymerization, stereo-regularity of polymer, crystallinity (concept of T_m) and amorphicity (Concept of T_g) of polymer.

Preparation, structure and use of some common polymers: plastic (HDPE, LDPE, PVC, PP, PMMA, Polyester, PTFE, Bakelite), rubber (natural rubber, SBR), fibre (nylon 6, nylon 6,6), Vulcanization of rubber, Conducting polymers and bio-polymers. **7L**

4.3 Nano material

Basic principles of nano science and technology, classification, preparation, properties and application of nano material. **2L**

Module 5 [5L]

5.1 Industrial Chemistry

Fuels

Solid Fuel: Coal, Classification of coal, constituents of coal, carbonization of coal (HTC and LTC), Proximate analysis of coal, Calorific value.

Liquid fuel: Petroleum, classification of petroleum, Refining, Octane number, Cetane number, Aviation Fuel (Aviation Gasoline, Jet Gasoline), Biodiesel.

Gaseous fuels: Natural gas, water gas, Coal gas, bio gas, CNG, LPG

3L

5.2 Water

Introduction, source of water, water quality parameter, specification for drinking water (BIS and WHO standards), Chlorination of Water, Types of hardness- Units, Brief Softening methods.

2L

Short overview of water treatment plants (Content beyond the syllabus)

Reference Books

1. Engineering Chemistry: Bandyopadhyay and Hazra
2. Physical Chemistry: P.C. Rakshit
3. Organic Chemistry: Finar, vol-1
4. Engineering Chemistry: B.Sivasankar, Tata Mc Graw Hill, 2008
5. A Text book of Engineering Chemistry: S.S.Dara, 10th Edition, S.Chand & Company Ltd., New Delhi, 2003.
6. Engineering Chemistry Simplified: S. Nandi and R. Bhattacharyya, Chayya Prakashani Pvt. Ltd.

CO-PO mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12
CH101.1	3	1	-	-	-	-	-	-	-	-	-	-
CH101.2	3	2	1	-	-	-	-	-	-	-	-	-
CH101.3	-	-	2	-	2	-	-	-	-	-	-	1
CH101.4	2	-	1	-	2	-	-	-	-	-	-	-
CH101.5	2	-	-	-	-	-	2	-	-	-	-	1
CH101.6	-	-	2	-	-	-	1	-	-	-	-	-

Paper Name: Basic Electrical Engineering

Paper Code: EE101

Total Contact Hours: 41

Credit: 4

Pre requisite: Basic 12st standard Physics and Mathematics

Course Objective:

Basic electrical engineering is an introductory course in electrical engineering. Students are introduced to simple applied electrical circuits, theories and practice to impart skill set to have visualization of electrical engineering applications. It is a course suitable for students pursuing electrical engineering as well as other related engineering disciplines.

Course Outcomes:

At the end of this course, students will able

EE 101.1: To understand and analyze basic electric and magnetic circuits.

EE 101.2: To understand and analysis the AC single phase and three phase circuit

EE101.3: To understand and analysis of the basic principles of various electrical machines

Course Contents:**DC CIRCUITS (7L)**

Definition of electric circuit, linear circuit, non-linear circuit, bilateral circuit, unilateral circuit, Dependent source, node, branch, active and passive elements, Kirchhoff's laws, Source equivalence and conversion, Network Theorems-Superposition Theorem, Thevenin's Theorem, Norton Theorem, Maximum Power Transfer Theorem, Star-Delta Conversions.

MAGNETIC CIRCUITS (3L)

Concept of Magnetic circuit, B-H curve, Analogous quantities in magnetic and electric circuits, Faraday's law, iron losses, self and mutual inductance, Energy stored in magnetic field.

AC SINGLE PHASE CIRCUITS (8L)

Sinusoidal quantities, Average and RMS values, peak factor, Form factor, Phase and Phase difference, concept of phasor diagram, V-I Relationship in R,L,C circuit, Combination R,L,C in AC series, parallel and series parallel circuits with phasor diagrams, impedance and admittance, Power factor, Power in AC circuit, Resonance in RLC series and parallel circuit, Q factor, band width of resonant circuit.

THREE PHASE CIRCUITS (3L)

Voltages of three balanced phase system, delta and star connection, relationship between line and phase quantities, phasor diagrams. Power measurement by two watt meters method.

DC MACHINES (6L)

Construction, Basic concepts of winding (Lap and wave). DC generator: Principle of operation, EMF equation, characteristics (open circuit, load) DC motors: Principle of operation, Torque Equation, Speed Torque Characteristics (shunt and series machine), starting (by 3 point starter), speed control (armature voltage and field control).

SINGLE PHASE TRANSFORMER (5L)

Constructional parts, Types of transformers, Emf equation, No Load no load and on load operation, phasor diagram and equivalent circuit, losses of a transformer, open and short circuit tests, regulation and efficiency calculation.

THREE PHASE INDUCTION MOTOR (6L)

Types, Construction, production of rotating field, principle of operation, Slip and Frequency, rotor emf and current, Equivalent circuit and phasor diagram, Torque Slip characteristics torque-speed characteristics Starting of induction motor by star delta starter and (DOL starter). Speed Control of Three phase induction motor by variation of supply frequency, supply voltage and number of poles.

GENERAL STRUCTURE OF ELECTRICAL POWER SYSTEM (3L)

Power generation to distribution through overhead lines and underground cables with single line diagram, Earthing of Electrical Equipment, Electrical Wiring Practice

Text books

1. V. Mittle & Arvind Mittal, Basic Electrical Engineering, TMH.
2. Ashfaq Hussain, Basic Electrical Engineering, S. Chand Publication
3. Chakrabarti, Nath & Chanda, Basic Electrical Engineering, TMH
4. C.L. Wadhwa, Basic Electrical Engineering, Pearson Education

Reference books

1. H. Cotton, Willey Press
2. J.B. Gupta, Basic Electrical Engineering, Kataria & Sons .
3. Kothari & Nagrath, Basic Electrical Engineering, TMH

CO-PO mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EE101.1	3	3	2	1								
EE101.2	2	2	1									
EE101.3	3	2	2									

Paper Name: Communicative English**Paper Code: HU101****Total Contact Hours: 26****Credits: 2****Pre requisites:** Basic knowledge of high school English.**Course Objectives:**

Designed to meet the basic survival needs of communication in the globalized workplace, including knowledge of and competency in the use of macro-skills in reading and writing proficiency, functional grammar and usage.

Course Outcomes:

At the end of this course, students will be

HU101.1: Able to comprehend and communicate in English through exposure to communication skills theory and practice.

HU101.2: Apply the basic grammatical skills of the English language through intensive practice.

HU101.3: Able to develop reading and comprehension skills.

HU101.4: Able to develop writing proficiency skills by writing Official Letters, Technical report, memo, notice, minutes, agenda, resume, curriculum vitae.

HU101.5: Able to apply/illustrate all sets of English language and communication skills in creative and effective ways in the professional sphere of their life

Course Content:

The proposed revised syllabus is as follows:

Module 1: Communication: Interface in a Globalized World [5L]

- a .Definition of Communication& Scope of Communication
- b. Process of Communication—Models and Types
- c. Verbal—Non-Verbal Communication, Channels of Communication
- d. Barriers to Communication & surmounting them

[to be delivered through case studies involving intercultural communication]

Module 2: Vocabulary and Reading [5L]

- a. Word origin—Roots, Prefixes and Suffixes, Word Families, Homonyms and Homophones
- b. Antonyms and Synonyms, One-word substitution

- c. Reading—Purposes and Skills
- d. Reading Sub-Skills—Skimming, Scanning, Intensive Reading
- e. Comprehension Practice (Fiction and Non fictional Prose/Poetry)

Texts:

- (i) Isaac Asimov, *I Robot* (—Robbie OR —Little Lost Robot)
- (ii) George Orwell, —Shooting an Elephant
- (iii) Ruskin Bond, —The Cherry Tree OR —The Night Train at Deoli
- (iv) Robert Frost, —Stopping by the Woods on a Snowy Evening.

f. Precise Writing

(Use of daily newspapers for reading practice is recommended)

Module 3: Functional Grammar and Usage [6L]

- a. Articles, Prepositions, Verbs
- b. Verb-Subject Agreement
- c. Comparison of Adjectives
- d. Tenses and their Use
- e. Transformation of Sentences (Singular-Plural, Active-Passive, Direct-Indirect, Degrees of Comparison)
- f. Error Correction

Module 4: Business writing [10L]

- a. Business Communication in the Present-day scenario
- b. Business Letters (Letters of Inquiry, Sales Letters, Complaint and Adjustment Letters, Job Application Letters)
- c. Drafting of a CV and Résumé
- d. Memo, Notice, Advertisement, Agenda, Minutes of Meetings
- e. E-mails (format, types, jargons, conventions)

References:

1. Raymond Murphy. *English Grammar in Use*. 3rd Edn. CUP, 2001.
2. Seidl & McMordie. *English Idioms & How to Use Them*. Oxford: OUP, 1978.
3. Michael Swan. *Practical English Usage*. Oxford: OUP, 1980.
4. Simeon Potter. *Our Language*. Oxford: OUP, 1950.
5. Pickett, Laster and Staples. *Technical English: Writing, Reading & Speaking*. 8th ed. London: Longman, 2001.
6. IIT Kanpur, English Language & Communication Skills (ENG 112 C) syllabus.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
HU101.1	-	-	1	-	-	1	-	1	3	3	3	3
HU 101.2	-	-	-	-	-	2	-	-	2	3	3	3
HU 101.3	-	3	2	2	-	3	2	2	3	3	3	3
HU 101.4	-	-	-	2	-	2	-	-	3	3	2	3
HU 101.5	-	2	1	-	-	2	2	1	3	3	2	3

Paper Name: Engineering Mechanics

Paper Code: ME101

Total Contacts Hours: 45

Credit: 4

Pre requisites: Higher Secondary with Physics, Chemistry & Mathematics.

Course Objective:

1. Understand the vector and scalar representation of forces and moments.
2. Describe static equilibrium of particles and rigid bodies in two dimensions and three dimensions including the effect of Friction
3. Analyze the properties of surfaces & solids in relation to moment of inertia.
4. Illustrate the laws of motion, kinematics of motion and their interrelationship.
5. Study the concepts of engineering mechanics on deformable materials under applied loads.

Course Outcome:

Upon successful completion of the course, student should be able to:

ME 101.1. Construct free body diagram and calculate the reactions necessary to ensure static equilibrium.

ME 101.2. Study the effect of friction in static and dynamic conditions.

ME 101.3. Understand the different surface properties, property of masses and material properties.

ME 101.4. Analyze and solve different problems of kinematics and kinetics.

Course Content:

Module1: Importance of Mechanics in engineering; Introduction to Statics; Concept of Particle and Rigid Body; Types of forces: collinear, concurrent, parallel, concentrated, distributed; Vector and scalar quantities; Force is a vector; Transmissibility of a force (sliding vector). 2L

Introduction to Vector Algebra; Parallelogram law; Addition and subtraction of vectors; Lami's theorem; Free vector; Bound vector; Representation of forces in terms of i, j, k ; Cross product and Dot product and their applications. 3L+1T

Two dimensional force system; Resolution of forces; Moment; Varignon's theorem; Couple; Resolution of a coplanar force by its equivalent force-couple system; Resultant of forces. 4L+1T

Module2: Concept and Equilibrium of forces in two dimensions; Free body concept and diagram; Equations of equilibrium. 3L+1T

Concept of Friction; Laws of Coulomb friction; Angle of Repose; Coefficient of friction. 3L+1T

Module3: Distributed Force: Centroid and Centre of Gravity; Centroids of a triangle, circular sector, quadrilateral, composite areas consisting of above figures. 4L+1T

Moments of inertia: MI of plane figure with respect to an axis in its plane, MI of plane figure with respect to an axis perpendicular to the plane of the figure; Parallel axis theorem; Mass moment of inertia of symmetrical bodies, e.g. cylinder, sphere, cone. 3L+1T

Principle of virtual work with simple application. 1L+1T

Module4: Concept of simple stresses and strains: Normal stress, Shear stress, Bearing stress, Normal strain, Shearing strain; Hooke's law; Poisson's ratio; Stress-strain diagram of ductile and brittle materials; Elastic limit; Ultimate stress; Yielding; Modulus of elasticity; Factor of safety. 2L+1T

Module5: Introduction to Dynamics: Kinematics and Kinetics; Newton's laws of motion; Law of gravitation & acceleration due to gravity; Rectilinear motion of particles; determination of position, velocity and acceleration under uniform and non-uniformly accelerated rectilinear motion; construction of x-t, v-t and a-t graphs. 3L+1T

Plane curvilinear motion of particles: Rectangular components (Projectile motion); Normal and tangential components (circular motion). 2L+1T

Module6: Kinetics of particles: Newton's second law; Equation of motion; D'Alembert's principle and free body diagram; Principle of work and energy ; Principle of conservation of energy; Power and efficiency. 3L+2T

Books Recommended

1. Engineering Mechanics [Vol-I & II]by Meriam & Kraige, 5th ed. – Wiley India
2. Engineering Mechanics: Statics & Dynamics by I.H.Shames, 4th ed. – PHI
3. Engineering Mechanics by Timoshenko , Young and Rao, Revised 4th ed. – TMH
4. Elements of Strength of Materials by Timoshenko & Young, 5th ed. – E.W.P
5. Fundamentals of Engineering Mechanics by Debabrata Nag & Abhijit Chanda– Chhaya Prakashani
6. Engineering Mechanics by Basudeb Bhattacharyya– Oxford University Press.
7. Engineering Mechanics: Statics & Dynamics by Hibbeler & Gupta, 11th ed. – Pearson

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
ME101.1	3	3	2	2	-	-	-	-	1	-	-	-
ME101.2	3	3	2	2	-	-	-	-	1	-	-	1
ME101.3	3	2	3	2	1	-	-	-	1	-	-	1
ME101.4	3	3	3	3	-	-	-	-	1	-	1	-

Practical

Paper Name: Chemistry Lab

Paper Code: CH 191

Total Contact hour: 36

Credit: 2

Pre requisites: 10+2 science with chemistry

Course Objective

Acquiring knowledge on Standard solutions and the various reactions in homogeneous and heterogeneous medium. Understanding the basic principles of pH meter and conductivity meter for different applications and analyzing water for its various parameters. Synthesis of Polymeric materials and Nanomaterials.

Course Outcome

CH191.1: Able to operate different types of instruments for estimation of small quantities chemicals used in industries and scientific and technical fields.

CH191.2: Able to work as an individual also as a team member

CH191.3: Able to analyze different parameters of water considering environmental issues

CH191.4: Able to synthesize nano and polymer materials.

CH191.5: Capable to design innovative experiments applying the fundamentals of chemistry

Course contents

List of Experiments:

1. To Determine the alkalinity in given water sample.
2. Redox titration (estimation of iron using permanganometry)
3. To determine calcium and magnesium hardness of a given water sample separately.
4. Preparation of phenol-formaldehyde resin (Bakelite).
5. Heterogeneous equilibrium (determination of partition coefficient of acetic acid between n-butanol and water).
7. Conductometric titration for determination of the strength of a given HCl solution by titration against a standard NaOH solution.
8. pH- metric titration for determination of strength of a given HCl solution against a standard NaOH solution.
9. Determination of dissolved oxygen present in a given water sample.
10. To determine chloride ion in a given water sample by Argentometric method (using chromate indicator solution).

Innovative experiment:

Preparation of silver nano-particles.

Note: From the list of 10 (Ten) experiments a minimum of 7 (seven) experiments shall have to be performed by one student of which Sl. No. 4 (Preparation of Bakelite) has to be mandatory.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12
CH191.1	3	2	1	1	1	1	-	-	2	-	-	-
CH191.2	-	-	-	-	-	-	-	-	3	-	-	-
CH191.3	-	-	-	-	-	2	3	-	-	-	-	1
CH191.4	-	-	-	-	2	1	-	-	-	-	-	-
CH191.5	2	-	2	-	1	-	-	-	-	-	-	1

Paper Name: Basic Electrical Engineering LAB

Paper Code: EE191

Total Contact Hours: 36

Credit: 2

Pre requisites:

1. Basic Physics and applied physics.
2. Basic Mathematics.
3. Basic concept of Electric Circuit
- 4.

Course Objective:

1. Provide knowledge for the analysis of basic electrical circuit.
2. To introduce electrical appliances, machines with their respective characteristics.

Course Outcome:

COs	CO Statement
EE191.1	Identify common electrical components and their ratings.
EE191.2	Make Circuit connection by wires of appropriate ratings.
EE191.3	Understand the usage of common electrical measuring instruments
EE191.4	Understand the basic characteristics of transformers and electrical machines

Course contents

LIST OF EXPERIMENTS

1. Characteristics of Fluorescent ,Tungsten and Carbon filament lamps
2. Verification of Thevenin's and Norton's Theorem
3. Verification of Superposition Theorem
4. Calibration of Ammeter and Wattmeter
5. Study of R-L-C series circuit
6. Open circuit and short circuit test of a single phase Transformer
7. Starting, Reversing of a and speed control of D.C shunt motor
8. Test on single phase Energy Meter
9. Familiarization of PMMC and MI type Meter
10. Familiarization with house wiring practice

CO-PO mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EE191.1	2	3		1	3				1		2	1
EE191.2	2		2	1	3				1	1		
EE191.3		3				3	2				2	1
EE191.4	3						1			2	2	2

Paper Name: Lang. Lab. and Seminar Presentation

Paper Code: HU191

Total Contact Hours: 26

Credit: 1

Pre requisites: Basic knowledge of LSRW skills.

Course Objectives: To train the students in acquiring interpersonal communication skills by focusing on skill acquisition techniques and error feedback.

Course Outcome:

HU191.1: Able to understand advanced skills of Technical Communication in English through Language Laboratory.

HU191.2: Able to apply listening, speaking, reading and writing skills in societal and professional life.

HU191.3: Able to demonstrate the skills necessary to be a competent Interpersonal communicator.

HU191.4: Able to analyze communication behaviors.

HU191.5: Able to adapt to multifarious socio-economical and professional arenas with the help of effective communication and interpersonal skills.

Course Contents:

Module 1: Introduction to the Language Lab

- a. The Need for a Language Laboratory
- b. Tasks in the Lab
- c. Writing a Laboratory Note Book

Module 2: Active Listening

- a. What is Active Listening?
- b. Listening Sub-Skills—Predicting, Clarifying, Inferencing, Evaluating, Note taking
- c. Contextualized Examples based on Lab Recordings

Module 3: Speaking

- a. Speaking (Choice of words, Speech Syntax, Pronunciation, Intonation)
- b. Language Functions/Speech Acts
- c. Speaking using Picture Prompts and Audio Visual inputs
- c. Conversational Role Plays (including Telephonic Conversation)
- d. Group Discussion: Principles and Practice

Module 4: Lab Project Work

- a. Keeping a Listening Log
- b. Writing a Film Review/Advertisements

References:

1. IIT Mumbai, **Preparatory Course in English** syllabus
2. IIT Mumbai, **Introduction to Linguistics** syllabus
3. Sasikumar et al. *A Course in Listening and Speaking*. New Delhi: Foundation Books, 2005.
4. Tony Lynch, *Study Listening*. Cambridge: Cambridge UP, 2004.

CO-PO-Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
HU 191.1	-	3	-	-	-	3	2	1	3	3	3	3
HU 191.2	-	3	-	2	-	3	-	-	3	3	3	3
HU 191.3	-	3	-	-	-	3	-	-	3	3	3	3
HU 191.4	-	3	2	3	-	3	2	-	3	3	3	3
HU 191.5	-	3	2	2	-	2	-	3	3	3	3	3

Paper Name: Engineering Drawing & Graphics**Paper Code: ME 191****Total Contact Hours: 36****Credit: 2****Pre requisites:** Higher Secondary with Physics, Chemistry & Mathematics**Course Objective:**

1. To learn basics of drafting and use of drafting tools.
2. To know about engineering scales, dimensioning and various geometric curves.
3. To Understand projection of line, surface and solids to create the knowledge base of orthographic and isometric view of structures and machine parts.
4. To acquire the knowledge of Computer Aided drafting using design software.

Course Outcomes:

Upon successful completion of this course, the student will be able to:

- ME 191.1.** Learn basics of drafting and use of drafting tools which develops the fundamental skills of industrial drawings.
- ME 191.2.** Know about engineering scales, dimensioning and various geometric curves necessary to understand design of machine elements.
- ME 191.3.** Understand projection of line, surface and solids to create the knowledge base of orthographic and isometric view of structures and machine parts.
- ME 191.4.** Become familiar with computer aided drafting useful to share the design model to different section of industries as well as for research & development.

Course contents:**List of Experiments:**

1. Lines, Lettering, Dimensioning, Scales (Plain scale & diagonal Scale).
2. Geometrical Construction and Curves – Construction of Polygons, Parabola, Hyperbola & ellipse
3. Projection of Points, Lines and Surfaces – orthographic projection- first angle and third angle projection, projection of lines and surfaces- Hexagon
4. Projection of Solids – (Cube, Pyramid, Prism, cylinder and Cone
5. Sectional Views – for simple solid objects

6. Introduction to Computer Aided Drafting – using auto cad & / or similar software- Introduction to Cartesian and polar coordinate systems, absolute and relative coordinates; Basic editing commands: line, point, trace, rectangle, polygon , circle, arc, ellipse, polyline; editing methods; basic object selection methods – window and crossing window, erase, move, copy, offset, fillet, chamfer, trim, extend, mirror; display command; zoom, pan, redraw, regenerate; simple dimensioning and text, simple exercises.

CO-PO Mapping

CO	PO1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
ME 191.1	2	-	1	2	-	1	-	-	1	-	-	1
ME 191.2	3	-	2	2	-	1	-	-	1	1	-	1
ME 191.3	2	2	2	1	-	1	-	-	1	-	-	1
ME 191.4	1	-	2	2	2	1	-	-	1	1	-	1

Sessional

Paper Name: Extra Curricular Activity (NSS/ NCC)

Paper Code: XC 181

Total Contact hours: 20

Credit: 1

Course Objectives:

The objectives of the course are as follows:

- To increase student awareness about the weaker and unprivileged sections of society
- To expose students to environmental issues and ecological concerns
- To make students self aware about their participatory role in sustaining society and the environment

Course contents

List of Activities:

- Creating awareness in social issues
- Participating in mass education programmes
- Proposal for local slum area development
- Waste disposal
- Environmental awareness ``
- Production Oriented Programmes
- Relief & Rehabilitation work during Natural calamities

Creating awareness in social issues:

1. Women's development – includes health, income-generation, rights awareness.

2. Hospital activities – Eg. writing letters for patients, guiding visitors
 3. Old age home – visiting the aging in-mates, arranging for their entertainment.
 4. Children's Homes - visiting the young in-mates, arranging for their entertainment
 5. Linking with NGOs to work on other social issues. (Eg. Children of sex-workers)
 6. Gender issues- Developing an awareness, to link it with Women's Cell of college
- Participating in mass education programmes

1. Adult education

2. Children's education

Proposal for local slum area development

One or two slums to be identified and according to the needs, activities to be developed and proposals and reports are to be submitted.

Environmental awareness

- Resource conservation – Awareness to be developed on water, energy, soil.
- Preservation of heritage monuments- Marches, poster campaigns
- Alternative energy consciousness amongst younger school-children.
- Plantation and beautification- Plantation of trees, their preservation and upkeep, developing NSS parks.
- Waste disposal- Proper methods of domestic waste disposal.

Production Oriented Programmes

5. Working with people and explaining and teaching improved agricultural practices
6. Rodent control and pest control practices;
7. Soil-testing, soil health care and soil conservation;
8. Assistance in repair of agriculture machinery;
9. Work for the promotion and strengthening of cooperative societies in villages;
10. Assistance and guidance in poultry farming, animal husbandry, care of animal health etc.;
11. Popularization of small savings and
12. Assistance in procuring bank loans

Relief & Rehabilitation work during Natural calamities

- g) Assisting the authorities in distribution of rations, medicine, clothes etc.;
- h) Assisting the health authorities in inoculation and immunization, supply of medicine etc.;
- i) Working with the local people in reconstruction of their huts, cleaning of wells, building roads etc.;
- j) Assisting and working with local authorities in relief and rescue operation; Collection of clothes and other materials, and sending the same to the affected areas;

**Detailed Syllabus of B.Tech in Biomedical Engineering Programme
(First Year - Second Semester)**

Curriculum

THEORY							
Sl No	Paper Code	Theory	Contact Hours /Week				Credit Points
			L	T	P	Total	
1	M 201	Mathematics -II	3	1	0	4	4
2	PH 201	Physics - I	3	1	0	4	4
3	EC 201	Basic Electronics Engineering	3	1	0	4	4
4	CS 201	Computer Fundamentals & Principle of Computer Programming	3	1	0	4	4
5	ME 201	Engineering Thermodynamics & Fluid Mechanics	3	1	0	4	4
Total of Theory						20	20
PRACTICAL							
6	PH291	Physics -I Lab	0	0	3	3	2
7	EC 291	Basic Electronics Engineering Lab	0	0	3	3	2
8	CS291	Computer Fundamentals & Principle of Computer Programming Lab	0	0	3	3	2
9	ME 292	Workshop Practice	0	0	3	3	2
Total of Practical						12	08
SESSIONAL							
10	MC 281	Soft Skill Development	0	0	2	2	0

Syllabus

THEORY

Paper Name: Mathematics-II

Paper Code: M 201

Total Contact Hours: 40

Credit: 4

Prerequisite: Any introductory course on calculus.

Course Objective: The purpose of this course is to provide fundamental concepts Ordinary Differential Equations, Graph Theory and Laplace Transform.

Course outcome:

On successful completion of the learning sessions of the course, the learner will be able to:

M 201.1: Recall the distinctive characteristics of Ordinary Differential Equations, Graph Theory and Laplace Transform.

M 201.2: Understand the theoretical workings of various algorithms related to graph theory and the theorems of differential equation and Laplace transforms.

M 201.3: Apply the principles of differential equation, graph theory and Laplace transforms to solve various problems.

Course contents:

Module I

[10L]

Ordinary differential equations (First order): First order and first degree Exact equations, Necessary and sufficient condition of exactness of a first order and first degree ODE (statement only), Rules for finding Integrating factors, Linear equation, Bernoulli's equation, General solution of ODE of first order and higher degree (different forms with special reference to Clairaut's equation), Applications related to Engineering problems.

Module II [10L]

Ordinary differential equations (Higher order): General linear ODE of order two with constant coefficients, C.F. & P.I., D-operator methods for finding P.I., Method of variation of parameters, Cauchy-Euler equations, Solution of simultaneous linear differential equations, Applications related to Engineering problems.

Module III [10L]

Basic Graph Theory: Graphs, Digraphs, Weighted graph, Connected and disconnected graphs, Complement of a graph, Regular graph, Complete graph, Subgraph, Walks, Paths, Circuits, Euler Graph, Cut-sets and cut-vertices, Matrix representation of a graph, Adjacency and incidence matrices of a graph, Graph isomorphism, Bipartite graph, Tree, Binary tree, Spanning tree of a graph, Minimal spanning tree, properties of trees, Algorithms: Dijkstra's Algorithm for shortest path problem, Determination of minimal spanning tree using Kruskal's and Prim's algorithm.

** Extra lecture hours may be taken for this module

MODULE IV: [10L]

Laplace Transform (LT): Definition and existence of LT, LT of elementary functions, First and second shifting properties, Change of scale property; LT of $t f(t)$, LT of $f(t)/t$, LT of derivatives of $f(t)$, L.T. of $\int f(u) du$. Evaluation of improper integrals using LT, LT of periodic and step functions, Inverse LT: Definition and its properties; Convolution Theorem (statement only) and its application to the evaluation of inverse LT, Solution of linear ODE with constant coefficients (initial value problem) using LT. Applications related to Engineering problems.

Beyond Syllabus:

Combinatorics: Fundamental Principles, Permutations, Combinations, Binomial Coefficients.

Text Books:

1. E. Kreyszig, Advanced engineering mathematics (8th Edition), John Wiley, 1999.
2. B.S.Grewal, Higher Engineering Mathematics, Khanna Publications, 2009.
3. R.K.Jain and S.R.K.Iyengar, Advanced Engineering Mathematics, Narosa Pub. House, 2008.

Reference Text Books:

1. W. E. Boyce and R. DiPrima, Elementary Differential Equations (8th Edition), John Wiley, 2005.
2. R.K. Ghosh and K.C.Maity, An Introduction to Differential Equations, New Central Book Agency.
3. V. K. Balakrishnan, Graph Theory, Schaum's Outline, TMH.
4. J. Clark and D. A. Holton, A first course at Graph Theory, Allied Publishers LTD.
5. D. B. West, Introduction to Graph Theory, Prentice-Hall of India.
6. N. Deo, Graph Theory, Prentice-Hall of India.
7. J. Bird, Higher Engineering Mathematics (4th Edition, 1st India Reprint), Elsevier, 2006.
8. L. Rade and B. Westergen, Mathematics Handbook: for Science and Engineering (5th edition, 1st Indian Edition), Springer, 2009.
9. Murray R. Spiegel, Laplace Transform, Schaum's Outline Series, McGRAW-HILL.

CO-PO Mapping:

PO \ CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12
M 201.1	3	2	-	-	-	-	-	-	-	-	-	1
M 201.2	3	2	-	-	-	-	-	-	-	-	-	1
M 201.3	3	2	2	-	-	-	-	-	-	-	-	1

Paper Name: Physics -I

Paper Code: PH 201

Total Contact Hours: 41

Credit: 4

Pre requisites: Knowledge of Physics upto 12th standard.

Course Objective:

The aim of courses in Physics is to provide an adequate exposure and develop insight about the basic physics principles along with the possible applications. The acquaintance of basic principles of physics would help engineers to understand the tools and techniques used in the industry and provide the necessary foundations

for inculcating innovative approaches. It can also create awareness of the vital role played by science and engineering in the development of new technologies. It also gives necessary exposure to the practical aspects, which is an essential component for learning sciences.

Course Outcome:

At the end of the course students' should have the

PH 201.1 : Ability to state and recall ➤ De-Broglie hypothesis, and Heisenberg's Uncertainty Principle ➤ Amplitude and Velocity Resonance ➤ Malus's Law, Brewster's Law ➤ Characteristics of LASER light	PO1 Or GA1
PH 201.2 : Ability to understand and explain ➤ Polarizer and analyzer ➤ basic principles and different types of LASER and Optical Fibre ➤ structure of solids, Miller indices ➤ theory of Matter Wave, equation of motion of Matter Wave ➤ wave function and its role in representing wave nature of matter	PO2 Or GA2
PH 201.3 : Ability to apply the knowledge of ➤ mechanical vibration in electrical circuits ➤ superposition principle in Newton's ring phenomenon, diffraction phenomenon ➤ quantum nature of e.m. waves for production of laser ➤ total internal reflection in transmitting light through optical fibres ➤ x-ray diffraction in crystal structure ➤ probability interpretation in Heisenberg's uncertainty principle	PO3 Or GA3
PH 201.4 : Ability to analyze ➤ grating as many slit system ➤ role of Q factor in a resonating circuit, conditions of different types of resonance ➤ minimum requirements for lasing action ➤ importance of light as a carrier of information ➤ the failures of classical physics in microscopic situation and need of quantum physics ➤ Einstein's A, B coefficient and predict the wavelength domain of Lasing action ➤ Requirement of Miller indices for describing crystallographic planes	PO2 Or GA2
PH 201.5 : Ability to evaluate / justify / compare ➤ X-ray production process is inverse of the process of Photoelectric Effect. ➤ different crystallographic structures according to their Co-ordination number and packing factors ➤ the outcome of Photo-electric effect, Compton effect and Davisson-Germer experiment to justify wave-particle duality of matter	PO12 Or GA12

Course contents

Module 1 (8L):-

Oscillations

1.1 Simple harmonic motion: Concepts with examples, Superposition of SHMs in two mutually perpendicular directions: Lissajous' figures, Engineering Applications and related Numerical problems 2L

1.2 Damped vibration: Differential equation and its solution, Logarithmic decrement, quality factor, Engineering Applications and related Numerical problems. 3L

1.3 Forced vibration: Differential equation and solution, Amplitude and Velocity resonance, Sharpness of resonance, relevant applications including LCR circuits, Numerical problems 3L

Module 2 (10L):-

Classical Optics:

2.1 Interference of light: Wave nature of light (Huygen's principle), Conditions of sustained interference double slit as an example; qualitative idea of spatial and temporal coherence, conservation of energy and intensity distribution; Newton's ring (qualitative descriptions of working principles and procedures-no deduction required). Engineering applications, Numerical Problems. 3L

Fresnel's biprism (beyond the syllabus). 1L(ext)

2.2 Diffraction of light: Fresnel and Fraunhofer class, Fraunhofer diffraction for plane transmission grating (elementary treatment of intensity distribution for N-slits), single slit and double slits as examples, missing order, Rayleigh criterion, resolving power of grating and microscope (Definition and formula; no deduction required). Engineering Applications, Numerical Problems. 4L

2.3 Polarization: Definition, plane of polarization, plane of vibration, Malus law, fundamental concepts of plane, circular and elliptical polarizations (only qualitative idea) with examples, Brewster's law, Double refraction: ordinary and extraordinary rays, Nicol's prism, Engineering applications, Numerical problems. 3L

Module 3 (9L):-

Quantum Physics:

3.1 Quantum Theory: Inadequacy of classical physics; Planck's quantum hypothesis-Qualitative (without deductions), particle concept of electromagnetic wave (example: photoelectric and Compton effect; qualitative discussions only), wave particle duality; phase velocity and group velocity; de Broglie wave; Davisson and Germer experiment. 4L

3.2 Quantum Mechanics 1: Concept of wave function, Physical significance of wave function, Probability interpretation; wave function normalization condition and its simple numerical applications; uncertainty principle-applications, Schrödinger equation (no mathematical derivation). 4L

Module 4 (6L):

X-ray & Crystallography

4.1 X-rays – Origin of Characteristic and Continuous X-ray, Bragg's law (No derivation), Determination of lattice constant, Applications, Numerical problems. 2L

4.2 Elementary ideas of crystal structure - lattice, basis, unit cell, Fundamental types of lattices – Bravais lattice, Simple cubic, fcc and bcc, hcp lattices, (use of models in the class during teaching is desirable) Miller indices and miller planes, Co-ordination number and Atomic packing factor, Applications, Numerical problems. 4L

Module 5 (8L):

Modern Optics-I:

5.1 Laser: Concepts of various emission and absorption process, working principle of laser, metastable state, Population Inversion, condition necessary for active laser action, optical resonator, ruby laser, He-Ne laser,

semiconductor laser, Einstein A and B coefficients and equations, industrial and medical applications of laser. 5L

5.2 Fibre optics and Applications: Principle and propagation of light in optical fibres- Numerical aperture and Acceptance angle, V number, Types of optical fibres (material, refractive index, mode), Losses in optical fibre- attenuation, dispersion, bending, Numerical problems. 3L

Recommended Text Books for Physics I (PH101//201):

Oscillations:

1. Classical Mechanics- J. C. Upadhyay (Himalya Publishers)
2. Classical Mechanics-Shrivastav
3. Classical Mechanics-Takwal & Puranik (TMH)
4. Sound-N. K. Bajaj (TMH)
5. Advanced Acoustics-D. P. Roy Chowdhury (Chayan Publisher)
6. Principles of Acoustics-B.Ghosh (Sridhar Publisher)
7. A text book of sound-M. Ghosh (S. Chand publishers)
8. Electricity Magnetism-Chattopadhyay & Rakshit (New Central Book Agency)
9. A text book of Light- K.G. Mazumder & B.Ghoshs, (Book & Allied Publisher)
10. R.P. Singh (Physics of Oscillations and Waves)
11. A.B. Gupta (College Physics Vol. II)
12. Chattopadhyay and Rakshit (Vibration, Waves and Acoustics)

Classical Optics & Modern Optics-I:

13. A text book of Light- K.G. Mazumder & B.Ghoshs (Book & Allied Publisher)
14. A text book of Light-Brijlal & Subhramaniam, (S. Chand publishers)
15. Modern Optics-A. B. Gupta (Book & Allied Publisher)
16. Optics-Ajay Ghatak (TMH)
17. Optics-Hecht
18. Optics-R. Kar, Books Applied Publishers
19. Möller (Physical Optics)
20. E. Hecht (Optics)
21. E. Hecht (Schaum Series)
22. F.A. Jenkins and H.E White
23. C.R. Dasgupta (Degree Physics Vol 3)

Quantum Physics

24. Introduction to Quantum Mechanics-S. N. Ghoshal (Calcutta Book House)
25. Quantum Mechanics-Bagde Singh (S. Chand Publishers)
26. Perspective of Quantum Mechanics-S. P. Kuilla (New Central Book Agency)
27. Quantum Mechanics-Binayak Datta Roy (S. Chand Publishers)
28. Quantum Mechanics-Bransden (Pearson Education Ltd.)
29. Perspective of Modern Physics-A. Beiser (TMH)
30. Eisberg & Resnick is published by Wiley India
31. A.K. Ghatak and S Lokenathan
32. E.E. Anderson (Modern Physics)
33. Haliday, Resnick & Krane : Physics Volume 2 is Published by Wiley India
34. Binayak Datta Roy [Elements of Quantum Mechanics]

X-ray & Crystallography

35. Solid state physics-Puri & Babbar (S. Chand publishers)
36. Materials Science & Engineering-Kakani Kakani
37. Solid state physics- S. O. Pillai
38. Introduction to solid state physics-Kittel (TMH)
39. Solid State Physics and Electronics-A. B. Gupta, Nurul Islam (Book & Allied Publisher)

40. S.O. Pillai (a. Solid state physics b. Problem in Solid state physics)

General Reference:

1. Refresher courses in physics (Vol. 1, Vol. 2 & Vol. 3)-C. L. Arora (S. Chand Publishers)
2. Basic Engineering Physics-Amal Chakraborty (Chaya Prakashani Pvt. Ltd.)
3. Basic Engineering Physics-I -Sujoy Bhattacharya, Saumen Paul (TMH)
4. Engineering Physics Vol: 1-Sudipto Roy, Tanushri Ghosh, Dibyendu Biswas (S. Chand).
5. Engineering Physics Vol:1-S. P. Kuila (New Central)
4. University Physics-Sears & Zemansky (Addison-Wesley)
- 5.B. Dutta Roy (Basic Physics)
6. R.K. Kar (Engineering Physics)
7. Mani and Meheta (Modern Physics)
8. Arthur Baiser (Perspective & Concept of Modern Physics)

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
PH 201.1	1											
PH 201.2		2										
PH 201.3	3											
PH 201.4		1										
PH 201.5												1

Paper Name: Basic Electronics Engineering

Paper code: EC201

Total Contact Hours: 40

Credits: 4

Prerequisites

A basic course in Electronics and Communication Engineering Progresses from the fundamentals of electricity, direct current (DC) devices and circuits , series and parallel circuits to the study of active and passive components, Ohm's Law, Kirchoff's Law i.e. KVL,KCL, Ampere's Law etc.

Course objectives: Students will be able to Analyze the behaviour of semiconductor diodes in Forward and Reverse bias . To design a half wave and full wave rectifiers , Explore V-I characteristics of Bipolar Junction Transistor n CB, CE & CC configurations. To acquire the basic engineering technique and ability to design and analyze the circuits of Op-Amps. Students will be able to explain feedback concept and different oscillators. They will also be familiar with the analysis of digital logic basics and measuring Electronic devices. Students will have knowledge about characteristics of FET.

Course Outcomes:

EC 201.1	Study PN junction diode, ideal diode, diode models and its circuit analysis, application of diodes and special diodes.
EC 201.2	Learn how operational amplifiers are modeled and analyzed, and to design Op-Amp circuits to perform operations such as integration, differentiation on electronic signals.
EC 201.3	Study the concepts of both positive and negative feedback in electronic circuits.
EC 201.4	Develop the capability to analyze and design simple circuits containing non-linear elements such as transistors using the concepts of load lines, operating points and incremental analysis.
EC 201.5	Learn how the primitives of Boolean algebra are used to describe the processing of binary signals.

Course contents**Module-I: Basics of semiconductor****6L**

Conductors, Insulators, and Semiconductors- crystal structure, Fermi Dirac function, Fermi level, E-k and Energy band diagrams, valence band, conduction band, and band gap; intrinsic, and extrinsic (p-type and n-type) semiconductors, position of Fermi level in intrinsic and extrinsic semiconductor, drift and diffusion current – expression only (no derivation) , mass action law , charge neutrality in semiconductor, Einstein relationship in semiconductor , Numerical problems on- Fermi level, conductivity, mass action law, drift and diffusion current .

Module-II: P-N Junction Diode and its applications**8L**

p-n junction formation and depletion region , energy band diagram of p-n junction at equilibrium and barrier energy , built in potential at p-n junction , energy band diagram and current through p-n junction at forward and reverse bias, V-I characteristics and current expression of diode , temperature dependencies of V-I characteristics of diode , p-n junction breakdown – conditions , avalanche and Zener breakdown , Concept of Junction capacitance, Zener diode and characteristics.

Diode half wave and full wave rectifiers circuits and operation (I_{DC} , I_{rms} , V_{DC} , V_{rms}) , ripple factor without filter, efficiency ,PIV,TUF; Reduction of ac ripples using filter circuit (Qualitative analysis); Design of diode clipper and clamper circuit - explanation with example, application of Zener diode in regulator circuit. Numerical problems.

Module-III : Bipolar junction transistor(BJT)**6L**

Formation of PNP/NPN Transistors ,energy band diagram, current conduction mechanism , CE ,CB,CC configurations , transistor static characteristics in CE ,CB and CC mode, junction biasing condition for active, saturation and cut-off modes ,current gain α , β and γ , early effect.

Biasing and bias stability; biasing circuits - fixed bias; voltage divider bias; collector to base bias , D.C. load line and Quiescent point, calculation of stability factors for different biasing circuits.

BJT as an amplifier and as a switch – Graphical analysis; Numerical Problems.

4L

Module-V: Feedback and Operational Amplifier

10L

Operational amplifier – electrical equivalent circuit ,ideal characteristics , Non ideal characteristics of op-amp – offset voltages ;bias current ;offset current; Slew rate ; CMRR and bandwidth, Configuration of inverting and non-inverting amplifier using Op-amp, closed loop voltage gain of inverting and non-inverting amplifier , Concept of virtual ground, Applications op-amp – summing amplifier; differential amplifier; voltage follower ; basic differentiator and integrator .

Module-VI: Cathode Ray Oscilloscope (CRO)

2L

Module-VII: Digital Electronics

4L

Text Books:

1. D. Chattopadhyay, P. C. Rakshit, Electronics Fundamentals and Applications, New Age International
2. Millman & Halkias, Integrated Electronics, Tata McGraw Hill.
3. Boyelstad & Nashelsky: Electronic Devices & Circuit Theory, McGraw Hill, 1976.
4. Sedra & Smith, Microelectronics Engineering

Reference Books:

1. John D. Ryder, Electronic Fundamentals and Applications, PHI
2. J.B.Gupta, Basic Electronics, S.K. Kataria.
3. Malvino: Electronic Principle.
4. Schilling & Belove: Electronics Circuits.

CO-PO Mapping

[illegible]

Paper Name: Computer Fundamentals & Principle of Computer Programming

Paper code: CS201

Total Contact Hours: 40

Credits: 4

Prerequisites:

1. Number system
2. Boolean Algebra

Course Objective(s)

1. To develop the programming skills of students
2. To know the principles of designing structured programs
3. To write basic C programs using
 - i) Selection statements
 - ii) Repetitive statements
 - iii) Functions
 - iv) Pointers
 - v) Arrays
 - vi) Strings

Course Outcome:

CS201.1 Understanding the concept of input and output devices of Computers and how it works and recognize the basic terminology used in computer programming.

CS201.2 Write, Compile and Debug programs in C language and use different data types for writing the programs.

CS201.3 Design programs connecting decision structures, loops and functions.

CS201.4 Explain the difference between call by value and call by address.

CS201.5 Understand the dynamic behavior of memory by the use of pointers.

Use different data structures and create / manipulate basic data files and developing applications for real world problems.

Course content

Fundamentals of Computer: (10 L)

History of Computer, Generation of Computer, Classification of Computers 1L

Basic structure of Computer System, Primary & Secondary Memory, Processing Unit, Input & Output devices 2L

Binary and Allied number systems representation of signed & unsigned numbers, BCD, ASCII, Binary number Arithmetic – Addition and Subtraction (using 1's complement and 2's complement) 2L

Logic gates – AND, OR, NOT, NAND, NOR, EX-OR, EX-NOR - only truth tables, logic gate symbols and logic equations for gates only. 1L

Assembly language, high level language, machine level language, compiler and assembler (basic concepts) 1L

Basic concepts of operating systems like MS DOS, MS WINDOW, UNIX 1L

Problem solving-Algorithm & flow chart 2L

C Fundamentals: (30 L)

Variable and Data Types:

The C character set identifiers and keywords, data type & sizes, variable names, declaration, statements
3L

C Operators & Expressions:

Arithmetic operators, relational operators, logical operators, increment and decrement operators, bitwise operators, assignment operators, conditional operators, special operators - type conversion, C expressions, precedence and associativity.

Input and Output: Standard input and output, formatted output - printf, formatted input scanf, bit fields
5L

Branching and Loop Statements:

Statement and blocks, if - else, switch, goto and labels, Loops - while, for, do while, break and continue
3L

Fundamentals and Program Structures:

auto, external, static and register variables

Functions, function types, function prototypes, functions returning values, functions not returning values, scope rules, recursion, C preprocessor and macro
6L

Arrays, Strings and Pointers:

One dimensional arrays, Two-dimensional arrays, Multidimensional arrays. Passing an array to a function

Character array and string, array of strings, Passing a string to a function, String related functions

Pointers, Pointer and Array, Pointer and String, Pointer and functions, Dynamic memory allocation
6L

Files handling with C:

formatted and unformatted files, Command line arguments, fopen, fclose, fgetc, fputc, fprintf, fscanf function
4L

Structures and Unions:

Basic of structures, arrays of structures, structures and pointers, structures and functions
3L

Text book:

1. Kerninghan B.W. & Ritchie D.M. - The C Programming Language
2. Gottfried - Programming with C Schaum
3. Kanetkar Y. - Let us C
4. Balaguruswamy - Programming in C

Recommended reference Books:

1. Pohl and Kelly - A Book on C
2. Kerninghan, B.W. - The Elements of Programming Style
3. Schied F.S. Theory and Problems of Computers and Programming
4. Rajaraman V. Fundamental of Computers
5. M.M.Oka Computer Fundamentals,EPH
6. Leon Introduction to Computers,Vikas
7. Leon- Fundamental of Information Technology,Vikas
8. Ram B. Computer Fundamentals, New Age International
9. Ravichandran D. Programming in C, New Age International
10. Xavier C. Introduction to Computers, New Age International

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CS201.1	3	3										
CS201.2		2										
CS201.3	3	3										
CS201.4												
CS201.5	3		3	3	3							

Paper Name: Engineering Thermodynamics & Fluid Mechanics**Paper Code: ME 201****Total Contact Hours: 48****Credits: 4****Pre requisites:** Higher Secondary with Physics, Chemistry & Mathematics.**Course Objective:**

1. To understand the basic principles of thermodynamics, heat and work transfer.
2. To acquire the knowledge of basic concepts of Heat Engine, Entropy from Second law of thermodynamics.
3. To get the knowledge of thermodynamic properties of a pure substance and inter-relationships between key properties of a system or state possessed by the substance.
4. To understand the basic principles of fluid mechanics, and ability to analyze fluid flow problems with the application of the momentum and energy equations.

Course Outcome:

Upon successful completion of this course, the student will be able to:

ME 201.1 Know about thermodynamic equilibrium, heat & work transfer, First law and its application.**ME 201.2** Understand the basic concepts of Heat Engine, Entropy from Second law of thermodynamics.**ME 201.3** Know the thermodynamic characteristics of a pure substance and its application in power cycles (Simple Rankine cycles, Air Standard cycles)**ME 201.4** Knowledge of basic principles of fluid mechanics, and ability to analyze fluid flow problems with the application of the momentum and energy equations**Course content****Module 1:**

8L+3T

Basic Concepts of Thermodynamics

Introduction: Microscopic and Macroscopic viewpoints

Definition of Thermodynamic systems: closed, open and isolated systems Concept of Thermodynamics state; state postulate.

Definition of properties: intensive, extensive & specific properties. Thermodynamic equilibrium

Thermodynamic processes; quasi-static, reversible & irreversible processes; Thermodynamic cycles.

Zeroth law of thermodynamics. Concept of empirical temperature.

Heat and Work

Definition & units of thermodynamic work.

Examples of different forms of thermodynamic works; example of electricity flow as work. Work done

during expansion of a compressible simple system
Definition of Heat; unit of Heat
Similarities & Dissimilarities between Heat & Work

Ideal Equation of State, processes; Real Gas

Definition of Ideal Gas; Ideal Gas Equations of State.
Thermodynamic Processes for Ideal Gas; P-V plots; work done, heat transferred for isothermal, isobaric, isochoric, isentropic & polytropic processes.
Equations of State of Real Gases: Van der Waal's equation; Virial equation of state.

Properties of Pure Substances

p-v, T-s & h-s diagrams of pure substance like H₂O
Introduction to steam table with respect to steam generation process; definition of saturation, wet & superheated status.
Definition of dryness fraction of steam, degree of superheat of steam.

Module 2:

4L+3T

1st Law of Thermodynamics

Definition of Stored Energy & Internal Energy 1st Law of Thermodynamics for cyclic processes Non Flow Energy Equation.
Flow Energy & Definition of Enthalpy.
Conditions for Steady State Steady flow: Steady State Steady Flow Energy Equation.

Module 3:

6L+3T

2nd Law of Thermodynamics

Definition of Sink, Source Reservoir of Heat.
Heat Engine, heat Pump & Refrigerator; Thermal efficiency of Heat Engines & co-efficient of performance of Refrigerators
Kelvin – Planck & Clausius statements of 2nd Law of Thermodynamics Absolute or Thermodynamic scale of temperature, Clausius Integral Entropy
Entropy change calculation for ideal gas processes. Carnot Cycle & Carnot efficiency
PMM-2; definition & its impossibility

Module 4:

6L+3T

Air standard Cycles for IC engines

Otto cycle; plot on P-V, T-S planes; Thermal efficiency Diesel cycle; plot on P-V, T-S planes; Thermal efficiency

Rankine cycle of steam

Chart of steam (Mollier's Chart)

Simple Rankine cycle plot on P-V, T-S, h-s planes Rankine cycle efficiency with & without pump work
(Problems are to solved for each module)

Module 5:

9L+3T

Properties & Classification of Fluids

Ideal & Real fluids
Newton's law of viscosity; Newtonian and Non-Newtonian fluids
Compressible and Incompressible fluids

Fluid Statics

Pressure at a point

Measurement of Fluid Pressure Manometers:

simple & differential U-tube
Inclined tube

Fluid Kinematics

Stream line
Laminar & turbulent flow
external & internal flow
Continuity equation

Dynamics of ideal fluids

Bernoulli's equation
Total head; Velocity head; Pressure head
Application of Bernoulli's equation

Measurement of Flow rate: Basic principles

Venturimeter, Pilot tube, Orificemeter

(Problems are to be solved for each module)

Engineering ThermodynamicsText:

- 1 Engineering Thermodynamics - P K Nag, 4th edn, TMH.

References:

- 1 "Fundamentals of Thermodynamics" 6e by Sonntag & Van Wylin published by Wiley India.
- 2 Engineering Thermodynamics – Russel & Adeliyi (Indian edition), OUP
- 3 Engineering Thermodynamics – Onkar Singhh, New Age International Publishers Ltd.
- 4 Basic Engineering Thermodynamics – R Joel, 5th Ed., Pearson

Fluid MechanicsText:

- 1 Fluid Mechanics and Hydraulic Machines - R Bansal

References:

- 1 Introduction to Fluid Mechanics and Fluid Machines - S.K.Som and G.Biswas. 2nd edn, TMH
- 2 Fluid Mechanics by A.K.Jain.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
ME201.1	3	3	2	2	-	1	1	1	1	-	1	2
ME201.2	3	3	2	2	-	1	2	-	1	-	1	2
ME201.3	2	2	1	1	-	2	1	-	-	-	-	1
ME201.4	3	3	2	2	-	1	1	-	-	-	1	1

Practical

Paper Name: Physics I Lab

Paper Code: PH 291

Total Contact Hours: 40

Credit: 2

Pre requisites: Knowledge of Physics upto 12th standard.

Course Outcome of Physics-I practical (PH 191)

At the end of the course students' should have the

PH 291.1 : Ability to define, understand and explain ✓ Error estimation, Proportional error calculation ✓ Superposition principle in Newton's ring, Fresnel's biprism, laser diffraction ✓ Basic circuit analysis in LCR circuits	PO1
PH 291.2 : Ability to conduct experiments using ➤ LASER, Optical fibre ➤ Interference by division of wave front, division of amplitude, diffraction grating, polarization of light ➤ Quantization of electronic energy inside an atom ➤ Torsional pendulum	PO4
PH 291.3 : Ability to participate as an individual, and as a member or leader in groups in laboratory sessions actively	PO9
PH 291.4 : Ability to analyze experimental data from graphical representations , and to communicate effectively them in Laboratory reports including innovative experiments	PO10

General idea about Measurements and Errors (One Mandatory):

- Error estimation using Slide calipers/ Screw-gauge/travelling microscope for one experiment.
- Proportional error calculation using Carrey Foster Bridge.

Any 7 to be performed from the following experiments

Experiments on Oscillations & Elasticity:

- Study of Torsional oscillation of Torsional pendulum & determination of time period using various load of the oscillator.
- Experiments on Lissajous figure (using CRO).
- Experiments on LCR circuit.
- Determination of elastic moduli of different materials (Young's modulus and Rigidity modulus)

Experiments on Optics:

- Determination of wavelength of light by Newton's ring method.
- Determination of wavelength of light by Laser diffraction method.
- Determination of numerical aperture and the energy losses related to optical fiber experiment
- Measurement of specific rotation of an optically active solution by polarimeter.

Experiments on Quantum Physics:

- Determination of Planck's constant using photoelectric cell.
- Verification of Bohr's atomic orbital theory through Frank-Hertz experiment.

In addition it is **recommended that each student should carry out at least one experiment beyond the syllabus/one experiment as Innovative experiment.

Probable experiments beyond the syllabus:

1. Determination of wavelength of light by Fresnel's bi-prism method (beyond the syllabus).
2. Study of half-wave, quarter-wave plate (beyond the syllabus)
3. Study of dispersive power of material of a prism.
4. Study of viscosity using Poyseuille's capillary flow method/using Stoke's law.
5. Measurement of nodal and antinodal points along transmission wire and measurement of wave length.
6. Any other experiment related to the theory.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
PH 291.1	2											
PH 291.2	1											
PH 291.3				2								
PH 291.4									3			

Paper Name: Basic Electronics Engineering Lab

Paper Code: EC291

Total Contact Hours: 36

Credit: 2

Prerequisites

A basic course in electronics and Communication engineering Progresses from the fundamentals of electricity, active and passive components, basic electronics laws like Ohm's law, Ampere's law

Course objectives:

Students will become familiar with the circuit design using semiconductor diodes in Forward and Reverse bias, They will also be able to design rectifiers like half-wave, full-wave rectifiers etc. using diodes. The ability of circuit design with Bipolar Junction Transistor in CB, CE & CC configurations will be improved. The students will acquire the basic engineering technique and ability to design and analyze the circuits of Op-Amp. Basic concepts and Circuit design with logic gates will be developed in the students. The students will be able design circuit using FET.

Course Outcomes:

EC291.1	Knowledge of Electronic components such as Resistors, Capacitors, Diodes, Transistors measuring equipment like DC power supply, Multimeter, CRO, Signal generator, DC power supply.
EC291.2	Analyze the characteristics of Junction Diode, Zener Diode, BJT & FET and different types of Rectifier Circuits.
EC291.3	Determination of input-offset voltage, input bias current and Slew rate, Common-mode Rejection ratio, Bandwidth and Off-set null of OPAMPs.
EC291.4	Able to know the application of Diode, BJT & OPAMP.
EC291.5	Familiarization and basic knowledge of Integrated Circuits

Course contents:**List of Experiments:**

1. Familiarization with passive and active electronic components such as Resistors, Inductors, Capacitors, Diodes, Transistors (BJT) and electronic equipment like DC power supplies, millimeters etc.
2. Familiarization with measuring and testing equipment like CRO, Signal generators etc.
3. Study of I-V characteristics of Junction diodes.
4. Study of I-V characteristics of Zener diodes.
5. Study of Half and Full wave rectifiers with Regulation and Ripple factors.
6. Study of I-V characteristics of BJTs.
7. Study of I-V characteristics of Field Effect Transistors.
8. Determination of input-offset voltage, input bias current and Slew rate of OPAMPs.
9. Determination of Common-mode Rejection ratio, Bandwidth and Off-set null of OPAMPs.
10. Study of OPAMP circuits: Inverting and Non-inverting amplifiers, Adders, Integrators and Differentiators.
11. Study of Logic Gates and realization of Boolean functions using Logic Gates.
12. Study of Characteristic curves for CB, CE and CC mode transistors.
13. Innovative Experiment

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12
EC 291.1	3	3	-	-	-	-	-	-	-	-	-	-
EC 291.2	2	3	-	-	-	-	-	-	1	1	-	1
EC 291.3	1	3	3	-	-	-	-	-	-	2	-	-
EC 291.4	1	2	3	-	-	-	-	-	-	1	-	1
EC 291.5	3	1	2	-	-	-	-	-	-	-	-	-

Paper Name: Computer Fundamentals & Principle of Computer Programming Lab**Paper Code: CS291****Total Contact Hours: 36****Credit: 2****Prerequisites:** Basic Computer Knowledge**Course Objective(s):**

1. To develop an understanding of the design, implementation, and compilation of a C program
2. To gain the knowledge about pointers, a fundamental for understanding data structure issues
3. To understand the usage of user defined data type for application development

Course Outcome:

- CS291.1.** Understanding the working of different operating systems like DOS, Windows, Linux.
- CS291.2.** Write, Compile and Debug programs in C language.
- CS291.3.** Design programs connecting decision structures, loops.
- CS291.4.** Exercise user defined functions to solve real time problems.
- CS291.5.** Inscribe C programs using Pointers to access arrays, strings, functions, structures and files.

Experiment should include but not limited to the following:

- Some basic commands of DOS, Windows and Linux Operating System, File handling and Directory structures, file permissions, creating and editing simple C program, compilation and execution of C program.
- Writing C Programs on variable, expression, operator and type-casting.
- Writing C Programs using different structures of if-else statement and switch-case statement.
- Writing C Programs demonstrating use of loop (for loop, while loop and do-while loop) concept and use of break and continue statement.
- Writing C Programs demonstrating concept of Single & Multidimensional arrays.
- Writing C Programs demonstrating concept of Function and Recursion.
- Writing C Programs demonstrating concept of Pointers, address of operator, declaring pointers and operations on pointers.
- Writing C Programs demonstrating concept of structures, union and pointer to structure.
- Writing C Programs demonstrating concept of String and command line arguments.
- Writing C Programs demonstrating concept of dynamic memory allocation.
- Writing C Programs demonstrating concept of File Programming.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO	PO9	PO10	PO11	PO12
CS291.1	3	3										
CS291.2		2										
CS291.3	3	3										
CS291.4												
CS291.5	3		3	3	3							

Paper Name: Workshop Practice

Paper Code: ME 292

Total Contact Hours: 36

Credit: 2

Pre requisites: Higher Secondary with Physics, Chemistry & Mathematics

Course Objective:

1. To understand the basic knowledge of Workshop Practice and Safety.
2. To identify and use of different hand tools and other instruments like Hand Saw, Jack Plane, Chisels etc and operations like such as Marking, Cutting etc used in manufacturing processes.
3. To get hands on practice in various machining metal joining processes such as Welding, Brazing, Soldering, etc.

Course Outcome:

Upon successful completion of this course, the student will be able to:

ME 291.1 Gain basic knowledge of Workshop Practice and Safety useful for our daily living.

ME 291.2 Identify Instruments of a pattern shop like Hand Saw, Jack Plain, Chisels etc and performing operations like such as Marking, Cutting etc used in manufacturing processes.

ME 291.3 Gain knowledge of the various operations in the Fitting Shop using Hack Saw, various files, Scriber, etc to understand the concept of tolerances applicable in all kind of manufacturing.

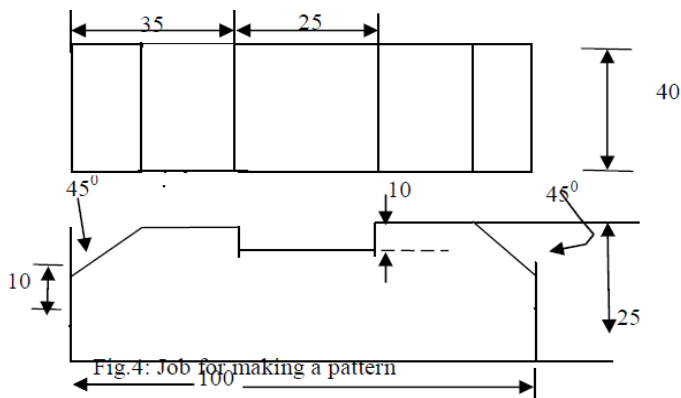
ME 291.4 Get hands on practice of in Welding and various machining processes which give a lot of confidence to manufacture physical prototypes in project works.

Course contents

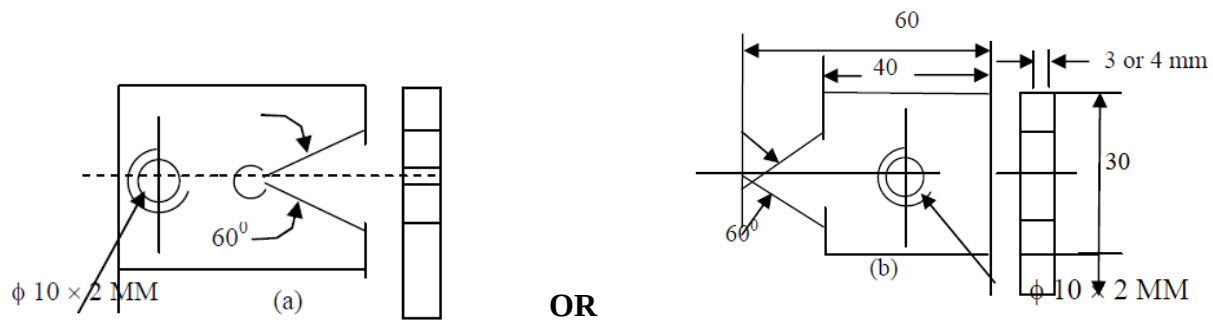
List of Activities:

Sl. No.	Syllabus	Contact Hrs
Module 1	Pattern Making	6
Module 2	Sheet Metal Work	6
Module 3	Fitting	9
Module 4	Machining in Lathe	9
Module 5	Welding	6

1 – PATTERN MAKING.



MODULE 3- FITTING SHOP.



MODULE 4 – MACHINING IN LATHE & SHAPING M/C

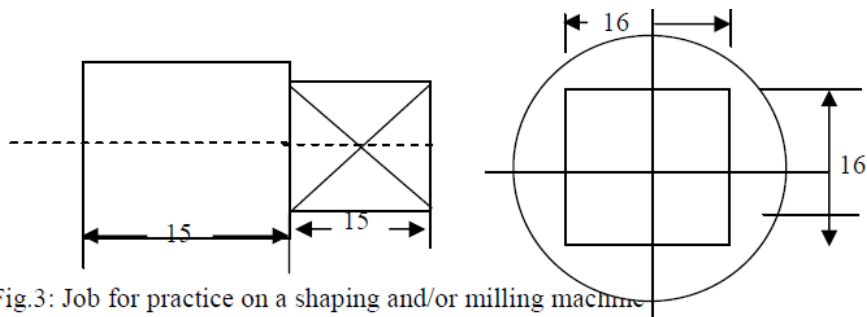
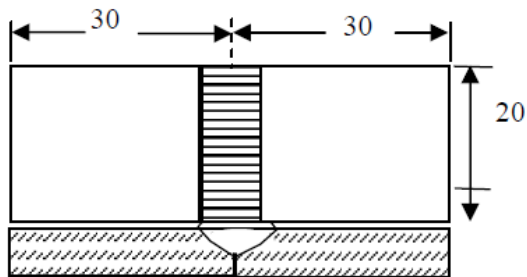


Fig.3: Job for practice on a shaping and/or milling machine

MODULE 5 – WELDING



CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
ME 292.1	2	-	-	-	-	2	-	1	-	-	1	-
ME 292.2	2	-	-	-	-	1	-	2	-	-	-	-
ME 292.3	2	-	-	-	-	1	-	1	-	-	-	-
ME 292.4	1	-	-	-	1	3	-	3	-	-	-	1

SESSIONAL

Paper Name: Soft Skills Development

Paper Code: MC-281

Total Contact hours: 26

Course Objectives:

The objectives of this course are as follows:

- To expose the students to different aspects of corporate life and workplace behavior
- To introduce workplace behavioral norms, etiquettes and standards
- To equip students to face interviews, presentations and other professional interactions

MODULE	CONTENT
One	Communication Training
Two	Communication Training (Accent Neutralization)
Three	Business Etiquette
Four	CV / Resume Writing
Five	Corporate Life and Protocols
Six	Group Discussion
Seven	Leadership Skill
Eight	Team Work
Nine	Public Speaking and Interview Basics
Ten	Business Telephone Etiquette
Eleven	Reading skill

Rearrange

MODULE ONE – COMMUNICATION TRAINING (2L)

1. Organisational Communication and Structure.
2. Vocabulary related to Corporate Operation.
3. Modes of Communication (Telephone, Conference Call, Team Huddle, Public Relation etc.
4. Communication with Clients, Customers, Suppliers etc.
5. Verbal and Non-Verbal Communication, Proxemics and Para Language.
6. Vocabulary Building (Synonym / Antonym / One word Substitution etc.)

MODULE TWO- COMMUNICATION TRAINING (ACCENT NEUTRALISATION) (2L)

7. Mother Tongue Influence
8. Vowel Sounds and Consonantal Sounds
9. Pronunciation and Neutral Accent.
10. Intonation.
11. Rate of Speech, Pausing, Pitch Variation and Tone.

MODULE THREE – BUSINESS ETIQUETTE (2L)

12. Presenting oneself in the Business Environment.
13. Corporate Dressing and Mannerism.
14. Table Etiquette (Corporate Acculturation, Office parties, Client/Customer invitations etc.)
15. Multi Cultural Etiquette.
16. Cultural Difference.
17. E-mail Etiquette.

MODULE FOUR – JOB APPLICATION AND CV / VIDEO RESUME (2L)

18. Format (Chronological, Skill Oriented, Functional etc.)
19. Style and Appearance.
20. Writing Tips and Video Content Presentation tips.
21. Types of Cover Letter or Job Application Letter.

MODULE FIVE - INTRODUCTION TO CORPORATE LIFE AND PROTOCOLS (2L)

22. Introduction of Companies (Domain Specific)
23. Opportunities and Growth Plan.
24. Performance and Corporate Behaviour.
25. Service Level Agreement and Corporate Jargon.
26. Networking and Adapting to Culture, Technology and Environment.

MODULE SIX – GROUP DISCUSSION (2L)

27. Introduction, Definition and Purpose.
28. Types of Group Discussion.
29. Strategies and Protocols of Group Discussion.
30. Skills and Parameters of Evaluation.
31. Practice Session and Video Viewing Task.

MODULE SEVEN – LEADERSHIP SKILL (2L)

32. Leadership Theories.
33. Traits and Skills of the Leader.
34. Roles, Duties and Responsibilities.
35. Case Study of Leaders.
36. Interpersonal relationship with Team.

MODULE EIGHT – TEAM WORK (2L)

37. Concept of Team Culture.
38. Stages of Team Development (Forming, Storming, Norming, Performing, Adjourning)
39. Team Working Agreement (Participation, Decision Making, Problem Solving.
40. Conflict Management, Flexibility, Negotiation Skill.
41. Team Building (Assess, Plan, Execute and Evaluate)

MODULE NINE – PUBLIC SPEAKING AND INTERVIEW BASICS (2L)

42. Extempore.
43. JAM.
44. Interview Skill
45. Interview over Telephone, Video Conference Interview etc.

MODULE TEN – BUSINESS TELEPHONE ETIQUETTE (2L)

46. Five Phases of a Business Call.
47. Pitch, inflection, Courtesy and Tone.
48. Understanding, Rate of Speech, Enunciation.
49. Hold Procedure.
50. Cold and Hot Transfer protocols.
51. Dealing with Different Types of Customers (Irate, Talkative, Turnaround etc.)

MODULE ELEVEN- READING SKILL

52. Vocabulary from context, speed reading, skimming, inferring, comprehension test etc.

ASSESSMENT		
1.	Viva	10
2.	Personal Skill Enhancement Log	25
3.	Movie Making: Video Resume	25
4.	Term End Project	40

LIST OF REFERENCE:

1. Effective Communication and Soft-Skills: Strategies for Success, Nitin Bhatnagar and Mamta Bhatnagar, Pearson, 2012.
2. Soft Skills: Know yourself and know the World, Dr. K.Alex, S Chand, 2009.
3. Soft Skills at Work: Technology for Career Success, Beverly Amer, Course Technology, 2009.
4. The Pronunciation of English, Daniel Jones, Cambridge University Press, 1998.
5. Global Business Etiquette: A Guide to International Communication and Customs, Jeanette S. Martin and Lillian H. Chaney, Praeger, 2012.
6. The CV Book: Your Definitive Guide to Writing the Perfect CV, James Innes, Pearson.
7. Understanding American Business Jargon: A Dictionary, W. Davis Folsom, Greenwood Press, 2005.
8. Navigating Corporate Life, Stanley Tyo.
9. Group Discussion: A Practical Guide to Participation and Leadership, Kathryn Sue Young, Julia T. Wood, Gerald M. Phillips and Douglas J. Pedersen, Waveland Press Inc., 2007.
10. The Leadership Skills Handbook, Jo Owen, KoganPage, 2006.
11. Teamwork Training, Sharon Boller, ASTD Press, 2005.
12. Public Speaking for Success, Dale Carnegie, Penguin, 2005.
13. Effective Interviewing Skills, Tracey A. Swift and Ivan T. Robertson, BPS Books, 2000.
14. Telephone Etiquette: Making Lasting First Impressions, Theo Gilbert-Jamison, Performance Solutions, 2013.
15. Reading Comprehension Strategies: Theories, Interventions and Technologies, Danielle S. McNamara, Lawrence Earlbaum Associates, 2007.
16. www.mindtools.com.

**Detailed Syllabus of B.Tech in Biomedical Engineering Programme
(Second Year - Third Semester)**

BME-Semester III

Curriculum

Subject Type	Subject Code	Subject Name	Contact hrs/week				Credits
			L	T	P	Total	
		THEORY					
BS	M(BME) 301	MATHEMATICS-III	3	1	0	4	4
PC	BME 301	ENGINEERING PHYSIOLOGY & ANATOMY	3	1	0	4	4
PC	BME 302	BIOPHYSICAL SIGNALS & SYSTEMS	3	1	0	4	4
ES	EE(BME) 303	CIRCUIT THEORY & NETWORKS	2	0	0	2	2
ES	EC(BME) 304	ANALOG ELECTRONIC CIRCUITS	2	0	0	2	2
		PRACTICAL					
PC	BME 391	ENGINEERING PHYSIOLOGY & ANATOMY LABORATORY	0	0	3	3	2
PC	BME 392	BIOPHYSICAL SIGNALS & SYSTEMS LABORATORY	0	0	3	3	2
ES	EE(BME) 393	CIRCUITS & NETWORKS LABORATORY	0	0	2	2	1
ES	EC(BME) 394	ANALOG ELECTRONIC CIRCUITS LABORATORY	0	0	2	2	1
		SESSIONAL					
MC	MC381	TECHNICAL SKILL DEVELOPMENT	0	0	2 Units	2 Units	0
		TOTAL	13	3	12	28	22

Syllabus

THEORY PAPERS

Subject Name: MATHEMATICS - III

Subject Code: M(BME) 301

Total Contact Hours: 44

Credits: 4

Prerequisite:

- Elementary mathematics including the notion of differential and integral calculus.
- Complex numbers, permutation & combination.

Course Objective: The purpose of this course is to provide fundamental concepts of Calculus of Complex Variables, Probability Distribution, Statistics, Ordinary Differential Equation, Partial Differential Equations.

Course Outcome:

On successful completion of the learning sessions of the course, the learner will be able to:

COURSE OUTCOMES (COs)	
CODE	DESCRIPTION
M(BME)301. CO 1	Recall the distinctive characteristics of mathematical approaches like Basic Probability and Probability Distribution, Sampling Theory, Estimation of Parameters, Correlation & Regression, Calculus of Complex Variables, Ordinary Differential Equations, Partial Differential Equations. (Remembering)
M(BME)301. CO 2	Understand the theoretical workings of mathematical approaches like Basic Probability and Probability Distribution, Sampling Theory, Estimation of Parameters, Correlation & Regression, Calculus of Complex Variables, Ordinary Differential Equations, Partial Differential Equations to evaluate the various measures in related field. (Understanding)
M(BME)301. CO 3	Develop mathematical model of various real world scenarios using concepts of mathematical approaches like Basic Probability and Probability Distribution, Sampling Theory, Estimation of Parameters, Correlation & Regression, Calculus of Complex Variables, Ordinary Differential Equations, Partial Differential Equations and solve the same. (Applying)

Course Content:

MODULE I: Theory of Probability

Topic: Basic Probability Theory

Sub-Topics: Classical definition and its limitations, Axiomatic definition, events, dependence and independence of events, conditional probability, Baye's theorem and related problems.

Topic: Random Variable & Probability Distributions. Expectation.

Sub-Topics: Definition of random variable. Continuous and discrete random variables. Probability density function & probability mass function for single variable only. Distribution function and its properties

(without proof). Examples. Definitions of Expectation & Variance, properties & examples. Some important discrete distributions: Binomial, Poisson, Normal distributions, Determination of Mean, Variance and standard deviation for Binomial, Poisson & Normal distributions only.

Discussions on application of the topic related to Engineering problems

10L

MODULE II: Calculus of Complex Variable

Topic: Introduction to Functions of a Complex Variable.

Sub-Topics: Complex functions, Concept of Limit, Continuity and Differentiability. Analytic functions, Cauchy-Riemann Equations (statement only). Sufficient condition for a function to be analytic. Harmonic function and Conjugate Harmonic function, related problems. Construction of Analytic functions: Milne Thomson method, related problems.

Topic: Complex Integration.

Sub-Topics: Concept of simple curve, closed curve, smooth curve & contour. Some elementary properties of complex Integrals. Line integrals along a piecewise smooth curve. Examples. Cauchy's theorem (statement only). Cauchy-Goursat theorem (statement only). Examples. Cauchy's integral formula, Cauchy's integral formula for the derivative of an analytic function, Cauchy's integral formula for the successive derivatives of an analytic function. Examples. Taylor's series, Laurent's series. Examples.

Topic: Zeros and Singularities of an Analytic Function & Residue Theorem.

Sub-Topics: Zero of an Analytic function, order of zero, Singularities of an analytic function. Isolated and non-isolated singularity, essential singularities. Poles: simple pole, pole of order m . Examples on determination of singularities and their nature. Residue, Cauchy's Residue theorem (statement only), problems on finding the residue of a given function, Introduction Conformal transformation, Bilinear transformation, simple problems.

Discussions on application of the topic related to Engineering problems

12L

MODULE III: PDE and ODE

Topic: Basic concepts of PDE.

Sub-Topics: Origin of PDE, its order and degree, concept of solution in PDE. Introduction to different methods of solution: Separation of variables, Laplace & Fourier transform methods.

Topic: Solution of Initial Value & Boundary Value PDE's by Separation of variables, Laplace & Fourier transform methods.

Sub-Topics: PDE I: One dimensional Wave equation.

PDE II: One dimensional Heat equation.

PDE III: Two dimensional Laplace equation.

Topic: Introduction to series solution of ODE.

Sub-Topics: Validity of the series solution of an ordinary differential equation. General method to solve $P_0 y'' + P_1 y' + P_2 y = 0$ and related problems to Power series method.

Discussions on application of the topic related to Engineering problems

12L

Module-IV: Statistics

Topic: Descriptive Measures

Sub-Topics: Measures of central tendency, Measures of dispersion.

Topic: Sampling theory

Sub-Topics: Random sampling. Parameter, Statistic and its Sampling distribution. Standard error of statistic. Sampling distribution of sample mean and variance in random sampling from a normal distribution (statement only) and related problems.

Topic: Estimation of parameters

Sub-Topics: Estimation of parameters (unbiasedness, consistency).

Topic: Correlation & Regression, Curve fitting and method of Least Square.

[Beyond Syllabus]: Numerical Integration: Trapezoidal rule, Simpson's $1/3^{\text{rd}}$ rule.

10L

Text Books:

1. Lipschutz & Lipson, Schaum's Outline in Probability (2nd Ed).
2. Colburn: Fundamentals of Probability and Statistics.
3. Advanced Ordinary & Partial Diff. Equation by M D Raisinghania.
4. Complex Variables and Applications (Brown and Churchill).
5. Probability and Statistics by N.G. Das
6. Gupta S. C and Kapoor V K: Fundamentals of Mathematical Statistics - Sultan Chand & Sons. 3. Lipschutz S: Theory and Problems of Probability (Schaum's Outline Series) - McGraw Hill Book Co.
7. Spiegel M R: Theory and Problems of Probability and Statistics (Schaum's Outline Series) - McGraw Hill Book Co.
8. Goon A.M., Gupta M K and Dasgupta B: Fundamental of Statistics - The World Press Pvt. Ltd.
9. Spiegel M R: Theory and Problems of Complex Variables (Schaum's Outline Series) - McGraw Hill Book Co.
10. Bronson R: Differential Equations (Schaum's Outline Series) - McGraw Hill Book Co.
11. Ross S L: Differential Equations - John Willey & Sons.
12. Sneddon I. N.: Elements of Partial Differential Equations - McGraw Hill Book Co.
13. Grewal B S: Higher Engineering Mathematics (thirty-fifth edn) - Khanna Pub.
14. Kreyzig E: Advanced Engineering Mathematics - John Wiley and Sons.
15. Jana- Undergraduate Mathematics
16. Lakshminarayan- Engineering Math 1.2.3
17. Rao B: Differential Equations with Applications & Programs, Universities Press
18. Murray: Introductory Courses in Differential Equations, Universities Press
19. Delampady, M: Probability & Statistics, Universities Press
20. Prasad: Partial Differential Equations, New Age International
21. Chowdhury: Elements of Complex Analysis, New Age International
22. Bhat: Modern Probability Theory, New Age International
23. Dutta: A Textbook of Engineering Mathematics Vol.1 & 2, New Age International
24. Sarveswarao: Engineering Mathematics, Universities Press

CO-PO MAPPING

POs COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
M(BME)301.1	3	2	-	-	-	-	-	-	-	-	-	1
M(BME)301.2	3	2	-	-	-	-	-	-	-	-	-	1
M(BME)301.3	3	2	2	-	-	-	-	-	-	-	-	1

Subject Name: ENGINEERING PHYSIOLOGY & ANATOMY**Subject Code: BME 301****Total Contact hours: 40****Credit: 4****Prerequisite:** Knowledge of 10+2 level Biology (Physiology Section)

Course Objective:

- Students will be able to get an in-depth understanding of anatomy and physiology of the cardiovascular system (heart and blood vessel), the pulmonary system (lung), the renal system, the digestive system, the nervous system, the muscular system and the skeletal system.
- The discussion of these physiological systems will cover the levels of cell, tissue and organ.
- Students will be able to understand the corresponding structure function relationship of these physiological systems.
- Students will be able to relate the structure and function of the cardiovascular, circulatory, respiratory, excretory, nervous and digestive systems in humans.
- Make measurements on and interpret data of physiological processes in living systems.
- Explain mechanisms of communication, integration and homeostasis involved in physiological parameters and energy balance.
- Extend students' vocabulary of anatomical concepts and terms.
- Students will understand and postulate physiological concepts based on anatomical information
- Enable students to develop their critical reasoning skills in the field of Engineering Physiology & anatomy.

Course Outcome:

Students will be able to

BME 301.1 Identify and get an in-depth understanding of anatomy and physiology of the cardiovascular system (heart and blood vessel), the pulmonary system (lung), the renal system, the digestive system, the nervous system, the muscular system and the skeletal system.

BME 301.2 Apply knowledge to comprehend and explain the corresponding structure function relationship of these physiological systems.

BME 301.3 Apply a broad knowledge of Physiology & Anatomy of organ system to logically analyze the mechanisms of function, integration and homeostasis involved in physiological parameters and energy balance.

BME 301.4 Analyze the Structure – Function relations of various human organ systems, to arrive at suitable conclusions to identify problems related to deformity or deviation from normal physiological processes in living systems.

BME 301.5 Interpret physiological abnormality and malfunctioning and its impact on health, safety, environment and society.

Course Content

Module No	Topic	No of Lectures
1	Blood Vascular system: Composition and functions of blood. Plasma proteins – normal values, origin and functions. Brief idea on Bone marrow. Formed elements of blood – origin, formation, functions and fate. Hemoglobin – functions, compounds and derivatives. Abnormal hemoglobin-overview. Erythrocyte sedimentation rate (ESR) and its significance. Hematocrit. PCV, MCV, MCH, MCHC. Blood coagulation –factors, process, anticoagulants, Prothrombin time. Clotting time. Bleeding time. Blood groups – ABO systems and Rh factors. Blood transfusion. Ultra structure & functions of blood vessels (artery, vein, capillary). Differences between artery & vein.	8L
2	Cardio Vascular System: Structure & function of Heart, Anatomical position, chambers of heart, Blood circulation through heart. Special junctional tissue of heart. Cardiac cycle. Heart Sound. Systemic & pulmonary circulation. Cardiac output. Blood Pressure-regulation & controlling factors.	6L

3	Muscular & Skeletal System: Microscopic and electron microscopic structure of skeletal, smooth and cardiac muscles. Difference between skeletal, smooth and cardiac muscles. The sarcotubular system. Red and white striated muscle fibers. Properties of muscle: excitability and contractility, all or none law, summation of stimuli, summation of contractions, effects of repeated stimuli, genesis of tetanus, onset of fatigue, refractory period. Muscle contraction – E C Coupling, Muscle fatigue, Rigor mortis, Sliding filament theory, Slow & fast muscle fibers, Isotonic & Isometric contraction. Types of Bones, Structure and Composition of Bone, Classification of Joints, Structure of Synovial Joint, Cartilage, Tendon, Ligament.	8L
4	Renal System: Function of kidney, Anatomy & Histology of Nephron & collecting duct. Urine formation (Filtration, reabsorption and secretion) Counter – current system of urine concentration, Anomalies in urine concentration.	4L
5	Digestive System: Organization of GI system, Digestion and Absorption, Movement of GI tract, Liver, Intestine, Pancreas, Role of Enzymes in Digestion.	3L
6	Respiratory System: Respiratory Pathways, Mechanism of Respiration, Respiratory membrane and gaseous exchange, Lungs, Role of Lungs in Respiration and Thermoregulation.	3L
7	Neuro Physiology: Electron microscopic structure of nerve cell or neurons. Neuroglia. Myelinated and nonmyelinated nerve fibers. The resting membrane potential. The action potential. Propagation of nerve impulse in different types of nerve fibers. Compound action potentials. Conduction velocity of nerve impulse in relation to myelination and diameter of nerve fibers. Synapses – types, structure, synaptic transmission of the impulse, synaptic potentials, neurotransmitters. Autonomic nervous system – Introduction. Structure of sympathetic and parasympathetic division. Neuromuscular Junction – structure, events in transmission, end-plate potential, post tunic potential. CNS- Brain and Spinal cord.	8L
	TOTAL	40L

Text/Reference Books:

1. Essential of Medical Physiology - Anil Baran Singha Mahapatra, Current Books International
2. Human Physiology - C.C.Chatterjee, Medical Allied Agency
3. Text book of Medical Physiology- Guyton
4. Concise Medical Physiology - Chauduri
5. Anatomy and Physiology – Ross & Wilson, Churchill Livigstone publications.
6. Modern Physiology & Anatomy for Nurses - J Gibson, Black-well Scientific Publishers

CO – PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BME 301.1	3	3	-	2	-	-	-	-	-	1	-	-
BME 301.2	3	3	-	1	-	-	-	-	-	-	-	-
BME 301.3	3	3	-	-	1	-	-	-	-	-	-	-
BME 301.4	2	3	-	3	1	-	-	-	-	-	-	-
BME 301.5	3	2	-	2	2	2	1	-	-	-	-	-

Subject Name: BIOPHYSICAL SIGNALS & SYSTEMS

Subject Code: BME 302

Total Contact hours: 42

Credit: 4

Prerequisite: Basic Knowledge of Integration, Differentiation, Complex Numbers

Course Objective:

The objectives of this course are

1. To develop good understanding about signals, systems and their classification;
2. To provide with necessary tools and techniques to analyze electrical networks and systems
3. To develop expertise in time-domain & frequency domain approaches to the analysis of continuous & discrete systems;
4. To introduce to the basics of probability, random variables and the various distribution and density functions
5. To develop students' ability to apply modern simulation software to system

Course Outcome:

Students will be able to

BME 302.1 Represent & classify signals, Systems & identify LTI systems

BME 302.2 Derive Fourier series for continuous time signals

BME 302.3 Find Fourier transform for different signals

BME 302.4 Analyze the Continuous Time systems by performing Convolution

BME 302.5 Analyze DT systems & their realization using Z-transforms

Course Content:

Module No	Content	No of Lectures
1	Signals and systems: Continuous time (CT) signals, Discrete time (DT) signals, periodic, aperiodic, random, energy and power signals, step, ramp, impulse and exponential function, Transformation in independent variable of signals: time scaling, time shifting and time inverting, Introduction to systems, system properties, interconnection of system, LTI systems- linear and circular convolution, correlation, auto-correlation, physiological signals and their properties, System Stability.	8L
2	Signal analysis: Basic concepts of the Fourier Series, Properties of continuous and discrete time Fourier series, Continuous Time Fourier Transform (CTFT) and Discrete Time Fourier Transform (DTFT), Discrete Fourier transform (DFT) and its inverse (IDFT), Introduction to Fast Fourier transform (FFT), ECG signal analysis.	9L
3	Sampling Theorem, Laplace Transforms and Z-Transforms: Representation of continuous time signals by its sample, Sampling theorem, Reconstruction of a Signal from its samples, aliasing, Laplace transform: basics, properties, inverse; z-transform: definition, properties, Poles and Zeros, inverse z-transform; Region of convergence (ROC), Representation of systems by differential equations and transfer functions, direct form-I and direct form-II representations, parallel and cascade representations.	10L
4	Noise and Feed Back System: Sources and types of noise, Basic Feedback concept, Positive and Negative Feedback, Control system, Open loop Control System, Control system With Feed Back, Application of feed back in physiological systems and its importance.	5L

5	Filtering Techniques: Types of filter (Active and Passive), General idea of L.P.F, H.P.F, B.P.F and N.F. Passive and Active Filters (L.P, H.P, B.P & N.F), use of filter for biomedical signal analysis, design of filter suitable for Bio-medical signal analysis.	4L
6	Physiological System: Block diagram representation of cardio vascular system, Electrical analog of blood vessels and its transfer function, model of coronary circulation and its analysis, system equation and transfer function, Characteristics of ECG, EEG and EMG signals, signal conditioning of these bio-potential signals	6L
TOTAL		42L

Reference Books:

1. Oppenheim, Wilskey and Nawab-Signal & System, Prentice Hall India.
2. Hayken & Van Veen- Signal & System, Willey
3. Taub & Schilling-Principles of Communication System, Tata McGraw Hill.
4. Kennedy & Devis-Electronic Communication System, Tata McGraw Hill
5. R.M. Rangayyan, Biomedical Signal Analysis, Wiley
6. A.K.Sawhney-Electrical & Electronic Measurement & Instrumentation, Dhanpat Rai & Co. (P) Ltd
7. J.G.Prokis & D.G.Manolakis, "Digital Signal Processing: Principles, Algorithm and Applications", PHI/Pearson Education.
8. I.J. Nagrath, Control Systems Engineering, New Age International.
9. Wills J. Tompkins, " Biomedical digital signal processing", Prentice Hall of India Pvt. Ltd.

CO vs PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BME 302.1	1	-	1	-	3	-	-	-	-	-	-	-
BME 302.2	2	3	1	-	-	-	-	-	-	1	-	-
BME 302.3	1	1	3	-	2	3	-	3	-	-	-	2
BME 302.4	-	2	1	1	3	-	-	-	-	-	-	-
BME 302.5	2	3	1	2	-	-	1	-	2	-	1	3

Subject Name: CIRCUIT THEORY & NETWORKS

Subject Code: EE(BME)303

Total Contact hours: 25

Credit: 2

Prerequisite:

1. Ability in identifying passive and active circuit elements/components and basic knowledge on their operation and application.
2. In depth knowledge in Integral & Differential Calculus and fundamental knowledge on Laplace Theorem & its inverse.
3. Knowledge of analog & digital signal should be clear.

Course Objective

1. To familiarize students with Resonance in Circuits and relevant parameters and methods for evaluating the same.
2. To introduce students the methods of Mesh Current and Node Voltage analysis and their application.
3. To describe Network Theorems and their applications.
4. To illustrate graph theory and its application in estimating electrical parameters in the circuit.
5. To introduce students with coupled circuits and their methods of analysis..

6. To introduce students with transient circuits and describe the methodology to evaluate relevant electrical parameters.
7. To highlight the application of Laplace & Inverse Laplace transform in analyzing circuits.

Course Outcome

After completion of this course the students will be able to

EE(BME)303.1 Understand, Describe, Analyze and Design series and parallel RLC circuits and solve related problems

EE(BME)303.2 Analyze circuits using Node Voltage & Mesh Current Analysis in electrical networks and solve related problems.

EE(BME)303.3 Apply and Analyze Network Theorems to electrical networks to evaluate network parameters in simplified ways.

EE(BME)303.4 Understand, Describe, Analyze and Design Graph and Trees for a given network and build network matrices and solve related problems

EE(BME)303.5 Understand Describe, Analyze and Design Coupled (Magnetic and Electromagnetic) Circuits and solve related problems

EE(BME)303.6 Understand, Describe and Analyze the Transients in electrical networks and solve related problems

EE(BME)303.7 Apply Laplace Transform and form Transfer Function for different kinds of electrical networks for analyzing them and solve related problems

Course Content

Module No	Topic	No of Lectures
1	Resonant Circuits: Series and Parallel Resonance, Impedance and Admittance Characteristics, Quality Factor, Half-Power Points, Bandwidth, Resonant voltage rise, Transform diagrams, Solution of Problems	2L
2	Mesh Current Network Analysis: Kirchoff's Voltage Law, Formulation of Mesh Equations, Solution of mesh equations by Cramer's rule and matrix method, Driving point impedance, Transfer impedance, Solutions of Problems with DC and AC sources	2L
3	Node Voltage Network Analysis: Kirchoff's Current Law, Formulation of node equations and solutions, Driving point admittance, Transfer admittance, Solutions of Problems with DC and AC sources	2L
4	Network Theorems: Definition and implications of Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Reciprocity Theorem, Compensation Theorem, Maximum Power Transfer Theorem, Millman's Theorem, Star-Delta transformations, Solutions and Problems with DC and AC sources	4L
5	Graph of Network: Concept of Tree Branch, Tree link, junctions, Incident matrix, Tie-set matrix, Cut-set matrix, determination of loop current and node voltages.	3L
6	Coupled Circuits: Magnetic Coupling, polarity of coils, polarity of induced voltage, concept of self and mutual inductance, coefficient of coupling, Solution of Problems	2L
7	Circuit Transients: DC Transient in R-L & R-C circuits with and without initial charge, R-L-C circuits, AC transients in sinusoidal RL, R-C, & R-L-C circuits, solution of problems	3L
8	Laplace Transform: Concept of complex frequency, transformation of $f(t)$ into $F(s)$, transformation of step, exponential, over-damped surge, critically damped surge, damped sine, undamped sine functions, properties of Laplace Transform, linearity, real-differentiation, real integration, Initial Value Theorem and Final Value Theorem, Inverse Laplace Transform, applications in circuit analysis, Partial Fractions expansion, Heaviside's Expansion Theorem, solution of problems	5L

9	Introduction to Physiological Parameter measurement circuits: Basic circuits of ECG, EMG, EOG signal measurement [as Beyond Syllabus content]	2L
	TOTAL	25L

Recommended Books:

1. Valkenburg M. E. Van, Network Analysis, Prentice Hall./Pearson Education
2. Hayt“Engg Circuit Analysis 6/e Tata McGraw-Hill
3. D.A.Bell- Electrical Circuits- Oxford
4. A.B.Carlson-Circuits- Cenage Learning
5. John Bird- Electrical Circuit Theory and Technology- 3/e- Elsevier (Indian Reprint)
6. Skilling H.H.: “Electrical Engineering Circuits”, John Wiley & Sons.
7. Edminister J.A.: “Theory & Problems of Electric Circuits”, McGraw-Hill Co.
8. Kuo F. F., “Network Analysis & Synthesis”, John Wiley & Sons.
9. R.A.DeCarlo & P.M.Lin- Linear Circuit Analysis- Oxford
10. P.Ramesh Babu- Electrical Circuit Analysis- Scitech
11. Sudhakar: “Circuits & Networks:Analysis & Synthesis” 2/e TMH
12. M.S.Sukhija & T.K.NagSarkar- Circuits and Networks-Oxford
13. Sivandam- “Electric Circuits and Analysis”, Vikas
14. V.K. Chandna, “A Text Book of Network Theory & Circuit Analysis”,Cyber Tech
15. Reza F. M. and Seely S., “Modern Network Analysis”, Mc.Graw Hill .
16. M. H. Rashid:Introduction to PSpice using OrCAD for circuits and electronics, Pearson
17. Roy Choudhury D., “Networks and Systems”, New Age International Publishers.
18. D.Chattopadhyay and P.C.Rakshit: “Electrical Circuits” New Age

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EE(BME)303.1	-	3	3	2	-	2	-	-	-	1	-	3
EE(BME)303.2	-	3	3	1	1	2	-	1	2	2	-	2
EE(BME)303.3	-	3	2	2	-	3	-	-	-	-	3	2
EE(BME)303.4	1	2	3	2	2	2	3	1	3	3	-	1
EE(BME)303.5	1	-	2	-	1	-	-	1	3	1	-	2
EE(BME)303.6	-	2	2	3	-	-	3	-	3	-	2	2
EE(BME)303.7	1	-	-	-	1	-	2	1	-	2	2	3

Subject Name: ANALOG ELECTRONICS CIRCUIT

Subject Code: EC(BME)304

Total Contact hours: 25

Credit: 2

Prerequisite: Mathematics, Basic Electrical Engineering, Basic Electronics Engineering

Course Objective:

1. To give the idea about fundamental properties of Analog Electronics Devices.

2. To prepare students to perform the analysis of any Analog Electronics Circuit.
3. To empower students to understand the design & working of BJT ,amplifiers, multivibrator, oscillators and OpAmps.

Course Outcome

After the course, students will be

EC(BME)304.1 Able to explain/give example/explain concept of Analog Electronics Circuits.

EC(BME)304.2 Able to apply knowledge, mathematics, science and engineering fundamentals to solve Analog electronics Circuits related problems.

EC(BME)304.3 Able to perform logical analysis of result/Systems of Analog Electronics Circuits.

Course Content

Module No	TOPIC	No of Lectures
1	Filters and Regulators: Capacitor filter, π -section filter, series and shunt voltage regulator, percentage regulation, 78xx and 79xx series, concept of SMPS.	3L
	Transistor Biasing and Stability: h-model of transistors. Expression for voltage gain, current gain, input and output impedance, trans-resistance & trans-conductance; Emitter follower circuits, High frequency model of transistors.	3L
2	Transistor Amplifiers: RC coupled amplifier, functions of all components , derivation of voltage gain, current gain, input impedance and output impedance, frequency response characteristics, lower and upper half frequencies, bandwidth, Concept of LPF, HPF and BPF	5L
	Power amplifiers – Class A, B, Conversion efficiency, Tuned amplifier	2L
3	Feedback Amplifiers & Oscillators: Negative & positive feedback, voltage/ current, series/shunt feedback, Colpitts, Hartley's, Phase shift, Wein bridge and crystal oscillators.	3L
	Applications of Operational Amplifiers: Integrator & differentiator, comparator, Schmitt Trigger. Instrumentation Amplifier, Log & Anti-log amplifiers, Trans-conductance multiplier, Precision Rectifier, voltage to current and current to voltage converter, free running oscillator.	4L
4	Multivibrator: Monostable, Bistable, Astable multivibrators; Monostable and astable operation using 555 timer.	3L
	Filter Circuit : Design of LPF , HPF and BPF Filter	2L
	TOTAL	25L

Reference Books:

1. Sedra & Smith-Microelectronic Circuits- Oxford UP
2. Franco—Design with Operational Amplifiers & Analog Integrated Circuits,3/e,McGraw Hill
3. Boylested & Nashelsky- Electronic Devices and Circuit Theory- Pearson/PHI
1. Millman & Halkias – Integrated El;ectronics, McGraw Hill.
2. Rashid-Microelectronic Circuits-Analysis and Design- Thomson (Cenage Learning)
3. Schilling & Belove—Electronic Circuit:Discrete & Integrated , 3/e , McGraw Hill
4. Razavi- Fundamentals of Microelectronic s- Wiley
5. Malvino—Electronic Principles, 6/e, McGraw Hill
6. Horowitz & Hill- The Art of Electronics; Cambridge University Press.

7. Bell- Operational Amplifiers and Linear ICs- Oxford UP
8. Tobey & Grame – Operational Amplifier: Design and Applications, Mc GrawHill.
9. Gayakwad R.A -- OpAmps and Linear IC's, PHI
10. Coughlin and Driscoll–Operational Amplifier and Linear Integrated Circuits–Pearson Edn

CO – PO Mapping

CO	PO1	PO2	PO3	PO 4	PO 5	PO 6	PO7	PO 8	PO9	PO10	PO11	PO12
EC (BME)304.1	-	3	2	-	-	-	-	-	-	-	-	2
EC(BME)304.2	3	3	2	-	-	-	-	-	1	-	1	-
EC(BME)304.3	-	2	3	2	-	-	-	-	1	-	-	1

PRACTICAL PAPERS

Subject Name: ENGINEERING PHYSIOLOGY & ANATOMY LABORATORY

Subject Code: BME 391

Contact hours/Week: 0:0:3

Credit: 2

Prerequisites: Knowledge of 10+2 level Biology (Physiology Section)

Objectives:

1. Understand the practical aspects of the body's internal organs and how they function.
2. Provide an active learning environment to teach the basic principles of human physiology & anatomy.
3. Teach students the principles of experimental documentation in a laboratory notebook.
4. Provide students with hands on opportunity to use commonly used physiological variables measuring equipments.
5. Promote and encourage team work and collaboration among students in the lab.
6. Students are encouraged to create additional test conditions and run additional experiments during the lab time that extend from the guided lesson plan.

Outcome:

Students will be able to

BME 391.1 Identify, understand and explain fundamentals of organ structure at the cellular, tissue, organ, & system levels.

BME 391.2 Apply knowledge of science and engineering fundamentals to get hands on exposure of the gross & microscopic approach to Anatomy & Physiology of various organs.

BME 391.3 Perform logical analysis of results, with all necessary lab tools through experiments to arrive at suitable conclusions to physiological problems that promote the critical understanding of the structure function relationship of human systems.

BME 391.4 Conduct and design experiments using modern engineering tools and instruments to demonstrate and interpret physiological abnormality and malfunctioning and its impact on health, safety, environment and society.

BME 391.5 Function effectively as an individual, and as a member in a team to conduct experiments and interpret results.

BME 391.6 Conform to Physiology Practical ethics, and understand the responsibilities and norms of Physiology Laboratory practice.

Course Contents

List of Experiments:

1. Study on Compound Microscope.
2. Identification of fixed histological slides: Cerebellum, Cerebral cortex, Spinal cord, Renal tissues, Blood vessels (artery & vein), Skin, Tongue, Liver.
3. Hemoglobin estimation.
4. Determination of blood pressure.
5. Blood film making & identification of different blood corpuscle.
6. ECG wave identification.
7. DC of WBC.
8. Determination of Blood Group (ABO; Rh).
9. Measurement of Bleeding Time (BT) & Clotting Time (CT).

CO – PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BME 391.1	3	2	-	-	1	-	-	-	-	-	-	-
BME 391.2	2	3	-	-	-	-	-	-	-	1	-	-
BME 391.3	2	2	3	-	2	1	-	-	-	1	-	-
BME 391.4	2	2	3	2	2	1	-	-	-	-	-	-
BME 391.5	2	1	3	-	2	-	-	-	3	1	-	-
BME 391.6	-	-	-	-	-	-	2	3	1	-	-	-

Subject Name: BIOPHYSICAL SIGNALS & SYSTEMS LABORATORY

Subject Code: BME 392

Contact hours/Week: 0:0:3

Credit: 2

Prerequisites: Engineering Mathematics and Basics of Vector theory and MATLAB

Course Objective:

1. To provide background and fundamentals of MATLAB tool for the analysis and processing of signals and to generate various continuous and discrete time signals.
2. To determine the Fourier Transform of signals and to convert a continuous time signal to the discrete time and reconstruction using the sampling theorem.
3. To analyze a continuous time LTI/LTV systems using convolution.
4. To apply the convolution theorem and correlation for continuous time signals.
5. To use Laplace and Z-transforms for analyzing Continuous/ Discrete time signals and systems

Course Outcome:

Students will be able to

BME 392.1 Analyze continuous-time and discrete-time signals and systems in the frequency domain using mixed signal classes Using MATLAB .

BME 392.2 Explore sampling concepts that link continuous-time and discrete-time signals and systems Using MATLAB.

BME 392.3 Analyze continuous-time signals and system responses using the concepts of transfer function representation by use of Laplace and inverse Laplace transforms Using MATLAB

BME 392.4 Analyze discrete-time signals and system responses using the concepts of transfer function representation by use of Z and inverse-Z transforms Using MATLAB .

BME 392.5 Apply time-domain and frequency-domain analysis tools to analog and digital filters Using MATLAB .

Course Content

List of Activities: The following simulation exercise should be carried out in MATLAB or C programming.

1. Familiarization with MATLAB and generation of various types of waveforms (sine, cosine, square, triangular etc.).
2. Generation of different functions (unit impulse, unit step, RAMP, etc.)
3. Generation of various types of noise (uniform white, Gaussian, coloured etc.).
4. Fourier transform of the signals (CTFT and DTFT)
5. To study Z- transform (MATLAB) of: a) Sinusoidal signals b) Step functions.
6. To study Laplace- transform (MATLAB) of: a) Sinusoidal signals b) Step functions.
7. To study LPF &HPF, band-pass and reject filters using RC circuits
8. ECG signal analysis / Equivalent electrical circuit analysis of blood vessels

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BME 392.1	2	-	1	-	3	-	-	-	-	-	-	-
BME 392.2	2	3	1	-	-	-	-	-	-	1	-	-
BME 392.3	3	2	2	-	-	2	-	3	-	-	3	1
BME 392.4	-	3	3	2	1	-	-	-	-	-	-	-
BME 392.5	1	3	1	2	-	-	2	-	3	-	1	3

Subject Name: CIRCUITS & NETWORKS LABORATORY

Subject Code: EE(BME)393

Contact hours/Week: 0:0:2

Credit: 1

Prerequisites:

1. Ability in identifying passive and active circuit elements/components and basic knowledge on their operation & application.
2. In depth knowledge in Integral & Differential Calculus and fundamental knowledge on Laplace Theorem & its inverse.
3. Knowledge of analog & digital signal should be clear.

Course Objective

1. To familiarize students with Resonance in Circuits and relevant parameters and methods for evaluating the same.
2. To introduce students the methods of Mesh Current and Node Voltage analysis and their application.
3. To describe Network Theorems and their applications.
4. To illustrate graph theory and its application in estimating electrical parameters in the circuit.
5. To introduce students with coupled circuits and their methods of analysis..

6. To introduce students with transient circuits and describe the methodology to evaluate relevant electrical parameters.
7. To highlight the application of Laplace & Inverse Laplace transform in analyzing circuits.

Course Outcome

After completion of this course the students will be able to

EE(BME)393.1. Describe Analyze and Design series and parallel RLC circuits using MATLAB

EE(BME)393.2. Analyze circuits using Node Voltage & Mesh Current Analysis in electrical networks using MATLAB

EE(BME)393.3. Verify and analyze Network Theorems to electrical networks using MATLAB

EE(BME)393.4. Understand Describe, Analyze and Design Graph and Trees for a given network and solve related problems using MATLAB

EE(BME)393.5. Understand Analyze and Design Coupled Circuits and solve related problem using

MATLAB. **EE(BME)393.6.** Understand, Describe and Analyze the Transients in electrical networks and solve related problems using MATLAB.

EE(BME)393.7. Implement Laplace Transform and its Inverse transform on various waveforms using MATLAB.

Course Content

List of Activities: Implementation of Following Experiments using Software (e.g. MATLAB/Pspice) or Hardware

1. Characteristics of Series & Parallel Resonant circuits
2. Verification of Network Theorems
3. Transient Response in R-L & R-C Networks ; simulation / hardware
4. Transient Response in RLC Series & Parallel Circuits & Networks; simulation / hardware
5. Determination of Impedance (Z), and Admittance (Y) parameters of Two-port networks
6. Generation of periodic, exponential, sinusoidal, damped sinusoidal, step, impulse, and ramp signals.
7. Representation of Poles and Zeros in s-plane, determination of partial fraction expansion in s-domain.
8. Determination of Laplace Transform, different time domain functions, and Inverse Laplace Transformation.

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EE(BME)393.1	3	2	2	2	3	-	-	-	3	3	2	2
EE(BME)393.2	-	2	2	-	-	1	-	2	3	2	-	1
EE(BME)393.3	-	-	-	2	2	3	-	3	3	3	-	1
EE(BME)393.4	-	2	2	1	2	1	-	3	2	3	2	2
EE(BME)393.5	3	-	2	3	-	3	1	-	3	3	-	1
EE(BME)393.6	-	1	3	1	2	-	1	-	2	2	-	2
EE(BME)393.7	3	-	3	3	2	-	2	2	3	2	1	2

Subject Name: ANALOG ELECTRONIC CIRCUITS LABORATORY

Subject Code: EC(BME)394

Contact hours/Week: 0:0:2

Credit: 1

Prerequisites: Basic Electrical Engineering Lab , Basic Electronics Engineering Lab

Course Objective :

1. To prepare students to design any Analog Electronics Circuit.
2. To prepare students to perform the analysis of any Analog Electronics Circuit from laboratory experiments.

Course Outcome -

After the course, students will be

EC(BME)394.1 Able to explain/give example/explain concept of Analog Electronics Circuits.

EC(BME)394.2 Able to apply knowledge, mathematics, science and engineering fundamentals to solve Analog electronics Circuits related problems.

EC(BME)394.3 Able to perform logical analysis of result/Systems of Analog Electronics Circuits.

Course Content**List of Activities:**

1. Study of Diode as clipper & clamper
2. Study of ripple and regulation characteristics of full wave rectifier without and with capacitor filter
3. Construction of a two-stage R-C coupled amplifier & study of its gain & Bandwidth.
4. Study of class A & class B power amplifiers.
5. Study of class C & Push-Pull amplifiers.
6. Realization of current mirror & level shifter circuit using Operational Amplifiers.
7. Study of timer circuit using NE555 & configuration for monostable & astable multivibrator.
8. Study of Switched Mode Power Supply & construction of a linear voltage regulator using regulator IC chip.
9. Construction of a simple function generator using IC.
10. Realization of a V-to-I & I-to-V converter using Op-Amps.

CO – PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EC(BME)394.1	-	3	-	1	1	-	-	-	2	-	-	1
EC(BME)394.2	3	3	2	-	1	-	-	-	-	-	-	-
EC(BME)394.3	-	2	3	2	-	-	-	-	-	-	-	1

SESSIONAL PAPERS

Subject Name: TECHNICAL SKILL DEVELOPMENT

Subject Code: MC381

Contact hours/Week: 2 Units

Credit: 0 Total Contact hours: 25 Units

Familiarization and measurements of electrical/electronic components (7 Units)

Resistor, inductors and capacitors- their types, specifications and applications. Basics of Transformer, Specifications & types, Fuse – types, use of fuses and its rating. Familiarization with integrated circuits. Soldering and De-soldering techniques. Different switches and their specification & uses. Power supply unit. Familiarization with operation controls of Analog and Digital Multimeters etc.

Familiarization with Medical terminology & Medical Instruments (7 Units)

Medical terms related to ECG, EMG, EEG, Blood pressure, Heart rate, Pulse oximeter, Defibrillator etc.
Familiarization with different Medical Instruments.

Biological Sample Collection & Preparation (10 units)

Blood sample collection, blood film making, Separation of plasma, Separation of corpuscles, Standardization of biological sample.

Microscope handling.

Preparation of new biomaterials, Sample preparation for biomaterials testing.

Familiarization with Biomedical Implants and their fixation techniques etc.

Mini Project handling (6 units)

Basic analog electronic circuit design - both by hardware and circuit simulation software based approach.

Text Book/References:

1. V K Mehta & Rohit Mehta, Principles of Electronics, 3ed., S. Chand Publishing
2. Giovanni Saggio, Principles of Analog Electronics, 1st ed., CRC Press
3. B L Theraja & A K Theraja, Textbook of Electrical Technology Vol I, 23 ed., S.Chand & Company Pvt. Limited
4. Daniel M. Kaplan, Christopher G. White, Hands-On Electronics:
A Practical Introduction to Analog and Digital Circuits, 1st ed., Cambridge University Press
5. Martin C. Brown, Practical Switching Power Supply Design, 1st Ed, Academic Press
6. Irving Gottlieb, Practical Transformer Handbook: for Electronics, Radio and Communications Engineers, 1st ed., Newnes
7. Norman Ahlhelm, An Introduction to High Reliability Soldering and Circuit Board Repair, 3 ed., CreateSpace Independent Publishing Platform
8. Y. C. Fung, Yuan-Cheng Fung, Biomechanics: mechanical Property of living Tissue, Springer, 1996.
9. Carol A. Oatis, The Mechanics and Pathomechanics of Human Movement, Lippincott Williams & Wilkins, 2010
10. Christina Vett-Joice (Editor), Capital Pathology Handbook, Buckner Printing Company, 2012

**Detailed Syllabus of B.Tech in Biomedical Engineering Programme
(Second Year- Fourth Semester)**

BME-Semester IV

Curriculum

Subject Type	Subject Code	Subject Name	Contact hrs/week				Credits
			L	T	P	Total	
		THEORY					
HS	HU (BME) 401	ENVIRONMENTAL SCIENCE	2	0	0	2	2
BS	PH(BME) 401	PHYSICS-II	3	1	0	4	4
ES	EC(BME) 401	DIGITAL ELECTRONIC CIRCUITS	2	0	0	2	2
PC	BME 402	BIOMECHANICS	3	1	0	4	4
PC	BME 403	BIOMATERIALS	3	1	0	4	4
		PRACTICAL					
BS	PH(BME) 491	PHYSICS-II LABORATORY	0	0	3	3	2
ES	EC(BME) 491	DIGITAL ELECTRONIC CIRCUITS LABORATORY	0	0	2	2	1
PC	BME 492	BIOMECHANICS & BIOMATERIALS LABORATORY	0	0	3	3	2
		SESSIONAL					
HS	HU 481	TECHNICAL REPORT WRITING LANGUAGE PRACTICE	0	0	2	2	1
		TOTAL	13	3	10	26	22

Syllabus

THEORY PAPERS

Subject Name: ENVIRONMENTAL SCIENCE

Subject Code: HU(BME)401

Total Contact Hour: 25

Credit: 2

Prerequisite: 10+2 science with chemistry

Course Objective:

After completion of this course the students will be able to:

- Apply the knowledge of environmental science to design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
- To analyze and discuss the relevance of environmental science to use research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of the information to provide valid conclusions.
- Function in multi/inter-disciplinary teams with a spirit of tolerance, patience and understanding so necessary for team work;
- Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course outcome:

After completion of this course the students will be able to:

HU(BME)401.1	Describe the structure and function of environment and different types of environmental pollution.
HU(BME)401.2	Identify all types of resources and learn the quality parameter to maintain proper balance.
HU(BME)401.3	Demonstrate environmental problems like global warming, acid rain, natural and manmade disasters.
HU(BME)401.4	Demonstrate the controlling method of environmental pollution and apply their knowledge for environment management.
HU(BME)401.5	Apply the method of synthesis of green chemistry and find green solution.

Course Content:

Module 1

(Total 7L)

General

1.1 Basic concept: Environment; components; man, society, environment interrelationship; Environmental degradation and sustainable development. 1L

1.2 Natural Resources: Types of resource, renewable, non-renewable, potentially renewable; Importance of Water resource, Food resource, Land resource, Forest resource, Energy resource; Growing energy needs and alternate source of energy (Hydro Electric, Solar, Biomass & Bio-gas, Hydrogen as an future source of Energy). 2L

1.3 Population Growth: Exponential growth and Logistic growth model, Maximum sustainable yield; Effect of excessive use of resource due to population growth. 1L

1.4 Ecology & Ecosystem: Definition, Components; Structure and function of the following ecosystem: Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems, Mangrove ecosystem (special reference to Sundarban); Food chain [definition and one example of each food chain], Food web. 2L

1.5 Biogeochemical Cycle: definition, significance, flow chart of different cycles with only elementary reaction [Hydrological cycle, Gaseous cycle and Sedimentary cycle]. 1L

Module 2

(Total 6L)

Air Pollution and control

2.1 Atmospheric structure: Troposphere, Stratosphere, Mesosphere, Thermosphere, Tropopause and Mesopause. 1L

2.2 Greenhouse effect: Definition, Greenhouse gases, Global warming and its consequence on the global climate and consequently on sea water level, agriculture and marine ecosystem, Control of Global warming. 1L

2.3 Air Pollutant: Definition of pollutants and contaminants, Primary and secondary pollutants, criteria pollutant, source and biochemical effect. 1L

2.4 Environmental degradation: Smog, Photochemical smog and London smog; acid rain, effects and control. 1L

2.5 Depletion of Ozone layer: CFC, destruction of ozone layer by CFC, impact of other green house gases, effect of ozone modification. 1L

2.6 Control measures: Industrial, commercial and residential air quality standard, control measure (ESP, cyclone separator, bag house, catalytic converter, scrubber (ventury), Statement with brief reference). 1L

Module 3

(Total 5L)

Water Pollution and control

3.1 Water Quality Parameters: Physical, Chemical, Biological water quality parameters; DO, BOD, 5 day BOD test, Seeded BOD test, BOD reaction rate constants, related problems, COD. 2L

3.2 Pollutants of water: Oxygen demanding wastes, pathogens, heavy metals, pesticides; Eutrophication (definition only). 2L

3.3 Water Treatment system: coagulation and flocculation, sedimentation and filtration, disinfection, hardness and alkalinity, softening. 1L

Module 4

(Total 3L)

Land Pollution

4.1 Solid Waste: Municipal, industrial, commercial, agricultural, domestic, pathogenic (bio-medical) and hazardous solid wastes, E-waste. 1L

4.2 Solid waste disposal method: Open dumping, Land filling, incineration, composting, recycling (Advantages and disadvantages). 1L

4.3 Solid waste management and control: Hazardous and Biomedical waste. 1L

Module 5

(Total 2L)

Noise Pollution

5.1 Noise and Pollution: Definition of noise, noise classification [Transport noise, occupational noise, neighbourhood noise], effect of noise pollution and its control. 1L

5.2 Measurement and permissible limit: Definition of noise frequency, noise pressure, noise intensity, noise level, mathematical expression of Decibel, related problem, noise threshold limit value, equivalent noise level, L10 (18hr Index). 1L

Module 6

(Total 2L)

Control

6.1 Environmental Management: Environmental impact assessment, Environmental Audit, Environmental laws and protection act of India, Different international environmental treaty/ agreement/ protocol, Initiatives by Non-governmental Organizations (NGO), Environmental Education, and Women Education. 1L

6.2 Green chemistry: Introduction, Significance, Research and Industrial application. 1L

References/Books

1. Masters, G. M., "Introduction to Environmental Engineering and Science", Prentice-Hall of India Pvt. Ltd., 1991.
2. De, A. K., "Environmental Chemistry", New Age International.
3. Environmental Engineering, J K Das Mohapatra, Vikas Publication

CO-PO mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
HU(BME)401.1	3	2	-	-	-	3	3	-	-	-	-	-
HU(BME)401.2	3	2	-	-	-	-	-	-	-	-	-	-
HU(BME)401.3	3	-		-	-	3	3	-	-	-	-	-
HU(BME)401.4	2	-	3	-	-	3	3	-	-	-	-	-
HU(BME)401.5	3	-	3	-	-	3	3	-	-	-	-	-

Subject Name: PHYSICS-II

Subject Code: PH-(BME) 401

Total Contact Hours: 40

Credit: 4

Prerequisite: Knowledge of Physics upto B.Tech 1st year Physics-I course

Objective of the Physics-II Course:

The Physics-II course will provide

- exposure to the physics of materials that are applied in medical applications
- an insight into the science & technology of next generation and related technicalities through quantum mechanics
- functionalities of optical instruments used for medical applications
- concept of fundamental particles and associated applications in semiconductors

Course Outcome of Physics-II Course (Theoretical: PH (BME) 401)

At the end of the course students' should have the

PH-(BME) 401.1: ability to define, understand and explain ➤ insulating and magnetic materials ➤ operator formalism in Quantum Mechanics ➤ categories of storage devices ➤ materials at the low-dimensions ➤ ultrasonic sound and its medical applications ➤ biomedical application of laser, x-ray, radioactivity ➤ organic semiconductors and their applications	PO1 & GA1
PH-(BME) 401.2: ability to apply the knowledge of ➤ Magnetism and semiconductors in data storage ➤ Motion of charges under a field in CRT ➤ Band theory in explaining LED action ➤ Magneto striction and piezoelectricity in ultrasonic sound generation and detection	PO1 & GA1
PH-(BME) 401.3: Ability to analyze ➤ Role of degenerate states in predicting energy bands of semiconductors ➤ the principle of display devices ➤ Which type of magnetic materials to be used for data storage purpose ➤ Role of quantum confinement in inducing novel feature of a nanomaterial ➤ change in electric and magnetic fields in various symmetrical bodies ➤ failure of band theory in organic semiconductors and novel applications of organic semiconductors	PO2 & GA2
Beyond the syllabus to meet to CO: ✓ Basics of probability interpretation ✓ Basics of energy band theory	PO1 PO12

Course Content

Module 1: Electric and Magnetic properties of materials (9L)

Module 1.01: Insulating materials:

Dielectric Material: Concept of Polarization, the relation between **D**, **E** and **P**, Polarizability, Electronic (derivation of polarizability), Ionic, Orientation & Space charge polarization (no derivation), internal field, Claussius Mossotti equation, ferroelectric & piezoelectrics (Qualitative study). **3L**

Module 1.02: Magnetic materials and storage devices:

Magnetic Field & Magnetization **M**, relation between **B**, **H**, **M**. Bohr magneton, susceptibility, Diamagnetism- & Paramagnetism - Curie law (qualitative discussion), Ferromagnetism– Curie Temperature, Weiss molecular field theory (qualitative) & Curie-Weiss law, concept of θ_p , Hysteresis, Hard ferromagnets, Comparison and applications of permanent magnets (storage devices) and Soft ferromagnets (Permalloys, Ferrites etc.) **4L**

Module 1.03: Super conductivity: Basic concept, qualitative study up to Meissner effect, examples of High Temperature Superconductor, BCS theory (qualitative), Applications. **2L**

Module 2: Ultrasound (4L)

Ultrasound-Introduction, definition and properties –Production of ultrasonics by Piezo-electric crystal and magnetostriction method; Detection of ultrasonics; Engineering & Medical applications of Ultrasonics (Non-destructive testing, cavitation, measurement of gauge) **Infrasound** – Introduction and definition, production, application, **4L**

Module 3: Display, Optical Instruments & optielctronic devices (10L)

3.01: Electron Optics: Operation and application of CRT, Physics of Liquid crystal display (LCD), LED, Plasma display, Thin film transistor display. **4L**

3.02: Optical Instruments: Imaging-Types of imaging (PET, CT), electron microscope. **3L**

3.03: Radiation therapy-radio activity, doses, strength, applications. **3L**

Module 4: Quantum Mechanics-II (7L)

Formulation of quantum mechanics and Basic postulates- superposition principle, orthogonality of wave function, expectation value; operator correspondence, Commutator. Measurements in Quantum Mechanics- Eigen value, Eigen function, Schrödinger's equation as energy eigen value equation. **4L**

Application of Schrödinger equation – Particle in an infinite square well potential (1-D and 3-D potential well; Discussion on degenerate levels), 1D finite barrier problem and concept of quantum tunnelling (solve only $E < V_0$). **3L**

Module 5: Statistical Mechanics (4L)

Concept of energy levels and energy states. Microstates, macrostates and thermodynamic probability, MB, BE, FD, statistics (Qualitative discussions)- physical significance, conception of bosons, fermions, classical limits of quantum statistics, Fermi distribution at zero & non-zero temperature, Concept of Fermi level. **4L**

Module 6: Physics of Organic semiconductors & Nanomaterials (6L)**Module 6.01: Physics of Organic semiconductors:**

Exciton, bi-exciton, polaron, bipolaron, soliton, organic semiconductors (qualitative discussions)-comparison with silicon based semiconductor electronics, applications. **3L**

Module 6.02: Physics of Nanomaterials

Reduction of dimensionality, properties of nanomaterials, Quantum wells (two dimensional), Quantum wires (one dimensional), Quantum dots (zero dimensional); Quantum size effect and Quantum confinement. Carbon allotropes. Application of nanomaterials (CNT, grapheme, electronic, environment, medical). **3L**

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
PH(BME401).1	3											
PH(BME401).2	3											
PH(BME401).3		1										

Subject Name: DIGITAL ELECTRONIC CIRCUITS

Subject Code: EC(BME) 401

Total Contact Hours: 25

Credit: 2

Prerequisite: Knowledge of Analog Electronics

Course Objective:

1. To introduce students with different number systems & their inter-conversion techniques.
2. To introduce students with codes & code conversion techniques.
3. To familiarize students with different logic families & technologies of circuit integration

4. To introduce basic postulates of Boolean algebra and its application in digital electronics.
5. To introduce the methods for simplifying Boolean expressions
6. To describe the procedures for the analysis & design of combinational circuits and sequential circuits
7. To introduce the concept of memories, programmable logic devices and digital ICs.

Course Outcome:

After completion of this course the students will be able to

EC(BME) 401.1 Understand and describe different number systems and their conversions, signed binary number representation and binary arithmetic and solve related numerical.

EC(BME) 401.2 Solve relevant numerical applying Boolean algebra and logic gates.

EC(BME) 401.3 Describe, analyze, formulate and construct combinational & sequential networks

EC(BME) 401.4 Understand and explain memory systems and different kinds of logic families

EC(BME) 401.5 Demonstrate basic analog-to-digital and digital-to-analog circuits.

Course Content

Module No	Topic	No of Lectures
1	Data and number systems: Binary, Octal and Hexadecimal representation and their conversions; BCD, ASCII, EBCDIC, Gray codes and their conversions; Signed binary number representation with 1's and 2's complement methods, Binary arithmetic.	4L
2	Boolean algebra: Various Logic gates- their truth tables and circuits; Representation in SOP and POS forms; Minimization of logic expressions by algebraic method, K-map method	5L
3	Combinational circuits: Adder and Subtractor circuits; Applications and circuits of Encoder, Decoder, Comparator, Multiplexer, De-Multiplexer and Parity Generator.	4L
4	Memory Systems: RAM, ROM, EPROM, EEROM, Programming logic devices and gate arrays.(PLAs and PLDs)	2L
5	Sequential Circuits: Basic memory element-S-R, J-K, D and T Flip Flops, various types of Registers and counters and their design, Irregular counter, State table and state transition diagram, sequential circuits design methodology.	6L
6	Different types of A/D and D/A conversion techniques.	2L
7	Logic families: Basics of different logic families, TTL, MOS and CMOS logic gates & their working principles	2L
TOTAL		25L

Text Books:

1. S.Salivahanan, S.Aribazhagan, Digital Circuit & Design, 3rd Ed., Vikas Publishing House Pvt. Ltd
2. Anand Kumar, Fundamentals of Digital Circuits- PHI
3. A.K.Maini- Digital Electronics- Wiley-India
4. Kharate- Digital Electronics- Oxford

References:

1. Morris Mano- Digital Logic Design- PHI
2. Leach & Malvino—Digital Principles & Application, 5/e, Mc Graw Hill
3. Floyd & Jain- Digital Fundamentals-Pearson.
4. Tocci, Widmer, Moss- Digital Systems, 9/e- Pearson
5. R.P.Jain—Modern Digital Electronics, 2/e , Mc Graw Hill
6. H.Taub & D.Shilling, Digital Integrated Electronics- Mc Graw Hill.
7. D.Ray Chaudhuri- Digital Circuits-Vol-I & II, 2/e- Platinum Publishers
8. Givone—Digital Principles & Design, Mc Graw Hill
9. S.K.Mandal, Digital Electronics Principles and Applications- Mc Graw Hill.

10. J.Bignell & R.Donovan-Digital Electronics-5/e- Cenage Learning.

11. P.Raja- Digital Electronics- Scitech Publications

CO-PO Mapping:

Sl. No.	B.Tech in Biomedical Engineering Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EC(BME)401.1	3	2	1									
EC(BME)401.2		3		1	2							
EC(BME)401.3		3	2		1							
EC(BME)401.4	2	3		1								
EC(BME)401.5		3	2		1							

Subject Name: BIOMECHANICS

Subject Code: BME402

Total Contact hours: 40

Credit: 4

Prerequisites: Basic knowledge of mechanics which includes kinetics & kinematics and human functional anatomy.

Course Objectives:

1. To describe the fundamental of biomechanics.
2. To Study the deformability, strength, viscoelasticity of bone and flexible tissues, modes of loading and failure.
3. To describe the types and mechanics of skeletal joints.
4. To describe movement precisely, using well defined terms (*kinematics*) and also to consider the role of force in movement (*kinetics*).
5. To teach students the unique features of biological flows, especially constitutive laws and boundaries.
6. To consider the mechanics of orthopedic implants and joint replacement, artificial heart valve, mechanical properties of cardiovascular and respiratory mechanics

Course Outcomes:

After completion of the course student will be able to

BME402.1 Understand the fundamentals of mechanics and its application in human system.

BME402.2 Describe the flow properties of blood, various properties of hard tissues (bone) & soft tissues (articular cartilage, tendons and ligaments) and identify the appropriate model to demonstrate mechanical behavior.

BME402.3 Analyze the biomechanics of different human joints and also the forces at a skeletal joint for various static and dynamic human activities.

BME402.4. Gain broad working knowledge about the mechanics of moving systems and familiarity with human anatomy to competently analyze gross movement and dynamics of the human body.

BME402.5. Demonstrate a detailed understanding of the design requirements of medical implants based on the human anatomy and biological responses to biomaterials.

Course Contents

Module No	Topic	No of Lecture
1	Introduction to Biomechanics: Review of the principles of mechanics, Vector mechanics- Resultant forces of Coplaner & Noncoplaner and Concurrent & non-concurrent forces, parallel force in space, Equilibrium of coplanar forces, Newton's laws of motion, Work and energy, Moment of inertia.	4L
2	Biofluid Mechanics: Newton's law, stress, strain, elasticity, Hooke's law, viscosity, Newtonian fluid, Non- Newtonian fluid, viscoelastic fluids, Hagen-poiseuille equation. Relationship between diameters, Velocity and pressure of blood flow, Resistance against flow. Rheological properties of blood, Flow properties of blood through blood vessels.	5L
3	Cardiac & Respiratory Mechanics: Cardiovascular system, Mechanical properties of blood vessels: arteries, arterioles, capillaries, and veins. Artificial heart valves, biological and mechanical valves development, testing of valves. Alveoli mechanics, Interaction of blood and lung, P-V curve of lung, Breathing mechanism, Airway resistance, Physics of lung diseases.	6L
4	Tissue Biomechanics: Hard Tissues: Bone structure & composition, Mechanical properties of bone, cortical and cancellous bones, viscoelastic properties, Maxwell & Voight models – anisotropy. Electrical properties of bone. Types of fractures, biomechanics of fracture healing, types of fracture fixators. Soft Tissues: Structure, Functions, Mechanical Properties & Modeling of Soft Tissues: Cartilage, Tendon, Ligament, and Muscle.	10L
5	Joints Biomechanics: Analysis of rigid bodies in equilibrium, free body diagrams, Types of joints, Skeletal joints, forces and stresses in human joints, Biomechanical analysis of elbow, shoulder, hip, knee and ankle.	6L
6	Movement Biomechanics: Gait analysis, body & limbs: mass & motion characteristics actions, forces transmitted by joints. Joints forces results in the normal & disable human body, normal & fast gait on the level. Foot Pressure measurements – Pedobarograph, Force platform, mechanics of foot. Moment of inertia-limb.	5L
7	Implant Mechanics: General concepts of Implants, classification of implants, Soft tissue replacements and Hard tissue replacements, basic consideration and limitation of tissue replacement, 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.	4L
Total		40L

Text Books

1. R. M. Kennedy, A textbook of Biomedical Engineering, GTU, 2010
2. Richard Shalak & ShuChien, Handbook of Bioengineering,
3. Sean P. Flanagan, Flanagan, Biomechanics: A case based Approach, Jones & Bartlett Publishers, 2013
4. Y. C. Fung, Yuan-Cheng Fung, Biomechanics: mechanical Property of living Tissue, Springer, 1996.
5. Carol A. Oatis, The Mechanics and Pathomechanics of Human Movement, Lippincott Williams & Wilkins, 2010
6. Sean P. Flanagan, Flanagan, Biomechanics: A Case Based Approach, Jones & Bartlett Publishers, 2013.

Reference Books

1. Prof. Ghista, Biomechanics, Private Publication UAF, 2009
2. White & Puyator, Biomechanics, Private publication UAE, 2010

CO-PO Mapping:

Sl. No.	B.Tech in Biomedical Engineering Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BME402.1	3	3	2	-	-	-	-	-	-	-	-	-
BME402.2	3	2	3	1	-	-	-	-	-	-	-	-
BME402.3	3	3	-	-	2	-	-	-	-	-	-	-
BME402.4	3	3	2	-	-	-	-	-	-	-	-	-
BME402.5	3	3	3	2	2	2	-	1	-	-	-	-

Subject Name: BIOMATERIALS**Subject Code: BME403****Total Contact hours: 40****Credit: 4****Prerequisites:** Basic knowledge of Chemistry, Physics and Human Physiology.**Course Objectives:**

1. To describe the fundamental of biomaterials.
2. To study the physical and mechanical properties of various biomaterials.
3. To describe the types, features and applications of metal, polymer, ceramic and composite.
4. To highlight the factors that influence failure of implants.
5. To teach students unique features of various bio-compatibility tests and its significance in designing new implants.
6. To illustrate the significance of sterilization and methods to improve biocompatibility.

Course Outcome:

BME403.1 Identify and understand the fundamental concepts in material science (e.g., atomic structure and bonding, crystalline structures and defects) and interpretation of phase diagrams.

BME403.2 Apply a broad knowledge of different types of biomaterials including metals, polymers, ceramics and composites and their use in typical biomedical devices and clinical applications.

BME403.3 Design an implant using fundamental concept and modern engineering tools to develop hard tissue and soft tissue replacement materials by suitable material selection.

BME403.4 Analyze the design of various biocompatible implants and artificial organ to develop and improve Health Care Service to serve mankind and society.

BME403.5 Demonstrate an understanding of standards, regulations and ethical responsibilities in the process of developing biomaterials and medical devices, evaluating and analysing possible hurdles in bringing a product to market.

Course Content:

Module No	Topic	No of Lectures
1	Characterization and Properties of Biomaterials: Introduction to biomaterials, Basic criteria for biomaterials, classification of biomaterials, selection and performance of biomaterials, biological responses, surface and physical properties, mechanical properties, stress-strain behaviour & hardness, mechanical failures, fatigue, electrical, optical and magnetic properties	7L
2	Metallic Biomaterials: Stainless steels, Co-Cr Alloys, Ti Alloys, Corrosion of metallic Implants. stress-corrosion, cracking. Hard tissue replacement materials: Orthopedic implants, Dental implants. Soft tissue replacement materials: Percutaneous and skin implants, Vascular implants, Heart valve implants.	7L
3	Polymeric Biomaterials: Polymerization and basic structure, Polymeric biomaterials: Polyethylene (PE), Polypropylene (PP), Polyvinylchloride (PVC), Polyamide (Nylon), Polytetrafluoroethylene (PTFE), Polymethylmetacrylate (PMMA), Polyetherether ketone (PEEK), Silicone rubber, Hydrogels, Biodegradable polymers. Classification according to thermosets, thermoplastics and elastomers. Applications of polymers in medical field.	7L
4	Ceramic Biomaterials: Definition of bioceramics. Non-absorbable materials: Alumina, Carbons, Zirconia. Biodegradable Ceramics: Calcium phosphate, Aluminum-Calcium-Phosphate (ALCAP) Ceramics. Bioactive ceramics: Glass ceramics, Hydroxyapatite. Medical applications.	5L
5	Composite Biomaterials: Properties and types of composites. Mechanics of improvement of properties by incorporating different elements. Composite theory of fiber reinforcement (short and long fibers, fibers pull out). Polymers filled with osteogenic fillers (e.g.hydroxyapatite).	5L
6	Biocompatibility & toxicological screening of biomaterials: Introduction to biocompatibility, blood compatibility and tissue compatibility. Toxicity screening tests of biomaterials. Evaluation of systemic toxicity, haemolysis, cytotoxicity and special tests.	5L
7	Sterilization of implantable biomaterials: ETO, gamma radiation, autoclaving. Effects of sterilization on material properties.	4L
	TOTAL	40L

Test books:

1. J B Park, *Biomaterials - Science and Engineering*, Plenum Press, 1984.
2. Sujata V. Bhat, *Biomaterials*, Narosa Publishing House, 2002.
3. Bronzino JD, ed. *The Biomedical Engineering Handbook*, Second Edition, Vol-II, CRC Press

References:

1. Jonathan Black, *Biological Performance of materials*, Marcel Decker, 1981
2. C.P.Sharma & M.Szycher, *Blood compatible materials and devices*, Tech.Pub.Co. Ltd., 1991.
3. Piskin and A S Hoffmann, *Polymeric Biomaterials* (Eds), Martinus Nijhoff Publishers.
4. Eugene D. Goldbera , *Biomedical Ploymers*, Akio Nakajima.
5. L. Hench & E. C. Ethridge, *Biomaterials - An Interfacial approach*.
6. Buddy D.Ratner, Allan S. Hoffman, *Biomaterial Sciences – Int. to Materials in Medicine*
7. Frederick H. Silver, *Biomaterials, Medical devices and Tissue Engineering*, Chapman & Hall

CO-PO Mapping:

Sl. No.	B.Tech in Biomedical Engineering Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BME 403.1	3	-	-	2	2	-	-	-	-	-	-	1
BME 403.2	3	-	-	2	-	-	-	-	-	-	-	-
BME 403.3	3	2	3	2	1	-	-	-	-	-	-	-
BME 403.4	3	2	2	2	2	2	-	-	-	-	-	-
BME 403.5	2	-	-	2	-	3	1	1	-	-	-	-

PRACTICAL PAPERS**Subject Name: PHYSICS-II Lab****Subject Code: PH (BME) 491****Contact hours/Week: 0:0:3****Credit: 2****Prerequisites:** Knowledge of Physics upto B.Tech Physics-I lab

Course Objective: This course is objected to train students with experimental techniques in the domain of Acoustics, Modern Optics & Radioactivity, Semiconductors & Optoelectronic Devices, Electron optics, Optical Instruments & Storage devices

Course Outcome:**At the end of the course students' should have the**

PH (BME) 491.1: ability to define, understand and explain ✓ Dipolar magnetic behavior ✓ Action of capacitors ✓ Fermi levels and band gap in a semiconductor ✓ Function of Light emitting diode ✓ Magnetic and semiconductor storage devices ✓ Motion of electron under cross fields	PO1 & GA1
PH (BME) 491.2: Ability to conduct experiments using ➤ Insulators, Semiconductors (extrinsic and intrinsic), Light emitting diodes ➤ Cathode ray oscilloscope ➤ Various types of magnetic materials	PO4 & GA4
PH (BME) 491.3: Function effectively as an individual, and as a member or leader in laboratory sessions	PO9
PH (BME) 491.4: Ability to communicate effectively, write reports and make effective presentation using available technology ➤ on presentation of laboratory experiment reports ➤ on presentation of innovative experiments	PO10

Course Content***At least 7 experiments to be performed during the semester****Experiments on Module 1: Electric and Magnetic properties of materials (8L)**

1. Study of dipolar magnetic field behavior.
2. Study of hysteresis curve of a ferromagnetic material using CRO.
3. Use of paramagnetic resonance and determination of Lande-g factor using ESR setup.
4. Measurement of Curie temperature of the given sample.

5. Determination of dielectric constant of given sample (frequency dependent)/Measurement of losses in a dielectric using LCR circuits.

Experiments on Module 2: Ultrasound (4L)

6. Determination of velocity of ultrasonic wave using piezoelectric crystal.

Module 3: Display, Optical Instruments & optielctronic devices (6L)

7. Measurement of specific charge of electron using CRT.

Experiments on Module 4: Quantum Mechanics-II (6L)

8. Determination of Stefan's radiation constant.

9. To study current-voltage characteristics, load response, areal characteristics and spectral response of photo voltaic solar cells & measurement of maximum workable power.

10. Determination of band gap of a semiconductor.

11. Determination of Hall co-efficient of a semiconductor and measurement of Magnetoresistance of a given semiconductor

****In addition to regular 7 experiments it is **recommended** that each student should carry out at least one experiment beyond the syllabus/one experiment as Innovative experiment.**

Probable experiments beyond the syllabus:

1. Determination of thermal conductivity of a bad conductor by Lees and Chorlton's method.

2. Determination of thermal conductivity of a good conductor by Searle's mothod.

3. Study of I-V characteristics of a LED.

4. Study of I-V characteristics of a LDR

5. Study of transducer property: Determination of the thermo-electric power at a certain temperature of the given thermocouple.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO 5	PO6	PO7	PO8	PO 9	PO10	PO11	PO12
PH(BME)491.1	2											
PH(BME)491.2				3								
PH(BME)491.3									1			
PH(BME)491.4										3		

Minimum CO attainment: 9/12=0.75

Subject Name: DIGITAL ELECTRONIC CIRCUITS LABORATORY

Subject Code: EC(BME)491

Contact hours/Week: 0:0:2

Credit: 1

Prerequisite: Knowledge of basic electronics and analog electronics.

Course Objective:

1. To familiarize students with different Digital ICs corresponding to different logic gates
2. To show the working operation of basic logic gates & Universal logic gates.
3. To familiarize students with the design of combinational circuits.
4. To introduce students with basic components of sequential circuits.
5. To familiarize students with the design of sequential circuits

Course Outcomes:**EC(BME)491.1.** Understand and describe Digital ICs of different logic gates.**EC(BME)491.2.** Design and show the operation of basic logic gates & Universal logic gates.**EC(BME)491.3.** Describe, design and analyze combinational circuits.**EC(BME)491.4.** Describe, design and analyze sequential circuits.**Course Contents:****List of Experiments:**

1. Familiarization with different digital ICs.
2. Realization of different gates like AND, OR, NOT, NAND, NOR, EX-OR and EX-NOR.
3. Realization of basic gates using universal logic gates.
4. Gray Code to Binary Code Conversion and Vice Versa.
5. Code Conversion between BCD and Excess-3
6. Four-bit parity generator and comparator circuits.
7. Construction of simple Decoder and Multiplexer circuits using logic gates.
8. Construction of simple arithmetic circuits-Adder, Subtractor.
9. Design of combinational circuit for BCD to decimal conversion to drive 7-segment display using multiplexer.
10. Realization of R-S, J-K and D flip-flops using Universal logic gates.
11. Realization of Asynchronous Up/Down counters.
12. Realization of Synchronous Up/Down counters

CO-PO Mapping

Sl. No.	B.Tech in Biomedical Engineering Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EC(BME)491.1	1	3	2									
EC(BME)491.2		1	3		2							
EC(BME)491.3		3	2	1	1							
EC(BME)491.4		3	2	1	1							

Subject Name: BIOMECHANICS & BIOMATERIALS LABORATORY**Subject Code: BME492****Contact hours/Week: 0:0:3****Credit: 2****Prerequisite:** Basic knowledge of mechanics including kinetics & kinematics and human functional anatomy.**Course Objective:**

This course provides basic hands on laboratory experiments in Biomaterials & Biomechanics which makes the students:

1. To study Mechanical properties of Biomaterials using destructive and non destructive method.
2. To study the moment of inertia of human limb.
3. To study the biocompatibility of implantable materials.
4. To measure the conductivity, pH of body fluid.
5. To study the stress-strain analysis of hip prosthesis

Course Outcomes:

BME492.1. Perform Mechanical characterization of biomaterials using destructive and non destructive methods.

BME492.2. Measure Surface roughness & *invitro* haemocompatibility of biomaterials

BME492.3. Determine the moment of inertia of human limb & torque required to tap and screwing the dental implants in Jaw bone.

BME492.4. Perform ph determination, viscosity and Conductivity measurement of any body fluid.

Course Content**List of Experiments:**

1. Mechanical characterization of biomaterials
2. Hardness testing of biomaterials
3. Surface roughness measurement of biomaterials
4. Estimation of haemocompatibility of biomaterials by hemolysis studies
5. Measurement of torque required to tap and screwing in jaw bone.
6. Determination of moment of inertia of human bone using compound pendulum method.
7. Ultrasonic characterization of biomaterials-NDE
8. Viscosity measurement of body fluid
9. Conductivity measurement of body fluid.
10. pH measurement of body fluid

CO-PO Mapping

Sl. No.	B.Tech in Biomedical Engineering Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BME 492.1	3	2	2	1	-	-	-	-	1	-	-	1
BME 492.2	2	2	1	1	-	-	-	-	-	-	-	
BME 492.3	3	2	3	2	-	-	1	-	1		-	1
BME 492.4	3	2	2	2	-	-	-	-	-	-	-	-

SESSIONAL PAPER

Subject Name: TECHNICAL REPORT WRITING LANGUAGE PRACTICE

Subject Code: HU 481

Contact hours/Week: 0:0:2

Credit: 1

Prerequisites: Knowledge of English till the level of B.Tech 1st year

Course Objectives:

1. To impart skill-based lessons in a manner conducive to develop communicative & socio-linguistic competence in learners.
2. General awareness building, through guided practice, of the taxonomy of listening and speaking skills and sub-skills.
3. Knowledge building of the skills required for professional and public speaking so as to inculcate discursial competence in the learners.

Course Content:**Module 1: The Need for a Language Laboratory [2L+2P]**

- (a) Introduction to the Language Lab (b) Skill-building exercises in the lab

Module 2: Power Listening [2L+3P]

- (a) Taxonomy of Listening Skills & Sub-skills [Aural Skimming, Scanning, Listening for Details, Note taking, Evaluative Listening, Empathetic Listening, Paralinguistic and Kinesic Inferencing]
(b) Audio-based Lessons (c) Repairing Listening 'Gaps' through Learner Feedback

Module 3: Speaking Skills [2L+6P]

- (a) The Need for Speaking: Content and Situation-based speaking
(b) Speaking Activities: [Just a Minute, Paired Role Play, Situational Speaking Exercises]
(c) The Pragmatics of Speaking—Pronunciation practice and learner feedback.

Module 4: Group Discussion [2L+6P]

- (a) Teaching GD Strategies (b) In-house video viewing sessions (c) Extended Practice and feedback

Module 5: Writing a Technical Report [2L+6P]

- (a) Organizational Needs for Reports and types (b) Report Formats
(c) Report Writing Practice Sessions and Workshops

Module 6: SWOT Analysis [2L+3P]

- (a) SWOT Parameters (b) Organizational SWOT (c) Case Study

Module 7: Presentation [2L+6P]

- (a) Teaching Presentation as a Skill (b) Speaking Strategies and Skills
(c) Media and Means of Presentation (d) Extended Practice and Feedback

Module 8: Personal Interview [2L+3P]

- (a) Preparing for the Interview: Interview Basics, Dressing and Grooming, Q & A (b) Mock Interview sessions and feedback

Books – Recommended:

Nira Konar: English Language Laboratory: A Comprehensive Manual
PHI Learning, 2011
D. Sudharani: Advanced Manual for Communication Laboratories &
Technical Report Writing
Pearson Education (W.B. edition), 2011

References:

Adrian Duff et. al. (ed.): Cambridge Skills for Fluency
A) Speaking (Levels 1-4 Audio Cassettes/Handbooks)
B) Listening (Levels 1-4 Audio Cassettes/Handbooks)
Cambridge University Press 1998
Mark Hancock: English Pronunciation in Use
4 Audio Cassettes/CD'S OUP 2004

**Detailed Syllabus of B.Tech in Biomedical Engineering Programme
(Third Year- Fifth Semester)**

BME-Semester V

Curriculum

Subject Type	Subject Code	Subject Name	Contact hrs/week				Credits
			L	T	P	Total	
	THEORY						
PC	BME 501	BIOMEDICAL INSTRUMENTATION	3	1	0	4	4
PC	BME 502	BIOMEDICAL DIGITAL SIGNAL PROCESSING	3	1	0	4	4
PC	BME 503	BIOSENSORS & TRANSDUCERS	3	0	0	3	3
PC	BME 504	MEDICAL IMAGING TECHNIQUES	3	1	0	4	4
PE-I	BME 505A	HOSPITAL ENGINEERING & MANAGEMENT	3	0	0	3	3
	BME 505B	BIOHEAT AND MASS TRANSFER					
	BME 505C	BIONANOTECHNOLOGY					
OE-I	CS(BME) 506A	DATA STRUCTURE & ALGORITHM	3	0	0	3	3
	CS(BME) 506B	DATA BASE MANAGEMENT SYSTEM					
	EE(BME) 506C	CONTROL ENGINEERING					
	PRACTICAL						
PC	BME 591	BIOMEDICAL INSTRUMENTATION LABORATORY	0	0	3	3	2
PC	BME 592	BIOMEDICAL DIGITAL SIGNAL PROCESSING LABORATORY	0	0	3	3	2
PC	BME 593	BIOSENSORS & TRANSDUCERS LABORATORY	0	0	3	3	2
OE-I	CS(BME) 596A	DATA STRUCTURE & ALGORITHM LABORATORY	0	0	3	3	2
	CS(BME) 596B	DATA BASE MANAGEMENT SYSTEM LABORATORY					
	EE(BME) 596C	CONTROL ENGINEERING LABORATORY					
	SESSIONAL						
PW	BME 582	MINI PROJECT	0	0	3	3	2
MC	MC 581	GROUP DISCUSSION PRACTICE	0	0	2 Units	2 Units	0
		TOTAL	18	3	17	38	31

Syllabus

THEORY PAPERS

Subject Name: BIOMEDICAL INSTRUMENTATION

Subject Code: BME 501

Total Contact Hour: 40

Credit: 4

Prerequisite: Knowledge of basic electronics, analog & digital electronics

Course Objective

1. To familiarize students with various aspects of measuring electrical parameters from living body.
2. To introduce students with the characteristics of medical instruments and related errors.
3. To illustrate various types of amplifiers used in biomedical instruments.
4. To familiarize students with biomedical recording devices.
5. To introduce students with patient monitoring systems & their characteristics.

Course Outcome

After completion of this course the students will be able to

BME 501.1 Describe and characterize the origin of bio-potentials and inspect common biomedical signals by their characteristics features

BME 501.2 Understand the basic instrumentation system with their limitations & familiarize with pc based medical instrumentation & control of medical devices.

BME 501.3 Describe and characterize medical instruments as per their specifications, static & dynamic characteristics and understand data acquisition system.

BME 501.4 Describe, analyze, characterize and design bio-potential amplifiers.

BME 501.5 Understand, describe, characterize and design various medical recording systems & their components.

BME 501.6 Understand and describe patient monitoring systems and its necessity in healthcare system.

Course Content

TOPIC	NO OF LECTURES
Medical Instrumentation: Sources of Biomedical Signals, Basic medical Instrumentation system, Performance requirements of medical Instrumentation system, Microprocessors in medical instruments, PC based medical Instruments, General constraints in design of medical Instrumentation system, Regulation of Medical devices.	6L
Measurement systems: Specifications of instruments, Static & Dynamic characteristics of medical instruments, Classification of errors, Statistical analysis, Reliability, Accuracy, Fidelity, Speed of response, Linearization of technique, Data Acquisition System.	6L
Bioelectric signals and Bioelectric amplifiers: Origin of bioelectric signals, Electrodes, Electrode-tissue interface, Galvanic Skin Response, BSR, Motion artifacts, Instrumentation amplifiers, Special features of bioelectric amplifiers, Carrier amplifiers, Chopper amplifiers, Phase sensitive detector.	8L
Biomedical recording systems: Basic Recording systems, General consideration for signal conditioners, Preamplifiers, Differential Amplifier, Isolation Amplifier, Electrocardiograph, Phonocardiograph, Electroencephalograph, Electromyography, Digital stethoscope Other biomedical recorders, Biofeedback instrumentation, Electrostatic and Electromagnetic coupling to AC signals, Proper grounding, Patient isolation and accident prevention.	12L

Patient Monitoring Systems: System concepts, Cardiac monitor, selection of system parameters, Bedside monitors, Central monitors, Heart rate meter, Pulse rate meter, Measurement of respiration rate, Holter monitor and Cardiac stress test, Catheterization Laboratory Instrumentation , Organization and equipments used in ICCU & ITU.	8L
Total	40L

Text Books:

1. R. S. Khandpur “Handbook of Bio-Medical Instrumentation”, 2nd Edition, Tata McGraw Hill.
2. J.J.Carr & J.M.Brown, “Introduction to Biomedical Equipment Technology” Pearson Education, Asia.
3. Cromwell, Weibell & Pfeiffer, “Biomedical Instrumentation & Measurement”, Prentice Hall, India

References:

1. Joseph Bronzino, “Biomedical Engineering and Instrumentation”, PWS Engg . , Boston.
2. J.Webster, “Bioinstrumentation”, Wiley & Sons.
3. Joseph D.Bronzino, “The Biomedical Engineering handbook”, CRC Press.

CO – PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BME 501.1	2	3	-	-	2	-	-	-	-	-	-	-
BME 501.2	3	3	2	1	-	-	1	-	-	-	-	-
BME 501.3	3	2	-	2	1	-	-	-	-	-	-	-
BME 501.4	3	3	3	2	2	-	-	-	-	-	-	-
BME 501.5	3	3	3	2	2	-	-	-	-	-	-	-
BME 501.6	3	-	1	-	2	2	1	-	-	-	-	-

Subject Name: BIOMEDICAL DIGITAL SIGNAL PROCESSING

Subject Code: BME 502

Total Contact Hour: 40

Credit: 4

Prerequisite: Knowledge of Biomedical Signal and Systems

Course Objectives

1. To build the required base for developing algorithms for signal processing systems.
2. To develop competency for transforming discrete signals and systems from time domain to frequency domain.
3. To apply the programming knowledge and logical thinking through MATLAB to design and simulate the BDSP systems

Course Outcomes

After completion students will be able to

BME 502.1 Understand the fundamental techniques & applications of digital signal processing with emphasis on biomedical signals.

BME 502.2 Implement algorithms based on discrete time signals.

BME 502.3 Understand circular and linear convolution and their implementation in DFT and analyze signals.

BME 502.4 Understand efficient computation techniques such as DIT and DIF FFT Algorithms.

BME 502.5 Design FIR filters using digital IIR filters by designing prototype analog filters and then applying analog to digital conversion.

Course Content

Module I	Introduction to Discrete Frequency Domain Transformation Review of Discrete Fourier Series and Discrete-Time Fourier Transform - Frequency domain sampling and reconstruction of discrete time signals - The Discrete Fourier Transform - DFT as a linear transformation - relationship to other transforms -properties of DFT - frequency analysis of signals using DFT - Linear filtering methods based on DFT– Convolution - Fast Fourier Transform algorithms – decimation in time-decimation in frequency-in place computation-direct computation, radix-2 algorithm, implementation of FFT algorithms - Applications of FFT	10 L
Module II	Design of Digital Filters General considerations - causality and its implications, characteristics of practical frequency selective filters - design of FIR filters - symmetric and anti-symmetric, linear phase-design of IIR filters from analog filters – Design of LPF, HPF, Band pass and band stop filters-Butterworth and Chebyshev filters – properties – design equations - using impulse invariance, bilinear transformation, characteristics of standard filters and their designs - Frequency transformations in the analog and digital domains, spectrum estimation method (periodogram, Welch’s method, etc.).	12L
Module III	Application of DSP IN Biomedical Signal Processing ECG Signal and its Processing: ECG Signal Filtering & Noise Removal, QRS Detection, Arrhythmia Detection, MI Detection. EMG Signal and its Processing: EMG Signal Filtering & Noise Removal, Detection of Flexion and extension. EEG Signal & its Processing: EEG Signal Filtering & Noise Removal, Decomposition of EEG Signal, Seizure Detection, Evoked Potential.	18L

Text Books:

1. S. Sharma, Digital Signal Processing, SK Kataria and Sons.
2. P. Ramesh Babu, Digital Signal Processing, SCITECH.
3. S. Salivahanan, A. Vallavaraj and C. Gnanapriya, Digital Signal Processing, TMH.
4. D.C Reddy, Biomedical Digital Signal processing, TMH

Reference Book:

1. J.R. Johnson, Introduction to Digital Signal Processing, PHI.
2. T. Bose, Digital Signal and Image Processing, Wiley.
3. S.K. Mitra, Digital Signal Processing, TMH.
4. J.G. Proakis and D.G. Manolakis, Digital Signal Processing

CO – PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BME 502.1	3	2	1	-	2	-	-	-	-	-	-	-
BME 502.2	3	3	2	-	2	-	-	-	1	-	-	-
BME 502.3	3	2	-	2	1	-	-	-	-	-	-	-
BME 502.4	3	2	3	2	-	-	-	-	-	-	-	-
BME 502.5	3	2	3	1	2	-	-	-	-	-	-	-

Subject Name: BIOSENSORS & TRANSDUCERS**Subject Code: BME 503****Total Contact Hour: 36****Credit: 3****Prerequisite:** Basic knowledge of sensors and transducers and fundamentals of instrumentation**Course Objective:**

1. To teach the fundamental concepts behind the operation of the most important classes of biosensors
2. To teach how biosensors are characterized, compared to each other, and designed to suit particular applications.
3. To teach how biochemical functionality is coupled to a biosensor transducer.
4. To expose students to several of the most important emerging biosensor technologies.
5. To encourage the practice of critical thinking when considering a new detection technology and to develop the ability to communicate well-researched opinions to others.

Course Outcome:

On completion of this course, the student will be able to

BME 503.1 Gain a broad knowledge of the applications of various sensors and transducers available for physiological and cellular measurements.

BME 503.2 Describe the fundamental transduction and bio-sensing principles.

BME 503.3 Understand various measurement devices and techniques, including the underlying biological processes that generate the respective quantities to be measured or controlled.

BME 503.4 Develop a clear concept and perform logical analysis of various measurement systems using different types of sensors, electrodes, signal conditioning circuits for acquiring and recording various physiological parameters.

BME 503.5 Critically review the literature in the application area and apply knowledge gained from the course to analyze simple bio-sensing and transduction problems.

Content

TOPIC	No Of Lecture
I. TRANSDUCERS PRINCIPLES AND MEDICAL APPLICATIONS Classification of transducers, characteristic of transducers, Temperature transducers: Resistance temperature detector (RTD), Thermistor, Thermocouple, p-n junction, chemical thermometry, Displacement transducers: potentiometer, resistive strain gauges, inductive displacement, capacitive displacement transducer, Pressure transducer: variable capacitance pressure transducers, LVDT transducers, strain gauge transducers, semiconductor transducers, catheter tip transducers, Piezoelectric transducer, Photoelectric transducers: photo-emissive tubes, photovoltaic cell, photoconductive cell, photodiodes, Flow transducers: magnetic, resistive and ultrasonic.	11 L
II. BIOPOTENTIAL ELECTRODES Electrode electrolyte interface, polarization, polarizable and non-polarizable electrodes, Electrode Behavior and, Circuit Models, Electrode-skin Interface and Motion Artifact, Body-Surface Recording Electrodes, Internal Electrodes: Needle & wire electrodes, Electrode Arrays, Microelectrodes: Metal supported metal, micropipette (metal filled glass and glass micropipette electrodes), properties of microelectrodes. Electrodes for Electric Stimulation of Tissue (i.e. for ECG, EMG & EEG)	9 L

III. CHEMICAL BIOSENSORS Electrochemical sensors (amperometric, potentiometric, conductimetric), Noninvasive Blood-Gas Monitoring, Blood-Glucose Sensors, Transducers for the measurement of ion and dissolved gases, Reference electrodes - Hydrogen electrodes, Silver- Silver Chloride electrode, Calomel electrodes, glass pH electrodes, Measurement of PO ₂ , PCO ₂ - Catheter type electrodes	7 L
IV. OPTICAL SENSOR AND RADIATION DETECTORS Principles of optical sensors, optical fiber sensors, indicator mediated transducers, optical fiber temperature sensors, Proportional counter, Gas-ionisation chamber, Geiger counters, Scintillation detectors.	4 L
V. BIOLOGICAL SENSORS Sensors / receptors in the human body and their basic mechanism of action, organization of nervous system-neural mechanism, Chemoreceptor: hot & cold receptors, baro receptors, sensors for smell, touch, sound, vision and taste, Ion exchange membrane electrodes, enzyme electrode, glucose sensors, immunosensors, Principles of MOSFET & BIOMEMS, Basic idea about Smart sensors	5 L

Text Books:

1. R. S. Khandpur, "Handbook of Biomedical Instrumentation", Tata McGraw Hill.
2. S.C. Cobbold, "Transducers for Biomedical Instruments", Wiley, 1974.
3. Gabor Harsanyi, "Sensors in Biomedical Applications: Fundamental Technologies and Applications" CRC Press, 1st Ed, 2000.
4. Rao & Guha, "Principles of Medical Electronics & Biomedical Instrumentation", University Press, India.
5. Deric P. Jones, "Biomedical Sensors", Momentum press, 1st Ed, 2010.

Reference Books:

1. D. L. Wise, "Applied Bio Sensors", Butterworth, London.
2. Shakti Chatterjee & Aubert Miller, "Biomedical Instrumentation Systems", Delmer Cengage Learning, 1st Ed, 2010.
3. John G. Webster, "Medical Instrumentation Application and Design" 4th Ed, Wiley, 2011.
4. Carr & Brown, Introduction to Biomedical Equipment Technology Pearson Edn, Asia

CO – PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BME 503.1	3	2	-	-	-	-	-	-	-	-	-	-
BME 503.2	3	2	2	-	-	-	-	-	-	-	-	-
BME 503.3	2	3	2	2	-	-	-	-	-	-	-	-
BME 503.4	3	2	3	1	2	-	-	-	-	-	-	-
BME 503.5	3	3	-	2	-	2	-	-	-	-	-	-

Subject Name: MEDICAL IMAGING TECHNIQUES

Subject Code: BME 504

Total Contact Hour: 40

Credit: 4

Prerequisite: Knowledge of Physics and Medical Instruments

Course Objective

To introduce the students with:

1. The physics & principles underlying the operation of medical imaging equipment.
2. Basics of X-ray imaging modality and its biological effects.
3. Imaging of soft tissues using ultrasound technique
4. Clinical applications of different imaging methods
5. Radiation safety issues in the operation of medical imaging equipments.

Course Outcome:

After completion of this course students will be able to

BME 504.1 Understand the physics & principles underlying the operation of different medical imaging equipment.

BME 504.2 Gain knowledge and explain the effects of radiations on biological tissues.

BME 504.3 Identify and analyze the basics of X-ray and US imaging modality.

BME 504.4 Interpret the most effective imaging modality for a particular organ.

BME 504.5 Implement efficient radiation safety protocols in the operation of various medical imaging equipments.

Course Content

Module No.	Topic	No of Lectures
I	X-Ray Machines and X-Ray Image Formation Physics and production of X-Rays, Stationary and Rotating Anode tube, Tube Enclosure, Tube Rating Charts, Conventional Electrical Circuit of X-Ray Machine, Conventional and High Frequency Generators, Control Circuits- HV control, Filament Control, Tube Current, Exposure Timing, Automatic Exposure Control, Filters, Collimators and Grids. Stationary X-Ray Unit, Mobile X-Ray and Portable Units. Specialized X-Ray Machine- Mammographic X-Ray Machines, Dental X-Ray Machines. X-Ray Film, Cassettes, Film Sensitometry, Radiographic Film Image Formation. Dark Room Accessories- Developer and Fixer. Image Quality Factors, CR, Image Intensifiers, DR, Safety Protocols and Doses, Dose Equivalent and REM.	20L
II	Computed Tomography Principles of Computed Tomography, Scanning Systems, Detectors in CT, Data Acquisition System and Processing, Storing and Viewing System, Gantry Geometry, Different Information from Gantry, Hounsfield Numbers, Image Reconstruction Techniques: Back Projections, Iterative and analytical methods, Image quality and Artifacts, Dose in CT, Spiral CT. Introduction to DICOM and PACS.	10L

III	Ultrasound Imaging Physics of ultrasound and Production of ultrasound, Medical ultrasound, acoustic impedance, absorption and attenuation of ultrasound energy, pulse geometry, ultrasonic field, ultrasonic transducers and probe structure, probe types, beam steering, Principles of image formation, capture and display - Principles of A Mode, B Mode and M Mode. Types of US Imaging, Real-time ultrasonic imaging systems, electronic scanners, Doppler ultrasound and Colour velocity mapping, duplex ultrasound, image artifacts, bio-effects and safety levels.	10L
	TOTAL	40L

Text Books:

1. Carr & Brown, "Introduction to Biomedical Equipment Technology" Pearson Education, Asia.
2. R. S. Khandpur, "Handbook of Bio-Medical Instrumentation", Tata McGraw Hill.
3. J. Webster, "Bioinstrumentation", Wiley & Sons

References:

1. Dowsett, Kenny & Johnston, "The Physics of Diagnostic Imaging", Chapman & Hall Medical, Madras/London.
2. Brown, Smallwood, Barber, Lawford & Hose, "Medical Physics and Biomedical Engineering", Institute of Physics Publishing, Bristol.
3. Massey & Meredith, "Fundamental Physics of Radiology", John Wright & Sons.
4. S. Webb, "The Physics of Medical Imaging", Adam Hilger, Bristol.

CO – PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BME 504.1	3	2				1						
BME 504.2		2		3		2						
BME 504.3	2	3		2	1							
BME 504.4		3		3	2	1						
BME 504.5	2	2		1		3		2				

Subject Name: HOSPITAL ENGINEERING & MANAGEMENT

Subject Code: BME505A

Total Contact Hour: 36

Credit: 3

Prerequisite: Basic Knowledge about biomedical instrumentation and various departments of hospital.

Course objectives:

To introduce the students with:

- Various departments of hospitals like IPD, OPD, EMERGENCY, ICU and OT.
- Departments of hospital providing Supportive and Auxiliary services.
- Effective hospital management techniques.
- Knowledge of hospital building maintenance, equipment and systems for health care.
- Knowledge regarding clinical engineering, biomedical engineering, safety technology and hospital information system.

Course outcome:

After completion of this course the students will be able to:

BME505A.1 Define and understand about hospital classification, criteria regarding organization, assessment, management, administration and regulation of modern healthcare technology.

BME505A.2 Gain broad knowledge of workflow of different departments of the hospital and their responsibilities.

BME505A.3 Investigate, evaluate and develop better management of information regarding identification of biomedical and hospital technology planning, procurement and operation requirements.

BME505A.4 Formulate and analyze network within the organization connecting medical professional and other healthcare technology managers for best practices and solutions for common issues.

BME505A.5 Understand and apply professional ethics and legal issues related to hospital engineering and healthcare system management, administration and regulation of healthcare technology.

BME505A.6 Implement efficient and safe technology use, considering the importance and impact of technology on patient care improving clinical effectiveness.

Course Content

Module	Topic	No. of Lectures
Module1	Healthcare System: Health organization of the country, Indian hospitals- challenges and strategies, modern techniques of hospital management.	4
Module2	Hospital Organization: Classification of hospital, Hospital- social system, location of hospital, site selection of new hospital, Line services, Supportive services and Auxiliary services of hospital.	9
Module3	Engineering Services of hospital: Biomedical engineer's role in hospital, Maintenance department, MRO, Electrical safety, Centralized gas supply system, Air conditioning system, Hospital waste management system, Fire safety and threat alarm system.	12
Module4	Hospital Management and Information System: Role of HMIS, Functional areas, Modules forming HMIS, HMIS and Internet, Centralized data record system, computerized patient record system, Health information system.	7
Module5	Regulation and planning of new hospital: FDA regulation, ISO certification, Fire protection standard, NABH	4
	TOTAL	36

Text/ Reference Books:

1. R.C. Goyal, Handbook of Hospital Personal Management, Prentice Hall of India, 1993.
2. Hans Pfeiff, Vera Dammann (Ed.), Hospital Engineering in Developing Countries, Z report Eschbom, 1986.
3. Cesar A. Caceres and Albert Zara, The practice of clinical engineering, Academic Press, 1977.
4. Webster, J. G and Albert M. Cook, Clinical Engineering Principles and Practices, Prentice Hall Inc. Englewood Cliffs, 1979.
5. Jacob Kline, Handbook of Bio Medical Engineering, Academic Press, San Diego 1988.

CO – PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BME 505A.1	3	1	-	2	-	1	-	-	-	-	-	-
BME 505A.2	3	1	-	-	-	2	1	2	-	2	-	-
BME 505A.3	2	2	-	3	2	-	-	-	-	1	3	-
BME 505A.4	-	2	-	-	2	2	3	1	1	-	2	-
BME 505A.5	2	1	-	-	-	2	-	3	-	3	1	-
BME 505A.6	-	1	-	2	3	2	3	3	-	-	1	-

Subject Name: BIOHEAT & MASS TRANSFER

Subject Code: BME 505B

Total Contact Hour: 34

Credit: 3

Prerequisite: Fundamentals of Thermodynamic equilibrium, first and second law, zero and first order kinetics; Solution of simplest ordinary first and second order differential equations with constant coefficients and solution of the heat equation and basic biological terminology and understanding of tissue and cell.

Course Objective:

- i) To understand the fundamentals of heat and mass transfer mechanisms in Biological systems.
- ii) Impart the knowledge to state, interpret, and solve the equations governing momentum, heat and mass transfer in fluids with appropriate simplifications and boundary conditions.
- iii) Students will learn about the diffusional mass transfer and Operation of cooling tower will be clearly understood.

Course Outcome:

BME505B.1 Ability to understand and solve conduction, convection and radiation problems

BME505B.2 Ability to design and analyze the performance of heat exchangers and evaporators

BME505B.3 Ability to design and analyze reactor heating and cooling systems

BME505B.4 Ability to understand about the diffusion mass transfer and operation of the cooling tower will be clearly understood.

Course Content:

MODULE-I: EQUILIBRIUM AND ENERGY CONSERVATION- Thermal Equilibrium and Laws of Thermodynamics; Energy Conservation. **3L**

MODULE- 2: FUNDAMENTALS OF HEAT AND MASS TRANSFER IN BIOLOGICAL SYSTEMS
- Thermoregulation, Metabolism, Thermal comfort. Temperature in living systems –hyperthermia and hypothermia. **5L**

MODULE-3: MODES OF HEAT TRANSFER – Conduction, Convection, and Radiation. Basic law of heat conduction – Fourier's law; thermal conductivity of biological materials, temperature dependence of thermal conductivity, steady state heat conduction through a layered surface with different thermophysical properties (e.g. skin). Effect of metabolism on heat transfer. Transient (unsteady state) heat conduction. Heat transfer with phase change – freezing of pure water, solution, cells and tissues and thawing. The bio-heat transfer equation for mammalian tissue. Convection heat transfer and the concept of heat transfer coefficient, individual and overall heat transfer coefficient, critical/optimum insulation thickness, heat transfer through extended surfaces. Thermal radiation as part of electromagnetic spectrum; Reflection, absorption and transmission; Thermal radiation emission from an ideal body; Radiation exchange between surfaces/bodies. **16L**

MODULE-4: MASS TRANSFER: Equilibrium, Mass conservation, and kinetics, Modes of Mass Transfer: Diffusion, Dispersion, and Advection. Molecular diffusion coefficients, First and second law and diffusion, mass transfer coefficients, film and penetration theories of mass transfer. Governing equations and boundary conditions of mass transfer, Steady and unsteady diffusion mass transfer (e.g. drug delivery), Convection mass transfer, Local and overall mass transfer coefficient, heat and mass transfer analogy. Flow in porous media. **12L**

Text Books:

1. Ashim K. Datta, Biological and Bioenvironmental Heat and Mass Transfer: Marcel Dekker, Inc., 2002.
2. Frank P. Incropera and David P. DeWitt, Fundamentals of Heat and Mass Transfer: John Wiley & Sons; 5th edition 2006.

CO – PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2
BME505B.1	3	3			2							
BME505B.2	2	2		3	3	2						
BME505B.3	2	2		3	3	1						
BME505B.4	2	2		1	3							

Subject Name: BIONANOTECHNOLOGY**Subject Code: BME 505C****Total Contact Hour: 36****Credit: 3**

Prerequisite: Fundamental knowledge of physics, biochemistry, biophysics, biomaterials and nano-materials.

Course Objective:

1. To impart knowledge on fundamental aspects of bionanotechnology
2. To learn the wide range of applications of nanotechnology and its interdisciplinary aspect.
3. To familiarize the students with native bio-nanomachinery in living cells.
4. To correlate the impact of nanotechnology and nano-science in a global, economic, environmental & societal context.
5. Identify career paths at the interface of nanotechnology, biology, environmental engineering and medicine.

Course Outcome:

After completion of this course the students will be able to :

BME 505C.1. Understand the basics of bio-nanotechnology and its application

BME 505C.2. Understand the fundamental principles of nanotechnology and their application to biomedical engineering.

BME 505C.3. Demonstrate a comprehensive understanding of state-of-the-art nano-fabrication methods.

BME 505C.4. Apply and transfer interdisciplinary systems engineering approaches to the field of bio- and nano-technology projects.

BME 505C.5. Practice and explain state-of-the-art characterization methods for nano-materials, understanding and critiquing nanomaterial safety and handling methods required during characterization.

Course Content:

Topic	No. of Lecture
UNIT - I BIONANOMACHINES AND THEIR BASICS Negligible gravity and inertia, atomic granularity, thermal motion, water environment and their importance in bionanomachines. The role of proteins- amino acids- nucleic acids- lipids and polysaccharides in modern biomaterials. Overview of natural Bionanomachines: Thymidylate Synthetase , ATP synthetase, Actin and myosin, Opsin, Antibodies and Collagen.	5

UNIT - II SYNTHESIS OF BIOMOLECULES & INTERPHASE SYSTEMS Recombinant Technology, Site-directed mutagenesis, Fusion Proteins. Quantum Dot structures and their integration with biological structures. Molecular modeling tools: Graphic visualization, structure and functional prediction, Protein folding prediction and the homology modeling, Docking simulation and Computer assisted molecular design. Interphase systems of devices for medical implants –Microfluidic systems –Microelectronic silicon substrates –Nano-biometrics –Introduction –Lipids as nano-bricks and mortar: self assembled nanolayers.	8
UNIT - III FUNCTIONAL PRINCIPLES OF NANOBIO TECHNOLOGY Information driven nanoassembly, Energetic, Role of enzymes in chemical transformation, allosteric motion and covalent modification in protein activity regulation, Structure and functional properties of Biomaterials, Biomolecular motors: ATP Synthetase and flagellar motors, Traffic across membranes: Potassium channels, ABC Transporters and Bacteriorhodopsin, Biomolecular sensing, Self replication, Machine-Phase Bionanotechnology Protein folding; Self assembly, Self-organization, Molecular recognition and Flexibility of biomaterials.	7
UNIT - IV PROTEIN AND DNA BASED NANOSTRUCTURES Protein based nanostructures building blocks and templates – Proteins as transducers and amplifiers of biomolecular recognition events – Nanobioelectronic devices and polymer nanocontainers – Microbial production of inorganic nanoparticles – Magnetosomes .DNA based nanostructures – Topographic and Electrostatic properties of DNA and proteins – Hybrid conjugates of gold nanoparticles – DNA oligomers – Use of DNA molecules in nanomechanics and Computing.	8
UNIT - V APPLICATIONS OF NANOBIO TECHNOLOGY Semiconductor (metal) nanoparticles and nucleic acid and protein based recognition groups – Application in optical detection methods – Nanoparticles as carrier for genetic material – Nanotechnology in agriculture – Fertilizer and pesticides. Designer proteins, Peptide nucleic acids, Nanomedicine, Drug delivery, DNA computing, Molecular design using biological selection, Harnessing molecular motors, Artificial life, Hybrid materials, Biosensors, Future of Bionanotechnology	8
Total	36L

Text / References:

1. C. M. Niemeyer, C. A. Mirkin, —Nanobiotechnology: Concepts, Applications and Perspectives, Wiley – VCH, (2004).
- 2 T. Pradeep, —Nano: The Essentials, McGraw – Hill education, (2007).
3. Challa, S.S.R. Kumar, Josef Hormes, Carola Leuschaer, Nanofabrication Towards Biomedical Applications, Techniques, Tools, Applications and Impact, Wiley – VCH, (2005).
4. David S Goodsell, “Bionanotechnology”, John Wiley & Sons, (2004).

CO – PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BME 505C.1	3	2	-	-	1	-	-	-	-	-	-	-
BME 505C.2	3	1	-	1	2	-	-	-	-	-	-	-
BME 505C.3	2	2	-	3	-	-	-	-	-	1	-	-
BME 505C.4	-	2	-	3	3	-	-	-	-	-	-	-
BME 505C.5	3	2	-	-	2	-	-	1	-	-	1	-

Subject Name: DATA STRUCTURE & ALGORITHM

Subject Code: CS(BME) 506A

Total Contact Hour: 36

Credit: 3

Prerequisite: Basic Mathematics, logic gets, details knowledge of programming with C.

Course Objective(s)

The objectives of this course are

1. To provide knowledge in various data structures and algorithms to introduce techniques for analyzing the efficiency of computer algorithms.
2. To provide efficient methods for storage, retrieval and accessing data in a systematic manner and explore the world of searching, sorting, traversal and graph algorithm.
3. To demonstrate understanding of the abstract properties of various data structures such as stacks, queues, lists, and trees.
4. To compare different implementations of data structures and to recognize the advantages and disadvantages of the different implementations.
5. To demonstrate understanding of various sorting algorithms, including bubble sort, insertion sort, selection sort, heap sort and quick sort.
6. To compare the efficiency of various sorting algorithms in terms of both time and space.
7. To trace and code recursive functions.

Course Outcome

CS(BME) 506A.1. Graduates will be able to use different kinds of data structures which are suited to different kinds of applications, and some are highly specialized to specific tasks. For example, B-trees are particularly well-suited for implementation of databases, while compiler implementations usually use hash tables to look up identifiers.

CS(BME) 506A .2. Graduates will be able to manage large amounts of data efficiently, such as large databases and internet indexing services.

CS(BME) 506A .3. Graduates will be able to use efficient data structures which are a key to designing efficient algorithms.

CS(BME) 506A .4. Graduates will be able to use some formal design methods and programming languages which emphasize on data structures, rather than algorithms, as the key organizing factor in software design.

CS(BME) 506A .5. Graduates will be able to store and retrieve data stored in both main memory and in secondary memory

Course Content

Module -I. Linear Data Structure

[8L]

Introduction (2L): Concepts of data structures: a) Data and data structure b) Abstract Data Type and Data Type. Algorithms and programs, basic idea of pseudo-code. Algorithm efficiency and analysis, time and space analysis of algorithms – order notations.

Array (2L): Different representations – row major, column major. Sparse matrix - its implementation and usage. Array representation of polynomials.

Linked List (4L): Singly linked list, circular linked list, doubly linked list, linked list representation of polynomial and applications.

Module -II: Linear Data Structure

[6L]

Stack and Queue (4L): Stack and its implementations (using array, using linked list), applications. Queue, circular queue, dequeue. Implementation of queue- both linear and circular (using array, using linked list), applications.

Recursion (2L): Principles of recursion – use of stack, differences between recursion and iteration, tail recursion. Applications - The Tower of Hanoi.

Module -III. Nonlinear Data structures

[12L]

Trees (9L): Basic terminologies, forest, tree representation (using array, using linked list). Binary trees - binary tree traversal (pre-, in-, post- order), threaded binary tree , expression tree. Binary search tree- operations (creation, insertion, deletion, searching). Height balanced binary tree – AVL tree (insertion, deletion with examples only). B- Trees – operations (insertion, deletion with examples only).

Graphs (6L): Graph definitions and Graph representations/storage implementations – adjacency matrix, adjacency list, adjacency multi-list. Graph traversal and connectivity – Depth-first search (DFS), Breadth-first search (BFS) – concepts of edges used in DFS and BFS

Module - IV. Searching, Sorting:

[10L]

Sorting Algorithms (5L): Internal sorting and external sorting Bubble sort and its optimizations, insertion sort, shell sort, selection sort, merge sort, quick sort, heap sort (concept of max heap), radix sort. Tree Sort technique .Searching (2L): Sequential search, binary search.

Hashing (3L): Hashing functions, collision resolution techniques.

Reference Book:

1. Fundamentals of Data Structures in C, E. Horowitz , Satraj Sahni and Susan Anderson, W. H. Freeman and Company
2. Data Structure Using C & C++, Tannenbaum, PHI
3. Data Structures & Program Design in C, 2nd Ed, Kruse, Tondo & Leung, PHI
4. Data Structures and Algorithm using C, Reema Thareja, Oxford Publishing.
5. Data Structures and Algorithm using C, A. Nag, Vikash Publishing

CO vs PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CS(BME) 506A .1	2	3	-	-	-	-	-	-	-	-	-	-
CS(BME) 506A .2	2	3	3	-	-	-	-	-	-	1	-	-
CS(BME) 506A .3	2	3	3	-	1	-	-	-	-	1	-	-
CS(BME) 506A .4	-	-	-	2	-	-	-	-	-	-	1	1
CS(BME) 506A .5	2	3	-	-	-	-	-	-	-	-	-	1

Subject Name: DATA BASE MANAGEMENT SYSTEM

Subject Code: CS(BME)506B

Total Contact Hour: 36

Credit: 3

Prerequisite: Elementary discrete mathematics including the notion of set, function, relation, product, partial order, equivalence relation, graph & tree. They should have a thorough understanding of the principle of mathematical induction and various proof techniques. There should be a thorough understanding about data structure and operating system knowledge

Course objective

After completion of this course the students will be able to

- define a Database Management System
- give a description of the Database Management structure
- understand the applications of Databases
- identify the various functions of Database Administrator
- implement different models
- know the advantages and disadvantages of the different models
- compare relational model with the Structured Query Language (SQL)
- know the constraints and controversies associated with relational database model.
- know the rules guiding transaction ACID
- identify the major types of relational management systems
- compare and contrast the types of RDBMS based on several criteria
- understand the concept of data planning and Database design
- know the steps in the development of Databases
- trace the history and development process of SQL
- know the scope and extension of SQL

Course outcome

After completion of this course student will be able to

CS(BME)506B.1. Understand fundamental elements of a relational database management system

CS(BME)506B.2. Understand the basic concepts of relational data model, entity-relationship model, relational database design, relational algebra and database language SQL

CS(BME)506B.3. Identify other data models such as object-oriented model and XML model

CS(BME)506B.4. Design entity-relationship diagrams to represent simple database application scenarios

CS(BME)506B.5. Convert entity-relationship diagrams into relational tables, populate a relational database and formulate SQL queries on the data

CS(BME)506B.6. Criticize a database design and improve the design by normalization

CS(BME)506B.7. Develop team spirit and professional attitude towards the development of database applications

Course Content

Introduction [3L]

Concept & Overview of DBMS, Data Models, Database Languages, Database Administrator, Database Users, Three Schema architecture of DBMS.

Entity-Relationship Model [3L]

Basic concepts, Design Issues, Mapping Constraints, Keys, Entity-Relationship Diagram, Weak Entity Sets, Extended E-R features.

Relational Model [4L]

Structure of relational Databases, Relational Algebra, Relational Calculus, Extended Relational Algebra Operations, Views, Modifications Of the Database.

SQL and Integrity Constraints [8L]

Concept of DDL, DML, DCL. Basic Structure, Set operations, Aggregate Functions, Null Values, Domain Constraints, Referential Integrity Constraints, assertions, views, Nested Subqueries, Database security application development using SQL, Stored procedures and triggers.

Relational Database Design [8L]

Functional Dependency, Different anomalies in designing a Database., Normalization using functional dependencies, Decomposition, Boyce-Codd Normal Form, 3NF, Normalization using multi-valued dependencies, 4NF, 5NF

Internals of RDBMS [6L]

Physical data structures, Query optimization : join algorithm, statistics and cost based optimization. Transaction processing, Concurrency control and Recovery Management : transaction model properties, state serializability, lock based protocols, two phase locking.

File Organization & Index Structures [4L]

File & Record Concept, Placing file records on Disk, Fixed and Variable sized Records, Types of Single-Level Index (primary, secondary, clustering), Multilevel Indexes, Dynamic Multilevel Indexes using B tree and B+ tree .

Text Books:

1. Henry F. Korth and Silberschatz Abraham, "Database System Concepts", Mc.Graw Hill.
2. Elmasri Ramez and Navathe Shamkant, "Fundamentals of Database Systems", Benjamin Cummings Publishing. Company.
3. Ramakrishnan: Database Management System , McGraw-Hill
4. Gray Jim and Reuter Address, "Transaction Processing : Concepts and Techniques", Morgan Kaufman Publishers.
5. Jain: Advanced Database Management System CyberTech
6. Date C. J., "Introduction to Database Management", Vol. I, II, III, Addison Wesley.
7. Ullman JD., "Principles of Database Systems", Galgotia Publication.

References:

1. James Martin, "Principles of Database Management Systems", 1985, Prentice Hall of India, New Delhi
2. "Fundamentals of Database Systems", Ramez Elmasri, Shamkant B.Navathe, Addison Wesley Publishing Edition
3. "Database Management Systems", Arun K.Majumdar, Pritimay Bhattacharya, Tata McGraw Hill

CO vs. PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CS(BME)506B.1					3				2			
CS(BME)506B.2					1							
CS(BME)506B.3			1	1	3				2			
CS(BME)506B.4					3				2			
CS(BME)506B.5				1	2							
CS(BME)506B.6					2							
CS(BME)506B.7					3				1			

Subject Name: CONTROL ENGINEERING

Subject Code: EE(BME)506C

Total Contact Hour: 34

Credit: 3

Prerequisite: Basic Electrical Engineering, Circuit Theory, Laplace transform, Second order differential Equation.

Course Objectives:

Control Engineering plays a fundamental role in modern technological systems. The aim of this course is to serve as an introduction to control system analysis and design.

The objectives include equipping students with:

1. Basic understanding of issues related to control systems such as modeling, time and frequency responses of dynamical systems, performance specifications and controller design
2. Skills and techniques for tackling practical control system design problems

Course Outcome

EE(BME)506C.1 Ability to understand and explain basic structure of control systems, basic terminologies, components.

EE(BME)506C.2 Ability to represent physical systems into transfer function form and thus can analyze system dynamic and steady state behavior.

EE(BME)506C.3 Ability to analyze system stability and design controllers, compensators in frequency domain.

Course Content:

Module I- Introduction to control system: Concept of feedback and Automatic control, Types and examples of feedback control systems, Definition of transfer function .Poles and Zeroes of a transfer function. **2L**

Module II- Mathematical modeling of dynamic systems: Writing differential equations and determining transfer function of model of various physical systems including -Translational & Rotational mechanical systems, Basic Electrical systems & transfer function , Liquid level systems, Electrical analogy of Spring–Mass-Dashpot system. Block diagram representation of control systems. Block diagram algebra. Signal flow graph. Mason’s gain formula. **6L**

Module III- Control system components: Potentiometer, Synchros, Resolvers, Position encoders. DC and AC tachogenerators. Actuators. **2L**

Module IV- Time domain analysis: Time domain analysis of a standard second order closed loop system. Determination of time-domain specifications of systems. Step and Impulse response of first and second order systems. Stability by pole location. Routh-Hurwitz criteria and applications. Control Actions: Basic concepts of PI, PD and PID control, Steady-state error and error constants. **4L**

Module V- Stability Analysis by Root Locus method: Root locus techniques, construction of Root Loci for simple systems. Effects of gain on the movement of Pole and Zeros. **4L**

Module VI- Frequency domain analysis of linear system: Bode plots, Polar plots, Nichols chart, Concept of resonance frequency of peak magnification. Nyquist criteria and Nyquist plots, measure of relative stability, phase and gain margin. Determination of margins in Bode plot. **8L**

Module VII- Control System performance: Improvement of system performance through compensation. Lead, Lag and Lead-lag compensation. **4L**

Module VIII- Case-studies: Block diagram level description of feedback control systems for position control, speed control of DC motors, temperature control, liquid level control, voltage control of an Alternator. **4L**

Numerical problems to be solved in the tutorial classes.

Text books:

1. Modern Control Engineering, K. Ogata, 4th Edition, Pearson Education.
2. Control System Engineering, I. J. Nagrath & M. Gopal. New Age International Publication.
3. Control System Engineering, D. Roy Choudhury, PHI
4. Automatic Control Systems, B.C. Kuo & F. Golnaraghi, 8th Edition, PHI

Reference Books:

1. Control Engineering Theory & Practice, Bandyopadhyaya, PHI
2. Control systems, K.R. Varmah, Mc Graw hill
3. Control System Engineering, Norman Nise, 5th Edition, John Wiley & Sons
4. Modern Control System, R.C. Dorf & R.H. Bishop, 11th Edition, Pearson Education.

CO vs. PO Mapping

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
EE(BME) 506C.1	3	-	-	1	-	-	-	-	-	-	-	-
EE(BME) 506C.2	3	2	3	2	1	-	-	-	-	-	-	-
EE(BME) 506C.3	3	2	3	-	2	-	-	-	-	-	-	-

PRACTICAL PAPERS

Subject Name: BIOMEDICAL INSTRUMENTATION LABORATORY

Subject Code: BME591

Contact hours/Week: 0:0:3

Credit: 2

Prerequisite: Knowledge of basic electronics, analog & digital electronics.

Course Objective

1. To familiarize students with the operation of DC to DC converter & its application.
2. To introduce students with timer circuits & heart-rate meter.
3. To emphasis on the study of EMG, ECG, EEG & PCG waveform & analysis.
4. To familiarize students with the design of bio-potential amplifiers.
5. To introduce students with basic operation of X-ray system.
6. To introduce students on the study of isolation of bio-signals.

Course Outcome

After completion of this course the students will be able to

- BME591.1** Understand and implement isolation techniques in designing biomedical instruments.
- BME591.2** Understand & describe the electrode placement and analyze QRS Component & Heart Rate.
- BME591.3** Describe the instrumentation & operation of an X-ray system.
- BME591.4** Investigate & evaluate ON-Time & OFF-Time delay of a waveform
- BME591.5** Analyze and Interpret EMG, ECG, EEG and PCG waveforms in diagnostic point of views
- BME591.6** Design power supply unit, bio-potential amplifiers and filters.

Course Content

List of experiments:

1. Power isolation: isolation transformer and DC-DC converters
2. Design of Timer circuits (astable multivibrator): ON delay and OFF delay study
3. Study on ECG electrodes placement and heart rate measurement.
4. ECG processing and analysis
5. EMG processing and analysis
6. EEG processing and analysis
7. Detection of QRS component from ECG signals
8. Study on filter circuit-Design
9. Design of Power Supply Unit
10. Study on X-ray radiography systems / X-ray simulator
11. Characterization of biopotential amplifier for ECG & EMG signals
12. Study on Instrumentation Amplifier-Design

CO – PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BME 591.1	3	2	3	1	-	1	-	-	-	-	-	-
BME 591.2	3	3	1	-	1	-	-	-	-	-	-	-
BME 591.3	3	3	2	-	1	-	-	-	-	-	-	-
BME 591.4	1	1	-	2	3	-	-	-	-	-	-	-
BME 591.5	3	3	1	3	2	1	-	-	-	-	-	1
BME 591.6	3	2	3	1	-	-	-	-	-	-	-	-

Subject Name: BIOMEDICAL DIGITAL SIGNAL PROCESSING LABORATORY

Subject Code: BME592

Contact hours/Week: 0:0:3

Credit: 2

Prerequisites: Knowledge in Biomedical Signal and Systems

Course Objectives:

To introduce the basic principles, methods, and applications of digital signal processing, to explore its algorithmic, computational, and programming aspects, and to learn programming of DSP hardware for real-time signal processing applications.

Course Outcome:

BME592.1. Understand the fundamental techniques and applications of DSP with emphasis on biomedical signals.

BME592.2. Implement z-transform, DTFT, DFT and DWT to analyze and design DSP systems.
BME592.3. Analyze the applications of FFT to DSP & finite word length effect on DSP systems.
BME592.4. Design adaptive filters for various applications of Biomedical Signal Processing.

Course Content

List of Experiments:

1. Waveforms, Plot
2. Implementation of Difference Equation in Time Domain (simple digital filters, audio effects).
3. Frequency Domain Description of Signals: DFT (sinusoidal signals).
4. Design and Application of Digital Filters: FIR Filters.
5. Design and Application of Digital Filters: IIR Filters.
6. Implementation of DSP in biomedical signal processing through TMS3206713
7. Implementation of a Practical DSP System for ECG Signals.
8. Implementation of a Practical DSP System for EMG Signals.
9. Implementation of a Practical DSP System for EEG Signals.
10. Introduction of coding for discrete wavelet transforms.

CO – PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BME 592.1	3	2	-	2	2	-	-	-	1	-	-	1
BME 592.2	3	2	3	-	-	-	-	-	1	-	-	-
BME 592.3	2	3	-	2	2	-	-	-	-	1	-	-
BME 592.4	3	2	3	-	2	-	-	-	-	-	1	-

Subject Name: BIOSENSORS & TRANSDUCERS LABORATORY

Subject Code: BME593

Contact hours/Week: 0:0:3

Credit: 2

Prerequisite: Working principles of sensors and transducers and fundamentals of basic electronics laboratory.

Course Objectives

- i) To study and analyze the theoretical and practical characteristics of the various transducers for the measurement of the vital physiological signals.
- ii) To familiarize the students with the operation of a few transducers having biomedical applications.
- iii) To provide experience on design, testing, analysis of some electronic circuits having application in biomedical equipment.
- iv) To empower the student to critically evaluate sensor and transducer options for a particular biomedical application.

Course Outcome:

After learning the course the students should be able to:

BME593.1 Understand the working principle and characteristics of different types of sensors and transducers useful in medical field.

BME593.2 Implement different sensors as per their applications in biomedical instrumentation.

BME593.3 Explain the different diagnostic methods for identification of human bio-potentials and their necessary instrumentation.

Course Content

List of Experiments

1. Temperature measurement using AD590 IC sensor
2. Study of the characteristics of Thermistor/ RTD
3. Displacement measurement by using a capacitive transducer
4. Study of the characteristics of a LDR
5. Pressure and displacement measurement by using LVDT
6. Study of a load cell with tensile and compressive load
7. Torque measurement using Strain gauge transducer
8. Study the characteristics of piezoelectric transducer
9. Study & characterization of bio-transducers – Pressure, Temperature, Humidity
10. Study & characterization of bio-electrodes – ECG, EMG, EEG

CO – PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BME 593.1	3	2	2	-	2	1	-	-	-	-	-	1
BME 593.2	3	2	2	-	2	1	-	-	-	-	1	-
BME 593.3	3	3	2	2	2	2	1	-	-	-	1	1

Subject Name: DATA STRUCTURE & ALGORITHM LABORATORY

Subject Code: CS(BME) 596A

Contact hours/Week: 0:0:3

Credit: 2

Prerequisite: Basic Mathematics, logic gets, details knowledge of programming with C.

Course Objectives:

1. To assess how the choice of data structures and algorithm design methods impacts the performance of programs.
2. To choose the appropriate data structure and algorithm design method for a specified application.
3. To solve problems using data structures such as linear lists, stacks, queues, hash tables, binary trees, heaps, binary search trees, and graphs and writing programs for these solutions.

Course Outcome

Graduates will be able to

CS(BME) 596A .1. Write well-structured procedure-oriented programs of up to large lines of code.

CS(BME) 596A .2. Analyze run-time execution of previous learned sorting methods, including selection, merge sort, heap sort and Quick sort.

CS(BME) 596A .3. To implement the Stack ADT using both array based and linked-list based data structures.

CS(BME) 596A .4 .To implement the Queue ADT using both array based circular queue and linked-list based implementations. Able to implement binary search trees.

Course Content

SL	Program Description	No. of Lab Session(hours)
Module I :Array		
1	Array Creation	1
2	Array insertion and deletion	1
3	Array merging	1
4	String matching	1
Module II :Stack		
1	Stack Using Array	1
2	Linear Queue using Array	1
3	Circular Queue using Array	1
4	Implement DEQUEUE	1
Module III :Link List		
1	Linear Linked List (LLL)- Create a node, Display Nodes.	1
2	Insert and Delete a node from Beginning of the LLL	1
3	Insert a node after a particular node of LLL. Insert a Node before a particular node.	1
4	Search a node, count number of nodes, update a node	1
5	Reverse display of LLL using recursion, Physically reverse a LLL	1
6	Circular Linked List (CLL) – Create Circular Linked List and Display Nodes.	1
7	Doubly Linked List (DLL) – Create nodes of DLL and Display nodes.	1
8	Polynomial – Create two polynomials and add two polynomials.	1
9	Convert infix to postfix expression and Evaluate Postfix expression	1
Module IV :Tree		
1	Tree – Create Binary Tree	1
2	Create Binary Search Tree (BST)	1
3	Implement in order () traversal without recursion.	1
4	Implement post order () traversal without recursion	1
5	Count number of nodes, count no of leave and non-leave nodes, create mirror image of nodes	1
6	Threaded Binary Search Tree (TBST) - Create TBST following in order predecessor and successor rules & display nodes	1
Module V:Sorting & Searching		
1	Search – Implement Binary Search using array	1
2	Sorting – Implement Bubble sort	1
3	Implement quick sort algorithm	1

4	Implement merge sort algorithm	1
5	Insertion sort	1
6	Selection sort	1
Module VI :Graph		
1	Graph - Create a graph using adjacency matrix. perform Depth First Search and Breath First Search	1

CO vs PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CS(BME) 596A.1	2	-	3	-	-	-	-	-	-	1	1	-
CS(BME) 596A.2	-	3	3	-	-	-	-	-	-	-	1	-
CS(BME) 596A.3	2	3	3	-	-	-	-	-	-	-	-	-
CS(BME) 596A.4	2	3		-	-	-	-	-	-	-	1	1

Subject Name: DATA BASE MANAGEMENT SYSTEM LAB

Subject Code: CS(BME)596B

Contact hours/Week: 0:0:3

Credit: 2

Prerequisite: Students should have a thorough knowledge about basic programming logic.

Course objective

- To understand values of Data.
- To understand significant role of DBMS.
- To understand need for normalizing a Database.
- To understand problems with unnecessary duplication of data.
- To understand concepts of transaction.

Course Outcome:

After completion of this course student will be able to

CS(BME)596B.1 Data Definition Language (DDL) commands in RDBMS.

CS(BME)596B.2 Data Manipulation Language (DML) and Data Control Language (DCL) commands in RDBMS.

CS(BME)596B.3 High-level language extension with Cursors.

CS(BME)596B.4 High level language extension with Triggers.

CS(BME)596B.5 Procedures and Functions. Embedded SQL.

CS(BME)596B.7 Database design using E-R model and Normalization.

CS(BME)596B.8 Development of mini projects

Course Content

Structured Query Language

1. Creating Database

- Creating a Database
- Creating a Table
- Specifying Relational Data Types
- Specifying Constraints
- Creating Indexes

2. Table and Record Handling

- INSERT statement
- Using SELECT and INSERT together
- DELETE, UPDATE, TRUNCATE statements
- DROP, ALTER statements

3. Retrieving Data from a Database

- The SELECT statement
- Using the WHERE clause
- Using Logical Operators in the WHERE clause
- Using IN, BETWEEN, LIKE , ORDER BY, GROUP BY and HAVING

Clause

- Using Aggregate Functions
- Combining Tables Using JOINS
- Subqueries

4. Database Management

- Creating Views
- Creating Column Aliases
- Creating Database Users
- Using GRANT and REVOKE

Cursors in Oracle PL / SQL

Writing Oracle PL / SQL Stored Procedures

CO vs. PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CS(BME)596B.1					3				2			
CS(BME)596B.2				1	1							
CS(BME)596B.3					3				1			
CS(BME)596B.4				1	3							
CS(BME)596B.5					2							
CS(BME)596B.6				2	2							
CS(BME)596B.7				1	3				2			

Subject Name: CONTROL ENGINEERING LABORATORY

Subject Code: EE(BME)596C

Contact hours/Week: 0:0:3

Credit: 2

Prerequisite: MATLAB/ SIMULINK

Course Objective:

1. The main objective is to give the students many opportunities to put the controller design principles.
2. Students learn to develop controllers for a set of interesting electromechanical hardware and software based applications.

Course Outcome:

EE(BME)596C.1 Ability to simulate, analyze system behavior using software simulator/hardware.

EE(BME)596C.2 Ability to design compensators, controllers to meet desired performance of a system.

Course Content:

List of Experiments-

1. Familiarization with MAT-Lab control system tool box, MAT-Lab- simulink tool box & PSPICE
2. Determination of Step response for first order & Second order system with unity feedback on CRO & calculation of control system specification like Time constant, % peak overshoot, settling time etc. from the response.
3. Simulation of Step response & Impulse response for type-0, type-1 & Type-2 system with unity feedback using MATLAB & PSPICE.
4. Determination of Root locus, Bode plot, Nyquist plot using MATLAB control system tool box for 2nd order system & determination of different control system specification from the plot.
5. Determination of PI, PD and PID controller action of first order simulated process.
6. Determination of approximate transfer functions experimentally from Bode plot.
7. Evaluation of steady state error, setting time, percentage peak overshoot, gain margin, phase margin with addition of Lead

CO Mapping with Departmental POs

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
EE(BME)596C.1	3			2	3							
EE(BME)596C.2	3		2	2	3							

**Detailed Syllabus of B.Tech in Biomedical Engineering Programme
(Third Year- Sixth Semester)**

BME-Semester VI

Subject Type	Subject Code	Subject Name	Contact hrs/week				Credits
			L	T	P	Total	
	THEORY						
PC	BME 601	ANALYTICAL & DIAGNOSTIC EQUIPMENTS	3	1	0	4	4
PC	BME 602	BIOPHYSICS & BIOCHEMISTRY	3	1	0	4	4
PC	BME 603	MODELLING OF PHYSIOLOGICAL SYSTEMS	3	0	0	3	3
PC	BME 604	ADVANCED IMAGING SYSTEMS	3	1	0	4	4
PE-II	BME 605A	COMMUNICATION SYSTEMS & BIOTELEMETRY	3	0	0	3	3
	BME 605B	DRUG DELIVERY SYSTEM					
	BME 605C	BIOINFORMATICS					
OE-II	EI(BME) 606A	MICROPROCESSORS & MICROCONTROLLERS	3	0	0	3	3
	EC(BME) 606B	VLSI & EMBEDDED SYSTEM					
	IT(BME) 606C	SOFT-COMPUTING					
	PRACTICAL						
PC	BME 691	BIOMEDICAL EQUIPMENT LABORATORY	0	0	3	3	2
PE-II	BME 695A	COMMUNICATION SYSTEMS & BIOTELEMETRY LABORATORY	0	0	3	3	2
	BME 695B	DRUG DELIVERY SYSTEM LABORATORY					
	BME 695C	BIOINFORMATICS LABORATORY					
OE-II	EI(BME) 696A	MICROPROCESSORS & MICROCONTROLLERS LABORATORY	0	0	3	3	2
	EC(BME) 696B	VLSI & EMBEDDED SYSTEM LABORATORY					
	IT(BME) 696C	SOFT-COMPUTING LABORATORY					
	SESSIONAL						
PW	BME 681	DESIGN LAB	0	0	6	6	3
PW	BME 682	HOSPITAL TRAINING (3 Weeks)	0	0	0	0	2
		TOTAL	18	3	15	36	32

Syllabus:

THEORY PAPER

Subject Name: ANALYTICAL & DIAGNOSTIC EQUIPMENT

Subject Code: BME 601

Total Contact Hour: 40

Credit: 4

Prerequisite: Knowledge of Biomedical Instrumentation

Course objectives:

This course is intended to impart the fundamental knowledge of versatile analytical & diagnostic equipments used in the healthcare system

Course outcome:

After completion of this course the students will be able to

BME601.1 Understand the fundamentals and application of current chemical and scientific theories in analytical & diagnostic equipments.

BME601.2 Apply the knowledge to identify the various types of analytical & diagnostic equipments used in Biomedical Engineering.

BME601.3 Explain the working principle, functional and constructional features of different analytical & diagnostic medical instruments used for sensing and measuring various physiological parameters of human body.

BME601.4 Acquire the knowledge and skills & apply proper techniques for measuring of basic medical parameters and analyze basic features of the equipment for using in electro diagnostic and electro therapy.

Course Content

Module	Topic	No. of Lectures
I	CLINICAL EQUIPMENTS Principles of photometric measurement, Optical filters, Colorimeter, Spectrometer , Design of Monochromators, Flame photometer, Atomic absorption spectrophotometer, Automated biochemical analyzer- Auto analyzer, Coagulometer, Ion Analyzer, Microscopes, Scanning Electron Microscope, Transmission Electron Microscope, Centrifuge-principles and applications. Methods of cell counting, Flow cytometry, Coulter Counters, automatic recognition and differential counting of cells.	12L
II	CARDIAC FUNCTION MEASUREMENT Blood pressure apparatus, Blood gas analyzers and Oximeters Sphygmomanometer, Automated indirect and specific direct method of B.P. monitor. Blood pH measurement, Blood pCO ₂ measurement, Blood pO ₂ measurement, a complete blood gas analyzer, Fiber optic based blood gas sensors. Oximetry & its Principles, Ear oximeter, Pulse oximeter, Intravascular oximeter. Blood Flow meters Electromagnetic blood flow meter, Ultrasonic blood flow meter-Transit time and Doppler blood flow meter, Cardiac output measurement-Dye dilution method and Impedance technique.	12L
III	PULMONARY FUNCTION MEASUREMENT Respiratory volumes and capacities, Compliance and related pressure, Spirometer, Pneumotachometer-different types, Measurement of respiration rate-impedance pneumograph / plethysmograph, apnea detector.	6L

IV	ENDOSCOPY Basic endoscopic equipment, Fibreoptic instruments and video-endoscopes, Accessories-illumination, instrument tips, instrument channels, tissue sampling devices, suction traps and fluid-flushing devices, Various endoscopic applications. Maintenance and Storage	6L
V	COMPUTER BASED INSTRUMENTS Computers in Biomedical Instrumentation, Types, Computer Interfacing, Computer Network	4L
	TOTAL	40

Text/ Reference Books:

Text Books:

1. R. S. Khandpur "Handbook of Bio-Medical Instrumentation", 3rd Edition, Tata McGraw Hill.
2. R. S. Khandpur "Handbook of Analytical Instruments", 3rd Edition, Tata McGraw Hill.
3. J.J.Carr & J.M.Brown, "Introduction to Biomedical Equipment Technology" Pearson Education, Asia.
4. Cromwell, Weibell & Pfeiffer, "Biomedical Instrumentation & Measurement", Prentice Hall, India

References:

1. Joseph Bronzino, "Biomedical Engineering and Instrumentation", PWS Engg . , Boston.
2. J.Webster, "Bioinstrumentation", Wiley & Sons.
3. Joseph D.Bronzino, "The Biomedical Engineering handbook", CRC Press

CO vs. PO Mapping

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
BME601.1	3	2	1	-	-	-	-	-	-	-	-	-
BME601.2	-	3	2	1	-	-	-	-	-	-	-	-
BME601.3	-	2	3	1	-	-	-	-	-	-	-	-
BME601.4	-	2	3	2	1	-	-	-	-	-	-	-

Subject Name: BIOPHYSICS & BIOCHEMISTRY

Subject Code: BME 602

Total Contact Hour/Week: 4

Credit: 4

Prerequisite: Fundamental Physics & Chemistry, Cell Biology.

Course objectives:

- To provide an in-depth knowledge of the core principles, biochemical & biophysical processes and their experimental basis.
- To enable students to acquire a concept and understanding of the theoretical and technical basis for biophysical & biochemical definition and determination of macromolecular structure.
- This course focuses on the phenomena related to the interaction and communication between living cells and their molecular constituents, drawing on advanced methods used within the fields of molecular, cellular and clinical biochemistry and biophysics.

Course outcome:

- **BME602.1** Acquire, articulate and retain broad and in-depth knowledge and understanding of the ways by which life functions are explained in terms of the principles of chemistry and physics and fundamental processes of Biochemistry and Biophysics.
- **BME602.2** Identify and analyze complex problems related to Formation of Structures in Biological Systems, Structural-Functional Relationships of Nucleic Acid and proteins, Biophysical activity, Radioactivity to arrive at suitable conclusions using first principles of Biophysics and Biochemistry.
- **BME602.3** Design, develop and conduct investigations to evaluate and interpret results to solve problems related to Cellular Biochemistry, Biophysical and Biochemical activity.
- **BME602.4** Apply appropriate techniques, resources, modern engineering tools including prediction and modeling to complex biophysical, biochemical and biomolecular activities with an understanding of the limitations to demonstrate concepts in Clinical Science.
- **BME602.5** Become familiar with the complexity of issues in the biochemistry, biophysics, and molecular biology domain, including scientific and moral ethics, cultural diversity and environmental concerns and in turn develops an awareness of ethical responsibilities while conducting and reporting investigations.

Course Content

Module	Topic	No. of Lectures
1	Biological Principles: Composition and properties of cell membrane, membrane transport, body fluid, electrolytes, filtration, diffusion, osmosis, electrophoresis, plasmapheresis, radioimmunoassay, Photochemical reaction, laws of photochemistry, fluorescence, phosphorescence.	5
2	Bioelectricity: Membrane potential, Action potential, Electrical properties of membrane, capacitance, resistance, conductance, dielectric properties of membrane.	4
3	Electrical stimulus and biophysical activity: Patient safety, electrical shock and hazards, leakage current, Electrical activity of heart (ECG), Electrical activity of brain(EEG), Electroretinogram (ERG), Electro-oculogram (EOG), Electromyogram(EMG).	5
4	Radioactivity: Ionizing radiation, U-V & IR radiations, Production of radioisotopes, Radioactive decay, Half life period.	4
5	Macromolecules: Classification & functions of carbohydrates, glycolysis, TCA cycle, ATP synthesis. Classification & functions of proteins, architecture of protein, Classification of amino acid, oxidative and non oxidative deamination, transamination. Classification & functions of lipids, biosynthesis of long chain fatty acid, oxidation and degradation of fatty acid.	8
6	Enzymes and Nucleic acid: Chemical nature & broad classification of enzymes, M-M kinetics, Isozymes and Allosteric enzymes. Structure of DNA, DNA Replication, Transcription, Translation.	8
	TOTAL	34

Text/ Reference Books:

Reference Books:

1. Radiation Biophysics, Second Edition - by Edward L. Alpen - Academic Press; 2 edition
2. Bio-Physics – Roland Glaser- Springer; 2nd printing edition (November 23, 2004)
3. Text book of Medical Physiology- Guyton
4. The Biomedical Engineering Hand Book- 3rd Ed- (Biomedical Engineering Fundamentals) - Joseph D. Bronzino – CRC –Taylor-Francis – 2006 (Section- III – Bio-Electrical Phenomena)
5. Lehninger Principles of Biochemistry, Fourth Edition - by David L. Nelson & Michael M. Cox, - W. H. Freeman; 4 edition (April 23, 2004)
6. Fundamentals of Biochemistry: Life at the Molecular Level - by Donald J. Voet, Judith G. Voet & Charlotte W. Pratt. - Wiley; 2 edition (March 31, 2005)

CO – PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12
BME602.1	3	3	-	-	-	-	-	-	-	-	-	-
BME602.2	3	3	-	1	-	-	-	-	-	-	-	-
BME602.3	3	2	3	3	-	-	-	-	-	-	-	-
BME602.4	3	2	-	2	3	-	-	-	-	-	-	-
BME602.5	2	-	-	-	-	2	2	3	-	-	-	1

Subject Name: MODELING OF PHYSIOLOGICAL SYSTEM

Subject Code: BME 603

Total Contact Hour: 36

Credit: 3

Prerequisite: Human anatomy and physiology, Control system & analysis, Physics, Higher Engineering Mathematics

Course Objective: The purpose of this course is to acquaint each student with the knowledge of modelling a physiological system and enable them to and thereby enable them to understand its interactions with various other system, and dependency on various conditions affecting its stability & behaviour.

Course Outcomes:

After Completion of the course, students will be able to

BME603.1: Understand the requirements for the development of mathematical and computational models in the analysis of physiological process/ biological systems

BME603.2: Select and apply appropriate analytical and numerical tools to solve ordinary differential equation models of biological problems.

BME603.3: Understand, predict and interpret the biological significance of linear and nonlinear control systems.

BME603.4: Integrate electrical, electrochemical, physiological and mechanical phenomena into the design of models to assess their inter-dependencies.

BME603.5: Break down a complex physiological system into the function of its component subsystems, and then build an engineering model based on subsystems.

Course Content:

Module	Topic	No. of Lectures
Module1	Basic Concepts of Physiological System: Introduction to physiological system and mathematical modelling of physiological system The technique of mathematical modeling, classification of models-black box & building block, characteristics of models. Purpose of physiological modeling and signal analysis, linearization of nonlinear models. Engineering system and physiological system, System variables & properties- Resistance, Compliance & their analogy. Time invariant and time varying systems for physiological modeling.	8
Module2	Equivalent circuit model: Electromotive, resistive and capacitive properties of cell membrane, change in membrane potential with distance, voltage clamp experiment and Hodgkin and Huxley's model of action potential, the voltage dependent membrane constant and simulation of the model, model for strength-duration curve, model of the whole neuron.	8

Module3	Linear Model: Respiratory mechanics & muscle mechanics, Huxley model of isotonic muscle contraction, modeling of EMG, motor unit firing: amplitude measurement, motor unit & frequency analysis.	4
Module4	Modelling of Blood flow and Urine formation: Electrical analog of blood vessels, model of systematic blood flow, model of coronary circulation, transfer of solutes between physiological compartments by fluid flow, counter current model of urine formation, model of Henle's loop	5
Module 5	Linearized model of the immune response: Germ, Plasma cell, Antibody, system equation and stability criteria.	3
Module 6	Cardio-Pulmonary Modelling: Cardiovascular system and pulmonary mechanics modelling and simulation, Model of Cardiovascular Variability, Model of Circadian Rhythms	4
Module 7	Eye Movement Model: Types of Eye movement, Eye movement system and Wetheimer's saccade eye model. Robinson's Model, Oculomotor muscle model, Linear Reciprocal Innervations Oculomotor Model.	4
	TOTAL	36

Text books:

1. Enderle, Blanchard & Bronzino, Introduction to Biomedical Engg. , Academic press.
2. Suresh.R.Devasahayam, Signals & Systems in Biomedical Engineering, Kluwer Academic/ Plenum Publishers.
3. V.Z. Marmarelis, Advanced methods of physiological modeling, Plenum Press.
4. J. Candy, Signal Processing: The Model Based approach, Mc. Graw Hill.
5. L.Stark, Neurological Control System, Plenum Press.
6. R.B. Stein, Nerve and Muscle, Plenum Press.

Reference Books:

1. Michel C Khoo, Physiological Control Systems -Analysis, simulation and estimation, Prentice Hall of India, 2001.
2. Joseph D, Bronzino, "The Biomedical Engineering Handbook", CRC Press, 3rd edition, 2006.
3. Christof Koch, "Biophysics of Computation", Oxford University Press, 28-Oct-2004.
4. Modeling and Simulation in Medicine and the Life Sciences (2nd Edition), by F.C. Hoppensteadt and C.S.Peskin, Springer (2002) ISBN: 0-387-95072-9.
5. John D. Enderle, "Model of Horizontal eye movements: Early models of saccades and smooth pursuit", Morgan & Claypool Publishers, 2010.

CO – PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BME603.1	3	3	2	2	-	-	-	-	-	-	-	-
BME603.2	3	2	2	2	-	-	-	-	-	-	-	-
BME603.3	3	2	2	3	-	-	-	-	-	-	-	-
BME603.4	3	2	3	2	2	-	-	-	-	-	-	-
BME603.5	3	2	3	2	2	-	-	-	-	-	1	-

Subject Name: ADVANCED IMAGING SYSTEMS

Subject Code: BME 604
Total Contact Hour: 40
Credit: 4

Pre-requisite: Knowledge of basic medical imaging techniques

Course objectives:

1. To extend your knowledge of the technical basis for advanced medical imaging systems and develop the skills to critically evaluate the performance and outputs of such systems.
2. To develop a comprehensive understanding of the functionality of advanced medical imaging systems including time-resolved, hybrid and treatment-room-integrated.

Course outcome:

BME 604.1 Advanced and integrated understanding of the applications of physical processes to the diagnosis and treatment of disease, including an understanding of contemporary developments in professional practice.

BME 604.2 Advanced understanding of the origins of radiation and its interactions with matter pertaining to the production and use of ionizing radiation, with particular regard to the protection of people and environments.

BME 604.3 Develop an understanding of the different modalities in Radiology and recognize the images of each modality.

BME 604.4 Describe the differences between the modalities, the method of imaging and safety precautions

Course Content

Module	Topic	No. of Lectures
I	PET and SPECT Imaging Introduction to emission tomography, basic physics of radioisotope imaging Compton cameras for nuclear imaging, Radio nuclides for imaging, nuclear decay and energy emissions, brief of radionuclide production, radiation detectors, pulse height analyzer, uptake monitoring equipments, Rectilinear scanners, Gamma Camera principles, Basic principles of PET , SPECT, Scintigraphy, Dual isotope imaging.	10
II	Magnetic Resonance Imaging (MRI) Principles of nuclear magnetism, RF magnetic field and resonance, magnetic resonance (MR) signal, nuclear spin relaxations, gradient pulse, slice selection, phase encoding, frequency encoding, spin echoes, gradient echoes, K-space data acquisition and image reconstruction. MRI scanner hardware: magnet, gradient coil, RF pulse transmission and RF signal reception. Diagnostic utility and clinical MRI, functional MRI, magnetic resonance angiography (MRA), magnetic resonance spectroscopy (MRS), diffusion MRI, bio-effects and safety levels.	14
III	Other Imaging Techniques Infrared (IR) imaging, infrared photography Thermography - Clinical applications of thermography, thermographic scanning systems, liquid crystal thermography, microwave thermography. Optical coherence tomography (OCT): Introduction and its medical applications, Fluoroscopy, Angiography.	10
IV	Computer requirements of imaging systems: Computer systems: operating systems, monitors-Generation & transfer of images: file formats, Picture archiving and communication systems, internet & intranet, teleradiology, medical image processing system-basic introduction.	6
	TOTAL	40

Text Books:

1. Carr & Brown, "Introduction to Biomedical Equipment Technology" Pearson Education, Asia.
2. R. S. Khandpur, "Handbook of Bio-Medical Instrumentation", Tata McGraw Hill.
3. J. Webster, "Bioinstrumentation", Wiley & Sons

References:

1. Dowsett, Kenny & Johnston, "The Physics of Diagnostic Imaging", Chapman & Hall Medical, Madras/London.
2. Brown, Smallwood, Barber, Lawford & Hose, "Medical Physics and Biomedical Engineering", Institute of Physics Publishing, Bristol.
3. Massey & Meredith, "Fundamental Physics of Radiology", John Wright & Sons.
4. S. Webb, "The Physics of Medical Imaging", Adam Hilger, Bristol.

CO – PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BME604.1	3	2	-	-	2	1	-	-	-	-	-	-
BME604.2	2	2	1	-	1	3	-	2	-	-	-	-
BME604.3	3	2	3	-	-	-	-	-	-	-	-	-
BME604.4	3	2	-	-	1	1	-	-	-	-	-	-

Subject Name: COMMUNICATION SYSTEMS & BIOTELEMETRY

Subject Code: BME 605A

Total Contact Hour: 36

Credit: 3

Prerequisite: Mathematics, Signal Theory.

Course objectives: This curriculum is designed for enabling the students to assimilate the principles of electronic communication. Theory of traditional communication systems, digital communication, wireless communication, information theory, Source coding, error correction strategies and their working methodology would be stressed.

Course outcome:

On course completion, the students would be able to,

BME605A.1. Define the methods of modulating signal,

BME605A.2. Recognize amplitude and phase/frequency of the electromagnetic wave,

BME605A.3. Illustrate transmission and receptions of binary streams and voice signals,

BME605A.4. Inspect constraints of designing communication systems namely noise, power.

BME605A.5. Integrate the idea of information as measurable quantity.

BME605A.6. Compare methods of probabilistic source coding and error correction techniques are ingrained quantitatively.

Course Content:

Module	Topic	No. of Lectures
1	ANALOG COMMUNICATION: Introduction to Communication Systems: Modulation –Types - Need for Modulation. Theory of Amplitude Modulation - Evolution and Description of SSB, SSBSC & VSB Techniques – Basic concepts of Frequency and Phase Modulation, inter-relation in between various analog modulation techniques. Noise: Basic concept of Noise, types of noise.	8
2	DIGITAL COMMUNICATION: Basic concepts of digital modulation, Amplitude	8

	Shift Keying (ASK) – Frequency Shift Keying (FSK) Minimum Shift Keying (MSK) – Phase Shift Keying (PSK) – BPSK – QPSK – 8 PSK – 16 PSK - Quadrature Amplitude Modulation(QAM) – 8 QAM – 16 QAM – Comparison of various Digital Communication System (ASK– FSK – PSK – QAM).	
3	DATA AND PULSE COMMUNICATION: Data Communication: History of Data Communication - Standards Organizations for Data Communication- Data Communication Circuits - Data Communication Codes – Error Detection and Correction Techniques - Data communication Hardware - serial and parallel interfaces. Pulse Communication: Pulse Amplitude Modulation (PAM) – Pulse Time Modulation (PTM) – Pulse code Modulation (PCM) - Comparison of various Pulse Communication System (PAM – PTM – PCM)	7
4	SOURCE AND ERROR CONTROL CODING: Entropy, Average mutual information, Source encoding theorem, Shannon fano coding, Huffman coding, channel capacity, channel coding theorem, Error Control Coding, linear block codes, cyclic codes, convolution codes, viterbi decoding algorithm	7
5	MULTI-USER RADIO COMMUNICATION: Advanced Mobile Phone System (AMPS) - Global System for Mobile Communications (GSM) – Code division multiple access (CDMA) – Cellular Concept and Frequency Reuse - Channel Assignment and Hand off - Overview of Multiple Access Schemes - Satellite Communication - Bluetooth.	6
TOTAL		36

Text Book:

1. B. P.Lathi, “Modern Analog and Digital Communication Systems”, 3rd Edition, Oxford University Press.

Reference Books:

1. Simon Haykin, “Communication Systems”, 4th Edition, John Wiley & Sons.
2. H.Taub, D L Schilling and G Saha, “Principles of Communication”, 3rd Edition, Pearson Education.
3. Rappaport T.S, "Wireless Communications: Principles and Practice", 2nd Edition, Pearson Education.
4. Wayne Tomasi, “Advanced Electronic Communication Systems”, 6th Edition, Pearson Education.
5. Blake, “Electronic Communication Systems”, Thomson Delmar Publications.
6. Martin S.Roden, “Analog and Digital Communication System”, 3rd Edition, Prentice Hall of India.
7. B.Sklar, “Digital Communication Fundamentals and Applications” 2 nd Edition Pearson Education.

CO – PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BME605A.1	3	1	1	-	-	-	-	-	-	-	-	2
BME605A.2	2	1	-	-	2	-	1	-	-		-	-
BME605A.3	-	3	2	1		3	-	-	-	3	-	1
BME605A.4	2	-	-	3	3	-	2	-	-	-	1	1
BME605A.5	-	1	3	1	3	-	-	-	-	2	-	2
BME605A.6	3	2	1	-		3	2	-	-	1	-	1

Subject Name: DRUG DELIVERY SYSTEM

Subject Code: BME 605B
Total Contact Hour/Week: 36
Credit: 3

Prerequisites: Knowledge of Organic& Inorganic Chemistry, Biophysics, Biochemistry.

Course Objectives:

- This course is based on the scientific background and technical aspects important for drug design, basic dosage forms and their therapeutic applications.
- It focuses on the biopharmaceutical considerations and physicochemical foundation of various dosage forms.

Course Outcomes:

Upon completion of the course, students will be able to

BME- 605B.1: Understand the various approaches for development of novel drug delivery systems.

BME- 605B.2: Select the criteria of drug and polymers for the development of drug delivering system.

BME- 605B.3: Formulate and evaluate the novel drug delivery systems.

Course Content:

Module	Topic	No. of Lectures
I	Sustained Release(SR) and Controlled Release (CR) formulations: Introduction & basic concepts, advantages/disadvantages, factors influencing, Physicochemical & biological approaches for SR/CR formulation, Mechanism of Drug Delivery from SR/CR formulation. Polymers: introduction, definition, classification, properties and application Dosage Forms for Personalized Medicine: Introduction, Definition, Pharmacogenetics, Categories of Patients for Personalized Medicines: Customized drug delivery systems, Bioelectronic Medicines, 3D printing of pharmaceuticals, Telepharmacy.	10
II	Rate Controlled Drug Delivery Systems: Principles & Fundamentals, Types, Activation; Modulated Drug Delivery Systems; Mechanically activated, pH activated, Enzyme activated, and Osmotic activated Drug Delivery Systems, Feedback regulated Drug Delivery Systems; Principles & Fundamentals.	6
III	Gastro-Retentive and Drug Delivery Systems: Principle, concepts advantages and disadvantages, Modulation of GI transit time approaches to extend GI transit. Buccal Drug Delivery Systems: Principle of mucoadhesion, advantages and disadvantages, Mechanism of drug permeation, Methods of formulation and its evaluations.	8
IV	Transdermal Drug Delivery Systems: Structure of skin and barriers, Penetration enhancers, Transdermal Drug Delivery Systems, Formulation and evaluation.	4
V	Protein and Peptide Delivery: Barriers for protein delivery. Formulation and Evaluation of delivery systems of proteins and other macromolecules.	4
VI	Vaccine delivery systems: Vaccines, uptake of antigens, single shot vaccines, mucosal and transdermal delivery of vaccines.	4
	TOTAL	36

Text/ Reference Books:

1. Y W. Chien, Novel Drug Delivery Systems, 2nd edition, revised and expanded, Marcel Dekker, Inc., New York, 1992.
2. Robinson, J. R., Lee V. H. L, Controlled Drug Delivery Systems, Marcel Dekker, Inc., New York, 1992.
3. Encyclopedia of controlled delivery, Editor- Edith Mathiowitz, Published by Wiley Interscience Publication, John Wiley and Sons, Inc, New York, Chichester/Weinheim
4. N.K. Jain, Controlled and Novel Drug Delivery, CBS Publishers & Distributors, New Delhi, First edition 1997 (reprint in 2001).
5. S.P.Vyas and R.K.Khar, Controlled Drug Delivery-concepts and advances, Vallabh Prakashan, New Delhi, First edition 2002

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BME605B.1	3	3	3	2	-	2	1	2	-	-	-	2
BME605B.2	2	2	3	-	-	2	1	-	-	-	-	2
BME605B.3	2	3	3	3	-	-	-	2	-	-	-	1

Subject Name: BIOINFORMATICS

Subject Code: BME 605C

Total Contact Hour/Week: 3L

Credit: 3

Prerequisite: Concept of Biological Science, Mathematics, Statistics, Organic Chemistry, Computational theory, Analysis and Algorithm Design.

Course objectives:

At the end of this course, the students would

- establish a successful career utilizing their education in bioinformatics or engage in advanced studies.
- Learnt about tools used in Bioinformatics & how to use them.
- Engage in lifelong learning to stay current with their profession as it changes.
- Demonstrate professional competence, integrity and responsibility in diverse work environments.

Course outcome:

By completion of the course student outcomes should include the following:

BME 605C.1: An ability to demonstrate the basic structure and functionalities of Cell Organelles.

BME 605C.2: Master computational techniques and diversified bioinformatics tools for processing data.

BME 605C.3: Ability to carry out bioinformatics research under advisement, including systems biology, structural bioinformatics and proteomics.

BME 605C.4: The broad education necessary to understand the impact of bioinformatics in a global, economic, environmental, and societal context.

Course Content

Module	Topic	No. of Lectures
MODULE 1: INTRODUCTION TO CELLULAR BIOLOGY	Concepts of Cell, types of cell, components of cell, organelle. Functions of different organelles.	3L
MODULE 2: THE	Concepts of DNA: Basic Structure of DNA; Double Helix structure;	9L

CENTRAL DOGMA	Watson and crick model. Exons and Introns and Gene Concept. Concepts of RNA: Basic structure, Difference between RNA and DNA. Types of RNA. Concept of Protein: Basic components and structure. Introduction to Central Dogma: Transcription and Translation Introduction to Metabolic Pathways.	
MODULE 3: BIOINFORMATICS DATABASES	Introduction to Bioinformatics. Recent challenges in Bioinformatics. Data Warehouse, Data models, Database Management Concepts. Different Bioinformatics database types. Protein Sequence Databases: PDB, SWISS-PROT database. DNA sequence databases: DDBJ, GenBank.	3L
MODULE 4: BIOINFORMATICS SEARCH ENGINES	Sequence database search programs like BLAST and FASTA. NCBI different modules: GenBank; OMIM, Taxonomy browser, PubMed.	3L
MODULE 5: DNA SEQUENCE ANALYSIS AND DATA VISUALIZATION	DNA Mapping and Assembly: Size of Human DNA, Copying DNA: Polymerase Chain Reaction (PCR), Hybridization and Microarrays, Cutting DNA into Fragments, Sequencing Short DNA Molecules, Mapping Long DNA Molecules. DeBruijn Graph. Sequence Alignment: Introduction, local and global alignment, pair wise and multiple alignments, Dynamic Programming Concept. Alignment algorithms: Needleman and Wunsch algorithm, Smith-Waterman.	12L
MODULE 6: INTRODUCTION PROBABILISTIC MODELS USED IN COMPUTATIONAL BIOLOGY	Probabilistic Models; Hidden Markov Model: Concepts, Architecture, Transition matrix, estimation matrix. Application of HMM in Bioinformatics: Gene finding, profile searches, multiple sequence alignment and regulatory site identification. Bayesian networks Model: Architecture, Principle, Application in Bioinformatics.	9L
MODULE 7: BIOLOGICAL DATA CLASSIFICATION AND CLUSTERING	Assigning protein function and predicting splice sites: Decision Tree	6L
	TOTAL	45

Text/ Reference Books:

Suggested Text / Reference Books:

1. Bioinformatics and Molecular Evolution Paul G. Higgs and Teresa K. Attwood
2. Bioinformatics Computing By Bryan Bergeron
3. BIOINFORMATICS AND FUNCTIONAL GENOMICS Jonathan Pevsner
4. GENE CLONING AND DNA ANALYSIS T.A. BROWN

CO – PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BME 605C.1	-	-	3	-	-	-	-	-	-	-	-	-
BME 605C.2	-	-	-	-	3	-	-	-	-	-	-	-
BME 605C.3	-	2	-	3	-	-	-	-	-	-	-	-
BME 605C.4	-	-	-	-	-	2	3	-	-	-	-	-

Subject Name: Microprocessors & Microcontrollers

Subject Code: EI(BME)606A
Total Contact Hour/Week: 3L
Credit: 3

Prerequisite: Knowledge in Digital Electronics

Course objectives: To develop an in-depth understanding of the operation of microprocessors and microcontrollers, machine language programming & interfacing techniques.

Course outcome:

EI(BME)606A.1. Able to correlate the architecture, instructions, timing diagrams, addressing modes, memory interfacing, interrupts, data communication of 8085

EI(BME)606A.2. Able to interpret the 8086 microprocessor-Architecture, Pin details, memory segmentation, addressing modes, basic instructions, interrupts

EI(BME)606A.3. Recognize 8051 micro controller hardware, input/output pins, ports, external memory, counters and timers, instruction set, addressing modes, serial data i/o, interrupts

EI(BME)606A.4 Apply instructions for assembly language programs of 8085, 8086 and 8051

EI(BME)606A.5 Design peripheral interfacing model using IC 8255, 8253, 8251 with IC 8085, 8086 and 8051.

Course Content:

Module	Topic	No. of Lectures
1	Introduction to Microcomputer based system. History of evolution of Microprocessor and Microcontrollers and their advantages and disadvantages, Architecture of 8085 Microprocessor. Address/data bus De multiplexing, status Signals and the control signal generation. Instruction set of 8085 microprocessor, Classification of instruction, addressing modes, timing diagram of the instructions (a few examples).	10
2	Assembly language programming with examples, Interrupts of 8085 processor, programming using interrupts, Stack and Stack Handling, Call and subroutine, DMA, Memory interfacing with 8085	3
3	8086 Microprocessor: 8086 Architecture, Pin details, memory segmentation, addressing modes, Familiarization of basic Instructions, Interrupts, Memory interfacing, ADC / DAC interfacing. Assembly language programming with 8086: Addition, Subtraction, Multiplication, Block Transfer, Ascending order, Descending order, Finding largest & smallest number etc	7
4	8051 Microcontroller: 8051 architecture, hardware, input/output pins, ports, external memory, counters and timers, instruction set, addressing modes, serial data i/o, interrupts, Memory interfacing, ADC / DAC interfacing.	4
5	Assembly language Programming using 8051: Moving data: External data moves, code memory read only data moves, PUSH and POP opcodes, data exchanges; Logical operations: Byte-level, bit-level, rotate and swap operations; Arithmetic operations: Flags, incrementing and decrementing, addition, subtraction, multiplication and division, decimal arithmetic; Jump and call instructions: Jump and call program range, jumps, calls and subroutines, interrupts and returns	4
6	Support IC chips: 8255, 8253 and 8251: Block Diagram, Pin Details, Modes of operation, control word(s) format. Interfacing of support IC chips with 8085, 8086 and 8051	5
7	Brief introduction to PIC microcontroller (16F877): Architecture, PIN details, memory layout.	2

Text Books:

1. Microprocessor architecture, programming and application with 8085 – R. Gaonkar, Penram International
2. The 8051 microcontroller - K. Ayala ,Thomson
3. Microprocessors & interfacing – D. V. Hall,Tata McGraw-hill
4. Ray & Bhurchandi, Advanced Microprocessors & Peripherals, TMH
5. The 8051 microcontroller and Embedded systems - Mazidi, Mazidi and McKinley, Pearson
6. An Introduction to Microprocessor and Applications –Krishna Kant,Macmillan

References:

1. Microprocessors and microcontrollers - N. Senthil Kumar, M. Saravanan and Jeevananthan,Oxford university press
2. 8086 Microprocessor –K Ayala, Cengage learning
3. The 8051 microcontrollers – Uma Rao and Andhe Pallavi ,Pearson

CO – PO Mapping:

CO	PO 1	PO 2	PO 3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO12
EI(BME)606A.1	3	3	2	2	-	2	-	-	-	-	2	3
EI(BME)606A.2	3	3	2	2	-	2	-	-	-	-	2	3
EI(BME)606A.3	3	3	3	3	-	2	-	-	-	-	2	3
EI(BME)606A.4	3	3	3	3	2	2	-	-	-	-	2	3
EI(BME)606A.5	3	3	3	3	2	2	-	-	-	-	2	3

Subject Name: VLSI & Embedded System

Subject Code: EC(BME) 606B

Total Contact Hour/Week: 3L

Credit: 3

Prerequisite: Basic Electronic circuits knowledge with BJT, FET, and MOSFET. Digital Electronics with logic gate based design and sequential and combinational circuit knowledge.

Course objectives:

Students will be able to apply the theoretical VLSI circuits and embedded systems fundamentals knowledge for designing circuits in the domain of biomedical chip (or subsystem design) or general VLSI chip design. Getting a strong foundation on the theoretical knowledge on VLSI as well as embedded systems will help them to get into the field of VLSI chip design in biomedical engineering field, which in turn help society to have biomedical chips for simplifying /helping everyday life either in form of advanced health care system design or in the form of biomedical computing systems or in medical image processing chip design.

Course outcome:

EC(BME) 606B.1 Describe MOS transistor structure and operation and write current voltage equations for nMOS & pMOS.

EC(BME) 606B.2 Explain the operation of CMOS combinational and sequential circuits.

EC(BME) 606B.3 Solve the problem of static and dynamic circuit design with CMOS.

EC(BME) 606B.4 Describe the operation of low power circuits

EC(BME) 606B.5 Generate different subsystems using MOS circuits.

EC(BME) 606B.6 Understand the fundamentals of the embedded systems.

EC(BME) 606B.7 State programming concepts paradigms of for embedded systems

EC(BME) 606B.8 Describe the Basic OS fundamentals and the RTOS

Course Content

Module	Topic	No. of Lectures
1	Introduction to MOSFETs: MOS-transistor structure, operation, characteristics. VLSI design flow and design hierarchy. Brief overview of circuit design techniques (Hierarchical design, Design abstraction, computer aided design).	2L
2	CMOS combinational and sequential circuits: basic gates, adder, CMOS transmission gates with examples, SR Latch, JK Latch, D latch, Edge triggered Flipflops.	5L
3	Dynamic Logic Circuits: Dynamic logic circuits basics, Pre-charge and evaluate logic, cascading problem, Domino Logic.	4L
4	Low power CMOS logic circuits: switching, short circuit & leakage power dissipation, variable threshold CMOS circuits, Multiple threshold CMOS circuits, pipelining and parallel processing approach, Switching activity estimation and optimization, Adiabatic logic circuits.	6L
5	Subsystem design: Single bit Adder, serial-parallel multiplier, RAM, ROM, SRAM, DRAM	4L
6	Introduction to Embedded systems: Embedded Systems –Definition, Difference between Embedded system and General Computing Systems, Importance of Embedded Systems , Hardware architecture of the real time systems, Different hardware units & processor overview for embedded systems.	4L
7	Programming Concepts for Embedded systems: High level languages, Macros, functions, data types, data structures, modifiers, statements ,loops, pointers Queue, stack, Lists and ordered lists, compilers and cross compilers.	3L
8	Real Time Operating Systems : Operating system basics, Tasks, Process and Threads, Multiprocessing and multitasking, task communication, task synchronization, Multiple tasks scheduling in real time systems by RTOS	8L
	TOTAL	36L

Text books:

1. Neil H.E Weste, Kim Haase, David Harris, A.Banerjee, —CMOS VLSI Design: A circuits & Systems Perspective, Pearson Education
2. Wayne Wolf, Modern VLSI Design – System-on-chip Design, Prentice Hall India/Pearson Education
3. Sung-Mo Kang & Yusuf Lablebici, —CMOS Digital Integrated Circuits, Analysis & Design, Tata McGraw-Hill Edition
4. Introduction to Embedded System: Shibu K. V. (TMH)
5. Embedded System Design – A unified hardware and software introduction: F. Vahid (John Wiley)
6. Embedded Systems: Rajkamal (TMH)

References:

1. David Hodges, Horace G Jackson & Resve A Saleh-Analysis & Design of Digital Integrated Circuits, Tata Mc Graw-Hill
2. Ken Martin, Digital Integrated Circuits, Oxford University Press
3. Embedded Systems : L. B. Das (Pearson)
4. Embedded System design: S. Heath (Elsevier)
5. Embedded microcontroller and processor design: G. Osborn (Pearson)

CO – PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EC(BME)606B.1	3	1	1	1	1	-	-	-	-	-	-	3
EC(BME)606B.2	3	1	1	1	3	-	-	-	-	-	-	3
EC(BME)606B.3	3	1	2	2	1	-	-	-	-	-	-	3
EC(BME)606B.4	3	1	3	1	3	-	-	-	-	-	-	3
EC(BME)606B.5	2	1	3	3	3	-	-	-	-	-	-	3
EC(BME)606B.6	3	1	1	1	1	-	-	-	-	-	-	3
EC(BME)606B.7	3	2	1	1	1	-	-	-	-	-	-	3
EC(BME)606B.8	3	2	1	1	1	-	-	-	-	-	-	3

Subject Name: SOFT COMPUTING

Subject Code: IT(BME)606C

Total Contact Hour/Week: 3

Credit: 3

Prerequisite: Knowledge of basic computing, and applied mathematics.

Course objectives:

1. To impart knowledge on origin and basics of soft computing and Neural Networks.
2. To impart knowledge on genetic algorithms and their applications.
3. To impart knowledge on various types of neural networks, learning methods and their applications
4. To impart knowledge on fuzzy logic and different stages in fuzzy systems

Course outcome: On completion of this course the students will able:

IT(BME)606C.1: To provide a strong foundation of fundamental concepts in Soft Computing.

IT(BME)606C.2: To provide a basic exposition to the goals and methods of Soft Computing.

IT(BME)606C.3: To enable the student to apply these techniques in applications which involve fuzzy-perception, reasoning and learning.

IT(BME)606C.4: To enable the student to apply these techniques in applications which involve Neuro-Fuzzy modeling and optimization.

Course Content

Module	Topic	No. of Lectures
1	INTRODUCTION TO SOFT COMPUTING AND NEURAL NETWORKS Evolution of Computing - Soft Computing Constituents – From Conventional AI to Computational Intelligence - Machine Learning Basics	4L
2	GENETIC ALGORITHMS Introduction to Genetic Algorithms (GA) – Applications of GA in Machine Learning – Machine Learning Approach to Knowledge Acquisition.	4L
3	NEURAL NETWORKS Machine Learning Using Neural Network, Adaptive Networks – Feed forward Networks – Supervised Learning Neural Networks – Radial Basis Function Networks - Reinforcement Learning – Unsupervised Learning Neural Networks – Adaptive Resonance architectures – Advances in Neural networks	11L
4	FUZZY LOGIC	11L

	Fuzzy Sets – Operations on Fuzzy Sets – Fuzzy Relations – Membership Functions- Fuzzy Rules and Fuzzy Reasoning – Fuzzy Inference Systems – Fuzzy Expert Systems – Fuzzy Decision Making	
5	NEURO-FUZZY MODELING Adaptive Neuro-Fuzzy Inference Systems – Coactive Neuro-Fuzzy Modeling – Classification and Regression Trees – Data Clustering Algorithms – Rulebase Structure Identification – Neuro-Fuzzy Control – Case studies	5L
6	HYBRID SYSTEMS Hybrid systems, GA based BPNN (Weight determination, Application); Neuro Fuzzy Systems—Fuzzy BPNN--fuzzy Neuron, architecture, learning, application; Fuzzy Logic controlled GA	5L
	TOTAL	40L

Text/ Reference Books:

1. Jyh-Shing Roger Jang, Chuen-Tsai Sun, Eiji Mizutani, “Neuro-Fuzzy and Soft Computing”, Prentice-Hall of India
2. A beginners approach to Soft Computing, Samir Roy & Udit Chakraborty, Pearson
3. George J. Klir and Bo Yuan, “Fuzzy Sets and Fuzzy Logic-Theory and Applications”, Prentice Hall
4. David E. Goldberg, “Genetic Algorithms in Search, Optimization and Machine Learning”, Addison Wesley

CO – PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO1 1	PO 12
IT(BME)606C.1	3	3	2	1	2	-	-	-	2	-	1	1
IT(BME)606C.2	3	-	3	2	-	-	-	-	2	-	-	1
IT(BME)606C.3	2	3	2	1	2	-	-	-	1	-	-	2
IT(BME)606C.4	3	3	3	2	1	-	-	-	1	-	-	2

PRACTICAL PAPER

Subject Name: BIOMEDICAL EQUIPMENT LABORATORY

Subject Code: BME 691

Total Contact hours/Week: 3

Credit: 2

Prerequisite: Knowledge in Basic Electronics & Biomedical Instrumentation

Course Objective:

1. To introduce students with operation & purpose of different analytical & diagnostic instrument.
3. To emphasis on the maintenance of various biomedical instruments.

Course Outcomes:

After completion of this course the students will be able to:

BME691.1. Understand the fundamental principles and utilization of different biomedical analytical devices and measurement of different sample concentration using those devices.

BME691.2. Acquire the knowledge and skills to recognize different biomedical diagnostic devices with their design, basic functions and application.

BME691.3. Analyze the working principle of different therapeutic devices and how they are applied to give physiotherapy to the patients.

BME691.4. Apply knowledge of engineering and science to understand the principle of biomedical electronic devices and understand how to apply, measure circuit performance, and solve problems in the areas of biomedical signals

Course Content

List of experiments:

1. Lead selection circuits
2. Study on pulse rate meter
3. Study on colorimeter/spectrophotometer
4. Study on electronic BP and calibration procedure
5. Pacemaker Circuits / Pacemaker simulator
6. Study on pulmonary function analyzer - spirometer
7. Study on respiratory rate meter & apnea detection
8. Study on diathermy unit (ultrasound & short-wave)
9. Study of ultrasonic devices - transmitter and detector
10. Study on blood flow velocity measurement - ultrasonic method

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BME691.1	2	3	-	-	1	-	-	-	-	-	-	-
BME691.2	-	3	2	2	1	-	-	-	-	-	-	-
BME691.3	-	3	-	2	1	-	-	-	-	-	-	-
BME691.4	-	3	2	2	1	-	-	-	-	-	-	-

Subject Name: COMMUNICATION SYSTEMS & BIOTELEMETRY LABORATORY

Subject Code: BME 695A

Total Contact hours/Week: 3

Credit: 2

Prerequisite: Mathematics, Signal Theory.

Course Objective: This curriculum is designed for enabling the students to assimilate the principles of electronic communication. Theory of traditional communication systems, digital communication, wireless communication, information theory, Source coding, error correction strategies and their working methodology would be stressed.

Course Outcomes: On course completion, the students would be able to,

1. practice the practical methods of the use of generating communication signals.
2. understand the concept of analog and digital communication techniques and their applications.
3. design various circuits which needs transmitting & receiving section.
4. measure various parameters of any signal.
5. choose among modulation techniques based on need.

Course Content**List of experiments:**

1. Measurement of MI of an AM signal,
2. Study of SSB modulation and demodulation technique,
3. Study of DSB modulation and demodulation technique,
4. Measurement of bandwidth of a FM signal,
5. Study of phase locked loop(PLL),
6. Study of PAM modulation and demodulation technique,
7. Study of PCM coder and decoder,
8. Study of PSK modulation and demodulation technique,
9. Study of FSK modulation and demodulation technique,
10. Study of time division multiplexing (TDM) and demultiplexing.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BME695A.1	1	3	-	2	3	-	2	-	-	-	-	2
BME695A.2	3	1	-	1	-	1	3	-	1	-	-	1
BME695A.3	2	2	1	1		-	-	-	-	-	1	-
BME695A.4	3	3	-	-	-	1	-	-	-	-	-	-
BME695A.5	1	2	-	3	-	-	2	-	1	3	3	1

Subject Name: DRUG DELIVERY SYSTEM LABORATORY**Subject Code: BME 695B****Total Contact hours/Week: 3****Credit: 2****Prerequisites:** Knowledge of Organic& Inorganic Chemistry, Biophysics, Biochemistry.**Course Objective:**

This course will focus on

- the biopharmaceutical considerations and physicochemical foundation of various dosage forms.
- preformulation factors (melting point, solubility, viscosity, dissolution, particle and solid state properties), rheology, pharmaceutical solutions, colloids and dispersions, complexation, chelation, and protein binding.

Course Outcomes

After completion of this course students will be able to

BME- 695B.1: Describe the effects of different factors influencing the solubility and availability of drugs.**BME- 695B.2:** Formulate the different drug delivery systems.**BME- 695B.3:** Analyze the different types of drugs available in the market.**Course Content:**

List of Experiments

1. Effect of surfactants on the solubility of drugs.
2. Effect of pH on the solubility of drugs.
3. Study on diffusion of drugs through various polymeric membranes.
4. Evaluation of drug-protein binding analysis.
5. Formulation and evaluation of trans-dermal drug delivery system.
6. Preparation and evaluation of liposome delivery systems.
7. Comparison of dissolution of two different marketed drugs.
8. Study of drug release from commercial suspension and emulsion dosage forms.
9. In vitro cell studies for permeability and metabolism of drugs.
10. Formulation and evaluation of microspheres / microencapsules.

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BME- 695B.1	2	3	2	3	2	-	-	-	-	-	-	1
BME- 695B.2	2	3	3	3	-	2	-	2	-	1	-	1
BME- 695B.3	3	3	2	2	2	2	-	2	-	2	-	1

Subject Name: BIOINFORMATICS LABORATORY

Subject Code: BME695C

Total Contact Hour/Week: 3

Credit: 2

Prerequisite: Concept of Biological Science, Mathematics, Statistics, Organic Chemistry, Computational theory, Analysis and Algorithm Design.

Course objectives:

At the end of this course, the students would

- Establish a successful career utilizing their education in bioinformatics or engage in advanced studies.
- Learnt about tools used in Bioinformatics & how to use them.
- Engage in lifelong learning to stay current with their profession as it changes.
- Demonstrate professional competence, integrity and responsibility in diverse work environments.

Course outcome:

By completion of the course student outcomes should include the following:

BME695C.1. An ability to extract information from different types of bioinformatics data (gene, protein, disease, ecological, environmental etc.), including their biological characteristics and relationships.

BME695C.2. An ability to employ different data representation models and formats used for bioinformatics data representation.

BME695C.3. Master computational techniques and diversified bioinformatics tools for processing data.

BME695C.4. Ability to carry out bioinformatics research under advisement, including systems biology, structural bioinformatics and proteomics.

BME695C.5. An ability to design and develop bioinformatics solutions by adapting existing tools, designing new ones or a combination of both.

Course Content:

List of Experiments:-

1. Familiarity with biological databases a) NCBI b) UniProt c) PDB d) PubMed
2. To retrieve a gene / amino acid sequence from NCBI / UniProt for detection of functional regions , domains, motifs
3. To retrieve the structure of a protein from PDB to identify the pattern of secondary structural elements, presence of active site regions, domains, GO terms and biological functions
4. To choose the literature(s) from PubMed relating to the aforementioned DNA or protein
5. To perform pairwise sequence alignment of a chosen DNA or protein sequence to find the homologs.
6. To perform multiple sequence alignments between the aforementioned homologues
7. To draw phylogenetic trees using the homologues and to detect the branch lengths
8. To build the three dimensional structures of a protein from sequence
9. To perform protein-protein docking

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BME695C.1	-	-	-	3	2	-	-	-	-	1	-	-
BME695C.2	-	-	3	-	-	2	-	-	-	-	1	-
BME695C.3	-	-	-	-	3	-	-	2	-	-	-	1
BME695C.4	-	2	-	3	-	-	-	-	1	-	-	-
BME695C.5	-	-	3	2	-	-	1	-	-	-	-	-

Subject Name: Microprocessors & Microcontrollers Lab**Subject Code: EI(BME)696A****Total Contact Hour/Week: 3****Credit: 2****Prerequisite: Knowledge in Digital Electronics**

Course Objective: To apply ALP Programming for arithmetic-logical solutions and also to interpret the interfacing programming by conducting experiments.

Course Outcomes:

EI(BME)696A.1 Able to solve small assignments using the 8085 basic instruction sets and memory mapping through trainer kit and simulator.

EI(BME)696A.2 Able to write 8085 assembly language programs like Addition, Subtraction, Multiplication, Square, Complement, Look up table, Copying a block of memory, Shifting ,Packing and unpacking of BCD numbers, Ascending order, Descending order etc. using trainer kit.

EI(BME)696A.3 Able to validate the interfacing technique using 8255 trainer kit through subroutine calls and IN/OUT instructions like glowing LEDs accordingly, stepper motor rotation etc.

EI(BME)696A.4 Able to test fundamental of 8051 programs using the trainer kit.

Course Content:**List of Experiments:-**

1. Write a program in 8085 microprocessor to swap the content of two register B and C containing the values 08H and 06H respectively.
2. Write a program in 8085 microprocessor to add two number 09H and 08H and store the result in 9085H location
3. Write a program in 8085 microprocessor to subtract 05H from 09H and store the result in 8072H. Write a program in 8085 microprocessor to add five (5) numbers and store the result in memory location 9071H. The numbers are stored from 9061H to 9065H location. The numbers are stored in 5 consecutive memory locations given below.
4. Write a program in 8085 microprocessor to multiply 08H with 03H and store the result in 9065H location.
5. Write a program in 8085 microprocessor to divide 07H by 03H and store the quotient in 9075H and remainder in 9076H memory location.
6. Write a program in 8085 microprocessor to add six (6) numbers and store the result in memory location 9071H and 9061H. The numbers are stored from 9050H to 9055H location. The numbers are stored in 6 consecutive memory locations given below.
7. Write a program in 8085 microprocessor of shifting block of five (5) data from 9055H location to 9080H location.
8. Write a program in 8085 microprocessor to count ones (1) in 8 bit data. The 8 bit no. is store in memory location 9070H. Store the counting result in memory location 9080H and draw the flow chart.
9. Write a program in 8085 microprocessor to interchange the nibble of a 8 bit number stored in memory location 9006H and store the interchanged number into memory location 9060H.[for example 78H will be 87H]. 1 nibble= 4 bits
10. In 8086 microprocessor write a program to add two numbers 0465H and 2010H and store the result at different registers.
11. In 8086 microprocessor write a program to subtract two numbers 0006H from 0009H and store the result at different registers .
12. In 8086 microprocessor write a program to multiply between 24H and 45H and store the result at different registers
13. In 8086 microprocessor write a program to divide 0009H by 0002H and store the quotient and remainder at different registers.
14. Configure 8255 A such that port A and port B as output port. Display the value of 45H through port A and 56H through port B. Execute the program at 8000H and draw the flow chart.
Port A Equ. 80H, Port B Equ. 81H, Control Register Equ. 83H
15. Configure 8255 A such that port A as an input and port B as output port. Take the input value through DIP switch of Port A. Display the input value though port B. Execute the program at 8000H, and draw the flow chart. Port A Equ. 80H, Port B Equ. 81H, Control Register Equ. 83H
16. Write a program in 8051 microcontroller to add 07H and 09H and store the result in RAM address 45H and draw the flow chart.
17. Write a program in 8051 microcontroller to send 55h to port 1 and port 2 and check the value of ports and draw the flow chart.
18. Write a program in 8051 microcontroller to multiply 06H by 05H and store the result in RAM address 46H .

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EI(BME)696A.1	2	2	1	1	1	1	1	1	3	1	2	3
EI(BME)696A.2	3	3	3	3	2	1	1	1	3	2	2	3
EI(BME)696A.3	3	3	3	3	2	2	1	1	3	2	2	3
EI(BME)696A.4	3	3	3	2	2	1	1	1	3	1	3	3

Subject Name: VLSI & EMBEDDED SYSTEM LABORATORY

Subject Code: EC(BME)696B

Total Contact hours/Week: 3

Credit: 2

Prerequisite: Basic knowledge of logic gates and devices(BJT,FFET,MOSFET).Basic knowledge of programming.

Course Objective:

The objective of the course is to provide students enough practical hand to design and simulate basic VLSI circuits to advanced ones and to make students able to write the codes in latest embedded environment to integrate, acquire, activate devices sensors and in general scenario as well.

Course Outcomes:

1. Identify circuit diagrams composed of CMOS.
2. Explain the simulation flow of the CMOS based Circuits.
3. Interpret a CMOS based circuit for functionality.
4. Generate any CMOS based circuit static as well as dynamic and simulate
5. Write embedded code for to acquire and display sensor data.
6. Write embedded code for interfacing.

Course Content:

List of Experiments

1. Design and simulation of CMOS AND, NAND, NOR gates by static CMOS design.
2. Design and simulation of 1 bit full adder and subtractor.
3. Design and simulation of single stage dynamic circuit(precharge and evaluate).
4. Design and simulation of a ROM circuit.
5. Design and Simulate SR,JK Latch and Flip flop.
6. Basics of arduino Board and different on board component identification.
7. Write a code to perform switching activity by arduino.
8. Write a code to perform serial communication between arduino and Host PC.
9. Write a code to read sensor data and visualization of the data.
10. Write code to interface arduino with relay with condition.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EC(BME)696B.1	1	2	1	-	1	-	-	-	3	3	1	3
EC(BME)696B.2	1	2	1	-	2	-	-	-	3	3	1	3
EC(BME)696B.3	2	2	1	-	2	-	-	-	3	3	1	3
EC(BME)696B.4	3	3	2	-	3	-	-	-	3	3	2	3
EC(BME)696B.5	3	3	3	-	3	-	-	-	3	3	3	3
EC(BME)696B.6	3	3	3	-	3	-	-	-	3	3	3	3

Subject Name: SOFT COMPUTING LABORATORY

Subject Code: IT(BME)696 C

Total Contact Hour/Week: 3
Credit: 2

Prerequisite: Knowledge of basic computing, and applied mathematics.

Course objectives:

- To impart knowledge on origin and basics of soft computing and Neural Networks.
- To impart knowledge on genetic algorithms and their applications.
- To impart knowledge on various types of neural networks, learning methods and their applications
- To impart knowledge on fuzzy logic and different stages in fuzzy systems

Course outcome: On completion of this course the students will able:

IT(BME)696C.1: To provide a strong foundation of fundamental concepts in Soft Computing.

IT(BME)696C.2: To provide a basic exposition to the goals and methods of Soft Computing.

IT(BME)696C.3: To enable the student to apply these techniques in applications which involve fuzzy-perception, reasoning and learning.

IT(BME)696C.4: To enable the student to apply these techniques in applications which involve Neuro-Fuzzy modeling and optimization.

Course Content: Fuzzy Logic, Neural Network and Genetic Algorithm.

List of Experiments:

Experiment 1:

- a) Overview Of Matrix , Matrix Operations , Giving input to Matrix, Displaying elements of Matrix.
- b) Performing Operations On Matrix like Addition , Subtraction , Multiplication.
- c) Performing Transpose Operations on Matrix.
- d) Plotting of mathematical functions like $\log(x)$, $\sin(x)$, $\cos(x)$. etc

Experiment 2:

- a) Write a Program in MATLAB to check whether a number is even or odd
- b) Write a program in MATLAB to find out the sum of “N” natural numbers.
- c) Write a Program in MATLAB to generate the fibonacci series upto N , where N is desired value input by user
- d) Write a MATLAB program to solve MATRIX based problems.

Experiment 3:

- a) Write a MATLAB Program to implement LMS Learning rule.
- b) Write a MATLAB program to verify McCulloch OR Function.
- c) Write a MATLAB program to verify Hebb’s Rule.

Experiment 4:

- a) Write a MATLAB program to implement various Fuzzy Operations . (Eg Union , Intersection , Complement, XOR Operation) Eg For two Fuzzy Set

$$P = (0.3/a) + (0.9/b) + (1.0/c) + (0.7/d) + (0.5/e) + (0.4/f) + (0.6/g)$$

$$Q = (1/a) + (1/b) + (0.5/c) + (0.2/d) + (0.2/e) + (0.1/f) + (0.4/g)$$

- b) Write a MATLAB program to implement Max-Min Composition

$$\text{For Two Fuzzy sets} \quad P = [0.3 \ 0.7 ; 0.9 \ 0.4 ; 0.2 \ 0.5] \quad Q = [0.4 \ 0.1 \ 0.8; 0.3 \ 0.7 \ 0.6]$$

Experiment 5: Implementation of Union , Intersection , Complement , XOR Operation and Demorgan's Law

Experiment 6:

- a) Write a MATLAB program to implement MAX Composition for the two set of Matrix
 $S = [0.3 \ 0.7; 0.9 \ 0.4; 0.2 \ 0.5]$ $R = [0.4 \ 0.1 \ 0.8; 0.3 \ 0.7 \ 0.6]$
- b) Write a MATLAB program to implement Defuzzification of α -cut method
For the following fuzzy set $F = (0.6/a) + (0.3/b) + (0.7/c) + (1.0/d)$.

Rest of Experiments may decided by the concerned subject teacher.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
IT(BME)696C.1	3	3	2	1	2				2		1	2
IT(BME)696C.2	3		3	2					2			2
IT(BME)696C.3	3	3	2	1	2				1			1
IT(BME)696C.4	2	3	3	2	1				1			1

**Detailed Syllabus of B.Tech in Biomedical Engineering Programme
(Fourth Year- Seventh Semester)**

BME-Semester VII

Subject Type	Subject Code	Subject Name	Contact hrs/week				Credits
			L	T	P	Total	
		THEORY					
HS	HU 703	ECONOMICS FOR ENGINEERS	2	0	0	2	2
PC	BME 701	THERAPEUTIC EQUIPMENTS	3	1	0	4	4
PE-III	BME 702A	MEDICAL IMAGE PROCESSING	3	0	0	3	3
	BME 702B	TISSUE ENGINEERING					
	BME 702C	MEDICAL ROBOTICS & AUTOMATION					
PE-IV	BME 703A	BIOLOGICAL CONTROL SYSTEMS	3	0	0	3	3
	BME 703B	BIOMEMS & BIOMICROFLUIDICS					
	BME 703C	BIOENERGY & BIOFUELS ENGINEERING					
		PRACTICAL					
PC	BME 791	MEDICAL INSTRUMENTS & SYSTEMS LABORATORY	0	0	3	3	2
PE-III	BME 792A	MEDICAL IMAGE PROCESSING LABORATORY	0	0	3	3	2
	BME 792B	TISSUE ENGINEERING LABORATORY					
	BME 792C	MEDICAL ROBOTICS & AUTOMATION LABORATORY					
		SESSIONAL					
PW	BME 781	PROJECT I	0	0	6	6	3
PW	BME 782	INDUSTRIAL TRAINING (4 WEEKS)	0	0	0	0	2
MC	MC 781	TECHNICAL SEMINAR PRESENTATION	0	0	3	3	0
		TOTAL	11	1	15	27	21

Syllabus

THEORY PAPER

Subject Name: ECONOMICS FOR ENGINEERS

Subject Code: HU 703

Total Contact hours/Week: 2

Credit: 2

Pre-requisites: MATH – College Algebra, Pre-Calculus Algebra and Trigonometry.

Course Objective: This course emphasizes the strong correlation between engineering design and manufacturing of products/systems and the economic issues they involve.

Course Outcome:

HU 703.1 Apply the appropriate engineering economics analysis method(s) for problem solving: present worth, annual cost, rate-of-return, payback, break-even, benefit-cost ratio.

HU 703.2 Evaluate the cost effectiveness of individual engineering projects using the methods learned and draw inferences for the investment decisions.

HU 703.3 Compare the life cycle cost of multiple projects using the methods learned, and make a quantitative decision between alternate facilities and/or systems.

HU 703.4 Evaluate the profit of a firm, carry out the break even analysis and employ this tool to make production decision.

HU 703.5 Discuss and solve advanced economic engineering analysis problems including taxation and inflation.

Course Content:

Module	Topic	No. of Lectures
1	Introduction: Managerial Economics-Relationship with other disciplines-Firms:Types,Objectives and goals-Managerial Decisions-Decision Analysis.	3
2	Demand and Supply Analysis: Demand-Types of demand-determinants of demand-Demand function-Demand Elasticity-Demand forecasting-Supply-Determinants of supply-Supply function-Supply Elasticity.	6
3	Cost Analysis: Element of costs, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost, Break-even analysis – PV ratio,	3
4	Elementary economic Analysis: Inflation-Meaning of inflation, types, causes, measures to control inflation. National Income-Definition, Concepts of national income, Method of measuring national income.	4
5	Financial Accounting: Concepts and Definition of Accounting,Journal,Ledger,Trial Balance. TradingA/C,Profit& Loss A/C and Balance Sheet.	6
6	Investment Decision: Time value of money- Interest - Simple and compound, nominal and effective rate of interest, Cash flow diagrams, Principles of economic equivalence. Evaluation of engineering projects-Present worth method, Future worth method, Annual worth method, Internal rate of return method, Cost benefit analysis for public projects.	3
	TOTAL	25

Text Books

1. Riggs, Bedworth and Randhwa, "Engineering Economics", McGraw Hill Education India
2. Principles of Economics, DevigaVengedasalam; KarunagaranMadhavan, Oxford University Press.
3. Engineering Economy by William G.Sullivan, ElinM.Wicks, C. PatricKoelling, Pearson
4. R.PaneerSeelvan, " Engineering Economics", PHI
5. Ahuja,H.L., "Principles of Micro Economics" , S.Chand& Company Ltd
6. Jhingan,M.L., "Macro Economic Theory"
7. Macro Economics by S.P.Gupta, TMH
- 8.Haniff and Mukherjee,Modern Accounting,Vol-1,TMG
- 9.Modern Economic Theory – K.K. Dewett (S.Chand)

CO – PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
HU 703.1	–	–	–	–	–	–	1	1	1	2	–	–
HU 703.2	–	–	–	–	–	1	2	3	1	2	–	–
HU 703.3	–	–	–	–	–	3	1	2	–	1	–	–
HU 703.4	–	–	–	–	–	3	2	1	–	–	–	–
HU 703.5	–	–	–	–	–	2	3	2	–	1	2	–

Subject Name: THERAPEUTIC EQUIPMENTS

Subject Code: BME 701

Total Contact hours/Week: 4

Credit: 4

Pre-requisites: This course requires basic chemistry and physics, physiology, differential equations, control systems, bioinstrumentation knowledge.

Course Objectives:

- 1.This course will provide to students brief review of physiology and common pathology from an engineering point of view for understanding of therapeutic medical devices.
- 2.The lectures will focus on function of therapeutic medical devices so that the students will gain the ability to contribute in their design, development and effective usage in their future careers.
3. To study the concept of various assist devices so as to enable the students to develop new assist devices.
- 4.To develop an understanding of the physiotherapy and diathermy equipment so that the student can learn to operate.
5. This course is also focus on function of therapeutic medical devices so that the students will gain the ability to contribute in their design, development and effective usage in their future careers.

Course Outcome:

After successful completion of the course the students will be able to

BME701.1: Identify suitable therapeutic devices for ailments related to cardiology, pulmonology, neurology, etc.

BME701.2: Understand and explain the working principle of different types of therapeutic devices like pacemakers, defibrillators, ventilators, anaesthesia machine and surgical devices like electrosurgery unit.

BME 701.3: Analyze different types of therapeutic devices including pediatric applications and support.

BME 701.4: Appreciate the application of lasers in biomedical applications.

Course Content:

Module	Topic	No. of Lectures
Module-I	Cardiac Pacemakers & Defibrillators: Need for pacemaker, External pacemakers, implantable pacemakers and types; Programmable pacemakers; Codes for pacemakers; Pulse generator: sensing, output and timing circuits. Power sources, electrodes and leads system, pacing system analyzers. Defibrillators- basic principle and comparison of output wave forms of different DC defibrillator, Types of defibrillator electrodes, energy requirements, synchronous operation, implantable defibrillators, defibrillator safety and analyzers, RF ablation treatment for arrhythmia.	10
Module-II	Ventilators & Anaesthetic system: Basic principles of ventilators, Ventilators and types, different generators, inspiratory phase and expiratory phase, different ventilatory adjuncts, neonatal ventilators, p based ventilator, ventilator testing. Anaesthesia: Need of anaesthesia, gas used and their sources, gas blending and vaporizers, anaesthesia delivery system, breathing circuits.	7
Module-III	Physiotherapy and Electrotherapy Equipments: IR diathermy, UV diathermy, short wave diathermy, microwave diathermy, ultrasonic diathermy; Electrotherapy and different waveforms, Electrode system, Electrical stimulators and types, Strength-duration curve, an electrodiagnostic / therapeutic stimulator. Nerve-muscle stimulators, peripheral nerve stimulator, Ultrasonic stimulators, pain relief through electrical stimulators.	7
Module-IV	Surgical Diathermy & LASER: Principles and applications of surgical diathermy, Electrosurgery machine, electrosurgery circuits, solid state electrosurgery generator circuits, electrosurgery safety, testing electrosurgery units, basic principle of ultrasonic lithotripter & extracorporeal shock wave lithotripter. Principle operation of LASER, various application of CO ₂ , argon, He -Ne, Nd – YAG & pulsed ruby LASER, Application of LASER in surgery.	8
Module-V	Neonatal Care and Drug Delivery Systems: Baby incubator, radiant warmer and phototherapy unit. Suction apparatus, Infusion pumps, Peristaltic pumps, Implantable infusion pumps, Programmable volumetric pumps.	4
TOTAL		36

Text/References Books:

Text Books:

1. R. S. Khandpur "Handbook of Bio-Medical Instrumentation", 2nd Edition, Tata McGraw Hill.
2. J.J.Carr & J.M.Brown, "Introduction to Biomedical Equipment Technology" Pearson Education, Asia.
3. J.Webster, "Bioinstrumentation", Wiley & Sons

References:

1. Joseph Bronzino, " Biomedical Engineering and Instrumentation", PWS Engg ., Boston.
2. Willard Van Nostrand, "Instrumental Methods of Analysis"-
3. Sharms, "Instrumental Methods", S Chand & Co.
4. Harry Bronzino E, "Handbook of Biomedical Engineering and Measurements", Reston, Virginia.
5. Jacobson & Websler, " Medicine & Clinical Engg"
6. Leslie Cromwell, " Biomedical Instrumentation and Measurements"

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BME 701.1	3	2	-	-	-	2	-	-	-	-	-	-
BME 701.2	3	2	-	2	-	-	-	-	-	-	-	-
BME 701.3	3	-	2	-	-	-	-	-	-	-	-	-
BME 701.4	2	-	3	2	2	-	-	-	-	-	-	-

Subject Name: MEDICAL IMAGE PROCESSING

Subject Code: BME 702A

Total Contact hours/Week: 3

Credit: 3

Pre-requisite: Digital Signal Processing

Course Objectives:

1. To introduce students about the importance of Medical image processing.
2. To understand the basic medical image enhancement, transforms, segmentation, compression, representation techniques & algorithms.
3. To prepare students to formulate solutions to general medical image processing problems.

Course Outcomes:

A student will be able to

BME702A.1. Understand different application of medical image processing.

BME702A.2. Analyze performance of different image processing technique in both spatial and frequency domain.

BME702A.3. Apply knowledge of Mathematics and Signal Processing to solve Medical Image Processing related problems.

Course Content:

Module No.	Topics	No. of Lectures
1	Medical Imaging Fundamentals: Basic idea of medical image, Image formation in human eye, Pixel, Mathematical and Logical operation of Medical Image, Sampling, Quantization	3
	Transform of Medical Images: Importance of Medical Image Transform, Fourier Transform of Medical Image (DFT), Inverse Fourier Transform (IDFT), Fast Fourier Transform, Inverse Fast Fourier Transform, Application of Medical Image Transform in different area	3
2	Medical Image Enhancement: Importance of Medical Image enhancement, enhancement in spatial and frequency domain, Bit plane slicing, Histogram, Histogram Equalization, Mean and Median filtering in Medical Images, Frequency domain filtering in Medical Images – LPF, HPF and BPF	6
	Medical Image Compression: Importance of Medical Image Compression, Types of Image Compression, Fidelity criteria, example of lossless and Lossy compression, Compression in spatial domain (up and down sampling), compression using Huffman coding, compression using DPCM; DCT and Wavelet based medical image compression	4

3	Medical Image Restoration : Importance of Medical Image Restoration, Reason for Image degradation, Inverse filtering, Weiner filtering	2
	Segmentation of Medical Images: Importance of Medical Image Segmentation, Segmentation based on Region Growing, Watershed algorithm, Otsu method, Application of different type	3
	Edge detection in Medical Image Processing : Importance of Edge detection in Medical Image Processing, Types of Edge Detection, Mathematical Equation of each operator.	2
4	Medical Image Security : Watermarking of medical images, Different Types of Watermarking, Steganography, Cryptography used in medical images	3
	Algorithm used in Medical Image Processing : Importance of Medical Image Reconstruction, Tomography, Reconstruction using Fan Beam Projection and Parallel Beam Projection, Radon Transform, Medical Image Reconstruction in Frequency Domain	4

Text Book :

1. Digital Image Processing – R C Gonzalez and Woods – 3rd Edition
2. Digital Image Processing – S Sridhar
3. Digital Image Processing – S Jayaraman, T Veerakumar, S Esakkirajan
4. Fourier Optics and Computational Imaging – KedarKhade
5. Medical Image Processing- Concept and Application – Sinha, Patel
6. Digital Image Processing for Medical Applications – G Dougherty
7. Digital Image Processing –Jain

CO – PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BME702A.1	2	3	2	1	-	-	-	-	-	-	-	1
BME702A.2	3	2	1	-	-	-	-	-	1	-	-	-
BME702A.3	-	2	3	2	-	-	-	-	1	-	-	-

Subject Name: TISSUE ENGINEERING

Subject Code: BME 702B

Total Contact Hour/Week: 3

Credit: 3

Prerequisite: Knowledge of cell biology, biomaterials

Course objectives:

- To provide an overview of different issues that play a major role in tissue engineering considering cell biology, extracellular matrix and basics of receptors, cell-cell and cell-matrix interactions..
- It will also provide an in-depth knowledge of the effects of physical (shear, stress, strain), chemical (cytokines, growth factors), and electrical stimuli on cell function.
- It also gives emphasis on scaffold preparation and its application in engineered tissue.

Course outcome:

After completion of this course the students will be able to

BME 702B .1. Understand the biological requirement for tissue engineering systems and also specify the different types of biodegradable biomaterials that can be used in tissue engineering applications.

BME 702B.2. Discuss the complex interactions between biomaterials, cells and signals in biological systems using stem cells, proteomics and bioreactors.

BME 702B.3. Design and fabricate scaffolds using advanced manufacturing technologies including 3D printing for growing biological materials.

BME 702B 4. Develop engineered tissue like cardiovascular tissues and also evaluate the patterning of bio-mimetic substances.

Course Content

Module	Topic	No. of Lectures
I	INTRODUCTION TO TISSUE ENGINEERING Introduction – definitions - basic principles - structure-function relationships – Biomaterials: metals, ceramics, polymers (synthetic and natural) – Biodegradable materials - native matrix - Tissue Engineering and Cell-Based Therapies –Tissue Morphogenesis and Dynamics- Stem Cells and Lineages - Cell-Cell Communication	6
II	TISSUE CULTURE BASICS Primary cells vs. cell lines - sterile techniques – plastics – enzymes - reactors and cryopreservation - Synthetic Biomaterial Scaffolds- Graft Rejection – Immune Responses-Cell Migration-Controlled Drug Delivery- Micro technology Tools	7
III	SCAFFOLD FORMATION Oxygen transport - Diffusion - Michaelis-Menten kinetics - oxygen uptake rates - limits of diffusion - Principles of self assembly - Cell migration - 3D organization and angiogenesis - Skin tissue engineering –Introduction - scar vs. regeneration - split skin graft -apligraft. Engineered Disease Models- Tissue Organization- Cell Isolation and Culture - ECM and Natural Scaffold Materials- Scaffold Fabrication and Tailoring	8
IV	CARDIOVASCULAR TISSUE ENGINEERING Blood vessels structure - vascular grafts - Liver tissue engineering – Bioartificial liver assist device - shear forces - oxygen transport - plasma effects – Liver tissue engineering - Self-assembled organoids - decellularized whole livers – Stem cells - basic principle - embryonic stem cells - Induced pluripotent stem cells -Material Biocompatibility - Cell Mechanics - Vascularization- Stem Cell Therapies	7
V	PATTERNING OF BIOMIMETIC SUBSTRATES Patterning of biomimetic substrates with AFM lithography primarily focusing on DPN-Nanotemplating polymer melts - Nanotechnology-based approaches in the treatment of injuries to tendons and ligaments - Progress in the use of electrospinning processing techniques for fabricating nanofiber scaffolds for neural applications -Nanotopography techniques for tissue-engineered scaffolds	8
TOTAL		36

Text/ Reference Books:

TEXT BOOKS

1. Ketul Popat “*Nanotechnology in Tissue Engineering and Regenerative Medicine*” CRC Press Taylor and Francis 2011.
2. Cato T. Laurencin, Lakshmi S “*Nanotechnology and Tissue Engineering: The Scaffold*” CRC Press Taylor and Francis 2008.

REFERENCES

1. Kun Zhou, David Nisbet, George Thouas, Claude Bernard and John Forsythe “*Bio-nanotechnology Approaches to Neural Tissue Engineering*”, NC-SA 2010.
2. Nair “*Biologically Responsive Biomaterials for Tissue Engineering*”, Springer Series in Biomaterials Science and Engineering, Vol. 1 Antoniac, Iulian (Ed.) 2012.

CO – PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BME702B .1	3	2	-	-	-	-	-	-	-	-	-	-
BME702B .2	3	2	-	1	-	-	-	-	-	-	-	-
BME702B .3	3	-	3	-	2	-	-	-	-	-	-	-
BME702B .4	3	2	-	2	2	-	-	-	-	-	-	-

Subject Name: MEDICAL ROBOTICS & AUTOMATION**Subject Code: BME 702C****Total Contact Hour/Week: 3****Credit: 3****Prerequisite:** Basic Knowledge of Electronics, Sensors, Mechanics.**Course objectives:**

To provide the basic knowledge on design, analysis, control and working principle of robotics in surgery, rehabilitation and drug delivery.

Course outcome:

After a successfully completed course the student should be able to:

BME702C.1. Understand and describe with the state of the art in medical robotics.

BME702C.2. Apply the knowledge to identify & describe different types of medical robots and their potential applications

BME702C.3. Acquire the basic concepts in kinematics, dynamics and control relevant to medical robotics along with various roles that robotics can play in healthcare.

BME702C.4. Develop the analytical and experimental skills necessary to design and implement robotic assistance for both minimally invasive surgery and image-guided interventions.

Course Content

Module	Topic	No. of Lectures
1	Introduction of Robotics: Introduction to Robotics and its history, Overview of robot subsystems, Degrees of freedom, configurations and concept of workspace, Automation, Mechanisms and movements, Dynamic stabilization- Applications of robotics in medicine	7
2	Actuators and Grippers Pneumatic and hydraulic actuators, Stepper motor control circuits, End effectors, Various types of Grippers, Design consideration in vacuum and other methods of gripping, PD and PID feedback actuator models	7
3	Manipulators & Basic Kinematics Construction of Manipulators, Manipulator Dynamic and Force Control, Electronic and pneumatic manipulator, Forward Kinematic Problems, Inverse Kinematic Problems, Solutions of Inverse Kinematic problems	6
4	Power Sources and Sensors Sensors and controllers, Internal and external sensors, position, velocity and acceleration sensors, Proximity sensors, force sensors, laser range finder, variable speed arrangements, Path determination - Machinery vision, Ranging – Laser-Acoustic, Magnetic fiber optic and Tactile sensor	8

5	Robotics in Medicine Da Vinci Surgical System, Image guided robotic systems for focal ultrasound based surgical applications, System concept for robotic Tele-surgical system for off-pump CABG surgery, Urologic applications, Cardiac surgery, Neuro-surgery, Pediatric-, and General- Surgery, Gynecologic Surgery, General Surgery and Nano robotics	8
	TOTAL	36

Text/ Reference Books:

TEXT BOOKS

1. Nagrath and Mittal, “Robotics and Control”, Tata McGraw-Hill, First edition, 2003.
2. Spong and Vidhyasagar, “Robot Dynamics and Control”, John Wiley and Sons, First edition, 2008.
3. Fu. K.S, Gonzalez, R.C., Lee, C.S.G, “Robotics, control”, sensing, Vision and Intelligence, Tata McGraw Hill International, First edition, 2008.

REFERENCES

1. Howie Choset, Kevin Lynch, Seth Hutchinson, George Kantor, Wolfram Burgard, Lydia Kavraki and Sebastian Thurn, “Principles of Robot Motion: Theory, Algorithms, and Implementations”, Prentice Hall of India, First edition, 2005.
2. Philippe Coiffet, Michel Chirouze, “An Introduction to Robot Technology”, Tata McGraw-Hill, First Edition, 1983.
3. Jacob Rosen, Blake Hannaford & Richard M Satava, “Surgical Robotics: System Applications & Visions”, Springer 2011.
4. http://www.lapsurg.com.br/arquivos/books/medical_robotics12402am020100000000.pdf
5. Barbara Webb and Thomas R Consi, “BioRobotics: Methods & Applications”, Barbara Webb and Thomas R Consi, AAAI Press/MIT Press, First Edition, 2001.
6. Constantinos Mavroidis, Antoine Ferreira, “Nanorobotics: Current approaches and Techniques” , Springer 2011

CO – PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BME702C.1	3	-	2	2	2	-	-	-	-	-	-	-
BME 702C.2	2	2	2	-	-	-	-	-	-	-	-	-
BME 702C.3	3	-	2	2	-	-	-	-	-	-	-	-
BME 702C.4	3	2	3	-	-	-	-	-	-	-	-	1

Subject Name: BIOLOGICAL CONTROL SYSTEMS

Subject Code: BME 703A

Total Contact Hour/Week: 3

Credit: 3

Pre-requisites: Fundamentals of control system.

Course Objective:

- To equip the students with necessary knowledge on analysis and design parameters of biological control system.
- To impart Knowledge about the application of various regulatory processes in designing a bio control system.

- Develop ability to create simple models of the biological control system as well as implement and evaluate it to meet desired needs in healthcare.

Course Outcome:

BME703A.1 Define and understand the basic concept of Engineering Control System as well as Biological Control System and their related Mathematical approaches.

BME703A.2 Gain in- depth knowledge to explain the different biological process regulations and biological control processes.

BME703A.3 Identify and logically comprehend the resemblance and difference among various Biological Control Systems & Engineering Control Systems.

BME703A.4 Analyze the reasons for deviance from normal physiology, considering uniqueness of biological process regulations and interpret the biological control system to restore homeostasis.

Course Content:

Module	Topic	No. of Lectures
Module1	Introduction: Technological Control System, Mathematical approaches, System stability, Differences & similarities between biological and engineering control system, Linearization of nonlinear model, Time invariant and time varying systems of Biological control processes.	10
Module2	Process regulation: Acid – base balance, Extra cellular water and electrolyte balance, Interstitial fluid volume, Blood pressure, Blood glucose, Thermal regulatory system.	12
Module3	Biological control: Cardiac rate, Respiratory rate, Mass balancing of lungs, Oxygen uptake by RBC and pulmonary capillaries, Oxygen and carbondioxide transport in blood and tissues, Urine formation and control, skeletal muscle servo mechanism and semicircular canal, Endocrine control system.	12
TOTAL		34

Text/ Reference Books:

1. Ogata Katsuhika, Modern Control Engineering. 2nd Edition, Prentice Hall of India.
2. Ibrell and Guyton, Regulation and control in physiological system.
3. Milsum Jhon H., Biological control system analysis, Tata McGraw-Hill.
4. Milhom T.H. Saunder. Application of control theory to physiological systems, The University of Chicago Press.

CO – PO Mapping:

CO	PO 1	PO2	PO 3	PO 4	PO 5	PO 6	PO7	PO8	PO9	PO10	PO11	PO12
BME703A.1	3	2	-	-	1	-	-	-	-	-	-	-
BME703A.2	3	2	-	-	-	-	-	-	-	1	-	-
BME703A.3	-	3	2	2	1	-	-	-	-	-	-	-
BME703A.4	-	3	-	3	2	-	-	-	-	1	-	-

Subject Name: BIOMEMS & BIOMICROFLUIDICS

Subject Code: BME 703B

Total Contact Hour/Week: 3

Credit: 3

Prerequisite: Mathematics, Basics of sensors, Introduction to device Fabrication, Micro-fabrication Techniques, Fluid Mechanics.

Course objectives:

1. To provide basic educational foundation in micro-systems engineering emphasizing Biomedical micro-devices. This would also include some basic biological/ biochemical concepts and techniques which are necessary for understanding of diagnostics and therapeutics.
2. To provide education and training in fundamental micro-fabrication/ microelectronic processing.
3. To provide experience in micro-system design issues and various characterization schemes / biomedical/ chemical testing practices and procedures.

Course outcome:

Students will be able to

BME 703B.1 Build a foundation in micro-systems engineering including basic biological/ biochemical concepts and techniques emphasizing biomedical devices.

BME 703B.2 Understand material properties important for MEMS system performance, analyze dynamics of resonant micromechanical structures.

BME 703B.3 Design and Development of models using microfabrication technique and simulate electrostatic and electromagnetic sensors and actuators

BME 703B.4 Design and evaluation of fluid flow in micro-fluidic devices

Course Content

Module	Topic	No. of Lectures
I	Introduction to BioMEMS and microfluidics, Introduction to Bio nano technology, Biosensors, fluidics. Introduction to device fabrication (Silicon and Polymers) Introduction to device fabrication (Silicon and Polymers) continued.. Sensors, Transduction and Performance factors. Sensors, Transduction and Performance factors continued	6
II	Important materials for fabrication of BioMEMS platforms Introduction to silicon device fabrication Some Fabrication Methods for soft materials Transduction Methods.About cell potential and SHEs Cell reaction, Nernst equation, Construction of Ion selective electrodes Measurement and calibration of electrodes, ion-solvent interaction	6
III	Introduction to Cell biology,Basic structure of DNA DNA hybridization, , DNA polymerization,PCR Thermal cycle , Real Time PCR.PCR design Electrophoresis, Gel and Capillary electrophoresis,Agarose DNA microarrays (concepts, and utility). Affymetrix and Nanogen approaches in realization of micro-arrays. DNA sequencing (Sanger's reaction). DNA nano-pores. DNA detection using Mechanical Cantilevers.Basics of Protein structure.	8
IV	Protein charging at different pH range, Amino acids, protein polymerization, Transcription , Translation Antibody, Microencapsulation, Cyclic voltametry Microfluidics,Similarity of Streamlines, Pathlines,Sreaklines and Timelines for a steady flow Stress tensor.Viscosity. Newtonian, nonNewtonian fluids,Pseudoplastic, Dilatant, Bingham Plastic materials, Thixotropic fluids. Flow over infinite plates, laminar and turbulent flow, Compressible and Incompressible flows Flow over an infinite plate. Types of flows. Types of Fluids.Kinematics of fluids	10
	TOTAL	30

Text/ Reference Books:

1. Introduction to BioMEMS, Albert Folch, CRC Press; 1st ed.
2. Essential Cell Biology, Bruce Albert, et al. Garland Science, 2nd ed.

CO – PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12
BME 703B.1	3	1	3	-	1	-	-	-	-	-	-	-
BME 703B.2	2	3	-	-	-	-	-	-	-	-	-	-
BME 703B.3	2	-	3	1	3	-	-	-	-	-	-	-
BME 703B.4	2	-	3	3	--	-	-	-	-	-	-	-

Subject Name: BIOENERGY AND BIOFUELS ENGINEERING**Subject Code: BME 703C****Total Contact Hour/Week: 3****Credit: 3****Prerequisites:** Basic concept of Environmental Science**Course Objectives:**

The objective of this course is to provide students with the basic principles of bioenergy and biofuels systems.

The course focuses on bioenergy and biofuels in particular on the exploitation of biomass and biomass waste for energy recovery. It also encompasses thermochemical energy processes (combustion, gasification, pyrolysis, reforming), mechanical and chemical processes (oil extraction and trans-esterification), finally biochemical processes (fermentation and anaerobic digestion).

Course Outcomes:

After completion of the course students will be able to

BME 703C.1: Explain fundamental and principles for chemical and biochemical biofuel synthesis

BME 703C.2: Differentiate between various renewable and non renewable energy resources

BME 703C.3: Recognize the use of theoretical concepts of biofuel production technology at commercial level

Course Content:

Module	Topic	No. of Lectures
I	INTRODUCTION AND PERSPECTIVE OF BIOENERGY AND BIOFUELS Overview of biofuel, bioenergy and biorefinery concepts, current energy consumption, Fundamental concepts in understanding biofuel/bioenergy production, Fossil versus renewable energy resources, economic impact of biofuels, Comparison of Bio-energy Sources, Biorefinery, Biofuel production and applications.	6
II	PROCESSES FOR BIOMASS CONVERSION Introduction to thermochemical, biochemical, and mechanical processes, Types of reactors, chemical equilibrium and reaction kinetics, Thermochemical conversion (pyrolysis, gasification, reforming, combustion), Biochemical conversion (various metabolic process, chemical oxygen demand and biological oxygen demand, anaerobic digestion, fermentation); Oil extraction and esterification; Pretreatment of biomass (pelleting; chipping; biodrying, etc.); Management of solids / liquids /	9

	gaseous biomass process waste.	
III	BIOMASS: PROPERTIES AND TYPES Properties: proximate and ultimate analysis, calorific value, density, moisture content, Type 1: ligno-cellulosic, starchy, sugar, oilseeds; Type 2: municipal residual waste, organic waste, sewage sludge, manure; Type 3: biofuels from biomass conversion processes (solid: biochar; liquids: bioethanol and biodiesel; gaseous: biogas and syngas).	6
IV	BIOENERGY FROM BIOMASS AS SOURCE OF ALTERNATIVE ENERGY Wet milling of grain for alcohol production, grain dry milling cooking for alcohol production, use of cellulosic feed stocks for alcohol production chemistry of biodiesel production; Biodeisel production by using various microorganisms, algae and Transesterification process: Chemistry of biodiesel production, oil Sources and production by plants and other sources, methods of biodiesel production	6
V	BIOFUEL FEEDSTOCKS AND PRODUCTION OF BIOFUEL Various types of feedstocks, starch feedstocks, sugar feedstocks, lignocellulosic feedstcoks, plant oils and animal fats, miscellaneous feedstcoks; Ethanol production from sugar, starch feedstock and lignocellulosic feedstocks; Different enzymes, enzyme hydrolysis, and their applications in ethanol production; fermentation process and types of fermentors, bioreactor operation and design.	6
VI	MICROBIAL FUEL CELLS AND ITS ROLE IN ENERGY PRODUCTION Microbiology of methane production, biomass sources for methane production, biogas composition and use, biochemical basis of fuel cell design	3
	TOTAL	36

Text Books:

1. Biofuels by Wim Soetaert, Erick J. Vandamme, Wiley.
2. Biofuels Engineering Process Technology by Caye M. Drapcho, Terry H. Walker, M.G.Hills.

Reference Book:

Product Recovery in Bioprocess Technology by Biotol series, VCH Ellis Horwood, Butterworth-Heinemann (Elsevier)

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BME 703C.1	3	2	-	-	-	2	2	-	-	-	-	2
BME 703C.2	3	2	-	-	-	-	1	-	-	-	-	-
BME 703C.3	3	-	-	-	-	-	2	-	2	-	2	1

PRACTICAL PAPER

Subject Name: MEDICAL INSTRUMENTS & SYSTEMS LABORATORY

Subject Code: BME 791

Total Contact hours/Week: 3

Credit: 2

Pre-requisite: Basic knowledge of Biomedical Instrumentation.

Course Objectives:

1. To familiarize students with different types of medical equipments
2. To make them understand about the working principle of versatile medical equipments
3. To accustom students with the application of such equipments

Course Outcome

After completion of the course the students will be to

BME 791.1: Understand about different types of medical equipments and demonstrate the measuring of basic medical parameters.

BME 791.2: Explain the working principle of versatile medical equipments

BME 791.3: Demonstrate the monitoring of basic medical parameters.

BME 791.4: Recommend problem solving and service procedures for electrical equipment and apply safety standards and procedures for medical equipment.

Course Content

List of experiments:

1. Study on simulated DC defibrillator
2. Study on muscle stimulator
3. Study on ECG heart rate monitor with alarm system
4. Study on peripheral pulse rate monitor with alarm system
5. Study on digital body/skin temperature monitoring system
6. Study on hearing aid and audiometer: air and bone conduction
7. Study on Nerve Conduction Velocity measuring system
8. Study on EMG biofeedback system
9. Study on ECG simulator and servicing of ECG machine
10. Study on US Doppler / Foetal monitor

CO – PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BME 791.1	3	3	-	3	-	2	-	2	2	-	-	1
BME 791.2	3	3	2	2	-	2	-	-	1	1	-	1
BME 791.3	3	3	-	2	-	-	-	-	-	2	-	2
BME 791.4	2	3	2	-	-	2	2	2	-	2	-	2

Subject Name: MEDICAL IMAGE PROCESSING LABORATORY

Subject Code: BME 792A

Total Contact hours/Week: 3

Credit: 2

Pre-requisite: Digital Signal Processing

Course Objectives:

1. To introduce students about the application of Medical image processing.
2. To understand the basic medical image enhancement, transforms, segmentation, compression, representation techniques & algorithms for quality improvement of an image.
3. To prepare students to design to general medical image processing models.

Course Outcomes:

A student will be able to

BME 792A.1. Understand different application of medical image processing.

BME 792A.2. Design innovative medical image processing models using different techniques.

BME 792A.3. Apply different image processing techniques in Medical Image Processing to achieve a better result.

Course Content:

List of Experiments-

1. Convert multiple RGB Medical Images into Grayscale Images and show result.
2. Transform a grayscale image into frequency domain and show its magnitude and phase angle.
3. Display histogram of a medical image and equalized the image.
4. Apply LPF and HPF in a Grayscale Medical Image and display result.
5. Apply Mean and Median filtering in a Grayscale Medical Image and display result.
6. Compress and reconstruct a RGB and Grayscale Medical Images in spatial domain.
7. Compress and reconstruct a Grayscale Medical Image in frequency domain.
8. Apply segmentation technique (any one) in a Medical Image and display result.
9. Apply Edge detection technique in a Medical Image and display result.
10. Apply any cryptography technique for image encryption and display result.
11. Innovative experiment

CO – PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BME 792A.1.	1	3	2	-	1	-	-	-	2	-	-	1
BME 792A.2.	3	3	2	-	1	-	-	-	-	-	-	-
BME 792A.3.	-	-	3	2	2	-	-	-	2	-	-	-

Subject Name: TISSUE ENGINEERING LABORATORY

Subject Code: BME 792B

Total Contact hours/Week: 3

Credit: 2

Prerequisite: Knowledge of cell biology, Human Physiology, biomaterials

Course objectives: To provide students with conceptual and practical understanding of cell and tissue bioengineering.

Course outcome: At the completion of this course, students will be able to:

BME 792B .1 Apply knowledge for preparing and maintaining cells, tissues and bone marrow in culture.

BME 792B .2 Fabricate and characterize the Biodegradable Scaffold.

BME 792B .3 Incorporate cell seeding techniques in scaffold and quantify it using analytical devices.

Course Content:

List of Experiments:-

1. Introduction to cells and cell culture.
2. Sterile technique.
3. Cell Subculture (Fibroblast and Macrophage).
4. Purification and separation of cells from primary culture.
5. Bone marrow culture.
6. Cell culture (differentiation and proliferation).
7. Scaffold Preparation.
8. Scaffold characterization.
9. Various Seeding techniques used for TE scaffolds.
10. Quantification of Cell Seeding using hemocytometer.

CO – PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BME 792B.1	3	2	-	3	-	-	-	-	-	-	-	-
BME 792B.2	3	-	3	3	-	-	-	-	-	-	-	-
BME 792B.3	2	-	-	3	3	-	-	-	-	-	-	1

Subject Name: MEDICAL ROBOTICS & AUTOMATION LABORATORY

Subject Code: BME 792C

Total Contact hours/Week: 3

Credit: 2

Prerequisite: Basic Knowledge of Electronics, Sensors, Mechanics.

Course objectives:

To provide the basic knowledge on design, analysis, control and working principle of robotics in surgery, rehabilitation and drug delivery.

Course outcome:

After a successfully completed course the student should be able to:

BME792C.1. Apply the knowledge to explain different types of medical robots and their potential applications

BME792C.2. Acquire the basic concepts in kinematics, dynamics and control relevant to medical robotics along with various roles that robotics can play in healthcare.

BME792C.3. Develop the analytical and experimental skills necessary to design and implement robotic assistance for both minimally invasive surgery and image-guided interventions.

Course Content

List of Experiments:

1. Open Loop Position Control
2. Closed Loop Position Control using positional and velocity feedback.
3. Use of analog and digital servo system.
4. Use of PID Control.
5. Experiments on Pneumatic Drives and Actuators.
6. Experiments on Hydraulic Drives and Actuators.
7. Uses of Logic Gates.
8. Programming on Arduino Platform.
9. Programming on PLC for simple control operation.

CO-PO Mapping:

Sl. No.	B.Tech in Biomedical Engineering Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BME792C.1.	3	-	-	2	1	-	-	-	-	-	-	-
BME792C.2.	3	2	2	-	1	-	-	-	-	-	-	-
BME792C.3.	-	-	3	-	2	2	-	1	-	-	-	-

**Detailed Syllabus of B.Tech in Biomedical Engineering Programme
(Fourth Year- Eighth Semester)**

BME-Semester VIII

BME Semester VIII							
Subject Type	Subject Code	Subject Name	Contact hrs/week				Credits
			L	T	P	Total	
	THEORY						
HS	HU 802	VALUES & ETHICS IN PROFESSION	2	0	0	2	2
PE-V	BME 801A	ARTIFICIAL ORGAN & REHABILITATION ENGINEERING	3	0	0	3	3
	BME 801B	BIOMEDICAL HAZARDS & SAFETY					
	BME 801C	TELEMEDICINE					
PE-VI	BME 802A	RADIOTHERAPY & NUCLEAR MEDICINE	3	0	0	3	3
	BME 802B	LASERS & OPTICS IN MEDICINE					
	BME 802C	BIOMEDICAL EQUIPMENT MANAGEMENT					
	SESSIONAL						
PW	BME 881	PROJECT II	0	0	12	12	6
PW	BME 882	GRAND VIVA	0	0	0	0	2
		TOTAL	8	0	12	20	16

Syllabus

THEORY PAPER

Subject Name: VALUES AND ETHICS IN PROFESSION

Subject Code: HU 802

Total Contact hours/Week: 2

Credit: 2

Pre requisites: Basic knowledge of management, basics of communication, Knowledge about environment science

Course Objective: To create awareness on professional ethics and Human Values

Course Outcome:

On Completion of this course student will be able to

HU802.1: Understand the core values that shape the ethical behavior of an engineer and Exposed awareness on professional ethics and human values.

HU802.2: Understand the basic perception of profession, professional ethics, various moral issues & uses of ethical theories

HU802.3: Understand various social issues, industrial standards, code of ethics and role of professional ethics in engineering field

HU802.4: Aware of responsibilities of an engineer for safety and risk benefit analysis, professional rights and responsibilities of an engineer.

HU802.5: Acquire knowledge about various roles of engineers in variety of global issues and able to apply ethical principles to resolve situations that arise in their professional lives

Course contents:

Module	Topic	No. of Lectures
1	Introduction: Definition of Ethics; Approaches to Ethics: Psychological, Philosophical, Social.	3
2	Psycho-social theories of moral development: View of Kohlberg; Morality and Ideology, Culture and Morality, Morality in everyday Context.	3
3	Ethical Concerns: Work Ethics and Work Values, Business Ethics, Human values in organizations: Values Crisis in contemporary society Nature of values: Value Spectrum of a good life.	4
4	Ethics of Profession: Engineering profession: Ethical issues in Engineering practice, Conflicts between business demands and professional ideals. Social and ethical responsibilities of Technologists. Codes of professional ethics. Whistle blowing and beyond, Case studies.	5
5	Self Development: Character strengths and virtues, Emotional Intelligence, Social intelligence, Positive cognitive states and processes (Self-efficacy, Empathy, Gratitude, Compassion, and Forgiveness).	4
6	Effects of Technological Growth: Rapid Technological growth and depletion of resources, Reports of the Club of	6

	Rome. Limits of growth: sustainable development Energy Crisis: Renewable Energy Resources, Environmental degradation and pollution. Eco-friendly Technologies. Environmental Regulations, Environmental Ethics Appropriate Technology, Movement of Schumacher; Problems of man, machine, interaction.	
	TOTAL	25

Text / Reference Books:

1. Stephen H Unger, Controlling Technology: Ethics and the Responsible Engineers, John Wiley & Sons, New York 1994
(2nd Ed)
2. Deborah Johnson, Ethical Issues in Engineering, Prentice Hall, Englewood Cliffs, New Jersey 1991.
3. A N Tripathi, Human values in the Engineering Profession, Monograph published by IIM, Calcutta 1996.

CO-PO mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
HU802.1	–	–	–	–	–	1	1	1	1	2	–	–
HU802.2	–	–	–	–	–	1	1	3	1	2	–	–
HU802.3	–	–	–	–	–	3	2	3	–	1	–	–
HU802.4	–	–	–	–	–	3	2	1	–	–	–	–
HU802.5	–	–	–	–	–	3	2	2	–	1	3	–

Subject Name: ARTIFICIAL ORGAN & REHABILITATION ENGINEERING

Subject Code: BME 801A

Total Contact hours/Week: 3

Credit: 3

Pre-requisites: Basic knowledge of Engineering Physiology, Anatomy, Biomaterials & Biomechanics.

Course Objective

1. To impart knowledge on various types of assist devices
2. To give a basic idea of the artificial organs that can aid a human to live a normal life.
3. To provide the awareness of how a help can be rendered to a differently-abled person

Course Outcome

BME801A.1 Identify various types of host tissue response with respect to different biomaterials used for design and development of artificial organ & prosthesis.

BME801A.2 Explain the working principles and design concept of various artificial organ and extra-corporeal devices used as prosthesis or rehabilitation purposes.

BME801A.3 Apply knowledge to comprehend and explain the abnormality in physiological system and analyze the performance measurement of the corresponding artificial organ.

BME801A.4 Identify the problem and Interpret physiological abnormality or malfunctioning and its impact on health & society.

BME801A.5 Acquire the knowledge and skills for providing effective solution in terms of rehabilitation engineering with respect to different impairments & disabilities

Course Content:

Module	Topic	No. of Lectures
1	Introduction to Artificial Organ: Biomaterials used in artificial organs and prosthesis, Inflammation-Rejection-Correction, Rheological properties of blood, Variation in blood viscosity (effect of shear rate, hematocrit, temperature & protein content), Casson Equation, Flow properties of Blood through blood vessels, Problems associated with extra-corporeal blood flow.	6
2	Artificial Kidney: Kidney Filtration & Basic methods of waste removal, Hemodialysis, Equation for artificial kidney & middle molecule hypothesis, Different types of Hemodialyzers (Flat-Plate, Coil Type & Hollow Fiber Type), Analysis of mass transfer in dialyzers (cross current & counter current flow), regeneration of dialysate, Wearable Artificial Kidney Machine	10
3	Artificial Heart-Lung Machine: Brief of lungs gaseous exchange, Artificial heart-lung device, different types of Oxygenators (bubble, film, membrane); Liver Support System; Artificial Pancreas; Artificial Blood and Artificial Skin.	6
4	Audiometry: Air and Bone Conduction, Masking, Functional Diagram of Audiometer, Different types of Hearing Aids; Ophthalmoscope & Retinoscope; IABP Principle & application	4
5	Rehabilitation Engineering: Measurement & Assessment of Impairments, Disabilities & Handicaps, Engineering concepts in communication disorders, sensory & motor rehabilitation. Rehabs for locomotion, visual, speech & hearing, Artificial Limb, Prosthetic Heart Valve, Externally powered and controlled orthotics & prosthetics, Myoelectric Hand & Arm Prosthesis, MARCUS Intelligent Hand Prosthesis, Gait Study, Spinal rehabilitation	10
	TOTAL	36

Text / Reference Books:

1. Handbook of Biomedical Engineering. Bronzino Joseph
2. Hand book of Biomedical Instrumentation. R. S.Khandpur ,TMH
3. Artificial Organs. Erie.D.Blom, Howard.B.Rotham
4. Biomedical Engineering Principles (Volume-II). David O. Cooney., Marcel Dekker Inc.
5. Rehabilitation Engineering. Robinson C.J.,CRC press 1995
6. Rehabilitation Engineering. IOS press 1993

CO – PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BME 801A.1	3	2	-	2	1	-	-	-	-	-	-	-
BME 801A.2	3	2	-	1	2	-	-	-	-	-	-	-
BME 801A.3	3	2	-	2	2	-	-	-	-	1	-	-
BME 801A.4	2	2	-	3	1	2	-	-	-	-	-	-
BME 801A.5	3	1	3	1	2	-	-	-	-	-	-	1

Subject Name: BIOMEDICAL HAZARDS & SAFETY

Subject Code: BME 801B

Total Contact hours/Week: 3

Credit: 3

Prerequisites: Knowledge of biomedical instrumentation and hospital management

Course objectives:

- 1.To impart sufficient information on the various hazards and relevant precautionary and safety measures in healthcare system
- 2.To provide basic knowledge on the concept of Healthcare Quality management towards continuous improvement of patient care.
- 3.To make the students aware of the role of biomedical engineer in hospitals, especially in the management of electrical supply, maintenance of electrical safety.

Course outcome:

After completion of the course the students will be able to

BME 801B.1: Demonstrate the types of hazards, planning, organization and training needed to work safely with hazardous materials.

BME 801B.2: Explain the different types of hazardous exposure and its biological effects, exposure guidelines and basic workplace monitoring.

BME 801B.3: Understand the policies, safety standards in compliance with regulatory requirements and within engineering limits.

BME 801B.4: Apply knowledge to prevent workplace injury, risk management and also for safety record keeping and management.

Course Content

Module	Topic	No. of Lectures
Module1	ELECTRICAL & FIRE SAFETY Electrical Hazards, Causes of Electrical Shock, Effect of Shocks, Macro & Micro shocks -Hazards, monitoring and interrupting the Operation from leakage current, Safety precautions for electrical hazards; Elements of fire, causes of fire , Action to be taken in case of fire in a Hospital.	6
Module2	LASER AND ULTRAVIOLET RADIATION SAFETY Classification of UV radiation -Sources of UV- Biological effects of UV- Hazards associated with UV radiation- UV control measures - Safety management of UV Classifications of LASER and its radiation hazards- control measures- Emergencies and incident procedures.	6
Module3	HOSPITAL SAFETY Security & Safety of Hospital -Property, Staff & Patients, Radiation safety, Safety precautions, hazardous effects of radiation, allowed levels of radiation, ICRP regulations for radiation safety, Disposal of Biological waste.	6
Module4	STANDARDIZATION OF QUALITY MEDICAL CARE IN HOSPITALS Define Quality- Need for Standardization & Quality Management, TQM in Health care organization-Quality assurance methods ,QA in (Medical Imaging & Nuclear medicine) Diagnostic services – Classification of equipments, Medical device safety and risk management , Effectiveness/performance of medical devices, The role of each participant/stakeholder , Shared responsibility for medical device safety and performance,	8
Module5	ASSESSING QUALITY HEALTH CARE Patient Safety Organization- Governmental & Independent, Measuring Quality care –	6

	Evaluation of hospital services – six sigma way, Quality Assurance in Hospitals Sop's – Patient Orientation for Total Patient Satisfaction. 5S techniques	
Module6	REGULATORY REQUIREMENT FOR HEALTH CARE FDA regulations, Accreditation for hospitals - JCI, NABH and NABL, Other regulatory Codes	4
	TOTAL	36

Text/Reference Books:

1. Khandpur R.S., Hand book of Biomedical instrumentation ,TMH
2. Carr & Brown , Introduction to Biomedical Equipment,PHI
3. Webster J.G and Albert M.Cook, Clinical Engg, Principles & Practices, Prentice Hall Inc., Engle wood Cliffs, New Jersey, 1979.
4. Cesar A. Cacere & Albert Zana, The Practice of Clinical Engg. Academic press, New York, 1977.
5. B.M.Sakharkar, Principles of Hospital administration and Planning, JAYPEE Brothers, Medical Publishers (P) Ltd.
6. K.Shridhara Bhat, Quality Management, Himalaya Publishing House.
7. Karen Parsley, Karen Parsley Philomena Corrigan Quality improvement in Healthcare, 2nd edition ,Nelson Thrones Pub, 2002
8. Sharon Myers —Patient Safety & Hospital Accreditation - A Model for Ensuring Success Springer Publishers 2012
9. Joseph F Dyro —Clinical Engineering Handbook— Elsevier Publishers, 2004

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BME 801B.1	3	2	-	-	-	3	3	2	2	-	-	2
BME 801B.2	3	2	-	-	-	-	2	-	2	-	-	-
BME 801B.3	-	2	-	-	-	3	3	3	-	2	-	-
BME 801B.4	3	-	-	-	-	3	2	2	3	-	-	-

Subject Name: Telemedicine

Subject Code: BME 801C

Total Contact Hour/Week: 3

Credit: 3

Prerequisite: To provide health staff and technologists with further education in telemedicine and e-health

Course objectives:

1. Know Scope, Benefits and Limitations of Telemedicine
2. Know Security and Standards and their use in Telemedicine Applications.
3. Explain basic parts of Teleradiology Systems like Image Acquisition System, Display System, Communication Network, Interpretation.
4. Describe the need of Various Communication Networks, Antennas in Designing the Telemedicine System.

Course outcome:

BME 801C.1 Describe the main types of telemedical applications in current use.

BME 801C.2 Understand how technology and e-health services can be exploited strategically to create new ways of working together.

BME 801C.3 Contribute in the design, implementation and use of telemedicine and e-health systems.

BME 801C.4 Promote and introduce telemedicine and e-health services and programmes.

BME 801C.5 Identify the conditions for successful implementing telemedicine and e-health systems and services

BME 801C.6 Apply telemedicine and e-health services in professional health work.

Course Content

Module	Topic	No. of Lectures
I	History of Telemedicine, Block diagram of telemedicine system, Definition of telemedicine, Tele health, Tele care, origins and Development of Telemedicine, Scope, Benefits and limitations of Telemedicine.	5
II	Types of information: Audio, Video, still Images, text and data, Fax. Types of Communication and Network: PSTN, POTS, ATN, ISDN, Internet, Wireless Communications: GSM, satellite and Micro Wave. Different modulation techniques, Types of antennas depending on requirements, Integration and Operational issues: system integration, Store-and-forward operation, realtime Telemedicine.	10
III	Data Exchanges: Network Configuration, Circuit and packet switching, H.320 series (Video phone based ISBN) T.120, h.324 (Video phone based PSTN), Video Conferencing.	7
IV	Data Security and Standards: Encryption, Cryptography, Mechanisms of encryption, Phases of Encryption. Protocols: TCP/IP, ISO-OSI, Standards to followed DICOM, HL7. Ethical and legal aspects of Telemedicine: Confidentiality and Law, patient rights and consent, access to medical Records, Consent treatment, jurisdictional Issues, Intellectual property rights	10
V	Tele radiology: Basic parts of Teleradiology system: Image Acquisition system, Display system, Communication network, Interpretation. Tele Pathology: Multimedia databases, color images of sufficient resolution: Dynamic range, spatial resolution, compression methods, Interactive control of colour, Controlled sampling, security and confidentiality tools. Tele cardiology, Teleoncology, Telesurgery.	8
TOTAL		40

Text/ Reference Books:

1. Olga Ferrer-Roca, M.Sosa Ludicissa, Handbook of Telemedicine, IOS press 2002.
2. A.C.Norris, Essentials of Telemedicine and Telecare, John Wiley & Sons, 2002.

CO – PO Mapping:

CO	P O1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BME801C.1	2	1	-	-	3	-	-	-	-	-	-	-
BME801C.2	2	2	3	1	3	-	-	-	-	-	-	-
BME801C.3	3	2	3	2	1	-	-	-	-	-	1	1
BME801C.4	1	-	-	-	-	-	-	-	1	2	-	3
BME801C.5	2	3	-	-	-	-	-	-	-	1	-	1
BME801C.6	1	-	-	-	1	3	2	-	-	1	-	2

Subject Name: Radiotherapy & Nuclear Medicine**Subject Code: BME 802A****Total Contact Hour/Week: 3****Credit: 3**

Pre-requisite: Demonstrate a comprehensive knowledge of different radiotherapy techniques and application of nuclear medicine in medical field.

Course objectives:

1. To make them understand the basics of radiotherapy physics.
2. To impart the knowledge about the different pretreatment imaging and treatment verification.
3. To make the students understand the function of various types of Radiotherapy equipments

Course outcome:

After completion of the course the students will be able to

BME 802A.1 Explain the utility of Radiotherapy & Nuclear Medicine in healthcare system.

BME 802A.2 Justify radiation safety measures drawing on theoretical knowledge and practical skill application.

BME 802A.3 Understand the principles of radiation detection and measurement - detection and electronics, counting systems and statistics and to Apply knowledge of statistical analysis to measure the limit of radiation exposure.

BME 802A.4 Gain broad knowledge of principles and applications of various radiation detectors.

BME 802A.5 Develop knowledge and practical skills related to different medical diagnostic tests and application of instrumentation used in clinical nuclear medicine.

Course Content

Module	Topic	No. of Lectures
I	Introduction to physical aspects of radiation therapy and treatment planning; Radiation sources in the Department; Design and description of NM department; Radiation protection	5
II	Absorption of radiation, Radiation chemistry, Survival curves-theory, Oxygen effect, Chemical modifiers of Radiation damage, Cell cycle dependence of radio sensitivity, Repair phenomena, Dose Rate effects, Solid tumor radiobiology, Cell and tumor kinetics, Tissue radio sensitivity, Acute and late effects, Partial and Whole Body Radiation, Time, Dose & Fractionation relationships, Biology of Hyperthermia	7
III	Radiation detectors: Construction and Principles of Operation – Ionization Chamber – Isotope calibrator – Proportional Counter – Geiger muller counter – Voltage calibration of a Geiger Mueller tube, optimum operating condition – Dead time correction – Uses of Gas – filled detectors – Semiconductor detectors	7
IV	Radioactivity: Natural and artificial radioactivity-alpha decay-beta decay and gamma emission, Positron decay-exponential decay-half life-unit of activity, Nuclear Fission-nuclear reactor ,Cyclotron unit-Radiation sources- Natural and artificial-production of radio isotopes-reactor produced isotopes-Fission products-Gamma ray source for Medical uses.	7
V	Nuclear medicine procedure and its applications in biomedical field : Basics of nuclear medicine, Design and description of NM department, Nuclear medicine procedure-PET, SPECT etc, Some common uses of nuclear medicine procedure, Benefits of nuclear medicine procedure, risks of nuclear medicine procedure, limitations of general nuclear medicine, Examples of general nuclear	10

	medicine techniques-Scintigraphy, bonescintigraphy,RIA and ELISA techniques and their applications, Tracer dose, Uptake monitoring instruments. Radiographic Image: Primary radiological image formation, use of contrast media. Density- contrast – brightness –X-ray film construction and film characteristics – exposure to x-rays – developer – effect of temperature and development time –. Image quality - Unsharpness, Resolution – Fog and noise. Documentation of images, Analog\digital images, hard copy, formatter, intensity settings, image resolution and contrast, gray scale, color scale	
	TOTAL	36

Text/ Reference Books:

Text book

1. Meredith, Fundamental Physics of Radiology
2. Faiz M Khan, The physics of Radiation Therapy, Edition 3rd
3. Hall E J, Radiobiology for the Radiologist, 6th Edition.
4. Physics of Nuclear Medicine, - James A. Sorenson & Michael
5. Principles and practice of Nuclear Medicine ,Bruce Sodee, Paul J.Early & Sharon Wikepy

Reference books

1. Nuclear Radiation Detection – William J. Price, McGraw – Hill Book Company
2. Principles of Nuclear Medicine – Henry N. Wagner, W.B. Saunders company, London
3. Principles and practice of Nuclear Medicine, Paul J. Early, D. Bruce Sodes. C.V. Mosby company Princeton
4. Instrumentation in Nuclear Medicine – Gerald J. Hine
5. Essentials of Nuclear Medicine, M.V.Merrick
6. Basic Science of Nuclear Medicine,Roy P Parker, Peter A S Smith & David Churchill Livingston, New York 35
7. Essentials of Nuclear Medicine Imaging ,Fred A Metter, Milton J W B Saunders company, London
8. Principles of Nuclear Medicine Henry N Wagner:W B Saunders company, London
9. Clinical Nuclear Medicine M N Masey, K E Britton & D L Gilday, Chapman and Hall medicals
10. Nuclear Medicine Technology & Techniques -Donald R. Bernier , Paul E. Christian & James K. Langan Mosby

CO – PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BME 802A.1	3	2	-	-	-	-	-	-	-	-	-	-
BME 802A.2	2	3	-	-	-	1	-	-	-	-	-	-
BME 802A.3	3	2	-	-	1	1	-	-	-	-	-	-
BME 802A.4	3	1	1	-	-	-	-	-	-	-	-	-
BME 802A.5	3	2	-	-	1	-	-	-	-	-	-	-

Subject Name: LASERS & OPTICS IN MEDICINE

Subject Code: BME 802B

Total Contact hours/Week: 3

Credit: 3

Prerequisites: Physics of Laser.

Course Objective: To study about the principles and applications of laser and fiber optics in medical field especially in diagnosis and therapy.

Course Outcome:

After completion of the course, students will be able to

BME 802B.1: Explain the fundamentals and different types of laser systems.

BME 802B.2: Describe the operation of laser systems and various medical applications of Laser.

BME 802B.3: Demonstrate the basic concepts of Optical fibers and their properties.

BME 802B.4: Illustrate the construction mechanism and selection criteria of Optical fiber cables.

Course Content:

Module	Topic	No. of Lectures
1	LASER Fundamentals: Characteristics of lasers, spontaneous and stimulated emission of radiation, Einstein's co-efficients, Population Inversion, Three level and four level lasers, Properties of laser, Laser modes, Resonator configuration, Cavity damping, Types of lasers: Gas lasers, solid lasers, liquid lasers, semiconductor lasers.	6
2	Lasers in surgery: Surgical instrumentation of CO ₂ , Ruby, Nd-YAG, He-Ne, Argon ion, Q-switched operations, continuous wave, Quasicontinuous, surgical applications: removal of tumours of vocal chords, brain surgery, plastic surgery, gynaecology and oncology.	7
3	Laser applications: Lasers in tissue welding, lasers in dermatology, lasers in ophthalmology, laser photocoagulations, laser in dentistry, Laser flow cytometry, Laser transillumination & diaphanography, Speckle interferometry, holography - Application Safety with biomedical Lasers.	7
4	Optical Fibres Fundamentals: Principles of light propagation through a fibre, Different types of fibres and their properties, fibre characteristic, transmission of signal in SI and GI fibres, attenuation in optical fibres, Connectors and splices, Fibre termination, Optical sources, Optical detectors.	7
5	Optical Fibre bundles and Applications: Introduction and construction details of optical fibres, non-ordered fiber optic bundles for light guides-fundamentals & principles, ordered fiberoptic bundles for imaging devices-fundamentals & principles, fiberscopes and endoscopes fundamentals, fiber optic imaging systems-advances, optical fiber in communication.	7
TOTAL		34

Text / Reference Books:

1. Leon Goldman, "The Biomedical laser Technology and Clinical Applications" Springer-Verlag
2. Leon Goldman, "Lasers in Medicine", Springer-Verlag
3. Pratesi E.D.R, and Sacchi, "Lasers in photomedicine and photo biology", Springer-Verlag
4. Basht M.L.Wel, "Laser applications in medicine and biology", Vol I,II,III, Plenum Press (1971 & 1974).
5. Nandini K. Jog, "Electronics in medicine and biomedical instrumentation", PHI.

6. J.M. Senior, “Optical Fiber Communication – Principles and Practice”, Prentice Hall of India, 1st edition, 1985.
7. J. Wilson and J.F.B. Hawkes, „Introduction to Opto Electronics“, Prentice Hall of India, 2nd Edition, 2001

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BME 802B.1	3	2	-	-	-	-	-	-	-	1	-	-
BME 802B.2	3	2	-	-	2	-	-	1	-	-	-	-
BME 802B.3	3	-	-	-	2	-	-	-	-	-	-	-
BME 802B.4	3	-	3	-	2	-	-	-	1	-	-	-

Subject Name: BIOMEDICAL EQUIPMENT MANAGEMENT

Subject Code: BME 802C

Total Contact Hour/Week: 3

Credit: 3

Prerequisite: Knowledge of Biomedical Instrumentation

Course objectives:

1. To introduce students with fundamental instrumentation of the equipments used in health care systems.
2. To familiarize students with the application and troubleshooting, maintenance and repairing aspects of versatile medical equipments

Course outcome:

After completion of the course the students will be able to

BME802C.1 Apply the knowledge and understanding to explain the various types of medical equipment used in healthcare, their working principles and design concept.

BME802C.2 Conduct investigation & analyze the datasheets for performance measurement of different biomedical equipment.

BME802C.3 Acquire the knowledge and skills & apply proper techniques for effective maintenance of medical equipment.

BME802C.4 Identify the problem, perform & recommend solution and service w.r.t troubleshooting for biomedical instruments.

Course Content

Module	Topic	No. of Lectures
Module1	Fundamentals of Medical Instrumentation: Bioelectric Signals and Physiological Transducers. Related Anatomy and Physiology. Patient Safety.	6
Module2	Repair, Service and Maintenance of a range of medical equipment: • Mechanical Equipment: BP Apparatus, Suction Machine and Microscope.	20
	• Recording and Monitoring Equipment: ECG and EEG Machines, Pulse Oximeter, Cardiac Monitor and Audiometer.	

	- Clinical Lab Equipment: Colorimeter, Spectrophotometer, Semi-Auto Analyzer, Centrifuge and Oven. - Imaging Systems: X-Ray and Ultrasound Machines.	
	Therapeutic Equipment: Cardiac Defibrillator, Short wave and Ultrasonic Diathermy. Anesthesia Machine.	
Module3	Maintenance of pc based medical equipment: Introduction to - System configuration and BIOS, Identification & Troubleshooting of PC components viz-Motherboard, HDD, FDD, CD ROM, Monitor, Printers, Modems, Ports etc.	8
	TOTAL	34

Text/ Reference Books:

TEXT BOOKS:

1. R. S. Khandpur, Biomedical Instrumentation Technology and Applications, McGraw-Hill Professional, 2004 (UNIT I, II)
2. Raja Rao, C; Guha, S.K, Principles of Medical Electronics and Biomedical Instrumentation, Orient Longman Publishers (2000) (UNIT III, IV & V)

REFERENCE BOOKS:

1. R.Anandanatarajan, "Biomedical Instrumentation", PHI Learning, 2009.
2. John G. Webster, Medical Instrumentation: Application and Design, 3rd edition, John Wiley & Sons, New York, 1998.

CO – PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BME 802C.1	3	2	-	-	1	-	-	-	-	-	-	-
BME 802C.2	3	2	-	3	1	-	-	-	-	-	-	-
BME 802C.3	3	-	2	3	1	-	-	-	-	-	-	-
BME 802C.4	-	3	3	2	3	-	-	1	1	1	-	-