KLE Technological University | Creating Value, Leveraging Knowledge

Curriculum Structure and Curriculum Content for the Academic Batch – 2022-26
School /Department: Biomedical Engineering
Program: Bachelor of Engineering

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Vision and Mission of KLE Technological University

Vision

KLE Technological University will be a national leader in Higher Education–recognised globally for innovative culture, outstanding student experience, research excellence and social impact.

Mission

KLE Technological University is dedicated to teaching that meets highest standards of excellence, generation and application of new knowledge through research and creative endeavours.

The three-fold mission of the University is:

- To offer undergraduate and post-graduate programs with engaged and experiential learning environment enriched by high quality instruction that prepares students to succeed in their lives and professional careers.

- To enable and grow disciplinary and inter-disciplinary areas of research that build on present strengths and future opportunities aligning with areas of national strategic importance and priority.

- To actively engage in the Socio-economic development of the region by contributing our expertise, experience and leadership, to enhance competitiveness and quality of life.

As a unified community of faculty, staff and students, we work together with the spirit of collaboration and partnership to accomplish our mission.

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Vision and Mission Statements of the School / Department

Vision

To impart quality education in the field of Biomedical science by applying engineering principles.

Mission

1. To achieve academic excellence by applying biomedical engineering knowledge.
2. To adapt emerging technologies in biomedical engineering through continual learning.
3. To acquire the knowledge of medical instrumentation through engineering and related R & D activities.
4. To work with hospitals and healthcare industries to enhance practical knowledge.
5. To develop competencies for employability and entrepreneurship in core and interdisciplinary areas.

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Curriculum Structure 2022-26

Semester					Total Program Credits: 180			
Course with course code	I	II	III	IV	V	VI	VII	VIII
	Single Variable Calculus (18EMAB101)	Multivariable Calculus (4-1-0) (18EMAB102)	BS: Integral Transforms and Statistics (15EMAB203) 4-0-0	BS: Linear Algebra and Partial Differential Equations (15EMAB208) 4-0-0	Fundamentals of Signals and DSP (22EBMC301) 4-0-0	Professional Aptitude and Logical reasoning (16EHSC301) 3-0-0	Medical Imaging Systems (4-0-0) (22EBMC401)	PSE Elective 5 (22EBME44X)/ Internship-Project (22EBMW403)
	Engineering Physics (15EPHB101)	Engineering Chemistry (15ECHB102)	ES1: Corporate Communication (22EHSH201) 0.5-0-0	ES2: Problem Solving and Analysis (22EHSH202) 0.5-0-0	Clinical Instrumentation (22EBMC302) 4-0-0	Industry Readiness and Leadership Skills (23EHSA304) 0-0-0	Generative AI 25EBMC402 (2-0-1)	Open Elective 1 (22EBMO40X)/ Internship-Project (22EBMW403)
	Engineering Mechanics (4-0-0) (15ECVF101)	Problem Solving with Data Structures (18ECSP102)	Circuit Analysis (22EBMC201) 4-0-0	Biomedical Instrumentation (22EBMC205) 4-0-0	Therapeutic Devices and Circuits (22EBMC303) 4-0-0	Medical Image Processing (24EBMC305) 3-0-1	PSE Elective 3 (22EBME42X) 3-0-0	Internship-Training (22EBMI401)
	C Programming for Problem solving (0-0-3) (18ECSP101)	Engineering Exploration (15ECRP101)	Analog Electronic Circuits (22EBMC202) 4-0-0	Signal Conditioning and Data Acquisition Circuits (22EBMC204) 4-0-0	Operating System and Embedded System Design (24EBMC304) 3-0-1	Biomedical Digital Signal Processing (24EBMC306) 3-0-1	PSE Elective 4 (22EBME43X) 3-0-0	

	Basic Electrical Engineering (3-0-0) (18EEEF101)	Basic Electronics (18EECF101)	Digital Circuits (19EBMC201) 4-0-0	Human Anatomy and Physiology (22EBMC206) 4-0-0	Clinical Instrumentation Lab (22EBMP301) 0-0-2	Machine Learning and Deep Learning (24EBMC307) 2-0-2	Senior Design Project (22EBMW401) 0-0-6	Capstone Project Work (22EBMW402)
	Social Innovation (0-1-1) (20EHSP101)	Basic Mechanical Engineering (15EMEF101)	Electronic Instrumentation and Measurements (22EBMC203) 4-0-0	ARM Processor and Applications (22EBMC207) 3-0-0	Mini Project (23EBMW301) 0-0-3	PSE Elective 1 (22EBME314) Python 3-0-0	Constitution of India, Professional Ethics and Environmental Studies (15EHSA401) 0-0-0	
	Engineering Physics Lab (0-0-1) (16EPHP101)	Professional Communication (15EHSH101)	Digital Circuits Lab (22EBMP201) 0-0-1	Signal Conditioning and Data Acquisition Circuits Lab (22EBMP204) 0-0-2	Arithmetical Thinking and Analytical Reasoning (23EHSA303) 0-0-0	PSE Elective 2 Medical Device Regulation and Safety (22EBME412) 3-0-0		
			Analog Electronic Circuits Lab (22EBMP202) 0-0-1	Biomedical Instrumentation Lab (22EBMP205) 0-0-2	Linear algebra and statistics (15EMAB302) 3-0-0	Minor Project 1 (24EBMW302) 0-0-6		
			Microcontroller Architecture and	ARM Microcontroller Lab				

			Programming (22EBMF202) 2-0-1 C Programming (22EBMF204) 0-0-2	(22EBMP203) 0-0-1				
			Calculus and Integral Transforms (15EMAB232) 4-0-0	Data Structure using C Lab (22EBMF205) 1-0-2				
				Vector calculus and differential equations (15EMAB242) 4-0-0				
Credits	**22**	**22**	**25.5**	**24.5**	**21**	**27**	**19**	**17**

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Curriculum Structure-Semester wise

Semester - I

No	Code	Course	Category	L-T-P	Credits	Contact Hours	ISA	ESA	Total	Exam Duration (in hrs)
1	18EMAB101	Single Variable Calculus	BS	4-1-0	5	6	50	50	100	3 hrs
2	15EPHB101	Engineering Physics	BS	3-0-0	3	3	50	50	100	3 hrs
3	15ECVF101	Engineering Mechanics	ES	4-0-0	4	4	50	50	100	3 hrs
4	18ECSP101	C Programming for Problem solving	ES	0-0-3	3	6	80	20	100	3 hrs
5	18EEEF101	Basic Electrical Engineering	ES	3-0-0	3	3	50	50	100	3 hrs
6	20EHSP101	Design Thinking for Social Innovation	HSS	0-1-1	2	3	50	50	100	1.5hrs
7	16EPHP101	Engineering Physics Lab	BS	0-0-1	1	2	80	20	100	3 hrs
			TOTAL	**14-2-5**	**21**	**27**	410	290	700	

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Semester - II

No	Code	Course	Category	L-T-P	Credits	Contact Hours	ISA	ESA	Total	Exam Duration (in hrs)
1	18EMAB102	Multivariable Calculus	BS	4-1-0	5	6	50	50	100	3 hrs
2	15ECHB102	Engineering Chemistry	BS	3-0-0	3	3	50	50	100	3 hrs
3	18ECSP102	Problem Solving with Data Structures	ES	0-0-3	3	6	80	20	100	3 hrs
4	15ECRP101	Engineering Exploration	ES	0-0-3	3	6	80	20	100	3 hrs
5	18EECF101	Basic Electronics	ES	4-0-0	4	4	50	50	100	3 hrs
6	15EMEF101	Basic Mechanical Engineering	ES	2-1-0	3	4	50	50	100	3 hrs
7	15EHSH101	Professional Communication	HSS	1-1-0	2	3	50	50	100	1.5 hrs
TOTAL				**15-2-6**	**23**	**32**	**410**	**290**	**700**	

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Semester- III

No	Code	Course	Category	L-T-P	Credits	Contact Hours	ISA	ESA	Total	Exam Duration (in hrs)
1	15EMAB203	Integral Transforms and Statistics	BS	4-0-0	4	4	50	50	100	3 hours
2	22EHSH201	Corporate Communication	ES	0.5-0-0	0.5	1	100	--	100	3 hours
3	22EBMC201	Circuit Analysis	PC	4-0-0	4	4	50	50	100	3 hours
4	22EBMC202	Analog Electronic Circuits	PC	4-0-0	4	4	50	50	100	3 hours
5	19EBMC201	Digital Circuits	PC	4-0-0	4	4	50	50	100	3 hours
6	22EBMC203	Electronic Instrumentation and Measurements	ES	4-0-0	4	4	50	50	100	3 hours
7	22EBMP201	Digital Circuits Lab	PC	0-0-1	1	2	80	20	100	2 hours
8	22EBMP202	Analog Electronic Circuits Lab	PC	0-0-1	1	2	80	20	100	2 hours
9	22EBMF202 22EBMF204	Microcontroller Architecture and Programming C Programming (Dip)	ES	2-0-1 0-0-2	3 2	4 4	80	20	100	2 hours

10	15EMAB232	Calculus and Integral Transforms		4-0-0	4	4	50	50	100	3 Hrs
			TOTAL	**22.5-0-3**	**25.5**	**29**	**590**	**310**	**900**	

Semester- IV

No	Code	Course	Category	L-T-P	Credits	Contact Hours	ISA	ESA	Total	Exam Duration (in hrs)
1	15EMAB208	Linear Algebra and Partial Differential Equations	BS	4-0-0	4	4	50	50	100	3 hours

2	22EHSH202	Problem Solving & Analysis	ES	0.5-0-0	0.5	1	100	--	100	3 hours
3	22EBMC205	Biomedical Instrumentation	PC	4-0-0	4	4	50	50	100	3 hours
4	22EBMC204	Signal Conditioning and Data Acquisition Circuits	PC	4-0-0	4	4	50	50	100	3 hours
5	22EBMC206	Human Anatomy and Physiology	PC	4-0-0	4	4	50	50	100	3 hours
6	22EBMC207	ARM Processor and Applications	PC	3-0-0	3	3	50	50	100	3 hours
7	22EBMP205	Biomedical Instrumentation Lab	PC	0-0-2	2	4	80	20	100	2 hours
8	22EBMP204	Signal Conditioning and Data Acquisition Circuits Lab	PC	0-0-2	2	4	80	20	100	2 hours
9	22EBMP203	ARM Microcontroller Lab	PC	0-0-1	1	2	80	20	100	2 hours
10	22EBMF205	Data Structure using C Lab (Diploma)	ES	1-0-2	3	6	80	20	100	2 hours
			TOTAL	**18.5-0-6**	**24.5**	**30**	**670**	**330**	**1000**	

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Semester- V

No	Code	Course	Categor	L-T-P	Credits	Contact Hours	ISA	ESA	Total	Exam Duration (in hrs)
1	22EBMC301	Fundamentals of Signals and DSP	PC	4-0-0	4	4	50	50	100	3 hours
2	22EBMC302	Clinical Instrumentation	PC	4-0-0	4	4	50	50	100	3 hours
3	22EBMC303	Therapeutic Devices and Circuits	PC	4-0-0	4	4	80	20	100	3 hours
4	24EBMC304	Operating System and Embedded System Design	PC	3-0-1	4	5	50	50	100	3 hours
5	22EBMP301	Clinical Instrumentation Lab	PC	0-0-2	2	4	80	20	100	2 hours
6	23EBMW301	Mini Project	PW	0-0-3	3	6	50	50	100	2 hours
7	23EHSA303	Arithmetical Thinking and Analytical Reasoning	Audit	0-0-0	--	1	100	--	100	3 hours
8	15EMAB302	Linear Algebra and Statistics		3-0-0	3	3	50	50	100	3 hours
			TOTAL	**15-0-6**	**21**	**28**	**460**	**240**	**700**	

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Semester- VI

No	Code	Course	Category	L-T-P	Credits	Contact Hours	ISA	ESA	Total	Exam Duration (in hrs)
1	16EHSC301	Professional Aptitude and Logical reasoning.	HC	3-0-0	3	3	50	50	100	3 hours
2	23EHSA304	Industry Readiness and Leadership Skills	ES	0-0-0	Audit	1	100	--	100	3 hours
3	24EBMC305	Medical Image Processing	PC	3-0-1	4	5	63	37	100	3 hours
4	24EBMC306	Biomedical Digital Signal Processing	PC	3-0-1	4	5	63	37	100	3 hours
5	24EBMC307	Machine Learning and Deep Learning	PC	2-0-2	4	6	50	50	100	3 hours
6	22EBME314	PSE Elective 1 (PYTHON)	PE	3-0-0	3	3	50	50	100	3 hours
7	22EBME412	PSE Elective 2 (Medical Device Regulation and safety)	PE	3-0-0	3	3	50	50	100	3 hours
8	24EBMW302	Minor Project - I	PC	0-0-6	6	12	50	50	100	2 hours
			TOTAL	**17-0-10**	**27**	**38**	**476**	**324**	**700**	

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Semester- VII

No	Code	Course	Category	L-T-P	Credits	Contact Hours	ISA	ESA	Total	Exam Duration (in hrs)
1	22EBMC401	Medical Imaging Systems	PSC	4-0-0	4	4	50	50	100	3 hours
2	25EBMC402	Generative AI	PSE	2-0-1	3	4	50	50	100	3 hours
3	22EBME42X	PSE Elective 3	PSE	3-0-0	3	3	50	50	100	3 hours
4	22EBME43X	PSE Elective 4	PSE	3-0-0	3	3	50	50	100	3 hours
5	22EBMW401	Senior Design Project	PW	0-0-6	6	12	50	50	100	3 hours
6	15EHSA401	Constitution of India, Professional Ethics and Environmental Studies	M	0-0-0	-	2	50	50	100	3 hours
TOTAL				**12-0-7**	**19**	**28**	**300**	**300**	**600**	

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Semester- VIII

No	Code	Course	Category	L-T-P	Credits	Contact Hours	ISA	ESA	Total	Exam Duration (in hrs)
1	22EBME44X	PSE Elective 5	PSE	3-0-0	3	3	50	50	100	3 hours
2	22EBMO40X	Open Elective 1	OE	3-0-0	3	3	50	50	100	3 hours
3	22EBMW402	Capstone Project Work	PRJ	0-0-11	11	22	50	50	100	3 hours
OR										
4	22EBMI401	Internship- Training	PRJ	0-0-6	6	12	50	50	100	3 hours
5	22EBMW403	Internship- Project	PRJ	0-0-11	11	22	50	50	100	3 hours
			TOTAL	**6-0-11**	**17**	**28**	**150**	**150**	**300**	

Semester	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**Total**
Credits	**22**	**22**	**25.5**	**24.5**	**21**	**27**	**19**	**17**	**178**

List of Open Electives

Sr. No	Name of the Course	Course Code
1.	Bio Instrumentation	22EBMO401
2.	Bio signal Processing	22EBMO402
3	Bio Informatics	22EBMO403
4.	Medical Physics	22EBMO404

List of Program Electives

Sr. No	Name of the Course	Course Code
1.	Java Programming	22EBME311
2.	Automotive Electronics	22EBME312
3.	OOP's using C++	22EBME313
4.	Python	22EBME314
5.	Hospital Design, Planning and Management	22EBME411
6.	Medical Device Regulations and Safety	22EBME412
7.	Biological Control systems	22EBME413
8.	Scientific and Analytical Instrumentation	22EBME414
9.	Embedded Intelligent System	22EBME421
10.	Introduction to Deep Learning	22EBME422
11.	Medical Internet of Things	22EBME423
12.	ARVR	22EBME424
13.	Data Base Management in Healthcare	22EBME431
14.	Bio – MEMS	22EBME432
15.	Rehabilitation Engineering	22EBME433
16.	Lasers and Optical Fibers in Medicine	22EBME434
17.	Biomaterials and Artificial Organs	22EBME441
18.	Computer Communication in Health Care Networking	22EBME442
19.	Medical Informatics and Expert systems	22EBME443
20.	Biomechanics	22EBME444

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Curriculum Content- Course wise

Program: Biomedical Engineering		**Semester: I**
Course Title: Single Variable Calculus		**Course Code: 18EMAB101**
L-T-P: 4-1-0	**Credits: 5**	**Contact Hours:5 hrs/week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 50Hrs	**Examination Duration: 3 Hrs**	

Unit I

1. Functions, Graphs and Models

Functions, types of functions, transformations and models (Linear, exponential, trigonometric).
MATLAB: Graphing functions, Domain-Range and Interpreting the models

2. Calculus of functions and models

Limit of a function, Infinite limits- graph, Continuity and discontinuity, Intermediate value theorem statement, Roots of the equation using Bisection Method and Newton- Raphson Method

Interpretation of derivative as a rate of change, All the rules of derivatives (List only), Maxima, Minima and optimization problems. Curvature and Radius of Curvature, Indeterminate forms, L- Hospital's Rule-Examples
MATLAB: optimization problems. Curvature problems

Unit II

3. Infinite Series

Definition, Convergence of series, Tests of convergence – p-series, Alternating series. Power series, radius of convergence, Taylor's and Maclaurin's series, Applications of Taylor's and Maclaurin's series
MATLAB: Convergence of series

4. Integral calculus

Tracing of standard curves in Cartesian form, Parametric form and Polar form; Beta and gamma function, relation between them, evaluation of integrals using Beta and gamma functions; Applications to find arc length, Area, Volume and surface area (Cartesian, parametric and polar curves). Approximate integration- Trapezoidal rule, Simpson's 1/3 rule
MATLAB: problems on arc length, area, volume and surface area

Unit III

5. Ordinary differential equations of first order

(a) Introduction to Initial Value problems. Linear and Bernoulli's equations, Exact equations and reducible to exact form, Numerical solution to Initial Value Problems-Euler's method, Modified Euler's method and Runge-Kutta method
(b) Applications of first order differential Equations-Orthogonal trajectories growth and decay problems, mixture problems, Electrical circuits, falling bodies.
MATLAB: Solve differential equations

Text Books

1. Early Transcendentals Calculus- James Stewart, Thomson Books, 7ed 2010.

Reference Books:

1. Calculus Single and Multivariable, Hughues-Hallett Gleason, Wiley India Ed, 4ed, 2009.

2. Thomas Calculus, George B Thomas, Pearson India, 12ed, 2010

Program: Biomedical Engineering		Semester: I
Course Title: Engineering Physics		Course Code: 15EPHB101
L-T-P: 3-0-0	Credits: 3	Contact Hours:3 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 50Hrs	Examination Duration: 3 Hrs	

Unit I

Chapter 1: Conduction in semiconductors

Atomic theory: The atom, electron orbits and energy levels, energy bands, Conduction in solids: Electron motion and hole transfer, conventional current and electron flow

Conductors, semiconductors and insulators: Bonding force between atoms, Energy bands in different materials.

n-type and p-type Semiconductors: Doping, n-Type material, p-Type material, Majority and minority charge carriers, Effects of heat and light, charge carrier density.

Semiconductor conductivity: Drift current, diffusion current, charge carrier velocity, conductivity, Hall Effect.

(Text 1 Page No 1-33)

Chapter 2: Junctions

The pn-Junctions: Junction of p-Type and n-Type, Barrier voltage, depletion region, Qualitative theory of p-n Junction

Biased junctions: Reverse biased junction, forward biased junction, junction temperature effects.

Junction currents and voltages: Shockley equation, junction currents, junction voltages.

p-n Junction Diode characteristics and parameters: Forward and reverse characteristics, diode parameters.

Diode approximations: Ideal diode and practical diodes, piecewise linear characteristics, DC equivalent circuits.

DC load line analysis: DC load line, Q-Point, calculating load resistance and supply voltage.

Temperature Effects: Diode power dissipation, forward voltage drops, dynamic resistance.

Diode AC models: Junction capacitance, AC-equivalent circuits (Reverse biased and forward biased), reverse recovery time.

Diode specifications: Diode data sheets, low power diodes, rectifier diodes

Diode testing: Ohmmeter tests, use of digital meter, plotting diode characteristics.

Zener diodes: Junction break down, circuit symbols and packages, characteristics and parameters, data sheet, equivalent circuits.

(Text 1 Page No 34-71)

Unit II

Chapter 3: Electrostatics

Review on vectors:

Coordinate Systems, Vector and Scalar Quantities, Properties of Vectors, Components of a Vector and Unit Vectors

(Text 2 Page No 59-77)

Electric Fields:

Properties of Electric Charges, Charging Objects by Induction, Coulomb's Law, Analysis Model: Particle in a Field (Electric), Electric Field of a Continuous Charge Distribution, Electric Field Lines Motion of a Charged Particle in a Uniform Electric Field

Gauss's Law:
Electric Flux, Gauss's Law, Application of Gauss's Law to Various Charge Distributions, Conductors in Electrostatic Equilibrium
Electric Potential:
Electric Potential and Potential Difference, Potential Difference in a Uniform Electric Field, Electric Potential and Potential Energy Due to Point Charges, Obtaining the Value of the Electric Field from the Electric Potential, Electric Potential Due to Continuous Charge Distributions Electric Potential Due to a Charged Conductor, Applications of Electrostatics
Capacitance and Dielectrics:
Definition of Capacitance, Calculating Capacitance, Combinations of Capacitors, Energy Stored in a Charged Capacitor, Capacitors with Dielectrics, Electric Dipole in an Electric Field, An Atomic Description of Dielectrics
(Text 2 Page No 690-807)

Unit III

Chapter 4: Electromagnetics

Magnetic Fields:
Analysis Model: Particle in a Field (Magnetic), Motion of a Charged Particle in a Uniform Magnetic Field, Applications Involving Charged Particles Moving in a Magnetic Field, Magnetic Force Acting on a Current-Carrying Conductor, Torque on a Current Loop in a Uniform Magnetic Field,
Sources of the Magnetic Field:
The Biot–Savart Law, The Magnetic Force Between Two Parallel Conductors, Ampere's Law, The Magnetic Field of a Solenoid, Gauss's Law in Magnetism, Magnetism in Matter
Faraday's Law:
Faraday's Law of Induction, Motional emf, Lenz's Law, Induced emf and Electric Fields Generators and Motors, Eddy Currents
(Text 2 Page No 868-969)

Text Book:

1. David A Bell, "Electronics Devices and Circuits", Fifth Edition, Oxford University Press.
2. Serway and Jewett, "Physics for Scientists and Engineers-with Modern Physics", 9th Edition, CENGAGE learning. 2014

Reference Books:

1. Jacob Millman and Christos Halkias, "Electronic Devices and Circuits" TMH
2. R P Feynman, Robert B Leighton, Matthew Sands, The Feynman Lectures on Physics Vol-II, Norosa Publishing House (1998).
3. Ben G Streetman, Solid State Electronic Devices, Prentice Hall, 1995

Program: Biomedical Engineering		Semester: I
Course Title: Engineering Mechanics		Course Code: 15ECVF101
L-T-P: 4-0-0	Credits: 4	Contact Hours:4 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 50Hrs	Examination Duration: 3 Hrs	

Unit I

Chapter 1: Overview of Civil Engineering

Evolution of Civil Engineering
Specialization, scope and role.
Impact of Civil Engineering on
National economy, environment and social & cultural fabric.
Challenges and Opportunities for Civil Engineers
Civil Engineering Marvels, Future challenges, Higher education and Research.

Chapter 2: Coplanar concurrent force system

Introduction to Engineering Mechanics:
Basic idealizations – Particle, Continuum, Body, Rigid body, Deformable body, Definition of force and its elements; Laws of Mechanics – Parallelogram law of forces, Principle of transmissibility, Law of Superposition, Newton's laws of motion. Classification of force systems

Resultant of coplanar concurrent force system: Definitions – Resultant, composition & Resolution of a force, Equilibrium, Equilibrant, Formulae for resultant of forces and resolution of a force. Numerical problems on resultant of forces.
Equilibrium of coplanar concurrent force system:
Conditions of equilibrium, Action & Reaction, Free body diagram, Lamis' theorem. Numerical problems on equilibrium of forces.

Chapter3 : Coplanar non-concurrent force system

Resultant of a force system: Moment, moment of a force, couple, moment of a couple, Characteristics of couple, Equivalent force-couple system, Numerical problems on moment of forces and couples, on equivalent force-couple system. Varignons principle of moments, Resultant of coplanar- non-concurrent force systems and numerical problems.

Unit II

Chapter4 : Equilibrium of a force system (Chapter 3 contd.)

Conditions of equilibrium, types of support and loading for a statically determinate beam, Reactions at support connections, Numerical problems on equilibrium of force systems and support reactions for a statically determinate beam.

Chapter 5: Static Friction

Introduction, types of friction, definition, limiting friction, coefficient of friction, laws of Coulomb friction, angle of friction and angle of repose, cone of friction. Wedge and belt friction theory. Derivation of belt friction formula. Numerical problems on, impending motion on horizontal and inclined planes (including connected bodies); wedge friction; Ladder friction and Belt friction.

Chapter 6: Simple Stress and Strain

Introduction, Properties of Materials, Stress, Strain, Elasticity, Elastic limit, Hooke's law & Young's modulus, Stress – Strain Diagram for structural steel, working stress and Factor of safety. Deformation of a bar due to force acting on it. Law of super position. Stresses in bars of uniform & varying cross sections. Composite sections. Problems connected to above topics.

Unit III

Chapter 7: Centroid of Plane Figures

Introduction, Definition, Methods of determining the centroid, axis of reference, axis of symmetry, Locating the centroid of simple plane figures (triangle, semicircle, quarter of a circle and sector of a circle etc.,) using method of integration, Numerical problems on Centroid of simple built up sections.

Chapter 8: Second moment of area (Plane figures)

Introduction, Definition, Method of determining the second moment of area, Section Modulus, Radius of gyration, perpendicular and Parallel axis theorems, Polar second moment of area, second moment of area of simple plane figures (triangle, rectangle, semicircle, circle etc,.) using method of integration, Numerical problems on MI of simple built up sections.

Text Books

1. Beer, F.P. and Johnston, R., *Mechanics for Engineers: Statics*, McGraw Hill Company, New York, 1988.
2. Bhavikatti, S.S., and Rajasshekarappa K.G., *Engineering Mechanics*, 3Ed., New Age International Pub. Pvt. Ltd., New Delhi, 2008.
3. Kumar, K.L., *Engineering Mechanics*, 3ed., Tata McGraw Hill Publishing Company, New Delhi, 2003.
4. Punmia, B.C., Jain, A. and Jain, A., *Mechanics of Materials*, Lakshmi Publications, New Delhi, 2006

Reference Books:

1. Jagadeesh, T.R. and Jayaram, *Elements of Civil Engineering*, Sapna Book House, Bangalore, 2006.
2. Ramamrutham, S., *Engineering Mechanics*, Dhanpat Rai Publishing Co., New Delhi, 1998.
3. Singer, F.L., *Engineering Mechanics*, 3rd edition Harper Collins, 1994.
4. Timoshenko, S.P. and Young, D.H., *Engineering Mechanics*, 4th edition, McGraw Hill Publishing Company, New Delhi, 1956.
5. Irving H Shames, *Engineering Mechanics*, 3rd edition, Prentice-Hall of India Pvt. Ltd, New Delhi- 110 001, 1995.

Program: Biomedical Engineering		Semester: I
Course Title: C Programming for Problem solving		Course Code: 18ECSP101
L-T-P: 0-0-3	Credits: 3	Contact Hours:6 hrs/week
ISA Marks: 80	ESA Marks: 20	Total Marks: 100
Teaching Hours: 78Hrs	Examination Duration: 3 Hrs	

Introduction to Problem solving

Introduction to algorithms / flowcharts and its notations, top down design, elementary problems.

Basics of C programming language

Characteristics and uses of C, Structure of C program, C Tokens: Keywords, Identifiers, Variables, Constants, Operators, Data-types, Input and Output statements.

Decision control statements

Conditional branching statements: if statement, if else statement, else if ladder, switch statement, unconditional branching statements: break, continue.

Introduction to Debugging Skills

Introduction to Test Driven Programming.

Iterative statements

while, do while, for, nested statements

Functions

Introduction, Function declaration, definition, call, returns statement, passing parameters to functions, introduction to macros.

Introduction to Coding Standards

Arrays and Strings

Introduction, Declaration, accessing elements, Storing values in arrays, Operations on one dimensional array, Operations on two dimensional arrays,

Introduction to Code Optimization and refactoring

Pointers

Introduction, declaring pointer, pointer variables, pointer expression and arithmetic, passing arguments to functions using pointers, pointers and arrays, passing an array to a function.

Structures and Unions

Introduction, passing structures to functions, Array of structures, Unions

Text Books

1. R.G. Dromey, how to Solve it by Computer, 1ed, PHI, 2008.
2. Yashvant Kanetkar, Let us C ,15th ed, BPS Publication, 2016.

Reference Books:

1. B W Kernighan, D M Ritchie, The Programming Language C, 2ed, PHI, 2004.
2. B S Gottfried, Programming with C, 2ed, TMH, 2006.
3. B.A. Forouzan, R.F. Gilberg, A Structured Program Approach Using C, 3ed, CENGAGE Learning, 2008.

Program: Biomedical Engineering		Semester: I
Course Title: Basic Electrical Engineering		Course Code: 18EEEF101
L-T-P: 3-0-0	Credits: 3	Contact Hours:3 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40Hrs	Examination Duration: 3 Hrs	

Unit I

Overview of Electrical Engineering

Specialization, scope & role, impact of Electrical Engineering on national economy, environment, Sources of generation, sustainability, challenges and opportunities for electrical engineers, electrical engineering marvels, future challenges.

DC Circuits

Voltage and current sources, Kirchoff's current and voltage laws, loop and nodal analysis of simple circuits with dc excitation. Time-domain analysis of first-order RL and RC circuits.

AC Circuits

Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase series and parallel R-L-C ac circuits. Three-phase balanced circuits, voltage and current relations in star and delta connections. power measurement using two watt meters

Unit II

Electrical Actuators

Electromagnetic principles, Solenoid, Relays, classification of Electric motors, DC motors-shunt, series, compound, separately excited, PMDC motors – Speed Control, Stepper Motors, BLDC motors, three phase induction motor, Characteristics and applications, selection of motors for various applications.

Power Electronics (Text1, chapter 45)

Introductory, Thyristor, some thyristor circuits, Limitations to thyristor operation, the thyristor in practice, the fully controlled AC/DC converter, AC/DC inversion, switching devices in inverters, Three-phase rectifier networks, the three-phase fully controlled converter, Inverter-fed induction motors, Soft-starting induction motors, DC to DC conversion switched-mode power

Unit III

Electrical Wiring, Safety and protection (Ref: Text3-page 1 to 10)

Types of wires and cables for internal wiring, Types of switches and Circuits, Types of wiring, Safety precautions and rules in handling electrical appliances, Electric shock, first aid for electrical shocks, Importance of grounding and earthing, Methods for earthing, Fuses, MCB, ELCB and Relays, Lockout and Tagout, Electrical Codes and Standards.

Batteries:

Basics of lead acid batteries, Lithium Ion Battery, Battery storage capacity, Coulomb efficiency, Numerical of high and low charging rates, Battery sizing. Numericals.

Text Books

1. Hughes, Electrical & Electronic Technology, 8th, Pearson Education, 2001
2. P C Sen, Principals of Electrical Machines and Power Electronics, 2nd, Wiley Publications
3. Gilbert M Masters, Renewable and efficient Electrical Power systems, Published by John Wiley & Sons 2004 edition
4. Frank D. Petronella, Electric Motors and Control Systems, McGraw Hill Education Private Limited 2009 Edition

Reference Books:

1. D C Kulshreshtha, Basic Electrical Engineering, Mc Graw Hill Publications
2. David G Alciatore and Michel B Histand, Introduction to Mechatronics and Measurement Systems, 3rd, Tata McGraw Hill Education Private Limited, New Delhi., 2005
3. Vincent Del Toro, Electrical Engineering Fundamentals, 2nd edition Prentice Hall India

KLE Technological University | Creating Value, Leveraging Knowledge

Program: Biomedical Engineering			**Semester: I**
Course Title: Design Thinking for Social Innovation			**Course Code: 20EHSP101**
L-T-P: 0-1-1	**Credits: 2**		**Contact Hours:3 hrs/week**
ISA Marks: 80	**ESA Marks: 20**		**Total Marks: 100**
Teaching Hours: 28Hrs	**Examination Duration: 3 Hrs**		

Module		Topics	Assignments	Support activities / Tools
KNOWLEDGE, TOOLS & DEVELOPMENT	**Course sensitization**	1. Introduction to Social Innovation: • Awakening social consciousness **(www.yourstory.com)** • Social Innovation and Leadership • Engineering& Social innovation (EPICS) **(Connecting SI Course to Mini Project, Capstone Project, Campus Placements)** • Course Overview • **Students' Self Introduction Activity** • Group formation **Activity**	**Reading assignments** • Read the handout on "The Process of Social Innovation" by Geoff Mulgan • Design thinking for Social Innovation **Written Assignments** • **Writing about Akshaya Patra in class.** **(Background information about Akshaya patra and the Social Cause it is addressing)** • **Brainstorming Session on Social Innovators in Class**	• Class activity on Behavioural Blocks to Innovation **Discussion on the behavioural blocks.** • **Introducing oneself with three Adjectives- Appreciating diversities and discovering self** • **Group Formation Activity (Forming square)** **(Making four equilateral triangles out of popsicle sticks to enhance group cohesiveness amongst the group mates)**

	Create Mindsets	**Seven Mindsets:** 1. Empathy **(Example of The Boy and the Puppies)** 2. Optimism **(Person Paralyzed waist down / Glass Half Full Half Empty)** 3. Iteration **(Thomas Alva Edison)** 4. Creative Confidence **(Origami – Josef Albers)** 5. Making it 6. Embracing Ambiguity **(Confusion is the Welcome doormat at the door of Creativity)** 7. Learning from Failure **(Designing Website first and then asking the stakeholders about the website)** **(Spending one lakh for the business which is never launched)**	**Reading assignments** • Handout on "Create Mindsets"	• **(How to train the Dragon? Common Video for all the mindsets)** • **Watching in Class TED Talk on "How to build your Creative Confidence by David Kelley – IDEO Founder)**
	Process of Social Innovation	**Engage** Community study and Issue Identification	**Reading assignments** • Handout on Community Study and Issue Identification • Case Study on "EGramSeva" • Case Study on "Janani Agri Serve" **Class Presentations**	• Activity on Observation skills To know how to use one's observation skills in understanding the social conditions • Experience

			• Initial observations being made by the group **(Literature Survey of Places of Hubli-Dharwad)** **www.readwhere.com** • Detailed interaction / engagements with the society and finalize the social issue for intervention **Use template 1: Frame your Design Challenge**	sharing by senior students • Brainstorming Deliberations on the initial observations and arrive at the "Social Issue" • Familiarization of the respective templates with the help of sample case study
		PEER REVIEW		
		2. Inspiration • Plan for the Research • Development of Interview guide • Capture your Learnings	**<u>Reading assignments</u>** • Handout on Overview of Inspiration **<u>Class Presentations</u>** • Entirety of the Social Issue • Identification of the Stake Holders **(Examples on Fluorescent Curtain and Students' Punctuality for Class)** • Interview Questions	• Familiarization of the respective templates with the help of sample case study

			(Role Play on Interview with Stakeholders) • Category wise Learnings capture **Use template 2: Plan your Research** **Template 3. Development of Interview Guide** **Template 4. Capture your Learning**	
		3. Ideation **3.1 Synthesis** • Search for meaning • Create "How might we" question	**Reading assignments** • Handout on Overview of Ideation-Synthesis **Class Presentations** • Create insights • "How might we" questions **Use template 5: Create Insights** **Template 6: Create "How Might We' Questions**	• Familiarization of the respective templates with the help of sample case study

		3.0 Ideation **3.2 Prototyping** • Generate Ideas • Select Promising Ideas • Determine what to prototype • Make your prototype • Test and get feedback	**Reading assignments** • Handout on Overview of Ideation-Prototyping **Class Presentations** • Story board- demonstrating the possible solutions **Use template 7: Select your best ideas** **Template 8 : Determine what to prototype**	• Brain storming • Familiarization of the respective templates with the help of sample case study • Activity on Risk management • Activity on Resource management Structure building games
		PEER REVIEW		
		4.0 Implementation • Create an action plan • Community Partners (if any) • Budgeting & Fundraising 1. **Peer to Peer** 2. **Crowd Funding** 3. **Giving Kiosks** 4. **Donation** 5. **Envelop Funding** 6. **Marathons/**	**Reading assignments** • Handout on Overview of Implementation **Class Presentations** • Pilot implementation plan with required resources and Budget indicating stake holders & their engagement	• Familiarization of the respective templates with the help of sample case study

		Walkathons **7. Conducting Yoga Classes** **(www.causevox.com / www.blog.fundly.com)** • Duration • Ethical concerns • Launch your solution • Feedback (Impact**)**		
		5.0 Reflect Reflection of the overall learning by the students	**<u>Reading assignments</u>** • Handout on Overview of students Reflection **Use template 9:** **Reflection on the Process** **<u>Class Presentations</u>** Final Presentation- After Implementation	• Familiarization of the respective templates with the help of sample case study

Program: Biomedical Engineering		**Semester: I**
Course Title: Engineering Physics lab		**Course Code: 16EPHP101**
L-T-P: 0-0-1	**Credits: 1**	**Contact Hours:2 hrs/week**
ISA Marks: 80	**ESA Marks: 20**	**Total Marks: 100**
Teaching Hours: 24Hrs	**Examination Duration: 3 Hrs**	
List of Experiments		
1. Four probe method		
2. V-I characteristics of p-n junction diode		
3. Zener diode characteristics		
4. Hysteresis loss		
5. Transistor characteristics		
6. Measurement of dielectric constant		
7. Resonance frequency of LCR circuits		
8. Study of frequency response of passive components		
9. Calibration of thermocouple		
10. Calibration of electrical meters		

Program: Biomedical Engineering		Semester: II
Course Title: Multivariable calculus		Course Code: 18EMAB102
L-T-P: 4-1-0	Credits: 5	Contact Hours:5 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 50Hrs	Examination Duration: 3 Hrs	

Unit I

1. **Partial differentiation**
   Function of several variables, Partial derivatives, Level curves, Chain rule, Errors and Approximations. Extreme value problems. Lagrange's multipliers.
2. **Double integrals**
   Double integrals- Rectangular and polar coordinates, Change the order of integration. Change of variables, Jacobian. Application of double integrals

MATLAB: optimization problems, application of double integrals

Unit II

3. **Triple integrals**
   Triple integrals, Cartesian, change to Cylindrical and Spherical Coordinates Application of Triple integrals
4. **Calculus of Vector Fields**
   Vector fields, Gradient and directional derivatives. Line and Surface integrals. Independence of path and potential functions. Green's theorem, Divergence of vector field, Divergence theorem, Curl of vector field. Stokes theorem.

MATLAB: application of Triple integrals, Vector calculus problems

Unit III

5. **Differential equations of higher orders**
   (a) Linear differential equations of second and higher order with constant coeffiISAntsThe The method of Variation of parameters. Initial and boundary value problems. (b) Applications of second order differential Equations-Newton's 2nd law, electrical circuits, Simple Harmonic motion. Series solution of differential equations. Validity of Series solution of Differential equations.

MATLAB: application of differential equations

Text Books

1. Early Transcendentals Calculus- James Stewart, Thomson Books, 7ed 2010.

Reference Books:

1. Calculus Single and Multivariable, Hughues-Hallett Gleason, Wiley India Ed, 4ed, 2009.
2. Thomas Calculus, George B Thomas, Pearson India, 12ed, 2010

Program: Biomedical Engineering		Semester: II
Course Title: Engineering Chemistry		Course Code: 15ECHB102
L-T-P: 3-0-0	Credits: 3	Contact Hours:3 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 50Hrs	Examination Duration: 3 Hrs	

Unit I

1. Chemical Bonding

Introduction, Ionic bond, factors influencing the formation of Ionic bond: Ionization energy. Electron affinity & electro negativity and properties of Ionic compounds. Covalent bond: Valence Bond theory & Molecular Orbital theory – formation of hydrogen molecule, factors influencing the formation of covalent bond, polar and non-polar covalent bond, dipole moment, problems on calculation of percentage of Ionic character and properties of covalent compounds, Co-ordinate bond: formation of hydronium ion and ammonium ion.

2. Electrochemical Energy Systems

Electrode potential, Nernst equation, formation of a cell; Reference electrodes – Calomel electrode, Determination of electrode potential, numerical problems on E, E_{cell}& E^0_{cell}.

Batteries: Classification, Characteristics, Lead - acid, Lithium ion battery. Fuel cells - Methonol-O_2 fuel cell.

3. Polymers

Introduction, polymerization; mechanism of polymerization taking ethylene as an example. Determination of molecular weight of a polymer – numerical problems. Commercial polymers - Plexi glass, PS, polyurethane.

Polymer composites: Carbon fiber and Epoxy resin – synthesis, properties and applications. Introduction to conducting polymers, mechanism of conduction in poly acetylene and applications.

Unit II

4. Plating Techniques

Introduction, technological importance. Electroplating, Principles of electroplating. Factors affecting nature of electrodeposit, throwing power, Numerical problems on throwing power, Electroplating process of gold by acid cyanide bath. Electro less plating, advantages of electro less plating over electroplating. Electro less plating of Cu and its application in the manufacture of PCB.

5. Wafer Technology

Introduction, physical and chemical properties of silicon. Purification of silicon; chemical vapor deposition (CVD) process, zone refining process. Crystal growth; preparation of single crystal silicon by Czhochralski crystal pulling technique – numerical problems. Crystal slicing and wafer preparation. Fabrication process: thermal oxidation, diffusion, ion implantation – numerical problems, epitaxial growth, masking and photolithography, wet etching, dry etching.

6. Material Chemistry

Liquid Crystals – Types of liquid crystals, applications of Liquid Crystal in Display system.

Fluorescence and Phosphorescence – Jablonski diagram, Thermoelectric and Piezoelectric materials – meaning, properties and applications.

Unit III

7. Instrumental methods of measurement

Advantages over conventional methods. Electro analytical methods: Potentiometer - principle, methodology and applications. Opt analytical methods: Colorimeter - Principle, methodology and applications.

Spectral methods of analysis: UV – Spectrophotometer - Instrumentation and applications.

8. Environmental Chemistry:

Water: Sources and ill effects of water pollutants – fluoride and nitrate; determination of total hardness of water by EDTA method – numerical problems. Sewage: Determination of Biological Oxygen Demand by Winkler's method – numerical problems and determination of Chemical Oxygen Demand – numerical problems.

Text Books

1. A text Book of Engineering Chemistry, 1st edition, Dara. S. S, S. Chand & Co. Ltd., 2009, New Delhi.
2. A text Book of Engineering Chemistry, 16th edition, Jain P.C and Jain M, Dhanpat Rai Publications, 2006, New Delhi.

Reference Books:

1. Text book of Inorganic Chemistry, P.L. Soni, Sultan Chand, 1999, New Delhi.
2. Hand book of batteries, David Linden, Thomas B Reddy, 3rd edition Mc Graw Hill publications, 2001, New York.
3. Polymer Science, 6th Edition, Gowariker V.R., Viswanathan N.V., Sreedhar J., New Age International (P) Ltd, 2007, New Delhi.
4. Solid State Devices& Technology, 4thEdition, V. Suresh Babu, sanguine Technical Publishers, 2005, Bangalore.
5. Material Science & Engineering: An Introduction, 9th Edition, Calister William D, John Wiley and sons, 2007, New York.
6. Instrumental methods of Chemical analysis, 5th Edition, Gurudeep R Chatwal, Shan K Anand, Himalaya Publishing House Pvt. Ltd, 2010, Mumbai.
7. VLSI Technology, 2nd Edition, S.M.Sze, McGraw Hill Series in electrical and computer engineering, 1998, New York.

Program: Biomedical Engineering		**Semester: II**
Course Title: Problem Solving with Data Structures		**Course Code: 18ECSP102**
L-T-P: 0-0-3	**Credits: 3**	**Contact Hours:6 hrs/week**
ISA Marks: 80	**ESA Marks: 20**	**Total Marks: 100**
Teaching Hours: 78Hrs	**Examination Duration: 3 Hrs**	

Pointers, Structures and Files

Recap of basics: Pointers ,Structures; Self-referential structures, dynamic memory management Files – File manipulation programs

Stacks and Recursion

Stack: Definition, Operations, Stack ADT Implementation of stack operations. Applications of stack. Recursion- Need for Recursion and problems on Recursion.

Queues

Queue: Definitions of Linear, Circular queues, Queue ADT Linear and circular queue operations Definition and working of Priority queue, Double ended queue; Applications of queues.

Lists

Concept of lists and dynamic memory management lists, definitions and representations: singly, doubly, circular lists. Dynamic Implementation of lists and its operations, Applications of linked lists

Binary trees

Binary Tree: Definition, Terminology and representation, Tree Traversals both recursive and iterative. Binary Search Tree and its applications.

Text Books

1. Data Structures with C -- Seymour Lipschutz, Schaum's Outline Series
2. Data Structures Using C and C++ -- Langsam and Tanenbaum, PHI Publication
3. Data Structures Through C -- Yashavant P Kanetkar, BPB Publication

Reference Books:

1. B W Kernighan, D M Ritchie, The Programming Language C, 2ed, PHI, 2004.
2. B S Gottfried, Programming with C, 2ed, TMH, 2006.
3. B.A. Forouzan, R.F. Gilberg, A Structured Program Approach Using C, 3ed, CENGAGE Learning, 2008.

Program: Biomedical Engineering		**Semester: II**
Course Title: Engineering Exploration		**Course Code: 15ECRP101**
L-T-P: 0-0-3	**Credits: 3**	**Contact Hours:6 hrs/week**
ISA Marks: 80	**ESA Marks: 20**	**Total Marks: 100**
Teaching Hours: 78Hrs	**Examination Duration: 3 Hrs**	
List of Experiments		
1. Introduction to Engineering and Engineering Study		
2. Role of Analysis in Engineering, Analysis Methodology		
3. Data Analysis Graphing		
4. Basics of Engineering Design, Multidisciplinary Nature of Engineering Design		
5. Project Management		
6. Sustainability in Engineering		
7. Ethics		
8. Modeling, Simulation and Data Acquisition using Software Tool		
9. Platform based development : Arduino		
10. Course Project		

Reference Books:

1. Engineering Fundamentals & Problem Solving by Arvid Eide, Roland Jenison, Larry Northup, Steven, McGraw Hill Higher Education, 6th Edition (2011)
2. Engineering Exploration (Edited Book, 2008) by Pearson Publication

Program: Biomedical Engineering		Semester: II
Course Title: Basic Electronics		Course Code: 18EECF101
L-T-P: 4-0-0	Credits: 4	Contact Hours:4 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 50Hrs	Examination Duration: 3 Hrs	

Unit I

Chapter 1: Trends in Electronic Industries:

Introduction, Roadmap of electronic sector, scope and opportunities in various segments of electronics (i.e., Consumer, Telecom, IT, Defense, Industrial, Medical and Automobiles), Government and private sectors, Growth profile of Electronic industries, Standards and Polis's, Electronic System Components.

Chapter 2: Basic Components, Devices and Applications:

Diode: PN junction characteristics; modeling as a circuit element, ideal and practical diode. AC to DC converter: Half wave and full wave rectifier (centre tap and bridge), capacitor filter and its analysis, numerical examples. Zener diode and its applications (Voltage reference and voltage regulator). Realization of simple logic gates like AND OR gates.

Chapter 3: Transistor:

BJT, transistor voltages and currents, Signal amplifier (Fixed bias, Collector base bias, Voltage divider bias, CE configuration). DC load line. Voltage, current and power gains. Transistor as a switch: NOT Gate, Basic (DTL) NAND gate. Transistor as a Small Signal Amplifier (Single Stage and Two Stage RC-coupled Amplifier).

Unit II

Chapter 4: Digital Logic:

Number systems: Decimal, Binary, Octal and Hexadecimal number systems, Conversions, Binary Operations-Addition and subtraction in binary number systems. Logic gates: Realization of simple logic functions using basic gates (AND, OR, NOT), Realization using universal gates (NAND, NOR). Boolean algebra: Theorems and postulates, DeMorgan'sTheorems, simplification of logical expressions, Karnaugh Maps, Use of Karnaugh Maps to Minimize Boolean Expressions (2 Variables, 3 Variables and 4 Variables), Design of Half Adder and Full Adder, Parallel Adder using full adders**.**

Chapter 5: Operational Amplifier:

OPAMP characteristics (ideal and practical), Linear and non-linear applications: Inverting amplifier, Non inverting amplifier, Voltage follower, Integration, Differentiation, Adder, Subtractor, ZCD and Comparator.

Unit III

Chapter 6: Communication Systems:

Basic block diagram of communication system, types of modulation. Amplitude modulation: Time-Domain description, Frequency-Domain description. Generation of AM wave: square law modulator. Detection of AM waves: envelope detector. Double side band suppressed carrier modulation (DSBSC), Generation of DSBSC wave: balanced modulator, Super heterodyne principle.

Chapter 7: Linear Power Supply, UPS & CRO:

Working principle of linear power supply, UPS and CRO. Measurement of amplitude, frequency

and phase of a given signal.

Text Books

1. David A Bell, Electronic devices and Circuits, PHI New Delhi, 2004
2. K. A Krishnamurthy and M.R. Raghuveer, Electrical, Electronics and Computer Engineering for SISAntist and Engineers, 2, New Age International Publishers, 2001
3. A.P. Malvino, Electronic Principles, Tata McGraw Hill, 1999

Reference Books:

1. George Kennedy, Electronic Communication Systems, Tata McGraw Hill, 2000
2. Morris Mano, Digital logic and Computer design, 21st Indian print Prentice Hall India, 2000
3. Floyd, Digital fundamentals, 3, Prentice Hall India, 2001
4. Boylestead Nashelsky, Electronic devices & Circuit theory, Prentice Hall India, 2000
5. Ramakant Gaikawad, Operational Amplifiers & applications, PHI, 2000

Course Title: Basic Mechanical Engineering		Course Code: 15EECF101
L-T-P: 2-1-0	Credits: 3	Contact Hours:4 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 50Hrs	Examination Duration: 3 Hrs	

Unit I

Chapter 1: Introduction to Mechanical Engineering:

Definition of engineering, Mechanical Engineering, Branches of Mechanical Engineering, who are Mechanical Engineers? Mechanical Engineers' top ten achievements.

Visit to Workshop and Machine Shop, Tools, Safety Precautions

Video presentations

Chapter 2: Manufacturing Engineering: Basics of Manufacturing

What is manufacturing? The main manufacturing sectors, The importance of the main manufacturing sectors to the Indian economy, Scales of production

Classification of manufacturing Processes.

Advances in Manufacturing: CNC machines, Mechatronics and applications

Demonstration on working of Lathe, milling, drilling, grinding machines

Demonstration on Welding (Electric Arc Welding, Gas Welding, Soldering)

Demonstration and Exercises on Sheet metal work.

Visit to Learning Factory

Unit II

Chapter 3: Design Engineering: Power Transmission Elements

Overview

Design Application:

- Belt Drives. Types, Length of Belt. Velocity Ratio, Initial Tension. Ratio of Tensions. Power Transmitted, Numerical Problems.
- Gears. Spur Gear, Rack and Pinion, Worm Gear, Bevel Gear, Helical Gears. Speed, Torque, and Power in Gear pair. Simple and Compound Gear trains. Numerical Problems.
- Ball and Roller Bearings, Types, Applications.

Design Problems like a moving experience, aluminium can crusher

Video presentations

Chapter 4: Thermal Engineering 1: Prime Movers.

Internal Combustion Engines: Classification, IC engine parts, 2 stroke SI and CI engine, 4 Stroke SI and CI Engine, PV diagrams of Otto and Diesel cycles, Comparison of 2 stroke and 4 stroke engine, comparison of CI and SI engine, Problems on Engine Performance, Future trends in IC engines.

Case study on power requirement of a bike, car or any machine

Video presentations

Unit III

Chapter 5: Thermal Engineering 2: Thermal Systems' Applications

Refrigeration system, Air conditioning system, Pumps, Blowers and Compressors, Turbines, and their working principle and specifications.

Case study on selection of various thermal systems

Video presentations

Text Books

1. Jonathan Wickert and Kemper Lewis, An Introduction to Mechanical Engineering, Third Edition, 2013- Cengage Learning.4
2. K.R. Gopalkrishna, Sudhir Gopalkrishna, S.C. Sharma. A Text Book of Elements of Mechanical Engineering, 30th Edition, Oct 2010,–Subhash Publishers, Bangalore.

Reference Books:

1. Course Material developed by the Department of Mechanical Engineering.
2. SKH Chowdhary, AKH Chowdhary, Nirjhar Roy, The Elements of Workshop Technology - Vol I & II, 11th edition 2001, Media Promoters and Publishers.
3. Basic Manufacturing, Roger Timings, Third edition, Newnes, An imprint of Elsevier

Program: Biomedical Engineering		**Semester: II**
Course Title: Professional Communication		**Course Code: 15EHSH101**
L-T-P: 1-1-0	**Credits: 2**	**Contact Hours:3 hrs/week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 42Hrs	**Examination Duration: 3 Hrs**	

List of Experiments

Chapter No. 1. Basics- English Communication

Course Introduction, Explanation of template mix-ups with correct usages & necessity of grammar in error detection, Usage of tenses

Chapter No. 2. Vocabulary and grammar

Vocabulary, Word Formation and Active and Passive Voice

Chapter No. 3. Bouncing Practice

Definition and types of bouncing and its practice with examples, reading skills, free style speech.Individual presentation.

Chapter No. 4. Rephrasing and Structures

Comprehension and Rephrasing, PNQ Paradigm and Structural practice.

Chapter No. 5. Dialogues

Introduction of dialogues, Situational Role plays.

Chapter No. 6. Business Communication

Covering letter, formal letters, Construction of paragraphs on any given general topic.

Reference Books:

1. Collins Cobuild Advanced Learner's English Dictionary
2. Raymond Murphy - Intermediate English Grammar, Cambridge University Press
3. Martin Hewings- Advanced English Grammar, Cambridge University Press.

Program: Bachelor of Engineering (Biomedical Engineering)		Semester: II
Course Title: Basic Electrical and Electronics Engineering		Course Code: 21EEXF101
L-T-P: 4-0-0	Credits: 4	Contact Hours: 4 Hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 50Hrs	Examination Duration:3 Hrs	

Unit I

Chapter 1: Introduction to Electrical & Electronics Technology

Electrical Power Generation (convention and renewable energy sources, with PV elaborated), transmission, distribution, utilization (Electric Vehicle as a case study), Electrical and Electronic Systems, concept and power of abstraction, lumped circuit abstraction, and its limitation.

Chapter 2: The Circuit Abstraction

Energy storage and dissipating elements (RLC), Ideal and practical sources, series and parallel circuits, concept of order of the system, voltage dividers, RC, RL, RLC with KCL and KVL, Mesh and Nodal analysis with an example.

Chapter 3: Introduction to Transformer and Electric Drive

Electromagnetic principles, classification of electric machines – static and rotary, transformers, motors, PMDC, stepper, BLDC, single and three-phase induction motors, selection of motors for various applications. Safety measures.

Unit II

Chapter No. 4: Semiconductor Devices and its Applications

Fundamentals of semiconductors, PN junction diode, BJT, FET, Thyristors, Integrated circuits, Linear application – Transistors and Operational amplifiers, oscillators (Op-Amp based), Nonlinear application – Power electronics converters.

Chapter No. 5: Digital Abstraction

Concept of digital abstraction, Number systems, base conversion – binary, decimal, hexadecimal, BCD, Gray code, Boolean algebra, logic gates, combinational circuits, - half adders, full adders, half subtractor and full subtractor using k-maps for 2 or 3 variables, sequential circuits – registers, counters.

Chapter No. 6: Mechatronic Subsystem

Power supply, Introduction to sensors and actuators, signal conditioning and interfacing, Control logic design for mechatronic applications.

Text Books:

1. Anant Agarwal and Jefferey H. Lang, Foundations of Analog and Digital Electronic Circuits, Morgan Kaufmann -Elsevier, 2005
2. Hughes, Electrical and Electronic Technology, 12th Edition, Pearson, 2016.

Reference Books:

1. N.P. Mahalik, Mechatronics - Principles, Concepts and Applications, Tata McGraw-Hill, 2011
2. K. A Krishnamurthy and M.R. Raghu veer, Electrical, Electronics and Computer Engineering for Scientist and Engineers, 2, New Age International Publishers, Wiley Eastern, 2001
3. George Kennedy, Electronic Communication Systems, 4, Tata McGraw Hill, 2000
4. Morris Mano, Digital Logic and Computer Design, 21st Indian print Prentice Hall India, 2000
5. Boylestead Nashelsky, Electronic devices & Circuit theory, 6, Prentice Hall India, 2000
6. David A Bell, Electronic Devices and Circuits, PHI New Delhi, 2004
7. Ramakant Gayakwad, Operational Amplifiers & applications, 3, PHI, 2000
8. W.Bolton, Mechatronics - Electronic Control Systems in Mechanical and Electrical Engineering, 3, Pearson Education, 2005
9. Ernest O Doeblin, Dhanesh N Manik, Measurement Systems, 6th Edition, McGraw Hill Education; 2017

Program: Bachelor of Engineering (Biomedical Engineering)		Semester: III Semester
Course Title: Integral transforms and Statistics		**Course Code:15EMAB203**
L-T-P: 4-0-0	**Credits: 4**	**Contact Hours: 4 Hrs/week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 50Hrs	**Examination Duration:3 Hrs**	

Unit I

Chapter 1. Laplace Transforms

Definition, transforms of elementary functions- transforms of derivatives and integrals- Properties. Periodic functions, Unit step functions and Unit impulse functions.

Inverse Transforms- properties- Convolution Theorem. Initial and Final value theorems, examples; Applications to differential equations, Circuit equations

Chapter 2: Probability

Definition of probability, conditional probability, Baye's rule, Chebyshev's inequality, random variables- PDF-CDF- Probability Distributions: Binomial, Poisson, Exponential, Uniform, and Normal.

Unit II

Chapter 3: Regression

Introduction to method of least squares, fitting of curves=a+bx, $y = ab^x$, correlation and regression. Engineering problems.

Chapter 4: Fourier Series

Complex Sinusoids, Fourier series representations of four classes of signals, Periodic Signals: Fourier Series representations, Derivation of Complex Co-efficient of Exponential Fourier Series and Examples. Convergence of Fourier Series. Amplitude and phase spectra of a periodic signal. Properties of Fourier Series (with proof): Linearity, Symmetry Properties, Time shift, Frequency Shift, Scaling, Time differential differentiation coefficients, Time domain Convolution, Multiplication Theorem, Parseval's theorem and Examples on these properties.

Chapter 6: Fourier Transform

Fourier representation of non-periodic signals, Magnitude and phase spectra. Properties of Fourier Transform: Linearity, Symmetry Properties, Time shift, Frequency Shift, Scaling, Time differential differentiation coefficients, Time domain Convolution, Multiplication Theorem, Parseval's theorem and Examples on these properties.

Unit III

Chapter 6: Random Process:

Introduction to Joint Probability Distributions, marginal distribution, joint pdf and cdf, mean, variance, covariance, correlation.

Introduction to Random process, stationary process, mean, correlation and covariance function, autocorrelation function, cross correlation, Power spectral Density: properties of the spectral density; Gaussian Process: Properties of Gaussian process.

Text Books

1. Kreyszig E., Advanced Engineering Mathematics, 10th edition, Wiley, 2015
2. Gupta S C and Kapoor V K, Fundamentals of Mathematical Statistics, 11th edition, Sultan Chand & Sons, 2018
3. Walpole and Myers, Probability and Statistics for Engineers and Scientists, 9th edition, Pearson Education India,2013.

Reference Books:

1. Simon Haykin, Barry Van Veen, Signals and Systems Wiley; Second edition ,2007
2. J. Susan Milton, Jesse C. Arnold, Introduction to Probability and Statistics: Principles and
3. Applications for Engineering and the Computing Sciences, 4th edition, TATA McGraw-Hill Edition, 2017
4. Ian Glover & Peter Grant, Digital Communications, 3rd edition, Pearson 2009.

Back to Semester- III

KLE Technological University | Creating Value, Leveraging Knowledge

Program: Biomedical Engineering		Semester: III
Course Title: Corporate Communication		Course Code: 22EHSH201
L-T-P: 0.5-0-0	Credits: 0.5	Contact Hours: 1 hrs/week
ISA Marks: 100	ESA Marks: --	Total Marks: 100
Teaching Hours: 16Hrs	Examination Duration: 3 Hrs	

Chapter No. 1. Communication Skills

Tools of Communication, Listening, Body Language, Common Postures and Gestures, Open and Closed Body Language, Body Language to be used in Corporate Scenarios, Voice: Pitch, Pace, and Pause, Verbal Language: Positive & Negative Vocabulary, Corporate Conversations

Chapter No. 2. Presentation Skills

Zero Presentation, Individual Presentations, and feedback, Making Presentations Interactive, Types of Questions, Taking off and Signing off differently, Captivating your Audience, Corporate Presentations

Chapter No. 3. Spoken English

Phonetic and Non-Phonetic Languages, Introduction to IPA, Sounds in English, Syllables, Word Stress, Rhythm, Pausing, and Intonation

Chapter No. 4. Written English

Vocabulary Enhancement Strategies, Root Words in English, Grammar Improvement Techniques, Dictionary Usage, Similar and Contradictory Words

Reference Books:

1. Diana Booher - Communicate with Confidence, Mc Graw Hill Publishers
2. Norman Lewis – Word Power Made Easy, Goyal Publishers
3. Cambridge Advanced Learner’s Dictionary, Cambridge University Press.

Program: Bachelor of Engineering (Biomedical Engineering)		Semester: III Semester
Course Title: Circuit Analysis		**Course Code: 22EBMC201**
L-T-P: 4-0-0	**Credits: 4**	**Contact Hours: 4 Hrs/week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 50Hrs	**Examination Duration:3 Hrs**	

Unit I

Chapter 1: Basics

Active and passive circuit elements, Voltage & current sources, Resistive networks, Nodal Analysis, Super node, Mesh Analysis, Super mesh, Star – Delta Transformation.
[Text 1: Chapter 4,5, 7]

Chapter 2: Network Theorems

Homogeneity, Superposition and Linearity, Thevenin's 's& Norton 's Theorems, Maximum Power Transfer Theorem, Miller 's theorem, Reciprocity principle.
[Text 1: Chapter 5]

Chapter 3: Network topologies

Graph of a network, Concept of tree and co-tree, incidence matrix, tie set and cut set schedules, Formulation of Equilibrium equations in matrix form, Solution of resistive networks.
[Text 1: Chapter 5]

Unit II

Chapter 4: Two Port Networks

Two port variables, Z, Y, H, G, A- Parameter representations, Input and output impedance calculation, Series, Parallel and Cascade network connections, and their (suitable) models.
[Text 2: Chapter 11]

Chapter 5: Time and Frequency Domain Representation of Circuits

Order of a system, Concept of Time constant, System Governing equation, System Characteristic equation, Initial conditions, Transfer Functions (Fourier and Laplace domain representation)
[Text 2: Chapter 4]

Chapter 6: First order circuits

Transient response of R-C and R-L networks (with Initial conditions) Concept of phasor, Phasor diagrams, Frequency response characteristics, Polar Plots-C, R-L circuits as differentiator and integrator models, time and frequency domain responses R-C, R-L circuits as Low pass and high pass filters
[Text 2: Chapter 5, Text 1: Chapter 8,9,10]

Unit III

Chapter No. 7. Higher order circuits

Higher order R-C, R-L, and R-L-C networks, time domain and frequency domain representation, Series R-L-C circuit, Transient response, damping factor, Performance parameters, Quality factor, Frequency response curve, peaking of frequency curve and its relation to damping factor. Series and Parallel Resonance, Quality factor, Selectivity and Bandwidth

[Text 2: Chapter 7,8] [Text 1: Chapter 4,5, 7]

Text Books

1. W H Hayt, J E Kemmerly, S M Durban, "Engineering Circuit Analysis" McGraw Hill Education; Eighth edition ,2013
2. M E. Van Valkenburg, Network Analysis, Third edition Pearson Education, 2019

Reference Books:

1. Joseph Edminister, Mahmood Nahavi, Electric Circuits, 5th edition, McGraw Hill Education, 2017
2. V. K. Aatre, —Network Theory and Filter Design,3rd edition, New Age International Private Limited,2014

Program: Bachelor of Engineering (Biomedical Engineering)		Semester: III Semester
Course Title: Analog Electronic Circuits		Course Code:22EBMC202
L-T-P: 4-0-0	Credits: 4	Contact Hours: 4 Hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 50Hrs	Examination Duration:3 Hrs	

Unit I

Chapter 1: Diode Models and Circuits

Recap of diode models: Exponential model, piece-wise linear model, constant voltage drop model, ideal diode model, small signal diode model and derivation of small signal diode resistance. Applications of diodes as a Clipping and clamping circuits with and without DC bias voltage; Voltage doublers Numericals on applications.

(T1: 2.2, 2.3.1 to 2.3.8, 2.6.1to 2.6.3.)

Chapter 2: Bipolar junction transistors

Recap of DC load line and bias point, small signal operation-the transfer characteristics, the amplifier gain, and operation as a switch. Biasing of BJT: voltage divider, small signal models of bipolar transistors, two port modelling of amplifiers, H-model, ac analysis of BJT circuits-coupling and bypass capacitor, Common emitter circuit analysis without RE resistance (Emitter resistor) Numericals on amplifiers and switch

(T1: 3.2.1,3.2.2, 3.2.3, 3.2.4, 3.3.1, 3.3.2, 3.3.4)

Chapter 3: MOSFETs structure and physical operation

MOSFET Device structure, NMOS :Depletion type ; operation with no gate voltage, positive and negative gate voltage and Enhancement type ; operation with no gate voltage, positive and negative gate voltage creating a channel for current flow, applying small vds, operation as vds is increased, Derivation of threshold voltage of MOSFET, Operating the MOS transistor in the sub threshold region, Pinch off effect , channel length modulation effect , derivation of the ID-VDS relationship, with and without channel length modulation. Finite output resistance (rds on) in saturation, PMOS: Drain and Transfer characteristics, circuit symbol, the ID v/s VDS characteristics, and the role of the substrate-the body effect, temperature effects, breakdown and input protection. Threshold Voltage Derivation MOSFET circuits at DC.

Unit II

Chapter 4: Biasing of MOSFETs

MOSFET circuits at DC continued. Biasing in MOS amplifier circuits: By fixing VGS; By fixing VG; With drain to gate feedback resistor; Constant current source biasing, MOSFET as a switch Large – signal operation, operation as a linear amplifier and Numericals.

(T1:4.3)

Chapter 5: MOSFET amplifiers

Small signal operation and models, single stage MOS amplifiers, the MOSFET internal capacitance, Derivation of CS, CG and CD amplifiers parameters and its comparison, Implications on gain and Bandwidth. Source degenerated common source amplifier, cascode and cascaded circuits High frequency model of the MOSFET, revision of common-gate, common- source, common-drain circuits; poles and zeros in the transfer function

(T1:4.4,4.5, 4.6.1 to 4.6.7, 4.7.1, 4.7.2, 4.7.3, 4.7.5, 4.7.6, 4.7.7;4.8.1,4.8.2, 4.8.3,4.8.4, 4.9.1 to 4.9.3)

Unit III

Chapter 6: Feedback Amplifiers

General feedback structure (Block schematic), Feedback desensitivity factor, positive and negative feedback Nyquist stability Criterion, RC phase shift oscillator, Wein bridge Oscar, merits of negative feedback, feedback topologies: series-shunt feedback amplifier, series-series feedback amplifier, and shunt-shunt and shunt-series feedback amplifier with examples
(T1:7.1 to 7.6)

Chapter 7: Large Signal Amplifiers

Classification of amplifiers: (A, B, AB and C); Transformer coupled amplifier, push-pull amplifier Transistor case and heat sink.
(T1:12.1 to 12.6;12.8.4)

Text Books

1. A.S. Sedra& K.C. Smith, "Microelectronic Circuits",7th edition, Oxford University Press, 2017

Reference Books:

1. Jacob Millman and Christos Halkias-Integrated Electronics "McGraw Hill Education, 2nd edition 2017
2. David A. Bell,-Electronic Devices and Circuits, Oxford Fifth edition 2008
3. Grey, Hurst, Lewis and Meyer,-Analysis and design of analog integrated circuits, Wiley,5th edition 2009
4. Thomas L. Floyd,-Electronic devices, Pearson, 10th edition, 2018
5. Richard R. Spencer & Mohammed S. Ghousi, — Introduction to Electronic Circuit Design‖, Pearson Education,2003
6. J. Millman& A. Grabel, "Microelectronics"-2nd edition, McGraw Hill,2017
7. Behzad Razavi,-Fundamentals of Microelectronics, 2nd edition Wiley;2013

Program: Bachelor of Engineering (Biomedical Engineering)		Semester: III Semester
Course Title: Digital Circuits		**Course Code: 19EBMC201**
L-T-P: 4-0-0	**Credits: 4**	**Contact Hours: 4 Hrs/week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 50Hrs	**Examination Duration:3 Hrs**	

Unit I

Chapter 1: Logic Families

Logic levels, output switching times, fan-in and fan-out, comparison of logic families

Chapter 2: Principles of Combinational Logic

Definition of combinational logic, canonical forms, Generation of switching equations from truth tables, Karnaugh maps-3,4 variables, incompletely specified functions (Don ‘t care terms), Simplifying Maxterm equations, Quine-McCluskey minimization technique- Quine-McCluskey using don ‘t care terms, Reduced Prime Implicant Tables.

Chapter 3: Analysis and design of combinational logic

General approach, Decoders-BCD decoders, Encoders, Digital multiplexers- Using multiplexers as Boolean function generators. Adders and subtractor-Cascading full adders, look ahead carry adders, Binary comparators.

Unit II

Chapter 4: Introduction to Sequential Circuits

Basic Bistable Element, Latches, A SR Latch, Application of SR Latch, A Switch De bouncer, The SR Latch, the gated SR Latch, the gated D Latch, The Master-Slave Flip-Flops (Pulse-Triggered Flip-Flops): The Master-Slave SR Flip-Flops, The Master-Slave JK Flip-Flop, Edge Triggered Flip- Flop: The Positive Edge-Triggered D Flip-Flop, Negative-Edge Triggered D Flip-Flop; Characteristic Equations

Chapter 5: Analysis of Sequential Circuits

Registers and Counters, Binary Ripple Counters, Synchronous Binary counters, Ring and Johnson Counters, Design of a Synchronous counters, Design of a Synchronous Mod-n Counter using clocked JK Flip-Flops Design of a Synchronous Mod-n Counter using clocked D, T or SR Flip-Flops.

Unit III

Chapter No. 6. Sequential Circuit Design

Introduction to Sequential Circuit Design, Mealy and Moore Models, State Machine notations, Synchronous Sequential Circuit Analysis, Construction of state Diagrams and counter design.

Chapter No. 7. Introduction to memories

Introduction and role of memory in a computer system, memory types and terminology, Read Only memory, MROM, PROM, EPROM, EEPROM, Random access memory, SRAM, DRAM, NVRAM.

Text Books

1. Donald D Givone, Digital Principles and Design, McGraw Hill Education ,2017
2. John M Yarbrough, Digital Logic Applications and Design,1st edition Cengage Learning,2006
3. A AnandKumar, Fundamentals of digital circuits 4th Revised edition, PHI ,2016

Reference Books:

1. Charles H Roth, Fundamentals of Logic Design,7th edition, Cengage Learning, 2015
2. ZviKohavi, Switching and Finite Automata Theory Cambridge University Press; 3 edition October 2009
3. R.D. Sudhaker Samuel, Logic Design, Pearson Education ,2010
4. R P Jain, Modern Digital Electronics ,4th edition, McGraw Hill Education,2009

Program: Bachelor of Engineering (Biomedical Engineering)		Semester: III Semester
Course Title: Electronic Instrumentation and Measurements		Course Code: 22EBMC203
L-T-P: 4-0-0	Credits: 4	Contact Hours: 4Hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 50Hrs	Examination Duration:3 Hrs	

Unit I

Chapter 1: Fundamentals of Measurements:

Introduction, Significance of measurements, methods of measurements, instruments and measurement systems, Functions of instruments and measurement systems, Applications of measurement systems.

Measurement Errors: Introduction Gross errors and systematic errors, Absolute and relative errors, basic concepts of accuracy, Precision, Resolution and Significant figures, Measurement error combinations.

Units and Dimensions: Review of fundamental and derived units, SI units, dimensional equations **10Hrs.**

Chapter 2: Ammeters, Voltmeter and Multimeters:

Introduction, DC ammeter principle only, DC voltmeter, Multi-range voltmeter, Extending voltmeter ranges, Loading, Peak responding and True RMS voltmeters. (relevant problems)

Digital Voltmeters:

Introduction, Ramp type, Dual slope integrating type (V–T), integrating type (V–F) and Successive approximation type (relevant problems).

Digital Instruments: Introduction, Block diagram of a Basic Digital Multi-meter. Digital frequency meters: Basic circuit of a Digital frequency meter, Basic circuit for frequency measurement **10Hrs**

Unit II

Chapter 3: Oscilloscopes: Introduction, Basic principles, CRT features, Block diagram and working of each block, Typical CRT connections, Dual beam and dual trace CROs, Electronic switch.

Analog storage oscilloscopes: Need for trace storage, bistable storage CRT, Variable persistence storage CRT.

Digital storage oscilloscopes: Block diagram and operation. **08 Hrs.**

Chapter 4: Signal Generators and Bridges:

Introduction, Fixed and variable AF oscillator, Standard signal generator, Modern laboratory signal generator, AF sine and Square wave generator, Function generator, Square and Pulse generator.

Bridge Circuits for Measurement of R, L & C:

DC bridges: Introduction, Wheatstone bridge, Kelvin Bridge

AC bridges: Capacitance Comparison Bridge, inductance Comparison Bridge, Maxwell's bridge, Schering Bridge **12Hrs.**

Unit III

Chapter 5: Display Devices and Recorders:

Introduction, electrical indicating instruments, digital instruments, digital display methods, digital display unit.

Segmental Displays: Seven segmental display, dot matrices, LED, LCD, decade counting assemblies, display systems

Recorders: Recording requirements, analog recorders- Graphic recorders, strip chart recorders & its types, X-Y recorder, Magnetic & Digital tape recorders **10 Hrs**

Text Books:

1. Electronic Instrumentation, H. S. Kalsi, TMH, 2004
2. Electronic Instrumentation and Measurements", David A Bell, PHI / Pearson Education2006/Oxford Higher Education, 2013.
3. Electrical and Electronic Measurements and Instrumentation – A. K. Sawhney, 17th Edition (Reprint 2004), Dhanpat Rai & Co. Pvt. Ltd., 2004

Reference Books:

1. Principles of Measurement Systems", John P. Beately, 3rd Edition, Pearson Education, 2000
2. Modern Electronic Instrumentation and Measuring Techniques", Cooper D & A D Helfrick, PHI, 1998.

Program: Bachelor of Engineering (Biomedical Engineering)		Semester: III Semester
Course Title: Digital Circuits Lab		**Course Code:22EBMP201**
L-T-P: 0-0-1	**Credits: 1**	**Contact Hours: 2Hrs/week**
ISA Marks: 80	**ESA Marks: 20**	**Total Marks: 100**
Teaching Hours: 32 Hrs	**Examination Duration: 2 Hrs**	

List of Experiments:

1. Characterization of TTL Gates– Propagation delay, Fan-in, Fan-out and Noise Margin.
2. To verify of Flipflops (a) JK Master Slave (b) T-type and (c)D-Type
3. Design and implement binary to gray, gray to binary, BCD to Ex-3 and Ex-3 to BCD code converters.
4. Design and implement BCD adder and Subtractor using 4 bitparalleladder.
5. Design and implement n bit magnitude comparator using 4- bit comparators.
6. Design and implement Ring and Johnson counter using shift register.
7. Design and implement 8:3 Priority Encoder
8. Design and implement frequency divider
9. Design and implement mod-6 synchronous and asynchronous counters using flip flops.
10. Design and implement given functionality using decoders and multiplexers.
11. Design and implement a digital system to display a 3-bit counter on a 7-segment display. Demonstrate the results on a general purposePCB.

****Note-All above experiments are to be conducted along with simulation.**

***Digital Circuits Lab:* Simulation of combinational and sequential circuits using netlist based Spice Simulators (Avoid using drag n drop), before implementing the circuits on breadboard**

Reference Books:

1. K.A. Krishnamurthy-Digital lab primer||, Pearson Education Asia Publications, 2003.
2. A.P. Malvino, -Electronic Principles 7th edition, McGraw Hill Education,2017

Program: Bachelor of Engineering (Biomedical Engineering)		Semester: III Semester
Course Title: Analog Electronic Circuits Lab		**Course Code:22EBMP202**
L-T-P: 0-0-1	**Credits: 1**	**Contact Hours:2Hrs/week**
ISA Marks: 80	**ESA Marks: 20**	**Total Marks: 100**
Teaching Hours: 32 Hrs	**Examination Duration: 2Hrs**	

List of Experiments:

1. Study of multi-meters, power supplies, function generators, Oscilloscopes; Identification of various components and devices, e.g. resistors, capacitors, diodes, transistors.
2. Design & analyze Diode Clipping circuits.
3. Design & analyze Positive and Negative Clamping circuits.
4. Study of BJT as a Switch.
5. Study the input and output characteristics of MOSFET.
6. To study the basic current mirror circuit.
7. MOSFET as a source follower (Buffer).
8. Study of transformer-less Class B push pull power amplifier and determination of its conversion efficiency
9. Design an amplifier using BJT and determine its gain, input, output impedance and frequency response of RC Coupled single stage BJT amplifier
10. Design an amplifier using MOSFET and determine its gain, input, output impedance and frequency response of a CS amplifier.
11. Design a regulated power supply for the given specifications

****Note-All above experiments are to be conducted along with simulation.**

***Analog Electronic Circuits Lab: Simulation of designed circuits using LTSpice Simulator, before implementing the circuits on breadboard.**

Reference Books:

1. "Integrated Electronics", by Jacob Millman and Christos Halkias, McGraw Hill,
2. "Microelectronic Circuits", by A.S. Sedra & K.C. Smith, 7th Edition, Oxford Univ. Press, 2017.
3. "Electronic Devices and Circuits" by David A. Bell, 4thedition, PHI publication 2007.
4. "Analysis and design of analog integrated circuits," by Grey, Hurst, Lewis and Meyer, 4thedition.

   Device data sheets.
5. KLETECH Electronics and Communication Engineering Department 2023-24 Analog Electronics Lab manual.

Program: Bachelor of Engineering (Biomedical Engineering)		Semester: III Semester
Course Title: Microcontroller Architecture and Programming		Course Code:22EBMF202
L-T-P: 2-0-1	Credits: 3	Contact Hours:4 Hrs/week
ISA Marks: 80	ESA Marks: 20	Total Marks: 100
Teaching Hours: 40Hrs	Examination Duration: 2 Hrs	

Unit I

Chapter 1: Microprocessors and microcontroller

Introduction, Microprocessors and Microcontrollers, A Microcontroller Survey, RISC & CISC CPU Architectures, Harvard & Von-Neumann CPU architecture.

Chapter 2: The 8051 Architecture

8051 Microcontroller Hardware, Input / Output Pins, Ports and Circuits, semiconductor Memories, Interfacing external RAM & ROM memories.

Chapter 3: Addressing Modes and Arithmetic Operations

Addressing modes, External data Moves, Code Memory, Read Only Data Moves / Indexed Addressing mode, Data exchanges, stack concept and related instructions, example programs. Logical Operations: Introduction, Byte level, logical Operations, Bit level Logical Operations, Rotate and Swap Operations, Example Programs, Arithmetic Operations: Introduction, Flags, Incrementing and Decrementing, Addition, Subtraction Multiplication and Division, Decimal Arithmetic, Example Programs.

Unit II

Chapter 4: Branch operations

Jump Operations: Introduction, The JUMP and CALL Program range, Jump calls and Subroutines Interrupts and Returns, Example Problems.

Chapter 5: 8051 Programming in 'C'

Data Types and Time delays in 8051C, I/O Programming, Logic operations, Data Conversion programs, Accessing code ROM space, Data serialization.

Chapter 6: Counter/Timer Programming in 8051

Programming 8051 Timers, Programming Timer0 and Timer1 in 8051C

Unit III

Chapter 7: Serial Communication

Basics of Serial Communication, 8051 connections to RS-232,8051 Serial Communication modes, Programming, Serial port programming in C.

Chapter 8: 8051 interfacing and applications

Interfacing 8051 to LCD, Keyboard, ADC, DAC, Stepper Motor, DC Motor.

Chapter 9: Interrupts

Introduction to interrupts, interrupts vs polling, classification of interrupts, interrupt priority, interrupt vector table, interrupt service routine

Text Books

1. "The 8051 Microcontroller Architecture, Programming & Applications" by ' Kenneth J. Ayala', Penram International, 1996
2. "The 8051 Microcontroller and Embedded systems", by ' Muhammad Ali Mazidi and Janice Gillispie Mazidi', Pearson Education, 2003

Reference Books:

1. " Programming and Customizing the 8051 Microcontroller ", by 'Predko', TMH.

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Program: Bachelor of Engineering (Biomedical Engineering)		Semester: III Semester
Course Title: C Programming (Diploma)		**Course Code:22EBMF204**
L-T-P: 0-0-2	**Credits: 2**	**Contact Hours:4 Hrs/week**
ISA Marks: 80	**ESA Marks: 20**	**Total Marks: 100**
Teaching Hours: 52Hrs	**Examination Duration: 2 Hrs**	

1. Write a C program to perform addition, subtraction, multiplication and division of two numbers.
2. Write a C program to
   i) Identify greater number between two numbers using C program.
   ii) To check a given number is Even or Odd.
3. Write a C program to
   i) To find the roots of a quadratic equation.
   ii) Find the factorial of given number.
4. Write a C program to
   i) To find the sum of n natural numbers.
   ii) Print the sum of 1 + 3 + 5 + 7 ++ n
5. Write a C program to
   i) Print the pattern.

```
*
* *
* * *
* * * *
* * * * *
```

   ii) Print the pattern

```
1
1 2
1 2 3
1 2 3 4
1 2 3 4 5
```

6. Write a C program to

To test whether the given character is Vowel or not. (using switch case)

7. Write a C program to

To accept 10 numbers and make the average of the numbers using one dimensional array.

8. Write a C program to

   Find out square of a number using function.

9. Write a C program to

   To find the summation of three numbers using function.

10. Write a C program to

Find out addition of two matrices.

Text Books

1. Programming in ANSI C, E Balagurusamy.

Program: Bachelor of Engineering (Biomedical Engineering)		Semester: IV Semester
Course Title: Linear Algebra and Partial Differential Equations		Course Code:15EMAB208
L-T-P: 4-0-0	Credits: 4	Contact Hours: 4 Hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 50Hrs	Examination Duration:3 Hrs	

Unit I

Chapter1: Partial differential equations

Introduction, classification of PDE, Formation of PDE, Solution of equation of the type Pp + Qq = R, Solution of partial differential equation by direct integration methods, method of separation of variables. Modeling: Vibration of string-wave equation, heat equation. Laplace equation. Solution by method of separation ofvariables.

Chapter2: Finite difference method

Finite difference approximations to derivatives, finite difference solution of parabolic PDE, explicit and implicit methods; Hyperbolic PDE-explicit method, Elliptic PDE-initial-boundary Value problems.

Unit II

Chapter 3: Fourier Series

Complex Sinusoids, Fourier series representations of four classes of signals, Periodic Signals: Fourier Series representations, Derivation of Complex Co-efficient of Exponential Fourier Series and Examples. Convergence of Fourier Series. Amplitude and phase spectra of a periodic signal. Properties of Fourier Series (with proof): Linearity, Symmetry Properties, Time shift, Frequency Shift, Scaling, Time differential differentiation coefficients, Time domain Convolution, Multiplication Theorem, Parseval ‘s theorem and Examples on these properties.

Chapter 4: Fourier Transform

Fourier representation of non-periodic signals, Magnitude and phase spectra. Properties of Fourier Transform: Linearity, Symmetry Properties, Time shift, Frequency Shift, Scaling, Time differential differentiation coefficients, Time domain Convolution, Multiplication Theorem, Parseval‘s theorem and Examples on these properties.

Unit III

Chapter5: Complex analysis

Function of complex variables. Limits, continuity and differentiability. Analytic functions, C-R equations in Cartesian and polar forms, construction of Analytic functions (Cartesian and polar forms).

Chapter 6: Complex Integration

Line integral, Cauchy ‘s theorem- corollaries, Cauchy ‘s integral formula. Taylor ‘s and Laurent Series, Singularities, Poles, Residue theorem – problems.

Text Books

1. Simon Haykin, Barry Van Veen, Signals and Systems,2nd edition, Wiley,2007
2. Peter V. O'neil, Advanced Engineering Mathematics Cengage Learning Custom Publishing; 7th Revised edition2011
3. DennisGZillandMichaelRCullin," Advanced Engineering Mathematics",4th edition, Narosa Publishing House, NewDelhi,2012

Reference Books:

1. Kreyszig E., Advanced Engineering Mathematics,10th edition, Wiley,2015
2. Stanley J Farlow, Partial differential equations for Scientists and Engineers, Dover publications, INC, New York,1993

Program: Biomedical Engineering		**Semester: IV**
Course Title: Problem Solving & Analysis		**Course Code: 22EHSH202**
L-T-P: 0.5-0-0	**Credits: 0.5**	**Contact Hours: 1 hrs/week**
ISA Marks: 100	**ESA Marks: --**	**Total Marks: 100**
Teaching Hours: 16Hrs	**Examination Duration: 3 Hrs**	

Chapter No. 1. Analytical Thinking

Analysis of Problems, Puzzles for practice, Human Relations, Direction Tests; Looking for Patterns: Number and Alphabet Series, Coding Decoding; Diagrammatic Solving: Sets and Venn diagram-based puzzles; Visual Reasoning, Clocks and Calendars

Chapter No. 2. Mathematical Thinking

Number System, Factors and Multiples, Using Simple Equations for Problem Solving, Ratio, Proportion, and Variation

Chapter No. 3. Verbal Ability

Problem Solving using Analogies, Sentence Completion

Chapter No. 4. Discussions & Debates

Team efforts in Problem Solving; A Zero Group Discussion, Mock Group Discussions, and Feedback; Discussion v/s Debate; Starting a Group Discussion: Recruitment and other Corporate Scenarios; Evaluation Parameters in a Recruitment Group Discussion, Types of Initiators: Verbal and Thought, Conclusion of a Discussion

Reference Books:

1. R. S. Aggarwal, “A Modern Approach to Verbal and Non – Verbal Reasoning”, Sultan Chand and Sons, New Delhi, 2018
2. R. S. Aggarwal, “Quantitative Aptitude”, Sultan Chand and Sons, New Delhi, 2018
3. Chopra, “Verbal and Non – Verbal Reasoning”, MacMillan India
4. M Tyra, “Magical Book on Quicker Maths”, BSC Publications, 2018
5. Diana Booher - Communicate with Confidence, Mc Graw Hill Publishers
6. Norman Lewis–Word Power Made Easy, Goyal Publishers
7. Cambridge Advanced Learner’s Dictionary, Cambridge University Press.
8. Kaplan’s GRE guide

Program: Bachelor of Engineering (Biomedical Engineering)		Semester: IV Semester
Course Title: Biomedical Instrumentation		Course Code: 22EBMC205
L-T-P: 4-0-0	Credits: 4	Contact Hours: 4Hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 50Hrs	Examination Duration:3 Hrs	

Unit I

Chapter 1: Bioelectric Signals and Electrodes: Sources of Biomedical Signals, Origin of Bioelectric Signals, Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Electrooculogram (EOG), Electroretinogram (ERG), Recording Electrodes– Electrode-tissue interface, Electrolyte-Skin interface, polarization, skin contact impedance, motion artifacts, Silver-Silver Chloride electrodes, Electrodes for ECG, Electrodes for EEG, Electrodes of EMG, Electrical conductivity of electrode jellies and creams, microelectrodes. **10 Hrs.**

Chapter 2: Pressure Measurement: Pressure Transducers-LVDT pressure transducers and Strain gauge pressure transducers. Physiological pressure ranges and measurement sites, Direct pressure measurement-catheters for pressure measurement, diaphragm displacement transducers, catheter tip pressure transducers, implantable pressure transducers and pressure telemetering capsules. Indirect pressure measurement-Indirect measurement of systolic, diastolic, and mean blood pressure, Detection of Kortokoff sound**. 10 Hrs.**

Unit II

Chapter 3: Temperature Measurement: Requirements for measurement ranges, Temperature transducers – Thermistors, thermocouples, wire and thin film thermoesistive elements, P-N junction diodes and transistors, infrared radiation thermometers, infrared thermography. Clinical thermometer probes, tympanic thermometers, telemetering capsules. Photoelectric Transducers: photovoltaic cells and photoemissive cells. **10 Hrs.**

Chapter 4: Flow Measurement: Requirements for measurement ranges – blood flow in a single vessel, tissue blood flow, and respiratory gas flow. Electromagnetic flowmeters – principle, methods of magnetic field excitation, perivascular probes, intravascular probes. Ultrasonic blood flowmeters– propagation of ultrasound in the tissue, ultrasonic Doppler flowmeters, blood flow measurement through Doppler imaging. Indicator dilution method – principle and working, thermodilution method, Fick method, thermistor velocity probe, impedance cardiography **10 Hrs.**

Unit III

Chapter 5: Biomedical Recorders: Basic recording system, Biomedical signal analysis, Biomedical Recorders: Electrocardiograph, Phonocardiograph, Electroenchephalograph, Electromyograph, Digital recorders. Biosensors and Smart Sensors **10 Hrs**.

Text Books:

1.Handbook of Biomedical Instrumentation- R S Khandpur, 2nd edition, Tata McGraw Hill, 2003

2.Biomedical Transducers and Instruments – Tatsuo Togawa, Toshiyo Tamura and P. Ake Oberg, CRC Press, 1997.

Reference Books:

1. Biomedical Instrumentation and Measurement – Leslie Cromwell, Fred J Weibell and Erich A. Pfeiffer, 2nd Edition, Prentice-Hall India Pvt. Ltd., 2004.
2. Transducers and Instrumentation -D. V. S. Murty Prentice Hall India Pvt ltd. 2nd Edition

Program: Bachelor of Engineering (Biomedical Engineering)		Semester: IV Semester
Course Title: Signal Conditioning and Data Acquisition Circuits		Course Code: 22EBMC204
L-T-P: 4-0-0	Credits: 4	Contact Hours: 4Hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 50Hrs	Examination Duration:3 Hrs	

Unit I

Chapter No 1. Introduction to Operational Amplifiers: Basic differential amplifier, Introduction, Block schematic of an Op-amp, Characteristics of an Ideal OP-AMP, Circuit symbol and terminals, power supply connections, equivalent circuit of op-amp, open loop operation of op-amp, Feedback in ideal opamp: Inverting Amplifier, Non-inverting Amplifier, Voltage follower, Differential Amplifier, CMRR, PSRR.(relevant problems)
08 Hrs.

Chapter No 2. Op-amp characteristics

DC characteristics – Input bias current, Input offset current, Input offset voltage; Total output offset voltage, Thermal drift. AC characteristics – Frequency response, Slew rate, **07 Hrs**.

Chapter No 3. Basic op-amp applications

Scale changer/Inverter. Summing amplifier: Inverting summing amplifier Non-inverting Summing amplifier, Subtractor, Instrumentation Amplifier. (Relevant problems). **05 Hrs**.

Unit II

Chapter No 4. Linear applications of OPAMP

V to I and I to V converters, Sample and hold circuit, Integrator, Differentiator, Active Filters – First and second order Low pass & High pass filters. **10Hrs**

Chapter No 5. Nonlinear applications of OPAMP

Comparators: Inverting comparator, non-inverting comparator, applications of comparator, Regenerative comparator (Schmitt Trigger), Astable and Monostable multivibrator, Triangular waveform generator. Oscillators: Phase shift oscillator, Wien bridge oscillator. (Relevant problems).
10 Hrs.

Unit III

Chapter No 6. Data Acquisition Systems: Types of instrumentation systems, Components of Analog and Digital data acquisition system.

Data Converters

Digital to Analog Converters: Basic DAC techniques, Weighted Resistor R-2R DAC **Analog to Digital Converters:** Functional diagram of ADC, Flash ADC, Counter type ADC, Successive approximation ADC, Dual slope ADC, Pipeline ADC.DAC and ADC features/specifications**.**
10 Hrs.

Text Books

1. Behzad Razavi, Design of Analog CMOS Integrated Circuits McGraw-Hill, 2nd edition, 2016

2. Phillip E. Allen, Douglas R. Holberg, CMOS Analog Circuit Design, Oxford University Press, USA, 2010
3. Ramakant A. Gayakwad, Op - Amps and Linear Integrated Circuits, 4th Edition

Reference Books:

1. A.S. Sedra & K.C. Smith, Microelectronic Circuits, 7th Edition, 2017
2. Design with Operational Amplifiers and Analog Integrated Circuits, Sergio Franco, 4th edition, Tata McGraw Hill 2014
3. David A. Bell, Operational Amplifiers and Linear IC's, 3rd ed., Oxford University Press, 2011
4. B. Razavi, Fundamentals of Microelectronics, 2nd edition.

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Program: Bachelor of Engineering (Biomedical Engineering)		Semester: III Semester
Course Title: Human Anatomy and Physiology		Course Code: 22EBMC206
L-T-P: 4-0-0	Credits: 04	Contact Hours: 4Hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 50 hrs.	Examination Duration: 3 hrs.	

UNIT 1

Chapter 1. Introduction: **Homeostasis, Tissue, Cartilage:** The internal environment and homeostasis, survival needs of the body, movement of substances within the body, body fluids, action potential, propagation of action potential, cell-structure and functions

Chapter 2. Epithelial tissue- simple epithelium, stratified epithelium, connective tissue- cells of connective tissue, loose connective tissue, Adipose tissue, Dense connective tissue, Lymphoid tissue, Cartilage- Hyaline cartilage, Fibrocartilage, Elastic cartilage. **10 Hrs.**

Chapter 3. Nervous System: Functional Components of nervous system, Neurons: Properties of neurons, Cell bodies, Axon and Dendrites, Types of nerves, Synapse and neurotransmitters, neuromuscular junction. Central nervous system: Meninges, ventricles of the brain and CSF.

Chapter 4. Brain: Cerebrum, functions of cerebrum, functional areas of the cerebrum, Brainstem, Cerebellum, Spinal cord- grey matter, white matter, spinal reflex, Spinal nerves (in brief list & functions), Cranial nerves (in brief list & functions), Autonomic nervous system (in brief)- functions and effects. Pituitary gland and hypothalamus. **10 Hrs.**

UNIT 2

Chapter 5: Cardiovascular System: Introduction, Blood vessels- Arteries and Arterioles, Veins and Venules, capillaries, control of blood vessel diameter, blood supply- internal respiration, cell nutrition. Heart- position, structure pericardium, myocardium, endocardium, interior of the heart, flow of blood through the heart, blood supply to heart, Conducting system of the heart, factors affecting heart rate, the Cardiac cycle, cardiac output, blood pressure, control of blood pressure, pulse and factors affecting the pulse rate. Circulation of the blood- pulmonary circulation, systemic circulation-aorta (different parts of aorta & their blood supply, in brief). Summary of the main blood vessels (arteries & veins, explanation with flow diagram only). **10 Hrs.**

Chapter 6: Respiratory and Digestive System: Organs of respiration, Nose and Nasal cavity- position, structure and functions, pharynx -position, structure, functions. Larynx - position, structure and functions. Trachea, bronchi, bronchioles and alveoli, lungs- position, associated structure, pleura and pleural cavity. Respiration - muscles of respiration, cycle of respiration, variables affecting respiration, lung volumes and capacity

Chapter 7: Organs of the digestive system – mouth, tongue, teeth, salivary glands, pharynx, oesophagus, stomach, gastric juice and functions of stomach, small intestine-structure, chemical digestion in small intestine, large intestine - structure, functions of the large intestine. Pancreas and Liver (only physiology). **10 Hrs.**

UNIT 3

Chapter 8: Skeletal Systems Muscles and Joints: Bone, Types of bone, structure, bone cells, functions of bone. Axial skeleton- skull, sinuses, Fontanelles, vertebral column characteristics of typical vertebra, different parts of vertebral column (parts only), features of vertebral column, movements and functions of vertebral column, sternum, ribs, shoulder girdle and upper limb, pelvic girdle and lower limb.

Skeletal muscle, Smooth muscle, Cardiac muscle, functions of muscle tissue, muscle tone and fatigue. Types of joint- Fibrous, Cartilaginous, Synovial, characteristics of synovial joints, shoulder joint, elbow joint, radio ulnar joint, wrist joint, Hip joint, Knee joint, ankle joint. **10 Hrs.**

Text Book

1. Ross & Wilson's Anatomy and Physiology in Health and Illness – by Anne Waugh and Allison Grant, 9th Edition, Churchill Livingstone Publications

References

1. Concise Medical Physiology- by Sujit K. Chaudhuri, 5th Edition, New Central Book Agency Pvt. Ltd.
2. Essentials of Medical Physiology - by K. Sembulingam and PremaSembulingam, 3rd Edition, Jaypee Publications
3. Human Physiology: From Cells to Systems – by Lauralee Sherwood, 6th Edition, Thomson India Edition, 2007.

Program: Bachelor of Engineering (Biomedical Engineering)		Semester: IV Semester
Course Title: ARM Processor and Applications		Course Code:22EBMC207
L-T-P: 3-0-0	Credits: 3	Contact Hours:3 Hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40Hrs	Examination Duration:3 Hrs	

Unit I

Chapter No. 1 ARM Architecture

The Acorn RISC machine, Architectural inheritance, Architecture of ARM7TDMI, ARM programmers model, ARM development tools, 3 stage pipeline ARM organization, ARM instruction execution.

Chapter No. 2 Introduction to ARM instruction set

Data processing instruction, Branch instruction, Load store instruction, Software interrupt instruction, Program status register instruction, Conditional execution, Example programs, introduction to thumb instruction and implementation

Chapter No. 3 Assembler rules and Directives

Introduction, structure of assembly language modules, Predefined register names, frequently used directives, Macros, Miscellaneous assembler features. Example programs.

Unit II

Chapter No. 4 Exception handling

Introduction, Interrupts, error conditions, processor exception sequence, the vector table, Exception handlers, Exception priorities, Procedures for handling exceptions.

Chapter No. 5 Introduction to Bus protocols:

I2C, SPI, AMBA (advanced memory bus architecture): AHB, APB

Chapter No. 6 LPC 2148 Controller Architectural overview and GPIO programming

LPC2148 architectural overview, Registers, GPIO Programming: LED, LCD, Seven segment, Stepper Motor, DC Motor, Buzzer, Switch, Keypad.

Unit III

Chapter No. 7 On-chip programming techniques using LPC 2148 Controller

ARM interfacing techniques and programming: Timers, RTC, UART, ADC, DAC, I2C and External Interrupt.

Chapter No. 8 Architectural support for high level languages

Abstraction in software design, data types, floating point data types, The ARM floating point architecture, use of memory, run time environment.

Text Books

1. The 8051 Microcontroller Architecture, Programming & Applications " By Kenneth J. Ayala, Cenage Learning; 3rd edition 2007
2. ARM System- on-Chip Architecture by 'Steve Furber', Second Edition, Pearson,2015
3. ARM Assembly Language fundamentals and Techniques by William Hohl, CRC press CRC Press; 2nd edition,2014

Reference Books:

1. ARM system Developer ‘s Guide- Hard bound, Publication date:2004 Imprint: MORGAN KAUFFMAN User manual on LPC21XX.

Program: Bachelor of Engineering (Biomedical Engineering)		Semester: IV Semester
Course Title: ARM Microcontroller Lab		Course Code:22EBMP203
L-T-P:0-0-1	Credits: 1	Contact Hours:2 Hrs/week
ISA Marks: 80	ESA Marks: 20	Total Marks: 100
Teaching Hours: 32Hrs	Examination Duration: 2 Hrs	

List of Experiments:

1. Write an ALP to achieve the following arithmetic operations:
   i) 32-bit addition
   ii) 64-bit addition
   iii) Subtraction
   iv) Multiplication
   v) 32-bit binary divide

Apply suitable machine dependent optimization technique and analyze for memory at time consumed

2. Write an ALP for the following using loops:
   i) Find the sum of 'N' 16 bit numbers
   ii) Find the maximum/minimum of N numbers
   iii) Find the factorial of a given number with and without look up table.

Apply suitable machine dependent optimization technique and analyze for memory and time consumed

3. Write an ALP to
   i) Find the length of the carriage return terminated string.
   ii) Compare two strings for equality.

Apply suitable machine dependent optimization technique and analyze for memory and time consumed

4. Write an ALP to pass parameters to a subroutine to find the factorial of a number or prime number generation.

Apply suitable machine dependent optimization technique and analyze for memory and time consumed

5. Write a C program to test working of LEDs and seven segment using LPC2148.

6. Write a C program & demonstrate an interfacing of Alphanumeric LCD 2X16 panel and 4X4 keypad to LPC2148 Microcontroller.

7. Write an ALP to generate the following waveforms of different frequencies
   i) Square wave
   ii) Triangular
   iii) Sine wave
8. Write a program that converts the data read from sensor to a data understandable for the ARM microcontroller.

9. Develop a C program to demonstrate the concept of serial communication with an example.

10. Develop an application code using embedded C to accept asynchronous inputs and control the connected device

11. Develop an application code using synchronous communication protocol to display the RTC value on a display device

.

Text Books

1. Steve Furber, ARM System- on-Chip Architecture, 2nd, LPE,2002
2. The8051 Microcontroller Architecture, Programming & Applications" By _Kenneth J. Ayala, Cenage Learning; 3rd edition 2007
3. William HohlARMAssembly Language fundamentals and Techniques by, CRC press CRC Press; 2nd edition ,2014

Reference Books:

1. -ARM system Developer ‘s Guide- Hardbound, Publication date:2004 Imprint: MORGAN KAUFFMAN
2. User manual onLPC21XX.

Program: Bachelor of Engineering (Biomedical Engineering)		Semester: IV Semester
Course Title: Signal Conditioning and Data Acquisition Circuits Lab		Course Code: 22EBMP204
L-T-P: 0-0-2	Credits: 2	Contact Hours: 4Hrs/week
ISA Marks: 80	ESA Marks: 20	Total Marks: 100
Teaching Hours: 52Hrs	Examination Duration: 2 Hrs	

List of Experiments:

1. To illustrate the functionality and the input-output relationships for the following basic signal conditioning circuits (Linear applications)
   a) Inverting Amplifier
   b) Non-Inverting Amplifier using OP AMP.
2. To implement and study non-linear application of Op-Amp - Precision Rectifier
3. Design & analyze Inverting Schmitt Trigger.
4. Design and realize the performance of inverting and non-inverting Summing amplifier.
5. Implement and study of V-I converters.
6. Realize Integrator and Differentiator for a given input frequency.
7. Realize and verify the performance of Wein-Bridge Oscillator using op-amp
8. Design and realize the frequency responses of 2nd order, Low pass and High pass filter.
9. Realize the following data converters to determine their respective performance parameters.
10. 4-bit R-2R D-A Converter.
11. To verify the electrical parameters of µA 741IC Op-amp.

**Note-All above experiments are to be conducted along with simulation.

* Data Acquisition and Controls Laboratory: Simulation of designed circuits using LTSpice or Proteus Simulator, before implementing the circuits on breadboard.

Reference Books

1. Ramakant Gayakwad, Operational Amplifiers and Linear Integrated Circuits, PHI 4ed.,
2. Sergio Franco Design with Op-amps and Analog Integrated circuits. Tata McGraw Hill, 3ed.,
3. Dan Sheingold Analog to Digital Conversion Hand Book, PH, 1986.
4. David A. Bell, Operational Amplifiers and Linear IC's, 2ed., PHI/Pearson, 2004
5. Manual: Lab manual prepared by SoECE Department.

Program: Bachelor of Engineering (Biomedical Engineering)		Semester: IV Semester
Course Title: Biomedical Instrumentation Lab		Course Code:22EBMP205
L-T-P:0-0-2	Credits: 2	Contact Hours:4Hrs/week
ISA Marks: 80	ESA Marks: 20	Total Marks: 100
Teaching Hours: --5o Hrs	Examination Duration:2 Hrs	

List of Experiments:

4. Measurement of blood pressure using sphygmomanometer and automatic digital BP instrument. Finding the systolic and diastolic values and calculate Mean Arterial Pressure (MAP)
5. Determination of Conductivity of a given unknown solution/ body fluid using conductivity meter.
6. Measurement of displacement using LVDT& determine its sensitivity and resolution
7. Temperature measurement using RTD, Thermistor and Thermocouple, and to find their sensitivity
8. Temperature measurement using AD590 / LM34
9. Characteristics of LDR, Photodiode & Phototransistor by variable illumination & variable distance
10. Measurement of unknown resistance by Wheatstone bridge & finding the sensitivity of the bridge
11. Measurement of self-inductance using Maxwell's bridge
12. Measurement of unknown capacitance using Schering's bridge.
13. Characteristics of Load cell and Cantilever beam using Strain gauge (Quarter, Half and Full bridge)
14. Measurement of unknown concentration of given solution/body fluid using Spectrophotometer and Colorimeter
15. Measurement of pH of a given solution/ body fluid using pH meter
16. Design and develop a thermistor being used as a temperature sensor
17. Design and develop a LVDT to measure displacement

Text Books

1. Electronic Instrumentation by H. S. Kalsi, TMH, 2004 (Module-2,3 & 4)
2. Electronic Instrumentation and Measurements by David A Bell, PHI / Pearson Education2006/ Oxford Higher Education, 2013. (Module 1& 3)

Reference Books:

1. -Measurement systems application and design by E.O. Doebline 4th Edition, TMH.
2. Instrumentation for Process Measurement by Norman. A. Anderson, 3rd Edition, CRC
3. Principle of Measurement System by John. P. Bentley, 3rd Edition, Pearson, 2007
4. Handbook of Biomedical Instrumentation- R S Khandpur, 2ndedition, Tata McGraw Hill, 2003

3. .

Program: Bachelor of Engineering (Biomedical Engineering)		Semester: IV Semester
Course Title: Data Structures using C Lab (Diploma)		Course Code:22EBMF205
L-T-P: 1-0-2	Credits: 3	Contact Hours: 5 Hrs/week
ISA Marks: 80	ESA Marks: 20	Total Marks: 100
Teaching Hours: 42Hrs	Examination Duration: 2 Hrs	

Category: Demonstration		Total Weightage: 0.00		No. of lab sessions: 6.00
Expt./ Job No.	**Experiment / Job Details**	**No. of Lab Session(s) per batch (estimate)**	**Marks / Experiment**	**Correlation of Experiment with the theory**
1	Programs on Pointer concepts.	2.00	0.00	
	Learning Objectives: *The students should be able to* Perform basic programming structures on 1. Pointers concepts. 2. 1D and 2Darrays. 3. Pointers to functions. 4. Memory management functions			1
2	Programs on string handling functions, structures union and bit-files.	2.00	0.00	
	Learning Outcomes: *The students should be able to write programs to:* a) Perform string handling functions like 1. String length. 2. String concatenate. 3. Strings compare. 4. String copy. 5. Strings reverse. b) Implement Structures, union and bit-field			1
3	Programming on files.	2.00	0.00	

	Learning Outcomes: *The students should be able to write a modular program to:* 1. Open and Close the file. 2. Read and Write the file. 3. Append the file.			1
Category: Exercise		**Total Weightage: 20.00**		**No. of lab sessions: 12.00**
Expt./ Job No.	**Experiment / Job Details**	**No. of Lab Session(s) per batch (estimate)**	**Marks / Experiment**	**Correlation of Experiment with the theory**
4	Programs on implementation of stacks and its applications.	2.00	3.00	
	Learning Outcomes: *The students should be able to:* 1. Write a program to Insert delete and display stack elements for an application. 2. Write a program using stack to convert from Infix to postfix & Infix to Prefix 3. Write a program using stack data structure for base conversion.			3
5	Programs on implementation of different queue data structures.	2.00	4.00	
	Learning Outcomes: *The students should be able to:* Write a program using queue data structure for an application.			3

6	Programs on implementation of different types of Linked lists	2.00	4.00	
	Learning Outcomes: *The students should be able to write a modular program to use the linked lists for an application* 1. Insert, delete and display a node in SLL. 2. Insert, delete and display a node in DLL. 3. Insert delete and display a node in CLL.			4
7	Programs on Implementation of trees.	2.00	3.00	
	Learning Outcomes: *The students should be able to write modular programs to:* 1. Perform various operations on binary trees. 2. To find max, min value in a binary search trees. 3. To find the height of a tree, 4. To count nodes in a tree. 5. To delete a node in a tree			5
8	Programs to implement different sorting techniques.	2.00	3.00	
	Learning Outcomes: *The students should be able to:* Write modular program on perform the following sorting techniques 1. Selection 2. Insertion 3. Bubble 4. Merge 5. Quick 6. Heap			5

9	Programming on hash tables	2.00	3.00	
	Learning Outcomes: *The students should be able to* Write modular program on 1. Direct-address tables 2. Hash tables			6

Reference Books:

1. Aaron M. Tenenbaum, et al, "Data Structures using C", PHI, 2006
2. Cormen, Leiserson, Rivest "Introduction to Algorithms", PHI, 2001
3. E Balaguruswamy, "The ANSI C Programming Language", 2ed., PHI, 2010.
4. Yashavant Kanetkar, "Data Structures through C", BPB publications 2010
5. Horowitz, Sahani, Anderson-Feed, "Fundamentals of Data Structures in C", 2ed, Universities Press, 2008
6. Richard F. Gilberg, Behrouz A. Forouzan "Data Structures: A Pseudocode Approach with C", 2nd Edition, Course Technology, Oct 2009.
7. Kernighan and Ritchie, The ANSI C Programming Language, 2 ed., PHI.
8. Robert Kruse, Data Structures and Program Design in C, 2 ed., Pearson

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Program: Bachelor of Engineering (Biomedical Engineering)		Semester: V Semester
Course Title: Fundamentals of Signals and DSP		Course Code: 22EBMC301
L-T-P: 4-0-0	Credits: 4	Contact Hours: 4 Hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 50Hrs	Examination Duration:3 Hrs	

Unit I

Chapter No. 1. Introduction to Signals and Systems:

Basic elements of a DSP System, Classification of Signals, Sampling Theorem (statement and problems on Nyquist rate), Discrete Time Signals (Representation, Standard Signals, Classification, and Operations), Discrete Time Systems, Convolution Sum, Cross correlation and Auto correlation of sequences. **10 Hrs**

Chapter No. 2. Z- Transform and its Application to analysis of LTI Systems:

Direct Z-Transform, Properties of the Z-Transform, Examples, Inverse Z- Transform by Partial-Fraction Expansion method only, System Function of a LTI System, Causality and Stability (from H (z)). Realization of Digital System: Direct Form I, Direct form II, cascade form and parallel form.

10 Hrs

Unit II

Chapter No. 3. DFT: Properties and Applications:

Definition and Problems on DFT&IDFT, DFT Properties – Periodicity, Linearity, Time Reversal, Circular Time Shift, Circular Frequency Shift, Circular Convolution, Multiplication of two DFTs& Circular Convolution, Parseval's Theorem, DFT in linear filtering. Introduction to FFT, 8-point DFT Computation using Radix-2 DIT-FFT&DIF-FFT methods only, relevant examples. **10 Hrs**

Chapter No.4. IIR & FIR Filters:

IIR Filters: Low-pass filter specifications, IIR filter Design by Impulse Invariance & Bilinear Techniques, Design of Digital IIR filter by Butterworth approach, Examples. Magnitude response of low pass Chebyshev Type I, II filter (Theoretical concept only)

FIR Filters: Design of FIR filters – Symmetric and Anti symmetric FIR filters, Design of Linear phase FIR filters by Rectangular Hamming & Hanning windows. Summary of window function characteristics (window shape, transition bandwidth, stop band attenuation, etc.). Implementation of FIR filters by direct form and Single-stage lattice structure only. **10 Hrs**

Unit III

Chapter No. 5. Multirate Digital Signal Processing & Adaptive Filters:

Introduction, Decimation Process, Interpolation Process, Digital Filter Bank, Adaptive Filters, LMS adaptive algorithm, Applications, Features & Architectural of TMS320C54XX processor. **10 Hrs**

Text Books

1. Dimitris G Manolakis, John G. Proakis, “Digital Signal Processing: Principles, Algorithms, and Applications”, 4th Edition, Pearson India, 2007.
2. V. Udayashankara, “Modern Digital Signal Processing”, Third Edition, PHI 2016

Reference Books:

1. Simon Haykin and Barry Van Veen “Signals and Systems”, John Wiley & Sons, 2nd edition.
2. S K Mitra, “Digital Signal Processing”, 4th Edition, McGraw-Hill.
3. Avtar Singh, “Digital Signal Processing Implementation”, Brooks Cole.

Program: Bachelor of Engineering (Biomedical Engineering)		Semester: V Semester
Course Title: Clinical Instrumentation		**Course Code: 22EBMC302**
L-T-P: 4-0-0	**Credits: 4**	**Contact Hours: 4 Hrs/week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 50Hrs	**Examination Duration:3 Hrs**	

Unit I

Chapter 1. Orthopaedics Instruments:

Microstructure of bone, Cartilages, Bones and joints, Fractures and its types, POP Plastering, Bone screws, bone plates, wires. Properties of metal components used in fractures. Wound healing process. Osteotomes, Bone Cutting Forceps, Gigli Saws, Plate Benders. **10 Hrs**

Chapter 2. Cardiology: Catheterization Laboratory Instrumentation, Arrhythmia monitor, Exercise stress testing, Ambulatory monitoring instruments Foetal Monitoring Instruments: Cardiotocograph, Abdominal Foetal Electrocardiogram, Foetal Phonocardiogram

Oximeters: Oximetry, Ear Oximeter, Pulse Oximeter, Skin reflectance Oximeters, Intravascular Oximeter. **10 Hrs**

Unit II

Chapter 3. Opthalmology: Anatomy of human eye, Physiology of vision, Errors of refraction and their optical correction, Aqueous humor production and drainage, Strabismus.

Clinical methods: Spectacles and contact lenses, Refractive surgery, Snellen‟s Chart, Cover – uncover test, Maddox rod test, Maddox wing test. **10 Hrs**

Chapter 4. Opthalmology Instruments: Tonometry and its types, Perimetry - Peripheral Field Charting, Central Field Charting, Fundus Fluorescein Angiography, Electroretinography, Electro-oculography, Loupe & Lens Examination, Slit-Lamp Examination, Gonioscopy, Retinoscope- Principle, Procedure & Types, Refractometry, Keratometry- principle and types, subjective refraction, Ophthalmoscopy-Direct & Indirect. **10 Hrs**

Unit III

Chapter 5. Opthalmology Surgical Instruments: Cataract – list of classification only, Surgical techniques for cataract extraction – Intracapsular cataract extraction & Extracapsular cataract extraction for adulthood cataract, Phacoemulsification, Intraocular lens implantation. General considerations of Glaucoma, surgical procedures for Glaucoma, Vitreous Liquefaction, Vitreous Opacities, Vitreous Haemorrhage, Vitrectomy-types and techniques, Lasers in Ophthalmology, Cryotherapy in Ophthalmology. **10 Hrs**

Text Books:

1. Textbook of Medical Physiology”, Guyton & Hall, 11th Edition, Reed Elsevier Pvt. Ltd., 2007.
2. “Handbook of Biomedical Instrumentation”, R S Khandpur, 2nd edition, McGrawHill Education, 2013.
3. “Comprehensive Ophthalmology”, A. K. Khurana, 4th Edition, New Age International Ltd., 2010

Course Code: 22EBMC303	Course Title: Therapeutic Devices and Circuits	
L-T-P : 4-0-0	Credits: 4	Contact Hrs: 4
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 50Hrs		Exam Duration: 3 Hrs

Content	Hrs
Unit - 1	
Chapter 1. Cardiac pace makers: Need for Cardiac pace maker. Types of pace makers:-external and Implantable pacemakers. Classification codes for Pacemakers. Ventricular synchronous demand pacemaker, Programmable pacemaker. Power sources for Implantable pacemakers. Cardiac defibrillators: Need for defibrillator. DC defibrillator. Pacer-Cardioverter-defibrillator. Defibrilatoranalyser. Principle of surgical diathermy. Solid state electrosurgical	10 hours
Chapter 2. Laser and its applications in biomedical: Fundamentals of Laser, Pulsed Ruby Laser, Nd-YAG Laser, Helium-Neon Laser, Argon Laser, Carbondioxide lasers, Excimer Laser, Semiconductor Laser safety. Electrotherapy Equipments: High frequency heat therapy, Shortwave diathermy, Microwave diathermy, Electrodiagnostic and Therapeutic apparatus.	10 hours
Unit - 2	
Chapter 3. Hemodialysis Machine: Function of the Kidneys. Changes in body fluids in renal disease. Artificial Kidney. Dialyzers: Parallel flow, coil, Hallow fibre type dialyzers. Performance analysis of dialyzers. Hemodialysis machine. Heart lung machine (Cardiac assist device), Lithotriptor machine, Extra-corporeal shock-wave therapy, Infant incubator.Anaesthesia machine	10 hours
Chapter 4. Ventilators: Types of ventilators, Classification, Pressure-volume-flow, High frequency ventilators, Humidifiers, Nebulizers and Aspirators. Automated Drug Delivery system: Infusion pump, Components of drug infusion systems, Implantable infusion system, Closed-loop control in infusion system Laser and its applications in biomedical	10 hours
Unit - 3	

Chapter 5 Introduction to man-Instrument system. Components of Man-Instrument system. Problems encountered in measuring a living system. Physiological effects of Electrical current. Shock Hazards from Electrical equipment‟s. Methods of accident prevention. Precautions to minimize Electric shock hazards. Safety codes for Electromedical equipment. Electrical safety analyser.	10 hours
Text Books: 1. “Handbook of Biomedical Instrumentation”, R S Khandpur, 2nd edition, McGrawHill Education, 2013 2. “Medical Instrumentation, Application and Design”, John G. Webster, 3rd Edition, John Wiley & Sons 3. “Biomedical Instrumentation and Measurements”, Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, 2nd Edition, Prentice Hall of India Private Limited, 2001 4. “Introduction to Biomedical Equipment Technology”, Joseph J Carr, John M. Brown, 4th Edition, Pearson Education, 2004.	

Program: Bachelor of Engineering (Biomedical Engineering)		Semester: V Semester
Course Title: Operating System and Embedded System Design		Course Code: 24EBMC304
L-T-P: 3-0-1	Credits: 4	Contact Hours: 5 Hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 68 Hrs	Examination Duration:3 Hrs	

Unit I

Chapter No 1. Introduction to Operating System

What is an operating system? Goals of an operating system. Operation of an OS. Operating System Services. System Calls and Types. Operating system Structure – Simple, Monolithic and Microkernels, System Boot

Chapter No 2. Process Management

Process concept- operating on the process, inter-process communication, process scheduling- CPU scheduler-preemptive scheduling, scheduling criteria, scheduling algorithms- first come, first served scheduling, shortest job first scheduling, priority scheduling, round robin scheduling

Chapter No 3. Introduction To Real-Time Operating Systems

Introduction To Real-Time Operating Systems, Introduction to the real-time embedded system and types. Key characteristics of RTOS, its kernel, components in RTOS kernel, and Scheduling types: Preemptive priority-based scheduling, Round-robin and preemptive scheduling

Unit II

Chapter No 5. Tasks, Task Synchronization and Programming:

Task: Structure, Semaphore: Structure, Types: binary semaphore, mutual exclusion (mutex) semaphore, and Uses. Event Flags: Structure, uses, and program using RTX kernel.

Priority Inversion problem and its solutions.

Chapter No 5. Intertask Communication and Programming:

Message Queue: Structure, state diagram, operation, Uses and program using RTX kernel.

Unit III

Chapter No 6 Embedded System Design Concepts and Firmware Development:

Classification and purposes of embedded system, Characteristics of embedded system, Operational and non-operational quality attributes of embedded system. Core and Supporting components of embedded system. Embedded firmware development.

Text Books

1. Silberschatz, Galvin and Gagne, Operating system concepts,9th edition, WILEYPublication,2018.
2. Qing Li with Caroline Yao, Real-Time Concepts for Embedded Systems, 1E, Published,2011
3. Shibu K V, Introduction to Embedded systems,2nd edition, McGraw Hill Education India Private Limited,2017
4. Raj Kamal, Embedded Systems, Paperback,3rdedition, McGraw-Hill Education, 2017

Reference Books:

1. Dhananjay Dhamdhere, Operating Systems a Concept Based Approach,3rd edition, McGraw-HillEducation,2017

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Experiment Wise Plan

List of experiments/jobs planned to meet the requirements of the course.

Category: Exercise	
Exp No	**Experiment / Job Details**
1	Write an optimized C program to Create Tasks using RTX Kernel. Also, comment on the performance.
2	Write an optimized RTOS program & demonstrate the concept of Round Robin Task Scheduling, and comment on performance.
3	Write an optimized RTOS program to demonstrate the concept of a basic preemptive scheduling algorithm using RTX Kernel and comment on performance.
4	Write an optimized RTOS program & demonstrate the concept of Events and Flags for inter-task communication using RTX Kernel. Also, comment on performance.
5	Write an optimized RTOS program & demonstrate the concept of Mailbox, and comment on performance.
6	Write an optimized RTOS program & demonstrate the concept of Semaphore, and comment on performance.

Category: Open Ended	
Expt./ Job No.	**Experiment / Job Details**
1	Design and implement an application using a Real-Time Operating System (RTOS) to address the specific requirements outlined in the given problem statement.

Program: Bachelor of Engineering (Biomedical Engineering)		Semester: V Semester
Course Title: Clinical Instrumentation Lab		**Course Code: 22EBMP301**
L-T-P: 0-0-2	**Credits: 2**	**Contact Hours: 4 Hrs/week**
ISA Marks: 80	**ESA Marks: 20**	**Total Marks: 100**
Teaching Hours: 52 Hrs	**Examination Duration: 2 Hrs**	

List of Experiments:

1. Design and Test the bio-potential amplifiers for ECG/ or EEG/ or EMG
2. Design and Test the Notch Filter for 50 Hz and 60 Hz.
3. Testing and analysis of the following by hardware circuit/simulation (i) DC Defibrillator (ii) Pacemaker
4. Acquisition of ECG: (i) Single lead (iii) Three lead, and (iii) 12-Leads. Analysis of the acquired ECG in amplitude, time and frequency domain.
5. Acquisition and analysis (time & frequency) of EEG.
6. Acquisition and analysis of Lung Volumes and Lung Capacities using Spirometer.
7. Quantification and assessment of hearing ability using audiometer (i) Measurement of corneal curvature using keratometer, (ii) Measurement of Visual Acuity using
8. Snell's Chart, and (iii) Measurement of refractive errors.
9. Study Experiments: Baby incubator, Ventilator, Heart-lung machine, Dialysis machine, Pacemaker, Ophthalmoscope, Recording ofpulse & oxygen saturation using Pulse Oximeter, and Infusion Pump.

Reference Books:

1. . "Medical Instrumentation, Application and Design", John G. Webster, 3rd Edition, John Wiley & Sons

Program: Bachelor of Engineering (Biomedical Engineering)		Semester: 5 Semester
Course Title: Mini Project		Course Code: 23EBMW301
L-T-P: 0-0-3	Credits: 3	Contact Hours: 6 Hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 60Hrs	Examination Duration:3 Hrs	

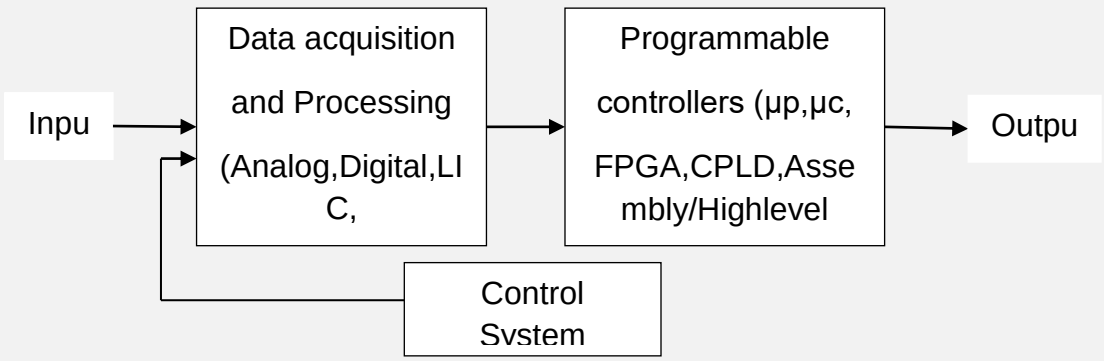
Guide lines for selection of a project:

The project needs to encompass the concepts leant in a subject/s studied in the previous four semesters, so that the student will learn to integrate, the knowledge base acquired to provide a solution to the identified need.

Project should be able to exhibit sensing, controlling and actuation sections.

The mini project essentially will comprise of two components:

- **The hardware design**
- **The graphical user interface (GUI) for application and data analysis with report generation.**



Student can select a project which leads to a product or model or prototype related to following areas (not limited to these areas).

- Pulse and digital circuits: simulate the working of one or more circuits
- Signals and systems: simulate the behaviour of a system by considering different signals
- Analog Electronic: simulate working of different devices
- Control systems: simulate the behaviour of a control system
- Linear Integrated Circuits: simulate working of one or more circuits
- Micro-controllers: simulate the ALU/control unit of microcontroller

Time plan: Effort to do the project should be between 120-150 Hrs per team, which includes self-study of an individual member (80-100 Hrs) and team work (40-50hrs). Learning overhead should be 20-25% of total project development time.

Program: Biomedical Engineering		Semester: V
Course Title: Arithmetical Thinking and Analytical Reasoning		Course Code: 23EHSA303
L-T-P: 0-0-0	Credits: 0	Contact Hours: 1 hrs/week
ISA Marks: 100	ESA Marks: --	Total Marks: 100
Teaching Hours: 16Hrs	Examination Duration: 3 Hrs	

Chapter No. 1. Analytical Thinking

Importance of Sense of Analysis for Engineers, Corporate Methodology of Testing Sense of Analysis, Puzzles for practice: Analytical, Mathematical, Classification Puzzles, Teamwork in Problem Solving

Chapter No. 2. Mathematical Thinking I

Problems on Finance: Percentages, Gain and Loss, Interest; Distribution and Efficiency Problems: Averages, Time Work, Permutations Combinations

Chapter No. 3. Mathematical Thinking II

Distribution Problems: Permutations Combinations

Chapter No. 4. Verbal Ability

Comprehension of Passages, Error Detection and Correction Exercises, Common Verbal Ability questions from Corporate Recruitment Tests

Reference Books:

1. George J Summers, “The Great Book of Puzzles & Teasers”, Jaico Publishing House, 1989
2. Shakuntala Devi , “Puzzles to Puzzle You”, Orient Paper Backs, New Delhi, 1976
3. R. S. Aggarwal, “A Modern Approach to Logical Reasoning”, Sultan Chand and Sons, New Delhi, 2018
4. M Tyra, “Magical Book on Quicker Maths”, BSC Publications, 2018
5. Cambridge Advanced Learner’s Dictionary, Cambridge University Press.
6. Kaplan’s GRE guide

Program: Bachelor of Engineering (Biomedical Engineering)		**Semester: VI Semester**
Course Title: Professional Aptitude and Logical reasoning		**Course Code: 16EHSC301**
L-T-P: 3-0-0	**Credits: 3**	**Contact Hours: 3Hrs/week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 40Hrs	**Examination Duration:3 Hrs**	

Unit I

Chapter 1. – Arithmetical Reasoning

Chapter 2. – Analytical Thinking

Chapter 3. – Syllogistic Logic

Unit II

Chapter 1. – Verbal Logic

Chapter 2. – Non-Verbal Logic

Unit III

Chapter 1. - Lateral Thinking

Text Books

1. A Modern Approach to Verbal and Non – Verbal Reasoning – R. S. Aggarwal, Sultan Chand and Sons, New Delhi
2. Quantitative Aptitude – R. S. Aggarwal, Sultan Chand and Sons, New Delhi

Reference Books:

1. Verbal and Non – Verbal Reasoning – Dr. Ravi Chopra, MacMillan India
2. Lateral Thinking – Dr. Edward De Bono, Penguin Books, New Delhi

Program: Biomedical Engineering		**Semester: VI**
Course Title: Industry Readiness & Leadership Skills		**Course Code: 23EHSA304**
L-T-P: 0-0-0	**Credits: 0**	**Contact Hours: 1 hrs/week**
ISA Marks: 100	**ESA Marks: --**	**Total Marks: 100**
Teaching Hours: 16Hrs	**Examination Duration: --**	

Chapter No. 1. Written Communication

Successful Job Applications, Résumé Writing, Emails, Letters, Business Communication, Essay, and Paragraph Writing for Recruitment Tests

Chapter No. 2. Interview Handling Skills

Understanding Interviewer Psychology, Common Questions in HR Interviews, Grooming, Interview Etiquette

Chapter No. 3. Lateral & Creative Thinking

Lateral Thinking by Edward de Bono, Fractionation and Brain Storming, Mind Maps, Creativity Enhancement through Activities

Chapter No. 4. Team Building & Leadership Skills

Communication in a Team, Leadership Styles, Playing a Team member, Belbin's team roles, Ethics, Effective Leadership Strategies

Reference Books:

1. Diana Booher – E Writing, Laxmi Publications
2. Edward de Bono–Lateral Thinking – A Textbook of Creativity, Penguin UK
3. William Strunk, E B White – The Elements of Style, Pearson
4. John Maxwell – The 17 Essential Qualities of a Team Player, HarperCollins Leadership
5. Robin Ryan – 60 Seconds and You're Hired! – Penguin Books

Program: Bachelor of Engineering (Biomedical Engineering)		Semester: VI Semester
Course Title: Medical Image Processing		Course Code: 24EBMC305
L-T-P: 3-0-1	Credits: 4	Contact Hours: 5 Hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 54 Hrs	Examination Duration:3 Hrs	

Unit I

Chapter No: 1.

Introduction: Background, Examples of fields that use DIP, Fundamental steps in Digital Image Processing (DIP), Components of DIP system, Image sensing and acquisition, A simple image formation model, Image sampling and quantization. Basic relationship between pixels.

Chapter No: 2. Image Enhancement in Spatial Domain: Background, Point processing – Image negatives, Log transformations, Power law transformations, Contrast stretching, Intensity level slicing, Bit plane slicing, Histogram processing – Histogram equalization, Histogram matching (specification), Arithmetic/Logic operations – Image subtraction, Image averaging. Fundamentals of spatial filtering, Smoothing spatial filters, Sharpening spatial filters. **16 Hrs**

Unit II

Chapter No: 3. Image Enhancement In Frequency Domain: Background, 2D-Discrete Fourier Transform and its Inverse, Basic properties of the 2D-Discrete Fourier Transform, Basics of filtering in the frequency domain.

Chapter No: 4. Image smoothing using frequency domain filters – Ideal low pass filters, Butterworth low pass filters, Gaussian low pass filters; Image sharpening using frequency domain filters – Ideal high pass filters, Butterworth high pass filters, Gaussian high pass filters, Homomorphic filtering. **16 Hrs**

Unit III

Chapter No: 5. Image Segmentation: Fundamentals, Point detection, Line detection, Edge models, Edge detection, Thresholding, Region based segmentation.

Chapter No: 6. Image Compression: Fundamentals, Image compression models, Basic compression methods – Huffman coding, Arithmetic coding, LZW coding, Run-length coding. **08 Hrs**

Text Books:

1. Digital Image Processing - Rafael. C. Gonzalez and Richard. E. Woods, Third Edition, Pearson Education, 2008.

Reference Books:

1. Fundamentals of Digital Image Processing - Anil K. Jain, 5th Indian Print, PHI, 2002.

2. Digital Image Processing and Computer Vision - Milan Sonka, India Edition, Cengage Learning

Program: Bachelor of Engineering (Biomedical Engineering)		**Semester: VI Semester**
Course Title: Biomedical Digital Signal Processing		**Course Code: 24EBMC306**
L-T-P: 3-0-1	**Credits: 4**	**Contact Hours: 5 Hrs/week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 54 Hrs	**Examination Duration:3 Hrs**	

Unit I

Chapter 1: Introduction

The nature of biomedical signals, objectives of biomedical signal analysis, difficulties encountered in biomedical signal analysis, Computer aided diagnosis.

Neurological Signal processing: Electrophysiological origin of Brain waves EEG signal and its characteristics, EEG analysis, Linear prediction theory, Autoregressive (AR) method, Recursive Estimation of AR parameters, Spectral error measure, Adaptive segmentation

Chapter 2: Signal averaging

Basics of signal averaging, Signal averaging as a digital filter, A typical averager, Software for signal averaging, Limitations of signal averaging.

Data Acquisition and classification of sleep stages, The Markov model and Markov chains, Dynamics of Sleep-wake Transitions, Hypnogram Model Parameters. **16 Hrs**

Unit II

Chapter 3: Filtering for Artifacts Removal :Random noise, structured noise and physiological interference, stationary versus non-stationary processes, time domain filters with application: Synchronized averaging, moving-average filters

Frequency domain filters with examples, removal of high frequency noise by Butterworth low pass filters, removal of low frequency noise by Butterworth high pass filter, removal of periodic artifacts by notch and comb filters.

Chapter 4: **ECG Parameters and their estimation**: QRS detection techniques, Estimation of ST-segment. A review of wiener filtering problem, Principle of an adaptive filter, Adoptive noise canceller, Cancellation 60Hz Interference in ECG, Cancelling Donor heart Interference in Heart-transplant ECG, Cancelling of maternal ECG in Fetal ECG. **16 Hrs**

Unit III

Chapter 5: Data Reduction

Direct ECG data compression techniques: TP, AZTECH, CORTES, Other data compression techniques: DPCM, Entropy coding, Peak-picking compression, Cycle-to-Cycle compression, Data compression techniques comparison.

08 Hrs

Text Books / References:

1. Biomedical signal analysis- A case study approach, Rangayyan Rangaraj, Wiley (IEEE Press)-2005
2. Biomedical Signal Processing- Principles and Techniques - D. C. Reddy, Tata McGraw-Hill, 2005.
3. Biomedical Digital Signal Processing-Willis J. Tompkins, PHI, 2000..

References

1. Biomedical Signal Processing and Signal Modeling by Eugene N Bruce, John Wiley & Son's publication
2. Biomedical Engineering and Design Handbook by Myer Kutz, McGraw Hill

Program: Bachelor of Engineering (Biomedical Engineering)		Semester: VI Semester
Course Title: Machine Learning and Deep Learning		Course Code: 24EBMC307
L-T-P: 2-0-2	Credits: 4	Contact Hours: 6 Hrs/week
ISA Marks: 40	ESA Marks: 60	Total Marks: 100
Teaching Hours: 50Hrs	Examination Duration: 2 Hrs	

Unit I

Chapter No.1 Introduction

Motivation, History and Evolution, Definition (ETP, Examples), Types of Machine Learning: Supervised, Unsupervised and Reinforcement learning. **02 Hrs**

Chapter No. 2 Supervised Learning

Model Representation: Basic Terminologies (Variable/features, Input, Output, Model, Learning Algorithm, Hypothesis, Cost/Loss function) Linear Regression: Single Variable (Representation of hypothesis, cost function, Optimization: Sum of squared error (L1 and L2), parameters/weights, bias) without bias and with bias. Model Optimization: Introducing Iterative optimization (Sum of squares error function, Gradient descent algorithm) and non-iterative optimization. Linear Regression: Polynomial Regression and Multi-variable Regression (Representation of hypothesis, cost function, Optimization).Model Optimization: Gradient descent algorithm (Learning rate/ step size, Normalization/ Feature Scaling).Model Optimization: Non-iterative optimization (Normal Equation).Logistic Regression: Hypothesis Representation, Decision boundary, Cost function, Logistic Regression: Optimization (Gradient Descent), Multi-class classification (One-vs.-all classification using logistic regression), Classical supervised learning algorithm- Support Vector Machine (SVM). **08 Hrs**

Chapter No. 3 Performance Evaluation

Performance Evaluation of learning models: Metrics (Confusion matrix, Precision, Recall, F1 Score, RoC curves), Modeling data and validating learning, Over fitting, Trade of Bias and Variance, Methods to overcome over fitting (Feature reduction, Regularization). **04 Hrs**

Unit II

Chapter No. 4 Unsupervised Learning Clustering:

Introduction, K-means Clustering, Algorithm, Cost function, Applications, Dimensionality Reduction: Motivation, Definition, Methods of Dimensionality reduction, Dimensionality Reduction: PCA- Principal Component Analysis. **04 Hrs**

Chapter No. 5: Introduction to Neural Network and deep learning

Introduction to Neural Networks (Motivation: non-linear model, Neurons and perception), Model representation: Neural Network Architecture (Activation units, Layers), Neural Network: Initialization, Forwards propagation, and Cost function, Back propagation algorithm, multi-class classification, Steps to train a neural network, Applications of Neural Networks. **05 Hrs**

Chapter No. 6 Introduction to Deep learning

Introduction to Deep Learning (Motivation, Overview), Convolution Neural Networks (CNN) (Architecture, terminologies, Evolution and Modelling), Recurrent Neural Networks (RNN), Self-supervised models (Auto encoders and variants), Generative Models (GAN, its variants and applications), Attention networks, Transformer based architecture, Transformer for Time-Series. **05 Hrs**

Text Books

1. Tom Mitchell, Machine Learning, 1, McGraw-Hill, 1997
2. Christopher Bishop, Pattern Recognition and Machine Learning, 1, Springer, 2007

Reference Books:

1. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning: Data Mining Inference and Prediction, 2, Springer, 2009

Program: Bachelor of Engineering (Biomedical Engineering)		Semester: VI Semester
Course Title: Minor Project I		**Course Code: 24EBMW302**
L-T-P: 0-0-6	**Credits: 6**	**Contact Hours: 12 Hrs/week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 60 Hrs	**Examination Duration: 3 Hrs**	

Application Areas are,

- Smart City
- Connected Cars
- Home Automation
- Health care
- Smart energy
- Agriculture

Guide lines for selection of a project:

1. The project needs to encompass the concepts leant in a subject/s studied in the previous five semesters, so that the student will learn to integrate, the knowledge base acquired to provide a solution to the defined problem statement of the minor-projects.
2. Student can select a project which leads to a product or model or prototype.
3. Time plan: Effort to do the project should be between 120-150 Hrs per team, which includes self-study of an individual member (80-100 Hrs) and team work (40-50hrs).
4. Learning overhead should be 20-25% of total project development time.

Criteria for group formation:

1. 3-4 students in a team.
2. Role of teammates: Team lead and members.

Allocation of Guides and Mentors for the projects:

Every Project batch will be allocated with one faculty.

Details of the project batches:

1. Number of faculty members: 64
2. Number of students: 278

Role of a Guide

The primary responsibility of the guide is to help students to understand the meaning and need of various stages in the implementation of the project. At every stage of the project development, guide should help towards its successful completion as per the predefined standards.

How student should carry out a project:

1. Define the problem
2. Specify the requirements
3. Specify the design in the understandable form (Block Diagram, Flowchart, Algorithm, etc)
4. Analyze the design
5. Select appropriate simulation tool and development board for the design.
6. Implement the design
7. Optimize the design and generate the results with optimized design.
8. Result representation and analysis
9. Prepare a document and presentation.

Report Writing

The format for report writing should be downloaded from ftp://10.3.0.3/minorprojects
The report needs to be shown to guide and committee for each review.

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Program: Bachelor of Engineering (Biomedical Engineering)		Semester: VI Semester
Course Title: Java Programming		**Course Code: 22EBME311**
L-T-P: 3-0-0	**Credits: 3**	**Contact Hours: 3 Hrs/week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 40Hrs	**Examination Duration:3 Hrs**	

Unit I

Chapter 1: Object Oriented Programming and JAVA: Object Oriented Paradigm, basic concepts, benefits and applications of OOPs. JAVA history and features, How java differs from C and C++, JAVA and Internet, JAVA and World Wide Web, Web browsers, JAVA support systems, JAVA environment. JAVA program structure, Tokens, Statements, JAVA Virtual Machine. Overview of JAVA Language: Simple Java Program, Math functions, An application with two classes, Java program structure, Java Tokens, Java Statement, Implementing a Java Program, Java Virtual Machines, Command and Line Arguments, Programming Style. **8 Hrs**

Chapter 2: Constants, Variables, Data Types: Declaration and scope of Variables, Symbolic constants, Type Casting, Standard Default values. Operators and Expression: Arithmetic, Relational, Logical, Assignment, Increment, Decrement, Conditional, Bitwise, Special Operators, Arithmetic Expressions, Evaluation, Procedure of Operators, Type Conversion in Expressions, Mathematical functions. Decision Making, Branching and Looping: If Statement, If….Else statement, Nesting of statements, Switch Statement, Operator, While Statement, Do statement, For statement, Jump in Loops. **8 Hrs**

Unit II

Chapter 3: Classes, Objects and Methods: Class definition and declaration, Creating Object, Accessing Class Members, Constructors, Methods Overloading, Static Members, Nesting Methods, Inheritance, Overriding Methods, Final Variables and Methods, Final Classes, Finalizer Methods, Abstract Methods and Classes, Visibility Control. Arrays, Strings and Vectors: One and two dimensional arrays, Strings, Vectors, Wrapper Classes **8 Hrs**

Chapter 4: Interfaces: Definition, Extending and Implementing Interfaces, Accessing Interface variables. Packages: JAVA API Packages, Using System packages, Naming conventions, Creating, Accessing and Using a package, Adding a class to a Package, Hiding Classes. Multithreaded Programming : Creating and Extending Thread Class, Stopping, Blocking and Life Cycle of Thread, Using Thread Methods, Thread Exceptions and Priority, Synchronization, Implementing runnable Interface. **8 Hrs**

Unit III

Chapter 5: Applet Programming: Introduction, How Applets Differ from Applications, Preparing to write Applets, Building Applet Code, Applet Life Cycle, Creating an Executable Applet , Designing a Web Page, Applet Tag, Adding Applet to HTML File, Running the Applet, Passing Parameters to Applets, Aligning the Display, More about HTML Tags, Displaying Numerical Values, Getting Input from the User, Event Handling. **8 Hrs**

Text Books:

1. E.Balaguruswamy – Programming with JAVA – A Primer – 5th Edition, McGraw Hill
2. Herbert Schildt, Java the Complete Reference, 7th Edition, Tata McGraw Hill, 2007

Reference Books:

1. Object oriented programming in TURBO C++ - Robert Lafore, Galgotia Publications, 2002.

Program: Bachelor of Engineering (Biomedical Engineering)		Semester: VI Semester
Course Title: Automotive Electronics		**Course Code: 22EBME312**
L-T-P: 3-0-0	**Credits: 3**	**Contact Hours: 3 Hrs/week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 40Hrs	**Examination Duration:3 Hrs**	

Unit I

Chapter No: 1. Automotive fundamentals and industry overview

Introduction to automotive electronics, Vehicle functional domains, ECU design cycle: Model Base Design (MBD), V and Agile.

Chapter No: 2. Automotive Control Systems Design

Vehicle safety and stability systems, sensors and actuators, powertrain control systems, vehicle dynamics control, brake control systems

Chapter No: 3. Fundamentals of electric vehicle

Drive cycles, EV drive train, EV Batteries, battery management system **16 Hrs**

Unit II

Chapter No: 4. Automotive communication protocols

Overview of Automotive communication protocols, CAN, CAN FD, Automotive Ethernet, LIN, Flex Ray, MOST.

Chapter No: 5. Introduction to ADAS/AD

Advanced Driver Assistance Systems (ADAS), Autonomous driving: sensing, planning and control, connected vehicles.

16 Hrs

Unit III

Chapter No: 6. Functional Safety Standards

Functional Safety: Need for safety standard-ISO 26262, safety concept, safety process for product life cycle.

Chapter No: 7. Vehicle Diagnostics

Introduction to vehicle diagnostics, onboard/off board Diagnostics, diagnostic tools, diagnostic fault codes, diagnostic protocols: KWP2000 and UDS. **08 Hrs**

Text Books

1. Ribbens, Understanding of Automotive electronics, 6th Edition, Elsevier, 2003
2. Denton, Automobile Electrical and Electronic Systems, Elsevier, 3rd Edition, 2004
3. Konrad Reif Ed, Brakes, Brake Control and Driver Assistance Systems, Professional Automotive Information, Springer, 2014
4. David Smith, Kenneth Simpson, The Safety Critical Systems Handbook, 5th Edition, 2020

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Program: Bachelor of Engineering (Biomedical Engineering)		Semester: VI Semester
Course Title: OOP's using C++		Course Code: 22EBME313
L-T-P: 3-0-0	Credits: 3	Contact Hours: 3 Hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40Hrs	Examination Duration: 3 Hrs	

Unit 1

Chapter No. 1.

Beginning with C++ and its features:

What is C++?, Applications and structure of C++ program, Different Data types, Variables, Different Operators, expressions, operator overloading and control structures in C++

Chapter No. 2

Functions, classes and Objects:

Functions, Inline function, function overloading, friend and virtual functions, Specifying a class, C++ program with a class, arrays within a class, memory allocation to objects, array of objects, members, pointers to members and member functions **16 Hrs**

Unit 2

Chapter No. 3.

Constructors, Destructors and Operator overloading:

Constructors, Multiple constructors in a class, Copy constructor, Dynamic constructor, Destructors, Defining operator overloading, Overloading Unary and binary operators, Manipulation of strings using operators

Chapter No. 4.

nheritance, Pointers, Virtual Functions, Polymorphism:

Derived Classes, Single, multilevel, multiple inheritance, Pointers to objects and derived classes, this pointer, Virtual and pure virtual functions. **16 Hrs**

Unit 3

Chapter No. 4.

Streams and Working with files:

C++ streams and stream classes, formatted and unformatted I/O operations, Output with manipulators, Classes for file stream operations, opening and closing a file, EOF. **08 Hrs**

Reference Books:

1. Object Oriented Programming with C++, E.Balaguruswamy, TMH, 6th Edition, 2013.
2. Object Oriented Programming using C++, Robert Lafore, Galgotia publication 2010.

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Program: Bachelor of Engineering (Biomedical Engineering)		Semester: VI Semester
Course Title: Python		**Course Code: 22EBME314**
L-T-P: 3-0-0	**Credits: 3**	**Contact Hours: 3 Hrs/week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 40Hrs	**Examination Duration:3 Hrs**	

Unit I

Chapter No. 1. Python Basics, Entering Expressions into the Interactive Shell, The Integer, Floating-Point, and String Data Types, String Concatenation and Replication, Storing Values in Variables, Your First Program, Dissecting Your Program, Flow control, Boolean Values, Comparison Operators, Boolean Operators, Mixing Boolean and Comparison Operators, Elements of Flow Control, Program Execution, Flow Control Statements, Importing Modules, Ending a Program Early with sys.exit(), Functions, def Statements with Parameters, Return Values and return Statements, The None Value, Keyword Arguments and print(), Local and Global Scope, The global Statement, Exception Handling. **8 Hrs**

Chapter No. 2.

Lista, The List Data Type, Working with Lists, Augmented Assignment Operators, Methods, Example Program: Magic 8 Ball with a List, List-like Types: Strings and Tuples,References, Dictionaries and Structuring Data, The Dictionary Data Type, Pretty Printing, Using Data Structures to Model Real-World Things, Manipulating Strings, Working with Strings, Useful String Methods, Project: Password Locker, Project: Adding Bullets to Wiki Markup **8 Hrs**

Unit II

Chapter No. 3.

Pattern Matching with Regular Expressions, Finding Patterns of Text Without Regular Expressions, Finding Patterns of Text with Regular Expressions, More Pattern Matching with Regular Expressions, Greedy and Nongreedy Matching, The findall() Method, Character Classes, Making Your Own Character Classes, The Caret and Dollar Sign Characters, The Wildcard Character, Review of Regex Symbols, Case-Insensitive Matching, Substituting Strings with the sub() Method, Managing Complex Regexes, Combining re .IGNORECASE, re .DOTALL, and re .VERBOSE, Project: Phone Number and Email Address Extractor, Reading and Writing Files, Files and File Paths, The os.path Module, The File Reading/Writing Process, Saving Variables with the shelve Module,Saving Variables with the pprint.pformat() Function, Project: Generating Random Quiz Files, Project: Multiclipboard, Organizing Files, The shutil Module, Walking a Directory Tree, Compressing Files with the zipfile Module, Project: Renaming Files with American-Style Dates to European-Style Dates,Project: Backing Up a Folder into a ZIP File, Debugging, Raising Exceptions, Getting the Traceback as a String, Assertions, Logging, IDLE‟s Debugger. **8 Hrs**

Chapter No. 4.

Classes and objects, Programmer-defined types, Attributes, Rectangles, Instances as return values, Objects are mutable, Copying, Classes and functions, Time, Pure functions, Modifiers, Prototyping versus planning, Classes and methods, Object-oriented features, Printing objects, Another example, A more complicated example,Theinit method, The __str__ method, Operator overloading, Type-based dispatch, Polymorphism, Interface and implementation,Inheritance, Card objects, Class attributes, Comparing cards, Decks, Printing the deck, Add, remove, shuffle and sort, Inheritance, Class diagrams, Data encapsulation **8 Hrs**

Unit III

Chapter No. 5.

Web Scraping, Project: MAPIT.PY with the webbrowser Module, Downloading Files from the Web with the requests Module, Saving Downloaded Files to the Hard Drive, HTML, Parsing HTML with the Beautiful Soup Module, Project: "Im Feeling Lucky" Google Search, Project: Downloading All XKCD Comics, Controlling the Browser with the selenium Module, Working with Excel Spreadsheets, Excel Documents, Installing the open pyxl Module, Reading Excel Documents, Project: Reading Data from a Spreadsheet, Writing Excel Documents, Project: Updating a Spreadsheet, Setting the Font Style of Cells, Font Objects, Formulas, Adjusting Rows and Columns, Charts, Working with PDF and Word Documents, PDF Documents, Project: Combining Select Pages from Many PDFs, Word Documents, Working with CSV files and JSON data, The csv Module, Project: Removing the Header from CSV Files, JSON and APIs, The json Module, Project: Fetching Current Weather Data **8 Hrs**

Text Books:

1. Al Sweigart,"Automate the Boring Stuff with Python",1stEdition, No Starch Press, 2015.

Reference Books:

1. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", 2nd Edition, Green Tea Press, 2015.

Program: Biomedical Engineering		Semester: VII
Course Title: Hospital Design, Planning and Management		Course Code: 22EBME411
L-T-P: 3-0-0	Credits: 3	Contact Hours: 3 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40Hrs	Examination Duration: 3 Hrs	

Unit 1

Chapter No. 1.

Planning & Building a New Hospital: Role of Hospital in Health Care, Hospital Planning & Design, Guiding principle in Hospital facilities & services, Functional Plans for Hospital construction, Design items, Functional program & design stage, Planning the Hospital building. **08 Hrs**

Chapter No. 2.

Effective Hospital Management: Planning, Organization, Directing & Leading, Controlling, Financial Management

Administrative Service: Medical Record, Hospital Infection, Hospital Utilization Statistics, Material Management, Evaluation of Hospital services. **08 Hrs**

Unit 2

Chapter No. 3.

Planning & Designing Medical Services: Out Patient service, Emergency service, Clinical laboratories, Radiology services, Radiation Therapy Department, Surgical Department, Nursing Department, Operation Theatre, CSSD Nursing services. **08 Hrs**

Chapter No. 4.

Planning & Designing Engineering Services: Engineering Department, Maintenance management, Clinical [Bio-medical] Engineering, Electrical System, Air Condition System, Water supply & sanitary system, Centralized Medical Gas System, Telecommunication System, Environmental Control, Safety & Security System, Disposal of Hospital Wastes. **08 Hrs**

Unit 3

Chapter No. 5.

Planning & Design of Supportive Services: Admitting Department, Medical Record Department, Centralized Sterilization & Supply department, Pharmacy Material Management, Food service Department, Laundry & Linen Services, House Keeping & Val entry Department. **08 Hrs**

Text Books

1. Principles of Hospital Administration & Planning - by B. M.Sakharkar, Jaypee Publications, 1998.
2. Hospital Facilities, Planning & Management - by G. D. Kunders, TataMcGraw Hill, 2004.

Reference Books

1. Hospital Administration & Management - by S. L. Goel& R. KumarDeep& Deep Publications
2. Applied Clinical Engineering - by Barry N. Feinberg, Prentice Hall,1984.
3. Clinical Engineering Principle & Practices - By John G. Webster &Albert M. Cook, Prentice Hall.

Program: Biomedical Engineering		Semester: VII
Course Title: Medical Device Regulations and Safety		Course Code: 22EBME412
L-T-P: 3-0-0	Credits: 3	Contact Hours: 3 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40Hrs	Examination Duration: 3 Hrs	

Unit 1

Chapter No. 1.

The medical device as an entity: What is a medical device?, Defining the device, The product definition process, Overview of quality function deployment, The QFD process, The business proposal Reliability: Definition, Quality Vs Reliability, Reliability Vs Unreliability, Types of Reliability, Optimizing reliability, Reliability's effects on medical devices. Concept of Failure: Causes of Failure, Practical aspects of failure, Failure rates, Hardware failure, Software Failure, Failure due to human errors, Failures from customer's point of view. Safety and Risk Management: Medical device safety and risk management, Effectiveness/performance of medical devices, Phases in the life span of a medical device, The risk management processes, Tools for risk estimation, Participants in ensuring the safety of medical devices, The role of each participant/stakeholder, Shared responsibility for medical device safety and performance. **08 Hrs**

Chapter No. 2.

Global Harmonization Task Force (GHTF): Objectives, Scope of the four GHTF study groups, Benefits of the GHTF, Final documents from the GHTF, Global Medical Device Nomenclature (GMDN) The Food and Drug Administration: History of device regulation, Device classification, Registration and listing, The 510 (k) Process, Declaration of conformance to a recognized standard, The PMA application, Investigational Device Exemptions (IDEs), Good Laboratory Practices (GLPs), Good Manufacturing Practices(GMPs), Human Factors, Design Control, The FDA and Software, Software classification, The FDA Inspection. **08 Hrs**

Unit 2

Chapter No. 3.

The European Union: European Directives, European Standardization Bodies, European Standards Development Process, Other European Standards Considerations, Conformity Assessment and Testing, European Organization for Testing and Certification, the NVCASE Program The Medical Devices Directives: Definition of a medical device, The Medical Devices Directives process, Choosing the appropriate directive, Identifying the applicable essential requirements, Identification of corresponding harmonized standards, Essential requirements, Classification of the medical devices, identification and choice of a notified body. **08 Hrs**

Chapter No. 4.

Standards and Regulations Background: Standards: What are standards? Voluntary and mandatory standards, Standards development process, Conformity assessment with standards, National and international standards systems, Identification of standards, Current trends in the use of standards in medical device regulations. The ISO 9000 Series of Standards. **08 Hrs**

Unit 3

Chapter No. 5.

Software and Quality system regulation: Software as a Technology, Domestic Software Regulations, Domestic Software Standards, International Software Regulations, International

Software Standards, The Move Toward One Software Standard History of the quality system regulations, Scope, General provisions, Quality system, Design controls, Document controls, Purchasing controls, Identification and traceability, Production and process controls, Acceptance activities, Non-conforming product, Corrective and preventive action. **08 Hrs**

Text Books

1. **Reliable Design of Medical Devices, Second Edition by Richard Fries, CRC Press, 2006**
2. **Medical Device Quality Assurance and Regulatory Compliance by Richard C Fries, CRC Press, 1998.**

Reference Books

1. **Medical device regulations: global overview and guiding principles By Michael Cheng, World Health Organization**
2. **Product Safety in the European Union by GáborCzitán, Attila Gutassy, Ralf Wilde, Akadémia, 2008.**

Program: Biomedical Engineering		**Semester: VII**
Course Title: Biological Control systems		**Course Code: 22EBME413**
L-T-P: 3-0-0	**Credits: 3**	**Contact Hours: 3 hrs/week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 40Hrs	**Examination Duration: 3 Hrs**	

Unit 1

Chapter No. 1.

OPEN AND CLOSED LOOP SYSTEMS: Mathematical models of physical systems, Transfer functions; Block diagram algebra, Signal flow graphs, Feedback characteristics of control systems; Control systems and components; DC and AC servomotors, Principles of stepper motors. **08 Hrs**

Chapter No. 2.

STANDARD TEST SIGNALS: Time response of first order and second order systems; Design specifications of second order systems; Proportional controller; Proportional derivative controller; Proportional-Integral Controller Proportional-Integral-Derivative Controller Performance indices of control systems; Necessary conditions for stability; Hurwitz and Routh stability criteria, Relative stability. **08 Hrs**

Unit 2

Chapter No. 3.

CONCEPT AND CONSTRUCTION OF ROOT LOCUS: Root contours, Frequency response analysis, Correlation between time and frequency response, Bode plots, Stability in frequency domain, Nyquist stability criteria. **08 Hrs**

Chapter No. 4.

CARDIOVASCULAR CONTROL SYSTEMS: Regulation of heart rate, Blood pressure and cardiac output, Respiratory Control System, Chemical regulation of ventilation cheyne Stokes breathing. **08 Hrs**

Unit 3

Chapter No. 5.

TYPES OF PHYSIOLOGICAL CONTROL SYSTEMS: Difference between general control systems and physiological control systems, Examples of positive and negative feedback physiological control systems; Body temperature Regulation; Blood glucose regulation, Pupil Control System, Visual Fixation System, Oculo-motor System, Muscle stretch reflex, Skeletal muscle Servo-mechanism. **08 Hrs**

Text Books

1. A. Nagoor Kani “Digital Signal Processing”, 2nd edition, Tata Mc. Graw Hill, 2012.
2. NagrathI. J and Gopal M., “Control Systems Engineering”, 3rd edition, New Age Publishers, 2002

Reference Books

1. Michael C. Khoo, “Physiological Control Systems-Analysis, Simulation and Estimation”, IEEE

Program: Biomedical Engineering		Semester: VII
Course Title: Scientific and Analytical Instrumentation		Course Code: 22EBME414
L-T-P: 3-0-0	Credits: 3	Contact Hours: 3 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40Hrs	Examination Duration: 3 Hrs	

Unit 1

Chapter No. 1.

An Introduction to Instrumental Methods: Terms associated with Chemical analysis, Classification of instrumental techniques, A review of important consideration in analytical methods, Basic functions of instrumentation, Fundamental Laws of photometry .

IR Spectroscopy: Basic Components of IR Spectrophotometers, monochromators- littrow mounting, Fourier Transform IR Spectroscopy. **08 Hrs**

Chapter No. 2.

UV and Visible Spectrometers –Instrumentation: Radiation Sources, Wavelength selection: absorption filters, interference filters, Detector, Readout modules(Text book 1), Instruments for absorption photometry: single beam and double beam spectrophotometer. **08 Hrs**

Unit 2

Chapter No. 3.

Flame Emission and Atomic Absorption Spectroscopy: Introduction, Instrumentation for flame spectrometric methods, Flame emission spectrometry, atomic absorption spectrometry, Atomic fluorescence spectrometry, Interferences associated with Flames & furnaces, applications, comparison of FES and AAS. **08 Hrs**

Chapter No. 4.

Gas Chromatography: Chromatograph, Basics parts of a chromatograph: carrier gas supply, sample injection system, chromatographic columns: packed column & capillary column, Detectors: katharometer cell, differential flame ionization detector, electron capture detector.

HPLC Instrumentation: Mobile –phase delivery system sample introduction, separation of columns, Detectors– Ultraviolet Photometers & Spectrophotometers, electrochemical detector (amperometric detector), Differential refractometer. **08 Hrs**

Unit 3

Chapter No. 5.

Blood analyzer: Introduction, Blood pH measurements: electrodes for blood pH measurement, measurement of blood pCO2, pO2 , A Complete blood gas analyzer.

Air pollution monitoring instruments: Carbon monoxide (CO) -Non-dispersive infrared analyzer, Sulphur dioxide (SO2)-Conductivitimetry, UV fluorescence method, Nitrogen oxides-Using CO laser, laser opto-acoustic spectroscopy, Hydrocarbons-Flame ionization detector, Ozone-Chemiluminescence, Automated wet chemical air analysis. **08 Hrs**

Text Books

1. Instrumental Methods of Analysis, 7th edition. H.H. Willard, L.L. Merritt, J.A. Dean, F.A. Settle, CBS Publishing & Distribution.
2. Handbook of Instruments – R.S. Khandpur, Tata McGraw Hill

Reference Books

1. Braun R.D., Introduction to Instrumental Analysis, McGraw –Hill Singapore,2006.

Semester VII

Program: Biomedical Engineering		**Semester: VII**
Course Title: Medical Imaging Systems		**Course Code: 22EBMC401**
L-T-P: 4-0-0	**Credits: 4**	**Contact Hours: 4 hrs/week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 50Hrs	**Examination Duration: 3 Hrs**	

Unit I

Chapter No. 1. X-Ray Imaging: Fundamentals of X-ray – Electromagnetic radiation, Interactions between X-rays and matter, Intensity of X-ray beam, Attenuation, Generation and Detection of X-rays – X-ray generation, X-ray generators, Filters, Beam restrictors and grids, Intensifying screens, fluorescent screens, and image intensifiers, X-ray detectors, Biological effects of ionizing radiation.

X-Ray Diagnostic Methods: Conventional X-ray radiography, Fluoroscopy, Angiography, Mammography and Xeroradiography. **10 Hrs**

Chapter No. 2. Computed Tomography: Conventional tomography, Computed tomography – Projection function, Algorithms for image reconstruction, CT number, Spiral CT. Recent developments – Digital radiography, Digital subtraction angiography (DSA), Dynamic spatial reconstructor (DSR). **06 Hrs**

Chapter No. 3. Thermal Imaging: Medical thermography, Physics of thermography, Infrared detectors, Thermographic equipment, Quantitative medical thermography, Pyroelectric vidicon camera, Thermal camera based on IR sensor with digital focal plane array. **04 Hrs**

Unit II

Chapter No. 4 Ultrasound Imaging: Fundamentals of acoustic propagation - Characteristic impedance, Intensity, Reflection and refraction, Attenuation, Doppler effect. Generation and detection of Ultrasound Piezoelectric effect, Ultrasonic transducers, Axial and Lateral resolution, Focusing, Arrays.

Ultrasonic Diagnostic Methods: Pulse echo systems- Amplitude mode (A-mode), Brightness mode (B-mode), Motion mode (M-mode), Doppler methods, Duplex imaging, Tissue characterization, Colour Doppler flow imaging, Image characteristics – Ultrasonic texture or speckle, Speckle reduction, Compensation of phase aberration, Biological effects of ultrasound. **10 Hrs**

Chapter No. 5: Radionuclide Imaging: Introduction, Fundamentals of Radioactivity – Nuclear particles, Nuclear activity and half-life, Units of measuring nuclear activity, Specific activity, Interaction of nuclear particles and matter, Attenuation of Gamma radiation, Radionuclides, Generation & Detection of Nuclear Emission – Radionuclide generators, nuclear radiation detectors, Collimators, Diagnostic methods using radiation detector probes – Thyroid function test, Renal function test, Blood volume measurement, Radionuclide imaging systems- Rectilinear scanner, Scintillation camera, SPECT, PET. **10 Hrs**

Unit III

Chapter No. 6: Basics of Magnetic Resonance Imaging: Fundamentals of nuclear magnetic resonance- Angular momentum, magnetic dipole moment, magnetization, Larmor frequency, Free induction decay (FID), Fourier spectrum of the NMR signal, Spin density, Relaxation times, Pulse sequences.

MRI System & Imaging Methods: Introduction, Magnet, NMR Coil/Probe, Transmitter, Receiver, Data acquisition. MRI Imaging Methods. Characteristics of MRI images- Spatial resolution, image contrast. Biological effects of magnetic fields- Static magnetic fields, Radio-frequency fields, Gradient magnetic fields, Imaging safety, Functional MRI (brief introduction only). **10 Hrs**

Text Book (List of books as mentioned in the approved syllabus)

1. Fundamentals of Medical Imaging – by Paul Suetens, Cambridge University Press, 2002
2. Principles of Medical Imaging – by Kirk Shung, Michael B. Smith and Banjamin Tsui, Academic Press, 1992.

References

1. The Physics of Medical Imaging – by Steve Webb (Editor), Adam Hilger, Bristol and Philadelphia Publications, 1988.

Program: Biomedical Engineering		Semester: VII
Course Title: Generative AI		Course Code: 25EBMC402
L-T-P: 2-0-1	Credits: 3	Contact Hours: 4 hrs/week
ISA Marks: 67	ESA Marks: 33	Total Marks: 100
Teaching Hours: 56Hrs	Examination Duration: 2 Hrs	

Unit I

Chapter No. 1. Introduction to Generative AI

Definition, Overview of Generative AI, Importance and applications of Generative AI, Evolution of AI towards generative models, Key milestones and breakthroughs in Generative AI. 02 Hrs

Chapter No. 2. Generative Models I:

Autoencoders (AE) and Variational Autoencoders (VAEs) Architecture: Encoder, Decoder, Latent Space, Training with ELBO (Evidence Lower Bound), Applications and limitations.

Generative Adversarial Networks (GANs): Architecture: Generator and Discriminator, Training process, loss functions, Common issues, Variants: DCGAN, Cycle GAN, and Style GAN.

Diffusion Models: Forward process (encoders), reverse process (decoders), score matching, guided diffusion **04 Hrs**

Chapter No. 3 Training and Evaluation of Generative AI Models:

Optimization Methods: Gradient Descent, Stochastic Gradient Descent (SGD), Adam Optimizer, Adam (Adaptive Moment Estimation), RMS Prop (Root Mean Square Propagation), Ada grad (Adaptive Gradient Algorithm), Ada Delta.

Evaluation Metrics: Inception Score (IS), Freshet Inception Distance (FID), Perplexity, Reconstruction Error, Mode Score, Diversity Metrics, Wasserstein Distance, Earth Mover's Distance (EMD), BLEU Score Challenges: Mode collapse, stability, and convergence. **04 Hrs**

Chapter No. 4 Generative Models II:

Autoregressive Models Definition and Principle: Autoregressive Property, Conditional Dependence, Autoregressive Process Examples of Autoregressive Models: AR Models in Time Series Analysis, Autoregressive Integrated Moving Average (ARIMA) Autoregressive Models for Generative AI: Pixel CNN - Overview, Architecture, Training, Applications Wave Net - Overview, Architecture, Training, Applications **04 Hrs**

Unit II

Chapter No. 5: Generative Models II: Transformers Introduction to Transformers, Origins and evolution from traditional sequence models (like RNNs and LSTMs) to transformers, self-attention mechanism, multi-head attention, position wise feedforward networks. Transformer Architecture: breakdown of encoder and decoder stacks, Layer normalization and residual connections, Masked self-attention in the decoder for auto-regressive generation, Pre-training and Fine-tuning. Transformer-based Autoregressive Models: Overview, Architecture, Training, Applications, BERT (Bidirectional Encoder Representations from Transformers), T5 (Text-to-Text Transfer Transformer) **05 Hrs**

Chapter 6: Generative Models II: Large Language Models (LLMs) Introduction to LLMs, Overview of Large Language Models (e.g., GPT-3, GPT-4), Training methodologies and scalability, Integration of LLMs in various generative tasks, Fine-tuning and transfer learning with LLMs, Building and deploying LLM-based applications. **05 Hrs**

Chapter 7: Ethical Considerations and Responsible AI:
Bias and fairness in generative AI models, Privacy concerns and data protection in generative AI applications, Responsible use of generative models in society **04Hrs**

Text Book (List of books as mentioned in the approved syllabus)

1. Christopher M. Bishop, Hugh Bishop, "Deep Learning - Foundations and Concepts",Springer 2024, ISBN 978-3-031-45467-7, pp. 1-607.
2. Akshay Kulkarni, Adarsha Shivananda, Anoosh Kulkarni, Dilip Gudivada, "Applied Generative AI for Beginners: Practical Knowledge on Diffusion Models, ChatGPT, and Other LLMs", 978-1-4842-9994-4, (2023), https://doi.org/10.1007/978-1-4842-9994-4.
3. Martin Musiol, "Generative AI: Navigating the Course to the Artificial General Intelligence Future". John Wiley & Sons Inc; 1st edition, (2024), ISBN-13: 978-1394205912, 1-288 pages.
4. Jospeh Babcock and Raghav Bali, "Generative AI with Python and TensorFlow 2: Create images, text, and music with VAEs, GANs, LSTMs, Transformer models", Packt Publishing (2021); Packt Publishing Limited, 1-488 Pages, ISBN-13: 978-1800200883.

References

1. The Physics of Medical Imaging – by Steve Webb (Editor), Adam Hilger, Bristol and Philadelphia Publications, 1988.

Program: Biomedical Engineering		Semester: VII
Course Title: CIPE & EVS		Course Code: 15EHSA401
L-T-P: 0-0-0	Credits: Audit	Contact Hours: 2 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 30Hrs	Examination Duration: 3 Hrs	

Unit I

Chapter No. 1 Features of Indian Constitution

Features of Indian Constitution, Preamble to the constitution of India, Fundamental rights under Part III – details of Exercise of rights, Limitations & Important cases. Berubari Union and Exchange of Enclaves, Kesavan and Bharati vs. UOI, Maneka Gandhi vs. UOI, Air India Ltd. vs. NargeesMeerza, T.M.A. Pai Foundation v. St. of Karnataka, M.C. Mehta vs. UOI etc.,

Chapter No. 2 Relevance of Directive principles of State Policy

Relevance of Directive principles of State Policy under Part IV, Fundamental duties & their significance. SarlaMudgal v. UOI

Chapter No. 3 Union

Union – President, Vice President, Union Council of Ministers, Prime Minister, Parliament & the Supreme Court of India.

Chapter No.4 State

State – Governors, State Council of Ministers, Chief Minister, State Legislature and Judiciary.

Chapter No. 5 Constitutional Provisions for Scheduled Castes & Tribes

Constitutional Provisions for Scheduled Castes & Tribes, Women &Children & Backward classes, Emergency Provisions.

Chapter No. 6 Electoral process

Electoral process, Amendment procedure, 42nd, 44th and 86th Constitutional amendments.

Unit II

Chapter No. 7 Scope & Aims of Engineering Ethics

Scope & Aims of Engineering Ethics: Meaning and purpose of Engineering Ethics, Responsibility of Engineers, Impediments to responsibility, Honesty, Integrity and reliability, risks, safety & liability in engineering. Bhopal Gas Tragedy, Titanic case.

Chapter No. 8 Intellectual Property Rights

Intellectual Property Rights (IPRs)- Patents, Copyright and Designs

Chapter No. 9 Ethical perspectives of professional bodies

Ethical perspectives of professional bodies- IEEE, ASME, NSPE and ABET, ASCE etc.

Unit III

Chapter No. 10 Effects of human activities on environment

Effects of human activities on environment - Agriculture, Housing, Industry, Mining, and Transportation activities, Environmental Impact Assessment, Sustainability and Sustainable Development.

Chapter No. 11 Environmental Protection

Environmental Protection – Constitutional Provisions and Environmental Laws in India.

Text Book (List of books as mentioned in the approved syllabus)

1. Dr. J. N. Pandey, “Constitutional Law of India”, Central Law Agency, 2005
2. Dr. M.K. Bhandari, “Law relating to Intellectual Property Rights”, Central Law Publications, Allahabad, 2010.
3. Charles E. Harris and others, “Engineering Ethics: Concepts and Cases”, Thomson Wadsworth, 2003

References

1. Durga Das Basu, “Introduction to the Constitution of India”, Prentice-hall EEE, 2001
2. Mike Martin and Ronald Schinzinger, “Ethics in Engineering”, Tata McGraw-Hill Publications.

Program: Biomedical Engineering		Semester: VII
Course Title: Senior Design Project		Course Code: 22EBMW401
L-T-P: 0-0-6	Credits: 6	Contact Hours: 12 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: --	Examination Duration: 3 Hrs	

- Smart City
- Connected Cars
- Home Automation
- Health care
- Smart energy
- Automation of Agriculture

Guide lines for selection of a project:

- The project needs to encompass the concepts learnt in the previous semesters, so that the student will learn to integrate, the knowledge base acquired to provide a solution to the defined problem statement of the project work.
- Student can select a project which leads to a product or model or prototype.
- Time plan: Effort to do the project should be between 60-70 Hrs per team, which includes self-study of an individual member (80-100 Hrs) and team work (40-50hrs).
- Learning overhead should be 20-25% of total project development time.

Criteria for group formation:

- 3-4 students in a team.
- Role of teammates: Team lead and members.

Allocation of Guides and Mentors for the projects:

Every Project batch will be allocated with one faculty.

Details of the project batches:

- Number of faculty - members: 50
- Number of students:3-4 students in a team**.**

Role of a Guide

The primary responsibility of the guide is to help students to understand the meaning and need of various stages in the implementation of the project. At every stage of the project development, guide should help towards its successful completion as per the predefined standards.

How student should carry out a project:

- Define the problem.
- Specify the requirements.
- Specify the design in the understandable form (Block Diagram, Flowchart, Algorithm, etc).
- Analyze the design and identify hardware and software components separately.
- Select appropriate simulation tool and development board for the design.
- Implement the design.

- Optimize the design and generate the results.
- Result representation and analysis.
- Prepare a document and presentation.

Report Writing

- The format for report writing should be downloaded from ftp://10.3.0.3/projects
- The report needs to be shown to guide and committee for each review.
-

Evaluation Scheme

- Internal semester assessment (ISA)
- Evaluation is done based on the evaluation rubrics given in Table 1
- Project shall be reviewed and evaluated by the concerned Guide for 50% of the marks.
- Project shall be evaluated by the review committee for 50% of the marks.

Program: Biomedical Engineering		Semester: VII
Course Title: Embedded Intelligent System		Course Code: 22EBME421
L-T-P: 3-0-0	Credits: 3	Contact Hours: 3 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40Hrs	Examination Duration: 3 Hrs	

Unit 1

Chapter No. 1. Basics of embedded systems

Linux Application Programming, System V IPC, Linux Kernel Internals and Architecture, Kernel Core, Linux Device Driver Programming, Interrupts & Timers, Sample shell script, application program, driver source build and execute. **08 Hrs**

Chapter No. 2. Heterogeneous computing

Basics of heterogeneous computing with various hardware architectures designed for specific type of tasks, Advanced heterogeneous computing with a. Introduction to Parallel programming b. GPU programming (OpenCL) c. Open standards for heterogeneous computing (Openvx), Basic OpenCL examples - Coding, compilation and execution. **08 Hrs**

Unit 2

Chapter No. 3. ML Frameworks lab with the target device

Caffe, TensorFlow, TF Lite machine learning frameworks & architecture, Model parsing, feature support and flexibility, supported layers, advantages and disadvantages with each of these frameworks, Android NN architecture overview, Full stack compilation and execution on embedded device. **08 Hrs**

Chapter No. 4. Model Development and Optimization

Significance of on device AI, Quantization, pruning, weight sharing, Distillation, Various pre-trained networks and design considerations to choose a particular pre-trained model, Federated Learning, Flexible Inferencing. **08 Hrs**

Unit 3

Chapter No. 5. Android Anatomy

Android Architecture, Linux Kernel, Binder, HAL Native Libraries, Android Runtime, Dalvik Application framework, Applications, IPC. **08 Hrs**

Text Books

1. Linux System Programming, by Robert Love, Copyright © 2007 O'Reilly Media
2. Heterogeneous Computing with OpenCL, 2nd Edition by Dana Schaa, Perhaad Mistry, David R. Kaeli, Lee Howes, Benedict Gaster, Publisher: Morgan Kaufmann

Reference Books

1. Deep Learning, MIT Press book, Goodfellow, Bengio, and Courville's
2. Beginning Android, by Wei-Meng Lee , Publisher: Wrox , O'Reilly Media

Program: Biomedical Engineering		**Semester: VII**
Course Title: Introduction to Deep Learning		**Course Code: 22EBME422**
L-T-P: 3-0-0	**Credits: 3**	**Contact Hours: 3 hrs/week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 40Hrs	**Examination Duration: 3 Hrs**	

Unit 1

Chapter 1:. Introduction to Deep Learning:

What is Deep Learning? Applications of deep learning, Differences between machine learning and deep learning, Basics of Neural Networks, Supervised Learning with Neural Networks, Logistic regression as a neural network, Computation graph, shallow neural networks, Deep neural networks. **08 Hrs**

Chapter 2: Hyper-Parameter Tuning, Regularization and Optimization:

Basics of Hyper-parameters, Regularization, Need for regularization, dropout regularization, gradient checking, mini-batch gradient descent, exponentially weighted averages and its bias correction, Gradient descent with decay, Adam's optimization algorithm, The problem of local minima, weight initialization in neural networks, Normalizing activations in a network, Fitting Batch norm into a network, Softmax regression, Softmax classifier, Introduction to metric tensors and tensorflow, Basic programs in tensorflow. **08 Hrs**

Unit 2

Chapter 3: Convolutional Neural Networks

Introduction to Computer Vision and Image Processing, 2D Convolutions, Strided convolution, convolution over volume, One layer of a convolution network, ReLu and pooling, Example of a ConvNet, Classic CNN Networks, ResNet architecture, Inception Networks, Transfer learning, Data Augmentation, Basics of Keras, Residual networks, Object Localization, Landmark and object detection, Convolutional implementation of sliding windows, YOLO algorithm, Car detection algorithm using YOLO, One shot learning, Face recognition algorithm. **08 Hrs**

Chapter 4: Recurrent Neural Networks

Back propagation through time, RNN model, Types of RNN, Vanishing gradients with RNN, Gated Recurrent Unit, LSTM, Bidirectional RNN, Deep RNN, basics of NLP and Concept of word embedding, speech recognition. **08 Hrs**

Unit 3

Chapter 5: Unsupervised Deep Learning

Concepts of Unsupervised deep learning, RBM (Restricted Boltzman Machine) and auto encoders, structure of Auto encoders, collaborative filtering with RBM, Deep belief networks. **08 Hrs**

Text Books

1. Deep Learning, Ian Goodfellow and Yoshua Bengio and Aaron Courville, MIT Press, http://www.deeplearningbook.org, 2016.
2. Neural Networks and Deep Learning by Michael Nielsen.

Reference Books

1. Deep Learning with Python, Francois Chollet, by Manning Publications, 2018.
2. Deep Learning by Microsoft Research.

Program: Biomedical Engineering		**Semester: VII**
Course Title: Medical Internet of Things		**Course Code: 22EBME423**
L-T-P: 3-0-0	**Credits: 3**	**Contact Hours: 3 hrs/week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 40Hrs	**Examination Duration: 3 Hrs**	

Unit 1

Chapter No. 1.

FUNDAMENTALS OF IoT- Evolution of Internet of Things, Enabling Technologies, M2M Communication, IoT World Forum (IoTWF) standardized architecture, Simplified IoT Architecture, Core IoT Functional Stack, Fog, Edge and Cloud in IoT, Functional blocks of an IoT ecosystem, Sensors, Actuators, Smart Objects and Connecting Smart Objects. **08 Hrs**

Chapter No. 2.

IoT PROTOCOLS- IoT Access Technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4, 802.11ah and Lora WAN, Network Layer: IP versions, Constrained Nodes and Constrained Networks,6LoWPAN, Application Transport Methods: SCADA, Application Layer Protocols: CoAP and MQTT. **08 Hrs**

Unit 2

Chapter No. 3.

DESIGN AND DEVELOPMENT- Design Methodology, Embedded computing logic, Microcontroller, System on Chips, IoT system building blocks IoT Platform overview: Overview of IoT supported Hardware platforms such as: Raspberry pi, Arduino Board. **08 Hrs**

Chapter No. 4.

DATA ANALYTICS AND SUPPORTING SERVICES:

Data Analytics: Introduction, Structured Versus Unstructured Data, Data in Motion versus Data at Rest, IoT Data Analytics Challenges, Data Acquiring, Organizing in IoT/M2M. **08 Hrs**

Unit 3

Chapter No. 5.

Supporting Services: Computing Using a Cloud Platform for IoT/M2M Applications/Services, Everything as a service and Cloud Service Models.

Healthcare IoT/Case Studies: IoT applications in Hospitals, infrastructures, buildings, security, Clinical appliances. **08 Hrs**

Text Books

1. IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, Cisco Press, 2017
2. Internet of Things – A hands-on approach, Arshdeep Bahga, Vijay Madisetti, Universities Press, 2015
3. Internet of Things: Architecture, Design Principles And Applications, Rajkamal, McGraw Hill Higher Education The Internet of Things – Key applications and Protocols, Olivier

Hersent, David Boswarthick, Omar Elloumi and Wiley, 2012 (for Unit2).

Reference Books

1. "From Machine-to-Machine to the Internet of Things – Introduction to a New Age of Intelligence", Jan Ho¨ ller, Vlasios Tsiatsis, Catherine Mulligan, Stamatis, Karnouskos, Stefan Avesand. David Boyle and Elsevier, 2014.
2. Architecting the Internet of Things, Dieter Uckelmann, Mark Harrison, Michahelles and Florian (Eds), Springer,2011.
3. Recipes to Begin, Expand, and Enhance Your Projects, 2nd Edition, Michael Margolis, Arduino Cookbook and O"Reilly Media,2011.

Program: Biomedical Engineering		**Semester: VII**
Course Title: Augmented Reality and Virtual Reality		**Course Code: 22EBME424**
L-T-P: 3-0-0	**Credits: 3**	**Contact Hours: 3 hrs/week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 40Hrs	**Examination Duration: 3 Hrs**	

Unit 1

Chapter No. 1.
INTRODUCTION TO VIRTUAL REALITY (VR): Defining Virtual Reality, Key elements of virtual reality experience, Virtual Reality, Telepresence, Augmented Reality and Cyberspace. Bird's-Eye View: Hardware, Software, Human Physiology and Perception. **08 Hrs**

Chapter No. 2.
Input Devices: (Trackers, Navigation, and Gesture Interfaces): Three-dimensional position trackers, navigation and manipulation, interfaces and gesture interfaces. **08 Hrs**

Unit 2

Chapter No. 3.
Modeling: Geometric modeling, Kinematics modeling, Physical modeling, Behaviour modeling, Model management. **08 Hrs**

Chapter No. 4.
Augmented Reality (AR): Taxonomy, Technology and Features of Augmented Reality, AR Vs VR, Challenges with AR, AR systems and functionality, Augmented Reality Methods, Visualization Techniques for Augmented Reality, Enhancing interactivity in AR Environments, Evaluating AR systems AR software development : AR software, Camera parameters and camera calibration, Marker-based augmented reality, AR Toolkit. **08 Hrs**

Unit 3

Chapter No. 5.
Interaction & Audio: Interaction - Motor Programs and Remapping, Locomotion, Manipulation, Social Interaction. Audio -The Physics of Sound, The Physiology of Human Hearing, Auditory Perception, Auditory Rendering. Interaction - Motor Programs and Remapping, Locomotion, Manipulation, Social Interaction. Audio -The Physics of Sound, The Physiology of Human Hearing, Auditory Perception, Auditory Rendering. (from Text Book2). **08 Hrs**

Text Books

1. Virtual Reality Technology, Second Edition, Gregory C. Burdea & Philippe Coiffet, John Wiley & Sons, Inc, 2017.
2. Virtual Reality, Steven M. LaValle, Cambridge University Press, 2016

Reference Books

1. Rajesh K. Maurya, Computer Graphics with Virtual Reality System, 3rd Edition, Wiley Publication, 2018.
2. William R. Sherman and Alan B. Craig, Understanding Virtual Reality Interface, Application, and Design, 2nd Edition, Morgan Kaufmann Publishers, Elsevier, 2019.
3. Grigore C. Burdea, Philippe Coiffet, Virtual Reality Technology, 2nd Edition, Wiley,2017.
4. K.S. Hale and K. M. Stanney, Handbook on Virtual Environments, 2nd Edition, CRC Press,

Program: Biomedical Engineering		Semester: VII
Course Title: Data Base Management in Healthcare		Course Code: 22EBME431
L-T-P: 3-0-0	Credits: 3	Contact Hours: 3 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40Hrs	Examination Duration: 3 Hrs	

Unit 1

Chapter No. 1.

Database and Database Users: Introduction, Characteristics of the Database Approach, Advantages of Using the DBMS Approach.

Database System Concepts and Architecture: Data models, Schemas, and Instances, Three – Schema Architecture and Data Independence, Database Languages and Interfaces, Classification of Database Management Systems.

Patient Database: Patient Database strategies for HIS, data acquisition, patient admission, transfer, discharge, evaluation & management. Computer based patient record, clinical decision support systems.

Overview of Database Systems: A Historical Perspective, File Systems versus a DBMS, Describing and Storing Data in a DBMS, Queries in a DBMS, Transaction Management, Structure of a DBMS. **08 Hrs**

Chapter No. 2.

Data Modeling using the Entity – Relationship (ER) Model: Using High – Level Conceptual Data Models for Database Design, An Example Database Application; Entity Types, Entity Sets, Attributes and Keys, Relationship types, Relationship Sets, Roles and Structural Constraints, Weak Entity Types, Refining the ER Design for the COMPANY Database, ER Diagrams, Naming Conventions and Design Issues.

Relational Model: Relational Model Concepts, Relational Model Constraints and Relational Database Schemas, Update Operations, Transactions, and Dealing with Constraint Violations. Relational Algebra and Relational Calculus: Unary Relational Operations: SELECT and PROJECT. **08 Hrs**

Unit 2

Chapter No. 3.

Relational Algebra and Relational Calculus: Relational Algebra Operations from Set Theory, Binary Relational Operations: JOIN and DIVISION, Additional Relational Operations.

SQL – 99: SQL Data Definition and Data Types, Specifying Constraints in SQL, Schema Change Statements in SQL, Basic Queries in SQL, More Complex SQL Queries, INSERT, DELETE and UPDATE Statements in SQL, Specifying Constraints as Assertions and Triggers, Views (Virtual Tables) in SQL , Additional Features of SQL. **08 Hrs**

Chapter No. 4.

Database Design Theory and Methodology: Informal Design Guidelines for Relation Schemas, Functional Dependencies, Normal Forms Based on Primary Keys, General Definitions of Second and Third Normal Forms, Boyce-Codd Normal Form.

Relational Database Design Algorithms and Further Dependencies: Properties of Relational Decompositions, Algorithms for Relational Database Schema Design, Multivalued Dependencies and Fourth Normal Form, Join Dependencies and Fifth Normal Form, Inclusion Dependencies, Other Dependencies and Normal Forms. **08 Hrs**

Unit 3

Chapter No. 5.

Overview Of Transaction Management: The ACID Properties, Transactions and Schedules, Concurrent Execution of Transactions, Lock-Based Concurrency Control, Performance of Locking, Transaction Support in SQL, Introduction to Crash Recovery.

Lock Conversions, Dealing with Deadlocks, Specialized Locking Techniques, Concurrency Control without Locking.

Crash Recovery : Introduction to ARIES, The Log, Other Recovery- Related Structures, The Write- Ahead Log Protocol, Check-pointing, Recovering from a System Crash, Media Recovery.

08 Hrs

Text Books

1. Database Management Systems - by Raghu Ramakrishna and Johannes Gehrke, (3rd Edition), McGraw Hill, 2003.
2. Fundamentals of Database Systems - by Ramez Elmasri and ShamkantB.Navathe (5thEdition), Pearson Education, 2007.
3. The Biomedical Engineering Handbook-Volume II (2nd Edition) – by Joseph D. Bronzino, CRC/IEEE Press, 2000.

Reference Books

1. Data base System Concepts - by Silberschatz, Korth and Sudharshan. (4th Edition), McGraw Hill, 2002.

Program: Biomedical Engineering		Semester: VII
Course Title: Bio – MEMS		Course Code: 22EBME432
L-T-P: 3-0-0	Credits: 3	Contact Hours:4 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40Hrs	Examination Duration: 3 Hrs	

Unit 1

Chapter No. 1.

Overview of MEMS and Micro systems: MEMS and Microsystems, Typical MEMS and Microsystem Products, Evolution of Micro-fabrication, Micro systems and Microelectronics, Multidisciplinary nature of Microsystem design and Manufacture, Microsystems and Miniaturization, Applications of Microsystem in Health-care Industry Application, Biocompatibility, Reliability consideration.

Microsensors: Acoustic wave sensor, Biomedical Sensors and Biosensors, Chemical Sensors, Optical Sensors, Pressure sensors, Thermal sensors. **08 Hrs**

Chapter No. 2.

Microactuation: Principal means of Microactuation, MEMS with Microactuators, Microaccelrometer, Microfluidic.

Engineering Science for Microsystem Design and Fabrication:Ions and Ionization, The Diffusion Process, Plasma Physics, Electrochemistry, Quantum Physics.

Scaling Laws: Scaling in Geometry, Scaling in Rigid body Dynamics, Scaling in Electrostatic force, Electricity, Fluid mechanics, Heat Transfer. **08 Hrs**

Unit 2

Chapter No. 3.

Engineering Mechanics for Microsystem Design: Static Bending of Thin plates – Circular Plates, Rectangular Plates, Square Plates with all Edges Fixed, Mechanical vibrations – General Formulation, Resonant Vibration, Design theory of Accelerometers.

Detection and Measurement methods: Detection Scheme – Electrochemical Detection, Chemiluminescence and Bioluminescence, Fluorescence, Molecular Beacons, Measurement Systems. **08 Hrs**

Chapter No. 4.

Materials for MEMS and Microsystems: Substrates and wafers, Active Substrate materials, Silicon as a Substrate material – Ideal Substrate, Crystal Structure, Mechanical Properties of Silicon, Silicon Compounds, Silicon Peizoresistors, Gallium Arsenide, Quartz, Polymers, Packaging Materials.

Emerging Bio-MEMS Technology: Minimally invasive Surgery, Cardiovascular, Diabetes, Endoscopy, Oncology, Ophthalmology, Tissue Engineering, Cell-Based Biosensors, Home land Security. **08 Hrs**

Unit 3

Chapter No. 5.

Microsystem Fabrication Process: Photolithography, Ion Implantation, Diffusion, Oxidation, Chemical Vapour Deposition, Physical Vapour Deposition, Deposition By Epitaxy, Etching, The LIGA Process, Design Consideration Overview, Design Constraints. **08 Hrs**

Text Books

1. "MEMS & Microsystems: Design and Manufacture", Tai-Ran Hsu, Tata McGraw-Hill, 2002.
2. "Fundamentals of Bio-MEMS and Medical Microdevices", Steven S. Saliterman, Wiley Interscience, 2006.

Reference Books

1. "Introduction to Bio-MEMS", Albert Folch, CRC Press, 2012.
2. "Bio-MEMS: Technologies and Applications", Wanjun Wang, Steven A. Soper, CRC Press, 2006.

Program: Biomedical Engineering		Semester: VII
Course Title: Rehabilitation Engineering		Course Code: 22EBME433
L-T-P: 3-0-0	Credits: 3	Contact Hours:4 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40Hrs	Examination Duration: 3 Hrs	

Unit 1

Chapter No. 1.

Introduction to Rehabilitation:

What is Rehabilitation, Medical Rehabilitation, Preventive Rehabilitation, Impairment, Disability and Handicap, Sociovocational Rehabilitation Rehabilitation Team: Classification of members, Medical, The Rehabilitation team – The medical team, Physical therapist, Occupational therapist, Prosthetist-Orthotist, Rehabilitation nurse, Speech pathologist, Psychologist and child development Specialist, Horticultural Therapist, Music therapist, Creative Movement Therapist, Dance and play Therapist, Recreational therapist, Biomedical engineer. **08 Hrs**

Chapter No. 2.

Therapeutic Exercise Technique: Coordination Exercises, Balance Training, Gait, Pathological Gaits, Gait Training – Crutch Walking: Patterns of Gait, Relaxation exercises, Methods for training Relaxation, Strengthening exercises, Mobilization exercises Principles in Management of Communication: Communication, Speech, Language, Aphasia, Dysarthria, Speech therapy, Dysphagia, Communication for Visually impaired, Types of visual aids, Writing aids. **08 Hrs**

Unit 2

Chapter No. 3.

Orthotic Devices in Rehabilitation Engineering: Definition, General Principles of Orthosis, Biomechanics of Orthosis, Classification, Material and fabrication for lower limb Orthosis, Calipers – Foot Orthoses, Ankle-Foot Orthosis, Knee-Ankle-Foot Orthosis, Hip-Knee-Ankle-Foot Orthoses, Functional Electrical Stimulation, Spinal Orthosis- Cervical, Head cervical Orthosis, Head cervical thoracic orthosis, Thoraco lumbar sacral orthosis, Lumbosacro-orthosis, Splints- its functions & types. **08 Hrs**

Chapter No. 4.

Amputation: General Principles of Amputation Surgery, Levels of Amputation in Upper limb and Lower limb, Rehabilitation of Lower limb amputations

Prosthetics: Classification, Components of Prosthesis, Upper limb Prosthetics – Terminal Devices, Myoelectric Prosthesis, Lower extremity Prosthesis – Transfemoral prosthesis, Prosthesis for hip disarticulation. **08 Hrs**

Unit 3

Chapter No. 5.

Mobility Aids: Functions, Parallel bars, Walking frames – types, Walking stick, Tripods, Quadripods, Crutches – types, Wheel chairs – parts and maintenance. **08 Hrs**

Text Books

1. Rehabilitation Medicine – By Dr. S. Sunder, 3rd Edition, Jaypee Medical Publications, Reprint 2004.

Program: Biomedical Engineering		Semester: VII
Course Title: Lasers and Optical Fibers in Medicine		Course Code: 22EBME434
L-T-P: 3-0-0	Credits: 3	Contact Hours:4 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40Hrs	Examination Duration: 3 Hrs	

Unit 1

Chapter No. 1.

Applications Of Lasers In Therapy & Diagnosis: Introduction, laser assisted diagnosis and therapyfundamentals, interaction of laser beams and materials-principles (except 3.3.4), laser interaction with tissue-principles, laser assisted diagnostics-principles, applications of lasers in diagnosis and imagingadvances, laser surgery and therapy-principles photo-thermal & photomechanical mechanisms, thermal interaction between laser and tissue-advances. **08 Hrs**

Chapter No. 2.

Single Optical Fibers: Introduction, historical background, optical fibers-fundamentals, light transmission in optical fibers-principles, optical properties of optical fibers-advances, fabrication of optical fibers-principles, optical fibers for UV, visible, IR light-principles, power transmission through optical fibers-principles, modified fiber ends and tips-principles, fiber lasers advances. **08 Hrs**

Unit 2

Chapter No. 3.

Optical Fiber Bundles: Introduction, non-ordered fiber-optic bundles for light guides-fundamentals & principles, ordered fiber-optic bundles for imaging devices-fundamentals & principles, fiber-scopes and endoscopes fundamentals, fiber optic imaging systems-advances. **08 Hrs**

Chapter No. 4.

Endoscopy: Introduction, endoscopic imaging systems-fundamentals, principles, advances, endoscopic diagnostics-advances, endoscopic therapy fundamentals, endoscopic ultrasound imaging-principles. **08 Hrs**

Unit 3

Chapter No. 5.

Clinical Applications Of Fiber Optic Laser Systems: Introduction, fiber-optic laser systems in cardiovascular disease (except 9.2.6), gastroenterology, gynecology, neurosurgery, oncology, ophthalmology, orthopedics, otolaryngology (ENT), urology, flow diagram for laser angioplasty & photodynamic therapy. **08 Hrs**

Text Books

1. Lasers and Optical Fibers in Medicine - by Abraham Katzir, Academic Press, 1998.

Reference Books

1. Lasers in Medicine - by Ronal W. Waynant, CRC Press, 2002.

Program: Biomedical Engineering		Semester: VII
Course Title: Computer Communication Networks in Health Care		Course Code: 22EBME442
L-T-P: 3-0-0	Credits: 3	Contact Hours: 3 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40Hrs	Examination Duration: 3 Hrs	

Unit 1

Chapter No. 1.

Computer Networks In Health Care: Introduction, history, impact of clinical data, information types, platforms, current technologies, identifier standards, communication (message format) standards.

Introduction To Computer Networks: Uses of Computer Networks: Business Applications, Home Applications, Mobile Users. Network Hardware: Local Area Networks, Metropolitan Area Networks, Wide Area Networks, Wireless Networks. Network Software: Design Issues for the Layers, Connection – Oriented and Connectionless Services, Service primitives. The Relationship of Services to Protocols.

Reference Models: The OSI Reference3 Model, The TCP/IP Reference Model, A Comparison of the OSI and TCP/IP Reference Models. Example Networks: Internet Usage, Architecture of the Internet, Connection– Oriented Networks: X.25, Frame Relay, and ATM. **08 Hrs**

Chapter No. 2.

The Physical Layer: The Theoretical Basis For Data communication: Bandwidth Limited Signals, The Maximum Data Rate of a Channel. Guided Transmission Media: Magnetic Media, Twisted Pair, Coaxial Cable, Fiber Optics. Wireless Transmission: The Electromagnetic Spectrum, Radio Transmission, Microwave Transmission, Infrared and Millimeter Waves, Light wave Transmission.

The Public Switched Telephone Network: Structure of the Telephone System. Trunks and Multiplexing: FDM, WDM&TDM, Switching. **08 Hrs**

Unit 2

Chapter No. 3.

The Data Link Layer: Data Link Layer Design Issues: Services Provided to the Network Layer, Framing, Error Control, Flow Control. Elementary Data Link Protocols: A Simplex Stop–and–Wait Protocol. Sliding Window Protocols: A One – Bit Sliding Window Protocol, A Protocol Using Go Back N, A Protocol Using Selective Repeat, HDLC –High – Level Data Link Control, The Data Link Layer in the Internet. **08 Hrs**

Chapter No. 4.

The Medium Access Control Sublayer: Multiple Access Protocols: ALOHA, Carrier Sense Multiple Access Protocols, Wireless LAN Protocols. Ethernet: Ethernet Cabling, Manchester Encoding, The Ethernet MAC Sublayer Protocol, The Binary Exponential Backoff Algorithm, Ethernet Performance.

Wireless Lans: The 802.11 Protocol Stack, The 802.11 Physical Layer, The 802.11 MAC Sublayer Protocol, The 802.11 Frame Structure, Services. **08 Hrs**

Unit 3
Chapter No. 5. Blue Tooth: Blue tooth Architecture, Bluetooth Applications. Data Link Layer SWITCHING: Local Internet Working, Repeaters, Hubs, Bridges, Switches, Routers, and Gateways, Virtual LANs. The Network Layer: Network Layer Design Issues: Store-and- Forward Packet Switching, Services Provided to the Transport Layer, Implementation of Connectionless Service, Implementation of Connection –Oriented Service. Routing Algorithms: The Optimality Principle, Shortest Path Routing, Distance Vector Routing, Link State Routing, Hierarchical Routing, Broadcast Routing. CONGESTION control Algorithms: General Principles of Congestion Control. Quality of Service: Requirements, Techniques for Achieving Good Quality of Service-leaky bucket algorithm, token bucket algorithm. Internetworking: How Networks Differ, How Networks Can Be Connected. The Network layer In The Internet: The IP Protocol, IP Address Formats, IPV6 Header Format. **08 Hrs**
Text Books 1. The Biomedical Engineering Handbook-Volume II (2nd Edition) – by Joseph D. Bronzino, CRC/IEEE Press, 2000. 2. Computer Networks – Andrew S. Tanenbaum, 4thEdn, Pearson Education / PHI, 2004. **Reference Books** 1. Data and Computer Communication – William Stallings, 7th Edition, Pearson Education, 2004. 2. Data Communications and Networking – Behrouz A Forouzan, 4th Edition, Tata McGraw Hill, 2006. **3.** Computer Networking – Kurose and Ross, Pearson Education, 2004.

Program: Biomedical Engineering		Semester: VII
Course Title: Medical Informatics and Expert systems		Course Code: 22EBME443
L-T-P: 3-0-0	Credits: 3	Contact Hours: 3 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40Hrs	Examination Duration: 3 Hrs	

Unit 1

Chapter No. 1.

Medical Informatics: Aim and scope, salient feature, Introduction, history, definition of medical informatics, bio-informatics, online learning, introduction to health informatics, prospectus of medical informatics.

Hospital Management And Information Science: Introduction, HMIS: need, Benefits, capabilities, development, functional areas. Modules forming HMIS, HMIS and Internet, Pre-requisites for HMISclient server technology, PACS, why HMIS fails, health information system, disaster management plans, advantages of HMIS. **08 Hrs**

Chapter No. 2.

Hospital Management And Information Systems-Structure And Functions :Central Registration Module, OPD / Consultant Clinic / Polyclinic Module, Indoor Ward Module, Patient Care Module, Procedure Module, Diet Planning Module, MLC Register Module, Pathology Laboratory Module, Blood Bank Module, Operation Theatre Module, Medical Stores Module, Pharmacy Module, Radiology Module, Medical Records Index Module, Administration Module, Personal Registration Module, Employee Information Module, Financial modules, Health & Family Welfare, Medical Examination, Account Billing, Medical Research, Communication, General Information. **08 Hrs**

Unit 2

Chapter No. 3.

Computer Assisted Medical Education: CAME, Educational software, Simulation, Virtual Reality, Tele-education, Tele-mentoring.

Computer Assisted Patient Education: CAPE, patient counseling software. Computer assisted surgery (CAS), Limitations of conventional surgery, 3D navigation system, intra-operative imaging for 3D navigation system, merits and demerits of CAS. **08 Hrs**

Chapter No. 4.

Telecommunication Based Systems: Tele-Medicine, Need, Advantages, Technology- Materials and Methods, Internet Tele-Medicine, Applications.

Tele-Surgery: Tele-surgery, Robotic surgery, Need for Tele-Surgery, Advantages, Applications. **08 Hrs**

Unit 3

Chapter No. 5.

Knowledge Based And Expert Systems: Introduction, Artificial Intelligence, Expert systems, need for Expert Systems, materials and methods- knowledge representation & its methods, production rule systems, algorithmic method, OAV, object oriented knowledge, database comparisons, statistical pattern classification, decision analysis, tools, neural networks, advantages of ES, applications of ES. **08 Hrs**

Text Books

1. Medical Informatics: A Primer - by Mohan Bansal, 1st Print, Tata McGraw Hill, Publications, 2003.

Reference Books

1. Medical Informatics: Computer Applications in Health Care and Biomedicine by E.H.Shortliffe, G. Wiederhold, L.E.Perreault and L.M.Fagan, 2ndEdition, Springer Verlag, 2000.
2. Handbook of Medical Informatics by J.H.VanBemmel, Stanford University Press/ Springer, 2000.

Program: Biomedical Engineering		Semester: VII
Course Title: Biomechanics		Course Code: 22EBME444
L-T-P: 3-0-0	Credits: 3	Contact Hours: 3 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40Hrs	Examination Duration: 3 Hrs	

Unit 1

Chapter No. 1.

Biomechanics Applications to Joint Structure and Function: Introduction to Kinematics, Displacement in space, Force vectors and gravity, Linear forces and concurrent forces. Kinetics of rotary and translatory forces. Classes of levers. Close chain force analysis.

Constitutive Equations: Equations for Stress and Strain, Non-viscous fluids, Newtonian viscous fluids, Elastic solids. Visco-elasticity andits applications in biology. **08 Hrs**

Chapter No. 2.

Joint Structure and Function: Properties of connective tissues; Human Joint design; Joint Function and changes in disease.

Integrated Functions: Kinetics and Kinematics of Postures; Static and Dynamic Postures; Analysis of Standing, Sitting and Lying Postures. **08 Hrs**

Unit 2

Chapter No. 3.

Gait Analysis: Gait cycle and joint motion; Ground reaction forces; Trunk and upper extremity motion; internal and external forces, moments and conventions; Gait measurements and analysis.

Force Platform and Kinematic Analysis: Design of force platforms, Integrating force and Kinematic data; linked segment, free-body analysis. **08 Hrs**

Chapter No. 4.

Bio-Viscoelastic Fluid: Viscoelasticity, Viscoelastic Models: Maxwell, Voigt and Kelvin Models Response to harmonic variation. Use of viscoelastic models. Bio-Viscoelastic fluids: Protoplasm. Mucus, saliva, synovial fluids. **08 Hrs**

Unit 3

Chapter No. 5.

Rheology of Blood in Microvessels: Fahreus·Lindqulsteffect and inverse effect, hematocrit in very narrow tube.

Finite Element Analysis in Biomechanics: Model creation,Solution, Validation of results and applications of FEA. **08 Hrs**

Text Books

1. Biomechanics: Mechanical Properties of living tissues by Y. C. Fung, 2nd Edition, Springer Verlag, 1993.
2. Joint Structure and Function, A Comprehensive Analysis – by Pamela K. Levangie and Cynthia C. Norkin, Jaypee Publications, 4th Edition, 2006.

Reference Books

1. Biomechanics of Human Motion - by T. McClurg Anderson, Sports Pub., 2007.
2. Biomechanics, Structures and Systems - by A. A. Biewener, Sports Publication.

Semester VIII

Program: Biomedical Engineering		**Semester: VIII**
Course Title: Biomaterials and Artificial Organs		**Course Code: 22EBME441**
L-T-P: 3-0-0	**Credits: 3**	**Contact Hours: 3 hrs/week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 40Hrs	**Examination Duration: 3 Hrs**	

Unit 1

Chapter No. 1.

Biomaterials: Introduction to biomaterials, uses of biomaterials, biomaterials in organs & body systems, materials for use in the body, performance of biomaterials.

Metallic Biomaterials: Introduction, Stainless steel, Cobalt- Chromium alloy, Titanium alloys, Titanium-Nickel alloys, Dental metals, Corrosion of metallic implants, Manufacturing of implants.

Ceramic Biomaterials: Introduction, non-absorbable/relatively bioinert-bioceramics, biodegradable/resorbable ceramics, bioreactive ceramics, deterioration of ceramics, bioceramic manufacturing techniques. **08 Hrs**

Chapter No. 2.

Polymeric Biomaterials: Introduction, polymerization and basic structure, polymers used as biomaterials, sterilization, surface modifications to for improving biocompatibility.

Composite Biomaterials: Structure, bounds on properties, anisotropy of composites, particulate composites, fibrous composites, porous materials, biocompatibility.

Biodegradable Polymeric Biomaterials: Introduction, Glycolide based biodegradable homopolymers polyesters, non-glycolide linear aliphatic polyesters, aliphatic and aromatic polycarbonates, and biodegradation properties of synthetic biodegradable polymers. TISSUE DERIVED BIOMATERIALS: Structure and properties of collagen and collagen-rich tissues, biotechnology of collagen, design of resorbable collagen-based medical implant. **08 Hrs**

Unit 2

Chapter No. 3.

Hard Tissue Replacements: Bone repair and joint implants-long bone repair and joint replacements, dental implants- effects of material selection, effects of surface properties, surface chemistry.

Preservation Techniques For Biomaterials: Phase behavior, nonfreezing storage-hypothermic, freeze-thaw technology, freezedrying, and vitrification.

Artificial Organs: Introduction: Substitutive medicine, outlook for organ replacement, design consideration, evaluation process. **08 Hrs**

Chapter No. 4.

Artificial Heart And Circulatory Assist Devices: Engineering design, Engg design of artificial heart and circulatory assist devices, blood interfacing implants – introduction, total artificial hearts & ventricular assist devices, vascular prostheses, Non-blood interfacing implants for soft tissues- sutures and allied augmentation devices, percutaneous and skin implants, maxillofacial implants, eye and ear implants.

Cardiac Valve Prostheses: Mechanical valves, tissue valves, current types of prostheses, tissue versus mechanical, engineering concerns and hemodynamic assessment of prosthetic heart valves, implications for thrombus deposition, durability, current trends in valve design, vascular grafts-history, synthetic grafts, regional patency, thrombosis, neointimal hyperplasia, graft

infections.

Artificial Kidney: Functions of the kidneys, kidney disease, renal failure, renal transplantation, artificial kidney, dialyzers, membranes for haemodialysis, haemodialysis machine, peritoneal dialysis equipment-therapy format, fluid and solute removal. **08 Hrs**

Unit 3

Chapter No. 5.

Artificial Blood: Artificial oxygen carriers, flurocarbons, hemoglobin for oxygen carrying plasma expanders, hemoglobin based artificial blood.

Artificial Lungs: Gas exchange systems, Cardiopulmonary bypass (heart-lung machine)-principle, block diagram and working, artificial lung versus natural lung. Liver functions, hepatic failure, liver support systems, general replacement of liver functions.

Artificial Pancreas: Structure and functions of pancreas, endocrine pancreas and insulin secretion, diabetes, insulin, insulin therapy, insulin administration systems. Tracheal replacement devices, laryngeal replacement devices, artificial esophagus Artificial Skin: Vital functions of skin, current treatment of massive skin loss, design principles for permanent skin replacement. **08 Hrs**

Text Books

1. **Biomedical Engineering Handbook-Volume1 (2nd Edition) by J. D. Bronzino (CRC Press / IEEE Press, 2000).**
2. **Biomedical Engineering Handbook-Volume 2 (2nd Edition) by J. D. Bronzino (CRC Press / IEEE Press, 2000)**
3. **Handbook of Biomedical Instrumentation (2nd Edition) by R. S. Khandpur (Tata McGraw Hill, 2003).**

Program: Biomedical Engineering		Semester: VIII
Course Title: Computer Communication Networks in Health Care		Course Code: 22EBME442
L-T-P: 3-0-0	Credits: 3	Contact Hours: 3 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40Hrs	Examination Duration: 3 Hrs	

Unit 1

Chapter No. 1.

Computer Networks In Health Care: Introduction, history, impact of clinical data, information types, platforms, current technologies, identifier standards, communication (message format) standards.

Introduction To Computer Networks: Uses of Computer Networks: Business Applications, Home Applications, Mobile Users. Network Hardware: Local Area Networks, Metropolitan Area Networks, Wide Area Networks, Wireless Networks. Network Software: Design Issues for the Layers, Connection – Oriented and Connectionless Services, Service primitives. The Relationship of Services to Protocols.

Reference Models: The OSI Reference3 Model, The TCP/IP Reference Model, A Comparison of the OSI and TCP/IP Reference Models. Example Networks: Internet Usage, Architecture of the Internet, Connection– Oriented Networks: X.25, Frame Relay, and ATM. **08 Hrs**

Chapter No. 2.

The Physical Layer: The Theoretical Basis For Data communication: Bandwidth Limited Signals, The Maximum Data Rate of a Channel. Guided Transmission Media: Magnetic Media, Twisted Pair, Coaxial Cable, Fiber Optics. Wireless Transmission: The Electromagnetic Spectrum, Radio Transmission, Microwave Transmission, Infrared and Millimeter Waves, Light wave Transmission.

The Public Switched Telephone Network: Structure of the Telephone System. Trunks and Multiplexing: FDM, WDM&TDM, Switching. **08 Hrs**

Unit 2

Chapter No. 3.

The Data Link Layer: Data Link Layer Design Issues: Services Provided to the Network Layer, Framing, Error Control, Flow Control. Elementary Data Link Protocols: A Simplex Stop–and–Wait Protocol. Sliding Window Protocols: A One – Bit Sliding Window Protocol, A Protocol Using Go Back N, A Protocol Using Selective Repeat, HDLC –High – Level Data Link Control, The Data Link Layer in the Internet. **08 Hrs**

Chapter No. 4.

The Medium Access Control Sublayer: Multiple Access Protocols: ALOHA, Carrier Sense Multiple Access Protocols, Wireless LAN Protocols. Ethernet: Ethernet Cabling, Manchester Encoding, The Ethernet MAC Sublayer Protocol, The Binary Exponential Backoff Algorithm, Ethernet Performance.

Wireless Lans: The 802.11 Protocol Stack, The 802.11 Physical Layer, The 802.11 MAC Sublayer Protocol, The 802.11 Frame Structure, Services. **08 Hrs**

Unit 3

Chapter No. 5.

Blue Tooth: Blue tooth Architecture, Bluetooth Applications. Data Link Layer SWITCHING: Local Internet Working, Repeaters, Hubs, Bridges, Switches, Routers, and Gateways, Virtual LANs.

The Network Layer: Network Layer Design Issues: Store-and- Forward Packet Switching, Services Provided to the Transport Layer, Implementation of Connectionless Service, Implementation of Connection –Oriented Service. Routing Algorithms: The Optimality Principle, Shortest Path Routing, Distance Vector Routing, Link State Routing, Hierarchical Routing, Broadcast Routing.
CONGESTION control Algorithms: General Principles of Congestion Control. Quality of Service: Requirements, Techniques for Achieving Good Quality of Service-leaky bucket algorithm, token bucket algorithm. Internetworking: How Networks Differ, How Networks Can Be Connected. The Network layer In The Internet: The IP Protocol, IP Address Formats, IPV6 Header Format. **08 Hrs**

Text Books

3. The Biomedical Engineering Handbook-Volume II (2nd Edition) – by Joseph D. Bronzino, CRC/IEEE Press, 2000.
4. Computer Networks – Andrew S. Tanenbaum, 4thEdn, Pearson Education / PHI, 2004.

Reference Books

4. Data and Computer Communication – William Stallings, 7th Edition, Pearson Education, 2004.
5. Data Communications and Networking – Behrouz A Forouzan, 4th Edition, Tata McGraw Hill, 2006.
6. Computer Networking – Kurose and Ross, Pearson Education, 2004.

Program: Biomedical Engineering		Semester: VIII
Course Title: Medical Informatics and Expert systems		Course Code: 22EBME443
L-T-P: 3-0-0	Credits: 3	Contact Hours: 3 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40Hrs	Examination Duration: 3 Hrs	

Unit 1

Chapter No. 1.

Medical Informatics: Aim and scope, salient feature, Introduction, history, definition of medical informatics, bio-informatics, online learning, introduction to health informatics, prospectus of medical informatics.

Hospital Management And Information Science: Introduction, HMIS: need, Benefits, capabilities, development, functional areas. Modules forming HMIS, HMIS and Internet, Pre-requisites for HMISclient server technology, PACS, why HMIS fails, health information system, disaster management plans, advantages of HMIS. **08 Hrs**

Chapter No. 2.

Hospital Management And Information Systems-Structure And Functions :Central Registration Module, OPD / Consultant Clinic / Polyclinic Module, Indoor Ward Module, Patient Care Module, Procedure Module, Diet Planning Module, MLC Register Module, Pathology Laboratory Module, Blood Bank Module, Operation Theatre Module, Medical Stores Module, Pharmacy Module, Radiology Module, Medical Records Index Module, Administration Module, Personal Registration Module, Employee Information Module, Financial modules, Health & Family Welfare, Medical Examination, Account Billing, Medical Research, Communication, General Information. **08 Hrs**

Unit 2

Chapter No. 3.

Computer Assisted Medical Education: CAME, Educational software, Simulation, Virtual Reality, Tele-education, Tele-mentoring.

Computer Assisted Patient Education: CAPE, patient counseling software. Computer assisted surgery (CAS), Limitations of conventional surgery, 3D navigation system, intra-operative imaging for 3D navigation system, merits and demerits of CAS. **08 Hrs**

Chapter No. 4.

Telecommunication Based Systems: Tele-Medicine, Need, Advantages, Technology- Materials and Methods, Internet Tele-Medicine, Applications.

Tele-Surgery: Tele-surgery, Robotic surgery, Need for Tele-Surgery, Advantages, Applications.

08 Hrs

Unit 3

Chapter No. 5.

Knowledge Based And Expert Systems: Introduction, Artificial Intelligence, Expert systems, need for Expert Systems, materials and methods- knowledge representation & its methods, production rule systems, algorithmic method, OAV, object oriented knowledge, database comparisons, statistical pattern classification, decision analysis, tools, neural networks, advantages of ES, applications of ES. **08 Hrs**

Text Books

2. Medical Informatics: A Primer - by Mohan Bansal, 1st Print, Tata McGraw Hill,

Publications, 2003.

Reference Books

3. Medical Informatics: Computer Applications in Health Care and Biomedicine by E.H.Shortliffe, G. Wiederhold, L.E.Perreault and L.M.Fagan, 2ndEdition, Springer Verlag, 2000.
4. Handbook of Medical Informatics by J.H.VanBemmel, Stanford University Press/ Springer, 2000.

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Program: Biomedical Engineering		Semester: VIII
Course Title: Biomechanics		Course Code: 22EBME444
L-T-P: 3-0-0	Credits: 3	Contact Hours: 3 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40Hrs	Examination Duration: 3 Hrs	

Unit 1

Chapter No. 1.

Biomechanics Applications to Joint Structure and Function: Introduction to Kinematics, Displacement in space, Force vectors and gravity, Linear forces and concurrent forces. Kinetics of rotary and translatory forces. Classes of levers. Close chain force analysis.

Constitutive Equations: Equations for Stress and Strain, Non-viscous fluids, Newtonian viscous fluids, Elastic solids. Visco-elasticity andits applications in biology. **08 Hrs**

Chapter No. 2.

Joint Structure and Function: Properties of connective tissues; Human Joint design; Joint Function and changes in disease.

Integrated Functions: Kinetics and Kinematics of Postures; Static and Dynamic Postures; Analysis of Standing, Sitting and Lying Postures. **08 Hrs**

Unit 2

Chapter No. 3.

Gait Analysis: Gait cycle and joint motion; Ground reaction forces; Trunk and upper extremity motion; internal and external forces, moments and conventions; Gait measurements and analysis.

Force Platform and Kinematic Analysis: Design of force platforms, Integrating force and Kinematic data; linked segment, free-body analysis. **08 Hrs**

Chapter No. 4.

Bio-Viscoelastic Fluid: Viscoelasticity, Viscoelastic Models: Maxwell, Voigt and Kelvin Models Response to harmonic variation. Use of viscoelastic models. Bio-Viscoelastic fluids: Protoplasm. Mucus, saliva, synovial fluids. **08 Hrs**

Unit 3

Chapter No. 5.

Rheology of Blood in Microvessels: Fahreus·Lindqulsteffect and inverse effect, hematocrit in very narrow tube.

Finite Element Analysis in Biomechanics: Model creation,Solution, Validation of results and applications of FEA. **08 Hrs**

Text Books

3. Biomechanics: Mechanical Properties of living tissues by Y. C. Fung, 2nd Edition, Springer Verlag, 1993.
4. Joint Structure and Function, A Comprehensive Analysis – by Pamela K. Levangie and Cynthia C. Norkin, Jaypee Publications, 4th Edition, 2006.

Reference Books

3. Biomechanics of Human Motion - by T. McClurg Anderson, Sports Pub., 2007.
4. Biomechanics, Structures and Systems - by A. A. Biewener, Sports Publication.

Program: Bachelor of Engineering (Biomedical Engineering)		Semester: VIII
Course Title: Bio Instrumentation		Course Code: 22EBMO401
L-T-P: 3-0-0	Credits: 3	Contact Hours: 3 Hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40 Hrs	Examination Duration: 3 Hrs	

Unit I

Chapter 1: Bioelectric Signals and Electrodes: Sources of Biomedical Signals, Origin of Bioelectric Signals, Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Electrooculogram (EOG), Electroretinogram (ERG), Recording Electrodes– Electrode-tissue interface, Electrolyte-Skin interface, polarization, skin contact impedance, motion artifacts, Silver-Silver Chloride electrodes, Electrodes for ECG, Electrodes for EEG, Electrodes of EMG, Electrical conductivity of electrode jellies and creams, microelectrodes. **08 Hrs.**

Chapter 2: Pressure Measurement: Pressure Transducers-LVDT pressure transducers and Strain gauge pressure transducers. Physiological pressure ranges and measurement sites, Direct pressure measurement-catheters for pressure measurement, diaphragm displacement transducers, catheter tip pressure transducers, implantable pressure transducers and pressure telemetering capsules. Indirect pressure measurement-Indirect measurement of systolic, diastolic, and mean blood pressure, Detection of Kortokoff sound**. 08 Hrs.**

Unit II

Chapter 3: Temperature Measurement: Requirements for measurement ranges, Temperature transducers – Thermistors, thermocouples, wire and thin film thermoesistive elements, P-N junction diodes and transistors, infrared radiation thermometers, infrared thermography. Clinical thermometer probes, tympanic thermometers, telemetering capsules. Photoelectric Transducers: photovoltaic cells and photoemissive cells. **08 Hrs.**

Chapter 4: Flow Measurement: Requirements for measurement ranges – blood flow in a single vessel, tissue blood flow, and respiratory gas flow. Electromagnetic flowmeters – principle, methods of magnetic field excitation, perivascular probes, intravascular probes. Ultrasonic blood flowmeters– propagation of ultrasound in the tissue, ultrasonic Doppler flowmeters, blood flow measurement through Doppler imaging. Indicator dilution method – principle and working, thermodilution method, Fick method, thermistor velocity probe, impedance cardiography **08 Hrs.**

Unit III

Chapter 5: Biomedical Recorders: Basic recording system, Biomedical signal analysis, Biomedical Recorders: Electrocardiograph, Phonocardiograph, Electroenchephalograph, Electromyograph, Digital recorders. Biosensors and Smart Sensors **08 Hrs**.

Text Books:

1.Handbook of Biomedical Instrumentation- R S Khandpur, 2nd edition, Tata McGraw Hill, 2003
2.Biomedical Transducers and Instruments – Tatsuo Togawa, Toshiyo Tamura and P. Ake Oberg, CRC Press, 1997.

Reference Books:

1. Biomedical Instrumentation and Measurement – Leslie Cromwell, Fred J Weibell and Erich A. Pfeiffer, 2nd Edition, Prentice-Hall India Pvt. Ltd., 2004.
2. Transducers and Instrumentation -D. V. S. Murty Prentice Hall India Pvt ltd. 2nd Edition

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Program: Bachelor of Engineering (Biomedical Engineering)		Semester: VIII
Course Title: Bio Signal Processing		Course Code: 22EBMO402
L-T-P: 3-0-0	Credits: 3	Contact Hours: 3 Hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40Hrs	Examination Duration: 3 Hrs	

Unit I

Chapter 1: Introduction

The nature of biomedical signals, objectives of biomedical signal analysis, difficulties encountered in biomedical signal analysis, Computer aided diagnosis.

Neurological Signal processing: Electrophysiological origin of Brain waves EEG signal and its characteristics, EEG analysis, Linear prediction theory, Autoregressive (AR) method, Recursive Estimation of AR parameters, Spectral error measure, Adaptive segmentation

Chapter 2: Signal averaging

Basics of signal averaging, Signal averaging as a digital filter, A typical averager, Software for signal averaging, Limitations of signal averaging.

Data Acquisition and classification of sleep stages, The Markov model and Markov chains, Dynamics of Sleep-wake Transitions, Hypnogram Model Parameters. **16 Hrs**

Unit II

Chapter 3: Filtering for Artifacts Removal :Random noise, structured noise and physiological interference, stationary versus non-stationary processes, time domain filters with application: Synchronized averaging, moving-average filters

Frequency domain filters with examples, removal of high frequency noise by Butterworth low pass filters, removal of low frequency noise by Butterworth high pass filter, removal of periodic artifacts by notch and comb filters.

Chapter 4: **ECG Parameters and their estimation**: QRS detection techniques, Estimation of ST-segment. A review of wiener filtering problem, Principle of an adaptive filter, Adoptive noise canceller, Cancellation 60Hz Interference in ECG, Cancelling Donor heart Interference in Heart-transplant ECG, Cancelling of maternal ECG in Fetal ECG. **16 Hrs**

Unit III

Chapter 5: Data Reduction

Direct ECG data compression techniques: TP, AZTECH, CORTES, Other data compression techniques: DPCM, Entropy coding, Peak-picking compression, Cycle-to-Cycle compression, Data compression techniques comparison. **08 Hrs**

Text Books / References:

1. **Biomedical signal analysis- A case study approach, Rangayyan Rangaraj, Wiley (IEEE Press)-2005**
2. **Biomedical Signal Processing- Principles and Techniques - D.C.Reddy, Tata McGraw-Hill, 2005.**
3. **Biomedical Digital Signal Processing-Willis J.Tompkins, PHI, 2000..**

References

3. Biomedical Signal Processing and Signal Modeling by Eugene N Bruce, John Wiley & Son's publication
4. Biomedical Engineering and Design Handbook by Myer Kutz, McGraw Hill

Program: Biomedical Engineering		Semester: VIII
Course Title: Bio Informatics		Course Code: 24EBMO403
L-T-P: 3-0-0	Credits: 3	Contact Hours: 3 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40Hrs	Examination Duration: 3 Hrs	

Unit 1

Chapter No. 1.

Medical Informatics: Aim and scope, salient feature, Introduction, history, definition of medical informatics, bio-informatics, online learning, introduction to health informatics, prospectus of medical informatics.

Hospital Management And Information Science: Introduction, HMIS: need, Benefits, capabilities, development, functional areas. Modules forming HMIS, HMIS and Internet, Pre-requisites for HMISclient server technology, PACS, why HMIS fails, health information system, disaster management plans, advantages of HMIS. **08 Hrs**

Chapter No. 2.

Hospital Management And Information Systems-Structure And Functions :Central Registration Module, OPD / Consultant Clinic / Polyclinic Module, Indoor Ward Module, Patient Care Module, Procedure Module, Diet Planning Module, MLC Register Module, Pathology Laboratory Module, Blood Bank Module, Operation Theatre Module, Medical Stores Module, Pharmacy Module, Radiology Module, Medical Records Index Module, Administration Module, Personal Registration Module, Employee Information Module, Financial modules, Health & Family Welfare, Medical Examination, Account Billing, Medical Research, Communication, General Information. **08 Hrs**

Unit 2

Chapter No. 3.

Computer Assisted Medical Education: CAME, Educational software, Simulation, Virtual Reality, Tele-education, Tele-mentoring.

Computer Assisted Patient Education: CAPE, patient counseling software. Computer assisted surgery (CAS), Limitations of conventional surgery, 3D navigation system, intra-operative imaging for 3D navigation system, merits and demerits of CAS. **08 Hrs**

Chapter No. 4.

Telecommunication Based Systems: Tele-Medicine, Need, Advantages, Technology- Materials and Methods, Internet Tele-Medicine, Applications.

Tele-Surgery: Tele-surgery, Robotic surgery, Need for Tele-Surgery, Advantages, Applications. **08 Hrs**

Unit 3

Chapter No. 5.

Knowledge Based And Expert Systems: Introduction, Artificial Intelligence, Expert systems, need for Expert Systems, materials and methods- knowledge representation & its methods, production rule systems, algorithmic method, OAV, object oriented knowledge, database comparisons, statistical pattern classification, decision analysis, tools, neural networks, advantages of ES, applications of ES. **08 Hrs**

Text Books

3. Medical Informatics: A Primer - by Mohan Bansal, 1st Print, Tata McGraw Hill, Publications, 2003.

Reference Books

5. Medical Informatics: Computer Applications in Health Care and Biomedicine by E.H.Shortliffe, G. Wiederhold, L.E.Perreault and L.M.Fagan, 2ndEdition, Springer Verlag, 2000.
6. Handbook of Medical Informatics by J.H.VanBemmel, Stanford University Press/ Springer, 2000.

Program: Biomedical Engineering		Semester: VIII
Course Title: Medical Physics		Course Code: 22EBMO404
L-T-P: 3-0-0	Credits: 3	Contact Hours: 3 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40Hrs	Examination Duration: 3 Hrs	

Unit I

Chapter No. 1. X-Ray Imaging: Fundamentals of X-ray – Electromagnetic radiation, Interactions between X-rays and matter, Intensity of X-ray beam, Attenuation, Generation and Detection of X-rays – X-ray generation, X-ray generators, Filters, Beam restrictors and grids, Intensifying screens, fluorescent screens, and image intensifiers, X-ray detectors, Biological effects of ionizing radiation.

X-Ray Diagnostic Methods: Conventional X-ray radiography, Fluoroscopy, Angiography, Mammography and Xeroradiography. **10 Hrs**

Chapter No. 2. Computed Tomography: Conventional tomography, Computed tomography – Projection function. CT number, Spiral CT. Recent developments – Digital radiography, Digital subtraction angiography (DSA), Dynamic spatial reconstructor (DSR). **06 Hrs**

Unit II

Chapter No. 3 Ultrasound Imaging: Fundamentals of acoustic propagation - Characteristic impedance, Intensity, Reflection and refraction, Attenuation, Doppler effect. Generation and detection of Ultrasound Piezoelectric effect, Ultrasonic transducers, Axial and Lateral resolution, Focusing, Arrays.

Ultrasonic Diagnostic Methods: Pulse echo systems- Amplitude mode (A-mode), Brightness mode (B-mode), Motion mode (M-mode), Doppler methods, Duplex imaging, Biological effects of ultrasound. **08 Hrs**

Chapter No.4: Radionuclide Imaging: Introduction, Fundamentals of Radioactivity – Nuclear particles, Nuclear activity and half-life, Units of measuring nuclear activity, Specific activity, Interaction of nuclear particles and matter, Attenuation of Gamma radiation, Radionuclides, Generation & Detection of Nuclear Emission – Radionuclide generators, nuclear radiation detectors, Collimators, Diagnostic methods using radiation detector probes – Thyroid function test, Renal function test, Radionuclide imaging systems- Rectilinear scanner, Scintillation camera. **08 Hrs**

Unit III

Chapter No. 6: Basics of Magnetic Resonance Imaging: Fundamentals of nuclear magnetic resonance- Angular momentum, magnetic dipole moment, magnetization, Larmor frequency, Free induction decay (FID), Fourier spectrum of the NMR signal, Spin density, Relaxation times, Pulse sequences.

MRI System & Imaging Methods: Introduction, Magnet, NMR Coil/Probe, Transmitter, Receiver, Data acquisition. MRI Imaging Method. Biological effects of magnetic fields- Static magnetic fields, Radio-frequency fields, Gradient magnetic fields, Imaging safety. **08 Hrs**

Text Book (List of books as mentioned in the approved syllabus)

1. Fundamentals of Medical Imaging – by Paul Suetens, Cambridge University Press, 2002
2. Principles of Medical Imaging – by Kirk Shung, Michael B. Smith and BanjaminTsui, Academic Press, 1992.

References

1. The Physics of Medical Imaging – by Steve Webb (Editor), Adam Hilger, Bristol and Philadelphia Publications, 1988.

Program: Biomedical Engineering		Semester: VIII
Course Title: Capstone Project Work		Course Code: 22EBMW402
L-T-P: 0-0-11	Credits: 11	Contact Hours: 22 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: --	Examination Duration: 3 Hrs	

- Smart City
- Connected Cars
- Home Automation
- Health care
- Smart energy
- Automation of Agriculture

Guide lines for selection of a project:

- The project needs to encompass the concepts learnt in the previous semesters, so that the student will learn to integrate, the knowledge base acquired to provide a solution to the defined problem statement of the project work.
- Student can select a project which leads to a product or model or prototype.
- Time plan: Effort to do the project should be between 60-70 Hrs per team, which includes self-study of an individual member (80-100 Hrs) and team work (40-50hrs).
- Learning overhead should be 20-25% of total project development time.

Criteria for group formation:

- 3-4 students in a team.
- Role of teammates: Team lead and members.

Allocation of Guides and Mentors for the projects:

Every Project batch will be allocated with one faculty.

Details of the project batches:

- Number of faculty - members: 50
- Number of students:3-4 students in a team.

Role of a Guide

The primary responsibility of the guide is to help students to understand the meaning and need of various stages in the implementation of the project. At every stage of the project development, guide should help towards its successful completion as per the predefined standards.

How student should carry out a project:

- Define the problem.
- Specify the requirements.
- Specify the design in the understandable form (Block Diagram, Flowchart, Algorithm, etc).
- Analyze the design and identify hardware and software components separately.
- Select appropriate simulation tool and development board for the design.
- Implement the design.

- Optimize the design and generate the results.
- Result representation and analysis.
- Prepare a document and presentation.

Report Writing

- The format for report writing should be downloaded from ftp://10.3.0.3/projects
- The report needs to be shown to guide and committee for each review.
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Evaluation Scheme

- Internal semester assessment (ISA)
- Evaluation is done based on the evaluation rubrics given in Table 1
- Project shall be reviewed and evaluated by the concerned Guide for 50% of the marks.
- Project shall be evaluated by the review committee for 50% of the marks.

Program: Biomedical Engineering		**Semester: VIII**
Course Title: Internship- Training		**Course Code: 22EBMI401**
L-T-P: 0-0-6	**Credits: 6**	**Contact Hours: 12 hrs/week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: --	**Examination Duration: 3 Hrs**	

Evaluation parameters for Internship Training

- Initiative and creativity
- Adaptation capacity
- Commitment and perseverance
- Independence
- Handling supervisor's comments and development skills
- Time management
- Formulation goals, framework project
- Theoretical underpinning, use of literature
- Use of methods and processing data
- Reflection on results
- Conclusions and discussion
- Presentation skills

Program: Biomedical Engineering		**Semester: VIII**
Course Title: Internship- Project		**Course Code: 22EBMW403**
L-T-P: 0-0-11	**Credits: 11**	**Contact Hours: 22 hrs/week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: --	**Examination Duration: 3 Hrs**	

Evaluation parameters for Internship Project

- Initiative and creativity
- Adaptation capacity
- Commitment and perseverance
- Independence
- Handling supervisor's comments and development skills
- Time management
- Formulation goals, framework project
- Theoretical underpinning, use of literature
- Use of methods and processing data
- Reflection on results
- Conclusions and discussion
- Presentation skills