RAJALAKSHMI ENGINEERING COLLEGE

(An AUTONOMOUS Institution and Affiliated to Anna University, Chennai)

DEPARTMENT OF BIOMEDICAL ENGINEERING

B.E BIOMEDICAL ENGINEERING

REGULATIONS 2023

CHOICE BASED CREDIT SYSTEM (CBCS)

CURRICULUM AND SYLLABUS

DEPARTMENT VISION

To create a center of academic excellence in the field of Biomedical engineering through innovative research contributions and industrial oriented teaching and training for betterment in healthcare.

DEPARTMENT MISSION

- To motivate faculty members and students to explode their creativity to develop innovative products by utilizing modern technologies to serve the society
- To inculcate the industrial need of the biomedical engineers among the students through relevant training and value added courses.
- To produce technically intense engineers by practicing innovative teaching methodologies

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

PEO I: To provide students with sound foundation in the mathematical, scientific and engineering fundamentals necessary to formulate, analyze and solve engineering problems and to prepare them for graduate studies and for successful careers in healthcare sector.

PEO II: To impart students with skills for research, design and development of biomedical devices and allied integrated systems for betterment of human society

PEO III: To instill the ethical values, skills, leadership and team spirit for comprehensive and wholesome personality, to promote entrepreneurial interest among students and to create fervour for use of Engineering in addressing societal concerns.

PROGRAMME OUTCOMES (PO)

Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSO)

PSO 1: An ability to apply advanced technology for measurement and interpretation of data acquired from biological system addressing the problems associated with the interaction between living and non-living materials and systems

PSO 2: An ability to use software tools, mathematics, science and engineering for precise diagnosis and therapeutic applications

PSO 3: An ability to develop healthcare information system for automation and remote access

CREDIT DISTRIBUTION

R-2023

CATEGORY	CREDITS AS PER SEMESTER								CREDITS TOTAL
	I	II	III	IV	V	VI	VII	VIII	
Humanities and Social sciences (HS)	2	1							**3**
Basic Sciences (BS)	9	9	4	4					**26**
Engineering Sciences (ES)	5	14		4	2				**25**
Professional Core (PC)			20	11	15	12	4		**62**
Professional Elective (PE)					3	6	9		**18**
Open Elective (OE)				3	3				**6**
Project, Seminar & Internship (EEC)				1	1	4	7	8	**21**
TOTAL	**16**	**24**	**24**	**23**	**24**	**22**	**20**	**8**	**161**

CURRICULUM

Semester I

SL. No	Course code	Category	Course Title	L	T	P	Contact Periods	Credits
Theory Courses								
1	HS23111	HS	Technical Communication I	2	0	0	2	2
2	MA23111	BS	Linear Algebra and Calculus	3	1	0	4	4
3	GE23111	ES	Engineering Graphics	2	0	4	6	4
4	GE23117	BS	தமிழர் மரபு /Heritage of Tamils	1	0	0	1	1
5	MC23112	HS	Environmental Science and Engineering	3	0	0	3	0
Lab Integrated Theory Course								
6	CY23131	BS	Chemistry For Electronics Engineering	3	0	2	5	4
Laboratory Course								
7	GE23121	ES	Engineering Practices - Civil and Mechanical	0	0	2	2	1
				14	**1**	**8**	**23**	
							TOTAL CREDITS	**16**

Semester II

SL. No	Course code	Category	Course Title	L	T	P	Contact Periods	Credits
Theory Courses								
1	MA23212	BS	Differential Equations and Complex Variables	3	1	0	4	4
2	ME23211	ES	Engineering Mechanics for Biomedical Engineers	3	1	0	4	4
3	GE23217	BS	தமிழரும் தொழில்நுட்பமும் / Tamils Technology/	1	0	0	1	1
Lab Integrated Theory Courses								
4	CS23232	ES	Fundamentals of Data Structures using C	3	0	4	7	5
5	PH23231	BS	Physics for Bioscience	3	0	2	5	4
6	BM23231	ES	Electric Circuits and Machines	3	0	2	5	4

Laboratory Courses								
7	HS23221/ HS23222	HS	Technical Communication II/ English for professional competence	0	0	2	2	1
8	GE23122	ES	Engineering Practices - Electrical and Electronics	0	0	2	2	1
				16	**2**	**12**	**30**	
							TOTAL CREDITS	**24**

Semester III

SL. No	Course code	Category	Course Title	L	T	P	Contact Periods	Credits
Theory Courses								
1	MA23312	BS	Fourier series and Number theory	3	1	0	4	4
2	BM23311	PC	Human Anatomy and Physiology	3	0	0	3	3
3	BM23312	PC	Biomedical Instrumentation	3	0	0	3	3
4	BM23313	PC	Biochemical Science	3	0	0	3	3
Lab Integrated Theory Courses								
5	BM23331	PC	Electronic Devices and Circuits	3	0	2	5	4
6	BM23332	PC	Sensors and Measurements	2	0	2	4	3
Laboratory Courses								
7	BM23321	PC	Biochemistry and Physiology Laboratory	0	0	4	4	2
8	BM23322	PC	Biomedical Instrumentation Laboratory	0	0	4	4	2
				17	**1**	**12**	**30**	
							TOTAL CREDITS	**24**

Semester IV

SL. No	Course code	Category	Course Title	L	T	P	Contact Periods	Credits
Theory Courses								
1	BM23411	PC	Analog and Digital Integrated Circuits	3	0	0	3	3
2	BM23412	PC	Communication Systems and Standards	3	0	0	3	3
3	MC23111	HS	Indian Constitution and Freedom Movement	3	0	0	0	0

4		OE	OE 1	3	0	0	3	3
Lab Integrated Theory Courses								
5	MA23436	BS	Probability and Random Processes	3	0	2	4	4
6	BM23431	PC	Pathology and Microbiology	2	0	2	4	3
7	CS23336	ES	Introduction to Python Programming	1	0	4	5	3
Laboratory Courses								
8	BM23421	PC	Analog and Digital Integrated Circuits Laboratory	0	0	4	4	2
9	BM23422	ES	PCB Design Laboratory	0	0	2	2	1
10	GE23421	EEC	Soft Skills-I	0	0	2	2	1
				18	**0**	**16**	**30**	
							TOTAL CREDITS	**23**

Semester V

SL. No	Course code	Category	Course Title	L	T	P	Contact Periods	Credits
Theory Courses								
1	BM23511	PC	Biocontrol systems	3	0	0	3	3
2	BM23512	PC	Diagnostic and Therapeutic Equipment	3	0	0	3	3
3		OE	OE 2	3	0	0	3	3
4		PE	PE 1	3	0	0	3	3
Lab Integrated Theory Courses								
4	BM23531	PC	Signals and Systems Analysis	1	1	2	4	3
5	BM23532	PC	Microcontroller and Embedded System Design	3	0	2	5	4
6	CS23422	ES	Python Programming for Machine learning	0	0	4	4	2
Laboratory Courses								
7	BM23521	PC	Diagnostic and Therapeutic Equipment Laboratory	0	0	4	4	2
8	GE23521	EEC	Soft Skills –II	0	0	2	2	1
				16	**1**	**14**	**31**	
							TOTAL CREDITS	**24**

Semester VI

SL. No	Course code	Category	Course Title	L	T	P	Contact Periods	Credits
Theory Courses								
1	BM23611	PC	Radiological Equipment	3	0	0	3	3
2	BM23612	PC	Biomechanics	3	1	0	4	4
3		PE	PE 2	3	0	0	3	3
4		PE	PE 3	3	0	0	3	3
Lab Integrated Theory Courses								
5	BM23631	PC	Biosignal Processing	1	1	2	4	3
6	BM23632	PC	Physiological Modeling Laboratory	1	0	2	3	2
7	GE23627	EEC	Design Thinking and Innovation	0	0	4	4	2
Laboratory Courses								
8	BM23621	EEC	Medical Industrial Training	0	0	2	2	1
9	GE23621	EEC	Problem solving techniques	0	0	2	2	1
				14	**2**	**12**	**28**	
							TOTAL CREDITS	**22**

Semester VII

SL. No	Course code	Category	Course Title	L	T	P	Contact Periods	Credits
Theory Courses								
1	BM23711	EEC	Comprehension In Biomedical Engineering	1	0	0	1	1
2		PE	PE 4	3	0	0	3	3
3		PE	PE 5	3	0	0	3	3
4		PE	PE 6	3	0	0	3	3
Lab Integrated Theory Courses								
5	BM23731	PC	Medical Image Processing	2	1	2	5	4
Laboratory Courses								
6	BM23721	EEC	Artificial Intelligence and Machine learning for Biomedical Engineering	0	0	4	4	2
7	BM23722	EEC	Project Phase-I	0	0	6	6	3

8	BM23723	EEC	Hospital Training	0	0	2	2	1
				12	**1**	**14**	**27**	
							TOTAL CREDITS	**20**

Semester VIII

SL. No	Course code	Category	Course Title	L	T	P	Contact Periods	Credits
Laboratory Course								
1	BM23821	EEC	Project Phase-II	0	0	16	16	8
				0	**0**	**16**	**16**	
							TOTAL CREDITS	**8**

TOTAL CREDITS: 161

PROFESSIONAL ELECTIVES

MEDICAL INSTRUMENTATION								
SLNo	**Course code**	**Course Title**	**Category**	**Contact Periods**	**L**	**T**	**P**	**C**
1	BM23A11	MEDICAL OPTICS	PE	3	3	0	0	3
2	BM23A12	BIOMEMS TECHNOLOGIES AND APPLICATIONS	PE	3	3	0	0	3
3	BM23A13	SURGICAL OPTICAL DEVICES	PE	3	3	0	0	3
4	BM23A14	INTERNET OF THINGS IN MEDICINE	PE	3	3	0	0	3
5	BM23A15	BIOSENSORS	PE	3	3	0	0	3
6	BM23A16	VLSI DESIGN FOR BIOMEDICAL APPLICATIONS	PE	3	3	0	0	3
BIO-ENGINEERING								
1	BM23B11	NEURAL ENGINEERING	PE	3	3	0	0	3
2	BM23B12	TISSUE ENGINEERING	PE	3	3	0	0	3
3	BM23B13	DRUG DELIVERY IN BIOLOGICAL SYSTEM	PE	3	3	0	0	3
4	BM23B14	BIOMATERIALS AND APPLICATIONS	PE	3	3	0	0	3
5	BM23B15	MEDICAL CODING	PE	3	3	0	0	3
8	BM23B16	NANOTECHNOLOGY AND APPLICATIONS	PE	3	3	0	0	3
7	BM23B17	MEDICAL PHYSICS	PE	3	3	0	0	3
MEDICAL IMAGING MODALITIES								
1	BM23C11	PATTERN RECOGNITION AND NEURAL NETWORKS	PE	3	3	0	0	3
2	BM23C12	BIOMETRIC SYSTEMS	PE	3	3	0	0	3
3	BM23C13	SOFT COMPUTING TECHNIQUES	PE	3	3	0	0	3
4	BM23C14	DEEP LEARNING AND DEPLOYMENT OF AI MODELS	PE	3	3	0	0	3
5	BM23C15	APPLICATIONS OF EXTENDED REALITIES IN HEALTHCARE	PE	3	3	0	0	3

6	BM23C16	MEDICAL INFORMATICS	PE	3	3	0	0	3
ASSISTIVE TECHNOLOGY								
1	BM23D11	MEDICAL TEXTILES FUNDAMENTALS	PE	3	3	0	0	3
2	BM23D12	MEDICAL ROBOTICS	PE	3	3	0	0	3
3	BM23D13	ASSIST DEVICES	PE	3	3	0	0	3
4	BM23D14	REHABILITATION ENGINEERING	PE	3	3	0	0	3
5	BM23D15	WEARABLE SYSTEMS	PE	2	2	0	0	2
6	BM23D16	TELEHEALTH TECHNOLOGY	PE	1	1	0	0	1
MODELLING AND SIMULATION								
1	BM23E11	3D PRINTING IN MEDICAL APPLICATIONS	PE	3	3	0	0	3
2	BM23E12	PHYSIOLOGICAL MODELLING	PE	3	3	0	0	3
3	BM23E13	BIOFLUID DYNAMICS	PE	3	3	0	0	3
4	BM23E14	MICRO FLUIDICS	PE	3	3	0	0	3
5	BM23E15	BIOSTATISTICS	PE	3	3	0	0	3
6	BM23E16	VIRTUAL BIOINSTRUMENTATION	PE	3	3	0	0	3
PRODUCT DEVELOPMENT AND MANAGEMENT								
1	BM23F11	MEDICAL ETHICS AND STANDARDS	PE	3	3	0	0	3
2	BM23F12	HOSPITAL ENGINEERING AND MANAGEMENT	PE	3	3	0	0	3
3	BM23F13	HEALTH CARE PRODUCT DEVELOPMENT	PE	2	2	0	0	2
4	BM23F14	ENTREPRENEURSHIP in BIOMEDICAL ENGINEERING	PE	1	1	0	0	1
5	BM23F15	MEDICAL SAFETY, QUALITY ASSURANCE AND REGULATORY AFFAIRS	PE	3	3	0	0	3
6	BM23F16	INDUSTRIAL SAFETY AND MANAGEMENT	PE	3	3	0	0	3
7	BM23F17	ENGINEERING ECONOMICS	PE	3	3	0	0	3

SEMESTER I

HS 23111	**TECHNICAL COMMUNICATION I**	**Category**	**L**	**T**	**P**	**C**
	Common to all branches of B.E/B. Tech programme	**HS**	**2**	**0**	**0**	**2**

OBJECTIVES

- To facilitate students develop their comprehension skills
- To enable students to improve their receptive skills
- To equip learners with better vocabulary and enhance their writing skills
- To aid students speak effectively in all kinds of communicative contexts.
- To improve the learners' basic proficiency in workplace communication

UNIT-I DEVELOPING COMPREHENSION SKILLS 6

Listening: Introduction to Informational listening – Listening to Podcasts, News
Reading: Intentional Reading - Short Narratives and Passages.
Speaking: Introducing Oneself, Narrating a Story / Incident.
Writing: Sequential Writing – connecting ideas using transitional words (Jumbled Sentences), Process Description
Grammar: Verbs – Main & Auxiliary: Simple Tenses – Form, Function and Meaning.
Vocabulary: Word formation – Prefix, Suffix, Compound Words.

UNIT-II LISTENING AND EXTENDED READING 6

Listening: Deep Listening – Listening to Talk Shows and Debates
Reading: In-depth Reading - Scanning Passages
Speaking: Describing Current Issues, Happenings, etc..,
Writing: Note Making, Note Taking – Paragraph Writing
Grammar: Continuous Tenses, Prepositions, Articles
Vocabulary: One Word Substitutes, Phrasal Verbs.

UNIT-III FORMAL WRITING AND VERBAL ABILITY 6

Listening: Listening to Lectures and Taking Notes
Reading: Interpretation of Tables, Charts and Graphs
Speaking:SWOT Analysis on Oneself
Writing: Formal Letter Writing and Email Writing
Grammar: Perfect Tenses, Phrases and Clauses, Discourse Markers
Vocabulary : Verbal Analogy / Cloze Exercise

UNIT-IV ENHANCING SPEAKING ABILITY 6

Listening: Listening to eminent voices of one's interest (Martin Luther King, APJ Abdul Kalam, etc.)
Reading: Timed Reading, Filling KWL Chart.
Speaking: Just a Minute, Impromptu
Writing: Check-list, Instructions.
Grammar: 'Wh' Questions / 'Yes' or 'No' Questions, Imperatives
Vocabulary: Synonyms, Antonyms, Different forms of the same words.

UNIT-V LANGUAGE FOR WORKPLACE 6

Listening: Extensive Listening (Audio books, rendering of poems, etc.)
Reading: Extensive reading (Jigsaw Reading, Short Stories, Novels)
Speaking: Short Presentations on Technical Topics
Writing: Recommendations, Essay Writing
Grammar: Impersonal Passive, Reported Speech, Concord
Vocabulary : Informal Vocabulary and Formal Substitutes

Contact Hours: 30

COURSE OUTCOMES

On completion of the course, students will be able to

- apply their comprehension skills and interpret different contents effortlessly
- read and comprehend various texts and audio visual contents
- infer data from graphs and charts and communicate it efficiently in varied contexts
- participate effectively in diverse speaking situations
- to present, discuss and coordinate with their peers in workplace using their language skills

TEXT BOOK(S):

1. Effective Technical Communication by M. Ashraf Rizvi (Author) 2nd Edition Paperback 2017.
2. Sylvan Barnet and Hugo Bedau, 'Critical Thinking Reading and Writing', Bedford/st. Martin's: Fifth Edition (June 28, 2004).
3. Meenakshi Upadhyay, Arun Sharma – Verbal Ability and Reading Comprehension.
4. Teaching Speaking: A Holistic Approach, Book by Anne Burns and Christine ChuenMengGoh, Cambridge University Press.

RFERENCE BOOKS(S) / WEB LINKS:

1. Basic Vocabulary in Use: 60 Units of Vocabulary Practice in North American English With Answers 2nd Edition by Michael McCarthy (Author), Felicity O'Dell (Author), John D. Bunting (Contributor)
2. Reading Development and Difficulties By Kate Cain
3. The 7 Habits of Highly Effective People by Stephen Covey, Simon and Schuster, UK
4. Everybody Writes: Your Go-To Guide to Creating Ridiculously Good Content Hardcover by Ann Handley.

CO/ PO	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2	PSO 3
CO 1	-	-	-	1	-	-	-	-	-	3	-	-	-	-	-
CO 2	-	-	-	1	-	-	-	-	-	3	-	-	-	-	-
CO 3	-	1	-	1	-	-	-	-	-	3	-	-	-	-	-
CO 4	-	-	-	2	-	-	-	-	1	3	-	-	-	-	-
CO 5	-	-	-	1	-	-	-	-	1	3	-	-	-	-	-
AVG.	**-**	**1**	**-**	**1.2**	**-**	**-**	**-**	**-**	**1**	**3**	**-**	**-**	**-**	**-**	**-**

MA23111	LINEAR ALGEBRA AND CALCULUS	Category	L	T	P	C
	Common to I sem. B.E. - CSE, EEE, ECE, BME and B.Tech. IT.	BS	3	1	0	4

OBJECTIVES

- To introduce the matrix techniques and to explain the nature of the matrix.
- To collect the matrix algebra techniques and the concepts of basis and dimension in vector spaces.
- To construct normalization of vectors and ortho-normal vectors.
- To understand techniques of calculus which are applied in the Engineering problems.
- To apply the techniques of Integration in finding area and volumes.

UNIT-I MATRICES 12

Matrices - Eigenvalues and eigenvectors - Diagonalization of matrices using orthogonal transformation - Cayley-Hamilton Theorem(without proof) - Quadratic forms - Reduction to canonical form using orthogonal transformation - Numerical computation of Eigen value using Power method.

UNIT-II LINEAR TRANSFORMATION 12

Vector spaces – Subspaces – Linear combinations and system of Linear equations – Linear independence and Linear dependence – Bases and Dimensions – Linear Transformation – Matrix representation of Linear Transformation - Null space, Range space and dimension theorem (without proof).

UNIT-III INNER PRODUCT SPACES 12

Inner product and norms - Gram Schmidt orthonormalization process - QR Factorization - Singular value decomposition.

UNIT-IV FUNCTIONS OF SEVERAL VARIABLES 12

Partial differentiation–Total derivative–Change of variables–Jacobians–Partial differentiation of implicit functions– Taylor's series for functions of two variables–Maxima and minima of functions of two variables–Lagrange's method of undetermined multipliers.

UNIT-V MULTIPLE INTEGRALS 12

Double integrals–Change of order of integration–Area enclosed by plane curves–Triple integrals–Volume of solids– Numerical computation of double integrals-trapezoidal rule.

Total Contact Hours: 60

COURSE OUTCOMES

On completion of the course, students will be able to

- Demonstrate the matrix techniques in solving the related problems in engineering and technology.
- Apply the concepts of basis and dimension in vector spaces to the solution of related complex engineering problems.

- Construct orthonormal basis by the concepts of normalization in inner products and to analyse complex engineering problems.
- Interpret the problems in Engineering and Technology using the principles of mathematical calculus.
- Evaluate multiple integrals to conduct investigations of complex problems.

TEXT BOOK(S):

1. Grewal B.S., “Higher Engineering Mathematics ”, Khanna Publishers, New Delhi, 43rd Edition, 2014.
2. T Veerarajan, Linear Algebra and Partial Differential Equations, McGraw Hill Education, 2019.
3. Friedberg, A.H., Insel, A.J. and Spence, L., Elementary Linear Algebra, a matrix approach, 2nd edition Pearson, 2014.

REFERENCE BOOKS(S) / WEB LINKS:

1. Ramana. B.V., “Higher Engineering Mathematics ", McGraw Hill Education Pvt. Ltd, New Delhi, 2018.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2016.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	1	-	-	-	-	-	-	-	1	-	1	1	-
CO 2	3	3	-	-	-	-	-	-	-	-	-	-	1	-	-
CO 3	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	2	2	-	-	-	-	-	-	-	-	1	1	-	-	-
CO 5	2	2	-	-	-	-	-	-	-	-	-	1	1	1	-
AVG.	**2.6**	**2.2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**1**	**1**	**-**

GE23111	ENGINEERING GRAPHICS	Category	L	T	P	C
		ES	2	0	4	4

OBJECTIVES:

- To understand the importance of the drawing in engineering applications
- To develop graphic skills for communication of concepts, ideas and design of engineering products
- To expose them to existing national standards related to technical drawings.
- To improve their visualization skills so that they can apply this skill in developing new products.
- To improve their technical communication skill in the form of communicative drawings

CONCEPTS AND CONVENTIONS (Not for Examination) 1

Importance of graphics in engineering applications–Use of drafting instruments– BIS conventions and specifications–Size, layout and folding of drawing sheets– Lettering and dimensioning. Basic Geometrical constructions.

UNIT-I PLANE CURVES AND PROJECTION OF POINTS 5+12

Curves used in engineering practices: Conics–Construction of ellipse, parabola and hyperbola by eccentricity method – Cycloidal Curves–Construction of cycloid, epicycloid and hypocycloid – Construction of involutes of square and circle–Drawing of tangents and normal to the above curves, Principles of Projection and Projection of points.

UNIT-II PROJECTION OF LINES AND PLANE SURFACES 6+12

Projection of straight lines (First angle projection) inclined to both the principal planes – Determination of true lengths and true inclinations by rotating line method

Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

UNIT-III PROJECTION OF SOLIDS AND PROJECTION OF SECTIONED SOLIDS 6+12

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

Sectioning of solids in simple vertical position when the cutting plane is inclined to HP and perpendicular to VP – obtaining true shape of the section.

Practicing three-dimensional modeling of simple objects by CAD software (Not for examination)

UNIT-IV DEVELOPMENT OF SURFACE AND ISOMETRIC PROJECTIONS 6+12

Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones.

Principles of isometric projection–isometric scale–Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders and cones

Model making of isometric projection of combination of solids as assignment (Not for End semester).

UNIT-V FREE HAND SKETCHING AND PERSPECTIVE PROJECTIONS 6+12

Free Hand sketching: Freehand sketching of multiple views from pictorial views of objects - Freehand sketching of pictorial views of object from multiple views

Perspective projection of simple solids-Prisms, pyramids, cylinder and cone by visual ray method.

Total Contact Hours: (L=30; P=60) 90 Periods

COURSE OUTCOMES:

On completion of the course, students will be able

- To construct different plane curves and to comprehend the theory of projection.
- To draw the basic views related to projection of lines and planes.
- To draw the projection of simple solids and to draw the projection of development of surfaces of Sectioned solids in simple vertical position.
- To draw the orthographic projection from pictorial objects and Isometric projections of simple solids
- To visualize Perspective view of simple solids

TEXTBOOK(S):

1. Bhatt N.D. and PanchalV.M., “Engineering Drawing”, Charotar Publishing House, 50th Edition, 2010.
2. NatarajanK.V., “A textbook of Engineering Graphics”, Dhanalakshmi Publishers, Chennai, 2017.

REFERENCE BOOKS(S) / WEB LINKS::

1. Varghese P I., “Engineering Graphics”, McGraw Hill Education (I) Pvt.Ltd. 2013.
2. V.B.Sikka “Civil Engineering Drawing”, S.K Kataria& Sons, New Delhi.
3. Venugopal K. and PrabhuRaja V., “Engineering Graphics”, New Age International (P) Limited, 2008.
4. Gopalakrishna K.R., “Engineering Drawing” (Vol. I&II combined), Subhas Stores, Bangalore, 2017.
5. Basant Agarwal and Agarwal C.M., “Engineering Drawing”, McGraw Hill Publishing Company Limited, New Delhi, 2018.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	2	1	-	1	-	2	2	2	-	2	-	-	-
CO 2	3	2	2	1	-	1	-	2	2	2	-	2	-	-	-
CO 3	3	2	2	1	-	1	-	2	2	2	-	2	-	-	-
CO 4	3	2	2	1	-	1	-	2	2	2	-	2	-	-	-
CO 5	3	2	2	1	-	1	-	2	2	2	-	2	-	-	-
AVG.	**3**	**2**	**2**	**1**	**-**	**1**	**-**	**2**	**2**	**2**	**-**	**2**	**-**	**-**	**-**

MC23112	ENVIRONMENTAL SCIENCE AND ENGINEERING	Category	L	T	P	C
	Common to all branches of B.E./B.Tech. courses (Except B.Tech-CSBS)	HS	3	0	0	0

OBJECTIVES:

- To develop the understanding of environmental and associated issues
- To develop an attitude of concern for the environment
- To promote enthusiasm in participating environmental protection initiatives
- To nurture skills to solve environmental degradation issues.
- To develop the knowledge about the environmental laws.

UNIT I AIR AND NOISE POLLUTION **9**

Definition –sources of air pollution –chemical and photochemical reactions in the atmosphere - formation of smog, PAN, acid rain, ozone depletion, particulate pollutants-Air quality standards-Air quality indices - control of particulate air pollutants-gravitational settling chambers, cyclone separators, wet collectors, fabric filters (Bag-house filter), electrostatic precipitators (ESP)-catalytic converters.
Noise pollution –sources - health effects - standards- measurement and control methods.

UNIT II WATER POLLUTION AND ITS MANAGEMENT **9**

Definition-causes-effects of water pollution-point and nonpoint sources of wastewater-marine pollution - thermal pollution - Control of water pollution by physical, chemical and biological methods – wastewater treatment-primary, secondary and tertiary treatment-sources and Characteristics of industrial effluents- zero liquid discharge.

UNIT III SOLID WASTE AND HAZARDOUS WASTE MANAGEMENT **9**

Solid waste – types- municipal solid waste management: sources, characteristics, collection, and transportation- sanitary landfill, recycling, composting, incineration, energy recovery options from waste - Hazardous waste – types, characteristics, and health impact - hazardous waste management: neutralization, oxidation reduction, precipitation, solidification, stabilization, incineration and final disposal.

E-waste-definition-sources-effects on human health and environment- E-waste management-steps involved - Role of E-waste management within the initiatives of the Govt. of India-Swachh Bharat Mission.

UNIT IV SUSTAINABLE DEVELOPMENT **9**

Sustainable development- concept-dimensions-sustainable development goals - value education- gender equality – food security - poverty – hunger - famine - Twelve principles of green chemistry - Green technology - definition, importance - Cleaner development mechanism - carbon credits, carbon trading, carbon sequestration, eco labeling-International conventions and protocols-Disaster management.

UNIT V ENVIRONMENTAL MANAGEMENT AND LEGISLATION 9

Environmental Management systems - ISO 14000 series- Environmental audit-Environmental Impact Assessment- life cycle assessment- human health risk assessment - Environmental Laws and Policy- Objectives - Polluter pays principle, Precautionary principle - The Environment (Protection) Act 1986 - Role of Information technology in environment and human health.

Contact Hours: 45

COURSE OUTCOMES:

On completion of the course, the students should be able to:

- associate air and noise quality standards with environment and human health.
- illustrate the significance of water and devise control measures for water pollution.
- analyze solid wastes and hazardous wastes.
- outline the goals of sustainable development in an integrated perspective.
- comprehend the significance of environmental laws.

TEXT BOOK(S):

1. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2016.
2. AnubhaKaushik and C. P. Kaushik's "Perspectives in Environmental Studies", 6th Edition, New Age International Publishers, 2018.
3. Johri R., E-waste: implications, regulations, and management in India and current global best practices, TERI Press, New Delhi

REFERENCE BOOKS(S) / WEB LINKS:

1. R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media. 38. Edition 2010.
2. Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia', Jaico Publ., House, Mumbai, 2001.
3. Fowler B, Electronic Waste – 1 st Edition (Toxicology and Public Health Issues), 2017Elsevier

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	1	2	3	1	-	2	2	2	1	1	1	2	-	2	-
CO 2	1	2	3	1	-	2	2	2	1	1	1	2	-	2	-
CO 3	-	-	3	1	-	2	3	2	1	-	1	2	-	2	-
CO 4	-	1	2	1	1	3	3	2	1	1	1	2	-	2	-
CO 5	-	1	2	-	-	2	2	2	1	2	2	2	-	2	-
AVG.	**0.4**	**1.2**	**2.6**	**0.8**	**0.2**	**2.2**	**2.4**	**2**	**1**	**1**	**1.2**	**2**	**-**	**2**	**-**

CY23131	CHEMISTRY FOR ELECTRONICS ENGINEERING	Category	L	T	P	C
	Common to B.E. - ECE, BME, EEE, MCT and R&A	BS	3	0	2	4

OBJECTIVES

- To understand the principles of electrochemical processes
- To explore the functioning of sensors and their applications in industries and health care
- To get familiarized with the functioning batteries of and fuel cells
- To acquire knowledge on polymeric materials used in electronics
- To develop proficiency in nanomaterials

UNIT-I DYNAMIC ELECTROCHEMISTRY 9

Applied Electrochemistry: Electrode Potential - EMF series - Corrosion- Causes, Consequences and Prevention. Surface Preparation- electro polishing -Electroplating of copper, electrophoretic deposition - Electrochemical machining, electrochemical etching - electrochemical etching of Cu from PCB.

UNIT-II ELECTROCHEMICAL SENSORS 9

Electrodes - reference electrodes - ion-selective electrode, determination of electrode potential - Galvanic and concentration cells - potentiometric, amperometric and conduct metric methods of analysis - potentiometric sensor, optical sensor, thermal sensor, chemical biosignals - sensors for health care – glucose and urea sensors, gas sensors for CO2, O2 and NH3 sensing- blood oxygen sensor.

UNIT-III ELECTROCHEMICAL ENERGY SYSTEMS 9

Batteries- types - characteristics-fabrication and working of lead-acid battery- NICAD battery – Nickel metal hydride batteries -lithium-ion battery – Super capacitors- introduction - types - electrochemical double layer capacitor - activated carbon - carbon aerogels. Fuel cells - classification – principle, working and applications of hydrogen-oxygen fuel cell - solid oxide fuel cell - direct methanol fuel cell and proton exchange membrane fuel cells-biofuel cells.

UNIT-IV POLYMERS IN ELECTRONICS 9

Conducting polymers **- c**onducting mechanisms- polyaniline, Poly pyrrole - photonic polymers - photo resists - Introduction, Liquid crystalline phases, Identification of the mesophases, Lyotropic main chain liquid crystalline polymers, Thermotropic main chain liquid crystal polymers, Applications of liquid Crystals in Displays (LCDs) - Organic LEDs- functioning- advantages and disadvantages over conventional LEDs- commercial uses.

UNIT-V NANO MATERIALS 9

Introduction-Types of nanomaterials-Emergence and challenges in nanotechnology-Synthesis routes for nanomaterials: Bottom-up and top-down approaches- Sol-gel, precipitation, Hydrothermal, Solvothermal, Microwave irradiation, Chemical Vapour Deposition (CVD), Electro deposition- Properties of nanomaterials- Mechanical properties, Chemical, Optical, Electrical and Magnetic properties-applications of nanomaterials.

Total Contact Hours:45

LIST OF THE EXPERIMENTS

1. Construction and determination of EMF of simple electrochemical cells and concentration cells
2. Estimation of acids by pH metry
3. Determination of corrosion rate on mild steel by weight loss method
4. Estimation of mixture of acids by conductometry
5. Estimation of extent of corrosion of iron pieces by potentiometry
6. Estimation of copper / ferrous ions by spectrophotometry
7. Estimation of DO by using sensors
8. Estimation of concentration of ions in the given sample solution.
9. Determination of molecular weight of a polymer by viscometry method
10. Synthesis of nanomaterials by simple precipitation method

Total Contact Hours: 30

COURSE OUTCOMES:

On completion of the course, the students should be able to:

- Apply the knowledge of electrochemistry in exploring electrochemical processes.
- Associate the knowledge of sensors in health care and in pollution abatement.
- Recognize the types of batteries and fuel cells.
- Employ advanced materials in industrial applications and display techniques.
- Develop nano and biomaterials for medical applications.

TEXT BOOK(S):

1. P. C. Jain and Monika Jain, “Engineering Chemistry”, DhanpatRai Publishing Company (P) Ltd,New Delhi, 2015.
2. O.G.Palanna, “Engineering Chemistry”, McGraw Hill Education (India) Pvt, Ltd, New Delhi, 2017.
3. ShikhaAgarwal “Engineering Chemistry-Fundamentals and applications”, Cambridge University Press, New Delhi, 2015

REFERENCE BOOKS(S) / WEB LINKS:

1. Gowarikar V. R., ViswanathanN.V. and Jayadev Sreedhar, —Polymer Science, New Age International (P) Ltd., New Delhi, 2011.
2. Sujata V Bhat, “Biomaterials”, Narosa Publishing House, New Delhi, 2002
3. PradeepT, “A Text Book of Nanoscience and Nanotechnology”, Tata McGraw Hill, New Delhi, 2012.
4. An Introduction To Nanomaterials And Nanoscience (PB 2020) : Asim K DAS, Mahua Das, CBS publishers and distributors Pvt. Ltd.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	2	1	-	-	-	-	-	-	-	-	1	-	-	-
CO 2	3	2	1	-	-	1	1	-	-	-	-	1	1	1	1
CO 3	2	1	1	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	2	1	1	-	-	-	-	-	-	-	-	1	-	-	-
CO 5	3	2	2	-	-	-	-	-	-	-	-	1	-	-	-
AVG.	**2.4**	**1.6**	**1.2**	**-**	**-**	**1`**	**1**	**-**	**-**	**-**	**-**	**1**	**1**	**1**	**1**

GE23121 ENGINEERING PRACTICES - CIVIL AND MECHANICAL **Category ES** **L 0 T 0 P 2 C 1**

OBJECTIVES

To provide exposure to the students with hands on experience on various basic engineering practices in Civil and Mechanical Engineering.

List of Experiments

CIVIL ENGINEERING PRACTICE

1. Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers, and elbows in household fittings.
2. Preparation of basic plumbing line sketches for wash basins, water heaters, etc.
3. Hands-on-exercise: Basic pipe connections – Pipe connections with different joining components.

Carpentry Works:

4. Study of joints in roofs, doors, windows and furniture.
5. Hands-on-exercise: Woodwork, joints by sawing, planning and chiselling.

MECHANICAL ENGINEERING PRACTICE

6. Preparation of butt joints, lap joints and T- joints by Shielded metal arc welding.
7. Gas welding practice.

Basic Machining:

8. Simple Turning and Taper turning
9. Drilling Practice

Sheet Metal Work:

10. Forming & Bending:
11. Model making – Trays and funnels
12. Different type of joints.

Machine Assembly Practice:

13. Study of centrifugal pump
14. Study of air conditioner

Total Contact Hours : 30

COURSE OUTCOMES

On completion of the course, the students should be

- Able to perform plumbing activities for residential and industrial buildings considering safety aspects while gaining clear understanding on pipeline location and functions of joints like valves, taps, couplings, unions, reducers, elbows, etc.
- Able to perform wood working carpentry activities like sawing, planning, cutting, etc. while having clear understanding of the joints in roofs, doors, windows and furniture.
- Able to produce joints like L joint, T joint, Lap joint, Butt joint, etc. through arc welding process while acquiring in depth knowledge in the principle of operation of welding and other accessories
- Able to perform operations like Turning, Step turning, Taper turning, etc. in lathe and Drilling operation in drilling machine

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	1	-	-	-	-	1	-	-	-	-	-	1	-	1	1
CO 2	1	-	-	-	-	1	-	-	-	-	-	1	-	1	1
CO 3	1	-	-	-	-	1	-	-	-	-	-	1	-	1	1
CO 4	1	-	-	-	-	1	-	-	-	-	-	1	-	1	1
CO 5	1	-	-	-	-	1	-	-	-	-	-	1	-	1	1
AVG.	**1**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**1**	**1**

SEMESTER II

MA23212	DIFFERENTIAL EQUATIONS AND COMPLEX VARIABLES	Category	L	T	P	C
	Common to II Sem. B.E. –AERO, AUTO, BME, CIVIL, EEE, ECE, MECH, MCT, R&A and B. Tech. - BT, FT &CHEM	BS	3	1	0	4

OBJECTIVES

- To provide students with an introduction to the theory of ordinary differential equations through applications, methods of solution, and numerical approximations.
- To introduce students to how to solve linear Partial Differential with different methods.
- To enable the students to study the Laplace Transforms, properties of Laplace Transform, inverse Laplace Transform and some applications to solve the differential equations and integral equations.
- To explain the concept of a vector integration in a plane and in space.
- To describe basic properties of complex variables and to have the ability to compute complex integrals.

UNIT-I ORDINARY DIFFERENTIAL EQUATIONS 12

Second and higher order Linear differential equations with constant coefficients - Method of variation of parameters – Legendre's linear equations – Numerical solution of ODE - Single Step methods: Taylor's series method, Euler's method.

UNIT-II PARTIAL DIFFERENTIAL EQUATIONS 12

Formation of partial differential equations - Classification of PDE – Solutions of standard types of first order partial differential equations - Lagrange's linear equation –Linear homogeneous partial differential equations of second and higher order with constant coefficients.

UNIT-III LAPLACE TRANSFORM 12

Laplace transform –Basic properties – Transforms of derivatives and integrals of functions - Transforms of unit step function and impulse functions, periodic functions. Inverse Laplace transform – Problems using Convolution theorem – Solution of linear ODE of second order with constant coefficients using Laplace transformation techniques.

UNIT-IV VECTOR CALCULUS 12

Gradient, divergence and curl – Directional derivative – Irrotational and Solenoidal vector fields – Vector integration – Green's theorem in a plane, Gauss divergence theorem and Stokes' theorem (excluding proofs) – Simple applications involving cubes and rectangular parallelepipeds.

UNIT-V COMPLEX VARIABLES 12

Analytic functions –– Construction of analytic function - Bilinear transformation –Singularities – Cauchy's integral theorem (without proof) - Residues – Residue theorem (without proof) - Simple problems - Contour integral over |z|=1.

Total Contact Hours: 60

COURSE OUTCOMES

On completion of the course, students will be able to

- Apply the methods as a potent tool in the solution of a variety of problems in the natural sciences and technology.
- Develop specific methodologies, techniques and resources in Partial differential equations to conduct research and produce innovative results in the area of specialization.
- Use Laplace transform and inverse transform techniques to solve the complex problems in engineering and technology.
- Apply the concepts in multivariable analysis, including space curves; directional derivative; gradient; multiple integrals; line and surface integrals; vector fields; divergence, curl; the theorems of Green and Stokes, and the divergence theorem in different fields of engineering.
- Demonstrate the concept of Analytic functions, conformal mapping and complex integration in solving Engineering problems.

TEXT BOOK(S):

1. Grewal B.S., “Higher Engineering Mathematics”, Khanna Publishers, New Delhi, 43rd Edition, 2014.
2. Veerarajan. T, Engineering Mathematics –II, McGraw Hill Education, 2018.
3. Erwin Kreyszig," Advanced Engineering Mathematics ", John Wiley and Sons, 10th Edition, New Delhi, 2016.
4. Glyn James, “Advanced Modern Engineering Mathematics”, Pearson Education, 4th Edition, New Delhi, 2011.
5. Jain R.K. and Iyengar S.R.K., “Advanced Engineering Mathematics”, Narosa Publications, 5 th Edition, New Delhi, 2017.

REFERENCE BOOKS(S) / WEB LINKS:

1. Ramana. B.V., "Higher Engineering Mathematics ", McGraw Hill Education Pvt. Ltd, New Delhi, 2016.
2. T Veerarajan, Transforms and Partial Differential Equations, Third Edition, 2018.
3. Bali, N.P. and Manish Goyal, A Text Book of Engineering Mathematics, Lakshmi Publications Pvt. Ltd., New Delhi, 4th Edition 2006.
4. Peter V.O’Neil, “Advanced Engineering Mathematics”, Cengage Learning India Pvt, Ltd, 7th Edition, New Delhi, 2012.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	1	-	-	-	-	-	-	-	-	1	1	1	-
CO 2	3	2	1	-	-	-	-	-	-	-	-	1	1	-	-
CO 3	3	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO 4	2	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO 5	3	2	1	-	-	-	-	-	-	-	-	1	1	-	-
AVG.	**2.8**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**1**	**-**

ME23211 ENGINEERING MECHANICS FOR BIOMEDICAL ENGINEERS **Category L T P C**

ES 3 1 0 4

OBJECTIVES:

- To understand the fundamental basics and principles of mechanics
- To learn the concept of equilibrium and to understand the effect of force on bodies
- To Understand the fundamental concepts related to motion, forces and friction and ability to apply these principles to analyze the effects on rigid body
- To learn about the deformation of rigid and non-rigid bodies and to learn to find the centroid , center of gravity and moment of inertia of objects
- To learn basics of fluid mechanics and relate it to bio-fluids.

UNIT I BASICS AND STATICS OF PARTICLES 12

Introduction – Units and Dimensions – Laws of Mechanics – Lami's theorem, Parallelogram and triangular Law of forces –– Vectorial representation of forces – Vector operations of forces - additions, subtraction, dot product, cross product – Coplanar Forces – rectangular components – Equilibrium of a particle – Forces in space – Equilibrium of a particle in space. Equivalent systems of forces – Principle of transmissibility.

UNIT II EQUILIBRIUM OF RIGID BODIES 12

Free body diagram – Types of supports –Action and reaction forces –stable equilibrium – Moments and Couples – Moment of a force about a point and about an axis – Vectorial representation of moments and couples – Scalar components of a moment – Varignon's theorem – Single equivalent force - Equilibrium of Rigid bodies in two and three dimensions.

UNIT III DYNAMICS OF PARTICLES 12

Displacements, Velocity and acceleration, their relationship – Relative motion – Newton's laws of motion – Work Energy Equation– Friction force – Laws of sliding friction – equilibrium analysis of simple systems with sliding friction.

UNIT IV MECHANICS OF SOLIDS 12

Rigid bodies and deformable solids – Tension, Compression and Shear Stresses – Deformation of rigid and non-rigid bodies - Centroids and centre of mass- Centroids of lines and areas - Rectangular, circular, triangular areas by integration – Principal moments of inertia of plane areas – Principal axes of inertia - Mass moment of inertia – mass moment of inertia for prismatic, cylindrical and spherical solids from first principle.

UNIT V BASICS OF MECHANICS OF FLUIDS 12

Fluids – density – pressure – blood pressure and gravity – buoyancy – moments of force and stability – movement in water –Newton's laws of viscosity – Definitions and simple problems on Newtonian fluid, Non-Newtonian fluid, Euler equations and Navier Stoke's equations, Viscoelasticity, laminar flow, Couette flow, turbulent flow and Hagen-Poiseuille equation.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

On Completion of the course, students will be able to

- Use scalar and vector analytical techniques for analysing forces in statically determinate structures
- Analyze the problems in equilibrium and to in engineering systems using the concept of static equilibrium
- Solve the problems in rigid body subjected to dynamic forces and to analyse the bodies subjected to frictional forces
- Apply fundamental concepts to find the centroid and moment of inertia of Rigid bodies and deformable solids
- Analyze fluid flow under different pressure and volume (hemodynamic conditions)

TEXT BOOK(S):

1. Beer, F.P and Johnston Jr. E.R., "Vector Mechanics for Engineers (In SI Units): Statics and Dynamics", 8th Edition, Tata McGraw-Hill Publishing company, New Delhi (2004).
2. Dr. R. K. Bansal, A Text Book of Fluid Mechanics, Laxmi Publications (P) Ltd., New Delhi.

REFERENCE BOOKS(S) / WEB LINKS:

1. Hibbeller, R.C and Ashok Gupta, "Engineering Mechanics: Statics and Dynamics", 11th Edition, Pearson Education 2010.
2. Vela Murali, "Engineering Mechanics", Oxford University Press (2010).

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	1	1	-	-	-	-	2	1	3	1	-	1	-
CO 2	3	3	1	1	-	-	-	-	2	1	3	1	-	1	-
CO 3	3	3	1	1	-	-	-	-	2	1	3	1	-	1	-
CO 4	3	3	1	1	-	-	-	-	1	1	3	1	-	1	-
CO 5	2	2	1	1	-	-	-	-	1	1	3	1	-	1	-
AVG.	**2.8**	**2.8**	**1**	**1**	**-**	**-**	**-**	**-**	**1.6**	**1**	**3**	**1**	**-**	**1**	**-**

CS 23232	FUNDAMENTALS OF DATA STRUCTURES USING C	Category	L	T	P	C
		ES	3	0	4	5

OBJECTIVES

- To learn the features of C
- To learn about functions, pointers and structures
- To explore the applications of linear data structures list
- To explore the applications of linear data structures stack and queue
- To learn the basic sorting and searching algorithms and about hashing

UNIT-I PROGRAMMING BASICS 10

Structure of a C program – Constants, Variables – Data Types – Expressions using operators in C – Managing Input and Output operations – Decision Making and Branching – Looping statements. Arrays – Initialization – Declaration – One dimensional and Two dimensional arrays. Strings - String operations

UNIT-II FUNCTIONS, POINTERS AND STRUCTURES 9

Functions – Pass by value – Pass by reference – Recursion – Pointers - Definition – Initialization – Structures and unions -definition – Structure within a structure - Programs using structures.

UNIT-III LINEAR DATA STRUCTURES – LIST 9

Abstract Data Types (ADTs) – List ADT – array-based implementation – linked list implementation — singly linked lists–applications of lists –Polynomial Manipulation – All operation (Insertion, Deletion, Merge, Traversal)

UNIT-IV LINEAR DATA STRUCTURES – STACKS, QUEUES 8

Stack ADT – Evaluating arithmetic expressions- Balancing Symbols- Queue ADT – circular queue implementation –applications of queues.

UNIT-V SORTING, SEARCHING AND HASH TECHNIQUES 9

Sorting algorithms: Insertion sort – Selection sort – Bubble sort – Quick sort – Merge sort – Searching: Linear search – Binary Search Hashing: Hash Functions – Separate Chaining – Open Addressing – Rehashing

Contact Hours : 45

LIST OF EXPERIMENTS

1. Programs using I/O statements and expressions.
2. Programs using decision-making statements
3. Programs using Arrays and Strings
4. Programs using Functions
5. Programs using Structures
6. Linked list implementation of List
7. Array implementation of Stack and Queue ADTs
8. Linked list implementation of Stack and Queue ADTs

9 Applications of List, Stack and Queue ADTs
10 Implementation of Searching and Sorting algorithms
11 Hashing –Linear probing

Contact Hours : 60
Total Contact Hours : 105

COURSE OUTCOMES:

On Completion of the course, students will be able to:

- Formulate simple algorithms and programs using branching and looping.
- Use arrays, pointers and structures to formulate algorithms and programs.
- Implement linear data structure operations using C.
- Suggest appropriate linear data structures for any given data set.
- Appropriately choose the sorting and searching algorithm for an application and apply hashing concepts for a given problem.

TEXT BOOKS(S):

1. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Pearson Education India, Second Edition, 2015.
2. Mark Allen Weiss, — Data Structures and Algorithm Analysis in C, Second Edition, Pearson Education, 2002.

REFERENCE BOOKS(S) / WEB LINKS:

1. Ellis Horowitz, Sartaj Sahni, Susan Anderson-Freed, —Fundamentals of Data Structures in C, Second Edition, University Press, 2008.
2. Alfred V. Aho, John E. Hopcroft and Jeffrey D. Ullman, —Data Structures and Algorithms, Pearson Education, 2009.
3. Reema Thareja, Data Structures Using C, Second Edition, Oxford University Press, 2014.
4. Robert Kruse, C.L.Tondo, Bruce Leung, Shashi Mogalla , — Data Structures and Program Design in C, Second Edition, Pearson Education, 2007.
5. Ellis Horowitz, Sartaj Sahni and Susan Anderson Freed, Fundamentals of Data Structures in C, 2nd Edition, University Press, 2008.
6. Herbert Schildt, C: The Complete Reference, Fourth Edition, McGraw Hill, 2017.

WebLink(s):

1 https://www.tutorialspoint.com/compile_c_online.php
2 https://www.codechef.com/ide
3 https://www.jdoodle.com/c-online-compiler
4 https://rextester.com/l/c_online_compiler_gcc
5 http://vlabs.iitb.ac.in/vlab/labscse.html
6 https://www.hackerrank.com/
7 https://www.geeksforgeeks.org/
8 https://leetcode.com/

PLATFORM NEEDED:

Hardware: PC with 2 GB RAM, i3 Processor Software: C compiler for Windows/Linux.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	1	2	2	2	1	-	-	-	1	2	1	1	2	3	-
CO 2	2	2	3	2	1	-	-	-	1	-	2	1	2	2	2
CO 3	1	2	1	2	1	-	-	-	-	-	-	1	1	2	-
CO 4	1	1	2	1	1	-	-	-	-	-	-	2	2	2	-
CO 5	1	1	2	1	1	-	-	-	-	-	-	1	1	2	-
AVG.	**1.2**	**1.6**	**2.0**	**1.6**	**1.0**	**-**	**-**	**-**	**1**	**2**	**1.5**	**1.2**	**1.6**	**2.2**	**2**

PH23231 PHYSICS FOR BIOSCIENCE Category L T P C

BS 3 0 2 4

OBJECTIVES:

- To enhance the fundamental knowledge of oscillations, Ultrasonic wave properties and its applications.
- To strengthen the basic information of semiconducting materials, characteristic and its applications.
- To study the behaviour of superconducting materials and optical fibres for medical applications.
- To understand the properties of nuclear radiation and elementary particles.
- To study the advanced analytical techniques.

UNIT-I WAVES AND ULTRASONICS 9

Oscillatory motion – forced and damped oscillations: differential equation and its solution – plane progressive waves – wave equation –Fundamentals of sound– generation of ultrasound – magnetostriction and piezo-electric method – properties - acoustical grating- velocity of Ultrasonics- Non-destructive Testing – pulse echo system through transmission and reflection modes - A,B and C – scan displays.

UNIT-II PHYSICS OF SEMICONDUCTORS 9

Fundamentals of semiconductors–Intrinsic semiconductor– carrier concentration in an intrinsic semiconductor – variation of Fermi level with temperature – band gap determination-Extrinsic semiconductor- carrier concentration of N-type and P-type–variation of Fermi level with temperature and impurity concentration –Hall effect – Determination of Hall coefficient – Formation of PN junction -LED and Solar cells.

UNIT-III MATERIALS FOR MEDICAL APPLICATIONS 9

Introduction to Superconductivity - Properties of Superconductors - BCS theory (qualitative) – Type-I and Type II Superconductors - Applications-Cryotron-Josephson devices- SQUID-MRI scan and Magnetic Levitation. Magnetism in materials - magnetic field and magnetic induction –permeability - susceptibility–types of magnetic materials – Dia, Para, Ferro, anti-ferro and ferrites-hysteresis. Fiber optics –Total internal reflection, Numerical aperture and acceptance angle - types of fibers-Temperature and displacement sensors- endoscopy.

UNIT-IV NUCLEAR AND PARTICLE PHYSICS 9

Radioactivity - characteristics of radioactive material – isotopes - probing by isotopes, reactions involved in the preparation of radioisotopes, the Szilard-Chalmer's reaction – radiochemical

principles in the use of tracers - nuclear medicines – Interaction of charged particles with matter –Specific ionization, Linear energy transfer, range, Bremsstrahlung, Annihilation. Gamma-Ray Spectrometry- Liquid Scintillation Counters-Characteristics of Counting Systems-Gamma Well Counters.

UNIT-V ADVANCED ANALYTICAL TECHNIQUES 9

Theory, Instrumentation and Applications of: Thermogravimetric Analysis - Differential Thermal Analysis - Differential Scanning Calorimetry. Surface analysis – Electron microscope-magnification-resolving power- Scanning electron microscope, Atomic force microscope - Transmission electron micropscope,–Principle, instrumentation and applications

Contact Hours : 45

List of Experiments

1. Determination of Velocity of ultrasound and compressibility of given liquid – Ultrasonic interferometer.
2. Determination of wavelength of diode laser and angular divergence.
3. Determination of Band gap of given semiconducting material.
4. Determination of Hall coefficient of the given semiconducting material.
5. Determination of solar cell characteristics.
6. Determine the energy loss of material by using B-H curve set up.
7. Determination of free space permeability using Helmholtz coil.
8. Determination of Numerical aperture and angle of acceptance of the optical fiber cable.
9. Spectrometer – Wavelength of Hg spectrum by diffraction grating.
10. Spectrometer –Determine refractive index of a prism.

Contact Hours : 30
Total Hours : 75

COURSE OUTCOMES:

On completion of the course, the students will be able to

- apply the knowledge of oscillating particles and generation of waves in real time applications.
- comprehend the principles of semiconductors and their device fabrication.
- make use the properties of superconductors and optical fibre in engineering and technology.
- apply the characteristics of nuclear and elementary particles to develop innovative instruments.
- utilize the concepts of advanced analytical techniques.

TEXT BOOK(S):

1. Kasap, S.O. “Principles of Electronic Materials and Devices”, McGraw-Hill Education, 2017.
2. Umesh K Mishra &Jasprit Singh, “Semiconductor Device Physics and Design”, Springer, 2014.
3. Wahab, M.A. “Solid State Physics: Structure and Properties of Materials”. Narosa Publishing House, 2009.
4. B.H Brown, R.H.Smallwood, D.CB

REFERENCE BOOK(S) / WEB LINKS:

1. S. O. Pillai, Solid state Physics (Multi colour Edition), New Age International Publisher, 2018.
2. Arthur Besier and S. RaiChoudhury, Concepts of Modern Physics (SIE), 7th Edition, 2017.
3. B.L.Theraja, Modern Physics, 16th edition, S.Chand, 2018.

4. J.B.Rajam, Atomic Physics, 7th edition, S.Chand, 2010.
5. Charles Kittel, Introduction to Solid State Physics, 8th Edition, Willey India Pvt.Ltd, 2012.
6. Garcia, N. & Damask, A. “Physics for Computer Science Students”. Springer-Verlag, 2012.

BM23231	ELECTRIC CIRCUITS AND MACHINES	Category	L	T	P	C
		ES	3	0	2	4

OBJECTIVES

- To provide knowledge on solving circuits using network theorems
- To impart knowledge on obtaining the transient response of RC, RL and RLC circuits
- To impart knowledge in types, construction and working of transformers
- To impart knowledge in types, construction and working of DC machines
- To impart knowledge in types, construction and working of AC rotating machines

UNIT I DC AND AC (ONLY SINUSOIDAL) CIRCUITS 9

Ohm’s Law – Kirchhoff’s laws – Resistors in series and parallel circuits – Mesh current and node voltage method of analysis, Network reduction using circuit theorems- Thevenin’s and Norton’s Theorem – Superposition Theorem

UNIT II RESONANCE AND TRANSIENT RESPONSE IN DC CIRCUITS 9

Series and parallel resonance –frequency response – Quality factor and Bandwidth, Transient response of RL, RC and RLC Circuits using Laplace transform for AC input

UNIT III TRANSFORMER 9

Introduction - Ideal and Practical Transformer – Phasor diagram-– Per Unit System – Equivalent circuit- Testing- Efficiency and Voltage Regulation– Three Phase Transformers –Applications- Auto Transformers, Advantages- Harmonics.

UNIT IV DC MACHINES 9

Introduction – Constructional Features– Motor and Generator mode - EMF and Torque equation – Circuit Model – Methods of Excitation- Characteristics – Starting and Speed Control – Universal Motor- Stepper Motors – Brushless DC Motors- Applications

UNIT V AC ROTATING MACHINES 9

Principle of operation of three-phase induction motors – Construction –Types – Equivalent circuit, Speed Control - Single phase Induction motors -Construction– Types–starting methods. Alternator: Working principle–Equation of induced EMF – Voltage regulation, Synchronous motors- working principle-starting methods – Torque equation.

LAB EXPERIMENTS: 30 Hours

1. Verification of KVL and KCL
2. Verification of super position theorem

3. Verification of Thevien's theorem
4. Verification of Norton's theorem
5. RC and RL transients
6. Series and parallel resonance
7. Load test on DC shunt motor.
8. Speed control of DC shunt motor.
9. No load and load test on single-phase transformer
10. Implementation of motor (0.5 Nm) control using optical technique
11. Design and development of 15V, 2A regulated power supply

TOTAL: 75 PERIODS

COURSE OUTCOMES:

On Completion of the course students will be able to

- Realise the working of DC and AC circuits
- Analyse the transient response of DC and AC Circuits
- Explain the working principle of electrical machines
- Analyze the output characterizes of electrical machines
- Choose the appropriate electrical machines for various applications

TEXT BOOK(S):

1. William H. HaytJr, Jack E. Kemmerly and Steven M. Durbin, "Engineering Circuits Analysis", Tata McGraw Hill publishers, 6th edition, New Delhi, 2003.
2. Dr. D P Kothari, Prof I J Nagrath "Basic Electrical Engineering", 3rd Edition, Tata McGraw-Hill, 2009.

REFERENCE BOOKS(S) / WEB LINKS::

1. Sudhakar A and Shyam Mohan SP, "Circuits and Network Analysis and Synthesis", Tata McGraw Hill, 2007.
2. Chakrabati A, "Circuits Theory (Analysis and synthesis), Dhanpat Rai & Sons, New Delhi, 1999.
3. Theraja B.L, Theraja.A.K. "A Textbook of Electrical Technology: Vol 2 AC and DC Machines, S.Chand Publication, 2012
4. K.Venkataratnam, — Special Electrical Machines‖, Universities Press (India) Private Limited, 2008.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1		1	1	-	-	-	-	-	-	-	-	-	1	-	-
CO 2	3	2	1	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	3	1	2	-	-	-	-	-	-	-	-	-	1	1	-
CO 4	3	1	1	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	3	1	2	-	1	-	-	-	-	-	-	-	1	1	-
AVG.	**3**	**1.6**	**1.4**	**-**	**0.2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**0.6**	**0.4**	**-**

HS23221 TECHNICAL COMMUNICATION II Category L T P C

Common to all branches of B.E/B.Tech programmes HS 0 0 2 1

OBJECTIVES

- To facilitate students to improve their vocabulary for a better communication
- To enable learners to understand and reproduce language
- To aid students to write technical reports in a convincing manner
- To expose students to different sentence structures
- To equip learners to present their ideas in an efficient manner

UNIT I VOCABULARY FOR BETTER COMMUNICATION 6

Listening: Telephonic Conversations and TV News
Reading: Newspapers and Magazines
Speaking: Conversational Practice: Speaking in a given situation, Asking permission and requesting etc..,
Writing: Job Application Letter and Resume
Grammar: Reference words: pronouns and determiners
Vocabulary: Guessing meanings of words in different contexts.

UNIT II FUNCTIONAL LANGUAGE ASPECTS 6

Listening: Motivational listening – listening to real life challenges
Reading: Articles and Technical reports
Speaking: Using Polite Expressions, Indirect Questions
Writing: Paraphrasing a Text, Poem
Grammar: Purpose Statements, Cause and Effect Expressions
Vocabulary: Neologisms.

UNIT III TECHNICAL REPORT WRITING 6

Listening: Empathetic Listening – Giving Solutions to Problems
Reading: Inferential Reading
Speaking: Dialogues – Interviewing Celebrities / Leaders / Sportspersons, etc..,
Writing: Report Writing
Grammar: Functional Usage of Expressions – used to, gone / been, etc..,
Vocabulary: Words Often Confused.

UNIT IV STRUCTURAL GRAMMAR **6**

Listening: Comprehension (IELTS practice tests)
Reading: Intensive Reading for specific information
Speaking: Pick and Talk
Writing: Proposals
Grammar: Sentence Structures – Simple, Compound, Complex Sentences
Vocabulary: Replacing dull words with vivid ones

UNIT V PRESENTATION SKILLS **6**

Listening: Discriminative listening – sarcasm, irony, pun, etc..,
Reading: Practice of chunking – breaking up reading materials
Speaking: Mini presentation on some topic
Writing: Minutes of the meeting
Grammar: Correction of Errors
Vocabulary: Advanced vocabulary – fixing appropriate words in the given context.

COURSE OUTCOMES

On completion of the course students will be able to

- Communicate effectively using appropriate vocabulary.
- Use the acquired language skills to comprehend various types of language contents .
- Evaluate different texts and write effective technical content.
- Use appropriate sentence structures to convey their thoughts in varied contexts.
- Present their concepts and ideas in an effective manner.

Total Contact Hours: 30

TEXT BOOK(S)

1. Raymond Murphy, “Intermediate English Grammar,” Second Edition , Cambridge University Press, 2018
2. Meenakshi Raman & Sangeeta Sharma, “Technical Communication” Third Edition, Oxford University Press, 2015
3. Teaching Speaking: A Holistic Approach, Book by Anne Burns and Christine ChuenMengGoh, Cambridge University Press.

REFERENCE BOOKS(S) / WEB LINKS::

1. Michael McCarthy (Author), Felicity O'Dell (Author), John D. Bunting (Contributor), “Basic Vocabulary in Use: 60 Units of Vocabulary Practice in North American English With Answers” 2nd Edition.
2. Dale Carnegie, “The Art of Public Speaking,” Insight Press
3. Jack C. Richards & Theodore S. Rodgers, “Approaches and Methods in Language Teaching, Second Edition, Cambridge University Press.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	-	-	-	1	-	-	-	-	-	2	-	-	-	-	-
CO 2	-	-	-	1	-	-	-	-	-	3	-	-	-	-	-
CO 3	-	2	-	1	-	-	-	-	-	3	-	-	-	-	-
CO 4	-	-	-	1	-	-	-	-	2	3	-	-	-	-	-
CO 5	-	-	-	1	-	-	-	-	2	2	-	-	-	-	-
AVG.	-	2	-	1	-	-	-	-	2	2.6	-	-	-	-	-

HS 23222 ENGLISH FOR PROFESSIONAL COMPETENCE Category L T P C

Common to all branches of B.E/B. Tech programme – Second Semester **HS 0 0 2 1**

OBJECTIVES:

- To facilitate the learners in acquiring listening and reading competence
- To enable the learners to communicate effectively through written and oral medium
- To assist the learners in preparing for competitive examinations
- To train the students in acquiring corporate skills
- To inculcate professional standards among the students and make them realize their responsibility in addressing the challenges

UNIT I RECEPTIVE SKILLS 6

Listening – Comprehensive Listening – Watching the news – Listening to a peer giving presentation, etc. – Critical Listening – Watching a televised debate, Listening to poems – **Reading** – Extensive Reading – Short stories and One-act Plays – Intensive Reading – Articles or Editorials in Magazines, Blog posts on topics like science and technology, arts, etc.

UNIT II PRODUCTIVE SKILLS 6

Speaking – Demonstrative Speaking – Process description through visual aids – Persuasive Speaking – Convincing the listener with the speaker's view – **Writing** – Descriptive Writing - Describing a place, person, process – Subjective Writing – Autobiography, Writing based on personal opinions and interpretations.

UNIT III ENGLISH FOR COMPETITIVE EXAMS 6

An introduction to International English Language Testing System (IELTS) – Test of English as a Foreign Language (TOEFL) – Graduate Record Examination (GRE) – Civil Service, Indian Economic Service Examination, Indian Statistical Service Examination, Combined Defence Services Examination, Staff Selection- (Language Related) – Aptitude tests.

UNIT IV CORPORATE SKILLS 6

Critical Thinking and Problem Solving – Case Study, Brainstorming, Q & A Discussion – **Team work and Collaboration** – Activities like Office Debates, Perfect Square, Blind Retriever, etc. – **Professionalism and Strong Work Ethics** – Integrity, Resilience, Accountability, Adaptability, Growth Mind set

UNIT V PROJECT WORK **6**

Case Study based on the challenges faced by the employers and the employees – Devise Plan, Provide Solution

Total Contact Hours 30

COURSE OUTCOMES:

On completion of the course, students will be able to

- interpret and respond appropriately in the listening and reading contexts.
- express themselves effectively in spoken and written communication
- apply their acquired language skills in writing the competitive examinations
- exhibit their professional skills in their work place
- identify the challenges in the work place and suggest strategies solutions

TEXT BOOK(S):

1. How to Read Better & Faster, Norman Lewis, Goyal Publishers
2. Teaching Speaking: A Holistic Approach, Book by Anne Burns and Christine Chuen Meng Goh, Cambridge University Press
3. The Official Cambridge Guide To IELTS by Pauline Cullen, Cambridge University Press
4. The 7 Habits of Highly Effective People by Stephen Covey, Simon and Schuster, UK

REFERENCE BOOKS(S) / WEB LINKS:

1. Board of Editors. Sure Outcomes. A Communication Skills Course for Undergraduate Engineers and Technologists. Orient Black Swan Limited, Hyderabad, 2013.
2. Hartley, Mary. “The Power of Listening,” Jaico Publishing House; First Edition (2015).
3. Chambers, Harry. “Effective Communication Skills for Scientific and Technical Professionals,” Persues Publishing, Cambridge, Massachusetts, 2000.
4.

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

GE23122	ENGINEERING PRACTICES- ELECTRICAL AND ELECTRONICS	Category	L	T	P	C
		ES	0	0	2	1

OBJECTIVES

- To provide hands-on experience on various basic engineering practices in Electrical Engineering.
- To provide hands-on experience on various basic engineering practices in Electronics Engineering.

LIST OF EXPERIMENTS

A. ELECTRICAL ENGINEERING PRACTICE

1. Residential house wiring using switches, fuse, indicator, lamp and energy meter.
2. Fluorescent lamp wiring.
3. Stair case wiring.
4. Measurement of electrical quantities – voltage, current, power & power factor in RL circuit.
5. Measurement of earth resistance using Megger.
6. Study of Ceiling Fan and Iron Box

B. ELECTRONICS ENGINEERING PRACTICE

1. Study of electronic components and equipment's – Resistor, colour coding, measurement of AC signal parameter (peak-peak, rms period, frequency) using CRO/DSO.
2. a) Measurement of electrical qunatities using Multimeter.
   b) Testing of electronic components.
3. Study of logic gates AND, OR, EXOR and NOT.
4. Generation of Clock Signals.
5. Soldering practice – Components Devices and Circuits – Using general purpose PCB.
6. Measurement of ripple factor of Half-Wave and Full-Wave Rectifiers.

Contact Hours : 30

COURSE OUTCOMES:

On completion of the course, the students will be able to

- fabricate the electrical circuits
- construct the house wiring circuits
- fabricate the electronic circuits
- verify the truth table of logic gates
- Design the Half-wave and Full-Wave Rectifiers using diodes and passive components.

REFERENCES

1. BawaH.S, “Workshop Practice”, Tata McGraw – Hill Publishing Company Limited, 2007.
2. Jeyachandran K., Natarajan S. & Balasubramanian S., “A Primer on Engineering Practices Laboratory”, Anuradha Publications, 2007.
3. Jeyapoovan T., Saravanapandian M. & Pranitha S., “Engineering Practices Lab Manual”,Vikas Publishing House Pvt.Ltd, 2006.
4. Rajendra Prasad A. & Sarma P.M.M.S., “Workshop Practice”, SreeSai Publication, 2002.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	2	-	-	2	-	3	2	-	3	3	3	2
CO 2	3	3	2	2	-	-	2	-	3	2	-	3	3	3	2
CO 3	3	3	3	2	-	-	2	-	3	2	-	3	3	3	2
CO 4	3	3	3	2	-	-		-	3	2	-	3	3	3	2
CO 5	3	3	3	2	-	-		-	3	2	-	3	3	3	2
AVG.	**3**	**3**	**2.67**	**2**	**-**	**-**	**2**	**-**	**3**	**2**	**-**	**3**	**3**	**3**	**2**

SEMESTER III

MA23312	FOURIER SERIES AND NUMBER THEORY	Category	L	T	P	C
		PC	3	1	0	4

OBJECTIVES:

- To express Fourier series to study the behaviour of periodic functions and their applications in system communications, digital signal processing and field theory.
- To represent continuous function arising in wave and heat propagation, signals and systems using Fourier Transforms
- To provide various numerical methods in solving problems that occurs in the field of Engineering and Technology.
- To introduce and apply the concepts of finite fields and congruences.
- To present a rigorous development of Number Theory using axioms, definitions, examples, theorems and their proofs.

UNIT-I FOURIER SERIES **12**

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series – Half range cosine series –Parseval's identity – Harmonic analysis.

UNIT-II FOURIER TRANSFORMS **12**

Statement of Fourier integral theorem – Fourier transform pair – Fourier sine and cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity - Application to boundary value problems.

UNIT-III NUMERICAL SOLUTIONS OF BOUNDARY VALUE PROBLEMS **12**

Finite difference method for solving second order differential equations - Finite difference techniques for the solution of two-dimensional Laplace and Poisson equations on rectangular domain – One dimensional heat flow equation by implicit and explicit methods – One Dimensional Wave Equation by Explicit method.

UNIT-IV CONGRUENCES **12**

Finite Fields -Linear Diophantine equations – Congruence's – Linear Congruence's – Applications: Divisibility tests – Modular exponentiation-Chinese remainder theorem – 2 x 2 linear systems.

UNIT-V CLASSICAL THEOREMS IN NUMBER THEORY **12**

Wilson's theorem – Fermat's little theorem – Euler's theorem – Euler's Phi functions – Tau and Sigma functions.

Contact Hours : 60

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Demonstrate Fourier series to study the behaviour of periodic functions and their applications in engineering problems such as system communications, digital signal processing and field theory.
- Apply the shifting theorems, Fourier integral theorems, Inverse Fourier sine and cosine transforms appropriate problems in engineering and technology.
- Solve differential equations numerically that arise in course of solving complex engineering

problems.
- Explain the fundamental concepts of finite fields and congruence, and their role in modern mathematics and applied contexts.
- Work effectively as part of a group to solve challenging problems in Number Theory.

TEXT BOOK(S):

1 Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India, 2015.
2 Veerarajan. T., "Transforms and Partial Differential Equations", Tata McGraw Hill Education Pvt.Ltd.,New Delhi, Second reprint, 2016.
3 Grimaldi, R.P and Ramana, B.V., "Discrete and Combinatorial Mathematics", Pearson Education, 5th Edition, New Delhi, 2007.
4 Koshy, T., “Elementary Number Theory with Applications”, Elsevier Publications, New Delhi, 2002.
5 Grewal B.S., "Higher Engineering Mathematics", 43rd Edition, Khanna Publishers, Delhi, 2014.

REFERENCE BOOK(S) / WEB LINKS:

1 Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company Limited, New Delhi, 2017.
2 Glyn James, "Advanced Modern Engineering Mathematics", 4th Edition, Pearson Education, 2016
3 GrewalB.S., and Grewal. J.S., "Numerical Methods in Engineering and Science", 11th Edition, Khanna Publishers, New Delhi, 2013.
4 Lidl, R. and Pitz, G, "Applied Abstract Algebra", Springer Verlag, New Delhi, 2nd Edition, 2006.
5 Niven, I., Zuckerman.H.S., and Montgomery, H.L., “An Introduction to Theory of Numbers”, John Wiley and Sons , Singapore, 2004.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	1	-	-	-	-	-	-	-	-	1	1	1	-
CO 2	3	2	1	-	-	-	-	-	-	-	-	1	1	-	-
CO 3	3	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO 4	2	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO 5	3	2	1	-	-	-	-	-	-	-	-	1	1	-	-
AVG.	**2.8**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**1**	**-**

BM23311	HUMAN ANATOMY AND PHYSIOLOGY	Category	L	T	P	C
		PC	3	0	0	3

OBJECTIVES:

- To understand human body basics: cells, tissues, homeostasis, and organization.
- To explore musculoskeletal system: bones, joints, muscles, and skin functions.
- To study cardiovascular and respiratory systems: blood, heart, and lung functions.
- To acquire knowledge of digestive and urinary systems for physiological understanding.
- To comprehend the intricate regulatory dynamics of nervous and endocrine systems.

UNIT-I BASIC ELEMENTS OF HUMAN BODY 9

Introduction to the human body, basic terminologies (directional, regional, planes, levels of organization), cell- structure and organelles, cell membrane transport, action potential (Nernst, Goldman equation), homeostasis, tissue-types and functions.

UNIT-II MUSCULOSKELETAL AND INTEGUMENTARY SYSTEMS: SUPPORT, MOVEMENT, AND PROTECTION 9

Skeletal System - types of bone, salient features and functions of bones of axial and appendicular skeletal system, Joints- Structural and functional classification, types of joints movements.

Organization of skeletal muscle, physiology of muscle contraction, neuromuscular junction, types of muscle contraction. Structure and functions of skin.

UNIT-III CARDIOVASCULAR AND RESPIRATORY SYSTEMS: CIRCULATION AND OXYGENATION 9

Blood - composition and functions, blood grouping and typing

Heart - anatomy, blood circulation, blood vessels, conducting system and electrocardiogram, cardiac cycle, arterial blood pressure, factors regulating blood pressure.

Respiratory system - organs, mechanics of respiration, lung volume and capacities, gaseous transport in the blood, regulation of respiration.

UNIT-IV DIGESTIVE AND URINARY SYSTEMS: NUTRIENT PROCESSING AND WASTE ELIMINATION 9

GI system - organization, accessory digestive organ - liver, pancreas and gallbladder, digestion and absorption of food stuffs, defecation.

Urinary system – structure and functions, physiology of urine formation, blood acid-base regulation by kidney.

UNIT-V NERVOUS AND ENDOCRINE SYSTEMS: REGULATION AND CONTROL 9

Organization of nervous system, neuron, neuroglia, neuronal signalling and synaptic transmission, cerebrospinal fluid, brain - structure and functions, spinal cord - gross structure, functions of afferent and efferent nerve tracts and reflex activity.

Special senses – vision and hearing

Endocrine glands - major glands and their hormones, maintenance of calcium homeostasis, maintenance of glucose homeostasis.

Contact Hours : 45

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Demonstrate the cellular components and their function and critically evaluate membrane transport mechanisms and tissue types
- assess different bones and muscles and emphasizing their collective role in maintaining structural integrity
- illustrate the interdependence of circulatory and respiratory systems.
- explain the processes of digestion and urine formation in detail.
- exhibit a thorough comprehension of how the nervous and endocrine systems coordinate to maintain physiological balance

TEXT BOOK(S):

1 Elaine.N. Marieb , “Essential of Human Anatomy and Physiology”, Eight Edition, Pearson Education, New Delhi 2007.
2 Guyton & Hall, “Medical Physiology”, 13th Edition, Elsevier Saunders, 2015.
3 Sarada Subramanyam, K.Madhavan Kutty and H.D.Singh - Text Book of 'Human Physiology'
S.Chand & Company, 1996.
4 Valerie C. Scanlon and Tina Sanders, “Essential of Human Anatomy and Physiology”, Fifth Edition, F.A. Davis Company, Philadelphia 2007.

REFERENCE BOOK(S) / WEB LINKS:

1 Prabhjot Kaur. Text Book of Anatomy and Physiology. Lotus Publsihers. 2014.
2 Eldra Pearl Solomon, “Introduction to Human Anatomy and Physiology”, Third Edition, W.B. Saunders Company, 2008.
3 Frederic H. Martini, Judi L. Nath, Edwin F. Bartholomew, Fundamentals of Anatomy and Physiology. Tenth Edition, Pearson Publishers, 2014.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	3	1	3	3	3	3	3	1	3	3	3	3
CO 2	3	3	3	3	1	3	3	3	3	3	1	3	3	3	3
CO 3	3	3	3	3	1	3	3	3	3	3	1	3	3	3	3
CO 4	3	3	3	3	1	3	3	3	3	3	1	3	3	3	3
CO 5	3	3	3	3	1	3	3	3	3	3	1	3	3	3	3
AVG.	**3**	**3**	**3**	**3**	**1**	**3**	**3**	**3**	**3**	**3**	**1**	**3**	**3**	**3**	**3**

BM23312	BIOMEDICAL INSTRUMENTATION	Category	L	T	P	C
		PC	3	0	0	3

OBJECTIVES:

- To design Bio potential amplifiers for acquisition of bio signals.
- To acquire knowledge in the basics of bio medical instrumentation.
- To understand the different types of electrodes and its placement for various recordings in clinical applications
- To understand the non-electrical physiological parameter measurements.
- To understand the design aspects of various assist and therapeutic devices.

UNIT-I BIOPOTENTIAL AMPLIFIERS 9

Need for bio-amplifier - single ended bio-amplifier, Instrumentation amplifier, differential bio amplifier, Right leg driven ECG amplifier. Band pass filtering, isolation amplifiers – transformer, optical isolation, isolated DC amplifier and AC carrier amplifier, Artifacts and removal, electrical safety equipment analyzer.

UNIT-II ELECTRODES IN CLINICAL APPLICATIONS 9

Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Electrooculogram (EOG), Electroretinogram (ERG), Recording Electrodes – Electrode-tissue 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, Needle electrodes.

UNIT-III BIOPOTENTIAL MEASUREMENTS 9

Bio signals characteristics – frequency and amplitude ranges. ECG – Einthoven ‘s triangle, standard 12lead system, Principles of vector cardiography. EEG – 10-20 electrode system, unipolar, bipolar and average mode. EMG– unipolar and bipolar mode. Recording of ERG, EOG and EGG.

UNIT-IV MEASUREMENT OF NON ELECTRICAL PHYSIOLOGICAL PARAMETERS 9

Temperature, respiration rate and pulse rate measurements, Plethysmography, Pulse oximeters: Transmission oximetry, Reflection oximetry, Blood Pressure: direct methods - Pressure amplifiers - systolic, diastolic, mean detector circuit, indirect methods - auscultatory method, oscillometric method, ultrasonic method. Blood flow - Electromagnetic and ultrasound blood flow measurement.

UNIT-V ASSIST DEVICES AND RESPIRATORY DEVICES 9

Pacemakers, Defibrillators, Hearing aid, Lung Volume and capacities, Spirometer, Ventilators, Pneumotachometers: different types.

Contact Hours : 45

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Design bio-amplifier for various physiological recordings
- Gain knowledge in electrodes and its functions
- Illustrate different electrode placement for various physiological recordings
- Measure various non-electrical physiological parameters.
- Design various assist and therapeutic devices

TEXT BOOK(S):

1 Joseph J. Carr and John M. Brown, “Introduction to Biomedical equipment technology”, Pearson Education, 4th Edition, 2014.
2 John G.Webster, “Medical Instrumentation Application and Design”, John Wiley and Sons, New York, 4th Edition, 2009.
3 A.K.Sawhney, “A Course in Electrical and Electronic measurements and Instruments”, DhanpatRaiand Sons, 2000.
4 M. Arumugam, “Biomedical Instrumentation”, Anuradha Agencies Publishers, Kumbakonam, R.M.S: 1992.

REFERENCE BOOK(S) / WEB LINKS:

1 Khandpur R.S, “Handbook of Biomedical Instrumentation”, Tata McGraw Hill, New Delhi, 3rd Edition, 2014.
2 L.A Geddes and L.E.Baker, “Principles of Applied Biomedical Instrumentation”, John Wiley and Sons, 3rd Edition, Reprint 2008.
3 Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, Biomedical Instrumentation and Measurements, Pearson Education India, 2nd Edition, 2015.
4 Myer Kutz, “Standard Handbook of Biomedical Engineering & Design”, McGraw-Hill Publisher, 2003.
5 John D .E, Susan M.B, Joseph Bronzino , "Introduction to Biomedical Engineering", Elsevier Ltd, Boston, 2012.
6 Joseph D Bronzino, "Management of Medical Technology", Elsevier Ltd, 1992.
7 Anandanatarajan, “Biomedical Instrumentation”, PHI Learning, 2009.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	3	3	3	2	3	-	-	-	-	-	2	3	3	2
CO 2	2	3	3	2	2	3	-	-	-	-	-	2	3	2	2
CO 3	1	3	3	-	2	2	-	-	-	-	-	2	3	3	3
CO 4	1	2	2	2	2	1	-	-	-	-	-	2	3	3	1
CO 5	1	2	2	2	2	1	-	-	-	-	-	2	3	3	3
AVG.	**1.4**	**2.6**	**2.6**	**1.8**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**2.8**	**2.2**

BM23313 BIOCHEMICAL SCIENCE Category L T P C

PC 3 0 0 3

OBJECTIVES:

- To understand and explain the fundamental concepts of biochemistry
- To study structural and functional properties of carbohydrates, proteins, lipids and nucleic acids
- To emphasize the role of biomolecules by providing basic information on their metabolism and energetics
- To gain comprehensive knowledge about enzymes, including their classification,

kinetics, mode of action, regulation, and clinical significance.
- To acquire knowledge about cell signalling mechanisms, GPCR signalling, and their relevance in human diseases.

UNIT-I INTRODUCTION TO BIOCHEMISTRY 7

Introduction to Biochemistry, water as a biological solvent, weak acid and bases, electrolytes, pH, buffers, Henderson – Hassel balch equation, physiological buffers in living systems, Properties of water and their applications in biological systems.

UNIT-II CLASSIFICATION AND PROPERTIES OF BIOMOLECULES 10

Classification of carbohydrates - mono, di, oligo and polysaccharides. Structure, properties of monosaccharides.

Classification of lipids- simple, compound and derived lipids. Nomenclature of fatty acid, physical and chemical properties of triglycerides.

Nucleic Acid: DNA - Watson and crick model of DNA, types. Structure and types of RNA. Amino acid: Classification. Protein: structural organisation.

UNIT-III METABOLISM AND ITS REGULATION 10

Carbohydrate Metabolic pathways: Glycolysis – aerobic and anerobic with energetics, TCA cycle – amphibolic pathway, energetics. ETC and Oxidative Phosphorylation.

Lipid Metabolic pathways: Degradation of fatty acid (beta oxidation), Hormonal regulation of fatty acid oxidation. Lipoprotein: LDL and HDL metabolism – Case Studies

Urea cycle - Detoxification of Ammonia, relationship with Liver Function and regulation.

UNIT-IV ENZYMES 9

Enzymes: Classification, Factors affecting enzymatic activity, Kinetics – Michaelis menton equation, line weaver burk plot, Mode of action, Regulation: Feedback, allosteric and covalent regulation. Clinical significance of enzymes – Case Studies.

UNIT-V CELL SIGNALLING 9

Cell signalling basics, Intercellular signalling: Autocrine, Paracrine, Endocrine, steps, regulation and role of hormones. Intracellular signalling: Reception, activation, deactivation and processing of signals, Molecular tools for intracellular signalling.

Signal transduction by G Protein coupled receptor: activation, inactivation, signalling pathway and role of second messengers.

Case Study: Role of GPCRs in Human Diseases.

Contact Hours : 45

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Demonstrate a proficient understanding of fundamental biochemistry concepts.
- Analyze and describe the structural and functional properties of carbohydrates, proteins, lipids, and nucleic acids.
- Apply the knowledge of biomolecules to explain their role in metabolism and energetics.
- Evaluate and interpret the significance of enzymes, considering their classification, kinetics, mode of action, regulation, and clinical importance.
  Exhibit a thorough grasp of cell signalling mechanisms, particularly GPCR signalling, and their significance in human diseases.
-

TEXT BOOK(S):

1 Peter J. Kennelly, Kathleen M. Botham , Owen McGuinness, Victor W. Rodwell, P. Anthony Weil –"Harper's Illustrated Biochemistry" , 32nd International Edition, Mc Graw Hill Lange Publication, 2023

2 Trevor palmer and Philip L Bonner, "Enzymes: Biochemistry, Biotechnology, Clinical Chemistry", 2nd Edition, Woodhead Publishing, 2012.

3 John T. Hancock. "Cell Signalling". Oxford University Press, 2017.

REFERENCE BOOK(S) / WEB LINKS:

1 Pamela.C.Champe & Richard.A.Harvey, "Lippincott Biochemistry Lippincott's Illustrated Reviews", 6th Edition, LWW publishers, 2013.

2 David L. Nelson, Michael M. Cox, "Lehninger Principles of Biochemistry",8th Edition, W H Freeman & Co Publisher, 2021.

3 Donald Voet, Judith G. Voet, Charlotte W. Pratt, "Voet's Principles of Biochemistry", 5th Edition, Wiley Publication, 2018.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	1	2	-	2	1	1	-	2	-	-	3	2	1
CO 2	3	2	1	2	-	2	1	1	-	2	-	-	3	2	1
CO 3	3	2	1	2	-	2	1	1	-	2	-	-	3	2	1
CO 4	3	2	1	2	-	2	1	1	-	2	-	-	3	2	1
CO 5	3	2	1	2	-	2	1	1	-	2	-	-	3	2	1
AVG.	**3**	**2**	**1**	**2**		**2**	**1**	**1**		**2**			**3**	**2**	**1**

BM23331 ELECTRONIC DEVICES AND CIRCUITS Category L T P C

PC 3 0 2 4

OBJECTIVES

- To Understand the V-I Characteristics of low-power semiconductor devices.
- To Understand the working of high-power devices and semiconductor devices.
- To Understand the nuances of small signal model of BJT and FET.
- To study the working of feedback amplifiers and oscillators.
- To Understand the medical applications of Amplifiers and Oscillators.

UNIT-I DIODES, RECTIFIERS AND IC REGULATORS 9

Semiconductor Devices-Types, PN Diode and Zener Diode-VI Characteristics, Rectifiers – Half wave – Full wave – Bridge - with and without capacitor filter – Voltage multiplier circuits – Voltage regulation – Shunt Regulators – Series Regulators – Current limiting technique – Three terminal IC regulators (78XX and 79XX).Design and analysis of rectifier and regulator circuits.

UNIT-II BJT AND FET - CONFIGURATIONS 9

JT-NPN Transistor-PNP Transistor-Configurations-Characteristics, JFET – Drain and Transfer Characteristics- Differences between BJT and FET, MOSFET- EMOSFET-DEMOSFET.

UNIT-III HIGH POWER DEVICES AND SPECIAL SEMICONDUCTOR DEVICES 9

UJT, SCR, DIAC, TRIAC, Power BJT- Power MOSFET- DMOS-VMOS, IGBT, VARACTOR diode –Tunnel diode-, LED and 7-segment display. LASER diode, LDR and its Biomedical Applications.

UNIT-IV BIASING AND SMALL SIGNAL ANALYSIS OF BJT AND FET 9

BJT – Biasing of BJT – Fixed Bias – Voltage Divider Bias – Emitter bias - Two port network Analysis of BJT–parameters - small signal analysis of BJT for CE configuration - Frequency response of, BJT for CE configuration, JFET–– Biasing of FET – Fixed Bias – Self Bias – Voltage Divider Bias - Small signal analysis of JFET for CS configuration – Frequency response of FET.

UNIT-V AMPLIFIERS AND OSCILLATORS – BIOMEDICAL APPLICATIONS 9

Basics of Feedback system - Types of Feedback Amplifiers (Block diagram approach), Types of Power Amplifiers – Class A (series fed and transformer-coupled), Principle of oscillators – Condition for oscillation – Audio Oscillators – RC Phase shift and Wien Bridge oscillators RF oscillators-Hartley and Colpitts, Multivibrators – Astable and Monostable - Blood Volume measurement using Photoresistor and Phototransistor Biotelemetry – Hearing Aids – EMG Amplifier

Mini Project on Biomedical applications using Transistors, Amplifiers and Oscillators.

Contact Hours : 45

LIST OF EXPERIMENTS

1. V-I Characteristics of PN Junction and Zener Diodes.
2. Zener Diode – Line and Load Regulation.
3. NPN Transistor – CE Configuration.
4. NPN Transistor – CB Configuration.
5. Drain and Transfer Characteristics of JFET.
6. Half Wave Rectifier – Center Tapped Full Wave Rectifier– Bridge Rectifier – Construction and Working.
7. Analysis of the Stability factors of Fixed Bias, Emitter Bias, and Voltage Divider Bias of BJT.
8. Design of RC Phase Shift Oscillator.
9. Design and Analysis of Astable and Monostable Multivibrator Circuit.
10. Design and Analysis of Class A Power Amplifier.

Contact Hours : 30
Total Contact Hours : 75

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Analyse the V-I Characteristics of low-power semiconductor devices
- Analyse the working of high-power devices and semiconductor devices
- Analyse the nuances of small signal model of BJT and FET
- Analyse the working of feedback amplifiers and oscillators
- Analyse the medical applications of Amplifiers and Oscillators

TEXT BOOK(S):

1 Robert L. Boylestead, Louis Nashelsky, “Electronic Devices and circuit Theory”, Prentice Hall of India, 2004
2 Donald A Neaman, “Semiconductor Physics and Devices”, Fourth Edition, Tata Mc GrawHill Inc. 2012.
3 William H. HaytJr, Jack E. Kemmerly and Steven M. Durbin, “Engineering Circuits Analysis”, Tata McGraw Hill publishers, 6th edition, New Delhi, 2003
4 Jacob Millman, Christos C Haikas, Satyabrata Jit, “Electronic Devices and Circuits”, Tata McGraw Hill publishers, 4th edition, New Delhi, 2015.

REFERENCE BOOK(S) / WEB LINKS:

1 David A. Bell, “Electronic Devices and Circuits”, 4th Edition Prentice Hall of India, 2003.
2 Millman Haykins, “Electronic Devices and Circuits”, 2nd Edition Tata MC Graw Hill 2007.
3 John G. Webster, —Medical Instrumentation Application and Design‖, 4th edition, Wiley India Pvt Ltd,New Delhi, 2015
4 Leslie Cromwell, —Biomedical Instrumentation and measurement, 2nd edition, Prentice hall of India, New Delhi, 2015
5 Joseph J. Carr and John M. Brown, —Introduction to Biomedical Equipment Technology, Pearson Education, 2004.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	1	-	1	-	1	-	-	-	-	-	-	3	-
CO 2	3	3	3	2	2	-	2	-	-	-	-	-	-	3	-
CO 3	3	3	3	3	3	-	3	-	-	-	-	-	-	3	-
CO 4	3	3	3	3	3	-	3	-	-	-	-	-	-	3	-
CO 5	3	3	3	3	3	-	3	-	2	1	3	3	3	3	3
AVG.	**3**	**3**	**2.6**	**2.7**	**2.4**	**-**	**2.4**	**-**	**2**	**1**	**3**	**3**	**3**	**3**	**3**

BM23332 SENSORS AND MEASUREMENTS Category L T P C

PC 2 0 2 3

OBJECTIVES

- To know about the types of transducers available and their applications in different fields.
- To understand the concepts of photo sensors and its functions.
- To study chemical biosensors.
- To get exposure in biopotential sensors.
- To get an idea about the various biological sensors.

UNIT-I TRANSDUCERS AND SENSORS 9

Resistive Transducers: Strain Gauge: Gauge factor, sensing elements, configuration, biomedical applications; strain gauge as displacement & pressure transducers, RTD materials & range, Characteristics, thermistor characteristics, biomedical applications of Temperature sensors

Capacitive transducer, Inductive transducer, LVDT, Active type: Thermocouple –characteristics.

UNIT-II PHOTOELECTRIC AND PIEZOELECTRIC SENSORS 9

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

UNIT-III CHEMICAL BIOSENSORS 9

Blood gas and Acid-Base Physiology, Electrochemical sensors, reference electrode, pH, pO2, pCO2 electrodes, Ion-Selective Field-Effect Transistor (ISFET), Non-invasive Blood-Gas Monitoring, Blood Glucose Sensors. Transcutaneous arterial oxygen tension and carbon dioxide tension monitoring enzyme electrode.

UNIT-IV BIO POTENTIAL ELECTRODES 9

Action Potential, Electrode electrolyte interface, polarization, polarizable and nonpolarizable electrodes, Electrode Behavior and, Circuit Models, Electrode-skin Interface and Motion Artifact, Body-Surface Recording Electrodes, Internal Electrodes: Needle and wire electrodes, Electrode Arrays, Microelectrodes: Metal supported metal, micropipette (metal filled glass and glass micropipette electrodes), microelectronic, properties of microelectrodes. Electrodes for Electric Stimulation of Tissue (i.e. for ECG, EMG and EEG).

UNIT-V BIOLOGICAL SENSORS 9

Sensors / receptors in the human body, basic organization of nervous system-neural mechanism, Chemoreceptor: hot and cold receptors, baroreceptors, sensors for smell, sound, vision, Ion exchange membrane electrodes, enzyme electrode, glucose sensors, immunosensors, Basic principles of MOSFET biosensors and BIOMEMS, basic idea about Smart sensors.

Contact Hours : 45

LIST OF EXPERIMENTS

1 Temperature measurement using AD590 IC sensor
2 Displacement measurement by using a capacitive transducer
3 Study of the characteristics of a LDR
4 Pressure and displacement measurement by using LVDT
5 Study of a load cell with tensile and compressive load
6 Torque measurement Strain gauge transducer
7 Study and characterize Bio transducers – Pressure, Temperature, Humidity
8 Study and characterize Bioelectrodes – ECG, EMG, EEG
9 Study and Characterize pH electrodes
10 Characteristics of Ultrasound Transducer and Phono Transducer.
11 Determination of characteristics of Polarized Electrodes, Non-polarized Electrodes and Multi Point Electrodes

Contact Hours : 30
Total Contact Hours : 75

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Understand various sensors and transducers available for physiological measurements.
- Apply fundamental transduction and photo sensing principles.
- Interpret various chemical sensors used in physiological measurements.
- Analyse different types of recording physiological signals using various bio potential electrodes.

- Review the application area of biological sensors.

TEXT BOOK(S):

1 A.K.Sawhney, "A Course in Electrical and Electronic measurements and Instruments", Dhanpat Rai and Sons, 2010.
2 Prof. Ping Wang and Dr.Qingjun Liu, "Biomedical Sensors and Measurement ",First Edition, Springer Publications", 2011.
3 Tatsuo Togawa ,Toshiyo Tamura andAke Oberg, " Biomedical Sensors and Instruments", Second Edition, CRC Press Taylor and Francis Group, 2011.

REFERENCE BOOK(S) / WEB LINKS:

1 R.Anandanatarajan, "Biomedical Instrumentation and measurements", Second Edition, PHI Learning, December 2015.
2 Ernest O Doebelin and Dhanesh N Manik, "Measurement Systems, Applications and Design", Fifth edition MC Graw-Hill, 2011.
3 Michael J. McGrath, CliodhnaNíScanaill, "Sensor Technologies: Healthcare, Wellness and Environmental Applications,Apress, 2013.
4 Richard S.C. Cobbold, "Transducers for Biomedical Measurements: Principles and Applications ", John Wiley and Sons, 2004.
5 Nandini K. Jog, "Electronics in Medicine and Biomedical Instrumentation ", Second Edition, PHI, 2013.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	3	2	-	-	-	-	-	-	1	3	2	-
CO 2	2	3	3	3	3	-	-	1	-	-	-	1	3	2	-
CO 3	3	3	3	-	3	-	-	1	-	-	-	1	3	2	-
CO 4	3	3	3	-	3	-	-	-	-	-	-	1	3	2	-
CO 5	3	3	3	2	3	-	-	-	-	-		1	3	2	-
AVG.	**2.8**	**3**	**3**	**2.7**	**2.8**	**-**	**-**	**1**	**-**	**-**	**-**	**1**	**3**	**2**	**-**

BM23321 BIOCHEMISTRY AND PHYSIOLOGY LABORATORY Category L T P C

PC 0 0 4 2

OBJECTIVES

- To study how biochemical knowledge can be applied to a range of medical investigations
- To learn the laboratory analysis of carbohydrates, lipids and proteins qualitatively and quantitatively
- To learn fundamental approaches for experimentally investigating biochemical problems
- To provide basic training in biochemical techniques such as chromatography and electrophoresis
- To study about the appropriate laboratory techniques and scientific methodology to determine

the physiological status of the body.

LIST OF EXPERIMENTS

1 General guidelines for working and functional component of biochemistry lab
2 General tests for carbohydrates, proteins and lipids
3 Preparation of serum and plasma from blood
4 Estimation of blood glucose
5 Estimation of creatinine
6 Estimation of urea
7 Assay of SGOT/SGPT
8 Separation of proteins by SDS electrophoresis(Demo)
9 Separation of amino acids by thin layer chromatography
10 Separation of plant pigments by thin layer chromatography
11 Identification of Blood groups
12 Estimation of Hemoglobin
13 Determination of ESR
14 Physical examination of urine
15 Chemical examination of urine - Protein, Glucose, Ketone bodies, Blood, Bilirubin and Urobilinogen

Contact Hours : 60

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Demonstrate proficiency in qualitative and quantitative procedures for major biomolecules, including carbohydrates, lipids, and proteins
- Exhibit competency in basic analytical techniques relevant to biochemical applications.
- Recognize and describe the fundamental features of electrophoresis.
- Compare and contrast normal physiological states, non-pathological variant states, and pathophysiological conditions.
- Apply the knowledge gained in biochemistry and physiology to address real-world scenarios and problem-solving exercises.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	1	2	-	2	1	1	-	2	-	-	3	2	1
CO 2	3	2	1	2	-	2	1	1	-	2	-	-	3	2	1
CO 3	3	2	1	2	-	2	1	1	-	2	-	-	3	2	1
CO 4	3	2	1	2	-	2	1	1	-	2	-	-	3	2	1
CO 5	3	2	1	2	-	2	1	1	-	2	-	-	3	2	1
AVG.	**3**	**2**	**1**	**2**	**-**	**2**	**1**	**1**	**-**	**2**	**-**	**-**	**3**	**2**	**1**

BM23322 BIOMEDICAL INSTRUMENTATION LABORATORY Category L T P C

PC 0 0 4 2

OBJECTIVES

- To record the biosignals and analyze it.
- To study the different modules used for amplifying the biosignals.
- To impart knowledge about the measurements and recordings of bioelectric and biochemical signals.
- To measure various physiological signals and the isolation concepts involved.
- To simulate and interpret the Diagnostic and respiratory equipment.

LIST OF EXPERIMENTS

1 Acquisition of ECG signals using 3 channel and 12 channel ECG machine
2 Real time EEG Acquisition and Measurement of Evoked Potential.
3 Recording and Analysis of EMG.
4 Construction and testing of pre amplifier to acquire bio signal
5 Measurement of Blood Flow Velocity using Ultrasonic blood flow Monitor
6 Study of EMG /ECG Isolation amplifier using analogy circuit
7 Study of Galvanic Skin Resistance using GSR System
8 Measurement of pH and conductivity.
9 To measure the blood pressure levels using Sphygmomanometer
10 Simulation of ECG – detection of QRS complex and heart rate
11 Design a suitable filter for bio signal Acquisition
12 To simulate EEG signal using VI LABS
13.a To simulate Pacemaker using VI LABS
13.b To simulate Defibrillator using VI LABS

Contact Hours : 60

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Design the pre amplifier and amplifier for Bio signal measurements.
- Apply the concepts of telemetry in physiological signal data transmission.
- Design circuits to record and analyze bio signals.
- Implement biochemical recorders for monitoring the levels of pH in biological fluids.
- Simulate and Analyse diagnostic equipment output waveforms.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	3	-	3	-	-	-	-	1	-	-	3	3
CO 2	3	3	3	3	-	3	-	-	-	-	1	-	-	3	3
CO 3	3	3	3	3	-	3	-	-	-	-	1	-	-	3	3
CO 4	3	3	3	3	-	3	-	-	-	-	1	-	-	3	3
CO 5	3	3	3	3	-	3	-	-	-	-	1	-	-	3	3
AVG.	**3**	**3**	**3**	**3**	**-**	**3**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**3**	**3**

SEMESTER IV

BM23411 ANALOG AND DIGITAL INTEGRATED CIRCUITS Category L T P C

PC 3 0 0 3

OBJECTIVES:

- To understand the basic of number system, Boolean algebra, and design of combinational logic circuits
- To understand the design of different Sequential logic circuits
- To know the basics of operational amplifier and its applications
- To understand the design of Active Filters, oscillators, and timer circuits
- To understand the Biomedical applications of Analog and Digital IC'S.

UNIT-I INTRODUCTION TO NUMBER SYSTEM AND COMBINATIONAL LOGIC CIRCUITS 9

Introduction to number system and conversion, Boolean algebra; Boolean identities, basic logic functions, standard form, Minimization of Boolean functions using K map, Combinational Logic Circuits; Arithmetic circuits, decoders, encoders, multiplexers, de-multiplexers, Magnitude Comparator.

9

UNI -II SEQUENTIAL CIRCUITS

Latches and Flip Flops (SR, JK, D, T), Timing in sequential circuits; Shift register; Counters – synchronous, asynchronous; Basic concepts and design of Moore and Mealy machines examples; State minimization/reduction, state assignment; Semiconductor Memories – ROM, SRAM, DRAM.

Case Study: Real time usage of Moore and Mealy machines.

UNIT-III OPAMP BASICS AND APPLICATIONS 9

Basic OPAMP configurations and characteristics, Linear & Non Linear Applications – Non inverting and Inverting amplifier-difference amplifier, adder, subtractor, integrator, differentiator, instrumentation amplifier, buffer, precision amplifier, logarithmic amplifier, square-root amplifier, comparators, Schmitt trigger using OPAMP.

Case Study: Real time usage of Linear & Non Linear Applications of OPAMP.

UNIT- IV ACTIVE FILTERS, OSCILLATORS AND TIMERS 9

Active Ist order LPF, HPF, BPF, BSF circuits using IC741, Introduction to higher order filters. Oscillators – criteria for oscillation, RC and Wein Bridge Oscillators, Timers; internal structure of 555 and its operations, Astable and monostable multivibrator circuits using IC 555, clock circuits.

UNIT- V BIOMEDICAL APPLICATIONS OF ANALOG & DIGITAL IC'S 9

Digital stethoscope, Digital blood pressure monitor, Digital blood glucose monitor, Digital thermometer, Rejection of power line interference using notch filter, Drug Delivery System using 555 timer.

Contact Hours : 45

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Solve Boolean equations using Boolean algebra and Karnaugh Map

- Design encoder, decoder, Multiplexer, Demultiplexer, Counters and Shift Registers circuits
- Design Non inverting, inverting, integrator, Differentiator amplifier circuits using op-amp
- Design Ist order Active filter LPF,HPF,BPF,BSF and oscillator using op-amp and timer circuits
- Develop circuits using analog and Digital ICS for biomedical applications

TEXT BOOK(S):

1 M.Morris Mano, "Digital logic and Computer design" Prentice Hall 1994.
2 Ramakant A. Gayakwad, "OP AMP and linear IC'S" Prentice Hall, 1994

REFERENCE BOOK(S) / WEB LINKS:

1 Robert B.Northrop, "Analysis and application of analog Electronic circuits" to bio medical instrumentation, CRC Press, 2004
2 Sergio Franco, Design with Operational amplifiers and analog integrated circuits, Mc Graw-Hills
3 Millman, J.Halkis.C. "Integrated Electronics", MCGrawHill, 1972 John. F. Wakerly, Digital design principles and practices", Pearson Education, Fourth Edition, 2007
4 Charles H.Roth, Jr, "Fundamentals of Logic design", Fourth Edition, Jaico Books, 2002
5 https://www.researchgate.net/publication/236060168_Recent_technologies_in_pulsatile_drug_delivery_systems
6 https://www.researchgate.net/publication/260668963_Digital_stethoscope_system_The_feasibility_of_cardiac_auscultation

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	2	-	-	-	-	2	-	2	-	2	3	-
CO 2	3	3	3	2	-	-	-	-	3	-	3	-	2	3	-
CO 3	3	3	3	3	-	-	-	-	2	-	3	-	3	3	-
CO 4	3	2	3	3	-	-	-	-	2	-	3	-	3	3	-
CO 5	3	2	3	3	-	-	-	-	2	-	2	-	3	3	-
AVG.	**3**	**2.4**	**3**	**2.6**	**-**	**-**	**-**	**-**	**2.2**	**-**	**2.6**	**-**	**2.6**	**3**	**-**

BM23412 COMMUNICATION SYSTEMS AND STANDARDS Category L T P C

PC 3 0 0 3

OBJECTIVES:

- To understand the concepts of various analog modulation schemes.
- To understand the fundamentals of various digital modulation techniques.
- To gain knowledge on multi-user radio communication and pulse modulation techniques.
- To impart the key principle of Bio-Telemetry System.
- To be familiarized with Medical device communication standards.

UNIT-I ANALOG MODULATION 9

Introduction to Communication Systems - Modulation –Types - Need for Modulation, Theory of Amplitude Modulation -Evolution and Description of SSB Techniques - Generation of FM-Varactor diode Modulator-Armstrong modulator, FM detection using PLL-Phase Modulation–

Comparison of Analog Communication Systems (AM –FM –PM).

UNIT-II DIGITAL MODULATION 9

Amplitude Shift Keying (ASK) – Frequency Shift Keying (FSK) Minimum Shift Keying (MSK) – Phase Shift Keying (PSK) – BPSK – QPSK – 8 PSK – 16 PSK – Quadrature Amplitude Modulation (QAM) – 8 QAM – 16 QAM – Bandwidth Efficiency– Comparison of various Digital Communication System (ASK – FSK – PSK – QAM).

Case Study: Exploration of modulation techniques adopted in Biomedical applications.

UNIT-III PULSE MODULATION AND MULTI USER COMMUNICATION 9

Pulse Modulation: Types of Pulse modulation, PAM (Single polarity, double polarity) PWM: Generation and demodulation of PWM, PPM, Generation and demodulation of PPM, Application of PM techniques, TDMA, FDMA, CDMA, Global System for Mobile Communications (GSM), Cellular Concept and Frequency Reuse - Channel Assignment and Hand off.

UNIT-IV BIOTELEMETRY 9

Bio-Telemetry System: Components of telemetry system, bio-telemetry and its importance, single and multi-channel biotelemetry, ECG telemetry system, temperature telemetry system, telemetry of ECG and respiration, sports telemetry, multi-patient telemetry, ambulatory patient monitoring, implantable telemetry systems, transmission of physiological signals over telephone line, telemedicine and applications.

UNIT-V MEDICAL DEVICES COMMUNICATION STANDARDS 9

Introduction to Medical device communication standard - ISO/IEEE 11073.Wireless communication- ZigBee, Wi-Fi, Satellite communication. FCC Regulation of medical devices, FDA standards for health care facilities and wireless medical devices. Case Study: Medical devices for biomedical signal processing using CDMA and FDMA.

Case study: Wearable and IoT device communication standards

Contact Hours : 45

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Analyse and explain various analog modulation schemes.
- Describe various digital modulation and pulse modulation techniques.
- Compare and contrast the strengths and weaknesses of various communication systems.
- Apply modern communication systems in Bio-Telemetry System.
- Describe the Medical device communication standards.

TEXT BOOK(S):

1 Wayne Tomasi, “Advanced Electronic Communication Systems”, 5th Edition, Pearson Education, 2009.
2 H Taub& D. Schilling, GautamSahe, “Principles of Communication Systems” - TMH, 2007, 3rd Edition.
3 Simon Haykin, “Communication Systems” - 2 Ed, Wiley Publications.
4 S. Khandpur; “Handbook of Bio-Medical Instrumentation”, 2nd Ed.; TMH

REFERENCE BOOK(S) / WEB LINKS:

1 B.P. Lathi, “Communication Systems” –BS Publication, 2004.
2 George Kennedy and Bernard Davis, “Electronics & Communication System”, TMH 2004.
3 Dennis Roddy and John Coolean, “Electronic Communications” - 4th Edition, PEA, 2004.

4 Robert J. Schoenbeck, “Electronic Communication Systems” - Modulation and Transmission - 2nd Edition, PHI.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	1	3	3	2	2	2	-	-	2	3	-	2	1	3	3
CO 2	1	2	3	1	2	2	-	-	2	3	-	2	1	2	3
CO 3	1	1	3	3	2	2	-	-	2	3	-	3	1	1	3
CO 4	1	3	3	2	2	2	-	-	2	3	-	2	1	3	3
CO 5	1	3	3	3	2	2	-	-	2	3	-	3	1	3	3
AVG.	**1**	**2.4**	**3**	**1.8**	**2**	**2**	**-**	**-**	**2**	**3**	**-**	**2.4**	**1**	**2.4**	**3**

MA23436 PROBABILITY AND RANDOM PROCESSES Category L T P C

PC 3 0 2 4

OBJECTIVES

- To apply the theoretical discrete and continuous probability distributions in the relevant application areas.
- To provide the required mathematical support in real life problems and develop probabilistic models which can be used in several areas of science and engineering.
- To classify random processes and to know the concepts of strict stationary, wide-sense stationary and ergodicity.
- To provide necessary concepts in spectral densities and correlation analysis.
- To explain linear time invariant systems with random inputs.

UNIT-I ONE DIMENSIONAL RANDOM VARIABLES 9

One dimensional Discrete and continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential and Normal distributions .

UNIT-II TWO DIMENSIONAL RANDOM VARIABLES 9

Two Dimensional Random Variables: Joint distributions – Marginal and conditional distributions - Moments – Covariance – Correlation and Linear regression – Transformation of random variables-Applications of Central Limit Theorem.

UNIT-III RANDOM PROCESS 9

Classification of Random Process: Stationary process – Binomial process – Gaussian process - Markov process - Poisson process and its properties – Discrete parameter Markov chain – Chapman Kolmogorov Theorem (without proof) – Limiting distributions.

UNIT-IV SPECTRAL DENSITIES 9

Auto correlation functions – Cross correlation functions – Properties – Power spectral density – Cross spectral density – Properties.

UNIT-V LINEAR SYSTEMS WITH RANDOM INPUTS 9

Linear time invariant system – System transfer function – Linear systems with random inputs – Auto correlation and Cross correlation functions of input and output.

Contact Hours : 45

LIST OF EXPERIMENTS

1. Basic functions in MATLAB
2. Mathematical functions in MATLAB
3. Plotting data sets using MATLAB
4. Control flow -Loops
5. Reading and writing data sets – importing data sets
6. Probability Distributions - PDF, CDF for Binomial, Poisson, Exponential, Uniform and Normal Distributions.
7. Correlation and regression
8. Fourier Transform using MATLAB
9. Linear system with random inputs
10. Analysis of Power spectral density – signal processing tool box.

Contact Hours : 15
Total Contact Hours : 60

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Apply the basic concepts of probability, one dimensional and two dimensional Random Variables in the engineering and technology problems.
- Analyse the data using correlation and regression in real life situation.
- Classify random processes and to apply the concepts of strict stationary, wide-sense stationary and ergodicity in the solution of complex engineering problems.
- Develop skills in solving problems on power spectral density function relevant to the various branches of engineering.
- Interpret linear time invariant systems with random inputs.

TEXT BOOK(S):

1 Veerarajan T, ‘Probability, Statistics and Random Processes with Queueing Theory and Queuing Networks’.
2 McGraw Hill, 2016. 2 Johnson R.A. and Gupta. C.B., "Miller and Freund’s Probability and Statistics for Engineers", Pearson Education, Asia, 7th Edition, 2007.
3 Oliver Ibe, “Fundamentals of Applied Probability and Random Processes", Elsevier, 1st Indian Reprint, 2014.
4 Peebles. P.Z., "Probability, Random Variables and Random Signal Principles", Tata Mc Graw Hill, second Edition, New Delhi, 2000.

REFERENCE BOOK(S) / WEB LINKS:

1 Jhon wiley & Sons .Erwin Kreyszig., "Advanced Engineering Mathematics", Pearson Education, Asia, 7th Edition, 2007.
2 Ramana. B.V., "Higher Engineering Mathematics ", McGraw Hill Education Pvt. Ltd, New Delhi, 2016.
3 Yates R. D. and Goodman. D.J., "Probability and Stochastic Processes- A Friendly

Introduction for Electrical and Computer Engineers ", 2nd Edition, Wiley India Pvt. Ltd., Bangalore, 2014
4 Stark H. and Woods. J.W., "Probability and Random Processes with Applications to Signal Processing", 3rd Edition, Pearson Education, Asia, 2002.
5 Miller S.L. and Childers. D.G., "Probability and Random Processes with Applications to Signal Processing and Communications", Academic Press, 2004.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	1	-	-	-	-	-	-	-	-	1	1	1	-
CO 2	3	2	1	-	-	-	-	-	-	-	-	1	1	-	-
CO 3	3	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO 4	2	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO 5	3	2	1	-	-	-	-	-	-	-	-	1	1	-	-
AVG.	**2.8**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**1**	**-**

BM23431 PATHOLOGY AND MICROBIOLOGY Category L T P C

PC 2 0 2 3

OBJECTIVES

- To understand the cause, pathogenesis and pathology of diseases
- To learn the fluid and hemodynamic disturbances in the body and to demonstrate bleeding and clotting time
- To gain awareness and knowledge of infectious and life style diseases
- To understand the normal flora of the human body, its routes of infection and growth
  To learn the different staining methods and principles of different types of microscopy

UNIT-I CELL DEGENERATION AND REPAIR 9

Cell injury and adaptation- causes and mechanism of cell injury, cellular adaptation to stress. Necrosis and Apoptosis. Neoplasia - Benign and Malignant tumours - carcinogenesis.

UNIT-II FLUID AND HEMODYNAMIC DERANGEMENTS 9

Homeostasis – normal water and electrolyte balance, pressure gradient and fluid exchange. Edema, thrombosis, embolism, shock, Bleeding disorders - vascular abnormality, platelet abnormality, disorders of coagulation factor.

Case study: Analysis of diseased condition associated with bleeding disorder.

UNIT-III SYSTEMIC PATHOLOGY 9

Immunopathology - Overview of hypersensitivity reaction Type I – IV, Cardiovascular pathology – Atherosclerosis and Myocardial Infarction, Respiratory pathology - PCOD, Gastrointestinal Pathology - Reflux gastritis, Renal Pathology - Chronic Kidney Disease.

Case study: Etiology of chronic kidney disease.

UNIT-IV MICROBIOLOGY **9**

Normal flora of the human body. Routes of infection and spread; endogenous and exogenous infections, Morphological features and structural organization of bacteria, growth curve, identification of bacteria.

UNIT-V MICROSCOPY **9**

Light microscope – bright field, dark field, and phase contrast, fluorescence. Electron microscope (TEM & SEM) – sample preparation, working principle, instrumentation and application.

Contact Hours : 45

LIST OF EXPERIMENTS

1 Demonstration of bright field microscope.
2 Simple staining.
3 Gram's Staining.
4 Acid Fast Bacilli Staining.
5 Determination of Bleeding time and clotting time.
6 Analysis of leukemia subtypes and malarial parasite types using microscopic images – Study Experiment

Contact Hours : 45
Total Contact Hours : 60

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Comprehend the cause, pathogenesis, and pathology of diseases.
- Demonstrate knowledge of fluid and hemodynamic disturbances, along with bleeding and clotting time assessment.
- Acquire awareness and understanding of infectious and lifestyle-related diseases.
- Analyze the normal human body flora, pathways of infection, and growth characteristics.
- Develop proficiency in different staining methods and principles of various types of microscopy.

TEXT BOOK(S):

1 Vinay Kumar, Abul Abbas, Jon C. Aster, "Robbins & Cotran Pathologic Basis of Disease", 10th Edition, Elsevier, 2020.
2 Harsh Mohan, "Textbook of Pathology" 8th Edition, Jaypee Brothers Medical Publishers (P) Ltd., 2018.
3 Ananthanarayanan & Panicker, "Textbook of Microbiology", University press (India) Private Limited, 10th edition, 2017.

REFERENCE BOOK(S) / WEB LINKS:

1 James C. E. Underwood and S. S. Cross, "General and Systematic Pathology", 5th edition, Elsevier Science & Technology Publisher, 2009.
2 Gary D. Hammer and Stephen J. McPhee "Pathophysiology of Disease: An Introduction to Clinical Medicine", 8th Edition, Mc Graw Hill Lange publication, 2018.
3 Prescott, Harley and Klein, "Microbiology", 10th edition, McGraw Hill, 2017.
4 Dubey RC and Maheswari DK. "A Text Book of Microbiology", 4th Edition, Chand & Company Ltd, 2023

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	1	1	-	1	2	2	3	-	-	2	2	2	1
CO 2	3	3	1	1	-	1	2	2	3	-	-	2	2	2	1
CO 3	3	3	1	1	-	1	2	2	3	-	-	2	2	2	1
CO 4	3	3	1	1	-	1	2	2	3	-	-	2	2	2	1
CO 5	3	3	1	1	-	1	2	2	3	-	-	2	2	2	1
AVG.	**3**	**2**	**1**	**1**	**-**	**1**	**2**	**2**	**3**	**-**	**-**	**2**	**2**	**2**	**1**

CS23336 INTRODUCTION TO PYTHON PROGRAMMING

Category	L	T	P	C
ES	1	0	4	3

OBJECTIVES

- To understand computers, programming languages and their generations and essential skills for a logical thinking for problem solving.
- To write, test, and debug simple Python programs with conditionals, and loops and functions
- To develop Python programs with defining functions and calling them
- To understand and write python programs with compound data-lists, tuples, dictionaries
- To search, sort, read and write data from /to files in Python.

LIST OF EXPERIMENTS

1 Study of algorithms, flowcharts and pseudocodes.
2 Introduction to Python Programming and Python IDLE/Anaconda distribution.
3 Experiments based on Variables, Data types and Operators in Python.
4 Coding Standards and Formatting Output.
5 Algorithmic Approach: Selection control structures.
6 Algorithmic Approach: Iteration control structures.
7 Experiments based on Strings and its operations.
8 Experiments based on Lists and its operations.
9 Experiments based on Tuples and its operations.
10 Experiments based on Sets and its operations.
11 Experiments based on Dictionary and its operations.
12 Functions: Built-in functions.
13 Functions: User-defined functions.
14 Functions: Recursive functions.
15 Searching techniques: Linear and Binary.
16 Sorting techniques: Bubble and Merge Sort.
17 Experiments based on files and its operations.

Contact Hours : 75

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Understand the working principle of a computer and identify the purpose of a computer programming language and ability to identify an appropriate approach to solve the problem.

- Write, test, and debug simple Python programs with conditionals and loops.
- Develop Python programs step - wise by defining functions and calling them.
- Use Python lists, tuples, dictionaries for representing compound data.
- Apply searching, sorting on data and efficiently handle data using flat files.

TEXT BOOK(S):

1 Allen B. Downey, Think Python: How to Think Like a Computer Scientist, Second edition, Updated for Python3, Shroff/ O'Reilly Publishers, 2016 (http://greenteapress.com/wp/think-python/).
2 Guido Van Rossum and Fred L. Drake Jr, An Introduction to Python-Revised and updated for Python3.2, Network Theory Ltd., 2011.

REFERENCE BOOK(S) / WEB LINKS:

1 JohnVGuttag, Introduction to Computation and Programming Using Python, Revised and expanded Edition, MIT Press, 2013.
2 Robert Sedgewick, Kevin Wayne, Robert Dondero, Introduction to Programming in Python: An Inter-disciplinary Approach, Pearson India Education Services Pvt. Ltd, 2016.
3 Timothy A.Budd, Exploring Python, Mc-Graw Hill Education (India) Private Ltd., 2015.
4 Kenneth A. Lambert, Fundamentals of Python: First Programs, Cengage Learning, 2012.
5 Charles Dierbach, Introduction to Computer Science using Python: A Computational Problem Solving Focus, Wiley India Edition, 2013.
6 Paul Gries, Jennifer Campbell and Jason Montojo, Practical Programming: An Introduction to Computer Science using Python3, Second edition, Pragmatic Programmers, LLC, 2013.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	1	2	2	2	1	-	-	-	1	2	1	1	2	3	-
CO 2	2	2	3	2	1	-	-	-	1	-	2	1	2	2	2
CO 3	1	2	1	2	1	-	-	-	-	-	-	1	1	2	-
CO 4	1	1	2	1	1	-	-	-	-	-	-	2	2	2	-
CO 5	1	1	2	1	1	-	-	-	-	-	-	1	1	2	-
AVG.	1.2	1.6	2.0	1.6	1.0	-	-	-	1	2	1.5	1.2	1.6	2.2	2

BM23421 ANALOG AND DIGITAL INTEGRATED CIRCUITS LABORATORY

CATEGORY: PC

L	T	P	C
0	0	4	2

OBJECTIVES

The core objective of the course is to make the students to learn circuit simulation and hardware designing of the following circuits

- To design of combinational and sequential logic circuits.
- To design of OPAMP based amplifiers.
- To design of multivibrators
- To design of Oscillator circuits
- To design of Timer circuits for generating Delay.

LIST OF EXPERIMENTS

1 Design of adder and subtractor circuits
2 Design of Encoder
3 Design of BCD to 7 segment decoder
4 Design of Multiplexer and demultiplexer using digital ICs
5 Design of Universal shift register using flip flops
6 Design of mod-N counter
7 Design of Inverting, non-inverting amplifier and comparator using Multisim or TINA Simulation
8 Design of Integrator and Differentiator using Multisim or TINA Simulation
9 Active filter – first order and second order LPF and HPF using Multisim or TINA Simulation
10 Current to Voltage convertor and Voltage to Current Convertor using Multisim or TINA Simulation
11 Instrumentation amplifier using IC741 using Multisim or TINA Simulation
12 Wein bridge oscillator using Multisim or TINA Simulation
13 Multivibrator using IC555 Timer using Multisim or TINA Simulation

Contact Hours : 60

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Design and build Circuits for applications using Logic gates
- Design and build Circuits for different application using Combinational Logic circuits
- Design and build Circuits for different application using Sequential logic circuits
- Design OPAMP based linear and non-linear circuits
- Design oscillator and waveform generator using ICs

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	1	2	-	-	-	-	2	-	2	-	2	3	-
CO 2	2	3	1	2	-	-	-	-	3	-	3	-	2	3	-
CO 3	3	2	3	3	-	-	-	-	2	-	2	-	3	3	-
CO 4	3	2	3	3	-	-	-	-	2	-	2	-	3	3	-
CO 5	3	2	3	3	-	-	-	-	2	-	2	-	3	3	-
AVG.	**2.8**	**2.4**	**2.2**	**2.6**	**-**	**-**	**-**	**-**	**2.2**	**-**	**2.2**	**-**	**2.6**	**2.8**	**-**

BM23422 **PCB DESIGN LABORATORY** **CATEGORY** **L T P C**

PC **0 0 2 1**

OBJECTIVES

- To design PCB layouts of circuits required for medical applications
- To perform appropriate routing of circuit tracks in EAGLE software
- To validate the correctness of the design and circuit
- To perform the Soldering and Desoldering efficiently
- To fabricate PCBs for real-time medical applications

LIST OF EXPERIMENTS

1. Introduction to PCB – Trends and Technologies
2. Eagle Software – Demonstration on the Creation of effective routing(manual & automatic) and generation of gerber file in EAGLE
3. Design of a PCB schematic and layout of a Voltage regulator circuit that regulates 5 V and 12 V DC output from the AC input in EAGLE
4. Design of a PCB schematic and layout of Zener Diode – Line and Load Regulation Circuits in EAGLE software
5. Design of a PCB schematic and layout of Automatic Dark and Light Detector Circuits in EAGLE software
6. Design of a PCB schematic and layout of Fixed Bias, Emitter Bias, and Voltage Divider Bias in EAGLE software
7. Design of a PCB schematic and layout of Astable and Monostable Multivibrator Circuits in EAGLE software
8. Introduction – Etching, Soldering and Desoldering in PCBs
9. Hands on Tutorial on Soldering and Desoldering in PCBs
10. Demonstration of fabricating a circuit on PCBs from scratch.

Contact Hours : 30

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Design layouts of circuits for medical applications.
- Perform efficient routing of the tracks in the software.
- Validate the correctness of the design and circuit.
- Perform the Soldering and Desoldering efficiently.
- Fabricate PCBs for real time medical applications.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	3	3	3	-	2	3	1	-	3	3	1	1	1
CO 2	3	2	3	3	3	-	2	3	1	-	3	3	1	1	1
CO 3	3	2	3	3	3	-	2	3	1	-	3	3	1	1	1
CO 4	3	2	3	3	3	-	2	3	1	-	3	3	1	1	1
CO 5	3	2	3	3	3	-	2	3	1	-	3	3	1	1	1
AVG.	**3**	**2**	**3**	**3**	**3**	**-**	**2**	**3**	**1**	**-**	**3**	**3**	**1**	**1**	**1**

GE23421	SOFT SKILLS-I	CATEGORY	L	T	P	C
		PC	0	0	2	1

PROGRAM LEARNING GOALS

This program will help our students to build confidence and improve their English communication in order to face the corporate world as well as providing them with opportunities to grow within an organization.

OBJECTIVE

- To help students break out of shyness.
- To build confidence.
- To enhance English communication skills.
- To encourage students' creative thinking to help them frame their own opinions.

LEARNING AND TEACHING STRATEGY:

The program is completely student centric where the focus is on activities led by students which include role plays, discussions, debates other games as well. These activities would be supplemented by interactive use of technology and brief trainer input.

Week	Activity Name	Description	Objective
1	Introduction	The trainer and the college facilitator talk to the students about the course and in turn the students introduce themselves.	To set expectations about the course and the students are made aware of the rules and regulations involved in this program
2	If I ruled the world	This is a quick and useful game by getting students to form a circle and provide their point of view. Each student then repeats what the other has said and comes up with their own opinion.	The aim of this activity is to for students to get to know each other and also develop their listening skills as well as learning how to agree and disagree politely.
3	Picture Narrating	This activity is based on several sequential pictures. Students are asked to tell the story taking place in the sequential pictures by paying attention to the criteria provided by the teacher as a rubric. Rubrics can include the vocabulary or structures they need to use while narrating.	The aim of this activity is to make the students develop creative way of thinking.
4	Brainstorming	On a given topic, students can produce ideas in a limited time. Depending on the context, either individual or group brainstorming	The activity aims at making the students speak freely without the fear of being criticized. It also

		is effective and learners generate ideas quickly and freely. The good characteristics of brainstorming are that the students are not criticized for their ideas so students will be open to sharing new ideas.	encourages students to come up with their own opinions.
5	Debate	Is competition necessary in regards to the learning process?	The aim of this activity is to develop the students ability to debate and think out of the box
6	Short Talks	Here the students are given topics for which they take one minute to prepare and two minutes to speak. They can write down points but can't read them out they can only use it as a reference.	The activity aims at breaking the students' shyness and encouraging them to standup in front of the class and speak. It also aims at creating awareness that they are restricted for time so they only speak points that are relevant and important.
7	Debate	Will posting students' grades on bulletin boards publicly motivate them to perform better or is it humiliating?	This activity aims at enhancing the students unbiased thought process when it comes to exams and grades as well as develop their skills to debate
8	The Art of diplomacy	The facilitator proceeds to share multiple concepts of conversation and helps the participants to identify the various methods of being diplomatic and how do deal with misinformation.	The aim of the lesson is to provide an opportunity for the participants to learn about body language and choosing the appropriate words for conversation.
9	Debate	Are humans too dependent on computers?	The aim of this activity is to test the students debating skills and thought process with a topic that affects everybody in daily life.
10	Story Completion	The teacher starts to tell a story but after 2 sentences he/she asks students to work in groups to create the rest of the story which includes the plot and the ending.	This activity aims at building their narrating skills as well as their creativity and ability to work in a team.

11	Role play debate	Students scrutinize different points of view or perspectives related to an issue. For example, a debate about the question "Should students be required to wear uniforms at school?" might yield a range of opinions. Those might include views expressed by a student (or perhaps two students – one representing each side of the issue), a parent, a school principal, a police officer, a teacher, the owner of a clothing store, and others.	The aim of this activity is to get students to speak based on other people's perspective instead of their own. The students take the role of various characters and debate accordingly.
12	I Couldn't Disagree More	This is a game where students practice rebuttal techniques where one student provides a thought or an idea and the other students starts with the phrase I couldn't disagree more and continues with his opinion	The aim of this activity is to improve general communication skills and confidence.
	Feedback	At the end of the session in the final week (12) the trainer would provide feedback to the students on best practices for future benefits	The aim is to do both give feedback to students as well as obtain feedback on the course from them.

COURSE OUTCOMES:

On completion of the course, students should be able to

- Be more confident.
- Speak in front of a large audience.
- Be better creative thinkers.
- Be spontaneous.
- Know the importance of communicating in English.

SEMESTER V

BM23511	BIOCONTROL SYSTEMS	Category	L	T	P	C
		PC	3	0	0	3

OBJECTIVES:

- To introduce the relevance of this course to the existing technology through case studies and simulations
- To study the mathematical techniques for analysis of given system
- To study the given system in time domain and frequency domain analysis.
- To study the stability analysis of the given system and to study the concept of physiological control system.

UNIT-I CONTROL SYSTEM MODELLING 9

Basic structure of control system, Positive and Negative Feedback, transfer functions, modeling of electrical systems, block diagram and signal flow graph representation of systems Introduction to Physiological control systems- Illustration, Linear models of physiological systems, Difference between engineering and physiological control systems.

UNIT-II TIME RESPONSE ANALYSIS 9

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

UNIT-III STABILITY ANALYSIS 9

Definition of stability, Routh- Hurwitz criteria of stability, Root locus technique – construction of root locus and study of stability. Nyquist stability criterion, Nyquist plot and determination of closed loop stability.

UNIT-IV FREQUENCY RESPONSE ANALYSIS 9

Frequency response, definition of gain margin and phase margin, determination of gain margin and phase margin using Bode plot, use of Nichol's chart to compute resonant frequency and band width.

UNIT-V BIOLOGICAL CONTROL SYSTEM ANALYSIS 9

Simple models of muscle stretch reflex action – steady state analysis of muscle stretch reflex action, transient response analysis of neuromuscular reflex model action, frequency response of circulatory control model, Stability analysis of Pupillary light reflex.

Contact Hours : 45

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Summarize the basic concepts of control systems.
- Analyze the time domain specifications and find the response.
- Develop mathematical model and perform stability analysis.
- Analyze the different systems in frequency domain.
- Apply the concept of control systems in physiological systems.

TEXT BOOK(S):

1 J.Nagrath and M.Gopal, “Control System Engineering”, New Age International Publishers,5th Edition, 2007.
2 Michael C K Khoo, — “Physiological control systems”, IEEE Press, Prentice Hall of India, 2005.
3 Milsum John H, "Biological Control System Analysis", 2nd Edition, McGraw Hill Publications, 1996.

REFERENCE BOOK(S) / WEB LINKS:

1 Farid Golnaraghi, Benjamin C. Kuo, — “Automatic Control Systems”, Wiley, 9th edition 2009.
2 M.Gopal, —Control System – “Principles and Design”, Mc Graw-Hill, 2nd edition 2006.
3 Constantine H. Houpis, Stuart N. Sheldon, — “Linear Control System Analysis and Design with MATLAB”, CRC Press, 6th edition 2013.
4 Richard C. Dorf & Robert H. Bishop, — “Modern Control Systems”, Prentice Hall, 12th edition 2010.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2			-	-	-	-	-	-	-	-	-	2	-
CO 2	3	2		1	-	-	-	-	-	-	-	-	-	2	-
CO 3	2	2		1	-	-	-	-	-	-	-	-	-	2	-
CO 4		2	1	1	-	-	-	-	-	-	-	-	2	2	-
CO 5				2	-	-	-	-	-	-	1	-	2	2	-
AVG.	**2.67**	**2**	**1**	**1.25**							**1**		**2**	**2**	

BM23512 DIAGNOSTIC AND THERAPEUTIC EQUIPMENT Category L T P C

PC 3 0 0 3

OBJECTIVES:

- Explain the various types of equipment used in Intensive Care Units (ICUs) and Neonatal Intensive Care Units (NICUs).
- To gain knowledge on the different types of diathermy and stimulation techniques used in medical practice.
- Understand the patient monitoring devices and various sensory measurements that hold clinical importance.
- Discuss the working of analytical equipment and importance of patient safety against electrical hazard.
- Familiarize the special medical equipment.

UNIT-I ICU EQUIPMENT AND NEONATAL EQUIPMENT 9

Introduction to ICU and NICU: overview of ICU and NICU environments, importance and role of critical care units, types of patients and conditions treated; Monitoring systems: Multiparameter monitors, Cardiac output monitors, Capnography; Respiratory support: Ventilators, CPAP, BIPAP machines, Nebulizers; Neonatal equipment: Incubators and warmers, Neonatal ventilators, Phototherapy units, Apnea monitors, Neonatal blood pressure monitors, Bilirubin meters; Emerging Technologies- Telemedicine and remote monitoring in ICUs and NICUs

UNIT-II DIATHERMY AND MEDICAL STIMULATORS 9

Physiological effects of HF radiation, depth of penetration, Short wave, Ultrasonic and Microwave diathermy, Surgical diathermy; Transcutaneous nerve stimulator, physiological effects of stimulation, Galvanic, Faradic and Surged types, Interferential therapy.

UNIT-III SENSORY INSTRUMENTATION AND PATIENT MONITORING 9

Mechanism of Hearing, Sound Conduction System - Basic Audiometer, Pure tone audiometer, Audiometer system Bekesy; Ophthalmoscope, Tonometer, Slit lamps; Measurement of Basal Skin response and Galvanic skin response; Instruments for testing Motor responses: Grip Strength Meter, Treadmill Systems, Biofeedback Instrumentation; Computerized patient monitoring system: Bedside, Central Monitoring system, Holter monitor; Wireless telemetry, Single channel and multichannel telemetry system, Multi patient Telemetry, Implantable Telemetry systems.

UNIT-IV CLINICAL LABORATORY INSTRUMENTS AND ELECTRICAL SAFETY 9

PH, PO2, PCO2,Colorimeter, Spectrophotometer, Auto Analyzer, Principles of Electrophoresis apparatus, Principles of Chromatography, Blood cell counter (Coulter and Pico-scale) Blood Gas Analyzer, Glucometer, Hemoglobin monitor, Flame photometer, Chromatography; Electrical safety: Leakage current, Micro and macro electric shock, GFI units, Earthing scheme, Electrical safety Analyser and Patient safety procedures.

UNIT-V SPECIAL EQUIPMENT 9

Surgical scopes: Endoscopy, Laparoscopy, Capsule endoscopy; Cryogenic Equipment; Automated drug delivery system: Components of drug infusion system, Implantable infusion systems; BMD Measurements: SXA, DXA, Quantitative ultrasound bone densitometer; Lithotripsy; Dental care equipment.

Contact Hours : 45

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Describe various ICU and neonatal equipment.
- Proficiently operate, maintain, and apply diathermy and medical stimulator devices in clinical settings.
- Infer the measurement techniques of sensory responses.
- Examine the biochemical equipment and electrical safety measurements.
- Explain the principle operation of special equipment used hospitals.

TEXT BOOK(S):

1 Albert M, Cook and Webster J G, "Therapeutic Medical Devices", Prentice Hall Inc., New Jersey, 1982.

2 Geddes L A and Baker L E, "Principles of Applied Biomedical Instrumentation", John Wiley, 3rd Edition, 1975, Reprint 1989

3 Khandpur R S, "Hand-book of Biomedical Instrumentation", Tata McGraw Hill, 2nd Edition, 2003.

REFERENCE BOOK(S) / WEB LINKS:

1 Leslie Cromwell, Fred J, Weibell, Erich A, Pfeiffer, "Biomedical Instrumentation and Measurements", Prentice-Hall India, 2nd Edition,1997.
2 John G, Webster, "Medical Instrumentation application and design", JohnWiley, 3rdEdition, 1997.
3 Fein Berg B N, "Applied Clinical Engineering", Prentice Hall Inc., New Jersey, 1986.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	3	3	3	2	3	-	-	-	-	-	2	2	3	2
CO 2	2	3	3	2	2	3	-	-	-	-	-	2	2	2	2
CO 3	1	3	3	-	2	2	-	-	-	-	-	2	2	3	3
CO 4	1	2	2	2	2	1	-	-	-	-	-	2	2	3	1
CO 5	1	2	2	2	2	1	-	-	-	-	-	2	2	3	3
AVG.	**1.4**	**2.6**	**2.6**	**2.25**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**2.8**	**2.2**

BM23531 SIGNALS AND SYSTEMS ANALYSIS Category L T P C

PC 1 1 2 3

OBJECTIVES

- To understand the basic properties of signal & systems and the various methods of classification.
- To learn Laplace Transform & Fourier transform and their properties.
- To know Z transform & DTFT and their properties.
- To characterize LTI systems in the Time domain and various Transform domains.
- To identify the systems are stable or not based on pole value.

UNIT-I ANALYSIS OF CONTINUOUS TIME SIGNALS 9

Continuous time signals: Types -Step, Ramp, Pulse, Impulse, Sinusoidal, Exponential, Classification - CT signals - Periodic & Aperiodic signals, Deterministic & Random signals, Energy & Power signals. Fourier Transform in CT Signal Analysis - Properties.

UNIT-II ANALYSIS OF CONTINUOUS TIME SYSTEMS 9

Continuous time systems: Classification – Static & Dynamic, Linear & Nonlinear, Time variant & Time-invariant, Causal & Noncausal, Stable & Unstable. Block Diagram Representation-Impulse response, convolution Integrals, Fourier and Laplace transforms in Analysis of CT systems.

UNIT-III ANALYSIS OF DISCRETE TIME SIGNALS 9

Sampling – Nyquist Criteria, Discrete time signals: Types - Step, Ramp, Pulse, Impulse, Sinusoidal, Exponential, Classification - CT signals - Periodic & Aperiodic signals, Deterministic & Random signals, Energy & Power signals. Z Transform – Analysis of DT signals, Properties.

UNIT-IV ANALYSIS OF DISCRETE TIME SYSTEMS 9

Discrete time systems – classification - Static & Dynamic, Linear & Nonlinear, Time variant & Time-invariant, Causal & Noncausal, Stable & Unstable. Block Diagram Representation-Impulse response, Convolution sum, Z Transform Analysis of Recursive & Non-Recursive systems.

UNIT-V INTRODUCTION TO BIOSIGNALS 9

Biomedical signal origin and dynamics, Physiological signals - ECG, EEG, EMG, EOG. Typical waveform, frequency spectrum, Noise associated with biosignals – random, structured, physiological interference, stationary and non-stationary. Motion artifacts in ECG, power line interference in ECG signal.

Contact Hours : 45

LIST OF EXPERIMENTS

1 Generation of Discrete Time Signals
2 Generation of Continuous Time Signals
3 Basic Operations on Signals (Shifting, Folding And Scaling)
4 Convolution of Two Discrete Signals
5 Generation of Periodic Signal
6 Addition of Two Continuous Time Signal
7 Verification of Sampling Theorem

Contact Hours : 30
Total Contact Hours : 75

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Classify signals and systems.
- Analyze CT signals.
- Implement a system to perform Fourier operation on CT signals
- Compute Fourier transform for DT signals
- Implement a system o perform Fourier and Z-transform on DT signals.

TEXT BOOK(S):

1 Allan V.Oppenheim, S.Wilsky and S.H.Nawab, “Signals and Systems”, Pearson, 2nd edition, 2007.

REFERENCE BOOK(S) / WEB LINKS:

1 B. P. Lathi, “Principles of Linear Systems and Signals”, Second Edition, Oxford, 2009.
2 R.E.Zeimer, W.H.Tranter and R.D.Fannin, “Signals & Systems - Continuous and Discrete”,Pearson, 2007.
3 John Alan Stuller, “An Introduction to Signals and Systems”, Thomson, 2007.
4 M.J.Roberts, “Signals & Systems Analysis using Transform Methods & MATLAB”, TataMcGrawHill, 2007.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	1	-	1	-	1	-	-	-	-	-	-	3	-
CO 2	3	3	3	2	2	-	2	-	-	-	-	-	-	3	-
CO 3	3	3	3	3	3	-	3	-	-	-	-	-	-	3	-
CO 4	3	3	3	3	3	-	3	-	-	-	-	-	-	3	-
CO 5	3	3	3	3	3	-	3	-	2	1	3	3	3	3	3
AVG.	**3**	**3**	**2.6**	**2.7**	**2.4**	**-**	**2.4**	**-**	**2**	**1**	**3**	**3**	**3**	**3**	**3**

BM23532 MICROCONTROLLER AND EMBEDDED SYSTEM DESIGN

Category	L	T	P	C
PC	3	0	2	4

OBJECTIVES

- To Provide students with a comprehensive understanding of microcontrollers, embedded systems.
- To Equip students with in-depth knowledge of 8051 microcontroller architecture and programming.
- To Impart detailed understanding of ARM LPC2148 processors, their architecture and programming.
- To Develop students' skills in interfacing microcontrollers with sensors and actuators.
- To design and develop embedded systems for biomedical applications.

UNIT-I 8051 MICROCONTROLLER 9

Introduction to Microcontrollers - Evolution, role in embedded systems. Architecture of 8051 – Special Function Registers(SFRs) - I/O Pins Ports and Circuits - Instruction set- Addressing modes - Assembly language programming- Timer programming - Serial Port Programming - Interrupts Programming.

UNIT-II PERIPHERAL INTERFACING 9

Memory Interfacing, 7-Segment LED Display, LCD and Keyboard Interfacing, ADC, DAC interfacing, relay, Stepper Motor Interfacing, DC motor control, Bio Sensors interfacing: Temperature, pressure, and bio-potential sensors. Case study: Pulse rate monitoring and display.

UNIT-III ARM ARCHITECTURE 9

ARM processor family overview - ARM Cortex-M series features. LPC2148 microcontroller - Architecture – memory organization – GPIO ports, timers, ADC, DAC, UART, SPI, and I2C. LPC2148, Programming using C, Interrupt handling, Case Study: Real-time operating systems (RTOS) with ARM.

UNIT-IV ARDUINO PROGRAMMING FOR EMBEDDED APPLICATIONS 9

Introduction to Arduino - IDE, pin configuration, programming basics. Digital and Analog I/O: Sensors interfacing (heart rate, blood pressure), actuators (motors, pumps). Communication Protocols: SPI, I2C, serial communication. Project-based learning: Real-time health monitoring system using Arduino.

UNIT-V EMBEDDED SYSTEMS FOR BIOMEDICAL APPLICATIONS 9

Communication protocols in biomedical systems - I2C - Bluetooth - Wi-Fi, Implantable medical devices, Wearable devices, ICU monitoring systems, remote patient monitoring systems, and security and privacy considerations in biomedical embedded systems. IoT application using Arduino - IoT architecture, and protocols.

Contact Hours : 45

LIST OF EXPERIMENTS

a 8051 Experiments using kits and MASM

1. Basic arithmetic and Logical operations
2. Square and Cube program, Find 2's complement of a number.

b 8051 interfacing with Peripherals

1. Traffic light control
2. Stepper motor control
3. Serial/Parallel interface
4. A/D and D/A interface for Waveform Generation
5. Temperature sensor interfacing with 8051 microcontroller

c Arduino IDE Based Experiments

1. Blinking of LEDs
2. Interfacing Buzzer and LCD
3. Measure temperature using a temperature sensor (e.g., LM35).
4. Display heart rate using a pulse sensor.
5. SpO2 Measurement Using MAX30100/30102.

d Mini Projects using Microcontroller in Healthcare application

1. Design a simple IoT-enabled system using Arduino.

Contact Hours : 30

Total Contact Hours : 75

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Understand the architecture, features, and programming of the 8051 microcontroller.
- Skillfully interface microcontrollers with a variety of biomedical sensors and actuators.
- Gain proficiency in ARM processors architecture and programming.
- Develop applications using Arduino for biomedical and healthcare applications.
- Apply embedded system concepts to solve problems in biomedical engineering.

TEXT BOOK(S):

1 Muhammad Ali Mazidi, Janice Gillispie Mazidi, RolinD.MCKinlay The 8051 Microcontroller and Embedded Systems, Second Edition, Pearson Education 2008.
2 Steve Furber, "ARM System-on-Chip Architecture," Addison-Wesley.

REFERENCE BOOK(S) / WEB LINKS:

1 Kenneth J. Ayala, The 8051 Microcontroller, Cengage Learning, 3rd Edition.
2 Jeremy Blum, "Exploring Arduino: Tools and Techniques for Engineering Wizardry," Wiley.

3 Joseph Yiu, The Definitive Guide to ARM Cortex-M, Newnes, 4th Edition.
4 Computers as Components –Wayne Wolf, Morgan Kaufmann (second edition).

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	1	2	1	1	1	1	3	1	3	3	2	3	2
CO 2	2	3	2	3	2	1	2	2	3	2	3	3	3	3	3
CO 3	3	3	3	2	2	2	3	2	3	3	3	3	3	3	3
CO 4	2	3	3	3	3	2	3	3	3	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
AVG.	**2.6**	**2.8**	**2.4**	**2.6**	**2.2**	**1.8**	**2.4**	**2.2**	**3.0**	**2.4**	**3.0**	**3.0**	**2.9**	**3.0**	**2.8**

CS23422 **PYTHON PROGRAMMING FOR MACHINE LEARNING** **Category** **L T P C**

ES **0 0 4 2**

OBJECTIVES

- To understand the relationship of the data collected for decision making.
- To know the concept of principal components, factor analysis and cluster analysis for profiling and interpreting the data collected.
- Lay the foundation of machine learning and its practical applications and prepare students for real-time problem-solving in data science.
- Develop self-learning algorithms using training data to classify or predict the outcome of future datasets.
- Distinguish overtraining and techniques to avoid it such as cross-validation.

LIST OF EXPERIMENTS

1 NumPy Basics: Arrays and Vectorized Computation
2 Getting Started with pandas
3 Data Loading, Storage, and File Formats
4 Data Cleaning and Preparation
5 Data Wrangling: Join, Combine, and Reshape
6 Plotting and Visualization
7 Data Aggregation and Group Operations
8 Time Series
9 Supervised Learning
10 Unsupervised Learning and Pre-processing
11 Representing Data and Engineering Features
12 Model Evaluation and Improvement

Contact Hours : 60

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Develop a sound understanding of current, modern computational statistical approaches and their application to a variety of datasets.
- Analyze and perform an evaluation of learning algorithms and model selection.
- Compare the strengths and weaknesses of many popular machine learning approaches.
- Appreciate the underlying mathematical relationships within and across machine learning algorithms and the paradigms of supervised and unsupervised learning.
- Design and implement various machine learning algorithms in a range of real-world applications.

TEXT BOOK(S):

1 Wes McKinney, Python for Data Analysis - Data wrangling with pandas, Numpy, and ipython, Second Edition, O'Reilly Media Inc, 2017.

2 Andreas C. Müller and Sarah Guido, Introduction to Machine Learning with Python - A Guide for Data Scientists, First Edition, O'Reilly Media Inc, 2016.

REFERENCE BOOK(S) / WEB LINKS:

1 Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 2nd Edition, O'Reilly Media Inc, 2019.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	2	2	2	1	-	-	-	1	1	1	1	3	3	-
CO 2	2	1	1	1	1	-	-	-	-	-	1	1	3	2	-
CO 3	1	1	2	1	2	-	-	-	-	-	1	1	2	3	2
CO 4	2	2	3	2	2	-	-	-	-	-	2	1	2	2	2
CO 5	2	2	3	2	3	-	-	-	-	-	2	1	2	2	2
AVG.	**1.8**	**1.6**	**2.2**	**1.6**	**1.8**	**0.0**	**0.0**	**0.0**	**0.2**	**0.2**	**1.4**	**1**	**2.4**	**2.4**	**2**

BM23521 **DIAGNOSTIC AND THERAPEUTIC EQUIPMENT LABORATORY**

Category	L	T	P	C
PC	0	0	4	2

OBJECTIVES

- Enhance practical skills in conducting a range of diagnostic tests and therapeutic procedures using specialized equipment.
- Develop proficiency in recording, analyzing and interpreting EMG, EEG, ECG, and PCG for diagnostic purposes.
- Encourage collaboration and teamwork through group-based laboratory activities focused on mastering instrument operation and procedural execution.

- Describe the mechanisms by which biosignals are collected, processed, and transmitted through IoT networks.
- Memorize safety protocols and guidelines for operating different types of medical devices.

LIST OF EXPERIMENTS

1 Patient Monitoring System.
2 Audiometer.
3 Spirometer for lung function assessment.
4 Measurement of maximal voluntary contraction (MVC) using EMG Signals using BIOPAC.
5 Electroencephalography (EEG) for brain activity assessment using BIOPAC.
6 Electrocardiography (ECG) for cardiac function assessment using BIOPAC.
7 Recording of phonocardiograph (PCG) using BIOPAC.
8 Shortwave Diathermy.
9 Surgical diathermy.
10 Study of haemodialysis machine using VI LABS.
11 Study of ventilator machine.
12 IoT-enabled biosignal transmission for remote health monitoring and intervention.

Contact Hours : 60

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Demonstrate the working and application of medical instruments, including patient monitoring systems, audiometers, spirometers, and diathermy for comprehensive healthcare assessment.
- Analyse the recordings of ECG, EEG, EMG and PCG signals for diagnosis of variousdiseases.
- Explain the key components and functions of ventilator machines in respiratory support and critical care settings
- Recall the basic components and principles involved in the operation of haemodialysis machines.
- Design innovative solutions utilizing IoT technology for enhanced remote health monitoring and timely intervention, considering usability, scalability, and accessibility factors.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	-	3	-	-	1	2	-	2	2	2	3	3
CO 2	3	3	3	1	3	-	-	1	2	-	2	2	2	3	3
CO 3	3	3	2	-	3	-	-	1	2	-	3	2	2	3	3
CO 4	3	3	2	1	3	-	-	1	2	-	3	3	2	3	3
CO 5	3	3	2	1	3	1	1	1	2	-	3	3	2	3	3
AVG.	**3**	**3**	**2.4**	**1**	**3**	**1**	**1**	**1**	**2**	**-**	**2.6**	**2.4**	**2**	**3**	**3**

GE23521	SOFT SKILLS-II	CATEGORY	L	T	P	C
		PC	0	0	2	1

PROGRAM LEARNING GOALS

This program will help our students to build confidence and improve their English communication in order to face the corporate world as well as providing them with opportunities to grow within an organization.

OBJECTIVES

- To help students break out of shyness.
- To build confidence.
- To enhance English communication skills.
- To encourage students' creative thinking to help them frame their own opinions.

LEARNING AND TEACHING STRATEGY

The program is completely student centric where the focus is on activities led by students which include role plays, discussions, debates other games as well. These activities would be supplemented by interactive use of technology and brief trainer input.

Week	Activity Name	Description	Objective
1	The News hour	Students are made to read news articles from the English newspapers. The students also have to find words and their meaning from the article they have not come across before and share it with the group. They then use these words in sentences of their own.	The aim of this activity is not only to get the students to read the newspaper but also aims at enhancing the students' vocabulary.
2	Court Case	The facilitator provides the participants the premise of a story and proceeds to convert the story into a court case. The students are required, department-wise to debate and provide their points to win the case for their clients.	The aim of the lesson is to encourage creative and out of-the -box thinking to ensure a good debate and defense skills.
3	The ultimate weekend	The students design activities they are going to do over the weekend and they have to invite their classmates to join in the activity. The students move around the class and talk to other students and invite them.	The aim of this activity is to develop the art of conversation among students. It also aims at practicing the grammatical structures of "going to" "have to" and asking questions.

4	The Four Corners	This is a debate game that uses four corners of the classroom to get students moving. The following is written on the 4 corners of the room “Strongly Agree, Somewhat Agree, Somewhat Disagree and Strongly Disagree”. The topics are then given to the class and students move to the corner that they feel best explains their opinions.	This activity aims at getting students to come up with their own opinions and stand by it instead of being overshadowed by others and forcing themselves to change based on others opinions.
5	Debate	Boarding school or day school? Which is more beneficial for a student?	The aim of this activity is to encourage students to draw up feasible points on the advantages and benefits of both. And enhance their debating ability
6	Grand Master	The facilitator starts the session by keeping an individual in mind, upon which the students guess it only through "Yes or No" questions. Post few trials the students are given same opportunity to do the same with the crowd.	The aim of the lesson is designed to teach the art of questioning. It also helps to enhance the students' speaking and listening skills.
7	Debate	Does violence on the TV and Video games influence children negatively?	This activity aims at encouraging the students to debate on real life scenarios that most students spend a lot of time on.
8	Turn Tables	This is a speaking activity where the students need to speak for and against the given topics when the facilitator shouts out 'Turn Table'.	The aim of this activity is to make the participants become spontaneous and have good presence of mind.
9	Debate	Do marks define the capabilities of a student?	This debate activity aims at allowing the students to argue on this worrisome adage of marks.
10	FictionAD	The Participants are asked to create an Ad for a challenging topic only using fictional characters.	The activity aims at developing their creativity and presentation skills.

11	Debate	Are social networking sites effective, or are they just a sophisticated means for stalking people?	This activity aims at refining the students debating skills on a very real life situation.
12	Talent Hunt	Talent Hunt is a fun activity where the students are selected at random and supported to present any of their own skills.	The aim of this activity is designed to evoke their inner talents and break the shyness and the fear of participating in front of a crowd.
	Feedback	At the end of the session in the final week (12) the trainer would provide feedback to the students on best practices for future benefits.	The aim is to do both give feedback to students as well as obtain feedback on the course from them.

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Be more confident.
- Speak in front of a large audience without hesitation.
- Think creatively.
- Speak impromptu.
- Communicate in English.

SEMESTER VI

BM23611	RADIOLOGICAL EQUIPMENT	Category	L	T	P	C
		PC	3	0	0	3

OBJECTIVES:

- To understand generation of x-rays and its applications in imaging.
- To learn different types of radio diagnostic techniques.
- To know techniques used for visualizing different sections of the body
- To learn radiation therapy methodologies and the radiation safety.
- To understand the various image reconstruction techniques in CT and MRI.

UNIT I MEDICAL X-RAY EQUIPMENT 9

Nature of X-rays, X-Ray absorption – Tissue contrast. X- Ray Equipment (Block Diagram) – X-Ray Tube, collimator, Bucky Grid, power supply. Digital Radiography-discrete digital detectors, storage phosphor and film scanning. Fluoroscopy - X-ray Image Intensifier tubes – Digital Fluoroscopy.

UNIT II COMPUTED TOMOGRAPHY 9

Principles of tomography, CT Generations - X- Ray sources, collimation, X- Ray detectors, Viewing systems, spiral CT scanning, ultra-fast CT scanners. Image reconstruction techniques - back projection and iterative method.

UNIT III MAGNETIC RESONANCE IMAGING 9

Fundamentals of magnetic resonance- Interaction of Nuclei with static magnetic field and Radiofrequency wave, rotation and precession. Induction of magnetic resonance signals – bulk Magnetization, Relaxation processes T1 and T2. Block Diagram approach of MRI system- system Magnet (Permanent, Electromagnet and Super conductors), Gradient magnetic fields, Radio Frequency coils (sending and receiving), shim coils, Electronic components, fMRI.

UNIT-IV NUCLEAR IMAGING SYSTEM 9

Radio Isotopes- alpha, beta, and gamma radiations. Radiopharmaceuticals. Radiation detectors – gas filled, ionization chambers, proportional counter, GM counter and scintillation Detectors.
Gamma camera- Principle of operation, collimator, photo multiplier tube, X-Y positioning circuit, pulse height Analyzer. Principles of SPECT and PET.

UNIT-V RADIATION THERAPY AND RADIATION SAFETY 9

Effects of radiation- direct and indirect. Radiation therapy – linear accelerator, Tele gamma Machine. Recent Techniques in radiation therapy - Stereotaxic Radiosurgery, Stereotaxic Radiotherapy, 3D CRT, IMRT, IGRT and Cyber knife. Radiation measuring instruments Dosimeter, film Badges, Thermo Luminescent dosimeters- electronic dosimeter. Radiation protection in medicine- radiation protection principles, ICRP, AERB.

Contact Hours : 45

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Discuss the principle and working of various radiography equipment.
- Explain the tomography concept and image reconstruction techniques.
- Describe the basic principle and working of Magnetic resonance imaging technique.
- Explain the concept of nuclear imaging techniques and radiation detectors.
- Demonstrate the effects of radiation, radiation safety and the principle of Radio therapy.

TEXT BOOK(S):

1 Steve Webb, "The Physics of Medical Imaging'', Adam Hilger, Philadelpia, 1988.
2 Jerrold T. Bushberg, J.Anthony Seibert, Edwin M.Leidholdt,Jr, John M.Boone, 'The Essential Physics of Medical Imaging'', Lippincott Williams and Wilkins, 3rd Edition, 2012.
3 R.Hendee and Russell Ritenour, "Medical Imaging Physics", William,Wiley- Liss, 4th Edition, 2002.

REFERENCE BOOK(S) / WEB LINKS:

1 Gopal B. Saha, "Physics and Radiobiology of Nuclear Medicine'', Springer, 3 rd Edition 2006.
2 B.H.Brown, PV Lawford, RH Smallwood, DR Hose, DC Barber, "Medical physics and Biomedical Engineering'', - CRC Press,1999.
3 Myer Kutz, "Standard handbook of Biomedical Engineering and design", McGraw Hill, 2003.
4 P.Ragunathan, "Magnetic Resonance Imaging and Spectroscopy in Medicine concepts and Techniques'', Orient Longman, 2007.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	-	-	-	-	-	-	-	-	3	-	3	1	1	-
CO 2	1	-	-	-	3	1	3	3	3	3	-	3	1	1	-
CO 3	1	-	-	-	3	3	3	3	3	3	-	3	1	1	-
CO 4	1	-	-	-	3	3	3	3	3	3	-	3	1	1	-
CO 5	1	-	-	-	3	3	3	3	3	3	-	3	1	1	-
AVG.	**1.4**	**-**	**-**	**-**	**3**	**2.5**	**3**	**3**	**3**	**3**		**3**	**1**	**1**	**-**

BM23612 BIOMECHANICS Category L T P C

PC 3 1 0 4

OBJECTIVES:

- To impart foundational knowledge of mechanics, how these principles apply to biological systems.
- To explore the mechanical behaviour of biological fluids
- To analyze the mechanical properties and behaviours of biological solids

- To understand the biomechanics of human joints and to analyze joint mechanics in both healthy and pathological conditions.
- To apply biomechanical principles and analytical methods in real-world applications like ergonomics and sports.

UNIT-I INTRODUCTION TO MECHANICS 9

Scalars and vectors, Statics: Force types, Resolution and composition of forces, Resultant of forces, moments of force and couple, vector method for resultant force determination. Dynamics: Basic principles, Linear motion, Newton's laws of motion, Impulse and Momentum, Work and Energy. Calculation of velocity and acceleration, Link segment models, Force transducers and force plates, Introduction to Constitutive equations.

UNIT-II MECHANICS OF BIOFLUIDS 9

Intrinsic fluid properties: Density, Viscosity, Compressibility and Surface Tension. Viscometers: Capillary, Coaxial cylinder and cone and plate. Rheological properties of blood. Pressure-flow relationship for Non-Newtonian Fluids: Power law fluid, Bingham Plastic, Casson's fluid. Blood Vessels: Structure of blood vessels, material properties and modelling of Blood vessels, Remodeling of Blood vessels. Heart: Material characterization of cardiac muscle, Native heart valves -Mechanical properties and valve dynamics, Prosthetic heart valve fluid dynamics. Fluid Forces: Buoyancy, Drag, Lift, The Magnus effect.

UNIT-III MECHANICS OF BIOSOLIDS 9

Constitutive equation of viscoelasticity: Maxwell & Voight models. Hard Tissues: Structure, function and properties of bones, anisotropic behaviour of bone, Geometrical properties of Human Bone, Bone fracture mechanics, Implants for bone fractures. Soft Tissues: Structure, functions, material properties and modelling of Soft Tissues – Cartilage, Tendons and Ligaments. Skeletal Muscle: Muscle action, Single Twitch and Wave Summation, Hill's three element models, Hill's Equation for Tetanised Muscle.

UNIT-IV BIOMECHANICS OF JOINTS 9

Skeletal joints, forces and stresses in human joints, Analysis of rigid bodies in equilibrium, Free body diagrams, Structure of joints, Types of joints, Biomechanical analysis of elbow, shoulder, spinal column, hip, knee and ankle. Biotribology: Lubrication of synovial joint. Total knee and hip joint replacement.

UNIT-V APPLICATIONS OF BIOMECHANICS 9

Whole body Biomechanics: Whole body vibrations, Hand transmitted vibrations, Posture, Biomechanics and Work Seating design. Ergonomics: Musculoskeletal disorders, Ergonomic principles contributing to good workplace and computer work station design. Gait analysis: GAIT cycle, Different Methods of GAIT analysis, Kinesiological EMG. Sports biomechanics: Motion analysis using video, Isokinetic dynamometry, Computer simulation modeling in sports. FEM: Introduction to Finite Element Analysis, Discretization procedure, finite element analysis of lumbar spine.

Case study: Biomechanical analysis of any one Paralympic sport, Biomechanical Assessment of Military Load Carriage.

Contact Hours : 45

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Analyze and solve mechanical problems involving forces, moments, and motion in biological systems.
- Evaluate the rheological properties of biological fluids like blood and determine their flow characteristics in various physiological and pathological conditions.
- Model and predict the response of hard and soft tissues to mechanical stresses and how they contribute to overall body mechanics.
- Conduct biomechanical analyses of major human joints, identifying the forces, stresses, and motion patterns in both healthy and pathological states.
- Design and evaluate ergonomic solutions and sports techniques using biomechanical analysis tools

TEXT BOOK(S):

1 Y.C. Fung, “Bio-Mechanics- Mechanical Properties of Tissues”, Springer-Verlag 1998.

2 Marcelo Epstein, “The Elements of Continuum Biomechanics”, ISBN: 978-1-119- 99923-2, 2012.

3 Subrata Pal, “Textbook of Biomechanics”, Viva Books Private Limited, 2009.

REFERENCE BOOK(S) / WEB LINKS:

1 Knudson, D. (2007). Fundamentals of Biomechanics. In Springer eBooks. https://doi.org/10.1007/978-0-387-49312-1

2 Shrawan Kumar, “Biomechanics in Ergonomics”, Second Edition, CRC Press2007.

3 Jay D. Humphrey, Sherry De Lange, “An Introduction to Biomechanics: Solids and Fluids, Analysis and Design”, Springer Science Business Media, 2004.

4 Carl J. Payton, “Biomechanical Evaluation of movement in sports and Exercise”, 2008.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	1	3	3	-	2	-	-	-	2	1	1	-
CO 2	3	3	3	1	3	3	-	2	-	-	-	2	3	1	-
CO 3	3	3	3	3	3	3	-	2	-	-	-	2	3	3	-
CO 4	3	3	3	3	3	3	-	2	-	-	-	2	3	3	-
CO 5	3	3	3	3	3	3	-	2	-	-	-	2	3	3	-
AVG.	**3**	**3**	**3**	**2.2**	**3**	**3**	**-**	**2**	**-**	**-**	**-**	**2**	**2.6**	**2.2**	**-**

BM23631	BIOSIGNAL PROCESSING	Category	L	T	P	C
		PC	1	1	2	3

OBJECTIVES

- To learn decimation process in frequency domain.
- To design IIR filters using suitable techniques.
- To design FIR filters using suitable techniques.
- To learn filters for Biosignals.
- To learn the applications of DSP in Biomedical Engineering.

UNIT-I DISCRETE FOURIER TRANSFORM 9

Introduction to DFT – Properties of DFT – Circular Convolution - Filtering methods based on DFT – FFT Algorithms –Decimation in time Algorithms, Decimation in frequency Algorithms – Use of FFT in Linear Filtering.

UNIT-II INFINITE IMPULSE RESPONSE FILTERS 9

Introduction to IIR filter - Impulse-invariant transformation technique – Bilinear transformation technique – frequency transformation in digital domain - design of Butterworth filter and Chebyshev filter (type-1) (restricted to 3rd order). Structure realization of IIR system – lattice structure and lattice-ladder structure.

UNIT-III FINITE IMPULSE RESPONSE FILTERS 9

Design of FIR filter using Fourier method, Rectangular window, Hanning window, Hamming window. Design using frequency sampling technique. Structure realization of FIR system – direct form, cascade form, linear phase FIR system.

UNIT-IV FILTERS FOR REMOVAL OF ARTIFACTS IN BIOSIGNALS 9

Noise in ECG signal – random, structured and interference. Time domain filters - synchronized averaging, MA filters. Frequency domain filters – removal of high frequency and low frequency noise, Optimal Filtering - The Weiner Filter. Adaptive Filtering – noise canceller, LMS, RLS

UNIT-V EVENT DETECTION AND SPEECH PROCESSING (QUALITATIVE ANALYSIS) 9

QRS, P and T waves detection in ECG signal, ECG Rhythm analysis, identification of heart sound, Detection of the Aortic Component of the Second Heart Sound ,Speech Processing-Modeling, Analysis, Synthesize and compression.

Contact Hours : 45

LIST OF EXPERIMENTS

1. Spectrum analysis using FFT.
2. Low pass, High pass, Band pass and Band stop filter design using windows.
3. QRS, P & T wave detection in ECG signal.
4. Frequency band spectrum in EEG signal.
5. EMG signal analysis.

Contact Hours : 30
Total Contact Hours : 75

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Apply FFT for the analysis of digital signals & systems.
- Design and implement IIR filters.

- Design and implement FIR Filters.
- To design and implement digital filters to remove artifacts.
- To apply signal processing concepts in speech processing.

TEXT BOOK(S):

1 JohnG.Proakis, Dimitris G.Manolakis, "Digital Signal Processing: Principles, Algorithms and Applications", Prentice Hall of India, New Delhi, 2007. (Unit I to III)

2 Rangaraj M Rangayyan, “Biomedical Signal Analysis”, 2nd Edition, Wiley Publications.

3 S.Salivahanan, “Digital Signal Processing,3rd Edition, McGraw Hill Education (India) Private Limited.

REFERENCE BOOK(S) / WEB LINKS:

1 Emmanuel C.Ifeachor, BarrieW.Jervis, "Digital Signal Processing: A Practical Approach”’ Prentice Hall ,Harlow, 2011.

2 Eugene N .Bruce, "Biomedical Signal Processing And Signal Modeling”, Wiley India, New Delhi, 2009.

3 Rangaraj M Rangayyan, "Biomedical Signal Analysis: A Case-Study Approach", Wiley India, New Delhi, 2015.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	1	-	1	-	1	-	-	-	-	-	-	3	-
CO 2	3	3	3	2	2	-	2	-	-	-	-	-	-	3	-
CO 3	3	3	3	3	3	-	3	-	-	-	-	-	-	3	-
CO 4	3	3	3	3	3	-	3	-	-	-	-	-	-	3	-
CO 5	3	3	3	3	3	-	3	-	2	1	3	3	3	3	3
AVG.	**3**	**3**	**2.6**	**2.7**	**2.4**	**-**	**2.4**	**-**	**2**	**1**	**3**	**3**	**3**	**3**	**3**

BM23632 PHYSIOLOGICAL MODELING LABORATORY Category L T P C

PC 1 0 2 2

OBJECTIVES

- To develop proficiency in simulation tools.
- To understand and apply control system analysis techniques.
- To model and simulate physiological systems.
- To perform steady state analysis.
- To integrate theoretical knowledge with practical applications.

LIST OF EXPERIMENTS

1 Introduction to Simulation – Basic mathematical operations using MATLAB Simulink

2 Simulation of analysis of Bode plot using Simulink control design

3 Simulation of analysis of Nichols plot using Simulink control design

4 Simulation of analysis of Nyquist plot using MATLAB
5 Steady state analysis of Routh- Hurwitz criterion.
6 Simulation of Chemical regulation model of ventilation
7 Simulation of frequency response model of Circulatory control
8 Simulation of frequency response of glucose-insulin regulation model
9 Simulation of Simple Lung Mechanics Model.
10 Simulation of steady state analysis of Muscle stretch reflex, and Neuromuscular model.

Contact Hours : 45

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Demonstrate the ability to perform basic mathematical operations in Simulink
- Analyse and interpret the frequency response of control systems
- Perform steady state analysis of physiological systems
- Develop and simulate mathematical model of physiological process
- Integrate theoretical concepts oh physiological modelling with practical simulation.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	1	-	2	3	-	1	-	-	-	-	-	1	1	-
CO 2	3	3	2	2	3	-	1	-	-	-	-	-	1	-	-
CO 3	3	3	3	3	3	-	-	-	-	-	-	-	-	-	-
CO 4	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	3	3	3	3	3		2	-	-	-	-	-	2	3	-
AVG.	**2.4**	**2.2**	**2.67**	**2.5**	**3**	**-**	**1.3**	**-**	**-**	**-**	**-**	**-**	**1.3**	**2**	**-**

GE23627 DESIGN THINKING AND INNOVATION Category L T P C

EEC 0 0 4 2

OBJECTIVES:

- To understand the design thinking concepts and deep understanding of user needs and experiences.
- To find the problem statement and To develop innovative design solutions that address identified user challenges
- To master the process of prototyping and iterating on designs.
- To conduct thorough market analysis and financial planning
- To effectively communicate design concepts and findings.

UNIT I INTRODUCTION TO DESIGN THINKING 9

The design thinking concepts - Different design thinking models - Details of Stanford Design thinking process: Empathize, Define, Ideate, Prototype, Test

Activities:

- Case studies of successful domain based Design Thinking and Innovative projects
- Group discussions on design thinking

UNIT II EMPATHIZE AND DEFINE 9

User research methods (interviews, surveys, observation, contextual inquiry) - Persona development- Journey mapping – Brainstorming Defining the design problem statement

Activities:

- Conducting user interviews and surveys.
- Creating user personas and journey maps.
- Identifying key user needs and pain points.
- Analyze the user needs and Brainstorming to define problem statement .
-

UNIT III IDEATE AND CREATE 9

Brainstorming techniques (e.g., mind mapping, SCAMPER) - Ideation tools (e.g., design thinking tools, concept sketching) - Concept generation and evaluation (e.g. Brainstorming)

Activities:

- Group brainstorming sessions to select the best idea.
- Creating concept sketches and prototypes.
- Evaluating ideas based on user needs and feasibility.

UNIT-IV PROTOTYPE AND TEST 9

Low, Medium and high level fidelity for prototyping-Usability testing -Iterative design

Activities:

- Building low-fidelity prototypes (e.g., paper prototypes).
- Conducting usability tests with users.
- Iterating on designs based on feedback.

UNIT-V MARKET ANALYSIS AND IMPLEMENTATION 9

Market research and analysis - Business model development- Financial planning-Implementation strategies

Activities:

- Conducting market research
- Developing a business model canvas
- Creating a financial projection
- Developing an implementation plan

Contact Hours : 45

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Construct design challenge and reframe the design challenge into design opportunity.
- Interview the user, and know the feelings of users to foster deep user understanding and be able to uncover the deep user insights and needs.
- Develop ideas and prototypes by brainstorming.
- Organize the user walkthrough experience to test prototype

- Develop smart strategies and implementation plan that will deliver/achieve the idea/solution deduced from earlier phases.

TEXT BOOK(S):

1 Handbook of Design Thinking by Christian Müller-Roterberg, Kindle Direct Publishing, 2018.

2 Design Thinking – A Beginner's Perspective, by E Balagurusamy, Bindu Vijakumar, MC Graw Hill, 2024.

REFERENCE BOOK(S) / WEB LINKS:

1 Design Thinking for Entrepreneurs and Small Businesses: Putting the Power of Design to Work – by Beverly Rudkin Ingle, Apress; 1st ed. Edition, 2013.

2 Design Thinking: Understanding How Designers Think and Work by Nigel Cross, Bloomsbury Visual Arts; 2 edition 2023.

3 Design thinking Guide https://www.rcsc.gov.bt/wp-content/uploads/2017/07/dt-guide-book-master-copy.pdf.

4 NPTEL Course on Design Thinking and Innovation By Ravi Poovaiah ; https://onlinecourses.swayam2.ac.in/aic23_ge17/preview.

5 IITB Design course tools and Resources https://www.dsource.in/.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	3	3	3	2	2	3	3	3	3	3	1	1	-
CO 2	3	2	3	3	3	2	2	3	3	3	3	3	1	-	-
CO 3	3	2	3	3	3	2	2	3	3	3	3	3	-	-	-
CO 4	3	2	3	3	3	2	2	3	3	3	3	3	-	-	-
CO 5	3	2	3	3	3	2	2	3	3	3	3	3	2	3	-
AVG.	**3**	**2**	**3**	**3**	**3**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**1.3**	**2**	**-**

BM23621 MEDICAL INDUSTRIAL TRAINING Category L T P C

EEC 0 0 2 1

OBJECTIVES

- To expose students to the operational processes and practices within medical industries and R&D centers.
- To develop technical skills and practical knowledge through hands-on experience in a real-world medical industry setting.
- To enhance students' ability to document and present industrial training experiences through structured report writing and presentations.
- To foster an understanding of the ethical and regulatory aspects of working in medical industries.
- To encourage students to apply theoretical knowledge in a practical environment, bridging the

gap between academia and industry.

Industrial Training – students will undergo a two-week industrial training program in biomedical industries or R&D centers. Upon completion, they must obtain a certification from the respective industry or research center, verifying their participation. Each student is also required to submit a detailed report that captures their observations and experiences from the training. The report should include personal comments, suggestions, and reflections on the practical knowledge gained. Additionally, students will undergo a Viva-Voce examination at the end of the semester to assess their understanding and insights derived from the training.

Internal Continuous Assessment

20% - Certificate from industries
30% - Presentation
30% - Report
20% - Regularity in the class

Contact Hours : 30

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Demonstrate the operational processes and practices within medical industries and R&D centers.
- Apply technical skills and practical knowledge gained in real-world medical industry settings.
- Effectively document and present industrial training experiences through structured reports and presentations.
- Demonstrate awareness of ethical and regulatory aspects relevant to the medical industry.
- Integrate theoretical knowledge with practical applications, effectively bridging the gap between academia and industry.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	3	3	3	3	3	2	2	2	2	3	3	2
CO 2	3	3	3	3	3	-	-	-	2	-	-	-	3	3	3
CO 3	-	-	-	-	-	-	-	-	3	3	3	-	-	-	-
CO 4	-	-	-	-	-	3	3	3	-	-	-	-	1	-	-
CO 5	3	3	3	3	2	1	1	-	-	-	-	-	3	3	3
AVG.	**3**	**3**	**3**	**3**	**2.6**	**2.3**	**2.3**	**3**	**2.3**	**2.5**	**2.5**	**2**	**2.5**	**3**	**2.67**

GE23621 PROBLEM SOLVING TECHNIQUES Category L T P C

EEC 0 0 2 1

OBJECTIVES

- To improve the numerical ability.
- To improve problem-solving skills.

COURSE TOPICS

1 Numbers system
2 Reading comprehension
3 Data arrangements and Blood relations
4 Time and Work
5 Sentence correction
6 Coding & Decoding, Series, Analogy, Odd man out and Visual reasoning
7 Percentages, Simple interest and Compound interest
8 Sentence completion and Para-jumbles
9 Profit and Loss, Partnerships and Averages
10 Permutation, Combination and Probability
11 Data interpretation and Data sufficiency
12 Logarithms, Progressions, Geometry and Quadratic equations
13 Time, Speed and Distance

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Have mental alertness
- Have numerical ability
- Solve quantitative aptitude problems with more confident

SEMESTER VII

BM23711	COMPREHENSION IN BIOMEDICAL ENGINEERING	Category	L	T	P	C
		EEC	1	0	0	1

OBJECTIVES

- To emphasize the importance of basic core subjects taught in different semesters of the programme through periodic exercise.
- To improve the technical knowledge, problem based learning skills, and application oriented design.
- To add values to knowledge gained by the students in order to prepare them for the campus interview and competitive exams.

The student will be tested for their understanding of the basic principles of the core engineering subjects. The internal assessment for a total of 50 marks will be made by a committee comprising of the faculty members of the department. The committee will conduct three written examinations of objective type questions type from the subjects.

Internal assessment:

Assessment 1: Electric Circuits and Electron Devices, Electronic Circuits, Analog and Digital ICs, Sensors and Measurements

Assessment 2: Microprocessors and Microcontrollers, Digital Signal Processing Techniques, Digital Image Processing Techniques, Principles of Communication Systems, Biocontrol Systems

Assessment 3: Human Anatomy and Physiology, Biochemical Science, Pathology and Microbiology, Biomedical Instrumentation, Diagnostic & Therapeutic Equipment, Radiological Equipment, Biomechanics

The end semester examination will be conducted by the Controller of Examinations.

Contact Hours : 15

COURSE OUTCOMES:

On completion of the course, the students will be able to

- On Completion of the comprehension, the student can able to write competitive exams like GATE, DBT-JRF, ICMR-JRF, IES, etc.

BM23731	MEDICAL IMAGE PROCESSING	Category	L	T	P	C
		PC	2	1	2	4

OBJECTIVES

- To learn the fundamental concepts of Digital Image Processing.
- To understand the concepts of various transforms and enhancement techniques for Image processing operations.
- To be familiar with the segmentation techniques.
- To gain knowledge on compression.

- To understand image registration and visualization techniques.

UNIT-I FUNDAMENTALS OF IMAGE AND MEDICAL IMAGE FORMATS 9

Imaging systems: Image formation and sensing, Image representation, Discrete sampling model, Quantization, Relationship between the pixels, Colour fundamentals and models.
Medical image file formats- DICOM, ANALYZE 7.5, NIFTI and INTERFILE.

UNIT-II IMAGE PREPROCESSING AND IMAGE TRANSFORMS 9

Basic gray level transformation- Log transformation, Power - law transformation, Piece wise linear transformation - Histogram processing.
Image Transforms- DFT – DCT– Walsh - Hadamard – Haar –Wavelet - Slant – KL –and their properties.
Case study: Application of DCT and Haar Transform in medical images.

UNIT-III IMAGE ENHANCEMENT , RESTORATION 9

Spatial Domain- Basics of Spatial Filtering–Smoothing and Sharpening Spatial Filters.
Frequency Domain- Smoothing and Sharpening -frequency domain filters – Ideal, Butterworth and Gaussian filters, Homomorphic Filtering.
Image Restoration- Noise models– Restoration in the presence of Noise – Inverse filter- Weiner filtering.
Case study: Enhancement of any medical images affected by noise.

UNIT-IV IMAGE SEGMENTATION AND COMPRESSION AND REGISTRATION 9

Segmentation- Thresholding - Foundation - Basic global thresholding - Optimum global thresholding using otsu's method - Region based segmentation-- Morphological processing - erosion and dilation - Segmentation using morphological watersheds- Clustering based segmentation techniques.
Image compression- Huffman coding technique - Arithmetic coding technique - Run length coding technique
Case Study: Segmentation of any medical image and identify the abnormality present.

UNIT-V MEDICAL IMAGE REGISTRATION AND VISUALIZATION TECHNIQUES 9

Registration- Rigid body transformation, principal axes registration, and feature based.
Visualisation-Orthogonal and perspective projection in medicine, Surface based rendering, Volume visualization in medical images.
Case Study: Registration of any two medical images and its application.

Contact Hours : 45

LIST OF EXPERIMENTS

1. Medical Image sampling and quantization.
2. Intensity transformation of images & Conversion between various Color models.
3. Transforms (DFT, DCT, Haar) used in medical images.
4. Histogram Processing.
5. Medical Image Enhancement- Spatial filtering and frequency domain.
6. Image restoration – Inverse and wiener filtering.
7. Segmentation of Region of Interest in medical images.
8. Registration of medical images.

Contact Hours : 30
Total Contact Hours : 75

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Demonstrate the concepts of Image formation, acquisition systems and color Representations.
- Develop algorithms to pre-process the images.
- Apply image enhancement and restoration techniques in spatial and frequency domain.
- Perform segmentation by applying suitable method.
- Explore and apply current research in registration and visualization for medical image analysis.

TEXT BOOK(S):

1 Rafael C, Gonzalez and Richard E. Woods, “Digital Image Processing”, Pearson Education Asia, Fourth Edition, 2018.

2 Anil.k.Jain, “Digital image processing”, Prentice Hall of India, First edition, 2015 .

3 S. Jayaraman, S. Esakkirajan, T. Veerakumar “Digital Image Processing”,Tata McGraw Hill Education, 2009.

4 Joseph V.Hajnal, Derek L.G.Hill, David J Hawkes, “Medical image registration”,Biomedical Engineering series, CRC press,2001.

REFERENCE BOOK(S) / WEB LINKS:

1 N.Efford, “Digital Image Processing”, Addison Wesley 2000, ISBN 0-201-59623-7.

2 *M Sonka*, *V Hlavac and R Boyle*,” *Image Processing, Analysis and Machine Vision*, *PWS*. *1999”*, *ISBN 0-534-95393-X.*

3 W K Pratt, “Digital Image Processing”, John Wiley and Sons, 1991.

4 SE Umbaugh, “Digital Image Processing and Analysis: Human and Computer Vision Application with CVIP tools”, 2nd Edition, CRC Press, 2011.

5 Mark Nixon Alberto Aguado “Feature Extraction and Image Processing for Computer Vision” 4th Edition, 2019.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	-	3	-	-	1	2	-	2	2	2	3	3
CO 2	3	3	3	1	3	-	-	1	2	-	2	2	2	3	3
CO 3	3	3	2	-	3	-	-	1	2	-	3	2	2	3	3
CO 4	3	3	2	1	3	-	-	1	2	-	3	3	2	3	3
CO 5	3	3	2	2	3	-	1	1	2	-	3	3	2	3	3
AVG.	**3.0**	**3.0**	**2.4**	**1.33**	**3.0**	**-**	**1.0**	**1.0**	**2.0**	**-**	**2.6**	**2.4**	**2.0**	**3.0**	**3.0**

BM23721	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING FOR BIOMEDICAL ENGINEERING	Category	L	T	P	C
		EEC	0	0	4	2

OBJECTIVES

- To gain proficiency in preprocessing medical images (e.g., fundus, CT, MRI, mammogram, dermoscopy, histopathological) to improve quality and prepare them for analysis.
- To learn and apply various techniques for extracting and engineering relevant features from medical images and genomic or behavioral data to enhance model performance.
- To implement and optimize machine learning and deep learning algorithms for classification, segmentation, and prediction tasks in medical image analysis and disease detection.
- To develop skills in evaluating and validating the performance of different models using appropriate metrics and validation techniques to ensure accuracy and robustness.
- To understand the clinical significance of the models and their results, and interpret the outcomes in a medically relevant context to contribute to improved healthcare diagnostics and treatments.

LIST OF EXPERIMENTS

1. Preprocessing and Segmentation of Lung Nodules in CT Scans.
2. Preprocessing and Segmentation of Blood Vessels in Retinal Images.
3. Preprocessing and Segmentation of Brain Tumor in MRI Scans.
4. Prediction of Blood Glucose Levels in Diabetic Patients.
5. Prediction of Drug Response in Cancer Treatment Using Genomic Data.
6. Autism Spectrum Disorder detection Using Behavioral Data.
7. Classification of Diabetic Retinopathy from Fundus Images using ANN, K-NN and naïve bayes.
8. Breast Cancer Detection in Mammograms using SVM, K-means clustering and Random forest classifiers.
9. Detection of Alzheimer Disease from MRI Images using XGboost and gradient boosting algorithms.
10. Prediction of Heart Disease Risk using logistic regression and decision tree.
11. Classification of Skin Lesions from Dermoscopy Images using ALEXNET and VGG16.
12. Classification of Retinal Diseases Using CNN (Fundus images).
13. Automated Analysis of Histopathological Images for Cancer Detection using Resnet18 and Inception net.

Contact Hours : 60

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Demonstrate the ability to preprocess, enhance, and segment medical images, improving their quality and making them suitable for further analysis.
- Develop expertise in extracting and engineering features from medical images and related data, enabling the application of advanced machine learning and deep learning techniques.
- Gain hands-on experience in implementing and optimizing machine learning and deep learning models for various medical diagnostic tasks, such as classification, segmentation, and prediction.

- Acquire the capability to evaluate and validate the performance of different models using appropriate metrics, ensuring the reliability and robustness of the models.
- Learn to interpret the results of the models in a clinical context, understanding their significance and contributing to enhanced healthcare diagnostics and patient outcomes.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	1	2	-	2	2	2	2	3	3	-	3	2	3
CO 2	3	2	1	2	-	2	2	2	2	3	3	-	3	2	3
CO 3	3	2	1	2	-	2	2	2	2	2	2	-	3	2	2
CO 4	3	2	1	2	-	2	2	2	2	3	3	-	3	2	3
CO 5	3	2	1	2	-	2	2	2	2	3	3	-	3	2	3
AVG.	**3**	**2**	**1**	**2**	**-**	**2**	**2**	**2**	**2**	**2.8**	**2.8**	**-**	**3**	**2**	**2.8**

BM23722 **PROJECT PHASE-I** **Category** **L T P C**

EEC **0 0 6 3**

OBJECTIVES

- To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same.
- To train the students in preparing project reports and to face reviews and viva voce examination.

The Project work can be undertaken in an industrial / research organization or Institute in consultation with the faculty guide. In case of Project work at industrial / research organization, the same shall be jointly supervised by a faculty guide and an expert from the organization. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Controller of Examinations.

Contact Hours : 90

COURSE OUTCOMES:

On completion of the course, the students will be able to

- On completion of the project phase-I students will be equipped to tackle challenging practical problems and formulate appropriate methodology for developing solutions.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	3	3	3	3	3	3	2	3	3	3	3	2
AVG.	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**2**

BM23723 **HOSPITAL TRAINING** **Category** **L T P C**

EEC **0 0 2 1**

OBJECTIVES

- To equip students with practical skills and knowledge in clinical settings to improve their ability to assess, diagnose, and manage patient care effectively.
- To foster strong communication skills with healthcare professionals, patients, and families to enhance teamwork and patient-centered care.
- To provide insights into hospital workflows, administrative procedures, and the integration of multidisciplinary teams in delivering comprehensive healthcare services.
- To enhance students' awareness of ethical, legal, and regulatory standards in healthcare practices, encouraging adherence to professional conduct and patient confidentiality.
- To Cultivate a habit of self-reflection, critical thinking, and continuous professional development to adapt to the evolving healthcare environment.

DEPARTMENTS FOR VISIT

- Cardiology
- ENT
- Ophthalmology
- Orthopaedic and Physiotherapy
- ICU/CCU
- Operation Theatre
- Neurology
- Nephrology
- Radiology
- Nuclear Medicine
- Pulmonology
- Urology
- Obstetrics and Gynecology
- Emergency Medicine
- Biomedical Engineering Department
- HistoPathology
- Biochemistry
- Paediatric/Neonatal
- Dental
- Oncology
- PAC’s

- Medical Records / Telemetry

ASSESSMENT:

- Students need to complete training in any leading Multi-speciality hospital for a period of 15 days. They need to prepare an extensive report and submit to their respective course in- charges during the session.
- Out of the above mentioned departments, it is mandatory to complete training in any ten.The students can give a presentation of the remaining departments during laboratory hours.

Contact Hours : 30

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Effectively apply clinical skills to assess, diagnose, and manage patient care within real-world healthcare environments.
- Demonstrate the ability to communicate clearly and collaborate efficiently within a healthcare team and with patients.
- Critically evaluate the organization of hospital functions and the collaborative efforts required for optimal patient care.
- Demonstrate integrity and accountability by adhering to the ethical, legal, and confidentiality norms in healthcare settings.
- Engage in reflective practices that promote ongoing self-assessment and professional growth in response to healthcare advancements.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	3	3	3	1	-	-	-	-	-	3	3	3
CO 2	-	-	-	-	-	-	-	-	3	3	2	2	1	1	1
CO 3	-	3	3	3	1	3	1	-	-	-	-	-	2	1	1
CO 4	-	-	-	-	-	-	3	3	1	-	-	-	2	1	1
CO 5	-	-	-	-	-	-	-	-	-	-	3	3	-	-	-
AVG.	**3**	**3**	**3**	**3**	**2**	**3**	**1.67**	**3**	**2**	**3**	**2.5**	**2.5**	**2**	**1.5**	**1.5**

SEMESTER VIII

BM23821	PROJECT PHASE-II	Category	L	T	P	C
		PC	0	0	16	8

OBJECTIVES

- To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same.
- To train the students in preparing project reports and to face reviews and viva voce examination.
- Finalization of system requirements and specification.
- Proposing different solutions for the problem based on literature survey.
- Proposing future trends in providing alternate solutions.

"Solving a real life problem" should be the focus of U.G. project. The project could be classified as hardware, software, modeling, and simulation. It should involve one or many elements of techniques such as analysis, design and synthesis.

The Head of the Department will appoint a project coordinator who will coordinate the

following:

• Grouping of students (Maximum 4 in a group)

• Allotment of projects and projects guides (Supervisors)

• Project monitoring at regular intervals

All projects allotment is to be completed by the 2nd week of 7th semester, so that students get sufficient time for completion of the project. All projects will be monitored at least twice in a semester through students' presentation. Sessional marks will be awarded by a monitoring committee comprising of faculty members as well as by the supervisor. Each student will be required to

1. Submit a one page synopsis before the seminar for display on notice board.

2. Give a 20 minutes presentation followed by 10 minutes discussion.

3. Submit a technical write-up on the talk delivered.

4. Actively participate in the oral presentations.

Each project group should maintain a log book of activities of the project. It should have entries related to the work done, problems faced, solution evolved etc. There shall be at least an Interim Evaluation and a final evaluation of the project in the 8th semester. Each project group has to submit an interim report in the prescribed format for the interim evaluation.

Students should execute the project work using the facilities of the institute. However, external projects can be taken up in reputed industries, if that work solves a technical problem of the external

firm. Prior sanction should be obtained from the head of department before taking up external project work and there must be an internal guide for such projects.

Each project group should complete the project work in the 8th semester. Each student is expected to prepare a report and a technical paper in the prescribed format, based on the project work. The paper may be prepared as per IEEE standard and can have a maximum of six pages. The project work is evaluated based on oral presentation, technical paper and the project report jointly by external and internal examiners constituted by the Controller of Examinations.

Internal Continuous Assessment

40% - Literature Survey, Design and development/Simulation and analysis

30% - Presentation & demonstration of results

20% - Report

10% - Regularity in the class

Contact Hours : 240

COURSE OUTCOMES:

On completion of the course students will be in a position to take up any challenging practical problems and find solution by formulating appropriate methodology.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	3	3	3	3	3	3	2	3	3	3	3	2
AVG.	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**2**

PROFESSIONAL ELECTIVES

DOMAIN: MEDICAL INSTRUMENTATION

BM23A11	MEDICAL OPTICS	Category	L	T	P	C
		PE	3	0	0	3

OBJECTIVES:

- To establish a basic background of tissue optics.
- To understand the basic principles, capabilities, and limitations of various light microscopy techniques.
- To develop the capability of analyzing the output of spectroscope applied for biochemical test.
- To understand different types of lasers and its application in medicine.

UNIT-I FUNDAMENTALS OF TISSUE OPTICS 9

Characteristics of Light- wavelength, coherence, polarization. Dual characteristics of light, Interaction of Light with tissues at molecular and bulk level – Absorption, reflection, scattering, photoablation and speckles.

UNIT-II OPTICAL MICROSCOPY 9

Basic principles - ray optics, lens and image formation, illumination technique, observation methods and views. Transmission microscopy, Confocal microscopy, Fluorescence microscopy, Multiphoton microscopy, photoacoustic microscopy.

UNIT-III MEDICAL APPLICATIONS OF LASERS 9

Laser physics, Medical laser, Laser safety, Laser Tissue Welding, Applications of Lasers in: Gynaecology: Treatment of Intraepithelial Neoplasia and endometriosis, Dermatology and Cosmetics: for Treating Port Wine Stains, Hemangioma-Tattoo and Hair Removal, Neurosurgery: Concept of Stereotactic Laser Neurosurgery-Dentistry: Treatment of Hard Tissues and Root Canal Treatment.

UNIT-IV OPTICAL SPECTROSCOPY AND IMAGING TECHNIQUES 9

Spectroscopy-Principle and function, Biochemical applications of UV-visible, Raman and Fluorescence spectroscopy, Photoelectron spectroscopy. Fluorescence resonance energy transfer imaging, Fluorescence lifetime imaging microscopy, Light scattering spectroscopy of cells and organelles in suspensions.

UNIT-V ADVANCED METHODS IN BIOMEDICAL OPTICS 9

Fundamentals of - Surface Enhanced and Coherence Anti-Stokes Raman Spectroscopy (SERS and CARS). Holographic Imaging, Application of infrared thermal imaging for creating temperature profile of biological organ, Diabetic monitoring – laser based technique, Spectroscopic method, infrared and absorption spectroscopy.

Contact Hours : 45

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Implement, model, value and verify light-tissue interaction models and apply light issue interaction models for diagnostic and therapeutic use.
- Describe and choose suitable optical microspcope for a specific biological application.
- Applying and understanding the role of lasers in medicine, their applications in diagnostic and therapeutic processes.
- Applying fundamental processes of light interaction with biological tissues for optical spectroscopy and imaging.
- Understanding the advanced topics in optical imaging.

TEXT BOOK(S):

1 Gerd Keiser, “Biophotonics-Concepts to Applications” 1st Edition, Springer, 2016.

2 Tuan Vo-Dinh, “Biomedical Photonics Handbook”, 2nd Edition, Taylor & Francis, 2019.

3 Paras N. Prasad, Introduction to Biophotonics, Wiley Interscience, 2003.

4 Markolf H.Niemz, “Laser-Tissue Interaction Fundamentals and Applications”, 4th Edition Springer, 2019.

REFERENCE BOOK(S) / WEB LINKS:

1 Robert Splinter, “An Introduction to Biomedical Optics”, 1st Edition, Taylor & Francis, 2007.

2 Francesco Pavone, Paul Campagnola, “Second Harmonic Generation Imaging”, Taylor & Francis, 2019.

3 Ashley JWelch, Martin JCvan Gemert, “Optical-Thermal Response of Laser Irradiated Tissue”, 2nd Edition, Springer, 2011.

4 Kevin Tsia, "Understanding Biophotonics: Fundamentals, Advances, and Applications', 1stEdition, Taylor& Francis, 2015.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	-	2	2	-	-	-	-	-	-	-	-	3	2	1
CO 2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AVG.	**2.75**	**3**	**2**	**2**	-	-	-	-	-	-	-	-	**3**	**2**	**1**

BM23A12	BIOMEMS TECHNOLOGIES AND APPLICATIONS	Category	L	T	P	C
		PE	3	0	0	3

OBJECTIVES:

- Learn various MEMS fabrication techniques.
- Understand different types of sensors and actuators and their principles of operation at the micro scale level.
- To learn the fundamental principles of microdevices
- Know the application of MEMS in different field of medicine
- Learn various MEMS fabrication techniques.

UNIT I MEMS MATERIALS AND FABRICATION 9

Typical MEMs and Microsystems, materials for MEMS - active substrate materials-Silicon and its compounds, Silicon piezoresistors, Gallium Arsenide, quartz, polymers. Micromachining photolithography, thin film deposition, doping, etching, bulk machining, wafer bonding, LIGA.

UNIT II MECHANICAL AND THERMAL SENSORS AND ACTUATORS AND ACTUATORS 9

Mechanics for MEMs design- static bending of thin plates, mechanical vibration, thermo-mechanics, fracture and thin film mechanics. Mechanical sensors and actuators – beam and cantilever –microplates, strain, pressure and flow measurements, Thermal sensors and actuators- actuator based on thermal expansion, thermal couples, thermal resistor, Shape memory alloys- Inertia sensor, flow sensor.

UNIT III ELECTROSTATIC AND PIEZOELECTRIC SENSORS AND ACTUATORS 9

Parallel plate capacitor, pull in effect, Electrostatic sensors and actuators- Inertia sensor, Pressure sensor, flow sensor, tactile sensor, comb drive. Properties of piezoelectric materials, Piezoelectric sensor and actuator – inchworm motor, inertia sensor, flow sensor.

UNIT IV MICROFLUIDICS AND BIOMEMS 9

Fluid dynamics, continuity equation, momentum equation, equation of motion, laminar flow in circular conduits. Properties of biological fluids in microchannels, devices Lab-on-a-Chip: Microanalytical systems in chemistry and biology MEMS Implants and Bioelectric Interfaces: Implantable microelectrodes, shunts.

Case study: Blood Flow Analysis in Microchannels.

UNIT V APPLICATIONS OF BIOMEMS 9

CAD for MEMs, micro total analysis systems (MicroTAS) detection and measurement methods, microsystem approaches to polymerase chain reaction (PCR), DNA sensor, MEMS based drug delivery, Micro-pumps and Microneedles, Implantable Devices, Smart Wearables, Emerging Bio-MEMS technology: Minimally invasive surgery, Oncology, Tissue Engineering, Biosensors.

Case study: Design of MEMS based Infusion Pump.

Contact Hours : 45

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Describe the various MEMS fabrication techniques.

- Outline different types of mechanical and thermal actuators and sensors.
- Understand the challenges and opportunities associated with biomedical micro devices.
- Analyze the fluid dynamics in Micro conduits and its applications.
- Illustrate various medical applications of MEMS.

TEXT BOOK(S):

1 Tai Ran Hsu, "MEMS and Microsystems Design and Manufacture", Tata McGraw Hill Publishing Company, New Delhi, 2002.
2 Wanjun Wang, Stephen A. Soper, "BioMEMS: Technologies and Applications", CRC Press, New York, 2007.
3 Meng, Ellis. Biomedical microsystems. CRC Press, 2010.

REFERENCE BOOK(S) / WEB LINKS:

1 Marc J. Madou "Fundamentals of Microfabrication: The Science of Miniaturization", CRC Press, 2002.
2 Nadim Maluf, Kirt Williams. "An introduction to Micro-electromechancial Systems Engineering", Second Edition, Artech House Inc, MA, 2004.
3 Nitaigour Premchand Mahalik, "MEMS", Tata McGraw Hill Publishing Company, New Delhi, 2007.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	2	2	3	-	1	1	-	1	1	2	-	2	-
CO 2	2	3	2	2	3	-	1	1	1	2	1	1	-	3	2
CO 3	2	2	3	2	2	3	3	2	1	1	1	3	3	2	3
CO 4	3	3	2	3	3	-	1	-	-	1	1	1	2	1	1
CO 5	3	2	2	3	3	2	3	2	1	2	-	2	3	3	3
AVG.	**2.6**	**2.4**	**2.2**	**2.4**	**2.8**	**2.5**	**1.8**	**1.5**	**1**	**1.4**	**1**	**1.8**	**2.67**	**2.2**	**2.25**

BM23A13 SURGICAL OPTICAL DEVICES Category L T P C

PE 3 0 0 3

OBJECTIVES:

- To learn about the instrumentation in photonics.
- To understand the fundamental principles, devices and various application of nanophotonics in biotechnology and nanomedicine.
- Know about invasive optical techniques and its applications.
- Identify the IoT based optical instrumentation.
- Learn photonics instrumentation in surgical procedure.

UNIT-I PHOTONIC INSTRUMENTATION 9

Basic principles of microscope - ray optics, lens and image formation, illumination technique, observation methods and views. Transmission microscopy, Confocal microscopy.
Spectroscopy- principle and function, Biochemical applications of UV-visible, Raman and Fluorescence spectroscopy, and Fluorescence resonance energy transfer imaging.

UNIT-II NANOPHOTONICS FOR BIOTECHNOLOGY AND NANOMEDICINE 9

Near-field bio imaging – nano particles for optical diagnostics and targeted therapy – semiconductor quantum dots for bio imaging – up-converting nanophores for bio imaging – biosensing. polariton guiding by sub wavelength metal grooves. Sub wavelength aperture plasmonics – plasmonic wave guiding – applications of metallic nanostructures.

UNIT-III INVASIVE OPTICAL TECHNIQUES 9

Optical guided therapy – Ophthalmology and oncology. Endoscopic imaging system fundamentals - Angioscope, Videoscopy, Fluorescence endoscopy, Endoscopic therapy, Endoscopic ultrasound imaging principles. Principle, function and application of optical coherence tomography.

UNIT-IV IOT BASED OPTICAL INSTRUMENTATION 9

Wearable optical fibersensors in medical monitoring applications, Optical single molecular sensors in healthcare, Optics for sensingmicro structure – (glands and blood vessels) during surgical procedure. IR sensors for tissue perfusion and tissue oxygenation, Integration of IoT technologies with biophotonic devices for periodical monitoring,Optical control of brain functioning.

UNIT-V PHOTONICS IN SURGICAL PROCEDURES 9

Laser surgery – eye and dental application. Organic photonics in biochemistry, Photonic monitoring of response to antimicrobial therapy, Surgical room lighting – types and methods. Optical biosensor for diagnosing TB, Surgical precision lens – implantable and for detection. Optical analysis using TracePro/COMSOL/MATLAB – assignment.

Contact Hours : 45

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Illustrate the principles of microscopes and discuss various illumination techniques in microscopy.
- Explain the basic principles and analyze different types of nanophotonic materials.
- Discuss the principles of optical techniques and its applications.
- Analyze the IoT based optical instrumentation involved in optic devices.
- Apply photonics principles in surgical procedures.

TEXT BOOK(S):

1 Gerd Keiser, “Biophotonics-Concepts to Applications” 1st Edition, Springer, 2016.
2 Tuan Vo-Dinh, “Biomedical Photonics Handbook”, 2nd Edition, Taylor & Francis, 2019.
3 Paras N. Prasad, Introduction to Biophotonics, Wiley Interscience, 2003.
4 Abraham Katzir, “Lasers and Optical Fibers in Medicine”, Academic press Inc.

REFERENCE BOOK(S) / WEB LINKS:

1 Robert Splinter, "An Introduction to Biomedical Optics", 1st Edition, Taylor & Francis, 2007.
2 John Crisp," Introduction to fiber optics", 2nd Edition, 2001, Newnes.
3 Optical Fiber Temperature Sensors and Their Biomedical Applications - PMC (nih.gov).
4 Sensors | Free Full-Text | Wearable Optical Fiber Sensors in Medical Monitoring Applications: A Review (mdpi.com).

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	-	2	2	-	-	-	-	-	-	-	-	3	2	1
CO 2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AVG.	**2.75**	**3**	**2**	**2**	-	-	-	-	-	-	-	-	**3**	**2**	**1**

BM23A14 **INTERNET OF THINGS IN MEDICINE**

Category	L	T	P	C
PE	3	0	0	3

OBJECTIVES:

- To provide a comprehensive understanding of IoT fundamentals and its applications in the medical field.
- To explore various IoT architectures, protocols, and platforms relevant to healthcare.
- To impart knowledge on the integration of IoT devices with biomedical equipment and systems.
- To analyze data security, privacy, and ethical issues associated with IoT in healthcare.
- To design and develop IoT-based solutions for real-time health monitoring and medical applications.

UNIT-I INTRODUCTION TO IOT IN MEDICINE 9

Introduction to IoT -Definitions, Characteristics, and Benefits, IoT in Healthcare - Applications, Trends, and Challenges, IoT Ecosystem - Devices, Gateways, and Cloud Integration, Case Studies - Remote Patient Monitoring, Smart Wearables.

UNIT-II IOT ARCHITECTURES AND PROTOCOLS FOR HEALTHCARE 9

IoT Architectures - Layers, Models, and Frameworks, Communication Protocols - MQTT, CoAP, HTTP/HTTPS, Wireless Technologies - BLE, ZigBee, LoRaWAN, 5G, Standards and Interoperability in Medical IoT.

UNIT-III INTEGRATION OF IOT WITH BIOMEDICAL DEVICES 9

IoT Device Integration - Sensors, Actuators, and Interfaces, Biomedical Signal Acquisition and Processing, Wearable Devices and Smart Implants, IoT Platforms for Biomedical Data Management.

UNIT-IV DATA SECURITY, PRIVACY, AND ETHICS IN MEDICAL IOT 9

Security Challenges - Authentication, Authorization, and Encryption, Privacy Concerns - Data Anonymization, Consent, and Compliance, Ethical Issues - Patient Rights, Data Ownership, and Liability, Regulatory Standards -HIPAA, GDPR, and Others.

UNIT-V IOT APPLICATIONS IN HEALTHCARE 9

IoT-based Health Monitoring Systems -Architecture and Case Studies, Smart Hospitals - IoT for Asset Management, Patient Tracking, IoT in Medical Research - Data Collection, Analysis, and AI Integration, Future Trends - AI, ML, and Predictive Analytics in IoT for Medicine.

Contact Hours : 45

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Demonstrate knowledge of IoT concepts, architectures, and protocols applicable to the medical field.
- Analyze and design IoT systems and networks for healthcare applications.
- Integrate IoT technologies with biomedical devices for improved healthcare solutions.
- Evaluate data security and privacy issues related to IoT in medical contexts.
- Develop innovative IoT solutions for healthcare challenges, demonstrating practical implementation skills.

TEXT BOOK(S):

1 Internet of Things for Healthcare Technologies by Chinmay Chakraborty, et al. - Springer, 2020.
2 Internet of Medical Things (IoMT): Techniques and Applications by Bharat S. Chaudhari and Marco Zennaro - Springer, 2020.
3 IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things by David Hanes, Gonzalo Salgueiro, et al. - Cisco Press, 2017.

REFERENCE BOOK(S) / WEB LINKS:

1 Internet of Things: Architectures, Protocols and Standards, by Simone Cirani, Gianluigi Ferrari, et al. - Wiley, 2018.
2 Healthcare 4.0: Next Generation Processes with the Internet of Things, by Kayvan Najarian and Robert Splinter - CRC Press, 2019.
3 IoT and Analytics for Healthcare: A Primer, by Akhil Kumar, et al. - Elsevier, 2020.
4 Handbook of Research on the Internet of Things Applications in Healthcare, by Adam Glowacz, Janusz Rajchel, et al. - IGI Global, 2019.
5 Coursera Course: Internet of Things: Sensing and Actuating by the University of California, Irvine.
6 edX Course: Internet of Things (IoT) - Free Online Course from Microsoft.
7 MIT OpenCourseWare: The Internet of Things: Roadmap to a Connected World.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	1	3	3	3	3	3	-	-	-	-	-	3	3	3	3
CO 2	1	3	3	3	3	3	-	-	-	-	-	3	3	3	3
CO 3	1	3	3	3	3	3	-	-	-	-	-	3	3	3	3
CO 4	1	3	3	3	3	-	-	2	-	-	-	3	3	3	3
CO 5	1	3	3	3	3	-	-	-	-	-	-	3	3	3	3
AVG.	**1**	**3**	**3**	**3**	**3**	**3**	**-**	**2**	**-**	**-**	**-**	**3**	**3**	**3**	**3**

M23A15 BIOSENSORS Category L T P C

PC 3 0 0 3

OBJECTIVES:

- To understand the fundamental principles of biosensors, their components.
- To explore the various types of biosensors and their applications.
- To learn various fabrication techniques and material selection for biosensor development.
- To analyse the performance of biosensors using signal processing and data analysis.
- To examine current trends, advancements, and ethical considerations in biosensor technology.

UNIT-I INTRODUCTION TO BIOSENSORS 9

Definition, Components of biosensors- Biological sensing element, Electrical sensing element, Selection of bioreceptors-enzymes, antibodies, nucleic acids, Methods of immobilisation-, Transducer. Classifications of biosensors, Properties, Applications in healthcare industry, Environmental monitoring.

UNIT-II TYPES OF BIOSENSORS 9

Electrochemical - Potentiometric, Amperometric and Conductometric sensors. Optical- Surface plasmon resonance, Fluorescence and Luminescence based sensors. Mass-based biosensors- Quartz crystal microbalance, Surface acoustic wave sensors. Thermal biosensors- Calorimetric sensors.

UNIT-III DESIGN AND FABRICATION OF BIOSENSORS 9

Materials and components - Biological materials – Enzymes, Antibodies, nucleic acids, Transducer materials- metals, semiconductors, polymers. Surface chemistry - Surface modification and functionalization techniques, SAMs (Self- Assembled Monolayers), polymers and nanomaterials. Interface properties and their impact on biosensor performance. Microfabrication techniques- Photolithography, Soft lithography. Integration and Packaging - Microfluidics, Lab-on-chip devices, Wearable biosensors. Biocompatibility- for Implantable and in vitro biosensors.

UNIT-IV SIGNAL PROCESSING AND DATA ANALYSIS 9

Signal Transduction- Principles of signal generation and transduction, Noice reduction techniques. Data acquisition and analysis- Analog and digital signal processing, data interpretation and calibration. Machine learning in biosensors-Pattern recognition, predictive modelling.

UNIT-V CURRENT TRENDS AND FUTURE DIRECTIONS 9

Advanced Biosensing Techniques- Nanotechnology in biosensors, CRISPR based biosensors, Commercialisation, and market trends- Regulatory considerations, Industry challenges and opportunities. Ethical and Societal Implications- Privacy and data security, Impact on healthcare industry.

Contact Hours : 45

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Understand the fundamental principles of biosensor design and operation.
- Identify different types of biosensors and their applications.
- Analyze the performance metrics of biosensors.
- Design and simulate biosensors for specific biomedical applications
- Evaluate emerging trends and future directions in biosensor technology.

TEXT BOOK(S):

1 Brain R. Eggins “Biosensors: An Introduction” 1999, Wiley and Teubner Publishers.
2 Prof. Ping Wang and Dr.Qingjun Liu, “Biomedical Sensors and Measurement”, First Edition, Springer Publications”, 2011.
3 Tatsuo Togawa, Toshiyo Tamura and Ake Oberg, “Biomedical Sensors and Instruments,” Second Edition, CRC Press Taylor, and Francis Group, 2011.

REFERENCE BOOK(S) / WEB LINKS:

1 R.Anandanatarajan, “Biomedical Instrumentation and measurements”, Second Edition, PHI Learning, December 2015.
2 Ernest O Doebelin and Dhanesh N Manik, “Measurement Systems, Applications and Design”, Fifth edition MC Graw-Hill, 2011.
3 Michael J. McGrath, Cliodhna NíScanaill, “Sensor Technologies: Healthcare, Wellness and Environmental Applications, A press, 2013
4 Richard S.C. Cobbold, “Transducers for Biomedical Measurements: Principles and Applications “, John Wiley and Sons, 2004.
5 Nandini K. Jog, “Electronics in Medicine and Biomedical Instrumentation “, Second Edition, PHI, 2013.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	1	3	3	-	2	-	-	-	2	1	1	-
CO 2	3	3	3	1	3	3	-	2	-	-	-	2	3	1	-
CO 3	3	3	3	3	3	3	-	2	-	-	-	2	3	3	-

CO 4	3	3	3	3	3	3	-	2	-	-	-	2	3	3	-
CO 5	3	3	3	3	3	3	-	2	-	-	-	2	3	3	-
AVG.	**3**	**3**	**3**	**2.2**	**3**	**3**	**-**	**2**	**-**	**-**	**-**	**2**	**2.6**	**2.2**	**-**

BM23A16 VLSI DESIGN FOR BIOMEDICAL APPLICATIONS Category L T P C

PE 3 0 0 3

OBJECTIVES:

- To provide students with a comprehensive understanding of MOS transistors, CMOS logic, and their application in VLSI design.
- To equip students with knowledge of various combinational and sequential MOS logic circuits, focusing on power management and advanced design techniques.
- To impart skills for designing arithmetic building blocks and memory subsystems, emphasizing power and speed trade-offs.
- To develop students' abilities in FPGA-based implementation and advanced testing strategies for VLSI circuits.
- To introduce students to the latest trends and technologies in VLSI design, including new memory architectures and advanced testing methodologies.

UNIT-I INTRODUCTION TO MOS TRANSISTOR 9

Introduction to MOSFETs, CMOS logic, and the basic inverter. Pass Transistor, Transmission gate, and their applications. Overview of design rules, gate layouts, and stick diagrams. Long-Channel I-V characteristics, C-V characteristics, and non-ideal I-V effects. Analysis of DC transfer characteristics, including the RC Delay Model, Elmore Delay, Linear Delay Model, Logical effort, parasitic delay, and delay in logic gates. Impact of scaling on MOS transistors and circuits.

UNIT-II COMBINATIONAL MOS LOGIC CIRCUITS 9

In-depth study of Static CMOS, Ratioed Circuits, Cascode Voltage Switch Logic, Dynamic Circuits, Pass Transistor Logic, and Transmission Gates. Domino, Dual Rail Domino, Complementary Pass-transistor Logic (CPL), Differential Cascode Voltage Switch with Pass-Gate (DCVSPG), and Dual Pass-transistor Logic (DPL). Common pitfalls in circuit design, dynamic power, static power, and low power architecture strategies.

UNIT-III SEQUENTIAL CIRCUIT DESIGN 9

Detailed study of static and dynamic latches and registers, pulse registers, and sense amplifier-based registers. Pipelining, Schmitt Trigger, monostable sequential circuits, and astable sequential circuits. Classification of digital system timing, synchronous design, and strategies to manage timing issues in high-speed circuits.

UNIT-IV DESIGN OF BIOMEDICAL ARITHMETIC BUILDING BLOCKS AND SUBSYSTEMS 9

Design and implementation of data paths – adders – multipliers – shifters - ALUs tailored for biomedical applications. Analyzing trade-offs specific to biomedical devices to ensure power efficiency and performance. Design of VLSI circuits for processing biomedical signals such as ECG, EEG, and EMG. **Case Studies**: Design of arithmetic building blocks in biomedical devices.

UNIT-V IMPLEMENTATION STRATEGIES AND TESTING FOR BIOMEDICAL APPLICATIONS **9**

Modern FPGA architectures for biomedical applications- signal processing and real-time monitoring. Techniques for interfacing FPGAs with various biomedical sensors and actuators. Testing strategies - ad hoc testing - scan design - built-in self-test (BIST) and IDDQ testing for biomedical VLSI circuits. Latest trends in VLSI testing - machine learning-based fault detection - testing for biomedical systems. **Case Studies:** VLSI design implementation and testing in biomedical engineering applications.

Contact Hours : 45

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Students will understand MOS transistor characteristics, CMOS logic, and layout design rules.
- Students will be proficient in designing combinational and sequential MOS logic circuits with an emphasis on power management.
- Students will acquire skills to design and optimize arithmetic building blocks and memory subsystems.
- Students will be able to implement VLSI designs using FPGAs and apply advanced testing techniques.
- Students will be familiar with the latest advancements in VLSI design and testing, including new memory technologies and machine learning-based fault detection.

TEXT BOOK(S):

1 Neil H.E. Weste, David Money Harris “CMOS VLSI Design: A Circuits and Systems Perspective”, 4th Edition, Pearson, 2017.

2 Jan M. Rabaey ,Anantha Chandrakasan, Borivoje. Nikolic, ”Digital Integrated Circuits:A Design perspective”, Second Edition, Pearson, 2016.

REFERENCE BOOK(S) / WEB LINKS:

1 M.J. Smith, “Application Specific Integrated Circuits”, Addisson Wesley, 1997.

2 Sung-Mo kang, Yusuf leblebici, Chulwoo Kim “CMOS Digital Integrated Circuits:Analysis& Design”,4th edition McGraw Hill Education,2013.

3 Wayne Wolf, “Modern VLSI Design: System On Chip”, Pearson Education, 2007.

4 R.Jacob Baker, Harry W.LI., David E.Boyee, “CMOS Circuit Design, Layout and Simulation”, Prentice Hall of India 2005.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	1	3	3	3	3	3	-	-	-	-	-	3	3	3	3
CO 2	1	3	3	3	3	3	-	-	-	-	-	3	3	3	3
CO 3	1	3	3	3	3	3	-	-	-	-	-	3	3	3	3
CO 4	1	3	3	3	3	-	-	-	-	-	-	3	3	3	3

CO 5	1	3	3	3	3	-	-	-	-	-	-	3	3	3	3
AVG.	**1**	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**3**	**3**

DOMAIN: BIO-ENGINEERING

BM23B11	NEURAL ENGINEERING	Category	L	T	P	C
		PE	3	0	0	3

OBJECTIVES:

- To discuss the various physiological aspects of nerve impulse generation and Electromyography.
- To apply Neural Engineering Principles to Clinical Applications.
- To explore the importance of evoked potentials.
- To introduce various methods to study central and peripheral nerve function.
- To discuss the various physiological aspects of nerve impulse generation and electromyography.

UNIT-I NEUROLOGICAL FUNCTIONS AND DISORDERS 9

Nerve Excitability: Functional insights derived from axonal structures, Nerve excitability findings in Neurologic diseases: Chemotherapy induced neurotoxicity, Porphyric Neuropathy, Inflammatory Neuropathy and its Treatment, Spinal Cord Injury; Electrophysiologic study of Disorders of Neuromuscular Junction, H-Reflex and F-Reflex, Blink reflex and other cranial nerve reflexes.

UNIT-II ELECTROPHYSIOLOGIC FINDINGS AND CLINICAL IMPLICATIONS 9

Nerve conduction studies, Microneurography and its potential clinical applications. Clinical Electromyography (EMG), Quantitative EMG, Electroencephalography (EEG): General Principles and Clinical Applications, Neonatal and Pediatric EEG, EEG Artefacts and Benign Variants, Video EEG monitoring for epilepsy, Invasive Clinical Neurophysiology in Epilepsy and movement disorders, Topographic mapping, Frequency analysis and other quantitative techniques in EEG, Intraoperative EEG monitoring during carotid endarterectomy and cardiac surgery, Magnetoencephalography.

UNIT-III EVOKED POTENTIALS 9

Evoked Potentials and Related Techniques: Visual Evoked potentials (VEPs), Electroretinography and other diagnostic approaches to the Visual System, VEPs in infants and children, Brainstem Auditory Evoked Potentials (AEPs), Brainstem AEPs in infants and children, Somatosensory evoked potentials, Diagnostic and therapeutic role of Magnetic stimulation in neurology.

UNIT-IV FUNCTIONAL NEUROIMAGING 9

Historical and physiological perspective, Functional neuroimaging methods: PET and fMRI, Network analyses, Functional neuroimaging of: Attention, Visual recognition, Semantic memory, Language, Episodic memory, Working memory, Cognitive aging, Neuro- psychologically impaired patients.

UNIT-V BRAIN-COMPUTER INTERFACES (BCI) 9

Basics of Brain-Computer Interfaces, Brain-Computer Interface types: Invasive BCI, partially invasive BCI, Noninvasive BCI acquisition techniques, Computational Neurobiology, Neuromodulation and Recordings: Brain-Computer Interfaces (BCI) Devices and Systems, Introduction to BCI Devices for Neural Recording and Stimulation.

Contact Hours : 45

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Apply nerve excitability in neurological disorders.
- Apply neural engineering principles to diagnose and manage neurological disorders and injuries.
- Identify various diagnostic approaches to the visual systems.
- Distinguish between a normal and abnormal signal coming from a healthy and a diseased nervous system respectively.
- Apply different electrophysiological evaluations in special situations.

TEXT BOOK(S):

1 Aminoff, Michael J., Jeffrey W. Ralph, and Francis Walker. Aminoff's Diagnosis of Neuromuscular Disorders-Ebook. Elsevier Health Sciences, 2024.
2 Barrett, Kim E., et al. Ganong's review of medical physiology. McGraw-Hill Companies, Inc., 2010.
3 Hassanien AE, Azar AA. Brain-computer interfaces. Switzerland: Springer. 2015;74.

REFERENCE BOOK(S) / WEB LINKS:

1 Eric R. Kandelet. al., ―Principles of Neural Science‖, McGraw-Hill, New York, 2012.
2 R. Cooper, et. al, ―Techniques in Clinical Neurophysiology: A Practical Manual, Elsevier, Amsterdam, The Netherlands, 2005.
3 Holodny, Andrei I., et al, ―Functional neuroimaging: a clinical approach‖. Informa HealthCare, 2008.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	1	-	1	-	1	-	-	-	-	-	-	3	-
CO 2	3	3	3	2	2	-	2	-	-	-	-	-	-	3	-
CO 3	3	3	3	3	3	-	3	-	-	-	-	-	-	3	-
CO 4	3	3	3	3	3	-	3	-	-	-	-	-	-	3	-
CO 5	2	3	3	3	3	-	3	1	3	2	3	1	3	3	3
AVG.	**2.8**	**3**	**2.6**	**2.7**	**2.4**	**-**	**2.4**	**1**	**3**	**2**	**3**	**1**	**3**	**3**	**3**

BM23B12 TISSUE ENGINEERING **Category** **L T P C**

PE 3 0 0 3

OBJECTIVES:

- To understand the fundamental concepts of tissue engineering.
- To explore cell biology principles relevant to tissue engineering.
- To investigate advanced scaffold materials and technologies.
- To analyze ethical considerations and integration strategies in tissue engineering.
- To apply tissue engineering techniques to biological problems.

UNIT-I FUNDAMENTAL OF TISSUE ENGINEERING 9

Fundamentals Of Stem Cell Tissue Engineering; Growth Factors; Extracellular Matrix: Structure, Function And Tissue Engineering Application; Mechanical Forces On Cells; Bioreactor Systems in Tissue Engineering.

UNIT-II CELL BIOLOGY IN TISSUE ENGINEERING 9

Cell Sources for Tissue Engineering: Types of cells, stem cells and their potential, Isolation and Culture of Cells: Methods of cell isolation and culture techniques, Cell Growth and Differentiation: Influencing factors and differentiation pathways, Cell Adhesion and Migration: Mechanisms of cell adhesion, migration, and signaling pathways, Bioreactors: Types, designs, and applications.

UNIT-III ADVANCED SCAFFOLD MATERIALS 9

Properties of ideal scaffold materials: mechanical strength, porosity, degradation rate. Natural Scaffold Materials - Collagen-based scaffolds, Chitosan and hyaluronic acid scaffolds; Synthetic Scaffold Materials - Polymeric scaffolds: PLGA, PCL, and their blends; Functionalization Techniques –: chemical and physical surface modification methods.

UNIT-IV SCAFFOLD FABRICATION TECHNOLOGIES 9

Techniques for modifying scaffold surfaces for enhanced cell interactions, 3D Bioprinting: Principles, technologies, and applications of 3D bioprinting for creating complex tissue structures, Electrospinning: Process and applications for producing nanofibrous scaffolds, Smart Biomaterials: Introduction to stimuli-responsive materials and their applications.

Case Studies: Examples of innovative scaffold technologies and their applications in research and clinical settings.

UNIT-V APPLICATIONS OF TISSUE ENGINEERING 9

Bone Tissue Engineering: Techniques and scaffold design for bone regeneration. Vascular Tissue Engineering: Methods for creating vascular tissues and current research. Corneal Tissue Engineering: Approaches and applications for corneal repair. Soft Tissue Engineering: Applications for sutures, adhesives, and implants. Prosthetic Cardiac Valves: Design and integration of cardiac valves.

Contact Hours : 45

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Demonstrate a comprehensive understanding of fundamental tissue engineering concepts.
- Implement key cell biology principles to tissue engineering practices.
- Evaluate and select advanced scaffold materials and technologies for specific applications.
- Address Ethical and Integration Challenges in Tissue Engineering.
- Implement tissue engineering techniques to address and solve biological challenges.

TEXT BOOK(S):

1 Pallua, N. and Suscheck, C.V., “Tissue Engineering: From Lab to Clinic” Springer,2010.

2 Saltzman, W.M., “Tissue Engineering”, Oxford University Press, 2004.

3 Meyer, U.; Meyer, Th.; Handschel, J.; Wiesmann H.P. Fundamentals of Tissue Engineering and Regenerative Medicine.2009.

REFERENCE BOOK(S) / WEB LINKS:

1 Palsson, B., Hubbell, J.A., Plonsey, R. and Bronzino, J.D., "Tissue Engineering", CRC Press, 2003.
2 Palsson, B.O. and Bhatia, S., "Tissue Engineering", Pearson Prentice Hall, 2004.
3 Scheper, T., Lee, K. and Kaplan, D., "Advances in Biochemical Engineering / Biotechnology – Tissue Engineering I", Volume 102, Springer-Verlag Berlin Heidelberg, 2006.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	1	-	1	-	1	-	-	-	-	-	-	3	-
CO 2	3	3	3	2	2	-	2	-	-	-	-	-	-	3	-
CO 3	3	3	3	3	3	-	3	-	-	-	-	-	-	3	-
CO 4	3	3	3	3	3	-	3	-	-	-	-	-	-	3	-
CO 5	2	3	3	3	3	-	3	1	3	2	3	1	3	3	3
AVG.	**2.8**	**3**	**2.6**	**2.7**	**2.4**	**-**	**2.4**	**1**	**3**	**2**	**3**	**1**	**3**	**3**	**3**

BM23B13 DRUG DELIVERY IN BIOLOGICAL SYSTEM Category L T P C

PE 3 0 0 3

OBJECTIVES:

- To acquire knowledge in advanced therapeutic delivery methods, focusing on formulation-relevant physicochemical properties.
- To understand the fundamental principles governing drug kinetics and dynamics within the body.
- To explore various approaches for developing sustained and controlled release systems
- To design and evaluate targeted drug delivery mechanisms to enhance efficacy and minimize side effects.
- To analyze the advanced concepts and practical applications of dendrimers, drug-eluting stents, and polymer drug conjugates in modern drug delivery systems.

UNIT-I FUNDAMENTALS OF DRUG DELIVERY SYSTEMS 9

Historical perspectives and evolution; an overview of types and classifications of drug delivery systems – polymer, hydrogel, lipid and metal based.

Molecular Properties of Drugs: Solubility - Importance of drug solubility in formulation development, techniques to enhance solubility - solubilizers, complexation, and particle size reduction; Stability - Chemical and physical stability of drugs, Factors affecting stability and

methods to improve it, Permeability -Drug permeability and absorption, Enhancing permeability - use of permeation enhancers and prodrugs

Drug Delivery Routes: Oral, parenteral, transdermal, and other routes.

UNIT-II PHARMACOKINETICS AND PHARMACODYNAMICS OF DRUGS 9

Pharmacokinetics: Principles of ADME -Absorption, Distribution, Metabolism, Excretion.

Pharmacokinetic Parameters: Half-life, clearance, bioavailability, and area under the curve (AUC)

Pharmacodynamics: Overview of pharmacodynamics and its role in understanding drug effects, Mechanisms of Drug Action: Drug-receptor interactions - Agonists, antagonists, partial agonists; Dose-response relationships -Potency, efficacy, therapeutic index.

UNIT-III CONTROLLED DRUG DELIVERY 9

Types of CDDS: diffusion-controlled, chemically controlled, osmotically controlled systems. Factors influencing the design of controlled drug delivery systems.

Formulation and Characterization: Polymers used in CDDS, drug-polymer interactions, In vitro and in vivo characterization, biodegradable implants and smart drug delivery system

Therapeutic Applications: Use of controlled drug delivery systems in various therapeutic areas such as oncology, diabetes, and cardiovascular diseases.

UNIT-IV TARGETED DRUG DELIVERY 9

Principles of drug targeting and molecular basis of targeted drug delivery: Receptor mediated endocytosis; Different levels of targeting-first order, second order and third order targeting; Different types of targeting-active and passive targeting.

Carrier based approach for targeted drug delivery: Functionalized liposomes, polymeric and lipid nanoparticles, liquid crystalline nanoparticles, polymeric micelles, functionalized carbon nanotubes and inorganic nanoparticles.

UNIT-V ADVANCED DRUG DELIVERY 9

Dendrimers: Characterization of dendrimers; Dendrimer–drug interactions; Dendrimer biocompatibility and toxicity

Drug-eluting stents: Role of stent design and coatings on restenosis and thrombosis; Mechanisms of controlled drug release from drug-eluting stents

Case study: Clinical experience and applications of drug-eluting stents in the noncoronary vasculature

Polymer drug conjugates (PDCs) in drug delivery: Need of PDCs as polymeric prodrugs in drug delivery; Polymers used in PDCs; linkers, Design of PDCs, Factors affecting PDCs; PDCs in cancer therapy.

Contact Hours : 45

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Demonstrate knowledge of advanced therapeutic delivery methods with an emphasis on formulation-relevant physicochemical properties.s
- Comprehend and apply the fundamental principles of drug kinetics and dynamics within the body.

- Evaluate various approaches for developing sustained and controlled release systems..
- Design and assess targeted drug delivery mechanisms to enhance efficacy and minimize side effects.
- Model and apply advanced concepts such as dendrimers, drug-eluting stents, and polymer drug conjugates in modern drug delivery systems.

TEXT BOOK(S):

1 Anya M. Hillery and Kinam Park,"Drug Delivery: Fundamentals and Applications", 2nd Edition, CRC Press, 2016
2 KK Jain, "Drug Delivery Systems", 1st Edition, Humana Press, 2008.
3 W. Mark Saltzman, "Drug Delivery: Engineering Principles for Drug Therapy", Oxford University Press, 2001.

REFERENCE BOOK(S) / WEB LINKS:

1 Amit Kumar Nayak, Md Saquib Hasnain, Bibek, "Advanced and Modern Approaches for Drug Delivery",1st Edition, Elsevier, 2023.
2 Vasant V. Ranade, John B. Cannon, "Drug Delivery Systems" 3rd Edition, CRC Press, 2009.
3 S.P. Vyas and R.K. Khar, "Controlled Drug Delivery -concepts and advances", First edition, Vallabh Prakashan, New Delhi, 2002.
4 D. K. Tripathi, Amit Alexander; "Novel Drug Delivery Systems", PharmaMed Press / BSP Books, 1st Edition, 2019.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	3	3	3	1	2	-	-	-	2	3	3	-
CO 2	3	3	3	3	3	3	1	2	-	-	-	2	3	3	-
CO 3	3	3	3	3	3	3	1	2	-	-	-	2	3	3	-
CO 4	3	3	3	3	3	3	1	2	-	-	-	2	3	3	-
CO 5	3	3	3	3	3	3	1	2	-	-	-	2	3	3	-
AVG.	**3**	**3**	**3**	**3**	**3**	**3**	**1**	**2**	**-**	**-**	**-**	**2**	**3**	**3**	**-**

BM23B14 BIOMATERIALS AND APPLICATIONS Category L T P C

PE 3 0 0 3

OBJECTIVES:

- To study the characteristics, classifications, properties, and biological applications of biomaterials .
- To understand different metals and ceramics used as biomaterials
- To study the types, properties and clinical application of polymeric and Composite biomaterials.
- To study the different types of soft and hard tissue implants.

- To understand the concept of biocompatibility testing methods and human body responses to biomaterials.

UNIT-I INTRODUCTION TO BIO-MATERIALS 9

Definition and classification of bio-materials, Biocompatibility, Biodegradable material, Bioresorbable material, Bio-inert material, Bio-active material, Characterization of biomaterials: mechanical properties, surface properties, Desirable Properties of Biomaterial, Performance of Biomaterials, Applications of Biomaterials with examples.

UNIT-II METALLIC AND CERAMIC BIOMATERIALS 9

Metallic Biomaterials: Stainless steels, co-based alloys, Ti-based alloys, shape memory alloy, applications.

Ceramic Biomaterials: Introduction, Types of Ceramics, Bio-inert ceramics: Alumina, Zirconia, Carbon, Bioresorbable ceramics: Calcium Phosphate, Bioactive ceramics: Glass ceramics, Applications.

UNIT-III POLYMERIC AND COMPOSITE BIOMATERIALS 9

Polymeric Biomaterials: Polymerization, Polyethylene, bioerodible polymers, Blood compatible polymers, Bioactive polymers, Hydrogels; Methacrylates, Drug incorporation polymer gels,

Case Study: Biodegradable polymers for medicinal applications.

Composite Biomaterials: Introduction, Dental filling Composites & cement, Porous Composites, Fibrous & Particulate composites.

UNIT-IV TISSUE REPLACEMENT IMPLANTS 9

Soft tissue replacements, sutures, surgical tapes, adhesive, Percutaneous and skin implants, maxillofacial augmentation, Vascular grafts, Prosthetic Cardiac Valves, hard tissue replacement Implants, Internal fixation device, joint replacements, dental implants.

Case Study: Failure analysis of internal fixation devices.

UNIT-V BIOCOMPATIBILITY TESTING AND RESPONSE OF BIOMATERIAL TO HUMAN BODY 9

Biocompatibility Testing: Introduction, In vitro assessment of tissue compatibility: assay methods - direct contact test, agar diffusion test, elution test, clinical use. In vivo assessment of tissue compatibility.

Response of Biomaterial to Human Body: Blood-Biomaterial Interactions, Biomaterials-Tissue Interactions, Tissue response to Implants, Inflammation, Wound Healing.

Contact Hours : 45

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Define and classify biomaterials, understanding their properties and applications.
- Identify metals and ceramic implants used for medical applications.
- Illustrate the types, composition, properties and applications of Polymeric & Composite biomaterials.
- Outline the concept behind the different tissue replacements.
- Decide the testing procedure for specific biomaterial implant and evaluate the response of biomaterial to Human body

TEXT BOOK(S):

1 Sujata V. Bhatt, “Biomaterials”, Second Edition, Narosa Publishing House, 2005.
2 BD Ratner, AS Hoffmann,FJ Schoen, JE Lemmons, “An Introduction to Materials inMedicine” Academic Press, Third Edition, 2013.
3 Park J.B, R.S Lakes “Biomaterials an Introduction”, Springer, 2007.

REFERENCE BOOK(S) / WEB LINKS:

1 Joseph D Bronzino, “Biomedical engineering Fundamentals”, CRC press, Third Edition, 2006.
2 A.C Anand, J F Kennedy, M.Miraftab, S.Rajendran, “Woodhead Medical Textiles andBiomaterialsfor Healthcare”, Publishing Limited 2006.
3 Andrew F.VonRacum, Handbook of Biomaterials Evaluation: Scientific, Technical and Clinical Testing of Implant Materials, Second Edition, CRC Press, 1998.
4 M.F. Maitz, Applications of synthetic polymers in clinical medicine, Biosurface and Biotribology, Volume 1, Issue 3, 2015, Pages 161-176, ISSN 2405-4518, https://doi.org/10.1016/j.bsbt.2015.08.002.
5 Baran, George &Kiani, Mohammad & Samuel, Solomon. (2014). Healthcare and biomedical technology in the 21st century: An introduction for non-science majors. 10.1007/978-1-4614-8541-4.
6 Birringer, R.P., Ganot, G.S. & James, B.A. Failure Analysis of Internal Fixation Medical Devices: Overview and Case Studies. J Fail. Anal. And Preven. 16, 849–857 (2016).

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	3	3	3	1	2	-	-	-	2	3	3	-
CO 2	3	3	3	3	3	3	1	2	-	-	-	2	3	3	-
CO 3	3	3	3	3	3	3	1	2	-	-	-	2	3	3	-
CO 4	3	3	3	3	3	3	1	2	-	-	-	2	3	3	-
CO 5	3	3	3	3	3	3	1	2	-	-	-	2	3	3	-
AVG.	**3**	**3**	**3**	**3**	**3**	**3**	**1**	**2**	**-**	**-**	**-**	**2**	**3**	**3**	**-**

BM23B15 **MEDICAL CODING** **Category** **L** **T** **P** **C**

PE **3** **0** **0** **3**

OBJECTIVES:

- To study the fundamentals of medical coding.
- To study the concepts of types of medical coding.
- To illustrate Current procedural Terminology and its necessities.
- To facilitate the processing of health insurance claims by Medicare and other insurers.
- To study about various health care facilities and health care organization.

UNIT-I MEDICAL TERMINOLOGY 9

Etymology, medical words, Medical Instruments & Equipment, Medical Specialties & Specialists, Diagnostic Medicine, Abbreviations, Anatomy and Physiology, Pharmacology, Drug listing – generic alpha, name brand cross-reference, plus 200 of the most commonly prescribed drugs, Medical Coding Basics-Introduction-Need, Types of Medical Coding, Medical Coding Tools & Resources.

UNIT-II INTERNATIONAL CLASSIFICATION OF DISEASES (ICD) 9

Introduction, ICD-9, ICD-10, ICD-11, Overview of ICD-9-CM Layout, Steps to Look Up a Diagnosis Code, ICD-9-CM Official Guidelines for Coding and Reporting, medical necessity, NCHS.

UNIT-III CURRENT PROCEDURAL TERMINOLOGY (CPT) 9

Introduction to CPT, CPT Category I, II & III Codes, CMS, sections of CPT, Significance of Parent codes, CPT Modifiers, CPT Evaluation and Management, Symbols and significance, Alphanumeric codes overview of categories II and III.

UNIT-IV HEALTHCARE COMMON PROCEDURE CODING SYSTEM CODES 9

Introduction, Significance and Usage, HCPCS Level I and HCPCS Level II codes, CPT vs HCPCS, Modifiers Level II HCPCS, Dental codes, Miscellaneous codes , Temporary national codes, Types of temporary HCPCS Level II Codes.

UNIT-V CROSSWALKING AND HEALTH INSURANCE SPECIALIST 9

Introduction, Requirement, Mapping, GEMS, CPT code-Musculoskeletal coding, Digestive System Coding, Urology and Reproductive system coding, Pulmonology and Cardiovascular coding.

Contact Hours : 45

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Understand the various medical terminologies and basics of medical coding basics. sign.
- Examine the ICD and its different forms.
- Demonstrate CPT and it various categories and their necessities.
- Analyze the concept of HCPCS codes, its types and modifiers.
- Point out the requirement of cross walking in medical coding. Familiarize the various health care facilities and health organizations.

TEXT BOOK(S):

1 Johnson, S. L., & Linker, R. (2015). Understanding medical coding: A comprehensive guide. Cengage Learning.
2 Aalseth, P. (2014). Medical coding. Jones & Bartlett Publishers.

REFERENCE BOOK(S) / WEB LINKS:

1 Shiland, B. J. (2014). Medical Terminology & Anatomy for ICD-10 Coding-E-Book. Elsevier Health Sciences.
2 Buck, C. J. (2016). Step-by-Step Medical Coding, 2017 Edition-E-Book.Elsevier Health

Sciences.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	1	-	2	2	3	-	-	1	1	-	3	2	1	-
CO 2	2	3	-	2	1	2	2	-	1	-	1	2	2	3	2
CO 3	1	1	-	3	2	3	1	1	1	-	1	2	3	3	2
CO 4	1	1	-	3	2	3	-	1	2	-	2	2	3	3	1
CO 5	1	2	-	3	2	3	1	2	2	-	2	2	3	3	3
AVG.	**1.6**	**1.6**	**-**	**2.6**	**1.8**	**2.8**	**1.33**	**1.33**	**1.4**	**1**	**1.5**	**2.2**	**2.6**	**2.6**	**2**

BM23B16 NANOTECHNOLOGY AND APPLICATIONS Category L T P C

PE 3 0 0 3

OBJECTIVES:

- To comprehend the foundational scientific principles underlying nanoscience.
- To integrate multidisciplinary approaches for the synthesis of nanomaterials.
- To explore the different types of nanomaterials and their classifications.
- To learn about the characterization tools used in nanotechnology.
- To evaluate the societal impact of nanotechnology, including its regulatory frameworks and ethical considerations.

UNIT I INTRODUCTION 9

Scientific revolutions –Time and length scale in structures – Definition of a nanosystem – Dimensionality and size dependent phenomena – Surface to volume ratio. Properties at nanoscale (optical, mechanical, electronic, and magnetic). Definition, Objective and goal of Nanotechnology, Importance of Nanoscale, revolution of Nanotechnology.

UNIT-II GENERAL METHODS OF SYNTHESIS 9

Nanoparticles through homogeneous and heterogeneous nucleation-Growth controlled by surface and diffusion process- Oswald ripening process - influence of reducing agents.

Fabrication methods – Top down processes: Milling, lithographics, Machining process, vapour deposition. Bottom–Up process: Colloidal and Sol – gel methods, electro deposition, Self Assembly. Emerging Technique- Additive manufacturing (3D printing), chemical vapor deposition (CVD), and laser ablation.

UNIT-III NANOMATERIALS 9

Classification based on dimensionality- Quantum Dots, Wells and Wires- Carbon- based nano materials (buckyballs, nanotubes, graphene)– Metalbased nano materials (nanogold, nanosilver and metal oxides) -Nanocomposites- Nanopolymers – Nanoglasses –Nano ceramics –Biological

nanomaterials.

Case Study: Engineered CNT and its applications.

UNIT-IV NANOSTRUCTURED MATERIALS CHARACTERIZATION TECHNIQUES **9**

X-ray diffraction (XRD), SEM, EDAX, TEM, Elemental mapping, FTIR, UV-Visible spectrophotometer, Laser Raman Spectroscopy, Nanomechanical Characterization Using Nanoindentation, Differential Scanning Calorimeter (DSC), Differential Thermal Analyzer (DTA), Thermogravimetric Analysis (TGA), TEM, X-ray Photoelectron Spectroscopy (XPS), ICP-AES chemical analysis, Electrochemical Characterization measurements, particle size analyzer.

UNIT-V NANOTECHNOLOGY IN HEALTH CARE **9**

Properties of nanocarriers; drug delivery systems used in nanomedicine; Enhanced Permeability and Retention effect; Blood-brain barrier; Active and passive targeting of diseased cells; Nanotechnology in diagnostics, Theranostics (therapeutic and diagnostic functions), Nanotechnology in regenerative medicine, Nanotechnology in defense applications, Environmental applications of nanotechnology, Health and environmental impacts of nanotechnology, Regulatory and ethical considerations.

Case Study: Nano-toxicological studies.

Contact Hours : 45

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Gain thorough knowledge of the general principles of physics, chemistry, electronics, and biology that play a role on the nanometer scale.
- Understand the essential concepts used in nanotechnology, including synthesis and fabrication techniques.
- Develop an understanding of materials and their properties at the atomic and nanometer levels, including the intimate relationship between material scale and the properties/functionality of materials.
- Acquire sound grounding in various characterization techniques used in nanotechnology.
- Demonstrate awareness of the socioeconomic impacts of nanotechnology and the toxicological issues associated with it.

TEXT BOOK(S):

1 Edelstein. A.S. and R.C. Cammearata, eds., “Nanomaterials: Synthesis, Properties and Applications”, Institute of Physics Publishing, Bristol and Philadelphia, 1996.

2 John Dinardo. N, “Nanoscale charecterisation of surfaces & Interfaces”, 2nd edition, Weinheim Cambridge, Wiley-VCH, 2000.

3 Bio-Nanotechnology_ Concepts and applications. Madhuri Sharon, Maheshwar Sharon,Sunil Pandey and Goldie Oza, Ane Books Pvt Ltd, 1 edition 2012.

REFERENCE BOOK(S) / WEB LINKS:

1 Timp .G, “Nanotechnology”, AIP press/Springer, 1999.

2 Akhlesh Lakhtakia (Editor),“The Hand Book of Nano Technology, Nanometer Structure, Theory, Modeling and Simulations”. Prentice-Hall of India (P) Ltd, New Delhi, 2007.

3 Niemeyer C. M., “Nanobiotechnology: Concepts, Applications and Perspectives”, Wiley –

VCH, 2006.

4 Nicolas Bertrand, Jun Wu, Xiaoyang Xu, Nazila Kamaly, Omid C. Farokhzad, Cancer nanotechnology: The impact of passive and active targeting in the era of modern cancer biology, Advanced Drug Delivery Reviews, Volume 66, 2014, Pages 2-25, ISSN 0169-409X, https://doi.org/10.1016/j.addr.2013.11.009.

5 Greish K. Enhanced permeability and retention (EPR) effect for anticancer nanomedicine drug targeting. Methods Mol Biol. 2010;624:25-37. doi: 10.1007/978-1-60761-609-2_3. PMID: 20217587.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	-	-	-	-		-	-	-	1	3	3	-
CO 2	3	3	3	-	-	-	-	-	-	-	-	1	3	3	-
CO 3	3	3	2	2	-	2	-		-	-	-	1	3	3	-
CO 4	3	3	3	-	-	-	-	-	-	-	-	1	3	3	-
CO 5	3	3	2	2	-	2	2	2	-	-	-	1	3	3	-
AVG.	**3**	**3**	**2.6**	**0.8**	**-**	**2**	**2**	**2**	**-**	**-**	**-**	**1**	**3**	**3**	**-**

BM23B17 MEDICAL PHYSICS Category L T P C

PE 3 0 0 3

OBJECTIVES:

- To study effects of sound and light in human body.
- To understand the effects of radiation in matter and how isotopes are produced.

UNIT-I NON IONIZING RADIATION AND ITS MEDICAL APPLICATION 9

Overview of non-ionizing radiation effects-Low Frequency Effects- Higher frequency effects. Thermography – Application. Ultrasound Transducer - Interaction of Ultrasound with matter; Cavitations, Conditions for reflection, Transmission-Scanning systems – Artefacts- Ultrasound Doppler-Double Doppler shift Clinical Applications.

UNIT-II PRINCIPLES OF RADIOACTIVE NUCLIDES 9

Radioactive Decay – Spontaneous Emission – Isometric Transition – Gamma ray emission, alpha, beta, Positron decay, electron capture, Sources of Radioisotopes Natural and Artificial radioactivity, Radionuclide used in Medicine and Technology ,Decay series, Production of radionuclides – Cyclotron produced Radionuclide- Reactor produced Radio- nuclide-fission and electron Capture reaction, radionuclide Generator-Milking process (Technetium generator).

UNIT-III INTERACTION OF RADIATION WITH MATTER 9

Interaction of charged particles with matter –Specific ionization, Linear energy transfer range, Bremsstrahlung, Annihilation, Interaction of X and Gamma radiation with matter- Photoelectric effect, Compton Scattering , Pair production, Attenuation of Gamma Radiation ,Interaction of

neutron with matter and their clinical significance.

UNIT-IV PRINCIPLES OF RADIATION DETECTION AND DOSIMETERS 9

Principles of radiation detection, Properties of dosimeters, Theory of gas filled detectors, Ionization Chamber, Proportional chamber, G.M. Counter, Film dosimetry, luminescence dosimetry, scintillation detectors, Radiation detection instruments, Area survey meters, Personal Radiation monitoring device, Film badge, TLD, OSLD.

UNIT-V BASIC RADIATION QUANTITIES 9

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

Contact Hours : 45

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Comprehend and appreciate the significance and role of this course in the present contemporary world.
- Discuss the effect of non-ionizing radiation in human body and applications in the field of medicine
- Understand radioactive decay and production of radio nuclides.
- Discuss the measurement of ionizing radiation.
- Enumerate the effect of ionizing radiation in human body.

TEXT BOOK(S):

1 JohnR Cameron, James G Skofronick, “Medical Physics”,John-Wiley&Sons,1978.

2 W.J.Meredith andJ.B. Massey, “Fundamental Physics of Radiology” Varghese Publishing.

REFERENCE BOOK(S) / WEB LINKS:

1 P.Uma Devi, A.Nagarathnam, BS Satish Rao, “Introduction to Radiation Biology”, B.I Chur Chill Livingstone Pvt. Ltd, 2000.

2 S.Webb, “The Physics of Medical Imaging”, Taylor and Francis, 1988.

3 J.P.Woodcock, Ultrasonic, “Medical Physics Handbook series 1”,Adam Hilger, Bristol, 2002.

4 Hylton B.Meire and Pat Farrant, “Basic Ultrasound”, John Wiley & Sons, 1995

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	-	-	-	-	-	-	-	-	3	-	3	1	1	-
CO 2	1	-	-	-	3	1	3	3	3	3	-	3	1	1	-
CO 3	1	-	-	-	3	3	3	3	3	3	-	3	1	1	-
CO 4	1	-	-	-	3	3	3	3	3	3	-	3	1	1	-
CO 5	1	-	-	-	3	3	3	3	3	3	-	3	1	1	-
AVG.	**1.4**	**-**	**-**	**-**	**3**	**2.5**	**3**	**3**	**3**	**3**		**3**	**1**	**1**	**-**

DOMAIN: MEDICAL IMAGING MODALITIES

BM23C11	PATTERN RECOGNITION AND NEURAL NETWORKS	Category	L	T	P	C
		PE	3	0	0	3

OBJECTIVES:

- To study the fundamentals of pattern recognition and its application.
- To learn algorithms suitable for pattern classification.
- To understand applications of pattern recognition and classification in image processing and computer vision.
- To know the fundamentals of Artificial Neural Network.
- To gain knowledge about various ANN model and self-organizing map.

UNIT-I SUPERVISED LEARNING 9

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

UNIT-II UNSUPERVISED LEARNING AND CLUSTERING ANALYSIS 9

Unsupervised learning- Hierarchical clustering- Single-linkage Complete – linkage Average - Linkage and Ward‘s method. Partitional clustering- Forgy‘s Algorithm and k-means algorithm- Case studies.

UNIT-III ARTIFICIAL NEURAL NETWORK: AN OVERVIEW 9

Basics of Artificial Neural network--Biological neuron, Properties-Artificial model-Network parameters: Weight, activation, threshold-Typical architecture: Single layer net, Multilayer net, competitive layer-Common activation function- - McCulloch Pitt’s net: Architecture- - Hebb net: Architecture- Hebb net: - Perceptron: Architecture.

UNIT-IV BACK PROPAGATION NETWORK AND ASSOCIATIVE MEMORY 9

Feed forward networks - Back propagation network- structure- Applications- BPN -Associative memory: Hetero-associative memory : Architecture-Applications- Associative memory: Auto associative Net: Architecture- Applications-Hopfield network: Architecture, -Boltzmann machine-Issue in network design-Radial Basis function.

UNIT-V NEURAL NETWORKS BASED ON COMPETITION 9

Kohonen SOM: Architecture--Learning vector Quantization (LVQ): Architecture-Max net: Architecture -Mexican Hat: Architecture-Hamming net: Architecture ART: Basic architecture-Learning in ART-Visualization in U matrix-Basics of SVM.

Contact Hours : 45

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Classify patterns using statistical pattern classifier :
- Perform unsupervised classification using clustering techniques.

- Explain the fundamentals of neural networks.
- Design Back Propagation and Hopfield network.
- Perform classification using competitive neural networks.

TEXT BOOK(S):

1 Duda R.O, Hart P.G, “Pattern Classification and scene analysis’’, Wiley Edition, 2000.

2 Earl Gose, Richard Johnsonbaugh Steve Jost, “Pattern Recognition and Image Analysis”, Prentice Hall of India Pvt Ltd., New Delhi,1999.

3 Freeman J. A., and Skapura B.M, “Neural networks, algorithms, applications and programming techniques”, Addison- Wesley, 2003.

4 Laurene Fausett, “Fundamentals of Neural Networks- Architectures, Algorithms and Application”, Prentice Hall, 1994.

REFERENCE BOOK(S) / WEB LINKS:

1 Hagan, Demuth and Beale, “Neural Network Design’’, Vikas Publishing House Pvt Ltd., New Delhi, 2002.

2 Robert Schalkoff, “Pattern recognition, Statistical, Structural and neural approaches”, John Wiley and Sons (Asia) Pvt Ltd., Singapore, 2005

3 B.Yegnanarayana, “Artificial Neural Networks”, Prentice Hall of India, 3rd edition, 2006.

4 Mohamad H. Hassoun, “Fundamentals of Artificial Neural Network”, Cambridge,The MIT Press, 1stedition,1995

5 S. N. Sivanandam, S. N Deepa, “Introduction to Neural Networks Using Matlab 6.0”, TataMcGrawHill, 2006

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	2	1	-	-	-	-	-	-	-	1	1	2	2
CO 2	3	2	2	1	-	-	-	-	-	-	-	1	1	2	2
CO 3	3	2	2	1	-	-	-	-	-	-	-	1	1	2	2
CO 4	3	2	2	1	-	-	-	-	-	-	-	1	1	2	2
CO 5	3	2	2	1	-	-	-	-	-	-	-	1	1	2	2
AVG.	**3**	**2**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**2**	**2**

BM23C12 BIOMETRIC SYSTEMS Category L T P C

PE 3 0 0 3

OBJECTIVES:

- To understand the fundamental principles and technologies of biometric systems.
- To explore various biometric modalities and their applications.
- To develop skills in designing and implementing biometric systems.
- To gain hands-on experience with biometric data acquisition and analysis.
- To foster innovation in solving security and identification challenges using biometric

technologies.

UNIT-I INTRODUCTION TO BIOMETRIC SYSTEMS 9

Principles and definitions of biometric systems - History and evolution of biometric technologies - Overview of biometric modalities – Fingerprint, Face, Iris, Voice - Introduction to biometric data acquisition devices (e.g., fingerprint scanners, cameras) - Hands on practice - Basic biometric data acquisition exercises.
Mini Project - Collect and analyze fingerprint data samples to understand variability and uniqueness.

UNIT-II FINGERPRINT RECOGNITION 9

Principles of fingerprint recognition - Fingerprint patterns and minutiae points - Fingerprint acquisition and preprocessing techniques –
Hands on Practices - Fingerprint image acquisition and preprocessing using software tools - Implementation of fingerprint matching algorithms
Mini Project - Design and implement a simple fingerprint recognition system.

UNIT-III FACE RECOGNITION 9

Principles of face recognition - Facial features and extraction techniques - Face recognition algorithms and methods - Facial feature extraction using image processing software
Hands on practice - Implementation of face recognition algorithms
Mini Project - Design and implement a simple face recognition system.

UNIT-IV IRIS AND VOICE RECOGNITION 9

Principles of iris recognition - Principles of voice recognition - Iris and voice data acquisition and preprocessing techniques
Hands-On Practices - Iris image acquisition and preprocessing using software tools, Voice data acquisition and preprocessing using audio processing tools
Mini Project - Design and implement a simple iris or voice recognition system.

UNIT-V MULTIMODAL BIOMETRIC SYSTEMS AND FUTURE TRENDS 9

Introduction to multimodal biometric systems - Security and privacy considerations in biometric systems - Future trends and innovations in biometric technologies (1 period)
Hands-On Practices - Integration of multiple biometric modalities using software tools, Implementation of a multimodal biometric system
Mini Project - Design and implement a multimodal biometric system using two or more modalities.

Contact Hours : 45

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Demonstrate knowledge of biometric systems and technologies.
- Analyze and evaluate different biometric modalities and their effectiveness.
- Design and implement biometric systems for various applications.
- Apply biometric techniques to solve practical security and identification problems.
- Gain expertise in biometric data acquisition, processing, and analysis.

TEXT BOOK(S):

1 "Handbook of Biometrics" by Anil K. Jain, Patrick Flynn, and Arun A. Ross.

2 “Biometrics: Identity Verification in a Networked World" by Samir Nanavati, Michael Thieme, and Raj Nanavati.

3 "Handbook of Fingerprint Recognition" by Davide Maltoni, Dario Maio, Anil K. Jain, and Salil Prabhakar.

REFERENCE BOOK(S) / WEB LINKS:

1 "Face Recognition: From Theory to Applications" by Harry Wechsler, Philip J. Phillips, Vicki Bruce, Frank Fogelman-Soulie, and Thomas S. Huang.

2 Iris Recognition: The Most Biometric" by Charles Daugman.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	3	3	3	-	3	3	3	3	3	3	3	3
CO 2	3	3	3	3	3	3	-	3	3	3	3	3	3	3	3
CO 3	3	3	3	3	3	3	-	3	3	3	3	3	3	3	3
CO 4	3	3	3	3	3	3	-	3	3	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	-	3	3	3	3	3	3	3	3
AVG.	**3**	**3**	**3**	**3**	**3**	**3**	**-**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

BM23C13 SOFT COMPUTING TECHNIQUES Category L T P C

PE 3 0 0 3

OBJECTIVES:

- To provide an introduction to soft computing techniques and their applications in biomedical engineering.
- To understand the fundamental principles and methodologies of fuzzy logic, neural networks, and evolutionary algorithms.
- To develop the ability to apply soft computing techniques to solve complex biomedical problems.
- To analyze and design systems using various soft computing techniques for real-world biomedical applications.
- To implement and evaluate soft computing models using appropriate tools and technologies.

UNIT-I INTRODUCTION TO SOFT COMPUTING 9

Overview of Soft Computing - Definition, Importance, and Components, Hard vs. Soft Computing, Applications of Soft Computing in Biomedical Engineering, Case Studies - Diagnostic Systems, Image Processing.

UNIT-II FUZZY LOGIC AND APPLICATIONS 9

Fundamentals of Fuzzy Logic - Fuzzy Sets, Membership Functions, Fuzzy Rules and Fuzzy Inference Systems, Fuzzy Logic in Control Systems and Decision Making, Applications in Medicine - Fuzzy Diagnostic Systems, Fuzzy Controllers.

UNIT-III ARTIFICIAL NEURAL NETWORKS 9

Basics of Neural Networks - Neurons, Activation Functions, Network Architectures, Learning Algorithms - Supervised, Unsupervised, and Reinforcement Learning, Neural Network Models - Perceptron, Multilayer Perceptron, RBF Networks, Applications in Biomedical Engineering - Pattern Recognition, Biomedical Signal Analysis.

UNIT-IV EVOLUTIONARY ALGORITHMS 9

Introduction to Evolutionary Algorithms - Genetic Algorithms, Evolution Strategies, Genetic Operators - Selection, Crossover, Mutation, Optimization Techniques - Fitness Functions, Convergence Criteria, Applications in Biomedical Engineering - Parameter Optimization, Feature Selection.

UNIT-V HYBRID SYSTEMS AND ADVANCED TOPICS 9

Hybrid Systems - Neuro-Fuzzy Systems, Genetic-Fuzzy Systems, Deep Learning - Basics of Deep Neural Networks and Architectures, Current Trends and Future Directions in Soft Computing, Case Studies - Integrated Systems for Biomedical Applications.

Contact Hours : 45

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Explain the key concepts and components of soft computing techniques and their relevance to biomedical engineering.
- Apply fuzzy logic techniques to solve problems in control and decision-making in biomedical contexts.
- Design and implement artificial neural networks for tasks such as pattern recognition and signal analysis in biomedical applications.
- Utilize evolutionary algorithms for optimization and feature selection in biomedical systems.
- Integrate various soft computing techniques to develop hybrid systems and address complex biomedical engineering challenges.

TEXT BOOK(S):

1 Soft Computing and Intelligent Systems Design: Theory, Tools, and Applicationsby Fakhreddine O. Karray and Clarence De Silva - Pearson, 2004.
2 Neural Networks and Learning Machinesby Simon Haykin - Pearson, 2008.
3 Fuzzy Logic with Engineering Applicationsby Timothy J. Ross - Wiley, 2016.

REFERENCE BOOK(S) / WEB LINKS:

1 Introduction to Evolutionary Computing by A.E. Eiben and J.E. Smith - Springer, 2015.
2 Deep Learning by Ian Goodfellow, Yoshua Bengio, and Aaron Courville - MIT Press, 2016.
3 Practical Applications of Soft Computing Techniques in Biomedical Engineering by Leondes Cornelius T. - Springer, 2007.

4 Computational Intelligence: Principles, Techniques, and Applications by Amit Konar - Springer, 2015.
5 Handbook of Neural Computation by Pijush Samui, et al. - Elsevier, 2017.
6 Coursera: Neural Networks for Machine Learning by University of Toronto.
7 edX: Introduction to Fuzzy Logic by Osaka University.
8 MIT OpenCourseWare: Introduction to Computational Intelligence.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	1	1	1	3	3	2	-	-	-	-	-	3	3	3	3
CO 2	1	1	1	3	3	2	-	-	-	-	-	3	3	3	3
CO 3	1	1	1	3	3	2	-	-	-	-	-	3	3	3	3
CO 4	1	1	1	3	3	2	-	-	-	-	-	3	3	3	3
CO 5	1	1	1	3	3	2	-	-	-	-	-	3	3	3	3
AVG.	**1**	**1**	**1**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**3**	**3**

BM23C14 DEEP LEARNING AND DEPLOYMENT OF AI MODELS

Category	L	T	P	C
PE	3	0	0	3

OBJECTIVES:

- To understand the foundational concepts of deep learning.
- To learn about the design, training, and evaluation of deep neural networks.
- To gain proficiency in deploying AI models on different platforms.
- To explore optimization and scalability issues in AI deployment.
- To study real-world applications of AI deployment.

UNIT-I INTRODUCTION TO DEEP LEARNING 9

Overview of AI, machine learning, and deep learning- Neural networks basics: Perceptron, activation functions- Understanding CNN architecture: convolutional layers, pooling layers, fully connected layers - Classic CNN models: LeNet, AlexNet, VGG, ResNet.

UNIT-II CONVOLUTIONAL NEURAL NETWORKS (CNNs) 9

Convolutional Neural Networks(CNN) – Architecture (INCEPTION, Efficient net) -Accelerating Training with Batch Normalization- Building a Convolutional Network using Tensor Flow- Object Detection (YOLO, SSD) – Semantic Segmentation (U-Net) –Visualizing Filters and Feature Maps.

UNIT-III RECURRENT NEURAL NETWORKS (RNNs) 9

Introduction to RNNs– RNN Architecture and Back propagation Through Time – Vanishing and Exploding Gradients – Long Short-Term Memory (LSTM) Networks – Gated Recurrent Units

(GRUs) – Encoder-Decoder Architectures – Sequence-to-Sequence Models – Attention Mechanisms – Tensor Flow Primitives for RNN Models – Practical Applications (NLP, Time Series Forecasting) .

UNIT-IV TRAINING AND TUNING OF DEEP LEARNING MODELS 9

Data preprocessing: normalization, augmentation, and splitting datasets- Loss functions and optimization algorithms: cross-entropy, mean squared error, SGD, Adam- Techniques to improve model performance: dropout, batch normalization, early stopping- Model evaluation metrics: accuracy, precision, recall, F1-score, ROC-AUC- Hyper parameter tuning: grid search, random search, and Bayesian optimization.

UNIT-V DEPLOYMENT STRATEGIES FOR AI MODELS 9

Overview of AI model deployment: importance and challenges- Different deployment strategies: edge, cloud, and on-premises deployment- Lifecycle of an AI model: from development to deployment - Introduction to containerization and orchestration (Docker, Kubernetes)- Setting up and using Docker and Kubernetes for deployment- Other deployment platforms: AWS, Google Cloud, Microsoft Azure.

Contact Hours : 45

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Demonstrate a thorough understanding of deep learning concepts and architectures.
- Design, train, and evaluate deep neural networks for various applications.
- Implement advanced neural network architectures such as RNNs and GANs.
- Deploy AI models using containerization and orchestration tools.
- Utilize specialized hardware accelerators for AI deployment.

TEXT BOOK(S):

1 Wei Di, Anuragh Bharadwaj, “Deep Learning Essentials”, Jianing Wei, Packt Publishers, 2018.
2 Nikhil Buduma, Nicholas, “Fundamentals of Deep Learning”, O Reilly Media, 2017.

REFERENCE BOOK(S) / WEB LINKS:

1 Ian Goodfellow, Yoshua Bengio, Aaron Courville, “Deep Learning”,MIT Press, 2016.
2 Suraj Sawant. “Deep Learning”, IGI Global, 2018.
3 https://www.coursera.org/specializations/deep-learning

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	3	3	3	2	3	-	-	-	-	-	2	3	3	2
CO 2	2	3	3	2	2	3	-	-	-	-	-	2	3	2	2
CO 3	1	3	3	-	2	2	-	-	-	-	-	2	3	3	3
CO 4	1	2	2	2	2	1	-	-	-	-	-	2	3	3	1
CO 5	1	2	2	2	2	1	-	-	-	-	-	2	3	3	3
AVG.	**1.4**	**2.6**	**2.6**	**2.25**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**2.8**	**2.2**

BM23C15 APPLICATIONS OF EXTENDED REALITIES IN HEALTHCARE

Category	L	T	P	C
PE	3	0	0	3

OBJECTIVES:

- To understand the fundamental concepts and technologies behind extended realities.
- To explore the various applications of VR, AR, and MR in healthcare.
- To analyze the benefits and challenges of implementing XR in medical practice.
- To gain practical experience in designing and developing XR applications for healthcare.
- To evaluate the impact of XR technologies on patient outcomes and healthcare delivery

.

UNIT-I INTRODUCTION TO EXTENDED REALITIES 9

Overview of extended realities: VR, AR, and MR - Technological foundations: hardware, software, and development tools- Historical perspective and evolution of XR technologies- Basic principles of XR technology- User interface and experience design in XR- Emerging trends and potential future applications of XR.

UNIT-II VR IN HEALTHCARE 9

VR for surgical planning and simulation- Therapeutic uses of VR: pain management, rehabilitation, mental health- VR-based physical and occupational therapy- Enhancing diagnostic procedures with VR- Visualizing complex medical images in 3D- Applications of VR in medical training and education.

Case studies: Successful implementations of VR in healthcare.

UNIT-III AR IN HEALTHCARE 9

AR for patient education and engagement- Enhancing medical imaging and visualization with AR- Enhancing rehabilitation exercises with AR- AR for visualizing complex drug interactions- Real-world examples of AR applications in healthcare- Applications of AR in surgery and diagnostics.

Case studies: AR applications in real-world healthcare settings.

UNIT-IV MR AND ITS INTEGRATION IN HEALTHCARE 9

Understanding mixed reality and its unique features- Applications of MR in healthcare: remote consultations, collaborative surgery- Integrating MR with other medical technologies- Combining MR with traditional imaging methods- Real-time patient monitoring using MR- MR applications in emergency and critical care. **Case study:** Innovative MR applications in healthcare.

UNIT-V CHALLENGES AND FUTURE TRENDS IN XR FOR HEALTHCARE 9

Technical and ethical challenges in implementing XR in healthcare- Evaluating the effectiveness and safety of XR applications- Regulatory considerations and standards for XR in healthcare- Future trends: advancements in XR technology and potential impacts on healthcare.

Contact Hours : 45

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Demonstrate a comprehensive understanding of XR technologies and their potential in healthcare.
- Identify and describe various use cases of XR in healthcare, including surgical training, patient education, and therapy.
- Develop and implement basic XR applications for healthcare settings.
- Critically assess the benefits and limitations of XR applications in healthcare.
- Discuss the future trends and potential advancements in XR technologies within the healthcare industry.

TEXT BOOK(S):

1 Michael W. Carter, "Virtual Reality and Augmented Reality in Medicine," CRC Press, 2020.
2 Eduardo Benitez Sandoval, "Augmented Reality in Medicine," Springer Publications, 2018.
3 Robert Riener and Matthias Harders, "Virtual Reality in Medicine," Springer Publications, 2012.

REFERENCE BOOK(S) / WEB LINKS:

1 Borko Furht, "Handbook of Augmented Reality," Springer Publications, 2011.
2 Dieter Schmalstieg and Tobias Hollerer, "Augmented Reality: Principles and Practice," Addison-Wesley Professional, 2016.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	3	2	3	3	-	2	2	3	2	3	3	2
CO 2	3	3	3	2	2	3	3	-	2	2	3	2	3	2	2
CO 3	3	3	3	-	2	2	3	-	3	2	3	2	3	3	3
CO 4	3	2	2	2	2	1	3	-	1	2	2	2	3	3	1
CO 5	3	2	2	2	2	1	3	-	3	2	2	2	3	3	3
AVG.	**3**	**2.6**	**2.6**	**2.25**	**2**	**2**	**3**	**-**	**2.2**	**2**	**2.6**	**2**	**3**	**2.8**	**2.2**

BM23C16	MEDICAL INFORMATICS	Category	L	T	P	C
		PE	3	0	0	3

OBJECTIVES:

- To understand the structure and subfields of medical informatics, and discuss the role of the internet in medicine
- To explore the patient record digitization techniques and medical standards
- To study and identify the clinical approaches and advancements in applying informatics using computers in imaging
- To understand the concept of computer-assisted medical decision-making (CMD) and differentiate between expert systems and decision support systems.
- Learn ICT applications in medicine with an introduction to health informatics.

UNIT-I INTRODUCTION TO MEDICAL INFORMATICS 9

Introduction, Structure of Medical Informatics, Internet and Medicine - Security issues, Computer based medical information retrieval, Hospital management and information system, Functional capabilities of a computerized HIS, e-health services. Health Informatics – Medical Informatics, Bioinformatics, Nursing Informatics.

UNIT-II COMPUTERISED PATIENT RECORD & MEDICAL STANDARDS 9

Introduction, History taking by computer, Dialogue with the computer, Components and functionality of CPR, Development tools, Intranet, CPR in Radiology- Application server provider. Clinical information system, Computerized prescriptions for patients. Evolution of Medical Standards – IEEE 11073, HL7, DICOM, IRMA, LOINC, HIPPA, Electronics Patient Records, Healthcare Standard Organizations, JCAHO (Join Commission on Accreditation of Healthcare Organization), JCIA (Joint Commission International Accreditation).

UNIT-III COMPUTERS IN CLINICAL LABORATORY AND MEDICAL IMAGING 9

Automated clinical laboratories - Automated methods in hematology, cytology and histology, Intelligent Laboratory Information System. Computerized ECG, EEG and EMG. Computer assisted medical imaging - nuclear medicine, ultrasound imaging, ultrasonography, computed X-ray tomography, Radiation therapy and planning, Nuclear Magnetic Resonance.

UNIT-IV COMPUTER ASSISTED MEDICAL DECISION-MAKING 9

Neuro computers and Artificial Neural Networks application. Expert system – General model of CMD. Computer assisted decision support system - production rule system cognitive model, semester networks. Decisions analysis in clinical medicine, computers in the care of critically patients. Computer assisted surgery-designing, Deep learning algorithms- CNN, MLP.

UNIT-V RECENT TRENDS IN MEDICAL INFORMATICS 9

Virtual reality applications in medicine, IOT healthcare and medical information distribution, GRID and Cloud Computing in Medicine, Computer assisted surgery, Surgical simulation Telemedicine - Tele surgery. Computer aids for the handicapped, computer assisted instrumentation in Medical Informatics - Computer assisted patient education and health, Medical education and health care information.

Contact Hours : 45

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Gain knowledge on the structure of medical informatics an its functioning.
- Implement computerization in clinical information system.
- Discuss about automatic computerization in different bio signal and image acquisition.
- Support the utilization of computer assisted medical decision making tools .
- Critically evaluate the potential impact of recent trends in informatics on the future of healthcare delivery.

TEXT BOOK(S):

1 R.D.Lele Computers in medicine progress in medical informatics, Tata McGraw Hill Publishing computers Ltd, 2005, New Delhi.

2 Mohan Bansal, Medical informatics Tata McGraw Hill Publishing computers Ltd, 2003 New Delhi.

3 Subrata Pal, “Textbook of Biomechanics”, Viva Books Private Limited, 2009.

REFERENCE BOOK(S) / WEB LINKS:

1 OrpitaBosu and Simminder Kaur Thukral, “Bioinformatics Databases, Tools and Algorithms”, Oxford University press, 2007

2 Yi Ping Phoebe Chen, “Bioinformatics Technologies”, Springer International Edition, New Delhi, 2007.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	1	1	1	1	1	-	1	-	-	-	1	1	1	3
CO 2	3	3	3	2	3	3	-	2	-	-	-	2	3	3	3
CO 3	3	3	3	3	3	3	-	3	-	-	-	2	3	3	3
CO 4	3	3	3	3	3	3	-	3	-	-	-	2	3	3	3
CO 5	3	3	3	3	3	3	-	3	-	-	-	2	3	3	3
AVG.	**3**	**2.6**	**2.6**	**2.4**	**2.6**	**2.6**	**-**	**2.4**	**-**	**-**	**-**	**1.8**	**2.6**	**2.6**	**3**

DOMAIN: ASSISTIVE TECHNOLOGY

BM23D11	MEDICAL TEXTILES FUNDAMENTALS	Category	L	T	P	C
		PE	3	0	0	3

OBJECTIVES:

- To provide a fundamental understanding of the materials and technologies used in medical textiles.
- To explore the applications of medical textiles in various healthcare settings.
- To understand the design, development, and performance evaluation of medical textiles.
- To analyze the biocompatibility, sterilization, and regulatory considerations of medical textiles.
- To equip students with knowledge on the latest advancements and future trends in medical textiles.

UNIT-I INTRODUCTION TO MEDICAL TEXTILES 9

Overview of Medical Textiles - Definitions, Importance, and History, Types of Medical Textiles - Woven, Non-Woven, and Knitted Fabrics, Basic Properties of Medical Textiles - Physical, Mechanical, and Chemical, Applications in Healthcare - Wound Care, Implantable Textiles, and Hygiene Products.

UNIT-II MATERIALS USED IN MEDICAL TEXTILES 9

Fibers and Yarns -Natural and Synthetic Materials, Polymer Chemistry for Medical Textiles, Smart and Functional Materials - Antimicrobial, Biodegradable, and Stimuli-Responsive, Case Studies - Use of Materials in Bandages, Surgical Sutures, and Grafts.

UNIT-III MANUFACTURING AND DESIGN OF MEDICAL TEXTILES 9

Manufacturing Techniques - Spinning, Weaving, Knitting, and Non-Woven Fabrication, Design Principles for Medical Textiles - Comfort, Durability, and Safety, Surface Modification and Coating Technologies, Performance Evaluation - Tensile Strength, Absorbency, and Permeability.

UNIT-IV BIOCOMPATIBILITY AND REGULATORY ASPECTS 9

Biocompatibility Testing - Cytotoxicity, Sensitization, and Irritation, Sterilization Methods - Autoclaving, Gamma Irradiation, and Ethylene Oxide, Regulatory Standards - ISO, ASTM, and FDA Guidelines, Case Studies -Regulatory Approval Processes for Medical Textile Products.

UNIT-V ADVANCEMENTS AND FUTURE TRENDS IN MEDICAL TEXTILES 9

Recent Advances - Nanotechnology, Electrospinning, and 3D Printing in Medical Textiles, Smart Textiles - Wearable Sensors, Drug Delivery Systems, and Responsive Fabrics, Sustainability in Medical Textiles - Eco-Friendly Materials and Processes, Future Trends - Personalized Medicine, Regenerative Textiles, and Biofabrication.

Contact Hours : 45

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Explain the fundamental principles and applications of medical textiles in healthcare.
- Identify and describe the materials used in the design and manufacture of medical textiles.
- Develop and evaluate medical textile products considering performance and safety requirements.
- Analyze the biocompatibility, sterilization, and regulatory aspects of medical textiles.
- Explain the fundamental principles and applications of medical textiles in healthcare.

TEXT BOOK(S):

1 Medical Textiles and Biomaterials for Healthcare by Subhash Anand, V. Subramanian, and Anbumani Narayanan - Woodhead Publishing, 2001.

2 Handbook of Medical Textiles by V. T. Bartels - Woodhead Publishing, 2011.

3 Biomedical Textiles for Orthopaedic and Surgical Applications: Fundamentals, Innovations and Opportunities by Todd Blair - Woodhead Publishing, 2015.

REFERENCE BOOK(S) / WEB LINKS:

1 Textiles for Advanced Applications by Bipin Kumar and Iwona Frydrych - InTech, 2017.

2 Advances in Healthcare Textiles: Applications in Medical, Protective, and Health Care by Subhash Anand, S. Rajendran - CRC Press, 2021.

3 Textiles for Protection by Richard A. Scott - Woodhead Publishing, 2005.

4 Medical Textile Materials by Yimin Qin - Woodhead Publishing, 2015.

5 Smart Textiles for Medicine and Healthcare: Materials, Systems and Applications by Lieva Van Langenhove - Woodhead Publishing, 2007.

6 Coursera: Medical Textiles and Healthcare by various institutions.

7 edX: Introduction to Smart and Wearable Textiles by the University of Manchester.

8 MIT OpenCourseWare: Textile Technology and Medical Applications.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	1	1	2	2	-	1	1	-	-	-	-	3	3	1	-
CO 2	1	1	2	2	-	1	1	-	-	-	-	3	3	1	-
CO 3	1	1	2	2	-	2	1	-	-	-	-	3	3	1	-
CO 4	1	1	2	2	-	3	3	-	-	-	-	3	3	1	-
CO 5	1	1	2	2	-	2	3	-	-	-	-	3	3	1	-
AVG.	**1**	**1**	**2**	**2**	**-**	**1.8**	**1.8**	**-**	**-**	**-**	**-**	**3**	**3**	**1**	**-**

BM23D12	MEDICAL ROBOTICS	Category	L	T	P	C
		PE	3	0	0	3

OBJECTIVES:

- To provide a comprehensive understanding of robotics technology in the medical field.
- To explore the design, development, and applications of robotic systems in healthcare.
- To equip students with knowledge on various medical robotics subsystems, sensors, actuators, and control systems.
- To analyze the role of medical robots in diagnostics, surgery, rehabilitation, and patient care.
- To understand the ethical, regulatory, and safety considerations in the use of medical robotics.

UNIT-I INTRODUCTION TO MEDICAL ROBOTICS 9

Introduction to Robotics in Medicine – Historical Perspective, Evolution, and Importance of Robotics in Healthcare. Basics of Robot Kinematics and Dynamics. Key Components of Medical Robots – Sensors, Actuators, and Control Systems. Applications of Robotics in Diagnostics, Therapeutics, and Rehabilitation. Types of Medical Robots – Surgical Robots, Diagnostic Robots, and Rehabilitation Robots.

UNIT-II ROBOTIC SURGICAL SYSTEMS 9

Robotics in Minimally Invasive Surgery (MIS) – Da Vinci, Mako, and Other Surgical Systems. Design Principles of Surgical Robots – Precision, Safety, and Ergonomics. Robot-Assisted Laparoscopic and Orthopedic Surgeries. Image-Guided Robotic Surgery and Navigation. Case Studies – Robotic Surgery in Cardiovascular, Neurosurgery, and Urology. Surgical Workflow Integration and Human-Robot Collaboration.

UNIT-III ROBOTICS IN REHABILITATION AND ASSISTIVE TECHNOLOGIES 9

Role of Robotics in Physical Rehabilitation – Robotic Exoskeletons, Prosthetics, and Gait Rehabilitation Systems. Assistive Robots – Robotic Wheelchairs, Manipulators, and Cognitive Assistance. Design Considerations for Rehabilitation and Assistive Robotics. Patient-Feedback and Adaptive Control Systems. Applications in Stroke Rehabilitation, Spinal Cord Injury, and Aging Populations. Case Studies of Rehabilitation Robots – Lokomat, ReWalk, and MyoPro.

UNIT-IV SENSORS, ACTUATORS, AND CONTROL IN MEDICAL ROBOTS 9

Types of Sensors Used in Medical Robotics – Force, Tactile, Vision, and Position Sensors. Actuators in Medical Robotics – Electric, Hydraulic, and Pneumatic Systems. Control Architectures for Medical Robots – Open-Loop and Closed-Loop Systems. Feedback Control and Motion Planning. Robotic System Calibration and Accuracy. Case Studies – Force Feedback in Surgery and Tactile Sensors in Rehabilitation Devices.

UNIT-V CHALLENGES, ETHICS, AND FUTURE TRENDS IN MEDICAL ROBOTICS **9**

Regulatory Aspects – FDA Guidelines and International Standards for Medical Robotics. Ethical Issues in Medical Robotics – Autonomy, Patient Safety, and Liability. Safety and Risk Management in Robotic Surgery and Rehabilitation. Emerging Trends – AI Integration, Wearable Robotics, and Autonomous Robotic Systems. Future Directions – Nanorobotics in Medicine, Soft Robotics, and Personalized Healthcare. Case Studies of Innovations in Medical Robotics.

Contact Hours : 45

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Understand the fundamental principles and applications of robotics in healthcare.
- Analyze the design, components, and control systems of medical robots.
- Evaluate the use of robotics in surgery, rehabilitation, and assistive technologies.
- Identify the challenges and ethical considerations in medical robotics.
- Explore the latest trends and future directions in the field of medical robotics.

TEXT BOOK(S):

1 Medical Robotics by Paolo Dario, Blake Hannaford, and Garth H. Ballantyne – Springer, 2012.

2 Robotics in Surgery by Russel H. Taylor and Jacques Marescaux – Springer, 2015.

3 Rehabilitation Robotics: Technology and Applications by Roberto Colombo and Vivian S. Chu – CRC Press, 2018.

REFERENCE BOOK(S) / WEB LINKS:

1 Robotics for Healthcare by Rui Pedro Paiva and Vasco Matos – Springer, 2020.

2 Medical Robotics: Minimally Invasive Surgery by Vanja Bozovic and Pranav Joshi – Springer, 2019.

3 edX: Introduction to Robotics in Healthcare by various institutions.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	1	1	2	2	-	1	1	-	-	-	-	3	3	1	-
CO 2	1	1	2	2	-	1	1	-	-	-	-	3	3	1	-
CO 3	1	1	2	2	-	2	1	-	-	-	-	3	3	1	-
CO 4	1	1	2	2	-	3	3	-	-	-	-	3	3	1	-
CO 5	1	1	2	2	-	2	3	-	-	-	-	3	3	1	-
AVG.	**1**	**1**	**2**	**2**	**-**	**1.8**	**1.8**	**-**	**-**	**-**	**-**	**3**	**3**	**1**	**-**

BM23D13	ASSIST DEVICES	Category	L	T	P	C
		PE	3	0	0	3

OBJECTIVES:

- Demonstrate knowledge of the principles and design of assistive devices.
- Analyze and evaluate different types of assistive devices and their effectiveness.
- Design and fabricate assistive devices for various applications.
- Apply assistive technology to improve the quality of life for individuals with disabilities.
- Gain expertise in assistive device development and rehabilitation engineering.

UNIT-I INTRODUCTION TO ASSISTIVE DEVICES 9

Principles and definitions of assistive devices - History and evolution of assistive technology - Overview of types of assistive devices (mobility aids, communication aids, etc.) (1 period) - Applications of assistive devices in daily living - Needs assessment for assistive devices (1 period) **Hands-On Practice -** Evaluation of different assistive devices, Practical exercises in assessing needs for assistive devices **Mini Project -** Conduct a needs assessment and recommend suitable assistive devices for a specific individual.

UNIT-II MOBILITY AND POSITIONING DEVICES 9

Principles of mobility aids - Design and functionality of wheelchairs and walkers - Positioning devices and their applications - Case studies of mobility and positioning devices - Standards and guidelines for designing mobility aids. **Hands-On Practice -** Designing custom mobility or positioning devices using CAD software, Fabrication, and post-processing of mobility aids **Mini Project -** Design and fabricate a custom wheelchair or walker.

UNIT-III COMMUNICATION AND SENSORY DEVICES 9

Principles of communication aids - Devices for speech and hearing impairments - Sensory devices for the visually impaired - Integration of communication and sensory devices - Case studies of communication and sensory devices . **Hands-On Practices -** Designing communication or sensory devices using software tools, Fabrication and post-processing of communication aids. **Mini Project -** Design and fabricate a custom communication or sensory device.

UNIT-IV ASSISTIVE ROBOTICS AND SMART TECHNOLOGIES 9

Principles of assistive robotics - Design and functionality of robotic aids - Smart technologies and IoT in assistive devices - Applications of assistive robotics in rehabilitation - Case studies of assistive robotics .**Hands-On Practices -** Designing robotic aids using software tools, Integration of smart technologies in assistive devices. **Mini Project -** Design and implement a custom assistive robotic system.

UNIT-V INNOVATIONS AND FUTURE TRENDS IN ASSISTIVE TECHNOLOGY 9

Innovative assistive technologies - Advanced materials and techniques - 3D printing and fabrication methods - Future trends and potential in assistive technology - Case studies of innovative assistive devices.

Hands-On Practice - Experimenting with advanced materials and techniques, Utilizing 3D

printing in assistive device development. **Mini Project -** Design and implement an innovative assistive device using advanced techniques.

Contact Hours : 45

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Describe innovative assistive technologies and their impact.
- Utilize advanced materials and techniques in assistive device development.
- Apply 3D printing and other fabrication methods in creating assistive devices.
- Identify future trends and potential applications in assistive technology.
- Complete an innovative assistive device project using advanced techniques.

TEXT BOOK(S):

1 "Assistive Technology: Principles and Applications for Communication Disorders and Special Education" by Giulio E. Lancioni and Jeff Sigafoos.

2 "Assistive Technology in the Classroom: Enhancing the School Experiences of Students with Disabilities" by Amy G. Dell, Deborah A. Newton, and Jerry G. Petroff.

3 "Rehabilitation Engineering: Applied Principles and Practice" by Alex Mihailidis and Roger Smith.

REFERENCE BOOK(S) / WEB LINKS:

1 "Design and Use of Assistive Technology: Social, Technical, Ethical, and Economic Challenges" by Meeko Mitsuko K. Oishi, Ian M. Mitchell, and H. F. Machiel Van der Loos

2 "Handbook of Research on Assistive Technology: Design, Adoption, and Applications" by Lawrence A. Tomei.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	2	2	1	2	3	3	-	1	2	-	2	2	1	2
CO 2	3	3	3	2	3	2	3	-	-	1	2	3	3	2	3
CO 3	3	3	3	3	3	1	2	-	2	2	3	3	3	3	3
CO 4	3	2	2	2	2	2	2	1	1	2	-	3	2	2	3
CO 5	3	3	3	3	3	3	3	2	3	3	3	3	3	3	3
AVG.	**2.8**	**2.6**	**2.6**	**2.2**	**2.6**	**2.2**	**2.6**	**1.5**	**1.8**	**2.0**	**2.7**	**2.8**	**2.6**	**2.2**	**2.8**

BM23D14 REHABILITATION ENGINEERING Category L T P C

PE 3 0 0 3

OBJECTIVES:

- To Understand the concepts of rehabilitation engineering
- To explore the design and development of assistive technologies for individuals with

disabilities.

- To analyze the role of biomechanics and human motion in rehabilitation engineering.
- To understand the use of robotics and other advanced technologies in rehabilitation.
- To equip students with knowledge of the regulatory and ethical aspects of rehabilitation technologies.

UNIT-I INTRODUCTION AND THERAPEUTIC EXERCISES 9

Overview of Rehabilitation Engineering – Definitions, Scope, and Importance. Historical Perspective of Rehabilitation Technologies. Types of Disabilities – Physical, Sensory, Cognitive, and Neurological. Principles of Assistive Technology and Human-Machine Interfaces. Interdisciplinary Approach – Collaboration with Medicine, Engineering, and Psychology. Case Studies of Early Rehabilitation Devices.

Therapeutic exercise: Co-ordination exercises, Frenkels exercises, Gait -Pathological Gaits, Gait Training, Relaxation exercises, Methods for training Relaxation, Strengthening exercises - Strength training, Types of Contraction, Mobilisation exercises, Endurance exercises.

UNIT-II ASSISTIVE DEVICES AND TECHNOLOGIES 9

Overview of Assistive Technologies – Mobility Aids, Communication Devices, and Sensory Aids. Design Principles of Assistive Devices – Usability, Accessibility, and Ergonomics. Prosthetics and Orthotics – Design and Material Considerations. Hearing Aids, Visual Aids, and Augmentative Communication Devices. Design of Smart wheel chairs, Integration of Smart Technologies in Assistive Devices – IoT and AI Applications. Case Studies of Successful Assistive Technologies in Daily Life.

UNIT-III BIOMECHANICS AND HUMAN MOTION ANALYSIS 9

Introduction to Biomechanics – Forces, Movement, and Kinematics of Human Motion. Gait Analysis – Methods and Applications in Rehabilitation. Modeling and Simulation of Human Motion. Wearable Sensors and Motion Capture Systems. Applications of Biomechanics in Prosthetic Design and Orthotic Assessment. Case Studies – Gait Analysis for Stroke Patients and Amputees.

UNIT-IV ROBOTICS AND ADVANCED TECHNOLOGIES IN REHABILITATION 9

Role of Robotics in Physical Rehabilitation – Exoskeletons, Robotic Arms, and Treadmill Training. Virtual Reality (VR) and Augmented Reality (AR) in Rehabilitation. Brain-Computer Interfaces (BCI) – Neuroprosthetics and Cognitive Rehabilitation. Adaptive and Intelligent Control Systems in Rehabilitation Robotics. Case Studies – Robotic Applications in Stroke Rehabilitation and Spinal Cord Injury Recovery.

UNIT-V ETHICAL, REGULATORY, AND FUTURE TRENDS IN REHABILITATION ENGINEERING 9

Ethical Considerations in Rehabilitation Engineering – Patient Autonomy, Informed Consent, and Accessibility. Regulatory Aspects – FDA and ISO Standards for Assistive and Rehabilitation Technologies. Societal Impact of Rehabilitation Engineering – Inclusion and Empowerment. Emerging Trends – 3D Printing in Prosthetics, AI and Machine Learning in Rehabilitation Devices.

Future of Rehabilitation Engineering – Personalized Rehabilitation and Neurorehabilitation. Case Studies of Innovative Rehabilitation Technologies.

Contact Hours : 45

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Understand the basic principles and applications of rehabilitation engineering.
- Analyze and design assistive devices for individuals with various disabilities.
- Apply the principles of biomechanics in the development of rehabilitation devices.
- Evaluate the role of robotics and advanced technologies in rehabilitation.
- Explore the ethical and regulatory aspects of rehabilitation technologies and discuss future trends.

TEXT BOOK(S):

1 Sunder 'Textbook of Rehabilitation', Jaypee Brothers Medical Publishers Pvt. Ltd, New Delhi, 2nd Edition, Reprint 2007

2 Barbara Gibson, “Rehabilitation: A Post-critical Approach”, Rehabilitation Science in Practice Series,
First Edition, 2016.

3 Marcelo Epstein, “The Elements of Continuum Biomechanics”, ISBN: 978-1-119-99923-2, 2012.

4 Subrata Pal, “Textbook of Biomechanics”, Viva Books Private Limited, 2009.

REFERENCE BOOK(S) / WEB LINKS:

1 Rehabilitation Engineering: Principles and Practice by Rory A. Cooper, Hisaichi Ohnabe, and Douglas A. Hobson – CRC Press, 2006.

2 Assistive Technology: Principles and Practice by Albert Cook and Janice Polgar – Elsevier, 2014.

3 Volker Dietz, Tobias Nef, William Zev Rymer, “Neuro Rehabilitation technology”, Springer, London,
2012.

4 Roberto Colombo (Editor), Vittorio Sanguineti, “Rehabilitation Robotics: Technology and Application”, 1st Edition, Elsevier, UK, 2018.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	1	3	3	-	2	-	-	-	2	1	1	-
CO 2	3	3	3	1	3	3	-	2	-	-	-	2	3	1	-
CO 3	3	3	3	3	3	3	-	2	-	-	-	2	3	3	-
CO 4	3	3	3	3	3	3	-	2	-	-	-	2	3	3	-
CO 5	3	3	3	3	3	3	-	2	-	-	-	2	3	3	-
AVG.	**3**	**3**	**3**	**2.2**	**3**	**3**	**-**	**2**	**-**	**-**	**-**	**2**	**2.6**	**2.2**	**-**

BM23D15	WEARABLE SYSTEMS	Category	L	T	P	C
		PE	2	0	0	2

OBJECTIVES:

- Study about sensors and its application in wearable systems
- Learn about wireless health system and BAN architecture and its technical challenges and the various power sources.
- Gain knowledge on real time wearable systems on basis of different case studies

UNIT-I SENSORS AND SIGNAL PROCESSING 10

Need for wearable systems, Sensors for wearable Systems-Inertia movement sensors, Respiration activity sensor, Inductive plethysmography, Impedance plethysmography, pneumography, Wearable ground reaction force sensor, GSR, Biosensor – Types and application. Wearability issues- physical shape and placement of sensor, Technical challenges - sensor design, signal acquisition, Rejection of irrelevant information.

UNIT-II WIRELESS HEALTH SYSTEMS 10

Need for wireless monitoring, Definition of Body area network, BAN and Healthcare, Technical Challenges- System security and reliability, BAN Architecture – Introduction, Wireless communication techniques, Power sources – Batteries and fuel cells for sensor nodes.

UNIT-III WEARABLE DEVICES IN HEALTHCARE 10

Medical Diagnostics, Medical Monitoring-Patients with chronic disease, Hospital patients, Elderly patients, Wearable system for ECG monitoring-EEG monitoring-/multichannel neural recording system, Gait analysis, Sports Medicine, Smart Fabrics, Smart Belt.

Contact Hours : 30

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Demonstrate knowledge on the basic principles and building blocks of sensors in wearable system
- Develop advanced techniques of BAN architecture for more medical applications.
- Design various safe and user friendly wearable devices for patients.

TEXT BOOK(S):

1 Annalisa Bonfiglio, DaniloDeRossi, "Wearable Monitoring Systems", Springer, 2011.

2 SandeepK.S.Gupta, TridibMukherjee, Krishna Kumar Venkata subramanian, "Body Area Networks Safety, Security, and Sustainability," Cambridge University Press, 2013.

REFERENCE BOOK(S) / WEB LINKS:

1 Hang, Yuan-Ting, "wearable medical sensors and systems", Springer-2013.

2 Mehmet R. Yuce,Jamil Y.Khan, "Wireless Body Area Networks Technology, ImplementationandApplications",PanStanfordPublishingPvt.Ltd,Singapore,2012.

3 Guang-ZhongYang(Ed.),"BodySensorNetworks,"Springer,2006.

4 Andreas Lymberis, Danilo de Rossi ,'Wearable eHealth systems for Personalised Health Management - State of the art and future challenges' IOS press, The Netherlands, 2004.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	2	2	3	-	-	1	-	-	2	3	2	1
CO 2	3	3	2	1	2	3	-	-	1	-	-	2	3	1	2
CO 3	3	3	2	3	2	3	-	-	1	-	-	2	2	1	1
AVG.	**3**	**3**	**2.3**	**2**	**2**	**3**	**-**	**-**	1	**-**	**-**	**2**	**2.6**	**1.3**	**1.3**

BM23D16 TELEHEALTH TECHNOLOGY Category L T P C

PE 1 0 0 1

OBJECTIVES:

- Learn the key principles of telemedicine and health.
- Understand telemedical technology.
- Know the basics of telemedical standards
- Know the basics of mobile telemedicine.
- To know the basics of telemedical and it applications.

UNIT-I TELEMEDICINE AND HEALTH 6

History and Evolution of telemedicine, Organs of telemedicine, Global and Indian scenario, Ethical and legal aspects of Telemedicine - Confidentiality, Social and legal issues, Safety and regulatory issues, Advances in Telemedicine.

UNIT-II WIRELESS HEALTH SYSTEMS 6

Principles of Multimedia - Text, Audio, Video, data, Data communications and networks, PSTN, POTS, ANT, ISDN, Internet, Air/ wireless communications Communication infrastructure for telemedicine – LAN and WAN technology. Satellite communication, Mobile communication.

UNIT-III TELEMEDICAL STANDARDS 6

Data Security and Standards: Encryption, Cryptography, Mechanisms of encryption, phases of Encryption. Protocols: TCP/IP, ISO-OSI, Standards to followed DICOM, HL7, H. 320 series Video Conferencing, Security and confidentiality of medical records, Cyber laws related to telemedicine.

UNIT-IV MOBILE TELEMEDICINE 6

Tele radiology: Image Acquisition system Display system, Tele pathology, Medical information storage and management for telemedicine- patient information, medical history, test reports, medical images, Hospital information system.

Case study: Acquire a basic parameter from the subject and display in mobile.

UNIT-V TELEMEDICAL APPLICATIONS 6

Telemedicine – health education and self-care. · Introduction to robotics surgery, Tele surgery.

Tele cardiology, Tele oncology, Telemedicine in neurosciences, Business aspects - Project planning and costing, Usage of telemedicine.

Contact Hours : 30

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Apply multimedia technologies in telemedicine.
- Explain Protocols behind encryption techniques for secure transmission of data.
- Apply telehealth in healthcare.
- Apply mobile telemedicine in healthcare.
- Apply telemedical technology for healthcare

TEXT BOOK(S):

1 Norris, A.C. “Essentials of Telemedicine and Telecare”, Wiley, 2002.

REFERENCE BOOK(S) / WEB LINKS:

1 Wootton, R., Craig, J., Patterson, V. (Eds.), “Introduction to Telemedicine. Royal Society of Medicine” Press Ltd, Taylor & Francis 2006

2 O'Carroll, P.W., Yasnoff, W.A., Ward, E., Ripp, L.H., Martin, E.L. (Eds), “Public Health Informatics and Information Systems”, Springer, 2003.

3 Ferrer-Roca, O., Sosa - Iudicissa, M. (Eds.), Handbook of Telemedicine. IOS Press (Studies in Health Technology and Informatics, Volume 54, 2002. Simpson, W. Video over IP. A practical guide to technology and applications. Focal Press Elsevier, 2006.

4 Bemmel, J.H. van, Musen, M.A. (Eds.) Handbook of Medical Informatics. Heidelberg, Germany: Springer, 1997 6. Mohan Bansal "Medical Informatics", Tata McGraw-Hill, 2004.

5 Wootton, R., Craig, J., Patterson, V. (Eds.), “Introduction to Telemedicine. Royal Society of Medicine” Press Ltd, Taylor & Francis 2006.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	3	3	3	2	3	-	-	1	-	-	2	2	3	2
CO 2	2	3	3	2	2	3	1	-	-	1	-	2	2	2	2
CO 3	1	3	3	-	2	2	1	1	-	-	1	2	2	3	3
CO 4	1	2	2	2	2	1	-	-	-	-	-	2	2	3	1
CO 5	1	2	2	2	2	1	-	-	1	1	-	2	2	3	3
AVG.	**1.4**	**2.6**	**2.6**	**2.25**	**2**	**2**	**1**	**1**	**1**	**1**	**1**	**2**	**2**	**2.8**	**2.2**

DOMAIN: MODELING AND SIMULATION

BM23E11	3D PRINTING IN MEDICAL APPLICATIONS	Category	L	T	P	C
		PE	3	0	0	3

OBJECTIVES:

- To understand the principles and technologies involved in 3D printing.
- To explore the applications of 3D printing in the medical field.
- To develop skills in designing and fabricating 3D printed medical devices.
- To gain hands-on experience with 3D printing software and hardware.
- To foster innovation and creativity in solving medical challenges using 3D printing.

UNIT-I INTRODUCTION TO 3D PRINTING 9

History and evolution of 3D printing - Basic principles of 3D printing - Types of 3D printing technologies (FDM, SLA, SLS, etc.) - Materials used in 3D printing - Overview of 3D printing software .

Hands-On Practices - Introduction to 3D printing software (e.g., TinkerCAD, Fusion 360), Basic 3D modeling exercises, Operating a basic 3D printer (setup, calibration, and printing)

Mini Project- Design and print a simple anatomical model (e.g., a bone structure or an organ).

UNIT-II 3D PRINTING IN ORTHOPEDICS 9

Applications of 3D printing in orthopedics - Design and fabrication of prosthetics and orthotic devices - Custom implants and surgical guides - Case studies of 3D printing in orthopedic surgeries .

Hands-On Practices- Designing a custom orthopedic implant using CAD software, Printing and post-processing of the implant, Testing the fit and functionality of the printed implant.

Mini Project- Design and fabricate a custom prosthetic limb or orthopedic implant.

UNIT-III 3D PRINTING IN DENTISTRY 9

Applications of 3D printing in dentistry - Dental implants, crowns, and bridges - Custom orthodontic devices - Surgical guides for dental surgery - Case studies of 3D printing in dental practice.

Hands-On Practices - Designing a dental model or device using CAD software, Printing and post-processing of the dental model/device, Evaluating the accuracy and fit of the printed model/device.

Mini Project- Design and fabricate a custom dental implant or orthodontic device.

UNIT-IV 3D PRINTING OF MEDICAL MODELS AND DEVICES 9

Anatomical models for surgical planning and training, Bioprinting and tissue engineering, Regulatory and ethical considerations in medical 3D printing, Case studies of 3D printing in medical education and practice.

Hands-On Practices - Designing anatomical models for specific medical applications, Printing and post-processing of anatomical models, Evaluating the utility of printed models in surgical planning or training.

Mini Project - Design and fabricate an anatomical model for a specific medical procedure.

UNIT-V INNOVATIONS AND FUTURE TRENDS IN MEDICAL 3D PRINTING 9

Advanced materials and techniques in medical 3D printing - 4D printing and its medical applications - Future trends and potential of 3D printing in medicine - Impact of 3D printing on personalized medicine.

Hands-On Practices - Experimenting with advanced 3D printing materials and techniques, Designing innovative medical devices using advanced 3D printing methods, Exploring potential future applications of 3D printing in medicine.

Mini Project- Develop an innovative medical device or application using advanced 3D printing techniques.

Contact Hours : 45

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Illustrate the principles of microscopes and discuss various illumination techniques in microscopy.
- Explain the basic principles and analyze different types of nanophotonic materials.
- Discuss the principles of optical techniques and its applications.
- Analyze the IoT based optical instrumentation involved in optic devices.
- Apply photonics principles in surgical procedures.

TEXT BOOK(S):

1 "3D Printing in Medicine: A Practical Guide for Medical Professionals" by Frank J. Rybicki and Gerald T. Grant.

2 "Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing" by Ian Gibson, David W. Rosen, and Brent Stucker.

3 "3D Printing for Biomedical Engineering and Healthcare: Principles and Applications" by Chee Kai Chua and Kah Fai Leong.

4 "3D Printing in Orthopaedic Surgery" by Matthew Dipaola.

REFERENCE BOOK(S) / WEB LINKS:

1 "3D Printing and Biofabrication" by Aleksandr Ovsianikov, James Yoo, and Vladimir Mironov.

2 "3D Printing in Medicine and Surgery: The Essential Guide" by Daniel J. Thomas and Deepti Singh.

3 "Medical Applications of 3D Printing" by Hamed Barazanchi, Jeremy Simcock, and Mutaz al-Habib.

4 "Handbook of 3D Printing: Technologies, Processes, and Applications" by Kamalpreet Sandhu and Bharat Bhushan.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	-
CO 2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	-
CO 3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	-
CO 4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	-
CO 5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	-
AVG.	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**-**

BM23E12 PHYSIOLOGICAL MODELING Category L T P C

PE 3 0 0 3

OBJECTIVES:

- To provide a comprehensive understanding of physiological systems and their modeling.
- To introduce mathematical tools and techniques used in physiological modeling.
- To analyze and simulate the behavior of various physiological systems.
- To understand the dynamics of biological systems and feedback control mechanisms.
- To equip students with knowledge on the latest advancements in computational modeling of physiological systems.

UNIT-I INTRODUCTION TO PHYSIOLOGICAL MODELING 9

Overview of Physiological Modeling – Definitions, Importance, and Applications. Basic Concepts in System Modeling – Deterministic and Stochastic Models. Physiological Systems – Cardiovascular, Respiratory, Neurological, and Musculoskeletal Systems. Lumped Parameter Models and Distributed Parameter Models. Case Studies – Modeling of Simple Physiological Processes (e.g., Blood Flow, Nerve Impulse Propagation).

UNIT-II MATHEMATICAL MODELING OF PHYSIOLOGICAL SYSTEMS 9

Mathematical Tools for Physiological Modeling – Differential Equations, Linear and Non-Linear Systems. Compartmental Models – Applications in Pharmacokinetics, Respiratory System, and Metabolic Systems. Transfer Functions and Block Diagrams in Physiological Systems. Stability Analysis and Feedback Control in Physiological Models. Case Studies – Applications of Mathematical Modeling in Real-life Physiological Systems.

UNIT-III DYNAMICS OF CARDIOVASCULAR AND RESPIRATORY SYSTEMS 9

Modeling of the Cardiovascular System – Blood Flow, Cardiac Output, and Pressure-Volume Relationships. Windkessel Model, Lumped Parameter Models of the Heart. Respiratory System Modeling – Gas Exchange, Lung Mechanics, and Control of Breathing. Simulation and Analysis of Cardiovascular and Respiratory Dynamics using Computational Tools. Case Studies – Simulation of Cardiovascular Diseases and Respiratory Disorders.

UNIT-IV MODELING OF NEUROMUSCULAR AND ENDOCRINE SYSTEMS 9

Neuromuscular System – Hodgkin-Huxley Model for Neuron Firing, Synaptic Transmission, Muscle Contraction Models. Endocrine System Modeling – Hormone Regulation, Insulin-Glucose Dynamics, and Thyroid Function. Feedback Control Mechanisms in Biological Systems. Simulation of Neuromuscular and Endocrine Systems using Computational Tools. Case Studies – Neurological Disorders and Hormonal Imbalances.

UNIT-V ADVANCED MODELING TECHNIQUES AND FUTURE TRENDS 9

Advanced Techniques – Computational Fluid Dynamics (CFD), Finite Element Analysis (FEA), and Agent-Based Modeling in Physiology. Data-Driven Models using Machine Learning and Artificial Intelligence for Predictive Modeling. Integration of Physiological Models with Wearable Devices and IoT for Real-time Monitoring. Future Trends in Physiological Modeling – Personalized Medicine, Virtual Organs, and In Silico Clinical Trials. Case Studies – Emerging Technologies in Physiological Modeling.

Contact Hours : 45

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Understand the fundamental principles of physiological modeling and its applications in biomedical engineering.
- Apply mathematical tools to model and simulate various physiological systems.
- Analyze the dynamics of cardiovascular, respiratory, neuromuscular, and endocrine systems using models.
- Explore advanced modeling techniques and their applications in personalized healthcare and real-time monitoring.
- Evaluate future trends and emerging technologies in physiological modeling.

TEXT BOOK(S):

1 Mathematical Modeling in Systems Biology: An Introduction by Brian Ingalls – MIT Press, 2013.
2 Physiological Control Systems: Analysis, Simulation, and Estimation by Michael C. K. Khoo – IEEE Press, 2018.
3 Computational Modeling in Biomedical Engineering and Medical Physics by Alexandru Morega and Luminita Morega – Academic Press, 2020.

REFERENCE BOOK(S) / WEB LINKS:

1 Introduction to Mathematical Modeling of Biological Systems by Edward Batschelet – Springer, 2014.
2 Modeling and Simulation in Biomedical Engineering: Applications in Cardiorespiratory, Neuromuscular, and Endocrine Systems by Willem van Meurs – McGraw-Hill, 2011.
3 Computational Physiology: Hemodynamics and Cardiovascular Control by Frank C.P. Yin – Springer, 2019.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	1	3	3	-	2	-	-	-	2	1	1	-
CO 2	3	3	3	1	3	3	-	2	-	-	-	2	3	1	-
CO 3	3	3	3	3	3	3	-	2	-	-	-	2	3	3	-
CO 4	3	3	3	3	3	3	-	2	-	-	-	2	3	3	-
CO 5	3	3	3	3	3	3	-	2	-	-	-	2	3	3	-
AVG.	**3**	**3**	**3**	**2.2**	**3**	**3**	**-**	**2**	**-**	**-**	**-**	**2**	**2.6**	**2.2**	**-**

BM23E13 BIOFLUID DYNAMICS Category L T P C

PE 3 0 0 3

OBJECTIVES:

- To introduce the fundamental principles of fluid mechanics and their applications to biological systems.
- To develop an understanding of the dynamics of blood flow and other biological fluids.
- To analyze complex biofluid systems using mathematical and computational methods.
- To apply biofluid dynamics concepts to the design and evaluation of medical devices.
- To critically assess and interpret research findings in the field of biofluid dynamics.

UNIT-I INTRODUCTION TO FLUID MECHANICS AND BIOLOGICAL SYSTEMS 9

Basic concepts of fluid mechanics: continuity, momentum, and energy equations - Properties of fluids: viscosity, density, and surface tension - Overview of biological fluid systems - Rheology of biological fluids.

Case Study: Analyzing the viscosity of blood under different physiological conditions.

UNIT-II HEMODYNAMICS AND BLOOD FLOW 9

Blood flow in the cardiovascular system - Poiseuille's law and its applications to blood flow - Pulsatile flow in arteries - Flow through stenosed arteries and aneurysms

Case Study - Modeling blood flow in a stenosed artery and analyzing the impact of stenosis on flow patterns.

UNIT-III MATHEMATICAL AND COMPUTATIONAL METHODS IN BIOFLUID DYNAMICS 9

Governing equations for biofluid dynamics - Analytical solutions for simple flow problems - Introduction to computational fluid dynamics (CFD) - Simulation of biofluid flows using CFD software

Case Study - Simulating blood flow in a bifurcating artery using CFD and interpreting the results.

UNIT-IV BIOFLUID DYNAMICS IN MEDICAL DEVICES 9

Principles of fluid dynamics in medical devices - Design considerations for blood pumps, heart valves, and artificial organs - Hemolysis and thrombosis in medical devices - Flow-induced stresses and their implications

Case Study: Evaluating the design of a mechanical heart valve using biofluid dynamics principles.

UNIT-V ADVANCED TOPICS AND RESEARCH IN BIOFLUID DYNAMICS 9

Microfluidics and lab-on-a-chip technologies - Respiratory fluid dynamics - Lymphatic fluid dynamics - Recent advances in biofluid dynamics research

Case Study: Reviewing a recent research paper on microfluidic devices and discussing its findings and implications.

Contact Hours : 45

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Demonstrate an understanding of the basic principles of fluid mechanics and their relevance to biological systems.
- Analyze the dynamics of blood flow and other biological fluids using appropriate models.
- Apply mathematical and computational methods to solve complex biofluid problems.
- Design and evaluate medical devices considering biofluid dynamics principles.
- Critically evaluate and interpret research studies in biofluid dynamics.

TEXT BOOK(S):

1 "Biofluid Mechanics: An Introduction to Fluid Mechanics, Macrocirculation, and Microcirculation" by David Rubenstein, Wei Yin, and Mary D. Frame.
2 "Biomechanics: Circulation" by Y.C. Fung.
3 "Mechanics of the Circulation" by Colin G. Caro, Tim Pedley, Robert Schroter, and W. A. Seed.

REFERENCE BOOK(S) / WEB LINKS:

1 "Fluid Mechanics" by Frank M. White.
2 "Introduction to Computational Fluid Dynamics: The Finite Volume Method" by H.K. Versteeg and W. Malalasekera
3 "The Biomedical Engineering Handbook" by Joseph D. Bronzino (sections on biofluid dynamics).

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	3	3	-	-	3	3	3	3	3	3	3	3
CO 2	3	3	3	3	3	-	-	3	3	3	3	3	3	3	3
CO 3	3	3	3	3	3	-	-	3	3	3	3	3	3	3	3
CO 4	3	3	3	3	3	-	-	3	3	3	3	3	3	3	3
CO 5	3	3	3	3	3	-	-	3	3	3	3	3	3	3	3
AVG.	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

BM23E15	BIOSTATISTICS	Category	L	T	P	C
		PE	3	0	0	3

OBJECTIVES:

- To understand the fundamental concepts of biostatistics and their applications in biomedical engineering.
- To learn various statistical methods for data collection, analysis, and interpretation in biomedical research.
- To apply statistical techniques to model and analyze biomedical data.
- To develop proficiency in using statistical software for biostatistical analysis.
- To interpret and communicate statistical results in a biomedical context.

UNIT-I INTRODUCTION TO BIOSTATISTICS AND DESCRIPTIVE STATISTICS 9

Introduction to Biostatistics - Types of data: qualitative and quantitative - Measures of central tendency (mean, median, mode) - Measures of dispersion (range, variance, standard deviation) - Data visualization: histograms, box plots, scatter plots.

Case Study - Analyzing patient demographics data to summarize key statistics and visualize distributions.

UNIT-II PROBABILITY AND DISTRIBUTIONS 9

Basic probability concepts - Conditional probability and Bayes' theorem - Probability distributions: Binomial, Poisson, and Normal distributions - Sampling distributions and the Central Limit Theorem.

Case Study - Applying probability distributions to model the occurrence of rare diseases.

UNIT-III HYPOTHESIS TESTING AND CONFIDENCE INTERVALS 9

Hypothesis testing: null and alternative hypotheses, type I and type II errors - P-values and significance levels - Confidence intervals for means and proportions - T-tests, chi-square tests, and ANOVA.

Case Study: Evaluating the efficacy of a new medical treatment using hypothesis testing.

UNIT-IV REGRESSION ANALYSIS AND CORRELATION 9

Simple linear regression - Multiple linear regression - Logistic regression - Correlation analysis - Model selection and validation.

Case Study: Modeling the relationship between patient characteristics and health outcomes using regression analysis.

UNIT-V ADVANCED BIOSTATISTICAL METHODS 9

Survival analysis: Kaplan-Meier curves, Cox proportional hazards model - Non-parametric methods: Mann-Whitney U test, Kruskal-Wallis test - Longitudinal data analysis - Meta-analysis - Introduction to Bayesian statistics.

Case Study: Performing survival analysis on clinical trial data to assess treatment effectiveness.

Contact Hours : 45

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Demonstrate an understanding of basic biostatistical concepts and their relevance to biomedical engineering.
- Apply descriptive and inferential statistical methods to biomedical data.
- Use regression analysis and other modeling techniques to analyze complex biomedical data.
- Implement advanced statistical techniques and interpret their results using statistical software.
- Critically evaluate biomedical research studies using statistical principles.

TEXT BOOK(S):

1 "Biostatistics: A Foundation for Analysis in the Health Sciences" by Wayne W. Daniel and Chad L. Cross.

2 "Principles of Biostatistics" by Marcello Pagano and Kimberlee Gauvreau.

REFERENCE BOOK(S) / WEB LINKS:

1 "Statistical Methods for the Analysis of Biomedical Data" by Robert F. Woolson and William R. Clarke.

2 "The Essentials of Biostatistics for Physicians, Nurses, and Clinicians" by Michael R. Chernick and Robert H. Friis.

3 "Applied Regression Analysis and Other Multivariable Methods" by David G. Kleinbaum, Lawrence L. Kupper, and Keith E. Muller.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	3	3	-	-	3	3	3	-	3	2	3	-
CO 2	3	3	3	3	3	-	-	3	3	3	-	3	2	3	-
CO 3	3	3	3	3	3	-	-	3	3	3	-	3	2	3	-
CO 4	3	3	3	3	3	-	-	3	3	3	-	3	2	3	-
CO 5	3	3	3	3	3	-	-	3	3	3	-	3	2	3	-
AVG.	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**3**	**3**	**3**	**-**	**3**	**2**	**3**	**-**

BM23E16 VIRTUAL BIOINSTRUMENTATION Category L T P C

PE 3 0 0 3

OBJECTIVES:

- Grasp the fundamentals and history of virtual instrumentation.
- Develop skills in using LABVIEW, including its environment and programming structures.
- Comprehend digital I/O techniques and data acquisition methods.

- Learn about different communication protocols and interfaces used in VI.
- Explore practical applications of VI in biomedical instrumentation, such as ECG and EMG acquisition, and virtual reality modeling.

UNIT-I INTRODUCTION TO VIRTUAL INSTRUMENTATION 9

Virtual instrumentation (VI): Evolution, Definition, Architecture; Conventional and Distributed VI; Comparison of VI with traditional Instruments, Need of VI, advantages, block diagram, data flow techniques; graphical programming, Comparison between graphical programming and conventional programming; VI in engineering process.

UNIT-II PROGRAMMING MODES IN VI 9

VI: front panel, block diagram; LABVIEW Environment: Start up, Shortcut, and Pull down menu, Pallets; Control structures: FOR loop, WHILE loop, Shift Registers, feedback nodes; Selection Structures: Case and sequence structures, Formulae nodes, Arrays, Clusters; Waveform Chart and graph, XY Graph, Strings, Tables, File I/O functions.

UNIT-III HARDWARE ASPECTS OF VI SYSTEM 9

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

UNIT-IV COMMON INSTRUMENT INTERFACE 9

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

UNIT-V ANALYSIS TOOLS AND APPLICATIONS OF VI 9

Fourier transform, Power spectrum, Correlation, Windowing, Analog-to-Digital & Digital-to-Analog Conversion; Sampling, noise and filtering, Oscilloscope, Waveform generator, Multi-channel data acquisition using LABVIEW, ECG acquisition for long term monitoring of heart rate using VI, Electromyography (EMG), Air Flow and Lung Volume, Virtual Reality & 3D graphical modelling.

Contact Hours : 45

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Articulate the evolution, definition, and architecture of virtual instrumentation.
- Create and interpret block diagrams and data flow techniques in VI.
- Apply digital I/O techniques and configure hardware for data acquisition in LABVIEW.
- Explain and use different communication protocols and interfaces such as RS232, USB, PCI, VXI, PXI, and others in VI systems.
- Implement practical VI applications such as ECG and EMG monitoring, lung volume measurement, and create virtual reality models for Biomedical Engineering.

TEXT BOOK(S):

1 Gary Jonson, "Labview Graphical Programming", Second Edition, McGraw Hill, New York, Fourth edition 2006.
2 Jerome, Jovitha. Virtual Instrumentation using Labview. India, PHI Learning, 2010.
3 Lisa K wells & Jeffrey Travis, "Labview for everyone", Prentice Hall Inc, New Jersey, First edition 1997.

REFERENCE BOOK(S) / WEB LINKS:

1 Gupta S J, Gu.pta P, "PC interfacing for Data Acquisition & Process Control", InstrumentSociety of America, Second Edition, 1994.
2 Technical Manuals for DAS Modules of Advantech and National Instruments.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	3	3	3	2	3	-	-	1	-	-	2	2	3	2
CO 2	2	3	3	2	2	3	1	-	-	1	-	2	2	2	2
CO 3	1	3	3	-	2	2	1	1	-	-	1	2	2	3	3
CO 4	1	2	2	2	2	1	-	-	-	-	-	2	2	3	1
CO 5	1	2	2	2	2	1	-	-	1	1	-	2	2	3	3
AVG.	**1.4**	**2.6**	**2.6**	**2.25**	**2**	**2**	**1**	**1**	**1**	**1**	**1**	**2**	**2**	**2.8**	**2.2**

DOMAIN: PRODUCT DEVELOPMENT AND MANAGEMENT

BM23F11	MEDICAL ETHICS AND STANDARDS	Category	L	T	P	C
		PE	3	0	0	3

OBJECTIVES:

- To understand the basics of morals and work ethics and its associated aspects.
- To understand the various concepts involved in Engineering ethics.
- To explore the ethical considerations and issues in medical field.
- To explore the various medical standards for regulations of healthcare devices.
- To explore the various global issues in multinational corporates and its impact in the society.

UNIT-I HUMAN VALUES 9

Morals- Values and Ethics – Integrity – Work Ethic – Service Learning – Civic Virtue – Respect for Others – Living Peacefully – caring – Sharing – Honesty – Courage – Valuing Time – Co-operation – Commitment – Empathy – Self-Confidence – Character – Spirituality.

UNIT-II ENGINEERING ETHICS 9

Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of professional roles - Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories- Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law.

UNIT-III MEDICAL ETHICS AND ISSUES 9

Introduction to medical ethics, Ethical theory, the relation between medical workers and patients, Beneficence and autonomy, Competence, Confidentiality.Hastening death, Active and passive euthanasia, the definition of death, the law - involuntary euthanasia Confidentiality-Truth telling-Informed consent-Abortion-Seriously ill patients-Euthanasia-Medical experimentation-Cloning-Justice and health care system.

UNIT-IV MEDICAL STANDARDS 9

Necessity for standardization-International Standards ISO 9000 – 9004 – Features of ISO 9001 – ISO 14000 –Environmental Management Systems- ISO 13485:2016 Quality Management Systems- ISO 14971 Risk Management Systems- ISO/TR 20416:2020 Medical Devices Post market surveillance for manufacturers – ISO 20417:2021 Medical Devices Information to be supplied by the manufacturer-Graphical symbols for medical devices.

UNIT - V GLOBAL ISSUES 9

Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership –Code of Conduct – Corporate Social Responsibility.

Contact Hours : 45

COURSE OUTCOMES:

On completion of the course, the students will be able to

- To apply the basics of morals and work ethics and its associated aspects in society.
- To comprehend and apply the various concepts involved in Engineering ethics.
- To apply the ethical considerations in medical field.
- Develop comprehensive understanding on diverse medical standards governing healthcare device regulations.
- To comprehend the issues happening globally and its associated leadership principles.

TEXT BOOK(S):

1 Charles D- Fleddermann- "Engineering Ethics"- Pearson Education / Prentice Hall-New Jersey- 2004 (Indian Reprint) Charles E Harris- Michael S- Protchard andMichael J Rabins- "Engineering Ethics Concepts and Cases"- Wadsworth ThompsonLearning- United States- 2000 (Indian Reprint now available).

2 Govindarajan M, Natarajan S, Senthil Kumar V. S, "Engineering Ethics", Prentice Hall of India,New Delhi, 2004.

REFERENCE BOOK(S) / WEB LINKS:

1 John R Boatright- "Ethics and the Conduct of Business"- Pearson Education- New Delhi- 2003.

2 Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, "Engineering Ethics – Concepts and Cases", Cengage Learning, 2009.

3 Edmund G Seebauer and Robert L Barry, "Fundamentals of Ethics for Scientists and Engineers", Oxford University Press, Oxford, 2001.

4 Laura P. Hartman and Joe Desjardins, "Business Ethics: Decision Making for Personal Integrity and Social Responsibility" Mc Graw Hill education, India Pvt. Ltd.,New Delhi, 2013.

5 https://www.iso.org/sectors/health/medical-equipment.

6 www.onlineethics.org.

7 www.nspe.org.

8 www.globalethics.org.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	-	-	-	-	-	-	-	-	1	3	3	1
CO 2	3	3	3	-	-	3	-	-	-	-	-	1	3	3	-
CO 3	3	3	3	-	-	3	-	-	2	-	-	1	3	3	-
CO 4	3	3	3	-	-	-	1	1	-	-	-	1	3	3	-
CO 5	3	3	3	-	-	2	-	-	-	-	-	1	3	3	-
AVG.	**3**	**3**	**3**	**-**	**-**	**2.6**	**1**	**1**	**2**	**-**	**-**	**1**	**3**	**3**	**1**

BM23F12	HOSPITAL ENGINEERING AND MANAGEMENT	Category	L	T	P	C
		PE	3	0	0	3

OBJECTIVES:

- To understand the fundamentals and principles of hospital engineering and administration.
- To understand the management and market related research contexts and its related process.
- To explore various roles and responsibilities of Engineers in hospital.
- To understand various waste management codes and its disposal techniques.
- To comprehend the standards and safety aspects in hospitals.

UNIT-I INTRODUCTION TO HOSPITAL ENGINEERING 9

Distinction between Hospital and Industry, History of engineering and technology in health care – Health care environment– Staff structure in hospitals – Careers, roles and responsibilities. Hospital and Functional Planning- Equipment Planning-Management Decisions and Related Information Requirement-Current issues in Hospital Management-Clinical Information Systems - Administrative Information systems.

Case study: Use of e-governance in medical field by Tamil Nadu Government.

UNIT-II MANAGEMENT AND MARKETING RESEARCH PROCESS 9

Manpower Planning - Different Departments of Hospital, Recruitment, Selection, Training Guidelines –Methods of Training – Evaluation of Training – Leadership grooming and Training, Promotion – Transfer, Communication, Marketing information systems – Consumer Markets & Consumer Buyer Behaviour - Model of consumer behaviour - The buyer decision process - Model of business buyer behaviour – General Agreement on Tariffs and Trade (GATT) - WTO and its implications.

Case study: Role of WHO and WTO in Indian Medical Device market.

UNIT-III ROLES AND RESPONSIBILITIES OF ENGINEERS IN HOSPITAL 9

Biomedical equipment procurement procedure - purchase & contract procedures, selection testing calibration and installation, Training to medical staffs – operating instructions. Management of medical equipment – Comprehensive maintenance system and Preventive maintenance system, planned preventive maintenance & repair. Requirements of inter departmental computerization. DBMS in hospital, computerized medical record evaluation.

Case study: Bridging the gap between medical equipment requirements and biomedical Engineers.

UNIT-IV BIOMEDICAL WASTE MANAGEMENT & SUPPORTIVE SERVICES 9

General and Hazardous health care waste – categories– Color coding, collection, segregation and disposal. Modern Technology for handling Biomedical Wastes – Hospital Acquired Infection – Monitoring & Controlling of Cross Infections, Protective Devices – Bioethics and Handling of Waste Management. Support Service, Technical information systems – Medical Records Department – Central Sterilization and Supply Department.

Case study: Exploration of Biomedical waste management in A multispecialty hospital.

UNIT-V STANDARDS AND SAFETY ASPECTS IN HOSPITALS 9

Necessity for standardization - Need for Accreditation of hospitals -FDA Regulations- Joint Commission International - Regulatory Bodies of India- NABH –procedures and documentation, National Medical Commission - Pharmacy Council Of India-International Standards ISO 9000 – 9004 – Features of ISO 9001 – ISO 14000 – ISO: 13485, ISO: 14791, risk management-Environmental Management Systems. Labor laws applicable to hospitals, Medical Ethics-Security – Loss Prevention – Fire Safety – Alarm System – Safety Rules. Health Insurance & Managing Health Care – Quality and Medical Audit – Hazard and Safety in a Hospital Setup.

Case study: Hospital electrical distribution system design.

Contact Hours : 45

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Explain the basic principles of Hospital administration and management.
- Identify the importance of management of staff and equipment.
- Identify the importance of Engineers in hospitals.
- Identify various techniques used for waste management and its corresponding codes.
- Understand the safety and regulatory procedures followed in hospitals.

TEXT BOOK(S):

1 Sharma D K, R.C.Goyal, “Hospital administration and Human Resource Management in Hospital”, Prentice Hall of India, New Delhi, 2017

2 G D Kunders “Hospitals- Facilities Planning & Management” 2017 1st edition, Tata McGraw Hill Education, New Delhi, India

3 V. J. Landrum, “Medical Waste Management and disposal, Elsevier.

4 K V Ramani “Hospital Management: Texts and Cases” 2013 1st edition, Pearson Education, New Delhi, India.

REFERENCE BOOK(S) / WEB LINKS:

1 Keith Willson, Keith Ison, SlavikTabakov, “Medical Equipment Management”, CRC Press, 2013.

2 Arnold D. Kalcizony & Stephen M. Shortell, “Health Care Management", 6th Edition Cengage Learning, 2011.

3 Norman Metzger, “Handbook of Health Care Human Resources Management”, 2nd edition Aspen Publication Inc. Rockville, Maryland, USA, 1990.

4 Cesar A. Caceres and Albert Zara, “The Practice of Clinical Engineering, AcademicPress, New York, 1977.

5 Thomas A. Mappes and David DeGrazia (editors), Biomedical Ethics, McGrawHill, 4th Edition, 1996.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
CO 2	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-
CO 3	-	-	-	-	-	3	-	-	2	-	-	3	-	-	-

CO 4	-	1	1	-	-	-	1	1	-	-	-	-	-	-	-
CO 5	2	2	-	-	-	2	-	-	-	-	-	3	-	-	-
AVG.	**2**	**1.5**	**1**	-	-	**2.6**	**1**	**1**	**2**	**-**	**-**	**3**	-	-	**1**

BM23F13 HEALTH CARE PRODUCT DEVELOPMENT Category L T P C

PE 3 0 0 3

OBJECTIVES:

- To understand the stages involved in the development of healthcare products.
- To explore the materials and technologies used in healthcare product design.
- To provide insights into the regulatory and quality control aspects of healthcare products.
- To analyze current trends and advancements in healthcare product development.
- To understand the stages involved in the development of healthcare products.

UNIT-I INTRODUCTION TO HEALTHCARE PRODUCT DEVELOPMENT **6**

Overview of Healthcare Product Development – Definitions, Importance, and Process. Types of Healthcare Products – Medical Devices, Diagnostics, and Wearables. Key Stages of Product Development – Conceptualization, Feasibility, Design, and Market Launch. Introduction to Regulatory Standards – FDA, CE Marking, and ISO Certifications.

UNIT-II MATERIALS AND TECHNOLOGIES IN HEALTHCARE PRODUCTS **6**

Materials for Healthcare Products – Polymers, Metals, Ceramics, and Composites. Emerging Technologies – 3D Printing, Nanotechnology, and Biosensors. Case Studies on the Application of Advanced Materials in Healthcare Devices.

UNIT-III DESIGN AND PROTOTYPING **6**

Design Principles – Usability, Durability, and Safety in Healthcare Devices. Prototyping Techniques – Rapid Prototyping and 3D Printing. Testing and Validation – Biocompatibility and Mechanical Testing of Devices.

UNIT-IV REGULATORY AND QUALITY ASPECTS **6**

Regulatory Frameworks for Medical Devices – FDA, ISO, and CE Marking. Quality Control – Good Manufacturing Practices (GMP) and Risk Management in Product Development. Case Studies on Regulatory Approvals and Compliance Processes.

UNIT-V MARKET AND FUTURE TRENDS IN HEALTHCARE PRODUCTS **6**

Market Analysis – Identifying Market Needs, Consumer Research, and Innovation. Emerging Trends in Healthcare Product Development – Telemedicine, AI, and IoT in Healthcare. Case Studies on Commercialization of Healthcare Products.

Contact Hours : 30

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Understand the process of healthcare product development from concept to market.
- Identify suitable materials and technologies for healthcare product design.
- Develop and prototype healthcare products with a focus on usability and safety.
- Understand the regulatory and quality assurance requirements in healthcare product development.
- Explore current trends and innovations in healthcare product development.

TEXT BOOK(S):

1 Healthcare Product Development: Concepts and Applications by Peter J. Ogrodnik – Academic Press, 2019.
2 Design of Biomedical Devices and Systems by Paul H. King, Richard C. Fries – CRC Press, 2018.

REFERENCE BOOK(S) / WEB LINKS:

1 Medical Device Development: A Regulatory Overview by Jonathan S. Kahan – RAPS, 2011.
2 Wearable Technology for Healthcare by Raymond Tong – CRC Press, 2021.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	1	3	3	-	2	-	-	-	2	1	1	-
CO 2	3	3	3	1	3	3	-	2	-	-	-	2	3	1	-
CO 3	3	3	3	3	3	3	-	2	-	-	-	2	3	3	-
CO 4	3	3	3	3	3	3	-	2	-	-	-	2	3	3	-
CO 5	3	3	3	3	3	3	-	2	-	-	-	2	3	3	-
AVG.	**3**	**3**	**3**	**2.2**	**3**	**3**	**-**	**2**	**-**	**-**	**-**	**2**	**2.6**	**2.2**	**-**

BM23F14 ENTREPRENEURSHIP IN BIOMEDICAL ENGINEERING

Category	L	T	P	C
PE	1	0	0	1

OBJECTIVES:

- To understand the stages involved in the development of healthcare products.
- To explore the materials and technologies used in healthcare product design.

UNIT-I INTRODUCTION TO ENTREPRENEURSHIP 8

Definition - characteristics and functions of an entrepreneur - common myths about entrepreneurs - importance of entrepreneurship. Creativity and innovation: The role of creativity - the innovation process - sources and methods of generating ideas -creative problem solving -

entrepreneurial process, the importance of a business model- components of an effective business model - case studies in developing and writing the business plan- Entrepreneurial advancements in biomedical field- Supporting societies and professional activities- Impact of innovation in medical devices.

UNIT-II FINANCING & MARKETING 7

Determining financial needs - sources of financing -support for product development, funding agencies, collaborative initiatives- equity and debt funding. Marketing function: Industry analysis - competitor analysis - marketing research for the new venture -defining the purpose or objectives - gathering data from secondary sources – gathering information from primary sources - analyzing and interpreting the results – the marketing process, ethics and business decisions- Impact of Globalization: Medical product manufacturing, marketing, leadership, quality management.

Contact Hours : 15

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Write effective business plan to become a successful entrepreneur.
- Identify the sources of finance and gain marketing knowledge for start-ups.

TEXT BOOK(S):

1 Jen-Shih Lee “Biomedical Engineering Entrepreneurship”, World Scientific Publishing, USA. 2010

2 Donald F.Kuratko and Richard M.Hodgetts, “Entrepreneurship”, South- Western/Cengage Learning, 2008.

3 Robert D Hisrich, Michael P Peters & Dean Shepherd, “Entrepreneurship”, Tata McGraw-Hill, 2007.

REFERENCE BOOK(S) / WEB LINKS:

1 Brant Cooper, Patrick Vlaskovits, “The Lean Entrepreneur”, Wiley, 2nd edition, New Jersy, 2016.

2 Nathan Furr, Jeff Dyer, “The Innovator's Method: Bringing the Lean Start-up into Your Organization”, Harvard Business Press, Boston, 2014.

3 Thomas W.Zimmerer, Norman M.Scarborough, Essentials of Entrepreneurship and Small Business Management, Prentice Hall of India, 2009.

4 Marc J Dollinger, Entrepreneurship - Strategies and Resources, Pearson Education,2003.

5 Mary Coulter, Entrepreneurship in Action, Prentice Hall of India, New Delhi, 2006.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	-	-	-	-	-	-	-	-	1	3	3	-
CO 2	3	3	3	-	-	-	-	-	-	-	-	1	3	3	-
AVG.	**3**	**3**	**3**	-	-	-	-	-	-	-	-	**1**	**3**	**3**	**-**

BM23F15	MEDICAL SAFETY, QUALITY ASSURANCE AND REGULATORY AFFAIRS	Category	L	T	P	C
		PE	3	0	0	3

OBJECTIVES:

- To understand the significance of safety within a healthcare organization.
- To understand the principles and practices of radiation in healthcare.
- To acquire knowledge on the facility safety management.
- To know how to assess medical devices and quality of healthcare provided.
- To acquire understanding of regulatory affairs in healthcare.

UNIT-I HOSPITAL SAFETY 9

Security & Safety of Hospital -Property, Staff & Patients, Safety precautions, Disposal of Biological waste. Safe medical devices – device requirements - devices for varying age – initial inspection – maintenance. Personal protective Equipment. Physiological effects of electricity - Electrical faults in medical devices - Micro shock, Macro shock, Leakage current, Electrical isolation - Grounding system - Electrical safety analyzer – Emergency power system - Uninterrupted power supply.

UNIT-II RADIATION IN MEDICINE: PRINCIPLES AND PRACTICES 8

Fundamentals of radiation detection. Molecular medicine and radiation safety. Classification of UV radiation - Biological effects of UV - Hazards associated with UV radiation - UV monitor and control measures. Classifications of LASER - radiation hazards - control measures. Guidelines for CT installations. MRI safety guidelines.

UNIT-III FACILITY SAFETY 9

Facility Safety - Introduction, Facility Guidelines Institute, Administrative Area Safety, Slip, Trip, and Fall Prevention - Safety Signs, Colors, and Marking Requirements, Scaffolding, Fall Protection - Tool Safety, Machine Guarding - Compressed Air Safety, Control of Hazardous Energy, Permit Confined Spaces - OSHA Hearing Conservation Standard, Heating, Ventilating, Air-Conditioning Systems - Assessing IAQ, Landscape and Grounds Maintenance - Fleet and Vehicle Safety.

UNIT-IV QUALITY ASSESSMENT IN HEALTHCARE 10

Quality management, risk management, types of responsibilities – CSR, Individual and Institutional responsibility. MDRA and medical device standards, ICRP regulations for radiation safety, Methods adopted to monitor the standards. Evaluation of hospital services – six sigma way, Quality Assurance in Hospitals SOP's – Patient Orientation for Total Patient Satisfaction. 5S techniques. TQM in Health care organization-Quality assurance methods, QA in (Medical Imaging & Nuclear medicine) Diagnostic services.

UNIT-V REGULATORY AFFAIRS 9

Overview of Indian Regulatory system - Central Drug Standard Control Organization (CDSCO) - CE and FDA regulations, Accreditation for hospitals – National Medical Council – Joint Commission of India, National Accreditation Board For Hospitals and Healthcare Providers (NABH) and National Accreditation Board for Testing and Calibration Laboratories (NABL) -Other

regulatory Codes.

Contact Hours : 45

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Gain knowledge on hospital safety.
- Gain knowledge in management of radiation in healthcare.
- Apply knowledge in the safety management of facility.
- Implement the various methods to monitor and assess quality in healthcare.
- Gain comprehensive understanding of healthcare regulatory affairs.

TEXT BOOK(S):

1 Bertil Jacobson and Alan Murray, “Medical Devices use and safety”, Reed Elsevier India Pvt. Ltd, New Delhi, 2011.

2 Massimo A.G.Mitolo, Electrical Safety of Low-voltage System, McGraw Hill, 2009.

3 Tweedy, James T., Healthcare hazard control and safety management-CRC Press Taylor and Francis (2014).

REFERENCE BOOK(S) / WEB LINKS:

1 Sharon Myers “Patient Safety & Hospital Accreditation - A Model for Ensuring Success” Springer Publishers 2012 7. Joseph F Dyro “Clinical Engineering Handbook“ Elsevier Publishers, 2004.

2 Steve Webb, “The Physics of Medical Imaging”, Taylor & Francis, New York, 1988.

3 G.D.Kunder, S.Gopinath, A.Katakam, “Hospital Planning, Design and Management”, Tata Mcgraw Hil publishers, New Delhi, 1998.

4 Joseph J. Carr and John M. Brown, “Introduction to Biomedical equipment technology”, John Willey and sons, New York, 1997.

5 https://cdsco.gov.in/opencms/opencms/en/Home/.

6 https://nabh.co/.

7 https://nabl-india.org/.

8 https://www.fda.gov/.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	-	-	-	-	-	-	-	-	1	3	3	-
CO 2	3	3	3	-	-	-	-	-	-	-	-	1	3	3	-
CO 3	3	3	3	-	-	2	-	-	-	-	-	1	3	3	-
CO 4	3	3	3	-	-	-	-	-	-	-	-	1	3	3	-
CO 5	3	3	3	-	-	-	-	-	2	2	2	1	3	3	-
AVG.	**3**	**3**	**3**	**-**	**-**	**2**	**-**	**-**	**2**	**2**	**2**	**1**	**3**	**3**	**-**

BM23F16	INDUSTRIAL SAFETY AND MANAGEMENT	Category	L	T	P	C
		PE	3	0	0	3

OBJECTIVES:

- To explain the fundamental principles and importance of industrial safety in the workplace.
- To outline the components and functioning of Safety Management Systems (SMS) in industrial settings.
- To teach the principles of industrial hygiene and environmental safety practices.
- To familiarize students with safety standards and protocols specific to biomedical engineering.
- To explore advanced safety technologies and their applications in industrial environments.

UNIT I INTRODUCTION TO INDUSTRIAL SAFETY 9

Overview of Industrial Safety – Importance of safety in industrial environments – History and evolution of industrial safety – Legal and regulatory aspects. Hazards in the Workplace – Types of hazards: physical, chemical, biological, ergonomic, and psychosocial – Hazard identification and risk assessment – Case studies of industrial accidents. Safety Culture and Behavior – Developing a safety culture – Role of management and employees in safety – Safety communication and training.

UNIT-II SAFETY MANAGEMENT SYSTEMS 9

Components of a Safety Management System (SMS) – Policy and objectives – Organizational structure and responsibilities – Planning and implementation. Risk Management – Risk assessment techniques – Hazard control and risk reduction methods – Emergency preparedness and response. Safety Performance Measurement – Key performance indicators (KPIs) for safety – Auditing and continuous improvement – Incident reporting and investigation.

UNIT-III INDUSTRIAL HYGIENE AND ENVIRONMENTAL SAFETY 9

Industrial Hygiene Principles – Anticipation, recognition, evaluation, and control of workplace hazards – Occupational exposure limits (OELs). Control of Hazardous Substances – Use of personal protective equipment (PPE) – Engineering controls and administrative controls – Safe handling and disposal of chemicals and biological agents. Environmental Safety and Compliance – Environmental impact of industrial operations – Waste management and pollution control – Compliance with environmental regulations.

UNIT-IV SAFETY IN BIOMEDICAL ENGINEERING 9

Biomedical Equipment Safety – Safety standards and regulations for biomedical equipment – Maintenance and calibration of biomedical devices – Safety testing and validation procedures. Clinical and Laboratory Safety – Biosafety levels and containment practices – Safe handling of biological samples and infectious materials – Laboratory safety protocols and best practices. Human Factors and Ergonomics – Ergonomic design of biomedical devices – Prevention of work-related musculoskeletal disorders – Human-machine interaction and usability.

UNIT-V INDUSTRIAL SAFETY TECHNOLOGIES AND INNOVATIONS 9

Safety Automation and Control Systems – Use of automation in industrial safety – Safety instrumented systems (SIS) – Real-time monitoring and control. Emerging Technologies in Safety – Role of IoT and AI in enhancing industrial safety – Wearable technology for monitoring worker health and safety – Virtual and augmented reality for safety training. Future Trends and Challenges – Innovations and advancements in safety technologies – Global safety standards and best practices – Addressing new and emerging risks in industrial environments.

Contact Hours : 45

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Students will be able to describe the types of workplace hazards and outline the steps to identify and assess risks.
- Students will be able to develop and implement a basic safety management plan, incorporating risk assessment and emergency preparedness.
- Students will be able to evaluate workplace environments for hazardous conditions and recommend appropriate control measures.
- Students will be able to apply safety standards to the design, maintenance, and testing of biomedical equipment and laboratory procedures.
- Students will be able to analyze and propose the integration of emerging technologies, such as IoT and AI, to enhance industrial safety.

TEXT BOOK(S):

1 "Industrial Safety and Health Management" by C. Ray Asfahl, David W. Rieske, Pearson, 7th Edition, 2010.

2 "Fundamentals of Industrial Hygiene" by Barbara A. Plog, Patricia J. Quinlan, National Safety Council Press, 6th Edition, 2012.

REFERENCE BOOK(S) / WEB LINKS:

1 "Principles of Safety Management" by R.J. Burke, Springer, 1st Edition, 1992.

2 "Occupational Health and Safety Management: A Practical Approach" by Charles D. Reese, CRC Press, 3rd Edition, 2015.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	-	-	-	-		-	-	-	1	3	3	-
CO 2	3	3	3	-	-	-	-	-	-	-	-	1	3	3	-
CO 3	3	3	2	2	-	2	-		-	-	-	1	3	3	-
CO 4	3	3	3	-	-	-	-	-	-	-	-	1	3	3	-
CO 5	3	3	2	2	-	2	2	2	-	-	-	1	3	3	-
AVG.	**3**	**3**	**2.6**	**2**	**-**	**2**	**2**	**2**	**-**	**-**	**-**	**1**	**3**	**3**	**-**

BM23F17	ENGINEERING ECONOMICS	Category	L	T	P	C
		PE	3	0	0	3

OBJECTIVES:

- Learn fundamental economic principles and their relevance to biomedical engineering.
- Analyze consumer behavior theories and apply them to biomedical product development and marketing
- Provide insight of cost structures and their implications for biomedical product manufacturing.
- Understand national income determination and its relevance to biomedical economic analysis.
- Know the impact of government schemes on biomedical research, development, and healthcare delivery.

UNIT I MICROECONOMICS 9

Basic Economic Concepts: Scarcity, choice, opportunity cost; Theory of Demand and Supply: Market equilibrium, price determination; Elasticity of Demand and Supply; Consumer Theory: Preferences, utility maximization, consumer equilibrium.

UNIT-II PRICE AND CONSUMER BEHAVIOR 9

Price Determination: Factors influencing pricing strategies in biomedical products; Consumer Behavior Analysis: Psychological and economic factors influencing consumer choices; Market Segmentation and Targeting: Strategies for biomedical products.

UNIT-III PRODUCTION FUNCTION AND COMPETITION 9

Production Function: Concepts and analysis in biomedical engineering; Cost Analysis: Fixed costs, variable costs, total costs; Market Structures: Perfect competition, monopoly, oligopoly, monopolistic competition.

UNIT-IV NATIONAL INCOME AND KEYNESIAN MULTIPLIER 9

National Income Determination: Measurement and analysis; Keynesian Economics: Theory and applications in biomedical sector; Fiscal Policy: Government spending, taxation, and economic stabilization.

UNIT-V POLICY, TAXES, AND LATEST GOVERNMENT SCHEMES 9

Economic Policy Tools: Monetary policy, fiscal policy, and their impact on biomedical sector; Taxation Systems: Types of taxes, tax incidence, and their implications for biomedical firms; Latest Government Schemes: Analysis of current schemes impacting the biomedical industry (e.g., Make in India, Ayushman Bharat, National Digital Health Mission).

Contact Hours : 45

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Apply microeconomic concepts effectively to analyse and predict pricing strategies and market behaviour within the biomedical industry.
- Utilize production functions and cost analysis techniques to optimize biomedical product design and manufacturing processes.
- Compare and contrast different market structures and their effects on competition,

innovation, and market efficiency in biomedical engineering.

- Develop strategic responses and recommendations to address economic challenges and opportunities within the biomedical industry.
- Critique the effectiveness of government schemes and initiatives in achieving healthcare delivery improvements and advancing biomedical research outcomes.

TEXT BOOK(S):

1 Paul A. Samuelson, William D. Nordhaus, Sudip Chaudhuri and Anindya Sen, Economics, 19thedition, Tata McGraw Hill, New Delhi, 2010.
2 D N Dwivedi, Managerial Economics, 8th Edition, Vikas Publishing House,2018
3 N. Gregory Mankiw, Principles of Economics, 3rd edition, Thomson learning, New Delhi, 2007.
4 Richard Lipsey and Alec Charystal, Economics, 12th edition, Oxford, University Press, New Delhi, 2011.

REFERENCE BOOK(S) / WEB LINKS:

1 Karl E. Case and Ray C. fair, Principles of Economics, 6th edition, Pearson, Education Asia, New Delhi, 2002.
2 William Boyes and Michael Melvin, Textbook of economics, Biztantra, 2005.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	1	3	3	2	2	3	-	3	1	3	3	3	2	3	3
CO 2	1	3	3	2	2	3	1	3	1	3	3	3	2	2	3
CO 3	1	3	2	1	2	2	1	1	1	3	1	3	2	3	3
CO 4	1	3	2	2	2	3	-	2	1	3	3	3	2	3	3
CO 5	1	3	3	2	3	3	-	1	2	3	3	3	2	3	3
AVG.	**1**	**3**	**2.6**	**1.8**	**2.2**	**2.8**	**1**	**2**	**1.2**	**3**	**2.6**	**3**	**2**	**2.8**	**3**