RAJALAKSHMI ENGINEERING COLLEGE

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

DEPARTMENT OF BIOMEDICAL ENGINEERING

CURRICULUM AND SYLLABUS REGULATIONS 2019

B.E BIOMEDICAL ENGINEERING

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 instil 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

CATEGORY	CREDITS AS PER SEMESTER								CREDITS TOTAL
	I	II	III	IV	V	VI	VII	VIII	
Humanities and Social sciences (HS)	3			3					**6**
Basic Sciences (BS)	8	8	4	4					**24**
Engineering Sciences (ES)	5	14		6					**25**
Professional Core (PC)			18	11	17	12	10		**68**
Professional Elective (PE)						3	6	6	**15**
Open Elective (OE)					3	3	3		**6**
Project, Seminar & Internship (EES)				1	1	4	5	8	**19**
TOTAL	**16**	**22**	**22**	**25**	**21**	**22**	**21**	**14**	**163**

CURRICULUM

Semester I

SL. No	Subject code	Category	Course Title	L	T	P	Contact Periods	Credits
1	HS19151	HS	Technical English	2	1	0	3	3
2	MA19152	BS	Linear Algebra and Applied Calculus	3	1	0	4	4
3	PH19142	BS	Physics for Bioscience	3	0	2	5	4
4	GE19101	ES	Engineering Graphics	2	2	0	4	4
5	GE19121	ES	Engineering Practices - Civil & Mechanical	0	0	2	2	1
6	MC19101	HS	Environmental Science and Engineering	3	0	0	3	0
				13	**4**	**4**	**21**	
							TOTAL CREDITS	**16**

Semester II

SL. No	Subject code	Category	Course Title	L	T	P	Contact Periods	Credits
1	MA19252	BS	Differential Equations and Complex Variables	3	1	0	4	4
2	CY19142	BS	Chemistry For Electronics Engineering	3	0	2	5	4
3	BM19241	ES	Electric Circuits and Electron Devices	3	1	2	6	5
4	ME19251	ES	Engineering Mechanics for Biomedical Engineers	3	1	0	4	4
5	GE19142	ES	Programming using C	2	0	4	6	4
6	GE19122	ES	Engineering Practices- Electrical and Electronics	0	0	2	2	1
7	MC19102	HS	Indian Constitution and Freedom Movement	3	0	0	3	0
				17	**3**	**10**	**30**	
							TOTAL CREDITS	**22**

Semester III

SL. No	Subject code	Category	Course Title	L	T	P	Contact Periods	Credits
1	MA19352	BS	Transforms and Special Functions	3	1	0	4	4
2	BM19301	PC	Human Anatomy and Physiology	3	0	0	3	3
3	BM19341	PC	Electronic Circuits	3	0	2	5	4
4	BM19342	PC	Sensors and Measurements	2	0	2	4	3
5	BM19343	PC	Electric fields and Machines	2	0	2	4	3
6	BM19302	PC	Biochemical Science	3	0	0	3	3
7	BM19311	PC	Biochemistry and Physiology Laboratory	0	0	4	4	2
				16	**1**	**10**	**27**	
							TOTAL CREDITS	**22**

Semester IV

SL. No	Subject code	Category	Course Title	L	T	P	Contact Periods	Credits
1	MA19452	BS	Probability and Random Process	3	1	0	4	4
2	BM19401	PC	Biomedical Instrumentation	3	0	0	3	3
3	BM19402	PC	Analog and Digital Integrated Circuits	3	0	0	3	3
4	BM19441	PC	Pathology and Microbiology	2	0	2	4	3
5	CS19241	ES	Data Structures	3	0	4	7	5
6	GE19303	HS	Economics for Engineers	3	0	0	3	3
7	BM19411	PC	Analog and Digital Integrated Circuits Laboratory	0	0	4	4	2
8	BM19421	ES	PCB Design Laboratory	0	0	2	2	1
9	GE19421	EES	Soft Skills-I	0	0	2	2	1
10	MC19301	HS	Essence of Indian Traditional knowledge	2	0	0	2	0
				19	**1**	**14**	**34**	
							TOTAL CREDITS	**25**

Semester V

SL. No	Subject code	Category	Course Title	L	T	P	Contact Periods	Credits
1	BM19501	PC	Biocontrol systems	3	0	0	3	3
2	BM19502	PC	Principles of Communication Systems	3	0	0	3	3
3	BM19541	PC	Signals and Systems Analysis	2	1	2	5	4
4	BM19542	PC	Microprocessor, Microcontroller and Embedded System Design	3	0	2	5	4
5		OE	OE 1	3	0	0	3	3
6	BM19511	PC	Biomedical Instrumentation Laboratory	0	0	4	4	2
7	GE19521	EES	Soft Skills -II	0	0	2	2	1
				14	**1**	**10**	**25**	
							TOTAL CREDITS	**20**

Semester VI

SL. No	Subject code	Category	Course Title	L	T	P	Contact Periods	Credits
1	BM19601	PC	Diagnostic and Therapeutic Equipment	3	0	0	3	3
2	BM19602	PC	Biomechanics	3	1	0	4	4
3	BM19641	PC	Digital Signal Processing Techniques	2	1	2	5	4
4		PE	PE 1	3	0	0	3	3
5		OE	OE 2	3	0	0	3	3
6	BM19611	PC	Diagnostic and Therapeutic Equipment Laboratory	0	0	4	4	2
7	BM19642	EES	Innovation and Design thinking for Biomedical Engineers	0	1	2	3	2
8	GE19621	EES	Problem solving techniques	0	0	2	2	1
9	BM19612	EES	Medical Industrial Training	0	0	2	2	1
				14	**3**	**12**	**29**	
							TOTAL CREDITS	**23**

Semester VII

SL. No	Subject code	Category	Course Title	L	T	P	Contact Periods	Credits
1	BM19701	PC	Hospital Engineering and Management	3	0	0	3	3
2	BM19702	PC	Medical Informatics	3	0	0	3	3
3	BM19741	PC	Digital Image Processing Techniques	2	1	2	5	4
4		PE	PE- 2	3	0	0	3	3
5		PE	PE- 3	3	0	0	3	3
6	BM19711	EES	Project Phase-I	0	0	6	6	3
7	BM19712	EES	Hospital Training	0	0	2	2	1
8	BM19713	EES	Comprehension	1	1	0	2	1
				15	**2**	**10**	**27**	
							TOTAL CREDITS	**21**

Semester VIII

SL. No	Subject code	Category	Course Title	L	T	P	Contact Periods	Credits
1		PE	PE-4	3	0	0	3	3
2		PE	PE-5	3	0	0	3	3
3	BM19811	EES	Project Phase-II	0	0	16	16	8
				6	**0**	**16**	**22**	
							TOTAL CREDITS	**14**

TOTAL CREDITS: 163

PROFESSIONAL ELECTIVES (PE)

Student has to earn three credits from each of the following group

SL No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
PROFESSIONAL ELECTIVE - I								
1	BM19P61	Medical Optics	PE	3	3	0	0	3
2	BM19P62	Medical Physics	PE	3	3	0	0	3
3	BM19P63	Nanotechnology and Applications	PE	3	3	0	0	3
4	BM19P64	Biomaterials and Applications	PE	3	3	0	0	3
5	BM19P65	Neural Engineering	PE	3	3	0	0	3
PROFESSIONAL ELECTIVE - II								
1	BM19P71	Soft Computing methods	PE	3	3	0	0	3
2	BM19P72	Rehabilitation Engineering	PE	3	3	0	0	3
3	BM19P73	Medical Safety and Quality Assurance	PE	2	2	0	0	2
4	BM19P74	Human Values and Medical Ethics	PE	1	1	0	0	1
PROFESSIONAL ELECTIVE - III								
1	BM19P75	BIOMEMS	PE	3	3	0	0	3
2	BM19P76	Medical Textiles Fundamentals	PE	3	3	0	0	3
3	BM19P77	Medical Robotics	PE	2	2	0	0	2
4	BM19P78	Biometric systems	PE	2	2	0	0	2
5	BM19P79	Entrepreneurship in Biomedical Engineering	PE	1	1	0	0	1
PROFESSIONAL ELECTIVE - IV								
1	BM19P81	Physiological Modeling	PE	3	2	0	2	3
	BM19P82	Embedded Systems and Application Development	PE	3	3	0	0	3
3	BM19P83	Bioelectromagnetism and Compatibility	PE	2	2	0	0	2
4	BM19P84	Telehealth Technology	PE	1	1	0	0	1
PROFESSIONAL ELECTIVE - V								
1	BM19P85	Healthcare Product Development	PE	3	3	0	0	3
2	BM19P86	Virtual Reality in Medical Applications	PE	2	2	0	0	2
3	BM19P87	Wearable Systems	PE	2	2	0	0	2
4	BM19P88	Internet of Things in medicine	PE	1	1	0	0	1

SEMESTER I

HS19151	**TECHNICAL ENGLISH**	**L**	**T**	**P**	**C**
	Common to all branches of B.E./ B.Tech programmes	**2**	**1**	**0**	**3**

OBJECTIVES

- To enable learners to acquire basic proficiency in English reading and listening.
- To write in English precisely and effectively.
- To speak flawlessly in all kinds of communicative contexts.

UNIT I VOCABULARY BUILDING 9

The concept of word formation - Root words from foreign languages and their use in English - Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives - Synonyms, antonyms, and standard abbreviations. Compound words – abbreviation – single word substitution – **Listening:** Listening comprehension, listening to motivational speeches, podcasts and poetry. **Speaking:** Short talks on incidents - place of visit – admiring personalities, etc.

UNIT II BASIC WRITING SKILLS 9

Sentence structures - Use of phrases and clauses in sentences - punctuation - coherence - Organizing principles of paragraphs in documents - Techniques for writing precisely. **Reading & Writing** – Free writing – paragraphs - article reading and writing criticism - change of tense forms in short text or story – inferential reading – rewrite or interpret text - prepare questions based on the text. **Speaking:** Everyday situations – conversations and dialogues, speaking for and against.

UNIT III GRAMMAR AND LANGUAGE DEVELOPMENT 9

Subject-verb agreement- Noun-pronoun agreement - Articles – Prepositions – Redundancies. **Reading & Writing:** Read from innovation and ideas that changed the world, newspaper column writing – **Speaking:** Demonstrative speaking practice using visual aids (charts, graphs, maps, pictures, etc.).

UNIT IV WRITING FOR FORMAL PRESENTATION 9

Nature and Style of sensible Writing - Describing – Defining – Classifying - Providing examples or evidence - Writing introduction and conclusion. **Reading & Writing –** Read from Literary pieces – identify different parts text – difference between print and digital writing. Writing: Recommendations - Foreword - Review of book. **Speaking-** Formal Presentations – Debate on social issues/taboos and solutions.

UNIT V EXTENDED WRITING AND SPEAKING 9

Writing: Précis writing – Essay writing – workplace communication: Resume – Business letters and emails – Proposals. **Speaking:** Panel discussion – reporting an event – mock interview – Master Ceremony.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course students will be able to

- Discuss and respond to the listening content.
- Read and comprehend different texts and appreciate them
- Understand structures and techniques of precise writing
- Analyse different genres of communication and get familiarized with new words, phrases, and sentence structures.
- Write and speak appropriately in varied formal and informal contexts.

TEXT BOOK:

1. English for Technologists & Engineers, Orient Black Swan Publications, Chennai.

REFERENCES:

1. Technical Communication, Meenakshi Raman & Sangeeta Sharma, Oxford University Press
2. Effective Communication Skills, Kulbushan Kumar, Khanna Publishing House, Delhi
3. Communication Skills, Pushplata, Sanjay Kumar, Oxford University Press
4. Practical English Usage. Michael Swan. OUP. 1995.
5. Remedial English Grammar. F.T. Wood. Macmillan.2007
6. On Writing Well. William Zinsser. Harper Resource Book. 2001
7. Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.
8. Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press

MA19152	**LINEAR ALGEBRA AND APPLIED CALCULUS**	**L**	**T**	**P**	**C**
	Common to CSE, BME, ECE, EEE, & I.T	**3**	**0**	**1**	**4**

OBJECTIVES

- To gain knowledge in using matrix algebra techniques and the concepts of basis and dimension in vector spaces.
- To understand the techniques of calculus which are applied in the Engineering problems.

UNIT I MATRICES 12

Symmetric and skew – symmetric matrices , orthogonal matrices – Eigen values and Eigen vectors - Cayley – Hamilton theorem (without proof) and applications - orthogonal transformation and quadratic forms to canonical forms - Nature of quadratic forms.

UNIT II VECTOR SPACES 12

Vector space – Linear dependence and independence of vectors, bases, dimensions - range and kernel of a linear map, rank and nullity – matrix of Linear transformation - inverse of a linear transformation - rank nullity theorem – composition of Linear maps – Matrix Associated with Linear Map - inner products and norms – Gram – Schmidt orthogonalisation.

UNIT III DIFFERENTIAL CALCULUS AND APPLICATIONS 12

Curvature in Cartesian co-ordinates – Centre and radius of curvature – Circle of curvature – Evolutes and Envelopes - Partial derivatives: Definitions and Simple problems - Jacobian

and properties – Taylor's series for functions of two variables – Lagrange's method of undetermined multipliers.

UNIT IV APPLICATION OF INTEGRATION AND IMPROPER INTEGRALS 12

Evaluation of area, surface area and volume of revolution - Centre of Gravity – Moment of inertia – Improper integrals: Beta and Gamma integrals and their properties.

UNIT V MULTIPLE INTEGRAL 12

Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Triple integrals – Volume of solids – Change of variables in double and triple integrals.

TOTAL: 60 PERIODS

OUTCOMES:

On completion of the course students will be able to

- Apply the concept of Eigen values and eigenvectors, diagonalization of a matrix for solving problems.
- Use concepts of basis and dimension in vector spaces in solving problems and to construct orthonormal basis using inner products.
- Analyze, sketch and study the properties of different curves and to handle functions of several variables and problems of maxima and minima.
- Apply the techniques of Integration in engineering problems.
- Evaluate surface area and volume using multiple integrals.

TEXT BOOKS:

1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition, 2014.
2. T Veerarajan , Linear Algebra and Partial Differential Equations, Mc Graw Hill Education,2019

REFERENCES:

1. Ramana. B.V., " Higher Engineering Mathematics ", McGraw Hill Education Pvt. Ltd, New Delhi, 2016.
2. Friedberg, A.H., Insel, A.J. and Spence, L., —Linear Algebrall, Prentice - Hall of India, New Delhi, 2004.
3. Erwin Kreyszig ," Advanced Engineering Mathematics ", John Wiley and Sons, 10th Edition, New Delhi, 2016.
4. Bali, N.P. and Manish Goyal, A Text Book of Engineering Mathematics, Lakshmi Publications Pvt. Ltd., New Delhi, 2006.
5. T Veerarajan, Engineering Mathematics –II , Mc Graw Hill Education, 2018
6. T Veerarajan, Engineering Mathematics –I , Mc Graw Hill Education, 2018

PH19142	PHYSICS FOR BIOSCIENCE	L	T	P	C
	Common to BME, Bio.Tech & Food Tech	3	0	2	4

OBJECTIVES

- To enhance the fundamental knowledge of Physical, Quantum, magnetic and dielectric properties of materials
- To study the behaviour of light, sound and nuclear radiation in materials.

UNIT I PROPERTIES OF MATTER 9

Elasticity – Stress-strain diagram and its uses - factors affecting elastic modulus and tensile strength – torsional stress and deformations – twisting couple - torsion pendulum: theory and experiment - bending of beams –area moment of inertia - bending moment – cantilever - applications – uniform and non-uniform bending- I-shaped girders - stress due to bending in beams.

UNIT II QUANTUM PHYSICS AND SUPERCONDUCTIVITY 9

Introduction to wave function - derivation of Schrodinger wave equation -Particle in a three dimensional box – degenerate states – Fermi- Dirac statistics – Density of energy states – Electron in periodic potential – Energy bands in solids - Tunneling -scanning tunneling microscope. - Introduction of Superconductivity - Properties of Superconductors - Meissner Effect - BCS theory (qualitative) - Type-I and Type II Superconductors -Magnetic Levitation and SQUID.

UNIT III MAGNETIC AND DIELECTRIC MATERIALS 9

Magnetism in materials – magnetic field and induction – magnetization - magnetic permeability and susceptibility–types of magnetic materials – microscopic classification of magnetic materials – Ferromagnetism origin and exchange interaction- saturation magnetization and Curie temperature – Domain Theory- M versus H behaviour – Hard and soft magnetic materials - Introduction electrostatics and EM waves – Tissue as a leaky dielectric - Relaxation processes: Debye model, Cole–Cole model.

UNIT IV WAVES, OPTICS, AND SOUND 9

Oscillatory motion – forced and damped oscillations: differential equation and its solution – plane progressive waves – wave equation -Physics of light-Measurement of light and its unit – an overview of limits of vision and colour vision - Physics of sound, Normal sound levels – ultrasound fundamentals – Generation of ultrasound (Ultrasound Transducer) Non-destructive Testing – pulse echo system through transmission and reflection modes - A,B and C – scan displays, Medical applications – Sonogram.

UNIT V 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

LIST OF EXPERIMENTS: PHYSICS LABORATORY (Any 10 experiments) 30

1. Determination of Young's Modulus of the given material by Uniform bending
2. Determination of Young's Modulus of the given material by Non Uniform bending
3. Determination of Rigidity Modulus of the given material by Torsion pendulum
4. Determination of Band gap of given Semiconducting material.
5. To determine the work function and threshold frequency using Einstein's Photoelectric effect.
6. Experiments on electromagnetic induction – B-H Curve experiment to determine magnetic parameter.

7. Determination of free space permeability using Helmholtz coil.
8. Diffraction- Determination of wavelength of diode laser.
9. Measurement of speed of light using fiber cable.
10. Spectrometer - Minimum deviation of a prism.
11. Determination of Resonance frequency of LC circuit and LCR circuits.
12. Detection of ionizing radiation using Geiger Muller Counter

Use the basic instruments like Vernier caliper, micrometer and microscope for various basic measurements.

TOTAL: 75 PERIODS

OUTCOMES:

On completion of the course students will be able to

- Apply the knowledge of properties of matter, elasticity and bending moments of beam for real time applications.
- Understand and apply the principles of quantum physics and superconductivity n devices.
- Make use of magnetic and dielectric properties of materials in engineering and technology.
- Apply the properties of optics and sound to develop innovating instruments.
- Utilize the concepts of nuclear and particle physics in imaging and irradiation techniques.

TEXT BOOKS:

1. Kasap, S.O. “Principles of Electronic Materials and Devices”, McGraw-Hill Education, 2007.
2. Umesh K Mishra &Jasprit Singh, “Semiconductor Device Physics and Design”, Springer, 2008.
3. Wahab, M.A. “Solid State Physics: Structure and Properties of Materials”. Naros Publishing House, 2009.
4. B.H Brown, R.H.Smallwood, D.C Barber, P.V Lawford Medical physics and Biomedical Engineering, CRC Press 1998.

REFERENCES:

1. S. O. Pillai, Solid state physics, New Age International, 2015
2. Arthur Besier and S. RaiChoudhury, Concepts of Modern Physics (SIE), 7th edition, McGraw-Hill Education, 1994.
3. J.B.Rajam, Atomic Physics, 7th edition, S.Chand, 2010.
4. B.L.Theraja, Modern Physics, 16th edition, S.Chand, 2012.
5. Charles Kittel, Introduction to Solid State Physics, 8th Edition, Willey India Pvt.Ltd, 2005.
6. Garcia, N. & Damask, A. “Physics for Computer Science Students”. Springer-Verlag, 2012.
7. Arnikar, H. J., Essentials of Nuclear Chemistry, 4th Edn., New Age International Publishers Ltd., New Delhi, 1995.

GE19101	ENGINEERING GRAPHICS	L	T	P	C
	Common to all branches of B.E/B.Tech	2	2	0	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 these skill in developing new products.
- To improve their technical communication skill in the form of communicative drawings

CONCEPTS AND CONVENTIONS (Not for Examination) 1

Importanceofgraphicsinengineeringapplications–Useofdraftinginstruments– BIS conventions and specifications–Size, layout and folding of drawing sheets– Lettering and dimensioning. Basic Geometrical constructions.

UNIT I PLANE CURVES AND FREE HAND SKETCH 11

Curves used in engineering practices: Conics–Construction of ellipse, parabola and hyperbola by eccentricity method– Construction of cycloids, Construction of involutes of square and circle–Drawing of tangents and normal to the above curves.

Visualization concepts and Free Hand sketching: Visualization principles –Representation of Three Dimensional objects – Layout of views- Freehand sketching of multiple views from pictorial views of objects

UNIT II PROJECTION OF POINTS, LINES AND PLANE SURFACE 12

Orthographic projection- principles-Principal planes- projection of points. First angle projection - Projection of straight lines 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 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.

UNIT IV PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES 12

Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section.

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

UNIT V ISOMETRIC, PERSPECTIVE PROJECTIONS AND FREEHAND SKETCHING 12

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

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

TOTAL: 60 PERIODS

OUTCOMES:

On Completion of the course students will be able to

- To construct different plane curves and free hand sketching of multiple views from pictorial objects.
- To comprehend the theory of projection and to draw the basic views related to projection of points, lines and planes
- To draw the projection of solids in different views
- To draw the projection of Sectioned solids and development of surfaces of solids
- To visualize and prepare Isometric and Perspective view of simple solids

TEXTBOOKS:

1. Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, 50th Edition, 2010.
2. Natrajan K.V., "A text book of Engineering Graphics", Dhanalakshmi Publishers, Chennai, 2017.

REFERENCES:

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

Publication of Bureau of Indian Standards:

1. IS10711– 2001: Technical products Documentation– Size and layout of drawing sheets.
2. IS9609 (Parts0&1)–2001:Technical products Documentation–Lettering.
3. IS10714 (Part20)–2001 & SP46–2003: Lines for technical drawings.
4. IS11669– 1986 & SP46– 2003: Dimensioning of Technical Drawings.
5. IS15021(Parts1 to4)–2001: Technical drawings–Projection Methods.

Special points applicable to University Examinations on Engineering Graphics:

1. There will be five questions, each of either or type covering all units of the syllabus.
2. All questions will carry equal marks of 20 each making a total of 100.
3. The answer paper shall consist of drawing sheets of A3 size only. The students will be permitted to use appropriate scale to fit solution with in A3 size.
4. The examination will be conducted in appropriate sessions on the same day

GE19121	ENGINEERING PRACTICES LABORATORY (Civil &Mech)	L	T	P	C
	Common to all branches of B.E/B.Tech	0	0	2	1

OBJECTIVES:

- To provide hands on experience on various basic engineering practices in Civil and Mechanical Engineering.

I CIVIL ENGINEERING PRACTICE 15

Study of plumbing and carpentry components of residential and industrial buildings. Safety aspects.

Plumbing Works:

(a) Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers, and elbows in household fittings.

(b) Preparation of basic plumbing line sketches for wash basins, water heaters, etc.

(c) Hands-on-exercise: Basic pipe connections – Pipe connections with different joining components.

Carpentry Works:

(a) Study of joints in roofs, doors, windows and furniture.

(b) Hands-on-exercise: Woodwork, joints by sawing, planning and chiseling.

II MECHANICAL ENGINEERING PRACTICE 15

Welding:

(a) Preparation of butt joints, lap joints and T- joints by Shielded metal arc welding.

(b) Gas welding practice.

Basic Machining:

(a) Simple Turning and Taper turning.

(b) Drilling Practice.

Sheet Metal Work:

(a) Forming & Bending:

(b) Model making – Trays and funnels.

(c) Different type of joints.

Machine assembly practice:

(a) Study of centrifugal pump

(b) Study of air conditioner

TOTAL: 30 PERIODS

MC19101	ENVIRONMENTAL SCIENCE AND ENGINEERING	L	T	P	C
	Common to all branches of B.E/B.Tech	3	0	0	0

OBJECTIVES:

- To understand the importance of natural resources, pollution control and waste management.

- To provide the students about the current social issues and environmental legislations.

UNIT I NATURAL RESOURCES 9

Environment -definition - scope and importance - forest resources -use and overexploitation -water resources -use and over utilization - dams - benefits and problems - water conservation -energy resources - growing energy needs - renewable and non renewable energy sources - use of alternate energy sources -land resources -land degradation - role of an individual in conservation of natural resources.

UNIT II ENVIRONMENTAL POLLUTION 9

Definition - causes, effects and control measures of air pollution -chemical and photochemical reactions in the atmosphere - formation of smog, PAN, acid rain, and ozone depletion- noise pollution -mitigation procedures - control of particulate and gaseous emission(Control of SO_2, NO_X, CO and HC).

Water pollution - definition-causes-effects of water pollutants–marine pollution-thermal pollution-radioactive pollution-control of water pollution by physical, chemical and biological processes–waste water treatment-primary, secondary and tertiary treatment.

Soil pollution: definition-causes-effects and control of soil pollution.

UNIT III SOLID WASTE MANAGEMENT 9

Solid wastes - sources and classification of solid wastes -solid waste management options - sanitary landfill, recycling, composting, incineration, energy recovery options from wastes. Hazardous waste -definition -sources of hazardous waste-classification (biomedical waste, radioactive waste, chemical waste, household hazardous waste)-characteristics of hazardous waste ignitability (flammable) reactivity, corrosivity, toxicity -effects of hazardous waste -case study- bhopal gas tragedy - disposal of hazardous waste-recycling , neutralization, incineration, pyrolysis, secured landfill - E-waste management -definition-sources-effects -electronic waste recycling technology.

UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT 9

Sustainable development -concept, components and strategies - social impact of growing human population and affluence, food security, hunger, poverty, malnutrition, famine - consumerism and waste products - environment and human health - role of information technology in environment and human health -disaster management– floods, earthquake, cyclone and landslide.

UNIT V TOOLS FOR ENVIRONMENTAL MANAGEMENT 9

Environmental impact assessment (EIA) structure -strategies for risk assessment–EIS-environmental audit-ISO 14000-precautionary principle and polluter pays principle-constitutional provisions- - pollution control boards and pollution control acts- environmental protection act 1986- role of non-government organizations- international conventions and protocols.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course students will be able to

- Be conversant to utilize resources in a sustainable manner.
- Find ways to protect the environment and play proactive roles.
- Apply the strategies to handle different wastes
- Develop and improve the standard of better living.
- Be conversant with tools of EIA and environmental legislation.

TEXTBOOKS:

1. Benny Joseph, "Environmental Science and Engineering", 2nd edition, Tata McGraw-Hill, New Delhi, 2008.
2. Gilbert M.Masters, "Introduction to Environmental Engineering and Science", 2nd edition, Pearson Education, 2004.

REFERENCES:

1. Dharmendra S. Sengar, "Environmental law", Prentice hall of India Pvt Ltd, New Delhi, 2007.
2. ErachBharucha, "Textbook of Environmental Studies", 3rd edition, Universities Press(I) Pvt Ltd, Hyderabad, 2015.,
3. G. Tyler Miller and Scott E. Spoolman, "Environmental Science", 15th edition, CengageLearning India PVT, LTD, Delhi, 2014.
4. Rajagopalan, R, "Environmental Studies-From Crisis to Cure", 3rd edition, Oxford University Press, 2015.
5. De. A.K., "Environmental Chemistry", New Age International, New Delhi,1996.
6. K. D. Wager, Environmental Management, W. B. Saunders Co., Philadelphia, USA, 1998

SEMESTER II

MA19252 DIFFERENTIAL EQUATIONS AND COMPLEX VARIABLES L T P C

Common to B.E. - CSE, BME, ECE & EEE and B.Tech. – I.T 3 0 1 4

OBJECTIVES

- To handle practical problems arising in the field of engineering and technology using differential equations.
- To solve problems using the concept of Vectors calculus, Complex analysis, Laplace transforms.

UNIT I SECOND AND HIGHER ORDER DIFFERENTIAL EQUATIONS 12

Second and higher order Linear differential equations with constant coefficients - Method of variation of parameters –Legendre's linear equations - Formation of partial differential equations - Solutions of standard types of first order partial differential equations - Lagrange's linear equation – Linear homogenous partial differential equations of second and higher order with constant coefficients.

UNIT II VECTOR CALCULUS 12

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

UNIT III ANALYTIC FUNCTIONS 12

Analytic functions – Necessary and sufficient conditions for analyticity in Cartesian and polar coordinates - Properties – Harmonic conjugates – Construction of analytic function - Conformal mapping – Mapping by functions $w = z + c,\ cz, \frac{1}{z}, z^2$ - Bilinear transformation.

UNIT IV COMPLEX INTEGRATION 12

Cauchy's integral theorem – Cauchy's integral formula **(**excluding proof) – Taylor's and Laurent's series – Singularities – Residues – Residue theorem **(**excluding proof) – Application of residue theorem for evaluation of real integrals - Evaluation of real definite integrals as contour integrals around semi-circle (excluding poles on the real axis).

UNIT V LAPLACE TRANSFORM 12

Laplace transform – Sufficient condition for existence – Transform of elementary functions – Basic properties – Transforms of derivatives and integrals of functions - Derivatives and integrals of transforms - Transforms of unit step function and impulse functions, periodic functions - Inverse Laplace transform – Problems using Convolution theorem – Initial and final value theorems – Solution of linear ODE of second order with constant coefficients using Laplace transformation techniques.

TOTAL: 60 PERIODS

OUTCOMES:

On completion of the course students will be able to:

- Apply various techniques in solving ordinary differential equations and partial differential equations
- Use the concept of Gradient, divergence and curl to evaluate line, surface and volume integrals.
- Use the concept of Analytic functions, conformal mapping and bilinear transformation.
- Use complex integration techniques to solve Engineering problems.
- Use Laplace transform and inverse transform techniques in solving differential equations.

TEXT BOOKS:

1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition, 2014.
2. T Veerarajan Transforms and Partial Differential Equations Mc Graw Hill Education, 2018
3. T Veerarajan, Engineering Mathematics –II , Mc Graw Hill Education, 2018

REFERENCES:

1. Ramana. B.V., "Higher Engineering Mathematics ", McGraw Hill Education Pvt. Ltd, New Delhi, 2016.
2. Erwin Kreyszig ," Advanced Engineering Mathematics ", John Wiley and Sons, 10th Edition, New Delhi, 2016.
3. Bali, N.P. and Manish Goyal, A Text Book of Engineering Mathematics, Lakshmi Publications Pvt. Ltd., New Delhi, 2006.

ME19251 ENGINEERING MECHANICS FOR BIOMEDICAL ENGINEERS

L	T	P	C
3	1	0	4

OBJECTIVES:

- To be exposed to the fundamental principles of mechanics
- To learn effect of force on bodies
- To learn basics of fluid mechanics and relate it to bio-fluids
- To understand the action of friction and motion

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

OUTCOMES:

On Completion of the course students will be able to

- Use scalar and vector analytical techniques for analysing forces in statically determinate structures
- Analyse the impact of force on bodies/structure
- Solve rigid body subjected to dynamic forces
- Apply fundamental concepts of kinematics and kinetics of particles to the analysis of simple practical problems
- Analyse fluid flow under different pressure and volume (hemodynamic conditions)

TEXT BOOKS:

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.

REFERENCES:

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).
3. Lee Waite, "Biofluid Mechanics in Cardiovascular Systems", The McGraw-Hill Companies, 2006.

CY19142 CHEMISTRY FOR ELECTRONICS ENGINEERING L T P C

Common to B.E. – ECE & BME 3 0 2 4

OBJECTIVES

- To understand the principles of electrochemical processes and corrosion control
- To get familiarised with the functioning batteries of and fuel cells
- To acquire knowledge on polymeric, ceramic and nano materials used in electronic and medical industry

UNIT I ELECTROCHEMISTRY 9

Electrode potential – Electrodes– standard and reference electrodes, glass electrode. Nernst equation, emf series–applications. Galvanic and concentration cells.-applications - pH measurement, acid- base titration-potentiometric redox titration- conductometric titrations - potentiometric sensors -chemical biosignals- glucose sensor, gas sensor- blood oxygen level.

UNIT II CORROSION AND ELECTROCHEMICAL PROCESSES 9

Cause and effects of corrosion – theories of chemical and electrochemical corrosion – types of corrosion: galvanic, stress, intergranular corrosion and pitting corrosion –factors affecting rate of corrosion.

Electroplating (copper)- electroless plating (Nickel) - electropolishing, electrochemical machining- electrochemical etching - surface preparation – etching – drying -electrochemical etching of Cu from PCB - electrophoretic painting

UNIT III BATTERIES AND FUEL CELLS 9

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

UNIT IV ADVANCED MATERIALS 9

Introduction to thermoplastics and thermosetting plastics- preparation and applications of polypropylene (PP), polyvinylchloride (PVC), polyurethanes,polyamide (Nylon 6,6), polyacrylates (PAN), silicone rubber, Biodegradable polymers(PGA and PLA) - conducting polymers – introduction and examples- polyaniline.

Metallic and ceramic implant materials : Composition ,properties and applications of stainless steel, titanium based alloys, cobalt – chromium alloys- ceramics – hydroxy apatite – medical applications - membranes for plasma separation and blood oxygenation-introduction.

UNIT V NANO MATERIALS 9

Nanomaterials: Basics-distinction between nanoparticles and bulk materials- size-dependent properties – synthesis of nanoparticles – chemical methods -metal nanocrystals by

reduction, solvothermal synthesis, photochemical synthesis, sonochemical synthesis and chemical vapour deposition - applications in electronics and medicine.

LIST OF EXPERIMENTS: CHEMISTRY LABORATORY (Any 10 experiments) 30

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 winkler's method
8. Determination of total, temporary and permanent hardness by EDTA method.
9. Estimation of alkalinity by indicator method
10. Estimation of chloride by argentometric method
11. Determination of molecular weight of a polymer by viscometry method.
12. Determination of phase change temperature of a solid.

TOTAL: 75 PERIODS

OUTCOMES:

On completion of the course students will be able to

- Apply the knowledge of electrochemistry in analyzing basic chemicals by measuring molecular/bulk properties like redox potential, conductance, DO of water and corrosion rate.
- Be conversant about surface modifications involving electrochemical processes.
- Be assertive on types of batteries and fuel cells.
- Apply the knowledge of industrial polymers in various fields.
- Develop nano and biomaterials for medical applications.

TEXT BOOKS:

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

REFERENCES

1. Gowarikar V. R., Viswanathan N.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. Joon Bu Park, Roderic S, Lakes, "Biomaterials", Springer-Verlag, New York Inc., 2010
4. Pradeep.T, "A Text Book of Nanoscience and Nanotechnology", Tata McGraw Hill, New Delhi, 2012

BM19241 ELECTRIC CIRCUITS AND ELECTRON DEVICES L T P C

3 1 2 5

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 study the construction, theory and operation of basic electronic devices such as PN junction diode and transistor
- To allow the students to acquire knowledge about FET & special semiconductor devices
- To provide knowledge on three phase circuits

UNIT I DC AND AC (ONLY SINUSOIDAL) CIRCUITS 12

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 12

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

UNIT III BASIC PN JUNCTION DEVICES 12

PN junction diode, current equations, energy band diagram, diffusion and drift current densities, forward and reverse bias characteristics, NPN & PNP Configurations of BJT - operations-Early effect-current equations – input and output characteristics of CE, CB, CC.

UNIT IV FET & SPECIAL SEMICONDUCTOR DEVICES 12

JFET–drain and transfer characteristics,-current equations-Pinch off voltage and its significance- MOSFET- threshold voltage -channel length modulation, DUAL GATE MOSFET- -Zener diode-Varactor diode –Tunnel diode-, LED and seven segment display, LASER diode, LDR – Characteristics curve and its advantages

UNIT V HIGH POWER DEVICES AND CIRCUITS 12

UJT, SCR, Diac, Triac, Power BJT- Power MOSFET- DMOS-VMOS, Three phase balanced / unbalanced voltage sources – analysis of three phase 3-wire and 4-wire circuits with star and delta connected loads, balanced & unbalanced

LAB EXPERIMENTS: 30

1. VI characteristics of PN junction diode
2. VI characteristics of Zener Diode
3. Input and output characteristics of Common emitter configuration
4. Input and output characteristics of Common emitter configuration
5. Drain and transfer characteristics of FET
6. Verification of KVL and KCL
7. Verification of super position theorem

8. Verification of Thevien theorem and Nortons theorem
9. RC and RL transients
10. Series and parallel resonance

TOTAL: 90 PERIODS

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
- Analyze the BJT terminal characteristics and its utilization in circuit models
- Analyze the characteristics of FETs and special semiconductor devices for their suitable applications
- Realise the concepts of high power devices and three phase AC circuits

TEXT BOOKS:

1. Donald A Neaman, "Semiconductor Physics and Devices", Fourth Edition, Tata Mc GrawHill Inc. 2012.
2. William H. HaytJr, Jack E. Kemmerly and Steven M. Durbin, "Engineering Circuits Analysis", Tata McGraw Hill publishers, 6th edition, New Delhi, 2003.

REFERENCES:

1. Boylestad and Louis Nashelsky, "Electron Devices and Circuit Theory" Pearson Prentice Hall, 10th edition, July 2008.
2. Sudhakar A and Shyam Mohan SP, "Circuits and Network Analysis and Synthesis", Tata McGraw Hill, 2007.
3. Chakrabati A, "Circuits Theory (Analysis and synthesis), Dhanpat Rai & Sons, New Delhi, 1999.
4. Salivahanan. S, Suresh Kumar. N, Vallavaraj.A, "Electronic Devices and circuits", Third Edition, Tata McGraw- Hill, 2008.

GE19142	**PROGRAMMING USING C**	**L**	**T**	**P**	**C**
		2	**0**	**4**	**4**

OBJECTIVES

- To develop simple algorithms for arithmetic and logical problems.
- To develop C Programs using basic programming constructs
- To develop C programs using arrays and strings
- To develop applications in C using functions , pointers and structures
- To do input/output and file handling in C

UNIT I GENERAL PROBLEM SOLVING CONCEPTS 9

Computer – components of a computer system-Algorithm, and Flowchart for problem solving with Sequential Logic Structure, Decisions and Loops.

UNIT II C LANGUAGE & TYPES OF OPERATOR AND EXPRESSIONS 9

Introduction- C Structure- syntax and constructs of ANSI C - Variable Names, Data Type and Sizes, Constants, Declarations - Arithmetic Operators, Relational Operators, Logical Operators, Type Conversion, Increment and Decrement Operators, Bitwise Operators, Assignment Operators and Expressions, Precedence and Order of Evaluation, proper variable naming and Hungarian Notation.

UNIT III I/O AND CONTROL FLOW 9

Standard I/O, Formatted Output – Printf, Variable-length argument lists- Formatted Input – Scanf, Statements and Blocks, If-Else-If, Switch, Loops – while, do, for, break and continue, Goto Labels.

UNIT IV FUNCTIONS AND PROGRAM STRUCTURE 9

Basics of functions, parameter passing and returning type, External, Auto, Local, Static, Register Variables, Scope Rules, Block structure, Initialisation, Recursion, C Preprocessor, Standard Library Functions and return types.

UNIT V POINTERS AND ARRAYS& STRUCTURES 9

Pointers and addresses, Pointers and Function Arguments, Pointers and Arrays, Address Arithmetic, character Pointers and Functions, Pointer Arrays, Pointer to Pointer, Multi-dimensional arrays, Strings, Initialisation of Pointer Arrays, Command line arguments, Pointers to functions, complicated declarations. Basic Structures, Structures and Functions, Array of structures, Pointer of Structures, Self-referential Structures, Table look up, Typed ef, Unions, Bit-fields, File Access -Error Handling, Line I/O, Miscellaneous Functions.

LIST OF EXPERIMENTS:

1. Algorithm and flowcharts of small problems like GCD
2. Structured code writing with:
   i. Small but tricky codes
   ii. Proper parameter passing
   iii. Command line Arguments
   iv. Variable parameter
   v. Pointer to functions
   vi. User defined header
   vii. Make file utility
   viii. Multi file program and user defined libraries
   ix. Interesting substring matching / searching programs
   x. Parsing related assignments

Platform Needed: GCC Compiler for Windows/Linux

TOTAL: 90 PERIODS

OUTCOMES:

On Completion of the course students will be able to

- To formulate simple algorithms for arithmetic and logical problems.

- To test and execute the programs and correct syntax and logical errors.
- To implement conditional branching, iteration and recursion.
- To decompose a problem into functions and synthesize a complete program using divide and conquer approach.
- To use arrays, pointers and structures to formulate algorithms and programs.
- To apply programming to solve matrix addition and multiplication problems and searching and sorting problems.
- To apply programming to solve simple numerical method problems.

TEXT BOOKS:

1. Brian W. Kernighan and Dennis M. Ritchie, "The C Programming Language", Second Edition, PHI.
2. Byron Gottfried, "Programming in C", Second Edition, Schaum Outline Series.

REFERENCES:

1. Herbert Schildt, "C: The Complete Reference", Fourth Edition, McGraw Hill.
2. Yashavant Kanetkar, "Let Us C", BPB Publications.

GE19122	ENGINEERING PRACTICES- ELECTRICAL AND ELECTRONICS	L	T	P	C
	Common to all branches of B.E/B.Tech	**0**	**0**	**2**	**1**

OBJECTIVES

- To provide exposure to the students with hands on experience on various basic engineering practices in Electrical and Electronics Engineering.

A. ELECTRICAL ENGINEERING PRACTICE **15**

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 RLC circuit.
5. Measurement of resistance to earth of electrical equipment.

B. ELECTRONICS ENGINEERING PRACTICE **15**

1. Study of Electronic components and equipment's – Resistor, colour coding measurement of AC signal parameter (peak-peak, rms period, frequency) using CR.
2. Study of logic gates AND, OR, EOR and NOT.
3. Generation of Clock Signal.
4. Soldering practice – Components Devices and Circuits – Using general purpose PCB.
5. Measurement of ripple factor of HWR and FWR.

TOTAL: 30 PERIODS

OUTCOMES:

On Completion of the course students will be able to

- fabricate carpentry components

- fit pipe connections including plumbing works.
- use welding equipment's to join the structures.
- fabricate electrical and electronic circuits

REFERENCES:

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

MC19102 INDIAN CONSTITUTION AND FREEDOM MOVEMENT L T P C

3 0 0 0

OBJECTIVES

- To inculcate the values enshrined in the Indian constitution
- To create a sense of responsible and active citizenship
- To know about Constitutional and Non- Constitutional bodies
- To understand sacrifices made by the freedom fighters.

UNIT I INTRODUCTION 9

Historical Background – Constituent Assembly of India – Philosophical foundations of the Indian Constitution – Preamble – Fundamental Rights – Directive Principles of State Policy – Fundamental Duties – Citizenship – Constitutional Remedies for citizens. Constitution' meaning of the term, Indian Constitution: Sources and constitutional history, Features: Citizenship, Preamble, Fundamental Rights and Duties, Directive Principles of State Policy

UNIT II STRUCTURE AND FUNCTION OF CENTRAL GOVERNMENT 9

Union Government – Structures of the Union Government and Functions – President – Vice President – Prime Minister – Cabinet – Parliament – Supreme Court of India – Judicial Review.

UNIT III STRUCTURE AND FUNCTION OF STATE GOVERNMENT AND LOCAL BODY 9

State Government – Structure and Functions – Governor – Chief Minister – Cabinet – State Legislature – Judicial System in States – High Courts and other Subordinate Courts- Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation, Pachayati Raj: Introduction, Elected officials and their roles, ,Village level: Role of Elected and Appointed officials,

UNIT IV CONSTITUTIONAL FUNCTIONS AND BODIES 9

Indian Federal System – Center – State Relations – President's Rule – Constitutional Functionaries – Assessment of working of the Parliamentary System in India- CAG, Election Commission, UPSC, GST Council and other Constitutional bodies-. NITI Aayog, Lokpal, National Development Council and other Non –Constitutional bodies.

UNIT V INDIAN FREEDOM MOVEMENT 9

British Colonialism in India-Colonial administration till 1857- Revolt of 1857- Early Resistance to British Rule-Rise of Nationalism in India-I**ndian Freedom Struggle under Mahatma Gandhi-**Non- Cooperation Movement-Civil Disobedience Movement- Quit India Movement-British Official response to National movement- Independence of India Act 1947-Freedom and Partition

TOTAL: 45 PERIODS

OUTCOMES:

On Completion of the course students will be able to

- Understand the functions of the Indian government
- Understand and abide the rules of the Indian constitution.
- Gain knowledge on functions of state Government and Local bodies
- Gain Knowledge on constitution functions and role of constitutional bodies and non constitutional bodies
- Understand the sacrifices made by freedom fighters during freedom movement

TEXTBOOKS:

1. Durga Das Basu, "Introduction to the Constitution of India ", Lexis Nexis, New Delhi., 21st ed 2013
2. Bipan Chandra, History of Modern India, Orient Black Swan, 2009
3. Bipan Chandra, India's Struggle for Independence, Penguin Books, 2016
4. Maciver and Page, " Society: An Introduction Analysis ", Mac Milan India Ltd., New Delhi.2nd ed, 2014
5. P K Agarwal and K N Chaturvedi , Prabhat Prakashan, New Delhi, 1st ed , 2017

REFERENCES:

1. Sharma, Brij Kishore, "Introduction to the Constitution of India:, Prentice Hall of India, New Delhi.
2. U.R.Gahai, "Indian Political System ", New Academic Publishing House, Jalaendhar.

SEMESTER III

MA19352 TRANSFORMS AND SPECIAL FUNCTIONS L T P C

3 1 0 4

OBJECTIVES

- To introduce Fourier series and to solve boundary value problems that arise in the field of Engineering.
- To acquaint the student with different transform techniques and special functions for use in handling Engineering problems.

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 BOUNDARY VALUE PROBLEMS 12

Classification of PDE – Solutions of one dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two dimensional equation of heat conduction (excluding insulated edges).

UNIT III 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 IV Z - TRANSFORMS AND DIFFERENCE EQUATIONS 12

Z- transforms - Elementary properties – Inverse Z - transform (using partial fraction and residues) –Convolution theorem - Formation of difference equations – Solution of difference equations using Z- transform.

UNIT V BESSELS FUNCTION 12

Bessel Equation – Bessel functions of first kind – Recurrence relations – Bessel's Integral for $J_n(x)$ – Orthogonality.

TOTAL: 60 PERIODS

OUTCOMES:

On Completion of the course students will be able to

- develop skills to construct Fourier series for different periodic functions and to evaluate infinite series.
- classify different types of PDE and solve boundary value problems.
- solve Engineering problems using Fourier transform techniques.
- solve difference equations using Z – transforms that arise in discrete time systems.
- use Bessels function to solve problems in Communication Engineering.

TEXT BOOKS:

1. Grewal B.S., "Higher Engineering Mathematics", 43rd Edition, Khanna Publishers, Delhi, 2014.
2. Veerarajan. T., "Transforms and Partial Differential Equations", Tata McGraw Hill Education Pvt.Ltd.,New Delhi, Second reprint, 2012.

3. P. Sivaramakrishna Das, C. Vijayakumari, “Mathematics – I”, Pearson India Education Services Pvt. Ltd. Edition 2019.

REFERENCES:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 8th Edition, Wiley India, 2007.
2. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company Limited, New Delhi, 2008.
3. Glyn James, "Advanced Modern Engineering Mathematics", 3rd Edition, Pearson Education, 2007.
4. Peter V. O’ Neil, “Advanced Engineering Mathematics”, 7th Edition, Global Engineering, 2012.

	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
CO1	3	3	2	3	-	-	-	-	-	-	-	2	1	2	-
CO2	3	3	2	3	-	-	-	-	-	-	-	2	1	2	-
CO3	3	3	3	3	1	-	-	-	-	-	-	2	1	2	-
CO4	3	3	2	3	-	-	-	-	-	-	-	2	1	2	-
CO5	3	2	2	2	1	-	-	-	-	-	-	2	2	2	-
AVG	**3**	**2.8**	**2.1**	**2.8**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2.4**	**2**	**-**

BM19301 HUMAN ANATOMY AND PHYSIOLOGY L T P C

3 0 0 3

OBJECTIVES

- To develop a vocabulary of appropriate terminology to effectively communicate information related to anatomy and physiology
- To recognize the anatomical structures and explain the physiological functions of body systems
- To predict the physiological consequences using anatomical knowledge and use knowledge of function to predict the features of anatomical structures

UNIT I BASICS OF HUMAN BODY 8

Anatomical terms, positions, planes and levels of organization. Cell: Structure and its organelles with functions. Cell Membrane – Transport across Cell Membrane -Membrane Potential – Origin and propagation of potential. Homeostasis. Tissues: Types and functions. Integumentary system.

UNIT II SKELETAL AND MUSCULAR SYSTEM 9

Skeletal System: Structure and types of Bone and its functions – Physiology of Bone formation – Division of Skeleton – Types of joints and functions – Types of cartilage and functions.

Muscular System: Types and functions of Muscles – Structure and activity of skeletal muscles – Sliding Filament Theory – Types of muscle contraction.

UNIT III CARDIOVASCULAR AND RESPIRATORY SYSTEM 10

Blood: Composition – Functions - Haemostasis – Blood groups and typing.

Cardiovascular System: Structure – Conduction System of heart – Cardiac Cycle – Cardiac output. Blood Vessels – Structure and types - Blood pressure.

Respiratory system: Parts of respiratory system – Respiratory physiology – Lung volumes and capacities – Gaseous exchange**.**

UNIT IV NERVOUS AND SPECIAL SENSORY SYSTEM 9

Nervous System: Cells of Nervous systems – Types of Neuron and Synapses – CSF: Composition and function– Brain: structure and function – Spinal Cord – Tract and Pathways – Reflex Mechanism. Autonomic Nervous systems and its functions.

Sense Organs: Eye and Ear.

UNIT V ENDOCRINE, DIGESTIVE AND URINARY SYSTEM 9

Endocrine Glands: major endocrine glands and their hormonal functions.

Digestive System: Organs of Digestive system – Mechanism of Digestion and Absorption.

Urinary System: Structure of urinary system – Mechanisms of Urine formation – Homeostasis and Acid base Regulation by Urinary System – Micturition reflex.

TOTAL: 45 PERIODS

OUTCOMES:

On Completion of the course students will be able to

- Recognize the cell structure and explain the principle of homeostasis
- Demonstrate the structure and functions of bone, joints and muscle
- Illustrate the functioning of cardiovascular system and mechanism of respiration.
- Analyze the functioning of nervous system and sense organs
- Describe the functioning of digestive system, endocrine system and urinary system.

TEXT BOOK:

1. Ross & Wilson, “Anatomy and Physiology in Health and Illness” 13th Edition, Elsevier, 2018.

REFERENCES:

1. Guyton & Hall, “Text book of Medical Physiology”, 13th Edition, Saunders, 2015.
2. Elaine.N. Marieb , “Essential of Human Anatomy and Physiology”, Ninth Edition, Pearson Education, New Delhi, 2018.
3. InduKhurana and Arushi Khurana, “Text book of Medical Physiology” 2nd Edition, CBS Publishers & Distributors, 2015.
4. Kim Barrett, Susan Barman, Scott Boitano, .et al., “Ganong's Review of Medical Physiology” Twenty sixth Edition, Lange Medical Book, 2015.

	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
CO1	3	2	1	2	-	2	1	1	-	2	-	-	3	2	1
CO2	3	2	1	2	-	2	1	1	-	2	-	-	3	2	1
CO3	3	2	1	2	-	2	1	1	-	2	-	-	3	2	1
CO4	3	2	1	2	-	2	1	1	-	2	-	-	3	2	1
CO5	3	2	1	2	-	2	1	1	-	2	-	-	3	2	1
AVG	**3**	**2**	**1**	**2**	**-**	**2**	**1**	**1**	**-**	**2**	**-**	**-**	**3**	**2**	**1**

BM19302 BIOCHEMICAL SCIENCE L T P C

3 0 0 3

OBJECTIVES

- To study structural and functional properties of carbohydrates, proteins, lipids and nucleic acids
- To emphasize the role of these biomolecules by providing basic information on their metabolism and disorders.
- To comprehend the organ function test and normal values of various biochemical parameters

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 CARBOHYDRATES 9

Classification of carbohydrates - mono, di, oligo and polysaccharides. Structure, physical and chemical properties of carbohydrates. Metabolic pathways – Glycolysis, glycogenesis, glycogenolysis, and its hormonal regulation. TCA cycle – amphibolic pathway.ETC and Oxidative Phosphorylation.Biochemical aspect of Diabetes mellitus.

UNIT III LIPIDS 10

Classification of lipids- simple, compound and derived lipids. Nomenclature of fatty acid, physical and chemical properties of fat. Metabolic pathways: synthesis and degradation of fatty acid (beta oxidation), Hormonal regulation of fatty acid metabolism. Cholesterol biosynthesis, regulation, and its transport (HDL & LDL role). Disorders of lipid metabolism

UNIT IV NUCLEIC ACID & PROTEIN 10

Nucleic Acid: DNA - Watson and crick model of DNA, types, DNA as genetic material. Structure and types of RNA. **Amino acid:** Classification and properties. **Protein:** structural organisation and classification. Inborn Metabolic error of amino acid metabolism and urea cycle.

UNIT V CLINICAL BIOCHEMISTRY 9

Enzymes: Classification - Factors affecting enzymatic activity – Kinetics - Mode of action - allosteric and covalent regulation. Clinical significance of enzymes. Renal and liver function test (LFT and RFT). Normal Values of major biochemical parameters.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course students will be able to

- Explain the fundamentals of biochemistry
- Describe the classification, structures and properties of carbohydrates and their metabolism.
- Discuss the metabolism of lipids and their physiological roles.
- Outline the structures and functions of nucleic acids, amino acids and proteins.
- Analyse the clinical importance of enzymes and organ function tests.

TEXT BOOKS:

1. W. Rodwell, David Bender, Kathleen M. Botham, Peter J. Kennelly, P. Anthony Weil—Harper's, "Review of biochemistry", 30th Edition, LANGE Medical Publications, 2015.
2. Trevor palmer and Philip L Bonner, "Enzymes: Biochemistry, Biotechnology, Clinical Chemistry", 2nd Edition, Woodhead Publishing, 2009.

REFERENCES:

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

	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
CO1	3	2	1	2	-	2	1	1	-	2	-	-	3	2	1
CO2	3	2	1	2	-	2	1	1	-	2	-	-	3	2	1
CO3	3	2	1	2	-	2	1	1	-	2	-	-	3	2	1
CO4	3	2	1	2	-	2	1	1	-	2	-	-	3	2	1
CO5	3	2	1	2	-	2	1	1	-	2	-	-	3	2	1
AVG	**3**	**2**	**1**	**2**	**-**	**2**	**1**	**1**	**-**	**2**	**-**	**-**	**3**	**2**	**1**

BM19341 **ELECTRONIC CIRCUITS** **L T P C**

3 0 2 4

OBJECTIVES

- To understand the working of half/full & bridge rectifier and voltage regulator circuits
- To understand the working of regulated DC power supplies
- To understand the working of simple amplifier circuits and design of signal generation circuits
- To understand and analyse the working of positive and negative feedbacks of circuits
- To understand the application of electronic circuits in clinical & non Clinical applications

UNIT I RECTIFIERS AND VOLTAGE REGULATORS 9

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)

UNIT II BIASING AND SMALL SIGNAL ANALYSIS OF BJT 9

BJT – Biasing of BJT – Fixed Bias – Voltage Divider Bias – Emitter bias - Two port network – h parameters - small signal analysis of BJT (CE configuration) - Frequency response of BJT (CE configuration)

UNIT III BIASING AND SMALL SIGNAL ANALYSIS OF FET 9

JFET— Biasing of FET – Fixed Bias – Self Bias – Voltage Divider Bias - Small signal analysis of JFET (CS configuration) – Frequency response of FET – Difference between BJT and FET

UNIT IV FEEDBACK AMPLIFIERS, OSCILLATORS & POWER AMPLIFIERS 9

Basics of Feedback system - Types of Feedback Amplifiers (Block diagram approach), Principle of oscillators – Condition for oscillation – Audio Oscillators – RC Phase shit and Wien Bridge oscillators RF oscillators-Hartley and Colpitts, Multivibrators – Astable and Monostable Definition – Types of Power Amplifiers – Class A (series fed and transformer coupled)

UNIT V APPLICATION OF ELECTRONIC CIRCUITS IN MEDICAL FIELD 9

Application of LED and photo transistor for blood volume measurement, Applications of rectifier and SMPS circuits in medical Equipments, Application of Oscillators for Biotelemetry, Application of Power amplifier in hearing aids, EMG amplifier using Biofeedback

LIST OF EXPERIMENTS: 30

1. Demonstrate the working of Bridge rectifier circuit and analyse the waveform
2. Demonstrate the significance of using zener diode as a voltage regulator in real time applications
3. Demonstrate the working of RC phase shift oscillator
4. Develop and demonstrate the working of astable multivibrator
5. Design a class A power amplifier circuit and analyse the waveform

TOTAL: 75 PERIODS

EQUIPMENT FOR A BATCH OF 9 STUDENTS

1. Variable DC power supply
2. Fixed power supply
3. CRO
4. Multimeter
5. Function generator
6. Digital LCR meter
7. BC107, BF195, 2N2222, BC147, BFW10, SL100
8. LEDs
9. Resistors
10. Capacitors
11. Inductors
12. Breadboards
13. Transformers, Diodes, Zener Diodes

OUTCOMES:

On completion of the course students will be able to

- design half/full and bridge rectifier circuits for the given specifications
- design voltage regulator circuits for the given specifications
- design sine wave oscillator circuits using BJT
- design multivibrator circuits using BJT for generating time delays
- design and analyse power amplifier circuits and implement it for real time applications

TEXT BOOKS:

1. Robert L. Boylestead, Louis Nashelsky, “Electronic Devices and circuit Theory”, Prentice Hall of India, 2004.

REFERENCES:

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. John G. Webster, —Medical Instrumentation Application and Design‖, 4th edition, Wiley India Pvt Ltd, New Delhi, 2015.
6. Joseph J. Carr and John M. Brown, —Introduction to Biomedical Equipment Technology‖, Pearson Education, 2004.
7. http://www.learnabout-electronics.org/PSU/psu30.php

	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
CO1	3	3	1	2	-	-	-	-	2	-	2	-	2	3	-
CO2	2	3	1	2	-	-	-	-	3	-	3	-	2	3	-
CO3	3	2	3	3	-	-	-	-	2	-	2	-	3	3	-
CO4	3	2	3	3	-	-	-	-	2	-	2	-	3	3	-
CO5	3	2	3	3	-	-	-	-	2	-	2	-	3	3	-
AVG	**2.8**	**2.4**	**2.2**	**2.6**					**2.2**		**2.2**		**2.6**	**3**	

BM19342 SENSORS AND MEASUREMENTS L T P C

2 0 2 3

OBJECTIVES:

- To understand the purpose of measurement, the methods of measurements, errors associated with measurements.
- To know the principle, classifications and the characteristics of different transducers.
- To study the clinical applications of various transducers.
- To understand various signal conditioning circuits.
- To know the different display and recording devices.

UNIT I FUNDAMENTALS OF MEASUREMENTS 6

Functional elements of a generalized instrument–classification of measuring instruments-definition of sensor/transducer-classification of sensors/transducers-selection criteria-performance characteristics: static and dynamic characteristics. SI units, types of errors, methods of error analysis,-uncertainty analysis-expression of uncertainty: accuracy and precision index, propagation of errors-calibration and standards.

UNIT II RESISTIVE & TEMPERATURE TRANSDUCERS 6

Measurement principle, characteristics, design and clinical applications of: resistive transducers: resistance potentiometer, loading effect, strain gauge-gauge factor-types of strain gauges, thermoelectric sensors-resistance thermometers, thermistor, thermocouples, and semi-conductor and fiber optics based temperature sensor. Non-contact type temperature measurement techniques: radiation thermography, total radiation pyrometer, optical pyrometer.

UNIT III INDUCTIVE & CAPACITIVE, DIGITAL TRANSDUCERS 6

Concepts of self-inductance and mutual inductance, linear variable differential transformer, rotary variable differential transformer, induction potentiometer, variable reluctance transducer. Capacitive: Basic principle-variable area type-variable air gap type-variable permittivity type-capacitive pressure sensors-biomedical applications, Hall magnetic sensor-clinical applications. Digital displacement transducers: incremental type, tachometer type, absolute type.

UNIT IV PIEZOELECTRIC, OPTICAL & PROXIMITY SENSORS 6

Introduction of piezoelectricity- piezoelectric crystals-clinical applications-Basic principles characteristics and clinical applications of PIN and avalanche photo diode (APD), photo emissive cell, photovoltaic cell-photo conductive cell-light dependent resistors. Proximity sensors-classification-working and clinical applications.

UNIT V MEASUREMENT, DISPLAY DEVICES & OTHER SENSORS 6

Bridge circuits: classification, Wheatstone's and Kelvins Bridge. Display Devices: cathode ray oscilloscope (CRO), digital storage oscilloscope (DSO), light emitting diode (LED) and liquid crystal (LC) displays. Recorders: magnetic tape-inkjet-thermal-Recorder-photographic recorders. Biosensors: transduction mechanism in a biosensor and Classification. Introduction to microelectromechanical systems (MEMS), wearable and smart sensors, electronic nose.

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LIST OF EXPERIMENTS: 30

1. Characteristics of Thermocouple.
2. Characteristics of RTD
3. Strain measurement.
4. Characteristics of optical sensor.
5. Measurement of resistance using Wheat Stone and Kelvin's Bridge.
6. Measurement of inductance using Maxwell's & Hay's Bridge.
7. Measurement of Capacitance using Schering's bridge.
8. Demonstration of CRO & DSO.

TOTAL: 60 PERIODS

LAB REQUIREMENTS FOR 30 STUDENTS:

1. Thermocouple-30 Nos
2. RTD-30 Nos
3. Strain Gauge (bonded and unbounded type)-20 each
4. Optical Sensors-Photovoltaic Cell, Photoconductive Cell, photo diode—15 Nos each
5. Resistors-Range between 1-0.0001 ohm – 30 Nos/each
6. CRO-10
7. DSO-5

OUTCOMES:

On completion of the course students will be able to

- Identify the methods of measurements, errors associated with measurements.
- Analyze the characteristics of different transducers.
- Develop simple medical devices using sensors.
- Design various signal conditioning circuits for biomedical applications.
- Demonstrate different display and recording devices for various applications.

TEXT BOOKS:

1. Doebelin E.O. and Manik D.N., "Measurement Systems", Tata McGraw-Hill Education Pvt. Ltd., 6 th Edition, 2011.
2. L.A Geddes and L.E.Baker , "Principles of Applied Biomedical Instrumentation", – John Wiley and sons, 3 rd Edition, Reprint 2008.
3. Albert D.Helfrick and William D.Cooper, "Modern Electronic Instrumentation and Measurement Techniques", Prentice Hall of India, 2007.

REFERENCES:

1. A.K.Sawhney, "Electrical & Electronics Measurement and Instrumentation", Dhanpat Rai&Co, New Delhi, 17th Edition, 2004.
2. Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw Hill, New Delhi, 3 rd Edition, 2014.
3. Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, "Biomedical Instrumentation and Measurement", Prentice Hall India Pvt. Ltd, New Delhi, 2nd Edition, Reprint, 2013.
4. https://nptel.ac.in/content/storage2/courses/112103174/pdf/mod2.pdf
5. https://nptel.ac.in/content/storage2/courses/108105063/pdf/L06(SS)(IA&C)%20((EE) NPTEL).pdf
6. https://nptel.ac.in/courses/108105064/
7. https://nptel.ac.in/content/storage2/courses/112103174/pdf/mod2.pdf
8. https://nptel.ac.in/content/storage2/courses/108105063/pdf/L0-6(SS) (IA&C) %20 ((EE) NPTEL).pdf

	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
CO1	3	2	-	1	-	-	-	-	-	-	-	3	3	-	-
CO2	3	3	-	3	-	-	-	-	-	-	-	3	3	-	-
CO3	3	3	3	3	3	3	3	1	-	-	2	3	3	3	-
CO4	3	3	3	3	3	2	1	-	-	-	-	3	3	3	-
CO5	3	3	-	3	3	-	-	-	3	-	-	3	-	3	-
AVG	**3**	**2.8**	**3**	**2.6**	**3**	**2.5**	**2**	**1**	**3**	**0**	**2**	**3**	**3**	**3**	**0**

BM19343 ELECTRIC FIELDS AND MACHINES L T P C
2 0 2 3

OBJECTIVES

- To understand the basics of AC and DC machines
- To study the principles of static Electric and magnetic fields
- To understand the behaviour of electromagnetic field in any medium

UNIT I DC MACHINES 6

Construction of DC machines – theory of operation of DC generators –EMF equation - Types and applications. Operating principle of DC motors – types of DC motors and their characteristics – speed control of DC motors-Applications, Stepper motor and Applications.

UNIT II AC MACHINES 6

Single phase transformer construction and principle of operation – EMF equation of Transformer - Transformer no–load phasor diagram –– Transformer on–load phasor diagram – Effect of load on regulation and efficiency. Introduction to high frequency

transformer Construction –Types. Construction of single-phase induction motors – Method of starting, Types – split phase and repulsion.

UNIT III STATIC ELECTRIC FIELD 6

Introduction to Co-ordinate System – Rectangular – Cylindrical and Spherical Coordinate System Definition of Curl, Divergence and Gradient – Electric Field Intensity – Relationship between potential and electric field – Electric polarization - Electric Flux Density – Gauss Law

UNIT IV STATIC MAGNETIC FIELD 6

The Biot-Savart Law in vector form – Magnetic Field intensity due to a finite and infinite wire carrying a current I – Magnetic field intensity on the axis of a circular and rectangular loop carrying a current I – Ampere's circuital law and simple applications. Magnetic flux density – The Lorentz force equation for a moving charge and applications – B-H relationship.

UNIT V ELECTRIC AND MAGNETIC FIELDS IN MATERIALS 6

Poisson's and Laplace's equation – Nature of dielectric materials and dielectric strength - Boundary conditions for electric fields – Electric current – Current density – point form of ohm's law – Nature of magnetic materials – magnetization and permeability - magnetic boundary conditions-Sources and effects of electromagnetic fields-Maxwell's equations (differential and integral form)

LIST OF EXPERIMENTS: 30

1. Load test on DC shunt motor.
2. Speed control of DC shunt motor.
3. No load and load test on single-phase transformer
4. Implementation of motor (0.5 Nm) control using optical technique
5. Design and development of 15V, 2A regulated power supply

TOTAL: 60 PERIODS

LAB REQUIREMENTS FOR 30 STUDENTS:

1. DC Motor – 2
2. Single transformer – 4
3. Restive load – 4
4. Relevant meters – 20 nos.

OUTCOMES:

On completion of the course students will be able to

- Make right choice on the suitability of DC motor for specific purpose
- Use different kinds of AC motor and transformer
- Apply the principles of electric field in real world problems
- Visualise magnetic effect and its relation to electric field.
- Analyse electromagnetic interaction in real time in any medium

TEXT BOOKS:

1. Dr. D P Kothari," ,Prof I J Nagrath Basic Electrical Engineering" , 3rd Edition, Tata McGraw-Hill, 2009.
2. John Daniel Kraus, Daniel A. Fleisch, "Electromagnetics: With Applications", 5th Edition, Tata McGraw, 2007.

REFERENCES:

1. Theraja B.L., Theraja A.K. "A Textbook of Electrical Technology: Vol 2 AC and DC Machines, S.Chand Publication, 2012
2. Joseph Edminister, Mahmood Nahvi, "Schaum's Outline of Electromagnetics", 4th Edition, Tata McGraw-Hill, 2013.

	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
CO1	3	3	3	2	-	-	-	-	2	-	2	-	2	3	-
CO2	2	3	3	2	-	-	2	-	3	-	3	-	3	3	-
CO3	3	2	3	3	-	-	-	2	2	1	3	-	3	2	1
CO4	3	2	2	3	-	-	-	2	2	1	3	-	3	3	-
CO5	3	2	3	3	-	-	-	2	2	2	2	-	3	3	1
AVG	**2.33**	**2.4**	**2.8**	**2.6**			**2**	**2**	**2.2**	**1.33**	**2.8**	**-**	**2.8**	**2.8**	**1**

BM19311 BIOCHEMISTRY AND PHYSIOLOGY LABORATORY L T P C

0 0 4 2

OBJECTIVES

- To estimate and quantify various biomolecules.
- To learn the separation technique of major macromolecules.
- To estimate and interpret the normal values of various biochemical parameter.

LIST OF EXPERIMENTS:

1. General guidelines for working and functional component of biochemistry lab
2. Preparation of solutions: 1) percentage solutions, 2) molar solutions, 3) normal solutions
3. Spectroscopy: Determination of absorption maxima (λmax) of a given solution
4. General tests for carbohydrates, proteins and lipids.
5. Preparation of serum and plasma from blood.
6. Estimation of blood glucose.
7. Estimation of creatinine.
8. Estimation of urea.
9. Estimation of cholesterol
10. Assay of SGOT/SGPT.
11. Separation of proteins by SDS electrophoresis(Demo)
12. Separation of amino acids by thin layer chromatography
13. Identification of Blood groups
14. Estimation of Hemoglobin
15. Determination of ESR
16. PCV, MCH, MCV,MCHC

TOTAL: 60 PERIODS

OUTCOMES:

On completion of the course students will be able to

- Identify the Biochemistry laboratory functional components
- Comprehend the basics principle of preparation of buffers.
- Perform various qualitative tests for different biomolecules.

- Explore the basic knowledge about Biochemical & haematological parameters and their interpretation in Blood sample.
- Demonstrate the separation technology of proteins and amino acids.

LAB REQUIREMENT FOR A BATCH OF 30 STUDENTS:

1. Colorimeter 2 Nos
2. Spectrophotometer 1No.
3. pH meter 1No
4. Weighing balance 1 No
5. Refrigerator 1No
6. SDS gel electrophoresis 1No
7. TLC, ready TLC plates 1No
8. Wintrobe's tube 2Nos.
9. Centrifuge Normal 1No
10. Microslides 2packets
11. Lancet 2boxes
12. Microscope 3No
13. Heparinized Syringe1box
14. Haemoglobinometer 1No
15. Blood Grouping Kit2

	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**
CO1	3	2	1	2	-	2	1	1	-	2	-	-	3	2	1
CO2	3	2	1	2	-	2	1	1	-	2	-	-	3	2	1
CO3	3	2	1	2	-	2	1	1	-	2	-	-	3	2	1
CO4	3	2	1	2	-	2	1	1	-	2	-	-	3	2	1
CO5	3	2	1	2	-	2	1	1	-	2	-	-	3	2	1
AVG	**3**	**2**	**1**	**2**	**-**	**2**	**1**	**1**	**-**	**2**	**-**	**-**	**3**	**2**	**1**

SEMESTER IV

MA19452 PROBABILITY AND RANDOM PROCESSES L T P C

3 1 0 4

OBJECTIVES

- 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 provide necessary basic concepts in probability and random processes for applications such as random signals, linear systems etc in communication engineering.

UNIT I ONE – DIMENSIONAL RANDOM VARIABLE 12

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

UNIT II TWO - DIMENSIONAL RANDOM VARIABLES 12

Joint distributions – Marginal and conditional distributions – Covariance – Correlation and Linear regression – Transformation of random variables-Applications of Central Limit Theorem.

UNIT III RANDOM PROCESSES 12

Classification – Stationary process – Markov process - Poisson process and its properties – Discrete parameter Markov chain – Chapman Kolmogorov Theorem (without proof) – Limiting distributions.

UNIT IV CORRELATION AND SPECTRAL DENSITIES 12

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

UNIT V LINEAR SYSTEMS WITH RANDOM INPUTS 12

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

TOTAL: 60 PERIODS

OUTCOMES:

On completion of the course students will be able to

- apply the basic concepts of probability, one dimensional and two dimensional Random Variables.
- apply the concept of correlation and regression in real life situation.
- analyze signals which evolve with respect to time in a probabilistic manner.
- develop skills in solving problems on power spectral density function.
- develop skills in solving problems in linear time invariant systems.

TEXT BOOKS:

1. Ibe.O.C., “Fundamentals of Applied Probability and Random Processes", Elsevier, 1st Indian Reprint, 2007.
2. Peebles. P.Z., "Probability, Random Variables and Random Signal Principles", Tata Mc Graw Hill, 4th Edition, New Delhi, 2002.

3. Veerarajan T., 'Probability, Statistics and Random Processes with Queueing Theory and Queueing Networks', McGraw Hill, 2016.

REFERENCES:

1. Yates R.D. and Goodman. D.J., "Probability and Stochastic Processes", 2nd Edition, Wiley India Pvt. Ltd., Bangalore, 2012.
2. Stark H., and Woods. J.W., "Probability and Random Processes with Applications to Signal Processing", 3rd Edition,Pearson Education, Asia, 2002
3. Miller S.L. and Childers. D.G., "Probability and Random Processes with Applications to Signal Processing and Communications", Academic Press, 2004.
4. Hwei Hsu, "Schaum"s Outline of Theory and Problems of Probability, Random Variables and Random Processes", Tata Mc Graw Hill Edition, New Delhi, 2004.
5. Cooper G.R., Mc Gillem. C.D., "Probabilistic Methods of Signal and System Analysis", 3rd Indian Edition, Oxford University Press, New Delhi, 2012.

	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
CO1	3	3	2	2	1	-	-	-	-	-	-	2	1	2	-
CO2	3	3	2	2	1	-	-	-	-	-	-	2	1	2	-
CO3	3	3	2	3	1	-	-	-	-	-	-	2	2	2	-
CO4	3	3	3	3	2	-	-	-	-	-	-	2	2	2	-
CO5	3	3	3	3	2	-	-	-	-	-	-	2	2	2	-
AVG	**3**	**3**	**2.4**	**2.6**	**1.4**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**1.6**	**2**	**-**

BM19401 BIOMEDICAL INSTRUMENTATION L T P C

3 0 0 3

OBJECTIVES

- To understand the basic theory of Bio potential Electrodes and Bio potential measurement.
- To design Bio potential amplifiers for acquisition of bio signals.
- To study the various non-electrical physiological parameter measurement and bio chemical measurements.

UNIT I BIOPOTENTIAL ELECTRODES 9

Origin of bio potential and its propagation: Nernst equation for membrane Resting Potential Generation and Propagation of Action Potential, Conduction through nerve to neuromuscular junction. Bio Electrodes: Electrode-electrolyte interface, electrode– skin interface, half-cell potential, impedance, polarization effects of electrode – non polarizable electrodes, Types of electrodes - surface, needle and micro electrodes and their equivalent circuits. Recording problems - measurement with two electrodes.

UNIT II BIOPOTENTIAL MEASUREMENTS 10

Bio signal characteristics– frequency and amplitude ranges, Cardiac Instrumentation: Electrical Conduction system of the heart. Cardiac cycle. Relation between electrical and mechanical activities of the heart, Specification of ECG machine. Einthoven triangle, Standard 12-lead configurations, Interpretation of ECG waveform with respect to electro

mechanical activity of the heart. Measurements of heart sounds - PCG. Neuro-Muscular Instrumentation: Specification of EEG and EMG machines, EEG - 10-20 electrode system, unipolar, bipolar and average mode, Functional block diagram , EMG - unipolar and bipolar mode, block diagram. Interpretation of EEG and EMG.Ophthalmic Instrumentation: Specification of EOG and ERG machines, Electrode placement for EOG and ERG recording. Interpretation of EOG and ERG.

UNIT III BIOPOTENTIAL AMPLIFIER 8

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.

UNIT IV NON ELECTRICAL PHYSIOLOGICAL PARAMETER MEASUREMENT 10

Temperature, respiration rate and pulse rate measurements, Plethysmography, Pulse 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. Cardiac output measurement- Indicator dilution, dye dilution and thermodilution method.

UNIT V BIOCHEMICAL MEASUREMENT 8

Biochemical sensors - pH, pO2 and pCO2, Ion selective Field Effect Transistor (ISFET), immunologically sensitive FET (IMFET), Blood glucose sensors - Blood gas analyzers, spectrophotometer, blood cell counter, auto analyzer.

TOTAL: 45 PERIODS

TEXT BOOKS:

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.

REFERENCES:

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.

OUTCOMES:

On completion of the course the students will be able to

- Describe the electrode behaviour and circuit models.
- Describe the fundamentals of Bio potential recording.
- Design various bio amplifiers.
- Measure various nonelectrical physiological parameters.
- Measure various biochemical parameters.

	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
CO1	2	3	3	3	2	3	-	-	-	-	-	2	3	3	2
CO2	2	3	3	2	2	3	-	-	-	-	-	2	3	2	2
CO3	1	3	3	-	2	2	-	-	-	-	-	2	3	3	3
CO4	1	2	2	2	2	1	-	-	-	-	-	2	3	3	1
CO5	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**

BM19402 ANALOG & DIGITAL INTEGRATED CIRCUITS L T P C

3 0 0 3

OBJECTIVES

1. To understand the basic of number system and Boolean algebra
2. To understand the design of different combinational logic circuits & Sequential logic circuits
3. To understand the basics of operational amplifier and its applications
4. To understand the design of different Active Filter and timer circuits
5. To understand the Real time applications of Analog and Digital IC'S

UNIT I INTRODUCTION TO DIGITAL SYSTEM 9

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

UNIT II SEQUENTIAL CIRCUITS 9

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

UNIT III OPAMP BASICS AND APPLICATIONS 9

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

UNIT IV FILTER 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, Astable and monostable multivibrator circuits; internal structure of 555 and its applications, clock circuits.

UNIT V REAL TIME APPLICATIONS 9

Basic Function Generator, Digital stethoscope and digital blood pressure monitor, Digital blood glucose monitor and thermometer, Rejection of power line interference using notch filter, Drug Delivery System using 555 timer, Analog and Digital interface circuits: A/D, D/A Converters

TOTAL: 45 PERIODS

TEXT BOOKS:

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

REFERENCES:

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, 1972John. 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

OUTCOMES:

On completion of the course the students will be able to

- solve Boolean equations and Karnaugh Map using Boolean algebra
- design the encoder, decoder, Multiplexer, Demultiplexer, Counters and Shift Registers
- design Non inverting, inverting, integrator, Differentiator amplifier circuits using opamp
- design Ist order Active filter LPF,HPF,BPF,BSF using opamp
- design Low frequency oscillator circuits and timer circuits also apply this knowledge for various clinical applications

	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
CO1	3	3	3	2	-	-	-	-	2	-	2	-	2	3	-
CO2	3	3	3	2	-	-	-	-	3	-	3	-	2	3	-
CO3	3	2	3	3	-	-	-	-	2	-	3	-	3	3	-
CO4	3	2	3	3	-	-	-	-	2	-	3	-	3	3	-
CO5	3	2	3	3	-	-	-	-	2	-	2	-	3	3	-
AVG	**3**	**2.4**	**3**	**2.6**					**2.2**	**-**	**2.6**	**-**	**2.6**	**3**	**-**

BM19441 **PATHOLOGY AND MICROBIOLOGY**

L	T	P	C
2	0	2	3

OBJECTIVES

- To understand the cause, pathogenesis and pathology of diseases.
- To learn the fluid and hemodynamic disturbances in the body
- To demonstrate bleeding and clotting time
- To gain awareness and knowledge of infectious and life style diseases
- To learn the different staining methods and principles of different types of microscopy

UNIT I CELL DEGENERATION, REPAIR AND NEOPLASIA 6

Cellular adaptation, Reversible and Irreversible cell injury, Necrosis, Gangrene, Apoptosis. Inflammation and Repair. Neoplasia - Benign and Malignant tumours - carcinogenesis.

UNIT II FLUID AND HEMODYNAMIC DERANGEMENTS 6

Edema, Hyperemia/Ischemia, thrombosis, embolism, shock, anemia, Bleeding disorders.

UNIT III SYSTEMIC PATHOLOGY 6

Life Style Diseases: Atherosclerosis, Myocardial Infarction, Diabetes Mellitus, Hypertension, COPD, Reflux Gastritis and PCOD.

Infectious Disease: Hepatitis, Pneumonia.

UNIT IV MICROBIOLOGY 6

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 IMMUNOPATHOLOGY AND MICROSCOPY 6

Basic structure of Antigen, Antibody. Immunity - Innate and Acquired. Hypersensitivity reactions.

Light microscope – bright field, dark field, and phase contrast, fluorescence, Electron microscope (TEM & SEM).

LIST OF EXPERIMENTS: 30

1. Demonstration of bright field microscope
2. Simple staining
3. Gram's Staining
4. AFB Staining
5. Determination of Bleeding time and clotting time

TOTAL: 60 PERIODS

EQUIPMENT FOR A BATCH OF 30 STUDENTS

1. Microscope – 2 No's
2. Staining kit : Simple, Gram's, AFB -1 kit
3. Capillary tube – 2 box
4. Lancet – 1 box
5. Filter paper

OUTCOMES:

On completion of the course students will be able to

- Analyse the pathology of various diseases.
- Outline the cause of various fluid imbalance and haematological disease.
- Discuss the pathology of lifestyle and infectious diseases
- Comprehend about the normal flora, structure and identification of bacteria
- Illustrate the interaction of cellular components of immune system and functional aspects of microscopes.

TEXT BOOKS:

1. Harsh Mohan, "Textbook of Pathology" 8th Edition, Jaypee Brothers Medical Publishers (P) Ltd., 2018.
2. Ananthanarayanan & Panicker, "Textbook of Microbiology", University press (India) Private Limited, 10th edition, 2017.

REFERENCES:

1. Churchill Livingstone "Underwood JCE: General and Systematic Pathology", 3rd edition, 2000.
2. Dubey RC and Maheswari DK. "A Text Book of Microbiology" Chand & Company Ltd, 2007.
3. Prescott, Harley and Klein, "Microbiology", 10th edition, McGraw Hill, 2017
4. Ramzi S Cotran, Vinay Kumar & Stanley L Robbins, "Pathologic Basis of Diseases", 7th edition, WB Saunders Co. 2005.

	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
CO1	3	2	-	-	-	1	-	1	-	-	-	1	3	3	-
CO2	3	2	-	-	-	1	-	1	-	-	-	1	3	3	-
CO3	3	2	-	-	-	1	-	1	-	-	-	1	3	3	-
CO4	3	2	-	-	-	1	-	1	-	-	-	1	3	3	-
CO5	3	2	-	-	-	1	-	1	-	-	-	1	3	3	-
AVG	**3**	**2**	**-**	**-**	**-**	**1**	**-**	**1**	**-**	**-**	**-**	**1**	**3**	**3**	**-**

CS19241 DATA STRUCTURES L T P C

3 0 4 5

OBJECTIVES

- To apply the concepts of List ADT in the applications of various linear and nonlinear data structures.
- To demonstrate the understanding of stacks, queues and their applications.
- To analyze the concepts of tree data structure.
- To understand the implementation of graphs and their applications.
- To be able to incorporate various searching and sorting techniques in real time scenarios.

UNIT I LINEAR DATA STRUCTURES – LIST 9

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

UNIT II LINEAR DATA STRUCTURES – STACKS, QUEUES 9

Stack ADT – Operations - Applications - Evaluating arithmetic expressions- Conversion of Infix topostfix expression - Queue ADT – Operations - Circular Queue –DEQUE – applications of queues.

UNIT III NON LINEAR DATA STRUCTURES – TREES 9

Tree Terminologies- Binary Tree–Representation-Tree traversals – Expression trees – Binary Search Tree–AVL Trees –Splay Trees - Binary Heap – Applications.

UNIT IV NON LINEAR DATA STRUCTURES – GRAPHS 9

Graph Terminologies – Representation of Graph – Types of graph - Breadth-first traversal - Depth-first traversal –Topological Sort - Shortest path - Dijikstra's Algorithm - Minimum Spanning Tree- Prim's Algorithm.

UNIT V SEARCHING, SORTING AND HASHING TECHNIQUES 9

Searching- Linear Search - Binary Search. Sorting - Bubble sort - Selection sort - Insertion sort – Shell sort – Quick sort - Merge Sort. Hashing- Hash Functions –Collision resolution strategies- Separate Chaining – Open Addressing – Rehashing.

LIST OF EXPERIMENTS: 60

1. Array implementation of Stack and Queue ADTs
2. Array implementation of List ADT
3. Linked list implementation of List, Stack and Queue ADTs
4. Applications of List, Stack and Queue ADTs
5. Implementation of Binary Trees and operations of Binary Trees
6. Implementation of Binary Search Trees
7. Implementation of AVL Trees
8. Implementation of Heaps using Priority Queues
9. Graph representation and Traversal algorithms
10. Applications of Graphs
11. Implementation of searching and sorting algorithms
12. Hashing –any two collision techniques

TOTAL: 105 PERIODS

OUTCOMES:

On completion of the course students will be able to

- Analyze the various data structure concepts.
- Implement Stacks and Queue concepts for solving real-world problems.
- Analyze and structure the linear data structure using tree concepts
- Critically Analyse various non-linear data structures algorithms
- Apply different Sorting, Searching and Hashing algorithms

TEXT BOOKS:

1. Mark Allen Weiss, “Data Structures and Algorithm Analysis in C”, 2nd Edition, Pearson Education, 2002.
2. ReemaThareja, “Data Structures Using C”, Second Edition, Oxford University Press, 2014.

REFERENCES:

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L.Rivest and Clifford Stein, “Introduction to Algorithms", Second Edition, McGraw Hill, 2002.
2. Aho, Hopcroft and Ullman, “Data Structures and Algorithms”, Pearson Education, 1983.
3. Stephen G. Kochan, “Programming in C”, 3rd edition, Pearson Education.
4. Ellis Horowitz, SartajSahni and Susan Anderson Freed, “Fundamentals of Data Structures in C”, 2nd Edition, University Press, 2008.
5. http://vlabs.iitb.ac.in/vlab/labscse.html

	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
CO1	2	2	2	-	1	-	-	-	1	1	1	1	1	2	1
CO2	3	3	3	1	1	-	-	1	1	1	1	1	1	2	1
CO3	2	3	3	1	1	-	-	-	1	1	1	1	1	2	1
CO4	3	3	3	1	1	1	1	-	1	1	2	1	1	2	1
CO5	3	3	3	2	1	-	-	1	1	1	1	1	1	2	1
AVG	**2.6**	**2.8**	**2.8**	**1.2**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.2**	**1.0**	**1.0**	**2.0**	**1.0**

GE19303 ECONOMICS FOR ENGINEERS L T P C

3 0 0 3

OBJECTIVES

The course will cover the determination of income, employment, the price level, interest rates and exchange rates in the economy. The economy will be analysed in the short run (e.g. business cycle and stabilization policy) and in the long run (e.g. economic growth). The insights of Keynesian and classical theories will be integrated. As macroeconomics is an empirical discipline the course will cover case studies and statistical data interpretation. .

UNIT I MICROECONOMICS 9

Microeconomics: Principles of Demand and Supply — Supply Curves of Firms — Elasticity of Supply; Demand Curves of Households — Elasticity of Demand; Equilibrium and Comparative Statics (Shift of a Curve and Movement along the Curve); Welfare Analysis — Consumers' and Producers' Surplus

.

UNIT II PRICE AND CONSUMER BEHAVIOUR 9

Price Ceilings and Price Floors; Consumer Behaviour — Axioms of Choice — Budget Constraints and Indifference Curves; Consumer's Equilibrium — Effects of a Price Change, Income and Substitution Effects —Derivation of a Demand Curve; Applications — Tax and Subsidies — Intertemporal Consumption — Suppliers' Income Effect

UNIT III PRODUCTION FUNCTION AND COMPETITION 9

Theory of Production — Production Function and Iso-quants — Cost Minimization; Cost Curves — Total, Average and Marginal Costs — Long Run and Short Run Costs; Equilibrium of a Firm under Perfect Competition; Monopoly and Monopolistic Competition

UNIT IV NATIONAL INCOME AND KEYNESIAN MULTIPLIER 9

National Income and its Components — GNP, NNP, GDP, NDP; Consumption Function; Investment; Simple Keynesian Model of Income Determination and the Keynesian Multiplier; Government Sector — Taxes and Subsidies; External Sector — Exports and Imports; Money

— Definitions; Demand for Money —Transactionary and Speculative Demand; Supply of Money — Bank's Credit Creation Multiplier; Integrating Money and Commodity Markets

UNIT V IS, LM MODEL, MONETARY, FISCAL POLICY AND TAXES 9

IS, LM Model; Business Cycles and Stabilization — Monetary and Fiscal Policy — Central Bank and the Government; The Classical Paradigm — Price and Wage Rigidities — Voluntary and Involuntary Unemployment- Introduction to individual Income Tax-and Corporate Income Tax- GST, GST Council.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course students will be able to

- Students are expected to become familiar with both principles of micro and macro economics. They would also become familiar with application of these principles to appreciate the functioning of both product and input markets as well as the economy.
- Students will be able to improve their economic vocabulary- the knowledge of the terms and concepts commonly used in discussions of economic issues
- Students will be able to demonstrate the ability to employ 'the economic way of thinking'.
- Students will learn to apply economic theories and concepts to contemporary social issues, as well as analysis of policies.
- Students will be able to formulate informed opinions on policy issues and recognize the validity of opposing view points

TEXTBOOKS:

1. Paul A. Samuelson, William D. Nordhaus, Sudip Chaudhuri and Anindya Sen, Economics, 19th edition, 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.

REFERENCES:

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.

BM19411	ANALOG & DIGITAL INTEGRATED CIRCUITS LABORATORY	L T P C 0 0 4 2

OBJECTIVES

- Learn the function of different ICs
- Understand the applications of operation amplifier.
- Learn the working of multivibrators

- Learn the working of Oscillator circuits for generating waveforms using ICs.
- Learn the working of Timer circuits for generating Delay

LIST OF EXPERIMENTS:

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

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course students will be able to

- To design and build Circuits for different application using Logic gates
- To design and build Circuits for different application using Combinational Logic circuits
- To design and build Circuits for different application using Sequential Logic gates circuits
- To design and build Circuits for oscillator and wave form generator
- To design and build Circuits for Converting the Signals from Analog to Digital Vice versa

LAB EQUIPMENTS FOR A BATCH OF 30 STUDENTS:

1. Digital Trainer Kit - 15 Nos.(with 5 V, Variable and fixed frequency Clock, Bread Board, Four Seven Segment displays, LEDs for output display, Logic 1 and 0 Input switches)
2. Logic ICs - 50Nos each (7400, 7402, 7404, 7408, 7410, 7420, 7432, 7447, 7448, 7474, 7476, 7483, , 7485, 7486, 7490, 7495, 74151, 741 Common Anode and cathode 7-segment displays, LEDs)
3. NE555 – 50 nos
4. A/D and D/A convertors – 50 nos
5. Resistors - 50 nos
6. Capacitors - 50 nos
7. IC Power supply (5 V fixed) - 15 Nos
8. Bread Boards - 15 Nos
9. Phase locked loops (PLL)-50 nos

	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
CO1	3	3	1	2	-	-	-	-	2	-	2	-	2	3	-
CO2	2	3	1	2	-	-	-	-	3	-	3	-	2	3	-
CO3	3	2	3	3	-	-	-	-	2	-	2	-	3	3	-
CO4	3	2	3	3	-	-	-	-	2	-	2	-	3	3	-
CO5	3	2	3	3	-	-	-	-	2	-	2	-	3	3	-
AVG	**2.8**	**2.4**	**2.2**	**2.6**					**2.2**		**2.2**		**2.6**	**3**	

BM19421 **PCB DESIGN LABORATORY** **L T P C**

0 0 2 1

OBJECTIVES

- To provide knowledge on the role of PCB industry and the EDA tools
- To make students familiar with PCB design procedure and various process involved
- To provide in-depth core knowledge in the fabrication of PCB
- To provide the knowledge in mounting and testing of the PCB based electronic circuits
- To provide knowledge on designing of real time PCB boards.

LIST OF EXPERIMENTS:

1. Introduction to PCB, industrial software and its applications
2. Design of PCB schematic and layout for HWR and FWR
3. Design of PCB schematic and layout for generating 5V,12V supply.
4. Design of PCB schematic and layout for digital trainer kit.
5. Introduction to chemical etching
6. Creation of effective routing(manual & automatic) and generation of gerber file
7. Soldering and Desoldering of components
8. PCB assembly and testing

TOTAL: 30 PERIODS

LAB REQUIREMENT FOR A BATCH OF 30 STUDENTS

1. Computers (64 bit OS) with EAGLE/KiCad software – 30 No's
2. Multimeter – 15 Nos.
3. Ferric Chloride – 10 Bottles
4. Isopropyl alcohol – 10 Bottles
5. Glass rod – 5 No's
6. Plastic tray – 5 No's

OUTCOMES:

On completion of the course students will be able to

- Design lay out for a circuit with suitable dimensions of the devices
- Validate the design before implementing
- Debugging of errors in routing
- Fabrication of PCB for real time problems
- Soldering of components on PCB

	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
CO1	3	3	2	3	-	-	-	-	-	-	2	-	-	2	1
CO2	3	3	2	3	-	-	-	-	-	-	2	-	-	2	1
CO3	3	3	2	3	-	-	-	-	-	-	2	-	-	2	1
CO4	3	3	2	3	-	-	-	-	-	-	2	-	-	2	1
CO5	3	3	2	3	-	-	-	-	-	-	2	-	-	2	1
Avg	**3**	**3**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**2**	**1**

GE19421 **SOFT SKILLS-I** **L T P C**

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 organisation.

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.	The activity aims at making the students speak freely

		Depending on the context, either individual or group brainstorming 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.	without the fear of being criticized. It also 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.

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.

MC19301 ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE L T P C

2 0 0 0

OBJECTIVE

- This course aims at imparting basic principles of thought process, reasoning and inference. Sustainability is the core of Indian traditional knowledge system connecting society and nature. Holistic life style of yogic science and wisdom are important in modern society with rapid technological advancements and societal disruptions. The course mainly focuses on introduction to Indian knowledge system, Indian perspective of modern science, basic principles of Yoga and holistic healthcare system, Indian philosophical, linguistic and artistic traditions.

  Pedagogy: Problem based learning, group discussions, collaborative mini projects.

UNIT I INTRODUCTION TO INDIAN KNOWLEDGE SYSTEM 6

Basic structure of the Indian Knowledge System –Veda – Upaveda - Ayurveda, Dhanurveda-Gandharvaveda, Sthapathyaveda and Arthasasthra. Vedanga (Six forms of Veda) – Shiksha, Kalpa, Nirukta, Vyakarana, Jyothisha and Chandas- Four Shasthras - Dharmashastra, Mimamsa, Purana and Tharkashastra

UNIT II MODERN SCIENCE AND YOGA 6

Modern Science and the Indian Knowledge System – a comparison - Merits and demerits of Modern Science and the Indian Knowledge System - the science of Yoga-different styles of Yoga – types of Yogaasana, Pranayam, Mudras, Meditation techniques and their health benefits – Yoga and holistic healthcare – Case studies

UNIT III INDIAN PHILOSOPHICAL TRADITION 6

Sarvadharshan/Sadhdharshan – Six systems (dharshans) of Indian philosophy - Nyaya, Vaisheshika, Sankhya, Yoga, Mimamsa, Vedanta-Other systems- Chavarka, Jain (Jainism), Boudh (Buddhism) – Case Studies

UNIT IV INDIAN LINGUISTIC TRADITION 6

Introduction to Linguistics in ancient India – history – Phonetics and Phonology – Morphology –Syntax and Semantics-Case Studies.

UNIT V INDIAN ARTISTIC TRADITION 6

Introduction to traditional Indian art forms – Chitrakala (Painting), Murthikala / Shilpakala (Sculptures), Vaasthukala, Sthaapathya kala (Architecture), Sangeeth (Music), Nruthya (Dance) and Sahithya (Literature) – Case Studies

TOTAL: 30 PERIODS

OUTCOMES:

At the end of the course, students will be able to appreciate the importance of traditional Indian knowledge system, Yoga and other Indian traditions that are important in a modern society with technological advancements and lifestyle changes.

TEXTBOOKS:

1. V. Sivaramakrishnan (Ed.), Cultural Heritage of India-course material, Bharatiya Vidya Bhavan, Mumbai. 5th Edition, 2014
2. Swami Jitatmanand, Modern Physics and Vedant, Bharatiya Vidya Bhavan
3. Swami Jitatmanand, Holistic Science and Vedant, Bharatiya Vidya Bhavan
4. Fritzof Capra, Tao of Physics
5. Fritzof Capra, The Wave of life

REFERENCES:

1. VN Jha (Eng. Trans.), *Tarkasangraha of Annam Bhatta*, International Chinmaya Foundation, Velliarnad, Arnakulam
2. Yoga Sutra of Patanjali, Ramakrishna Mission, Kolkata
3. GN Jha (Eng. Trans.), Ed. RN Jha, *Yoga-darshanam with Vyasa Bhashya*,Vidyanidhi Prakashan, Delhi 2016
4. RN Jha, *Science of Consciousness Psychotherapy and Yoga Practices*, Vidyanidhi Prakashan, Delhi 2016

SEMESTER V

BM19501	BIOCONTROL SYSTEMS	L	T	P	C
		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
- To study the concept of physiological control system

UNIT I CONTROL SYSTEM MODELING 9

Terminology and basic structure of control system, example of a closed loop system, transfer function, modeling of electrical systems, translational and rotational mechanical systems, and electromechanical systems, block diagram and signal flow graph representation of systems, reduction of block diagram and signal flow graph, conversion of block diagram to signal flow graph. Need for modeling physiological system.

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, definition of dominant poles and relative stability.

UNIT IV FREQUENCY RESPONSE ANALYSIS 9

Frequency response, Nyquist stability criterion, Nyquist plot and determination of closed loop stability, definition of gain margin and phase margin, Bode plot, determination of gain margin and phase margin using Bode plot, use of Nichol‘s chart to compute frequency and bandwidth.

UNIT V PHYSIOLOGICAL CONTROL SYSTEM 9

Difference between engineering and physiological control systems, generalized system properties, models with combination of system elements, linear models of physiological systems-Examples, Introduction to simulation. Examples of Biological control Systems: Cardiovascular Control System, Skeletal Muscle Servomechanism.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course students will be able to

- Summarize the basic concepts of control systems.
- Analyse 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.

TEXTBOOKS:

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

REFERENCES:

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.
5. Joseph J. DiStefano, Allen R. Stubberud, Schaum's Outline of — "Feedback and Control Systems", McGraw-Hill Education; 2nd edition 2013.

	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
CO1	3	2												2	
CO2	3	2		1										2	
CO3	2	2		1										2	
CO4		2	1	1									2	2	
CO5				2							1		2	2	
Avg	**1.6**	**1.6**	**0.2**	**1**							**0.2**		**.8**	**2**	

BM19502 PRINCIPLES OF COMMUNICATION SYSTEMS L T P C

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 be familiarized with source and Error control coding
- To familiarize with the standards and applications of the medical devices and their related bio signal processing

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).

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 SOURCE AND ERROR CONTROL CODING 9

Entropy, Source encoding theorem, Shannon fano coding, Huffman coding, mutual information, channel capacity, Error Control Coding, linear block codes, cyclic codes, convolution codes, Viterbi decoding algorithm.

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.

TOTAL: 45 PERIODS

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
- Describe the source and Error control coding of information
- Analyse the concept of medical devices and case study of bio signal communication

TEXTBOOKS:

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.

REFERENCES:

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.

5. Bernard Sklar and Pabitra Kumar Ray, "Digital Communications: fundamentals and practice", 2nd edition, Pearson edition, 2001.

	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
CO1	1	3	3	2	2	2	-	-	2	-	-	2	1	3	3
CO2	1	2	3	1	2	2	-	-	2	-	-	2	1	2	3
CO3	1	1	3	3	2	2	-	-	2	-	-	3	1	1	3
CO4	1	3	3	2	2	2	-	-	2	-	-	2	1	3	3
CO5	1	3	3	1	2	2	-	-	2	-	-	3	1	3	3
Avg	**1**	**2.4**	**3**	**1.8**	**2**	**2**	**-**	**-**	**2**	**-**	**-**	**2.4**	**1**	**2.4**	**3**

BM19541 SIGNALS AND SYSTEMS ANALYSIS L T P C

2 1 2 4

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

UNIT I CLASSIFICATION OF SIGNALS AND SYSTEMS 9

Continuous time signals (CT signals) - Discrete time signals (DT signals) - Step, Ramp, Pulse,Impulse, Sinusoidal, Exponential, Classification of CT and DT signals - Periodic & Aperiodic signals, Deterministic & Random signals, Energy & Power signals - CT systems and DT systems-Classification of systems – Static & Dynamic, Linear & Nonlinear, Time-variant & Time-invariant, Causal & Noncausal, Stable & Unstable.

UNIT II ANALYSIS OF CONTINUOUS TIME SIGNALS 9

Fourier series analysis-spectrum of Continuous Time (CT) signals- Fourier and Laplace Transforms in CT Signal Analysis - Properties.

UNIT III LINEAR TIME INVARIANT- CONTINUOUS TIME SYSTEMS 9

Differential Equation-Block diagram representation-impulse response, convolution Integrals-Fourier and Laplace transforms in Analysis of CT systems.

UNIT IV ANALYSIS OF DISCRETE TIME SIGNALS 9

Sampling – Nyquist Criteria- DTFT – Properties of DTFT - Z Transform – Properties of Z Transform

UNIT V LINEAR TIME INVARIANT-DISCRETE TIME SYSTEMS 9

Difference Equations-Block Diagram Representation-Impulse response - Convolution sum-Discrete Fourier and Z Transform Analysis of Recursive & Non-Recursive systems

Practical:

1. Time Shifting, Time Reversing, Time Scaling
2. Construction of signals with different Frequencies.
3. Analyse the stability of a CT System with various inputs.
4. Analyse the stability of a DT System with various inputs.
5. Reconstruct a signal from samples and study the effect of Aliasing.

TOTAL (L: 30 + T: 15 +P: 30): 75 PERIODS

Equipment required for 30 students

Computers with MATLAB / Equivalent software- 15 Numbers

OUTCOMES:

On completion of the course students will be able to

- classify real time signals and systems.
- analyse CT signals.
- implement a system to perform Fourier operation on CT signals
- compute Fourier transform for DT signals
- implement a system to perform Fourier and Z transform on DT signals.

TEXT BOOK:

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

REFERENCES:

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.

	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
CO1	3	3	2	1	-	-	-	-	-	-	-	3	-	3	2
CO2	3	3	3	2	-	1	-	-	-	-	-	3	-	3	2
CO3	3	3	3	3	3	-	-	-	-	-	2	3	-	3	3
CO4	3	3	3	2	2	-	-	-	-	-	-	3	-	3	2
CO5	3	3	3	3	3	-	-	-	-	-	2	3	-	3	3
Avg	**3**	**3**	**2.8**	**2.2**	**2.7**	**1**	**-**	**-**	**-**	**-**	**2**	**3**	**-**	**3**	**2.4**

BM19542 MICROPROCESSOR, MICROCONTROLLER & EMBEDDED SYSTEM DESIGN **L T P C 3 0 2 4**

OBJECTIVES:

- To Study the Architecture of 8086 microprocessor
- To learn the design aspects of I/O and Memory Interfacing circuits.
- To Study the Architecture of 8051 microcontroller
- To Study the design requirements of microcontroller with display devices and converter IC
- To study the design aspects of an embedded system

UNIT I THE 8086 MICROPROCESSOR 9

Introduction to 8086 – Microprocessor architecture – Addressing modes - Instruction set and assembler directives – Assembly language programming – Stacks – Interrupts and interrupt service routines.

UNIT II THE 8086 INTERFACING WITH I/O 9

Memory Interfacing and I/O interfacing - Parallel communication interface – Serial communication interface – D/A and A/D Interface - Timer –Interrupt controller– Interfacing 8086 with LED, Seven segment LED display, LCD display. Programming and applications for Case study: Traffic Light control

UNIT III MICROCONTROLLER 9

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 IV MICROCONTROLLER INTERFACING 9

LED and 7 segment LED interfacing, Keyboard Interfacing with 8051 microcontroller– ADC interfacing with 8051 microcontroller and DAC interfacing with 8051 microcontroller for wave generation, LCD interfacing with 8051 microcontroller

UNIT V MICROCONTROLLER FOR EMBEDDED SYSTEM APPLICATIONS 9

Temperature Sensor Interfacing in Digital thermometer using 8051, Non contact temperature measurement using 8051. Motors for syringe pumps, Infusion pump

LIST OF EXPERIMENTS:

8086 Programs using kits and MASM

1. Basic arithmetic and Logical operations
2. Move a data block without overlap
3. Code conversion, decimal arithmetic

Peripherals and Interfacing Experiments with 8086

4. Traffic light control
5. Stepper motor control
6. Parallel interface
7. A/D and D/A interface for Waveform Generation

8051 Experiments using kits and MASM

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

8051 interfacing with Peripherals

10. Temperature sensor interfacing with 8051 microcontroller

LAB EQUIPMENT FOR A BATCH OF 5 STUDENTS:

HARDWARE:

1. 8086 development kits - 5 nos
2. Interfacing Units - Each 1 nos
3. Microcontroller development kits - 5 nos

SOFTWARE:

1. Intel Desktop Systems with MASM - 1 nos
2. 8086 Assembler

TOTAL: 75 PERIODS

OUTCOMES:

On completion of the course students will be able to

- write assembly language programs for 8086 microprocessor and execute
- interface the 8086 processor with RAM and ROM IC's
- interface the 8086 processor with data converter IC
- write assembly language programs for 8051 microcontroller
- interface the 8051 Microcontroller with RAM, ROM, DAC, ADC IC's, LED and LCD display

TEXTBOOKS:

1. Ramesh S. Gaonkar, "Microprocessor Architecture Programming and Applications with 8085". Fourth edition, Penram International Publishing 2006.
2. Douglas V.Hall, "Microprocessor and Interfacing, Programming and Hardware Revised" second Edition, Indian edition,Tata McGraw Hill, 2007.
3. Muhammad Ali Mazidi, Janice GillispieMazidi, RolinD.MCKinlayThe 8051Microcontroller and Embedded Systems, Second Edition, Pearson Education 2008.

REFERENCES:

1. Kenneth J.Ayala., "The 8051 Microcontroller, 3rd Edition, Thompson Delmar Learning, New Delhi, 2007.
2. A.K. Ray , K.M .Bhurchandi "Advanced Microprocessor and Peripherals" ,Second edition, Tata McGraw-Hill, 2007.
3. Barry B.Brey, "The Intel Microprocessors Architecture, Programming and Interfacing"Pearson Education, New Delhi, 2007,
4. ZdravkoKarakehayov, "Embedded System Design with 8051 Microcontroller hardware and software", MercelDekkar, 1999.
5. Krishna Kant, " Microprocessor and Microcontroller Architecture, programming and system design using 8085, 8086, 8051 and 8096, PHI, 2007
6. https://www.circuitstoday.com/thermometer

	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
CO1	2	2	-	2	-	-	2	2	-	2	-	-	2	3	-
CO2	2	3	-	3	-	-	2	2	-	2	-	-	3	3	-
CO3	2	3	-	2	-	-	3	3	-	3	-	-	3	2	-
CO4	3	2	-	3	-	-	2	2	-	2	-	-	2	2	-
CO5	3	2	-	2	-	-	2	2	-	2	-	-	2	2	-
Avg	**2**	**2**	**-**	**2**	**-**	**-**	**2**	**2**	**-**	**2**	**-**	**-**	**2**	**2**	**-**

BM19511 BIOMEDICAL INSTRUMENTATION LABORATORY L T P C

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 design and simulate basic timer circuits and circuit boards

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 of EMG and Measurement of NCV
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 analog circuit
7. Study of Galvanic Skin Resistance using GSR System
8. Measurement of pH and conductivity.
9. Study of biotelemetry Unit
10. To measure the blood pressure levels using Sphygmomanometer.
11. Simulation of ECG – detection of QRS complex and heart rate
12. Design a suitable filter for bio signal Acquisition
13. Timer circuits: ON delay and OFF delay study
14. Design PCB schematic and layout for bio amplifier.

TOTAL: 60 PERIODS

LAB REQUIREMENTS FOR A BATCH OF 30 STUDENTS:

1. Multiparameter patient monitoring system : 1 No.
2. EEG recorder with accessories for evoked studies: 1 No.
3. ECG recorder: 1 No.
4. EMG recorder: 1 No.
5. pH meter, conductivity meter: 1 No.
6. Blood flow measurement system using ultrasound transducer: 1 No.
7. GSR measurement setup. : 1 No.
8. Function Generators
9. DSOs
10. Regulated Power supplies
11. Bread boards

12. IC 741
13. Software tool for PCB design

OUTCOMES:

On completion of the course 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.
- Design alarm circuits to monitor the patient well being

	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
CO1	3	3	3	3	-	3	-	-	-	-	1	-	-	3	3
CO2	3	3	3	3	-	3	-	-	-	-	1	-	-	3	3
CO3	3	3	3	3	-	3	-	-	-	-	1	-	-	3	3
CO4	3	3	3	3	-	3	-	-	-	-	1	-	-	3	3
CO5	3	3	3	3	-	3	-	-	-	-	1	-	-	3	3
Avg	**3**	**3**	**3**	**3**	**-**	**3**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**3**	**3**

BM19521 **SOFT SKILLS II** **L T P C**

0 0 4 2

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,

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	The aim of this activity is to develop the art of conversation among students. It also aims at

		students move around the class and talk to other students and invite them.	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.

OUTCOMES:

On completion of the course 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

BM19601	DIAGNOSTIC AND THERAPEUTIC EQUIPMENT	L	T	P	C
		3	0	0	3

OBJECTIVES

- To understand the concepts of GSR, audiometer and extracorporeal devices used in critical care unit.
- To explain the concepts of basic patient monitoring system, applications of bio-telemetry units and Ultrasonic imaging.
- To describe the concepts of X-ray and CT imaging technique.
- To outline the concepts of MRI and nuclear medicine.
- To understand the operating principles of surgical and radio therapy equipment.

UNIT I SENSORY MEASUREMENT SYSTEM AND ASSIST DEVICES 9

Sensory measurement: Galvanic skin resistance (GSR)- Audiometer-Pure tone, Speech.

Assist devices: Cardiac pacemaker- different modes of operation, external and implantable pacemakers- Defibrillator and its Ac and DC types- Heart Lung Machine- Ventilators, Types of ventilators, Humidifiers, Nebulizers and Aspirators- Hemodialyzer unit- Need for Anaesthesia, Anaesthesia machine.

UNIT II PATIENT MONITOR, TELEMETRY AND ULTRASONIC EQUIPMENT 9

Basic patient monitoring systems - Foetal Monitor- Central consoling controls - Radio Telemetry (single, multi), Portable and Landline Telemetry unit, Ambulatory Telemonitoring, Real time applications in bio signal Transmission- Ultra sound Echo technique, display techniques A, B and M mode, B Scan, Application of ultrasound as diagnostic tool – Echocardiogram, Echoencephalogram, abdomen, obstetrics and gynaecology, ophthalmology-Spiro meter, measurement of Lung Volume and vital capacity.

UNIT III X-RAY AND COMPUTED TOMOGRAPHY IMAGING 8

X-ray: X-ray machine- X-Ray Tube, the collimator, Bucky Grid, Image Intensifier tubes – Digital radiography – Digital Fluoroscopy-Digital Subtraction Angiography.

Computed Tomography: Principles of tomography, CT Generations, Differences between conventional imaging equipment and digital imaging equipment: Image characteristics, Image reconstruction techniques- back projection and iterative method. Spiral CT, 3D Imaging and its application.

UNIT IV MRI AND NUCLEAR MEDICINE 10

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

Nuclear medicine: PET, SPECT and Gamma camera

UNIT V SURGICAL EQUIPMENT 9

Surgical equipment: Diathermy, Short wave diathermy, ultrasonic diathermy, Microwave diathermy, Electro surgery machine - Current waveforms, Tissue Responses, Electro surgical current level- Transcutaneous electrical nerve stimulation (TENS)-Lithotripsy-Principles of Cryogenic technique and application-Endoscopy-Laparoscopy.

Radiation therapy: linear accelerator, Tele gamma Machine.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course students will be able to

- Demonstrate the recording setup of sensory measurement recorders and understand the applications of various equipment used in ICU.
- Explain electronics used in patient monitor, telemetry and basics of ultrasound as a diagnostic tool.
- Describe the working principle of X ray and CT machine.
- Illustrate the principle working of MRI and nuclear medicine.
- Understand the concepts of surgical and radio therapy equipment.

TEXT BOOKS:

1. John G. Webster, Medical Instrumentation Application and Design, 4th edition, Wiley India PvtLtd,New Delhi, 2015
2. Joseph J. Carr and John M. Brown, Introduction to Biomedical Equipment Technology, Pearson education, 2012.
3. Steve Webb, The Physics of Medical Imaging, Adam Hilger, Philadelpia, 1988 (Units I, II, III and IV).
4. R.Hendee and Russell Ritenour Medical Imaging Physics, Fourth Edition William, Wiley-Liss, 2002.

REFERENCES:

1. Khandpur R.S, Handbook of Biomedical Instrumentation, 3rdedition, Tata McGraw-Hill, New Delhi, 2014.
2. Leslie Cromwell, Biomedical Instrumentation and measurement, 2nd edition, Prentice hall of India, New Delhi, 2015.
3. Richard Aston Principles of Biomedical Instrumentation and Measurement, Merril Publishing Company, 1990.
4. L.A Geddas and L.E.Baker Principles of Applied Biomedical Instrumentation 2004.
5. Myer Kutz Standard Handbook of Biomedical Engineering and Design, McGraw-Hill Publisher, 2003.

	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
CO1	3	3	3	3	2	3	1	1	2	1	1	1	3	3	2
CO2	3	2	3	2	2	3	1	1	1	1	1	1	2	3	2
CO3	3	2	3	1	2	3	1	1	1	1	1	1	2	3	2
CO4	3	2	3	1	2	3	1	1	1	1	1	1	1	3	2
CO5	3	2	3	1	2	3	1	1	1	1	1	1	1	3	2
Avg	**3**	**2.2**	**3**	**1.6**	**2**	**3**	**1**	**1**	**1.2**	**1**	**1**	**1**	**1.8**	**3**	**2**

BM19602 BIOMECHANICS L T P C

3 0 0 3

OBJECTIVES

- Be exposed to principles of mechanics.
- Understand the fluid mechanics.
- Learn the mechanics of physiological systems.
- Be familiar with the mathematical models used in the analysis of biomechanical systems.
- Be exposed to the advancements in biomechanics.

UNIT I INTRODUCTION TO MECHANICS 9

Introduction- 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 Kinetics: Calculation of velocity and acceleration, Kinematics: Link segment models, Force transducers and force plates. Introduction to Constitutive equations.

UNIT II MECHANICS OFBIOFLUIDS 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; 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.

Case study: A computational model of blood vessel.

UNIT III MECHANICS OFBIOSOLIDS 9

Constitutive equation of visco elasticity: Maxwell & Voight models, anisotropy. Hard Tissues: Structure, function and properties of bones, 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, Hill's models.

UNIT IV BIOMECHANICS OFJOINTS 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 joints, Total knee and hip joint replacement.

UNIT V APPLICATIONS OF BIOMECHANICS 9

Introduction to Finite Element Analysis, finite element analysis of lumbar spine; Ergonomics: Musculoskeletal disorders, Ergonomic principles contributing to good workplace design, Design of a Computer work station; Whole body vibrations, Hand transmitted vibrations. Gait analysis, Kinesiological EMG; Sports biomechanics: Motion analysis using video, Isokinetic dynamometry, Computer simulation modeling in sports.

Case study: Biomechanical analysis of any one Paralympic sport.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course students will be able to

- Solve the dynamics and fluid mechanics problems.
- Explain the mechanics of physiological systems.
- Analyze the biomechanical systems.
- Work with the knowledge of Ergonomics.
- Design orthopaedic applications.

TEXT BOOKS:

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. Neil J. Mansfeild, "Human Response to Vibration", CRC Press, 2005.

REFERENCES:

1. Jay D. Humphrey, Sherry De Lange, "An Introduction to Biomechanics: Solids and Fluids, Analysis and Design", Springer Science Business Media, 2004.
2. Shrawan Kumar, "Biomechanics in Ergonomics", Second Edition, CRC Press2007.
3. Sheraz S. Malik et. al. "Orthopaedic Biomechanics Made Easy", Cambridge University Press, 2015.
4. Carl J. Payton, "Biomechanical Evaluation of movement in sports and Exercise", 2008.

	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
CO1	3	2	3	3										2	
CO2				2								1	3		
CO3			2	2									3		
CO4					2	2	2								
CO5				3		3									3
Avg	**0.6**	**0.4**	**1**	**2**	**0.4**	**1**	**0.4**	**0**	**0**	**0**	**0**	**0.2**	**1.2**	**0.4**	**0.6**

BM19641 DIGITAL SIGNAL PROCESSING TECHNIQUES L T P C

2 1 2 4

OBJECTIVES:

- To learn discrete Fourier transform and its properties
- To know the characteristics of IIR and FIR filters learn the design of infinite and finite impulse response filters for filtering undesired signals
- To understand finite word length effects
- To study the concept of Multirate and adaptive filters

UNIT I DISCRETE FOURIER TRANSFORM 9

Discrete Signals and Systems- A Review – 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 (IIR) FILTER 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.

Case Study : Applications of IIR filters in Biomedical Engineering.

UNIT III FINITE IMPULSE RESPONSE (FIR) FILTER 9

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

Case Study : Applications of FIR filters in Biomedical Engineering.

UNIT IV ANALOG TO DIGITAL CONVERSION & QUANTIZATION ERROR 9

Sampling of analog signals- Sampling theorem- ADC - Quantization of continuous amplitude signals, Sinusoidal signal- Fixed point and floating point number representations. Quantization- Truncation and Rounding errors - Quantization noise – coefficient quantization error – Product quantization error - Overflow error – Round off noise power - limit cycle oscillations due to product round off and overflow errors – Principle of scaling

UNIT V STOCHASTIC PROCESSING AND ITS APPLICATION IN BIOSIGNAL ANALYSIS (ONLY QUALITATIVE ANALYSIS) 9

Introduction to probability function, joint probability and conditional probability, ensemble average - mean squared value, variance, standard deviation, moment, correlation, covariance, auto covariance, auto correlation, cross covariance, cross correlation, Decimation and interpolation – frequency domain analysis. Biomedical signals – characteristics, examples, challenges in acquisition and interpretation, statistical methods for biosignal analysis – a primitive outlook

Practical:

1. Spectrum Analysis using FFT
2. Filter Design &Analysis.
3. Finite word length effect.
4. Multirate Filters.
5. DSP Processor Implementation. (Linear and Convolution, FFT implementation, IIR and FIR filters implementation)

TOTAL (L: 30 + T: 15 + P: 30): 75 PERIODS

Equipment required for 30 students

1. Computers with MATLAB / Equivalent software- 15 Numbers
2. TMS320C5416 Processors – 5 Numbers

OUTCOMES:

On completion of the course students will be able to

- Apply DFT for the analysis of digital signals & systems

- Design and implement IIR filters.
- Design and implement FIR Filters.
- Characterize finite Word length effect on filters
- Analyse random signals and apply it for biosignal processing

TEXT BOOKS:

1. John G. Proakis and Dimitris G. Manolakis, "Digital Signal Processing, Algorithms and Applications", Pearson education, New Delhi, 4th Edition, 2007.
2. E. C. Ifeachor and B.W. Jervis, "Digital Signal processing – A Practical Approach", Pearson education, New Delhi, 4th Edition, 2004.

REFERENCES:

1. Sanjit K. Mitra, "Digital Signal Processing – A computer Based Approach", Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 3rd edition, 1998
2. Andreas Antoniou, Digital filter Analysis and Design", Tata McGraw-Hill Publishing Co. Ltd., 2nd edition, 1993.
3. R. Rabiner and B. Gold, "Theory and Application of Digital Signal processing", PHI, 1975.
4. Rangaraj M. Rangayyan, 'Biomedical Signal Analysis-A case study approach', Wiley Interscience/ IEEE Press, 2002.

	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
CO1	3	3	3	3	2	-	-	-	-	-	-	3	2	3	2
CO2	3	3	3	3	2	-	-	-	-	-	-	3	3	3	2
CO3	3	3	3	3	2	-	-	-	-	-	-	3	3	3	3
CO4	3	3	3	3	2	-	-	-	-	-	-	3	1	3	2
CO5	3	3	3	3	2	-	-	-	-	-	-	3	3	3	3
Avg	**3**	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2.4**	**3**	**2.4**

BM19611 DIAGNOSTIC AND THERAPEUTIC EQUIPMENT LABORATORY L T P C

0 0 4 2

OBJECTIVES

- To acquire and analyze the bio signals using various diagnostic equipment.
- To work with various signal processing software.
- To study various therapeutic equipment.
- To work with simulation software.
- To develop a prototype for acquisition of a biosignal and analyze the signals acquired from it

LIST OF EXPERIMENTS

1. Analyze EMG and EEG signals using LabVIEW / Matlab.
2. Heart rate variability Analysis (HRV) using Kubios HRV software.

3. Recording of lung flow, volume and capacities graph using PC based Spirometer.
4. To plot the human auditory response using Audiometer.
5. Recording of PCG (Phonocardiograph) for measurement of heart sound.
6. Analysis of physiological parameters recorded using patient monitoring system using R lab
7. Study of surgical diathermy.
8. Study and simulation of pacemaker & defibrillator using VI LABS.
9. To study and demonstrate the working of a haemodialysis machine.
10. To study and demonstrate the working of a respiratory ventilator.
11. Study of shortwave and ultrasonic diathermy.
12. Design and demonstrate the working of TENS.
13. Mini project (Should include hardware and software).

TOTAL: 60 PERIODS

LAB REQUIREMENTS FOR 30 STUDENTS

1. Multi output power supply (+15v. - 15v. +30V variable, +5V, 2A) - 2 Nos.
2. Single parameter biotelemetry system - 1 No.
3. Spirometry with associated analysis system - 1 No.
4. ECG Simulator - 1 No.
5. Medical stimulator - 1 No.
6. Audiometer – 1 No.
7. Tuning forks (256 Hz, 512 Hz, 1024 Hz) and rubber mallet – each one No.
8. PC installed with LabVIEW & Kubios HRV software
9. PC installed with BIOPAC software and Hardware kit. - 1 No.
10. Multi Output power supply (+15v, -15v, +30V variable, +5V, 2A) - 2 Nos.
11. ECG Simulator - 1 No.
12. PC installed with R software
13. NI DAO device - 1 No.
14. PC installed with Matlab software.
15. Short wave Diathermy - 1 No.
16. Ultrasound diathermy - 1 No.
17. Haemodialysis machine - 1 No.
18. Surgical diathermy with analyzer - 1 No.

OUTCOMES:

On completion of the course students will be able to

- Analyse normal and abnormal conditions in biosignals.
- Calculate the respiratory capacity to analyze acute and chronic conditions
- Apply various types of diathermy for rehabilitation purposes.
- Implement the basics of safety procedure for patients against electrical hazard
- Design and develop a prototype for acquisition and analysis of biosignals

	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
CO1	**3**	**2**	**2**	**-**	**3**	**-**	**-**	**-**	**3**	**-**	**-**	**3**	**3**	**3**	**-**
CO2	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**2**	**3**	**-**
CO3	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO4	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO5	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**2**	**3**	**3**	**3**	**2**	**-**	**-**	**-**
Avg	**2.6**	**2.25**	**2.5**	**3**	**3**	**-**	**-**	**2**	**2.6**	**3**	**3**	**2.5**	**2.5**	**3**	**-**

BM19642 INNOVATION AND DESIGN THINKING FOR BIOMEDICAL ENGINEERS **L T P C 0 1 2 2**

OBJECTIVES

- To study about innovation techniques in biomedical engineering field
- To learn about the design aspects of equipments and products in biomedical engineering field
- To Study about the design challenges in biomedical engineering field

Innovations in biomedical engineering field

Referring journals and magazine like Nature, scientist magazine, Elsevier journal and IEEE journal for innovation techniques in biomedical engineering field

Assessment 1: A write up for new innovation in biomedical engineering field

Design aspects of equipments and products used in biomedical engineering field

Design aspects of Biomedical instrumentation and analysis - its limitations - Drawbacks of it by the customer feedbacks - Overcome the drawbacks by new design approach.

Assessment 2: To propose a new design approach for any one the equipment for overcoming the drawbacks faced by the users

OUTCOMES:

On completion of the course students will be able to

- Able to produce new ideas for innovation of the new technology to existing biomedical Equipment
- Able to overcome the drawbacks in the existing biomedical Equipment using their new design ideas

	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
CO1	3			3	2	-	-	-	-	-	-	3	2	3	
CO2	3			3	2	-	-	-	-	-	-	3	3	3	
CO3	3			3	2	-	-	-	-	-	-	3	3	3	
CO4	3			3	2	-	-	-	-	-	-	3	1	3	
CO5	3			3	2	-	-	-	-	-	-	3	3	3	
Avg	**3**			**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2.4**	**3**	

BM19621 PROBLEM SOLVING TECHNIQUES L T P C

0 0 2 1

OBJECTIVES

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

Course topics:

S.No.	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

OUTCOMES:

On completion of the course students will be able to

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

BM19612 MEDICAL INDUSTRIAL TRAINING L T P C

0 0 2 1

OBJECTIVES

- To know the various biomedical industries and training centres.
- To develop the report writing and presentation skills of the students.

Industrial Training – Students will undergo two weeks of Industrial Training during fifth semester in biomedical industries or R&D centres and should produce the certificate

from the industries or research centres. In addition to that each student will be required to submit a report. Reports are to represent the observations of the students after the training with their personal comments/ suggestions. Viva-Voce will be conducted in the end semester examinations

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

TOTAL: 30 PERIODS

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OUTCOMES:

On completion of the course students will be able to

- Approach an industry or training centre for collaboration.
- Draft technical reports flawlessly.
- Know the recent developments in industries.

SEMESTER VII

BM19701	HOSPITAL ENGINEERING AND MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES

- To understand the fundamentals of hospital administration
- To know the management and market related research process
- To explore various roles and responsibilities of Engineers in hospital.
- To understand various waste management techniques,
- To learn 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 – Educational responsibilities – Staff structure in hospitals – Careers, roles and responsibilities. Hospital Planning- Equipment Planning – Functional Planning - Management Decisions and Related Information Requirement - 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, Current Issues in Hospital Management. Marketing information systems – Consumer Markets & Consumer Buyer Behaviour - Model of consumer behaviour - The buyer decision process - Model of business buyer behaviour - 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. Planned preventive maintenance system, preventive maintenance & repair. Requirements of inter departmental computerization. DBMS in hospital, computerized medical record evaluation, Database approach to laboratory computerization.

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 – Monitoring & Controlling of Cross Infections, Protective Devices – Bioethics and Handling of Waste

Management. Support Service, Technical information systems – Medical Transcription, Medical Records Department – Central Sterilization and Supply Department.
Case study: Exploration of Biomedical waste management in multi speciality hospitals in Chennai

UNIT V STANDARDS AND SAFETY ASPECTS IN HOSPITALS 9

Necessity for standardization, Quality Auditing - Need for Accreditation of hospitals - FDA Regulations- Joint Commission International - Regulatory Bodies of India- NABH – procedures and documentation, Medical Council of India - Pharmacy Council Of India, International Standards ISO 9000 – 9004 – Features of ISO 9001 – ISO 14000 – Environmental Management Systems. Labor laws applicable to hospitals, Medical Ethics. Security – Loss Prevention – Fire Safety – Alarm System – Safety Rules. Health Insurance & Managing Health Care – Medical Audit – Hazard and Safety in a hospital Setup.
Case study: Hospital electrical distribution system design

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course students will be able to

- Explain the principles of Hospital administration and its information systems.
- Identify the importance of management of staff and equipment.
- Identify the importance of Engineers in hospitals.
- Identify various techniques used for waste management.
- Understand safety procedures followed in hospitals.

TEXT BOOKS:

1. R.C. Goyal, “Hospital Administration and Human Resource Management”, PHI – Fifth Edition, 2010.
2. G.D. Kunders, “Hospitals – Facilities Planning and Management – TMH”, New Delhi” – Fifth Reprint 2007.
3. V. J. Landrum, “Medical Waste Management and disposal, Elsevier”, 1991

REFERENCES:

1. Cesar A. Caceres and Albert Zara, “The Practice of Clinical Engineering, Academic Press, New York, 1977.
2. Norman Metzger, “Handbook of Health Care Human Resources Management”, 2nd edition Aspen Publication Inc. Rockville, Maryland, USA, 1990.
3. Arnold D. Kalcizony & Stephen M. Shortell, “Health Care Management", 6th Edition Cengage Learning, 2011.
4. Thomas A. Mappes and David DeGrazia (editors), Biomedical Ethics, McGraw Hill, 4th Edition, 1996

	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
CO1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
CO2	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-
CO3	-	-	-	-	-	3	-	-	2	-	-	3	-	-	-
CO4	-	1	1	-	-	-	1	1	-	-	-	-	-	-	-
CO5	2	2	-	-	-	2	-	-	-	-	-	3	-	-	-
Avg	**2**	**1.5**	**1**	**-**	**-**	**2.6**	**1**	**1**	**2**	**-**	**-**	**3**	**-**	**-**	**1**

BM19702 MEDICAL INFORMATICS L T P C

3 0 0 3

OBJECTIVES:

- To understand the structure of medical informatics and its systems
- To explore the patient record digitisation techniques
- To study the clinical approaches and advancements in applying informatics using computers in imaging
- Understand the theories and practices adopted in Hospital Information Systems in medical data formats
- Learn ICT applications in medicine with an introduction to health informatics.

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UNIT I 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

UNIT II COMPUTERISED PATIENT RECORD 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.

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 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.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course the students will be able to

- Gain knowledge on the structure of medical informatics an its functioning
- Learn about the clinical information system computerization
- Discuss about automatic computerization in different bio signal acquisition.
- Explain the function of Hospital Information Systems
- Discuss about health informatics and different ICT applications in medicine

TEXT BOOKS:

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.

REFERENCES:

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.

BM19741 DIGITAL IMAGE PROCESSING TECHNIQUES L T P C

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 in the techniques of segmentation, compression and Deep learning techniques for various applications

UNIT I FUNDAMENTALS OF IMAGE PROCESSING 9

Image Analysis and Computer Vision- Overview. Image acquisition system- Film and digital camera. Imaging systems: Image formation and sensing, Image representation, Characteristics of grey-level digital images-Discrete sampling model, Quantization, Relationship between the pixels, Colour fundamentals and models.

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.

UNIT III IMAGE ENHANCEMENT AND RESTORATION 10

Spatial Domain- Basics of Spatial Filtering–Smoothing and Sharpening Spatial Filtering **Frequency Domain**- Introduction to Fourier Transform – 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 a medical image affected by noise

UNIT IV IMAGE SEGMENTATION AND COMPRESSION 8

Segmentation- Detection of discontinuities–Edge linking and boundary detection – Region based segmentation- Morphological processing - erosion and dilation.

Image compression- Introduction- Image compression models, Lossless and lossy compression methods, Image compression standards

Case Study: Segmentation of any medical image and identify the abnormality present

UNIT V IMAGE REPRESENTATION, DESCRIPTION AND DEEP LEARNING TECHNIQUES 9

Boundary representation – Chain Code – Polygonal approximation, signature, boundary segments – Boundary description – Shape number – Fourier descriptor, moments-**Regional Descriptors** –Topological feature, Texture - Patterns and pattern classes – Deep learning applications in image processing.

Case study: Automated recognition of an image and display the output

TOTAL: 45 +30 PERIODS

LIST OF EXPERIMENTS:

1. Image sampling and quantization
2. Intensity transformation of images.
3. Transforms (DFT, DCT, Walsh, Hadamard, Haar)
4. Histogram Processing and Basic thresholding functions
5. Image Enhancement-Spatial filtering
6. Image Enhancement- Filtering in frequency domain
7. Image restoration – Inverse and wiener filtering
8. Basic Morphological operations.
9. Analysis of images with different colour models**.**

OUTCOMES:

On completion of the course 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 segment and restore the images by applying suitable method
- Represent the images by different descriptors for feature selection and recognition based on deep learning techniques.

TEXT BOOKS:

1. SE Umbaugh, "Digital Image Processing and Analysis: Human and Computer Vision Application with CVIP tools", 2nd Edition, CRC Press, 2011
2. Rafael C Gonzalez, Richard E Woods, "Digital Image Processing", 3rd edition, Pearson Education India, ISBN-10: 9332570329

REFERENCES:

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. Anil Jain K. "Fundamentals of Digital Image Processing", PHI Learning Pvt. Ltd., 2011.
5. Mark Nixon Alberto Aguado "Feature Extraction and Image Processing for Computer Vision" 4th Edition.
6. Rafael C Gonzalez, "Digital Image Processing Using MATLAB", Pearson Education India, 2006

	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
CO1	3	3	3	-	3	-	-	1	2	-	2	2	2	3	3
CO2	3	3	3	1	3	-	-	1	2	-	2	2	2	3	3
CO3	3	3	2	-	3	-	-	1	2	-	3	2	2	3	3
CO4	3	3	2	1	3	-	-	1	2	-	3	3	2	3	3
CO5	3	3	2	2	3	-	1	1	2	-	3	3	2	3	3
Avg	3.0	3.0	2.4	1.3	3.0	-	1.0	1.0	2.0	-	2.6	2.4	2.0	3.0	3.0

BM19711 **PROJECT PHASE-I** **L T P C**

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.

TOTAL: 90 PERIODS

OUTCOMES:
On completion of the project phase-I students are capable to overcome the challenges in the final project work.

BM19712 HOSPITAL TRAINING L T P C

0 0 2 1

OBJECTIVES

- Give you the opportunity to observe medical professionals at work in the wards and the roles of Allied Health Professionals;
- Provide access to healthcare Professionals to get a better understanding of their work;
- Demonstrate patient-care in a hospital setting.

S.No.	Departments for visit
1	Cardiology
2	ENT
3	Ophthalmology
4	Orthopaedic and Physiotherapy
5	ICU/CCU
6	Operation Theatre
7	Neurology
8	Nephrology
9	Radiology
10	Nuclear Medicine
11	Pulmonology
12	Urology
13	Obstetrics and Gynecology
14	Emergency Medicine
15	Biomedical Engineering Department
16	Histo Pathology
17	Biochemistry
18	Pediatric/Neonatal
19	Dental
20	Oncology
21	PAC's
22	Medical Records / Telemetry

TOTAL: 30 PERIODS

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 following departments, it is mandatory to complete training in any 10. The students can give a presentation of the remaining departments during laboratory hours.

OUTCOMES:
On completion of the course students will be able to

- Advocate a patient-centred approach in healthcare
- Communicate with other health professionals in a respectful and responsible manner

- Recognize the importance of inter-professional collaboration in healthcare.
- Propose a patient-centred inter-professional health improvement plan based upon the patient's perceived needs
- Use the knowledge of one's own role and those of other professions to address the healthcare needs of populations and patients served

BM19713	COMPREHENSION	L	T	P	C
		1	1	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, Principles of Communication Systems, Biocontrol Systems

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

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

TOTAL: 30 PERIODS

OUTCOMES:

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

SEMESTER VIII

BM19711	PROJECT PHASE-II	L	T	P	C
		0	0	16	8

OBJECTIVES

- Identification of a real life problem in thrust areas
- Developing a mathematical model for solving the real life problem
- 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 8^{th} 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 8^{th} 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

OUTCOMES:

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

TOTAL: 240 PERIODS

PROFESSIONAL ELECTIVES

PROFESSIONAL ELECTIVE – I

BM19P61	MEDICAL OPTICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To establish a basic background of tissue optics
- To employ quantitative approaches to analyze photon-tissue interactions
- To understand the basic principles, capabilities, and limitations of various light microscopy techniques
- To develop the capability of applying the right microscopy technique(s) to address specific biomedical questions

UNIT I FUNDAMENTALS OF TISSUE OPTICS 9

Interaction of Light with Matter-Characteristics of Light-What is Biomedical Optics?-Tissue Optical Properties-Mathematical Models for Light Transport in Turbid Media like Tissues: Radiative Transport Equation: First Order Approximation-Diffusion Approximation-Monte Carlo Modelling, KubelkaMunk Theory-Laser Characteristics-Laser Tissue Interaction-Chemical-Thermal-Electromechanical-Photoabalative Processes.

UNIT II BASIC INSTRUMENTATION IN BIOPHOTONICS 9

Instrumentation for Absorption-Scattering and Emission Measurements, Excitation Light Sources-High pressure Arc Lamp-Light Emitting Diode (LED)-Lasers, Optical Filters-Polarizer**,** Optical Detectors: Single Channel and Multichannel Detectors-Optical Fibers-Time Resolved and Phase Resolved Detection Methods.

UNIT III MEDICAL APPLICATIONS OF LASERS 9

Laser Tissue Welding-Applications of Lasers in: Gynaecology: Treatment of Intraepithelial Neoplasia-Endometriosis-Sterilization-Dermatology and Cosmetics: for Treating Port Wine Stains, Hemangioma-Tattoo and Hair Removal-Laser Skin Resurfacing-Ophthalmology: Surgery of the Cornea-Anterior Chamber Angle-Iris and Lens-Neurosurgery: Concept of Stereotactic Laser Neurosurgery-Dentistry: Treatment of Hard Tissues and Root Canal Treatment.

UNIT IV OPTICAL SPECTROSCOPY AND IMAGING TECHNIQUES 9

Spectroscopy-Definition-Diagnostic Applications of Fluorescence, Raman and Diffuse Reflectance Spectroscopy-Imaging: Basic Principles and Clinical Applications of-Optical Coherence Tomography-Optical Elastography-Fluorescence Microscopy-Basic Principles of: Confocal Microscopy-Photoacoustic Microscopy- Case Study: Application of Optical Coherence Tomography and Fluorescence Spectroscopy

UNIT V ADVANCED METHODS IN BIOMEDICAL OPTICS 9

Fundamentalsof-Surface Enhanced and Coherence Anti-Stokes Raman Spectroscopy (SERS and CARS)-Holographic Imaging-Multiphoton Microscopy-Light Sheet Microscopy-*Stimulated Emission Depletion (*STED) Microscopy-Case Study: Application of Multiphoton Microscopy

TOTAL: 45 PERIODS

OUTCOMES*:*

On completion of the course students will be able to,

- Implement, model, value and verify light-tissue interaction models and apply light-tissue interaction models for diagnostic and therapeutic use
- Describe and choose suitable light sources, detectors and wavelengths applicable to specific medical applications and demands
- 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 BOOKS:

1. Gerd Keiser, "Biophotonics-Concepts to Applications" 1st Edition, Springer, 2016.
2. Irving J. Bigio, Sergio Fantini, "Quantitative Biomedical Optics Theory, Methods, and Applications", 1st Edition, Cambridge University Press, 2016.
3. Markolf H.Niemz, "Laser-Tissue Interaction Fundamentals and Applications", 4th Edition Springer, 2019.
4. Tuan Vo-Dinh, "Biomedical Photonics Handbook", 2nd Edition, Taylor & Francis, 2019.

REFERENCES:

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.

	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**
CO1	3	-	2	2	-	-	-	-	-	-	-	-	3	2	1
CO2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO5	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Avg	**2.75**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**	**1**

BM19P62 **MEDICAL PHYSICS** **L T P C**

3 0 0 3

OBJECTIVES:

- To study the complete non-ionizing radiations interact with matter, how it affects living organisms
- To understand the principles of ultrasound radiation and its applications in medicine

- To learn about radioactive nuclides and also the interactions of radiation with matters and how isotopes are produced
- To know various detectors for detecting the presence of ionizing radiation

UNIT I NON-IONIZING ELECTROMAGNETIC RADIATION 9

Introduction to Electromagnetic (EM) Waves-Tissue as a Leaky Dielectric-Relaxation Processes: Debye Model, Cole-Cole Model- Effects of Non-Ionizing Radiation at Low Frequencies: Properties of Tissue, Neural Effects, and Cardiac Stimulation and High Frequencies: Surgical Diathermy, Heating Effects-Ultraviolet (UV) Radiation: Measurement and Therapy with UV Radiation.

UNIT II ULTRASOUND IN MEDICINE 9

Physics of Sound, Normal Sound Levels-Ultrasound Fundamentals-Generation of Ultrasound-Interaction of Ultrasound with Matter: Cavitation, Reflection, Transmission-Ultrasound Transducers: Piezoelectric Effect, Transducer Design, Transducer Frequency Response-Acquisition Modes: Amode-B mode-M mode-Doppler-Clinical Applications of Ultrasound-Case Study: Application of Ultrasound in Tumour Diagnosis.

UNIT III PRINCIPLES OF RADIOACTIVE NUCLIDES AND DECAY 9

Fundamentals of Radioisotopes - Radioactive Decay : Spontaneous Fission, Isomeric Transition, Alpha Decay, Beta Decay, Positron Decay, Electron Capture-Kinetics of Radioactive Decay: General Equation-Half Life-Mean Life-Effective Half-Life-Natural and Artificial Radioactivity-Production of Radionuclides: Cyclotron Produced Radionuclide-Reactor Produced Radionuclide: Fission and Electron Capture Reaction-Target and its Processing Equation for Production of Radionuclides-Radionuclide Generator-Technetium Generator.

UNIT IV INTERACTION OF RADIATION WITH MATTER 9

Interaction of Charged Particles with Matter: Specific Ionization, Linear Energy Transfer Range, Bremsstrahlung, Annihilation-Interaction of Gamma radiation with Matter: Photoelectric Effect, Compton Scattering, Pair Production: Rayleigh Scattering and Photo-Disintegration-Attenuation of Gamma Radiation-Interaction of Neutron with Matter and their Clinical Significance-Essentials of Radionuclides-Nuclear Medicine Applications: Uptake and Point Measurements-Planar Nuclear Imaging-Emission Computed Tomography.

UNIT V RADIATION DETECTORS 9

General Properties of Detectors-Scintillation Detectors: Solid Scintillation Detectors: Scintillation Materials-Scintillator Sealing and Coupling-Light Sensors: Photomultiplier Tubes and Thin Film Photodiodes-Liquid Scintillation Detectors-Semiconductor Radiation Detectors-Gas Filled Detectors: Ionization Chamber, Proportional Counters, Geiger-Müller Tubes-Fundamentals and Performance Parameters of Gamma Cameras- Basics of Thermoluminescent Dosimeters and Neutron Detectors.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course students will be able to,

- Analyze the low frequency and high frequency effects of non-ionizing radiation and physics of light
- Define various clinical applications based on ultrasound wave
- Explain the process of radioactive nuclide production using different techniques

- Explain the difference between imaging with ionizing and non-ionizing radiation in the context of radiation dosimetry and risk
- Outline different methods of detecting and recording the ionizing radiation and its interaction with matter

TEXT BOOKS:

1. BH Brown, RH Smallwood, DC Barber, PV Lawford and DR Hose, "Medical Physics and Biomedical Engineering", 2nd Edition, IOP Publishers, 2001.
2. Gopal B Saha, "Physics and Radiobiology of Nuclear Medicine", 4thEdition, Springer, 2013.
3. Ehsan Samei and Donald J. Peck , "Hendee's Physics of Medical Imaging", 5thEdition, John Wiley& Sons Inc, 2019.
4. R Hendee and Russell Ritenour, "Medical Imaging Physics", 4th Edition, Wiley-Liss Inc, 2002.

REFERENCES:

1. Muhammed Maqbool, "An Introduction to Medical Physics", Springer, 2017.
2. Ervin B. Podgoršak, "Radiation Physics for Medical Physicists", 3rd Edition, Springer, 2016.

	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
CO1	3	2	-	1	-	-	-	-	-	-	-	3	3	-	-
CO2	3	3	-	3	-	-	-	-	-	-	-	3	3	-	-
CO3	3	3	3	3	3	3	3	1	-	-	2	3	3	3	-
CO4	3	3	3	3	3	2	1	-	-	-	-	3	3	3	-
CO5	3	3	-	3	3	-	-	-	3	-	-	3	-	3	-
Avg	**3**	**2.8**	**3**	**2.6**	**3**	**2.5**	**2**	**1**	**3**	**0**	**2**	**3**	**3**	**3**	**0**

BM19P63 NANOTECHNOLOGY AND APPLICATIONS L T P C

3 0 0 3

OBJECTIVES

- To understand the basic scientific concepts underpinning nanoscience
- To understand the multidisciplinary aspects of synthesizing nanomaterials
- To understand the different types of nanomaterials
- To demonstrate specifically the characterization tools used in nanotechnology.
- To appreciate the emerging role of nanotechnology in society, the regulatory framework within which it operates and the ethical issues it raises.

UNIT I INTRODUCTION 8

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 12

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.

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 EXPERIMENTAL TECHNIQUES 9

Characterization – X- ray diffraction (XRD), Scanning Electron Microscopy, Transmission Electron Microscope, Atomic force microscopy, Scanning Tunneling microscopy (STM), Scanning probe microscopy (SPM), Optical and Raman spectroscopy.

UNIT V NANOTECHNOLOGY IN HEALTH CARE 7

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 defense - environmental application, Health and environmental impacts of nanotechnology.
Case Study: Nano Toxicological Studies.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course students will be able to

- Thorough knowledge of the general principles of physics, chemistry, electronics and biology that play a role on the nanometer scale
- Understanding the essential concepts used in nanotechnology, synthesis and fabrication
- Understanding of materials and their properties at the atomic and nanometer level, including an understanding of the intimate relationship between material scale (nanostructure) and the properties/functionality of materials
- Having a sound grounding knowledge in the characterization techniques
- Demonstrate the socioeconomic impact of nanotechnology and toxicological issues associated with it.

TEXT BOOKS:

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

REFERENCES:

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.

	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
CO1	3	3	3	-	-	-	-		-	-	-	1	3	3	-
CO2	3	3	3	-	-	-	-	-	-	-	-	1	3	3	-
CO3	3	3	2	2	-	2	-		-	-	-	1	3	3	-
CO4	3	3	3	-	-	-	-	-	-	-	-	1	3	3	-
CO5	3	3	2	2	-	2	2	2	-	-	-	1	3	3	-
Avg	**3**	**3**	**2.6**	**0.8**	**-**	**0.8**	**0.4**	**0.4**	**-**	**-**	**-**	**1**	**3**	**3**	**-**

BM19P64 BIOMATERIALS AND APPLICATIONS L T P C

3 0 0 3

OBJECTIVES

- To study the characteristics of Biomaterials and its reaction in the host and understand its degradation mechanism
- To understand different metals and ceramics used as biomaterials
- To study the different polymeric materials and their clinical application and role in drug delivery
- To study the different types of soft and hard tissue implants.
- To understand the concept of biocompatibility and the methods of biomaterial testing

UNIT I INTRODUCTION TO BIO-MATERIALS 9

Definition and classification of bio-materials, Characterization of biomaterials: mechanical properties, surface properties, viscoelasticity. Host reactions to biomaterials: Inflammation, Wound Healing and Foreign Body Response, Failure mechanisms: corrosion, fracture, degradation of Implanted materials in the biological environment.

UNIT II METALLIC AND CERAMIC MATERIALS 9

Metallic implants: Stainless steels, co-based alloys, Ti-based alloys, shape memory alloy, applications. Ceramic implant: bioinert, biodegradable or bio resorbable, bioactive ceramics, applications.

UNIT III POLYMERIC IMPLANT MATERIALS 9

Polymerization, Polyethylene, Clinical study of synthetic polymers, Bioerodible polymers, Blood compatible polymers, Bioactive polymers, Hydrogels; Methacrylates, Drug incorporation polymer gels, Biomedical application of polymers outside the body and temporary in vivo applications.

Case Study: Biodegradable polymers for medicinal applications.

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 TESTING BIOMATERIALS 9

Testing of blood-material interactions: blood compatibility and thrombogenicity, In vitro assessment of tissue compatibility: assay methods - direct contact test, agar diffusion test, elution test, clinical use. In vivo assessment of tissue compatibility: mechanical testing, criteria for assessing acceptability of the tissue response. Sterilization of implants: steam sterilization, EtO sterilization, radiation sterilization.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course students will be able to

- Explain the properties of biomaterials and biomaterial- tissue reaction.
- Identify metals and ceramic implants used for medical applications
- Compare different polymeric materials, their application in biomedical field and its function in drug delivery
- Outline the concept behind the different tissue replacements.
- Demonstrate various testing and evaluation techniques for biomaterials.

TEXT BOOKS:

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.

REFERENCES:

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). https://doi.org/10.1007/s11668-016-0159-1

	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
CO1	3	3	3	-	-	-	-	-	-	-	-	2	3	3	-
CO2	3	3	2	-	-	-	-	-	-	-	-	2	3	3	-
CO3	3	3	3	3	-	-	-	-	-	-	-	2	3	3	-
CO4	3	3	3	3	-	-	-	-	-	-	-	2	3	3	-
CO5	3	3	3	-	-	-	-	-	-	-	-	2	3	3	-
Avg	**3**	**3**	**2.8**	**1.2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**3**	**-**

BM19P65 **NEURAL ENGINEERING** **L T P C**

3 0 0 3

OBJECTIVES

- To discuss the various physiological aspects of nerve impulse generation and Electromyography
- To discuss about the various applications of EEG
- To explore the importance of evoked potentials
- To introduce various methods to study central and peripheral nerve function

UNIT I NERVE EXCITABILITY AND ELECTROMYOGRAPHY 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; Nerve conduction studies, Microneurography and its potential clinical applications. Clinical Electromyography (EMG), Quantitative EMG, Neuromuscular Ultrasound as a compliment to the electrodiagnostic evaluation, Electrophysiologic study of Disorders of Neuromuscular Junction:, H-Reflex and F-Reflex, Blink reflex and other cranial nerve reflexes, Electrophysiological evaluation of movement disorders, Evaluation of autonomic nervous system.

UNIT II ELECTROENCEPHALOGRAPHY 9

Electroencephalography (EEG): General Principles and Clinical Applications, Neonatal and Paediatric 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, Somatosensoryevoked potentials, Diagnostic and therapeutic role of Magnetic stimulation in neurology.

UNIT IV FUNCTIONAL NEUROIMAGING AND COGNITION 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 ELECTROPHYSIOLOGICAL EVALUATION IN SPECIAL SITUATIONS 9

Electrophysiological evaluation of sacral function: Bladder, bowel and sexual function, Vestibular laboratory testing, Polysomnographic evaluation of sleep disorders, Electrophysiologic evaluation of: brain death, patients in the intensive care unit, patients with suspected neurotoxic disorders.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course students will be able to

- Apply nerve excitability in neurological disorders.
- Identify various techniques for evaluating the function of central and peripheral nervous system.
- 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 evaluation in special situations.

TEXT BOOKS:

1. Michael J. Aminoff, et. al., —Aminoff‘ selectro diagnosis in Clinical Neurologyǁ, Sixth Edition, Elsevier Saunders, 2012.
2. Kim E. Baretteet. al., —Ganong‘s review of Medical Physiologyǁ, 24th Edition, McGraw Hill Medical, 2010.

REFERENCES:

1. Eric R. Kandelet. al., —Principles of Neural Scienceǁ, 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 approachǁ. Informa Health Care, 2008.

PROFESSIONAL ELECTIVE – II

BM19P71	SOFT COMPUTING METHODS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To learn the basics of artificial intelligence, various types of production systems, characteristics of production systems.
- To understand the basic principles of fuzzy sets.
- To understand the principles of fuzzy logic, various fuzzy systems and their functions.
- To understand the various machine learning and genetic algorithms
- To implement genetic and fuzzy control algorithms in Matlab and C++

UNIT I INTRODUCTION TO SOFT COMPUTING 9

Evolution of Computing - Soft Computing Constituents – From Conventional AI to Computational Intelligence – Neural Networks - Scope and Evolution – Types of Neural Networks – Feed forward – Supervised Learning– Associative memory – Unsupervised learning – Special

UNIT II FUZZY SETS 9

Fuzzy Sets – Operations–Relations – Rules, Non –interactive fuzzy sets – Fuzzification– Intuition , inference, Rank ordering –Defuzzification – Max-membership principle, centroid method, center of sums, center of largest area.

UNIT III FUZZY MEASURES 9

Fuzzy arithmetic and measures –Fuzzy reasoning – approximate–categorical, qualitative, syllogistic, dispositional – Fuzzy inference systems – fuzzy decision making – individual, multiperson, multi objective, Bayesian – fuzzy logic control system – architecture, model and application

UNIT IV MACHINE LEARNING AND GENETIC ALGORITHM 9

Machine Learning Techniques – Machine Learning Using Neural Nets – Genetic Algorithms (GA) – Simple and General GA – Classification of Genetic Algorithm – Messy, Adaptive, Hybrid, Parallel – Holland Classifier System.

Case Study: Machine learning applications in embedded systems

UNIT V APPLICATION OF SOFT COMPUTING TECHNIQUES 9

Genetic algorithms - Internet Search Techniques –Fuzzy Controllers – Bayesian, Belief networks for Rocket Engine Control – Neural Network, Genetic algorithm and Fuzzy logic implementation in Matlab and C++

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course students will be able

- To use various types of neural network algorithms for training a system
- To apply the principle of fuzzy set methodologies in robotics
- To understand various fuzzy measure algorithms for driving a system.
- To understand the significance of various machine learning and genetic algorithms
- To apply soft computing techniques in real time applications

TEXT BOOKS:

1. S.N. Sivanandam & S.N. Deepa, Principles of Soft Computing, Wiley Publications, 2nd Edition, 2011.
2. S, Rajasekaran & G.A. Vijayalakshmi Pai, Neural Networks, Fuzzy Logic & Genetic Algorithms, Synthesis & applications, PHI Publication, 1st Edition, 2009.

REFERENCES:

1. N.K.Bose, Ping Liang, Neural Network fundamental with Graph, Algorithms & Applications, TMH, 1st Edition, 1998.
2. Bart Kosko, Neural Network & Fuzzy System, PHI Publication, 1st Edition, 2009.
3. Rich E, Knight K, Artificial Intelligence, TMH, 3rd Edition, 2012.
4. George J Klir, Bo Yuan, Fuzzy sets & Fuzzy Logic, Theory & Applications, PHI Publication, 1st Edition, 2009.
5. Martin T Hagen, Neural Network Design, Nelson Candad, 2nd Edition, 2008

	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
CO1	2		2	2	2			1				2	3	1	3
CO2	2		1	2	1			3			2	2	3	1	3
CO3	1		1						2		1	3	2	1	3
CO4	2		2		2			2				2	3	1	3
CO5	2		1						3			3	1	1	3
Avg	1.5	0	1.4	0.8	1.3	0	0	1.2	1.3	0	0.6	2.4	2.4	1	3

BM19P72 REHABILITATION ENGINEERING L T P C

3 0 0 3

OBJECTIVES

- To interactively and effectively introduce students to the field of rehabilitation and discuss the principles of rehabilitation.
- To provide insight into the orthopaedic prosthetics and orthotics in rehabilitation.
- To learn therapeutic Exercise Techniques and Understand types and concepts of wheelchairs.
- To gain knowledge on assist devices for management of communicational impairments.
- To describe the essential principles, methods, and strategies of assessment of individuals with disabilities in VR settings and to gain knowledge of the robotic developments in the field of rehabilitation engineering.

UNIT I FUNDAMENTALS OF REHABILITATION 9

Introduction to Rehabilitation Engineering - Epidemiology of Rehabilitation, Health, Levels of Prevention, Preventive Rehabilitation, Diagnosis of Disability, Functional Diagnosis, Importance of Psychiatry in Functional diagnosis, Impairment disability handicap, Primary & secondary Disabilities-Rehabilitation team, Classification of members-The human component, Principles of Assistive Technology Assessment, Principles of Rehabilitation Engineering- Key Engineering Principles, Key Ergonomic Principles.

UNIT II PROSTHETIC AND ORTHOTIC DEVICES 9

Prosthetics: Hand and Arm replacement, body powered prosthetics, externally powered limb prosthetics, Myoelectric hand and arm prosthetics - FES System: Restoration of hand function; restoration of standing and walking. Hybrid Assistive systems (HAS) Active prostheses. Active Above knee Prosthesis, intelligent hand prosthesis (MARCUS).

Orthotics: General orthotics, Classification of orthotics-functional & regional, General principles of Orthosis, Callipers- FO, AFO, KAFO, HKAFO.

UNIT III THERAPEUTIC DEVICES AND WHEELCHAIRS 9

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.

Wheelchair: History and Categories of Wheelchairs, Seating Assessment, Wheelchair Structure and Component Design, Ergonomics of wheel chair propulsion, Power Wheelchair Electrical System- Wheel chair transportation.

UNIT IV MANAGEMENT OF COMMUNICATION IMPAIRMENTS 9

Speech Impairment: introduction to communication, Aphasia, Types of aphasia, Treatment of aphasic patient.

Visual impairment: Anatomy of eye, Categories of visual impairment - Cortical & retinal implants - Auditory Information Display, Blind mobility aids, reading writing & graphics access, Braille Reader, Tactile devices for visually challenged, Text voice converter, screen readers, Orientation & navigation Aids – Ultra sonic and laser canes.

Auditory impairment: Anatomy of ear – hearing functional assessment, Types of deafness - Surgical and non-surgical hearing aids, Cochlear implants - Assistive technology solutions for hearing Tactile - Information Display, Voice synthesizer, speech trainer – Alternative Augmentative communication.

UNIT V RECENT TRENDS IN REHABILITATION 9

Rehabilitation Robots- Automated gait training devices, Automated training devices for the upper extremities, Devices for arm assistance. Virtual Reality Applications- virtual environments in the treatment of motor skills impairments-VR based tele-rehabilitation. CAD/CAM Application in Rehabilitation- analysis of prostheses and wheelchairs and to the design and production of sockets for amputees, prosthetic implants and custom seating.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course the students will be able to

- Understand the roles of rehabilitation team and decide quality and safety standards in design of devices for user needs.
- Describe the applications of different orthosis and prosthesis for various disabilities.
- Compare and know the different therapeutic exercises to improve person's health and design an orthopaedic wheelchair for physically challenged.
- Interpret the techniques and aids for impairments related to sensory and motor functions.

- Explore the use of Robots and Virtual Reality tool in rehabilitative curative care.

TEXT BOOKS:

1. Rory A, Cooper, Hisaichi Ohnabe, Douglas A, Hodson, "An Introduction to Rehabilitation Engineering", CRC Press, First edition, 2006.
2. Joseph D Bronzino, "The Biomedical Engineering Handbook". 2nd edition, CRC Press, 2000.
3. Sunder 'Textbook of Rehabilitation', Jaypee Brothers Medical Publishers Pvt. Ltd, New Delhi, 2nd Edition, Reprint 2007

REFERENCES:

1. Marion A Hersh, Michael A, Johnson, "Assistive Technology for Visually impaired and blind people", Springer Publications, First edition, 2008.
2. Sashi S Kommu; Rehabilitation Robotics,1 edition, CRC Press, 2007.
3. Suzanne Robitaille, "The illustrated guide to Assistive technology and devices–Tools and gadgets for living independently", Demos Health New York, First edition, 2010.
4. Patrice L. (Tamar) Weiss, Emily A. Keshner, Mindy F. Levin, "Virtual Reality for Physical and Motor Rehabilitation", 2014.
5. https://imotions.com/blog/virtual-reality-rehabilitation

	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
CO1	1	1	2	1	-	2	1	1	1	1	-	-	-	-	1
CO2	3	3	3	2	2	2	2	2	2	1	1	1	3	3	3
CO3	3	3	3	2	2	2	2	2	2	2	1	-	1	2	1
CO4	3	3	3	3	2	2	1	2	2	2	2	1	1	3	2
CO5	2	2	2	2	3	2	3	2	2	2	2	-	1	2	2
Avg	**2.4**	**2.4**	**2.6**	**2**	**1.8**	**2**	**1.8**	**1.8**	**1.8**	**1.6**	**1.2**	**0.4**	**1.2**	**2**	**1.8**

BM19P73 MEDICAL SAFETY AND QUALITY ASSURANCE L T P C

2 0 0 2

OBJECTIVES

- To understand how safety is important for health care systems.
- To know about various electrical and radiation hazardous.
- To know how to assess medical devices and quality of healthcare provided

UNIT I HOSPITAL SAFETY 10

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. Safe handling and operation, Reporting, Bed rails, Flawed mechanics, removable parts and packaging. Personal protective Equipment.

UNIT II ELECTRICAL SAFETY AND RADIOLOGICAL SAFETY 11

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. 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 QUALITY ASSESSMENT IN HEALTHCARE 9

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

TOTAL: 30 PERIODS

OUTCOMES:

On completion of the course the students will be able to

- Gain knowledge about safety devices necessary for health care system can be identified
- Demonstrate various techniques to shield patient from electrical and radiation hazardous.
- Implement the various methods to monitor and assess quality in healthcare

TEXT BOOKS:

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

REFERENCES:

1. Steve Webb, "The Physics of Medical Imaging", Taylor & Francis, New York, 1988.
2. G.D.Kunder, S.Gopinath, A.Katakam, "Hospital Planning, Design and Management", Tata Mcgraw Hil publishers, New Delhi, 1998.
3. Joseph J. Carr and John M. Brown, "Introduction to Biomedical equipment technology", John Willey and sons, New York, 1997.

	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
CO1	3	3	3	-	-	-	-		-	-	-	1	3	3	-
CO2	3	3	3	-	-	-	-	-	-	-	-	1	3	3	-
CO3	3	3	3	-	-	-	-	-	-	-	-	1	3	3	-
Avg	3	3	3	-	-	-	-	-	-	-	-	1	3	3	-

BM19P74 HUMAN VALUES AND MEDICAL ETHICS L T P C

1 0 0 1

OBJECTIVES

- To understand the basics of morals and work ethics and its associated aspects
- To explore the ethical considerations and issues in medical field

UNIT I HUMAN VALUES 7

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 MEDICAL ETHICS AND ISSUES 8

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

TOTAL: 15 PERIODS

OUTCOMES:

On completion of the course the students will be able to

- Demonstrate knowledge on the basic principles and strategies of human morals and ethics
- Develop ethical relationships in medical industry and its applications.

TEXT BOOK:

1. Charles D- Fleddermann- “Engineering Ethics”- Pearson Education / Prentice Hall- New Jersey- 2004 (Indian Reprint) Charles E Harris- Michael S- Protchard and Michael J Rabins- “Engineering Ethics Concepts and Cases”- Wadsworth Thompson Learning- United States- 2000 (Indian Reprint now available).

REFERENCE:

1. John R Boatright- “Ethics and the Conduct of Business”- Pearson Education- New Delhi- 2003.

	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
CO1	3	3	3	-	-	-	-		-	-	-	1	3	3	-
CO2	3	3	3	-	-	-	-	-	-	-	-	1	3	3	-
Avg	3	3	3	-	-	-	-	-	-	-	-	1	3	3	-

PROFESSIONAL ELECTIVE - III

BM19P75	BIOMEMS	L	T	P	C
		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.
- Know the application of MEMS in different field of medicine

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 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 MICROFLUIDIC SYSTEMS 9

Fluid dynamics, continuity equation, momentum equation, equation of motion, laminar flow in circular conduits, fluid flow in microconduits, in submicrometer and nanoscale. Microscale fluid, expression for liquid flow in a channel, fluid actuation methods, dielectrophoresis, microfluid dispenser, microneedle, micropumps-continuous flow system, micromixers.

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, Emerging Bio-MEMS technology: Minimally invasive surgery, Oncology, Tissue Engineering, Biosensors.

Case study: Design of MEMS based Infusion Pump.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course students will be able to

- Describe the various MEMS fabrication techniques.
- Outline different types of mechanical and thermal actuators and sensors**.**
- Explain different types of electrostatic and piezoelectric actuators and sensors**.**
- Analyze the fluid dynamics in Micro conduits and its applications.
- Illustrate various medical applications of MEMS.

TEXT BOOKS:

1. Tai Ran Hsu, "MEMS and Microsystems Design and Manufacture", Tata McGraw Hill Publishing Company, New Delhi, 2002. (Unit I, II, III & IV).
2. Wanjun Wang, Stephen A. Soper, "BioMEMs: Technologies and Applications", CRC Press, New York, 2007. (Unit V).

REFERENCES:

1. Marc J. Madou "Fundamentals of Microfabrication: the Science of Miniaturization", CRC Press, 2002.
2. Nadim Maluf, Kirt Williams. "An introduction to Microelectro Mechancial Systems Engineering", Second Edition, Artech House Inc, MA, 2004.
3. Chang Liu,' Foundations of MEMS', Pearson Education International, New Jersey, USA,2006.
4. Nitaigour Premchand Mahalik, "MEMS", Tata McGraw Hill Publishing Company, New Delhi, 2007.

	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
CO1	1		3		3			1						3	
CO2	1		3		3			1						3	
CO3	1		3		3			1						3	
CO4	1		3		3			1						3	
CO5							2					1			
Avg	**0.8**	**0**	**2.4**	**0**	**2.4**	**0**	**0.4**	**0.8**	**0**	**0**	**0**	**0.2**	**0**	**2.4**	**0**

BM19P76 MEDICAL TEXTILES FUNDAMENTALS L T P C

3 0 0 3

OBJECTIVES

- To understand the technologies of medical textiles
- To understand the general property of fabric materials
- To know the various medical application of textiles.
- To study the development and applications of healthcare nanofibers.
- To explore the various healthcare applications of smart medical textiles.

UNIT I INTRODUCTION TO MEDICAL TEXTILES 10

Characteristics of textile fibers - structures of natural and man-made fibers – physical, chemical and morphological structures. Molecular conformations – planar zig-zag, helical, lamellar, and spherulites conformations. Medical textiles – An overview, classification: Implants, Non implants, Extra corporeal, Health care and hygiene

UNIT II MEDICAL TEXTILE SCIENCE AND TEXTILE COATING 10

Medical textile products, processes and their applications - sutures - bandages - surgical implants - non-surgical implants - extracorporeal devices- non-woven technology - medical textile testing. Testing methods and international standards. Fabric coating: properties - polymer coatings - coating methods - medical applications -lamination.

UNIT III MEDICAL AND HEALTHCARE NANOFIBERS 8

Fabrication of Nanofibers - Biopolymers Used for Nanofibers - Modification of Nanofibers - Biomedical Applications of Nanofibers.

UNIT IV BIOTEXTILES AND WOUND CARE TEXTILES 8

Sutures – Vascular Grafts – Ligament Prosthesis – Hernia Repair Mesh Grafts – Artificial Kidney. Human skin wounds – Wound dressing – Pressure garments

UNIT V SMART MEDICAL TEXTILES AND ITS APPLICATIONS 9

Patient specific smart medical textiles – Smart medical textiles in rehabilitation – Monitoring pregnancy – Monitoring hospitalized children – Wearable textiles for mobile health monitoring.

TOTAL: 45 PERIODS

OUTCOMES

On completion of the course students will be able to

- Demonstrate knowledge on basics of medical textiles.
- Design and apply nanofiber technology in medical textile fabrication.
- Develop different fabrics and technology for specific medical applications.
- Design and implement wearable sensors in the textiles using modern technology.
- Determine new ways to use medical textiles with advancements for patient care.

TEXT BOOKS:

1. Volkmar T. Bartels, “Handbook of Medical Textiles”, Wood head Publishing, 2011.
2. Wen Zong, “An introduction to healthcare and medical Textiles”, DEStech Publications, Inc. 2013.

REFERENCES:

1. Subhash Anand, “Medical textiles and biomaterials for healthcare”, Woodhead, 2006.
2. Van Langenhove, L. (2007), Smart textiles for medicine and healthcare, Wood head publishing Ltd, UK

	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
CO1	-	-	2	-	3	2	1	-	-	-	-	-	-	-	1
CO2	2	-	3	-	3	2	2	-	-	-	-	-	3	3	3
CO3	2	-	3	-	3	2	2	-	-	-	-	-	3	3	3
CO4	2	-	3	-	3	2	2	-	-	-	-	-	3	3	3
CO5	2	-	3	-	3	2	2	-	-	-	-	-	3	3	3
Avg	**2**	**-**	**2.8**	**-**	**3**	**2**	**1.8**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**2.6**

BM19P77 MEDICAL ROBOTICS L T P C

2 0 0 2

OBJECTIVES

- To gain knowledge about the basic concepts of robots and types of robots.
- To understand manipulators, actuators and grippers and sensors.
- To know the various applications of surgical robots.
- To introduce various applications of robotics in rehabilitation.

UNIT I INTRODUCTION OF ROBOTICS 10

Introduction to Robotics and its history, Overview of robot subsystems, Degrees of freedom, configurations and concept of workspace, Automation, Mechanisms and movements, Dynamic stabilization, Actuators and Grippers, Kinematics & Inverse Kinematics, Sensors and controllers.

UNIT II SURGICAL ROBOTICS 10

Da Vinci Surgical System, Image guided robotic systems for focal ultrasound based surgical applications, System concept for robotic Tele-surgical system, Urologic applications, Cardiac surgery, Neuro-surgery, Pediatric and General Surgery, Gynecologic Surgery, Nanorobotics.

UNIT III REHABILITATION ROBOTICS 10

Pediatric Rehabilitation, Portable Robot for Tele-rehabilitation, Prosthetic Devices for Upper Limb Amputees, Machine for Injured Fingers, Exoskeleton-Based Exercisers for the Disabilities of the Upper Arm and Hand, Tremor Suppression, Facial Automaton Tool for People with Autism.

TOTAL: 30 PERIODS

OUTCOMES

On completion of the course students will be able to

- Identify the components required to design a robot.
- Know the utilization of robotics in medical field.
- Understand the basic concepts of rehabilitation robotics

TEXTBOOKS:

1. Nagrath and Mittal, “Robotics and Control”, Tata McGraw-Hill, First edition, 2003.
2. Jacob Rosen, Blake Hannaford & Richard M Satava, “Surgical Robotics: System Applications & Visions”, Springer 2011.

REFERENCES:

1. Howie Choset, Kevin Lynch, Seth Hutchinson, George Kantor, Wolfram Burgard, Lydia Kavraki and Sebastian Thurn, “Principles of Robot Motion: Theory, Algorithms, and Implementations”, Prentice Hall of India, First edition, 2005.
2. Fu.K.S, Gonzalez.R.C., Lee, C.S.G, “Robotics, control”, sensing, Vision and Intelligence, Tata McGraw Hill International, First edition, 2008.
3. Barbara Webb and Thomas Consi. R, “BioRobotics: Methods & Applications”, AAAI Press/MIT Press, First Edition, 2001.
4. Constantinos Mavroidis, Antoine Ferreira, “Nanorobotics: Current approaches and Techniques”, Springer 2011.
5. Sashi S Kommu; Rehabilitation Robotics,1 edition, CRC Press,2007

	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
CO1	3	3	3	-	-	-	-		-	-	-	1	3	3	-
CO2	3	3	3	-	-	-	-	-	-	-	-	1	3	3	-
CO3	3	3	3	-	-	-	-	-	-	-	-	1	3	3	-
Avg	3	3	3	-	-	-	-	-	-	-	-	1	3	3	-

BM19P78 BIOMETRIC SYSTEMS L T P C

2 0 0 2

OBJECTIVES:

- To understand the technologies of fingerprint, iris, face, and speech recognition
- To identify issues in the realistic evaluation of biometrics-based systems.

UNIT I INTRODUCTION TO BIOMETRICS 9

Introduction and background – biometric technologies- passive biometrics –active biometrics - Biometric systems- data acquisition methods – Enrolment – templates – Algorithm – verification – Biometric applications – biometric characteristics -Authentication technologies - Need for strong authentication - Protecting privacy.

UNIT II FINGERPRINT & IRIS SCAN TECHNOLOGY 10

History of fingerprint pattern recognition - General description of fingerprints - Finger print feature processing techniques –fingerprint enhancement – Feature extraction – fingerprint classification – fingerprint matching – Iris scan Introduction, Anatomical and Physiological underpinnings, Components, Sensing, Iris Scan Representation and Matching, Iris Scan Strengths and Weaknesses. Case study on Forensic sciences and finger prints

UNIT III MULTIMODAL BIOMETRICS AND PERFORMANCE EVALUATION 11

Introduction to face recognition, components, Facial Scan Technologies- Face Detection, Face Recognition- Representation and Classification, Voice scan – components, features and model, Introduction to multimodal biometric system - Integration strategies –Architecture – level of fusion – combination strategy – training and adaptability – examples of multimodal biometric systems – Performance evaluation and quality assessment. Case study on Aadhaar –Unique Identification System of India, implementation and challenges

TOTAL: 30 PERIODS

OUTCOMES:

On completion of the course the students will be able to

- Choose a biometric for specific application
- Design a simple authentication system
- Implement multimodal biometric system in real time.

TEXTBOOKS:

1. James Wayman, Anil Jain, DavideMaltoni, Dario Maio, “Biometric Systems, Technology Design and Performance Evaluation”, Springer, 2005
2. S.Y. Kung, S.H. Lin, M.W.Mak, “Biometric Authentication: A Machine Learning Approach”Prentice Hall, 2005

REFERENCES:

1. Paul Reid, “Biometrics for Network Security”, Pearson Education, 2004.
2. Nalini K Ratha, Ruud Bolle, “Automatic fingerprint Recognition System”, Springer, 2003
3. L C Jain, I Hayashi, S B Lee, U Halici, “Intelligent Biometric Techniques in Fingerprint and Face Recognition” CRC Press, 1999.
4. John Chirillo, Scott Blaul, “Implementing Biometric Security”,John Wiley, 2003.
5. Arun A. Ross, Karthik Nanda Kumar, Anil K. Jain, “Handbook of Multibiometrics”, Springer, 2006.

	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
CO1	3	3	3	-	-	-	-		-	-	-	1	3	3	-
CO2	3	3	3	-	-	-	-	-	-	-	-	1	3	3	-
CO3	3	3	3	-	-	-	-	-	-	-	-	1	3	3	-
Avg	3	3	3	-	-	-	-	-	-	-	-	1	3	3	-

BM19P79 ENTREPRENEURSHIP IN BIOMEDICAL ENGINEERING L T P C

1 0 0 1

OBJECTIVES

- To understand the characteristics and functions of an entrepreneur.
- To know about various components of an effective business model.
- To gain knowledge in financing and marketing strategies.

UNIT I INTRODUCTION TO ENTREPRENEURSHIP 8

Definition - characteristics and functions of an entrepreneur - common myths about entrepreneurs - importance or entrepreneurship. Creativity and innovation: The role of creativity - the innovation process - sources of new ideas - 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.

UNIT II FINANCING & MARKETING 7

Determining financial needs - sources of financing - 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.

TOTAL: 15 PERIODS

OUTCOMES:

On completion of the course students will be able to

- Write effective business plan to become a successful entrepreneur.
- Identify the sources of finance for start-ups

TEXT BOOKS:

1. Robert D Hisrich, Michael P Peters & Dean Shepherd, “Entrepreneurship”, Tata McGrawHill, 2007.
2. Donald F.Kuratko and Richard M.Hodgetts, “Entrepreneurship”, South-Western/Cengage Learning, 2008.

REFERENCES:

1. Thomas W.Zimmerer, Norman M.Scarborough, Essentials of Entrepreneurship and Small Business Management, Prentice Hall of India, 2009.
2. Marc J Dollinger, Entrepreneurship - Strategies and Resources, Pearson Education, 2003.
3. Mary Coulter, Entrepreneurship in Action, Prentice Hall of India, New Delhi, 2006.

	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
CO1	3	3	3	-	-	-	-		-	-	-	1	3	3	-
CO2	3	3	3	-	-	-	-	-	-	-	-	1	3	3	-
Avg	3	3	3	-	-	-	-	-	-	-	-	1	3	3	-

PROFESSIONAL ELECTIVE – IV

BM19P81	PHYSIOLOGICAL MODELING	L	T	P	C
		2	0	2	3

OBJECTIVES

- Study the properties of physiological systems.
- Understand and appreciate the value and application of Physiological models and Vital organs.
- Model dynamically varying physiological system.
- Understand methods and techniques for stability analysis of dynamic models.
- Develop differential equations to describe the dynamic models, simulate and visualize, dynamic responses of physiological models using software.

UNIT I INTRODUCTION 6

Introduction to physiological system modeling – classification of model – grey box & black box, parametric & non parametric, lumped & distributed models, linear & non-linear, characteristics of models. System properties- Resistance, Compliance & their analogy.

UNIT II TIME DOMAIN ANALYSIS 6

Time domain analysis – Introduction to first order and second order model -Respiratory mechanics – open loop and closed loop model of lung mechanics – First order model – impulse and step response – Second order model – Impulse response – undamped, under damped, critically damped, and over damped behaviour – Method of obtaining step response from impulse response – Transient response descriptors – Model of neuromuscular reflex motion.

UNIT III FREQUENCY DOMAIN ANALYSIS 6

Frequency response analysis of linearized lung mechanics, circulatory control system, glucose insulin regulation.

UNIT IV STABILITY ANALYSIS 6

Stability and transient response, Methods to find the stability, Stability Analysis of the Pupillary Light Reflex, Model of Cheyne-Stokes Breathing.

UNIT V NON LINEAR ANALYSIS 6

The Hodgkin Huxley model, Model of Cardiovascular Variability, Model of Circadian Rhythms, Eye movement model.

THEORY: 30 PERIODS

PRACTICAL EXPERIMENTS

1. Introduction to simulation.
2. Simulation of Simple Lung Mechanics Model.
3. Simulation of Neuromuscular Reflex Model.
4. Simulation of Blood Circulatory Model.
5. Stability analysis of Cheyne-Stokes breathing model.

TOTAL: 30+30= 60 PERIODS

LAB EQUIPMENT FOR A BATCH OF 30 STUDENTS

List of software required:

1. MATLAB with Simulink Tool Box or Equivalent Open Source Software in desktop systems -15Nos

OUTCOMES:

On completion of the course students will be able to

- Explain application of Physiological models.
- Model dynamically varying physiological system.
- Discuss methods and techniques to analyze and synthesis dynamic models.
- Develop differential equations to describe the dynamic models, simulate and visualize.
- Implement physiological models using software to get dynamic responses.

TEXT BOOKS:

1. MichealC.K.Khoo, "Physiological Control System" Analysis, Simulation and Estimation".- Prentice Hall of India , New Delhi , 2001
2. William B. Blesser, "A System Approach to Biomedicine", Mc Graw Hill Book Co., New York, 1969

REFERENCES:

1. ManfreoClynes and John H.Milsum, "Biomedical Engineering System", McGraw Hill and Co., NewYork , 1970.
2. Benjamin C Kuo, —Automatic control systems ll, Tenth Edition, McGraw-Hill Education, 2017.
3. Richard Skalak and Shu Chien, "Hand Book of Biomedical Engineering", Mc Graw Hill and Co.New York, 1987.
4. Douglas S.Rigg., "Control Theory and Physiological Feedback Mechanism", The Wilkliam and Wilkins Co. Baltimore, 1970.

	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
CO1	3	3										2		2	
CO2		3	3	2	3								3	3	
CO3		3	3	3	2										
CO4	3	3													
CO5					3									3	
Avg	**1.2**	**2.4**	**1.2**	**1**	**1.6**							**0.4**	**0.6**	**1.6**	

BM19P82 EMBEDDED SYSTEMS AND APPLICATION DEVELOPMENT L T P C

3 0 0 3

OBJECTIVES:

- To introduce the basics of embedded systems in ROTS.
- To have exposure on the various embedded networking tools and their operations.
- To educate in various embedded system development strategies.
- To introduce the knowledge of various processor and scheduling algorithms.
- To learn the real time implementation of embedded application programs, hardware design and tools.

UNIT I INTRODUCTION TO EMBEDDED DEVELOPMENT STRATEGIES 9

Introduction – The build process of embedded systems – software and hardware selection process for ES – Structural units and memory devices – DMA – Timer and counter devices – Watch dog timer – Real time clock – In circuit emulator – Target hardware debugging.

UNIT II EMBEDDED NETWORKING 9

Introduction – I/O device ports and busses – Serial bus communication protocols – RS232 standard – RS422 – RS485 – CAN bus – serial peripheral interface (SPI) – Inter integrated circuits (I2C) – Need for device drivers.

UNIT III RTOS BASED EMBEDDED SYSTEM DESIGN 10

Introduction to basic concepts of RTOS – Task, Processes and Threads, interrupt routines in RTOS, Multiprocessing and Multitasking, Pre-emptive and non- pre-emptive scheduling, Task communication shared memory, Message passing, Inter processes communication – Synchronization between processes – semaphores, Mail box, pipes, priority inversion, priority inheritance.

UNIT IV ARM CORTEX M4 MICROCONTROLLER 8

STM32407xx – Architecture – Embedded flash and SRAM clocks and setup – Real time clock (RTC) - Timer and watch dogs – PC – USART – SPI – SDIO.

UNIT V EMBEDDED 'C' PROGRAMMING 9

Introduction to IDE – Embedded C data types – Programming structure – reading and writing data from/to parallel ports – Timer counter programming – Interrupt handling – Serial port programming – Design of calculator program using RS232 port and Digital thermometer with high alarm output using STM32407xx.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course the students will be able to

- Acquire knowledge about embedded systems and processors and their application.
- Demonstrate knowledge on networking protocols and its applications
- Develop advanced techniques using the concept of RTOS in embedded systems.
- Design and develop new architectures of ARM cortex M4 microcontroller and its peripheral devices.
- Demonstrate sound knowledge on embedded software tool and design the real time embedded systems.

TEXT BOOKS:

1. Wayne Wolf, "Computers as Components: Principles of Embedded computing system Design", Morgan Kaufman Publishers, 2008.
2. Lyla B Das, "Embedded systems- An Integrated Approach", Pearson, 2013.
3. Jane.W.S. Liu, "Real-Time systems", Pearson Education Asia, 2000.
4. ARM Cortex M4 (STM32407xx) Data sheet, ST Microelectronics.

REFERENCES:

1. Valvano "Embedded Microcomputer Systems" Thomson Asia PVT LTD first reprint 2001.
2. Elicia White, "Making Embedded Systems", O' Reilly series, SPD, 2011.
3. Rajkamal, "Embedded System-Architecture, Programming, Design', Mc Graw Hill, 2013.
4. Microcontroller Projects in C for the 8051, By Dogan Ibrahim., Published by Newnes. Edition 2000.

	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
CO1	1	-	1	-	-	-	-	-	-	-	-	-	-	1	3
CO2	1	-	3	-	-	-	-	-	-	-	-	-	2	-	3
CO3	1	-	3	-	3	-	-	-	-	-	-	-	2	-	3
CO4	-	-	-	-	-	-	-	-	-	-	-	-	-	2	3
CO5	-	-	-	-	3	-	-	-	-	-	-	-	-	3	3
Avg	**1**	**-**	**2.6**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**3**

BM19P83 BIOELECTROMAGNETISM AND COMPATIBILITY L T P C

2 0 0 2

OBJECTIVES:

- To understand behaviour of EMF with respect to time and its impact on medical devices
- To gain knowledge on the electric impedances of living tissues: dielectric and conductive properties of biological media

UNIT I TIME VARYING ELECTRIC AND MAGNETIC FIELDS 10

Faraday's law, Transformer and Motional Induction, Maxwell's equation from Faraday's law, Self and Mutual Inductance, Displacement current, Maxwell's equation from Ampere's law and its in consistency, Boundary relation, Poynting Vector, Comparison of field and circuit theory, Circuit application of Pointing Vector.

UNIT II ELECTROMAGNETIC RADIATION AND ITS INTERACTION WITH BIOLOGICAL SYSTEMS 10

Electrical properties of human system – conductivity, permittivity, impedance; human body as volume conductor, source field models, inductive power transfer in implanted devices, RF/microwave interaction mechanism with human system and its effects, therapeutic applications of microwaves.

UNIT III ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY IN MEDICAL EQUIPMENTS 10

EMI-EMC definitions and Units of parameters; Sources and victim of EMI; Conducted and Radiated EMI Emission and Susceptibility, EM coupling, EMI control -Shielding, filtering and grounding, Standards for medical devices - ISO 14117:2012, IEC 60601-1-2, testing Case study on EM interference during MR imaging

TOTAL: 30 PERIODS

OUTCOMES:

On completion of the course students will be able to

- Apply the principles of EMF in real time
- Identify various causes and effects of EM interference in living body
- Design compatible circuits that could prevent medical devices from showing wrong results

TEXT BOOKS:

1. Clayton R.Paul, "Introduction to Electromagnetic Compatibility", John Wiley Publications, 2008
2. Bioelectromagnetism–"Principles and Applications of Bioelectric and Biomagnetic Fields" by Jaakko Malmivuo, Oxford University press, 1995

REFERENCES:

1. John D. Kraus & Keith R. Carver, "Electromagnetics", McGraw-Hill Inc. 1973

2. Edward Conrad Jordan, Keith George Balmain, “Electromagnetic waves and radiating systems”, Prentice Hall, 1968.
3. Andre Vander Vorst, Arye Rosen, Youji Kotsuka, John Wiley & Sons, “RF/Microwave Interaction with Biological Tissues”, Inc., 2006.

	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
CO1	3	3	3	-	-	-	-		-	-	-	1	3	3	-
CO2	3	3	3	-	-	-	-	-	-	-	-	1	3	3	-
Avg	3	3	3	-	-	-	-	-	-	-	-	1	3	3	-

BM19P84 TELEHEALTH TECHNOLOGY L T P C

1 0 0 1

OBJECTIVES

- Understand the key principles for Telehealth.
- Learn various technologies and standards related to telehealth
- Learn the applications of telemedicine in health care domain
- Understand the concepts of multimedia and their role in healthcare
- Learn the concepts of maintaining clinical data and data encryption

UNIT I FUNDAMENTALS OF TELEMEDICINE 7

History of telemedicine, definition of telemedicine, tele-health, tele-care, scope, Telemedicine Systems – Functional diagram, benefits & limitations of telemedicine, Applications of Telemedicine - Teleradiology, telepathology, telecardiology, teleoncology, teledermatology, telesurgery, e Health and Cyber Medicine.

UNIT II TELEMEDICINE TECHNOLOGIES 8

Principles of Multimedia - Audio, video, still images, text and data, fax-type of communications and network: PSTN, POTS, ANT, ISDN, internet, air/ wireless communications, GSM satellite, micro wave, Mobile health and ubiquitous healthcare. Internet technology and telemedicine using world wide web (www). Clinical data – local and centralized, PACS architecture. Encryption, Cryptography.

TOTAL: 15 PERIODS

OUTCOMES:

On completion of the course students will be able to

- Apply the concepts of multimedia technologies in telemedicine
- Apply the fundamentals of telemedicine in prototype development and implement the concepts of telemedicine for various applications

TEXT BOOKS:

1. Norris A C, “Essentials of Telemedicine and Telecare”, John Wiley, New York, 2002.
2. H K Huang, “PACS and Imaging Informatics: Basic Principles and Applications” Wiley, New Jersey, 2010.
3. Khandpur R S, “Telemedicine – Technology and Applications”, PHI Learning Pvt Ltd., New Delhi, 2017.

REFERENCES:

1. Wootton R. Craig, J., Patterson, V. (Eds.), Introduction to Telemedicine. Royal Society of Medicine Press Ltd (ISBN 1853156779), 2006.

2. Keith J Dreyer, Amit Mehta, James H Thrall, “Pacs: A Guide to the Digital Revolution”, Springer, New York, 2002.
3. Olga Ferrer Roca, Marcelo Sosa Iudicissa, “Handbook of Telemedicine”, IOS Press, Netherland, 2002.
4. Bemmel, J.H. van, Musen, M.A. (Eds.) (1997). Handbook of Medical Informatics. Heidelberg, Germany: Springer. (ISBN 3-540-63351-0)

	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**
CO1	3	1	-	-	-	-	-	-	-	-	-	-	2	-	3
CO2	3	1	-	-	-	-	-	-	-	-	-	-	2	-	3
Avg	**3**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**3**

PROFESSIONAL ELECTIVE – V

BM19P85	HEALTHCARE PRODUCT DEVELOPMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To give an exposure to the basic concept of engineering design
- To make the students understand various clinical requirements
- To make the students understand the various steps and constraints involved in developing medical device

UNIT I BASICS ON PRODUCT DEVELOPMENT 9

Need for developing products – the importance of engineering design – types of design –the design process – relevance of product lifecycle issues in design –designing to codes and standards- societal considerations in engineering design –generic product development process – various phases of product development-planning for products –establishing markets- market segments- relevance of market research.

UNIT II IDENTIFICATION OF CLINICAL NEEDS 9

Market survey, Conceptualising the solution to clinical requirement, Researching the disease state – anatomy, physiology, pathophysiology, epidemiology, present pathways, setbacks, Feasibility screening – finance, technical and market, New technologies – brainstorming, literature and R&D forums, Ways of implementation.

UNIT III ENGINEERING SOLUTION TO CLINICAL NEEDS 9

Document sketching, Modeling – software and physical, Model for all strategies, Testing and clinical correlation, Material selection – sensors, actuators, Instrumentation circuit design, Interface selection, Output visualisation and calibration Case study: To identify a real time problem and to propose suitable engineering solution.

UNIT IV REGULATORY AND ETHICAL ISSUES 9

Regulations and standards involved in the design – CE mark and FDA, Regulatory bodies in India, Biocompatibility of the test probes, ISO 14155 standards for clinical investigations, Steps for getting FDA approval, Function and role of ethical committee, Medical ethics proposed by ICMR.

UNIT V MARKETING STRATEGY 9

Post market Surveillance and its role in design, Various tools – Process control chart, bathtub curve, Weibull plot, Measles chart, Pareto analysis, Exploring various contacts – early adopters, focus groups, conference, Vigilance, Promotion through media, Comparison with existing products – merits and demerits.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course the students will be able to

- Analyse various strategies in product development
- Identify clinical need
- Provide engineering solution for medical applications
- Abide regulatory and ethical norms

- Develop product that suits market requirements

TEXT BOOKS:

1. Beth Ann Fiedler, Managing medical devices within a regulatory framework, Elsevier, 2017
2. Benjamin Blass, Basic Principles of Drug Discovery and Development, 1st Edition, Elsevier.
3. Ezekiel J. Emanuel, Ethical and Regulatory Aspects of Clinical Research: Readings and Commentary, 1st Ed., The Johns Hopkins University Press; first Edition, 2003.
4. Davis, Organizational Behavior, Tata McGraw Hill, Eleventh Edition, New Delhi, 2005.
5. Ira R. Berry, the Pharmaceutical Regulatory Process (Drugs and the Pharmaceutical Sciences), First Edition. Informa HealthCare, 2004.

.

REFERENCES:

1. Peter J. Ogrodnik, Medical Device Design Innovation from Concept to Market, Elsevier, 2013
2. Des O'brien, Medical Device Regulations Roadmap: A Beginners Guide, 2017
3. Richard C. Fies, Handbook of Medical Device Design, CRC Press, 2000.

	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
CO1	1	-	1	-	-	-	-	-	-	-	-	-	-	1	3
CO2	1	-	3	-	-	-	-	-	-	-	-	-	2	-	3
CO3	1	-	3	-	3	-	-	-	-	-	-	-	2	-	3
CO4	-	-	-	-	-	-	-	-	-	-	-	-	-	2	3
CO5	-	-	-	-	3	-	-	-	-	-	-	-	-	3	3
Avg	**1**	**-**	**2.6**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**3**

BM19P86 VIRTUAL REALITY IN MEDICAL APPLICATIONS L T P C

2 0 0 2

OBJECTIVES:

- To understand the basics of virtual reality and its associated technologies
- To explore the VR application in education and future scopes of VR
- To study the clinical approaches and advancements in applying VR for patient care

UNIT I INTRODUCTION TO VIRTUAL REALITY 11

History of VR - The three I's of virtual reality- the five classic components of a VR system - Input Devices: Trackers, Navigation, 3D position trackers, navigation and manipulation interfaces, Gesture Interfaces -Output Devices: Graphics displays, sound displays, and haptic feedback.

UNIT II VIRTUAL REALITY IN REHABILITATION AND SURGERIES 10

Rehabilitation for PTSD - Parkinson's disease - Neuro rehabilitation - treatment for Phobias - Rehabilitation for elderly and general trauma patients. VR surgical simulators, telepresence surgery and its benefits - Robotic surgeries - Pre-op patient preparation and education- Pain management

UNIT III VIRTUAL REALITY IN EDUCATION AND ITS FUTURE 9

Complex medical data visualization using VR and AR - academic training - Emergency training - Medical conferences. VR health and safety issues - cyber sickness -side effects of exposures to virtual reality environment. Future of Augmented virtuality and its applications.

TOTAL: 30 PERIODS

OUTCOMES:

On completion of the course the students will be able to

- Demonstrate knowledge on the basic principles and building blocks of virtual reality.
- Develop advanced techniques of VR for more medical applications.
- Design various safe and user friendly VR devices for patients.

TEXT BOOKS:

1. C. Burdea & Philippe Coiffet, “Virtual Reality Technology”, Second Edition, Gregory, John Wiley & Sons, Inc.,2008.
2. James Roland, “Virtual Reality and Medicine”, Referencepoint Press, 2017.
3. Le, Chung Van, Le, Dac-Nhuong, Nguyen, Nhu Gia, Tromp, Jolanda G, “Emerging technologies for health and medicine: virtual reality, augmented reality, artificial intelligence, internet of things, robotics, industry 4.0”, John Wiley & Sons ; Salem, 2018.

REFERENCES:

1. William R.Sherman, Alan Craig, “Understanding Virtual Reality, interface, Application and Design”,Elsevier, Morgan Kaufmann, 2002.
2. Alan Craig, William R. Sherman, Jeffrey D. Will, “Developing Virtual Reality Applications: Foundations of Effective Design” , Morgan Kaufmann, 2009.
3. Peters, Terry M, “Mixed and augmented reality in medicine”, CRC Press,2019.
4. John Vince, “Virtual Reality Systems”, Pearson Education, 2007
5. https://www.google.co.in/books/edition/Using_VR_in_Medicine/s63XDwAAQBAJ?hl=en&gbpv=0&kptab=overview

	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
CO1	-	-	2	-	3	2	1	-	-	-	-	-	-	-	1
CO2	2	-	3	-	3	2	2	-	-	-	-	-	3	3	3
CO3	2	-	3	-	3	2	2	-	-	-	-	-	3	3	3
Avg	**2**	**-**	**2.6**	**-**	**3**	**2**	**1.6**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**2.3**

BM19P87 WEARABLE SYSTEMS L T P C

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
- 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, E-Textiles, Bio compatibility. 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.

UNIT III REAL TIME WEARABLE DEVICES **10**

Medical Diagnostics, Medical Monitoring-Patients with chronic disease, Hospital patients, Elderly patients, Multi parameter monitoring, Neural recording, Gait analysis, Sports Medicine, Smart Fabrics

TOTAL: 30 PERIODS

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 BOOKS:

1. Annalisa Bonfiglio, Danilo De Rossi, "Wearable Monitoring Systems", Springer, 2011.
2. Sandeep K.S. Gupta, Tridib Mukherjee, Krishna Kumar Venkatasubramanian, "Body Area Networks Safety, Security, and Sustainability," Cambridge University Press, 2013.

REFERENCES:

1. Hang, Yuan-Ting,"wearable medical sensors and systems",Springer-2013
2. Mehmet R. Yuce,Jamil Y.Khan, "Wireless Body Area Networks Technology, Implementation and Applications",Pan Stanford Publishing Pvt.Ltd, Singapore, 2012
3. Guang-Zhong Yang(Ed.), "Body Sensor Networks, "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

	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
CO1	3	3	3	2	2	3	-	-	1	-	-	2	3	2	1
CO2	3	3	2	1	2	3	-	-	1	-	-	2	3	1	2
CO3	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**

BM19P88 INTERNET OF THINGS IN MEDICINE L T P C

1 0 0 1

OBJECTIVES

- To learn how the general Internet as well as Internet of Things works.
- To understand the computing tools used for Internet of Things.
- To know the applications of IoT in healthcare.

UNIT I BASICS OF IOT, NETWORKING & COMPUTING 8

IoT-An Architectural Overview, Devices and gateways, Local and wide area networking, Building a network – Requirements - Layering and protocols - Internet Architecture – Network software – Performance ; Link layer Services - Framing - Error Detection - Flow control, Fundamentals of Wireless Communication Technology, Introduction to Mobile Computing– Cloud computing

UNIT II IOT IN HEALTHCARE 7

Introduction to Raspberry Pi – Implementation of IoT with Raspberry Pi – Wearable Technologies and IOT - Electronic tattoos - Smart lenses for diabetics - Bio-monitoring drugs - AliveCor - eCall - Remote monitoring - Aging in place - Wireless patient Monitoring - Virtual consultation .

TOTAL: 15 PERIODS

OUTCOMES:

On completion of the course students will be able to

- Identify the required components and build different types of networks
- Apply IoT in medical field.

TEXT BOOKS:

1. Olivier Hersent , David Boswarthick , Omar Elloumi, “The Internet of Things: Key
2. Applications and Protocols”, John Wiley and Sons Ltd, 2012.
3. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan , “From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence”, Elsevier Ltd, 2014

REFERENCES

1. Prasant Kumar Pattnaik, Rajib Mall, “Fundamentals of Mobile Computing”, PHI Learning Pvt. Ltd, New Delhi – 2012.
2. Larry L. Peterson, Bruce S. Davie, “Computer Networks: A systems approach”, Fifth Edition, Morgan Kaufmann Publishers, 2011.

	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
CO1	3	1	-	-	-	-	-	-	-	-	-	-	2	-	3
CO2	3	1	-	-	-	-	-	-	-	-	-	-	2	-	3
Avg	**3**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**3**