SETHU INSTITUTE OF TECHNOLOGY

PULLOOR, KARIAPATTI – 626115

(An Autonomous Institution

Affiliated to Anna University Chennai)

B.E. BIOMEDICAL ENGINEERING

CURRICULUM & SYLLABUS

REGULATIONS 2019

CHOICE BASED CREDIT SYSTEM

(Applicable to candidates admitted in the Academic Year 2019 - 2020)

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Chairman
Board of Studies

Chairperson
Board of Studies
Bio Medical Engineering
Sethu Institute of Technology
Kariapatti - 626 115.

Chairman
Academic Council

CHAIRMAN
ACADEMIC COUNCIL
Sethu Institute of Technology
Pulloor, Kariapatti - 625 115

PROGRAMME: B.E. BIOMEDICAL ENGINEERING

VISION

To provide high quality technical education and to become a Centre of Excellence in education and research in Biomedical Engineering ensuring quality healthcare services.

MISSION

- Providing quality technical education to enable the students to meet the industrial needs.
- Adapting innovative teaching methodologies to produce competent technocrats.
- Facilitating the students towards employability and entrepreneurship.
- Promoting Industry Institute Interaction to enable new technologies.
- Enriching the student's technical competence in research and development.
- Serving the society by conducting research to improve health care services.

PROGRAMME EDUCATIONAL OBJECTIVES:

Our graduates will

PEO-1: Demonstrate their skills in solving challenges in health care by the knowledge acquired in engineering. **(Technical Competence)**

PEO-2: Exhibit leadership; make decisions with societal and ethical responsibilities effectively in multidisciplinary settings. **(Life-Long Learning)**

PEO-3: Recognize the need for sustaining and expanding their technical competence throughout their careers. **(Professionalism)**

PROGRAMME OUTCOMES:

The graduates of Biomedical Engineering Program will have an ability to:

PO-1: Apply knowledge of basic science, Biomedical, Mathematics and Engineering to solve the solution of complex engineering problems. **(Engineering knowledge)**

PO-2: Identify, formulate and analyze complex problems in the field of biomedical engineering using principles of mathematics, natural, biological and engineering sciences. **(Problem Analysis)**

PO-3: Design components, systems, or processes to meet the medical and health care needs within realistic constraints of economic, safety, cultural, societal, ethical and environmental considerations. **(Design and Development of Solutions)**

PO-4: Use research-based knowledge and research methods including design of medical equipments, analysis and interpretation of medical data, and synthesis of the information to provide valid conclusions. **(Conduct investigations of complex problems)**

PO-5: Use the techniques and skills to develop products such as artificial organs, prostheses medical information system that solve medical and health related problems by combining their knowledge of biology and medicine with engineering principles and practices. **(Modern Engineering Tools)**.

PO-6: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the biomedical engineering practice. **(Engineer and Society)**.

PO-7: Understand the impact of the biomedical engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development. **(Environment and sustainability)**

PO-8: Apply ethical principles and commit to professional ethics, responsibilities and norms of the engineering practice. **(Ethics)**

PO-9: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings. **(Individual and Team Work)**.

PO-10: 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. **(Communication)**.

PO-11: 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. **(Project Management and Finance)**

PO-12: Recognize the need for, and prepare to engage in independent and life-long learning in the broadest context of technological change and contemporary issues. **(Life-long learning)**

PROGRAMME SPECIFIC OUTCOMES:

PSO-1: Analyze, design and develop the systems to supplement and / or assist human healthcare.

PSO-2: Develop the mathematical model to understand the inter-relation among various Physiological systems.

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Pulloor, Kariapatti - 626 115

(An Autonomous Institution)

B.E. Degree Programme

CHOICE BASED CREDIT SYSTEM

CURRICULUM

Regulation 2019

Bachelor of Engineering in Biomedical Engineering

OVERALL COURSE STRUCTURE

S.No.	Course Category	Total No. of Courses	Credits	Percentage
1	Humanities and Social Sciences (HS)	7	13.5	7.63 %
2	Basic Science courses (BS)	9	27.5	15.54 %
3	Engineering Science courses (ES)	8	21	11.86 %
4	Professional Core courses (PC)	28	70	39.55 %
5	Professional Elective (PE)	6	18	10.17 %
6	Open Elective (OE)	4	12	6.78 %
7	Project work (P)	5	15	8.47 %
8	Mandatory Courses (MC)	5	--	--
TOTAL		72	177	100

COURSE CREDITS - SEMESTER WISE

Branch	I	II	III	IV	V	VI	VII	VIII	TOTAL
BME	23	20.5	22	25.5	25.5	25	21.5	14	177

SEMESTER I

S.No.	Course Code	Course Title	Course Category	L	T	P	C
THEORY							
1.	19UEN101	English for Technical Communication (Common to ALL Branches)	HS	2	0	0	2
2.	19UMA102	Engineering Mathematics – I (Common to ALL Branches)	BS	3	1	0	4
3.	19UPH103	Engineering Physics (Common to ALL Branches)	BS	3	0	0	3
4.	19UCY105	Applied Chemistry (Common to ECE, EEE, CSE, IT, BME & BT)	BS	3	0	0	3
5.	19UCS108	Problem Solving and Python Programming (Common to ALL Branches)	ES	3	0	0	3
6.	19UME109	Engineering Graphics (Common to ALL Branches)	ES	3	1	0	4
PRACTICAL							
7.	19UCS110	Problem Solving and Python Programming Laboratory (Common to ALL Branches)	ES	0	0	3	1.5
8.	19UCS112	Engineering Fundamentals Laboratory (Common to ECE, CSE, IT, BME & BT)	ES	0	0	3	1.5
9.	19UGS113	Basic Sciences Laboratory (Common to ALL Branches)	BS	0	0	2	1
MANDATORY							
10.	19UGM131	Induction Program (Common to ALL Branches)	MC	0	3	0	P/F
			Total	17	5	8	23
Total Credits : 23							

SEMESTER II

S.No.	Course Code	Course Title	Course Category	L	T	P	C
THEORY							
1.	19UEN201	Communication Skills for Professionals (Common to ALL Branches)	HS	1	0	1	1.5
2.	19UMA207	Calculus, Complex Analysis and Transform Techniques (Common to AGRI, CHE, BME &BT)	BS	3	1	0	4
3.	19UPH204	Biomaterial Physics (Common to BME & BT)	BS	3	0	0	3
4.	19UCY204	Environmental Science (Common to ALL Branches)	HS	3	0	0	3
5.	19UBM205	Introduction to Biomedical Engineering	ES	3	0	0	3
6.	19UBM206	Electrical Circuits and Measurements	ES	3	0	0	3
PRACTICAL							
7.	19UGS210	Energy and Environmental Science Laboratory (Common to ALL Branches)	BS	0	0	3	1.5
8.	19UBM211	Electrical Circuits Laboratory	ES	0	0	3	1.5
			Total	16	1	7	20.5
Total Credits : 20.5							

SEMESTER III

S.No.	Course Code	Course Title	Course Category	L	T	P	C
THEORY							
1.	19UMA326	Transform Techniques and PartialDifferential Equations (Common to AGRI, CHE & BME)	BS	3	1	0	4
2.	19UBM302	Human Anatomy and Physiology	PC	3	0	0	3
3.	19UBM303	Biochemistry	PC	3	0	0	3
4.	19UBM304	Biomedical Instrumentation	PC	3	0	0	3
5.	19UBM305	Semiconductor Devices and Circuits	PC	3	0	0	3
6.	19UBM306	Sensors and Measuring Techniques	PC	3	0	0	3
PRACTICAL							
7.	19UBM307	Semiconductor Devices and CircuitsLaboratory	PC	0	0	3	1.5
8.	19UBM308	Biochemistry and Human Physiology Laboratory	PC	0	0	3	1.5
MANDATORY							
9.	19UGM331	Biology for Engineers (Common to BME & BT)	MC	2	0	0	P/F
			Total	20	1	6	22
Total Credits : 22							

SEMESTER IV

S.No.	Course Code	Course Title	Course Category	L	T	P	C
THEORY							
1.	19UMA424	Probability and Inferential Statistics	BS	3	1	0	4
2.	19UBM402	Analog and Digital Integrated Circuits	PC	4	0	0	4
3.	19UBM403	Medical Physics	PC	3	0	0	3
4.	19UBM404	Principles of Signals and Systems	PC	3	0	0	3
5.	19UBM405	Pathology and Microbiology	PC	3	0	0	3
6.	19UBM406	Diagnostic and Therapeutic Equipments – I	PC	3	0	0	3
PRACTICAL							
7.	19UBM407	Analog and Digital Integrated Circuits Laboratory	PC	0	0	3	1.5
8.	19UBM408	Sensors and Biomedical Instrumentation Laboratory	PC	0	0	3	1.5
9.	19UBM409	Pathology and Microbiology Laboratory	PC	0	0	3	1.5
10.	19UBM410	Technical Seminar	P	0	0	2	1
MANDATORY							
11.	19UGM431	Gender Equality	MC	1	0	0	P/F
			Total	20	1	11	25.5
Total Credits : 25.5							

SEMESTER V

S.No.	Course Code	Course Title	Course Category	L	T	P	C
THEORY							
1.	19UBM501	Microprocessors and Microcontrollers	PC	3	0	0	3
2.	19UBM502	Diagnostic and Therapeutic Equipments - II	PC	3	0	0	3
3.	19UBM503	Bio Control System	PC	3	1	0	4
4.	13UBM504	Principles of Digital Signal Processing	PC	3	0	0	3
5.	PE - I	Professional Elective – I	PE	3	0	0	3
6.	OE - I	Open Elective – I	OE	3	0	0	3
PRACTICAL							
7.	19UBM507	Creative Thinking and Innovation	P	0	0	2	1
8.	19UBM508	Microprocessors and microcontrollers Laboratory	PC	0	0	3	1.5
9.	19UBM509	Diagnostic and Therapeutic Equipments Laboratory	PC	0	0	3	1.5
10.	19UBM510	Signal Processing Laboratory	PC	0	0	2	1
11.	19UGS533	Interpersonal Skills Laboratory	HS	0	0	3	1.5
			Total	18	1	13	25.5
Total Credits : 25.5							

SEMESTER VI

S.No.	Course Code	Course Title	Course Category	L	T	P	C
THEORY							
1.	19UBM601	Medical Imaging Equipments	PC	3	0	0	3
2.	19UBM602	Biomechanics	PC	3	0	0	3
3.	19UIT623	Object Oriented Programming and Data Structures	ES	2	0	3	3.5
4.	PE - II	Professional Elective – II	PE	3	0	0	3
5.	PE - III	Professional Elective – III	PE	3	0	0	3
6.	OE - II	Open Elective – II	OE	3	0	0	3
PRACTICAL							
7.	19UBM607	Product Development Project	P	0	0	8	4
8.	19UGS631	Logical Reasoning and Aptitude	HS	1	0	0	1
9.	19UGS632	Soft skills and Communication Laboratory	HS	0	0	3	1.5
MANDATORY							
10.	19UGM632	Indian Constitution and Essence of Indian Traditional Knowledge (Common to BME, CSE, ECE & IT)	MC	1	0	0	P/F
			Total	19	0	14	25
Total Credits : 25							

SEMESTER VII

S.No.	Course Code	Course Title	Course Category	L	T	P	C
THEORY							
1.	19UME701	Project Management and Finance	HS	3	0	0	3
2.	19UBM702	Hospital Management	PC	3	0	0	3
3.	19UBM703	Image Processing Techniques	PC	3	0	0	3
4.	PE - IV	Professional Elective – IV	PE	3	0	0	3
5.	PE - V	Professional Elective – V	PE	3	0	0	3
6.	OE - III	Open Elective – III	OE	3	0	0	3
PRACTICAL							
7.	19UBM707	Summer Internship	P	0	0	0	1
8.	19UBM708	Hospital Training	PC	0	0	2	1
9.	19UBM709	Image Processing Laboratory	PC	0	0	3	1.5
MANDATORY							
10.	19UGM731	Professional Ethics and Human Values	MC	2	0	0	P/F
			Total	20	0	5	21.5
Total Credits : 21.5							

SEMESTER VIII

S.No.	Course Code	Course Title	Course Category	L	T	P	C
THEORY							
1.	PE - VI	Professional Elective – VI	PE	3	0	0	3
2.	OE - IV	Open Elective – IV	OE	3	0	0	3
PRACTICAL							
3.	19UBM801	Project work	P	0	0	16	8
			Total	6	0	16	14
Total Credits : 14							

LIST OF PROFESSIONAL ELECTIVES

S.No.	Course Code	Course Title	L	T	P	C
1.	19UBM901	Bio-MEMS and Nano Electronics	3	0	0	3
2.	19UBM902	Clinical Engineering	3	0	0	3
3.	19UBM903	Principles of Tissue Engineering	3	0	0	3
4.	19UBM904	Biomaterials and Artificial Organs	3	0	0	3
5.	19UBM905	Pattern Recognition and Neural Networks	3	0	0	3
6.	19UBM906	Forensic Science	3	0	0	3
7.	19UBM907	Drug Delivery Systems	3	0	0	3
8.	19UBM908	Nuclear Medicine	3	0	0	3
9.	19UBM909	Medical Radiation Safety Engineering	3	0	0	3
10.	19UBM910	Medical Technology	3	0	0	3
11.	19UBM911	Medical Optics	3	0	0	3
12.	19UBM912	Genetic Engineering	3	0	0	3
13.	19UBM913	Communication Engineering	2	0	2	3
14.	19UBM914	Biometric Systems	3	0	0	3
15.	19UBM915	Medical Informatics	3	0	0	3
16.	19UBM916	Telemedicine	3	0	0	3
17.	19UBM917	Rehabilitation Engineering and Robotics	3	0	0	3
18.	19UBM918	Virtual Bio-Instrumentation	2	0	2	3
19.	19UBM919	Medical Embedded Systems	3	0	0	3
20.	19UBM920	Brain Computer Interface and virtual reality	3	0	0	3
21.	19UBM921	Neuroscience	3	0	0	3
22.	19UBM922	Cancer Biology	3	0	0	3
23.	19UBM923	Human Assist Devices	3	0	0	3
24.	19UBM924	Body Area Networks and Mobile Healthcare	3	0	0	3
25.	19UBM925	Regenerative Medicine and Ergonomics	3	0	0	3
26.	19UBM926	Physiological Modeling	2	0	2	3
27.	19UBM927	Big Data and IOT in Medical Applications	3	0	0	3
28.	19UBM928	VLSI System Design	3	0	0	3
29.	19UBM929	Medical Waste management	3	0	0	3
30.	19UBM930	Digital System Design	3	0	0	3
31.	19UBM931	Bio-Signal Processing	3	0	0	3
32.	19UBM932	Principles of Machine Learning	3	0	0	3
33.	19UBM933	Bio Statistics	3	0	0	3
34.	19UBM934	Electro Magnetic Interference and Compatibility	3	0	0	3
35.	19UBM935	Smart Healthcare Engineering and Artificial Intelligence	3	0	0	3

LIST OF OPEN ELECTIVES

S.No.	Course Code	Course Title	L	T	P	C
1.	19UBM971	Biomedical Instrumentation Systems	3	0	0	3
2.	19UBM972	Computer Applications in Medicine	3	0	0	3
3.	19UBM973	Forensic Science in Health Care	3	0	0	3
4.	19UBM974	Radiotherapy and Nuclear Medicine	3	0	0	3
5.	19UBM975	Occupational Safety and Health in Public Health Emergencies	3	0	0	3

LIST OF INTER-DISCIPLINARY COURSES

S.No.	Course Code	Course Title	L	T	P	C
1.	19UGM951	Electrical Hazards and Safety In Hospitals	3	0	0	3
2.	19UGM952	Bio-Fluid Mechanics	3	0	0	3

LIST OF ONE CREDIT COURSES

S.No.	Course Code	Course Title	L	T	P	C
1.	19UBM861	Fundamentals of MATLAB Programming	0	0	2	1
2.	19UBM862	Python Programming	0	0	2	1
3.	19UBM863	Virtual Learning of Anatomy and Physiology	0	0	2	1
4.	19UBM864	DICOM Introduction and Interpretation	0	0	2	1
5.	19UBM865	Multi Medical Equipments Operating Skills Laboratory	0	0	2	1
6.	19UBM866	Medical Science	0	0	2	1
7.	19UBM867	3D Printing applicable to Medical Field	0	0	2	1
8.	19UBM868	Occupational Emergency Care	0	0	2	1
9.	19UBM869	Intellectual Property Rights	1	0	0	1
10.	19UBM870	Entrepreneurship in Biomedical Engineering	1	0	0	1
11.	19UBM871	Troubleshooting and Quality Control in Medical Equipments	0	0	2	1
12.	19UBM872	Regulation Perspective of Medical Research	1	0	0	1
13.	19UBM873	Introduction to Fuzzy Logic and Genetic Algorithms	1	0	0	1
14.	19UBM874	Numerical methods for Biomedical Engineers	1	0	0	1
15.	19UBM875	Introduction to International Medical Data Banks	1	0	0	1
16.	19UBM876	Role of Biomedical Engineers in Disaster Management	1	0	0	1
17.	19UBM877	Medical Coding and Transcription	0	0	2	1
18.	19UBM878	Calibration and Testing of Medical Equipments	0	0	2	1

SEMESTER I

S.No.	Course Code	Course Title	Course Category	L	T	P	C
THEORY							
1.	19UEN101	English for Technical Communication (Common to ALL Branches)	HS	2	0	0	2
2.	19UMA102	Engineering Mathematics – I (Common to ALL Branches)	BS	3	1	0	4
3.	19UPH103	Engineering Physics (Common to ALLBranches)	BS	3	0	0	3
4.	19UCY105	Applied Chemistry (Common to ECE, EEE, CSE, IT, BME & BT)	BS	3	0	0	3
5.	19UCS108	Problem Solving and Python Programming (Common to ALL Branches)	ES	3	0	0	3
6.	19UME109	Engineering Graphics (Common to ALLBranches)	ES	3	1	0	4
PRACTICAL							
7.	19UCS110	Problem Solving and Python Programming Laboratory (Common to ALL Branches)	ES	0	0	3	1.5
8.	19UCS112	Engineering Fundamentals Laboratory (Common to ECE, CSE, IT, BME & BT)	ES	0	0	3	1.5
9.	19UGS113	Basic Sciences Laboratory (Common to ALL Branches)	BS	0	0	2	1
MANDATORY							
10.	19UGM131	Induction Program (Common to ALL Branches)	MC	0	3	0	P/F
			Total	17	5	8	23
Total Credits : 23							

Course Code	Course Title	L	T	P	C
19UEN101	ENGLISH FOR TECHNICAL COMMUNICATION (Common to ALL Branches)	2	0	0	2

OBJECTIVES:

- To enhance the vocabulary of students.
- To strengthen the application of functional grammar and basic skills.
- To improve the language proficiency of students.

UNIT – I	**8**

Listening: Formal and informal conversations and comprehension – Speaking: introducing oneself – exchanging personal and social information – Reading: Skimming and Scanning – Writing: Sentence Formation, Formal Letters (Permission/Requisition) – Grammar: Parts of Speech – Tense Vocabulary Development: Technical Word Formation- Prefix – suffix – Synonyms and Antonyms Phrases and Clauses.

UNIT – II	**8**

Listening: Telephonic Conversations – Speaking: Pronunciation rules with Stress pattern –Reading: comprehension-pre-reading, post-reading – comprehension questions – Writing: Punctuation rules, paragraph writing – topic sentence – main ideas – free writing, short narrative descriptions, Precisewriting, Developing Hints – Report Writing (Industrial, Accident) – Grammar: Voice – Vocabulary – Development: Words from other languages in English.

UNIT – III	**7**

Listening: Motivational speech by Great Speakers – Speaking: Narrating daily events – retelling short stories – Reading: Newspaper reading – Writing: Job application letter – Transformation of Information (Transcoding) – Grammar: Subject-Verb Agreement (Concord) – Vocabulary – Development: Same word in different parts of speech.

UNIT – IV	**7**

Listening: Understating the instruction – Speaking: Intonation and preparing dialogue on variousformal and informal situation — Reading: Note Making from given text — Writing: Creating coherence, Essay writing with proper introduction and conclusion, Giving Instruction (Guidance/Procedure) – Grammar: Spot the Errors in English – Vocabulary Development: One word substitution.

TOTAL : 30 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Apply grammar effectively in writing meaningful sentences and paragraphs.	Apply
CO2	Exhibit reading skills and comprehension to express the ideas in the given text.	Understand
CO3	Develop writing skills to present the ideas in various formal situations.	Create
CO4	Develop oral fluency to express the ideas in various formal situations.	Create
CO5	Exhibit writing skills to prepare reports for various purposes.	Create

TEXT BOOKS:

1. KN Shoba, Lourdes Joavani Rayen, Communicative English, New Delhi, Cambridge University Press, 2017

REFERENCES:

1. Raman, Meenakshi, Sangeetha Sharma, Business Communication, New Delhi, Oxford University Press, 2014.
2. Lakshminarayanan. K.R, English for Technical Communication, Chennai, Scitech Publications (India) Pvt. Ltd, 2004.
3. Rizvi. Asraf M, Effective Technical Communication, New Delhi, Tata McGraw-Hill Publishing Company Limited, 2007.

Course Code	Course Title	L	T	P	C
19UMA102	ENGINEERING MATHEMATICS – I (Common to ALL Branches - Except CSBS)	3	1	0	4

OBJECTIVES:

- To make the students capable of identifying linear equations based problems (Eigen Value)from practical areas and obtain the Eigen value oriented solutions in certain cases.
- To widen the students' knowledge base on linear algebra, growth rate computation andapplication of integrals.
- Able to integrating various types of functions using various integration methods.
- To familiarize the students with the basic rules of differentiation and use them to findderivatives of products and quotients of functions
- To apply these mathematical concepts (matrix theory, differentiation and integration) inengineering field.

UNIT – I	MATRICES	8 + 3

Eigen value and eigenvector of a real matrix — Characteristic equation — Properties — Cayley-Hamilton theorem (excluding Proof) – Orthogonal reduction – (transformation of a symmetric matrix to diagonal form) – Quadratic form – Reduction of quadratic form to canonical form by orthogonal transformation.

UNIT – II	DIFFERENTIAL CALCULUS	9 + 3

Introduction – Definition of derivatives – Limits and Continuity – Differentiation techniques (Productrule, Quotient rule, Chain rule) – Successive differentiation (n^{th} derivatives) – Leibnitz theorem (without proof) – Maclaurin's series – Physical Applications (Newton's law of cooling – Heat flow problems, Rate of decay of radioactive materials - Chemical reactions and solutions, Ohm's law, Kirchoff's law – Simple electric circuit problems).

UNIT – III	FUNCTIONS OF SEVERAL VARIABLES	9 + 3

Partial derivatives – Euler's theorem for homogenous functions – Total derivatives – Differentiationof implicit functions – Jacobian – Taylor's expansion – Maxima and Minima – Method of Lagrangian Multipliers.

UNIT – IV	INTEGRAL CALCULUS	8 + 3

Definitions and concepts of integrals – Methods of integration (Decomposition method, Substitutionmethod, Integration by parts) – Definite integrals – Properties and problems – Reduction formulae – Beta and Gamma functions.

UNIT – V	MULTIPLE INTEGRALS	8 + 3

Double integration – Cartesian and Polar coordinates – Change of order of integration – Area as a double integral - Change of variables between Cartesian and Polar coordinates – Triple integrationin Cartesian coordinates — Volume as triple integral.

SUPPLEMENT TOPIC (for internal evaluation only)	3

Evocation /Application of Mathematics, Quick Mathematics — Speed Multiplication and Division Applications of Matrices.

TOTAL : 45 (L) + 15 (T) = 60 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Apply the Characteristic Equation, Characteristic roots and use the applicability of Cayley – Hamilton theorem to find the Inverse of matrix.	Apply
CO2	Analyze functions using limits, continuity, derivatives and to solve Physical application problems.	Analyze
CO3	Apply differentiation techniques and Lagrange multiplier method to predict the extreme values of the functions with constrain.	Apply
CO4	Apply the concept of some special function like Gamma, Beta function and their relation to evaluate some definite integral.	Apply
CO5	Apply integration to compute Multiple integrals, Area and Volume in addition to change of order and change of variables.	Apply
CO6	Understand the basic concept in Matrix, Differentiation and Integration.	Understand

TEXT BOOKS:

1. Bali N. P and Manish Goyal, “A text book of Engineering Mathematics”, Laxmi Publications (p) Ltd, New Delhi, 8th Edition, 2011.
2. Veerarajan. T “Engineering Mathematics” Tata Mcgraw Hill Publishing Company, NewDelhi, 2008.
3. Grewal. B.S, “Higher Engineering Mathematics”, Khanna Publications, New Delhi, 42nd Edition, 2012.

REFERENCES:

1. Ramana B.V, “Higher Engineering Mathematics”, Tata McGraw Hill Publishing Company,New Delhi, 11th Reprint, 2010.
2. Glyn James, “Advanced Engineering Mathematics”, Pearson Education, New Delhi, 7thEdition, 2007.
3. Jain R.K and Iyengar S.R.K,” Advanced Engineering Mathematics”, Narosa PublishingHouse, New Delhi, 3rd Edition, 2007.
4. Bharati Krishna Tirthaji, “Vedic Mathematics - Mental Calculation”, Motilal Banarsi Dass Publications, New Delhi, 1st Edition, 1965.
5. Kreyszig. E, “Advanced Engineering Mathematics”, John Wiley & Sons, New York, 10thEdition, 2011.
6. P.Sivaramakrishna Das, E.Rukmangadachari “Engineering Mathematics”, Volume 1, Pearson Edison New Delhi, 2nd Edition, 2013.

Course Code	Course Title	L	T	P	C
19UPH103	ENGINEERING PHYSICS (Common to ALL Branches)	3	0	0	3

OBJECTIVES:

- To develop the research interest in crystal physics.
- To use the principles of Lasers and its types.
- To apply principles of Quantum physics in engineering field.
- To develop knowledge on properties of materials.

UNIT – I	CRYSTAL STRUCTURE	12

Introduction – Classification of solids – Space lattice – Basis-Lattice parameter – Unit cell – Crystalsystem – Miller indices – d-spacing in cubic lattice – Calculation of number of atoms per unit cell –Atomic radius – Coordination number – Packing factor for SC, BCC, FCC and HCP structures – crystal imperfection – Point defects – Line defects – Surface defects – Volume defects Burger vector.

UNIT – II	PHOTONICS	10

Introduction – Principles of Laser – Characteristics of laser – Spontaneous and stimulated emission – Population inversion – Einstein's A and B coefficients – Pumping methods – Basic components of Laser — Types of lasers — Nd-YAG laser — CO2 laser — Holography — Construction andReconstruction of hologram – Industrial and Medical Applications.

UNIT – III	QUANTUM MECHANICS	13

Introduction — Black body radiation — Planck's law of radiation — Wien's displacement law —Rayleigh Jeans law – Compton Effect – Theory and experimental verification – Matter waves – Schrodinger's wave equation – Time dependent – Time independent equation – Particle in 1-D dimensional box

UNIT – IV	PROPERTIES OF SOLIDS	10

Introduction – Elasticity – Stress and Strain – Hooke's law – Three moduli of elasticity – stress-strain curve – Poisson's ratio – Factors affecting elasticity – Bending moment – Depression of a cantilever – Young's modulus by uniform bending – I-shaped girders.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Classify the types of crystals, lasers and elastic behavior of solids.	Understand
CO2	Apply the basic knowledge of crystal, quantum mechanics and mechanical behavior of solids to solve engineering problems.	Apply
CO3	Apply the principle of laser to estimate the wavelength of emitted photons.	Apply
CO4	Analyze the dual nature of matter using the concepts of quantum mechanics.	Analyze
CO5	Analyze the structural and optical properties of crystals in industrial and medical applications.	Analyze
CO6	Analyze the structural and optical properties of materials for specific Engineering Applications.	Analyze

TEXT BOOKS:

1. Dr. Mani.P, "Engineering Physics", Dhanam Publications, Edition, 2018, Chennai.
2. Rajendran.V, "Engineering Physics", Tata Mc-Graw Hill Publishing Company limited, NewDelhi, Revised Edition 2018.
3. Palanisami P.K., "Physics For Engineers", Scitech Publications (India), Pvt Ltd., Chennai, 2018.

REFERENCES:

1. Raghuvenshi G.S., "Engineering Physics", PHI Learning Private Limited, New Delhi, Revised Edition 2018.
2. Arul doss .G. "Engineering Physics", PHI Learning Limited, New Delhi, Revised Edition2018.
3. Marikani. A., "Engineering Physics", PHI Learning Private Limited, New Delhi, Revised Edition 2017.
4. Sankar B.N., and Pillai .S.O., "A Text book of Engineering Physics", New Age InternationalPublishers Private Limited, New Delhi, Revised Edition 2017.
5. Avadhanulu M.N. and Kshirsagar P.G., "A Textbook: of Engineering Physics", S.Chand &Company Ltd., New Delhi, 2018.

Course Code	Course Title	L	T	P	C
19UCY105	APPLIED CHEMISTRY (Common to ECE, EEE, CSE, IT, BME & BT)	3	0	0	3

OBJECTIVES:

- To gain the knowledge on Chemical bonding and types.
- To make the students conversant with boiler feed water requirements, related problems andwater treatment techniques.
- To know the importance of smart material and green chemistry.
- To acquire knowledge on energy storage devices.

UNIT – I	CHEMICAL BONDING	11

Chemical Bonding: Electronic Configuration – Ionic Bond – Covalent Bond – Metallic bond – Aufbau principle, Pauli Exclusion principle, Valence bond theory application and its limitations, Various types of hybridization (sp, sp^2,sp^3) (C_2H_2, C_2H_4, CH_4) – bond strength and bond energy – Hydrogen bonding, Vander Waals forces.

UNIT – II	WATER AND ITS TREATMENT TECHNOLOGIES	11

Hardness of water – types – expression of hardness (Problems) – units – estimation of hardness ofwater by EDTA – boiler troubles (scale and sludge) – Internal treatment (phosphate, colloidal, sodium aluminate and calgon conditioning) – External treatment Ion exchange process – Zeolite process – desalination of brackish water – Reverse Osmosis.

UNIT – III	SMART MATERIALS AND GREEN CHEMISTRY	11

Introduction to smart materials and their structure – Organic Light Emitting Diodes – Principles and applications, Liquid crystals – definition and applications. Green chemistry – Concept, importance, principles – e-waste disposal.

UNIT – IV	ENERGY STORAGE DEVICES	12

Batteries, fuel cells and super capacitors: Types of batteries – primary battery (dry cell) secondary battery (lead acid battery, lithium-ion-battery) fuel cells – H_2-O_2 fuel cell and application.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Describe the basic concept of chemistry involved in chemical bonding, water treatment methods, smart materials, e-waste management and energy storage devices.	Understand
CO2	Apply the knowledge of chemical bonding to identify the types of bonds in molecules.	Apply
CO3	Analyze the impurities of water to find its hardness and remove the hardness causing substances.	Analyze
CO4	Explain the principles and application of organic light emitting diodes, liquid crystals and green chemistry.	Understand
CO5	Apply the knowledge of the basic electrochemical cell terminology to differentiate various types of energy storage devices.	Apply

TEXT BOOKS:

1. Jain P.C. and Monica Jain, “Engineering Chemistry”, Dhanpat Rai Publishing Company (P)Ltd, New Delhi, 2002.
2. Dr.Sunita Rattan, “A Textbook of Engineering Chemistry” S.K. Kataria & Sons, New Delhi,2013.

REFERENCES:

1. Derek Pletcher and Frank C. Walsh, “Industrial Electrochemistry”, Chapman and Hall, NewYork, 1993.
2. Peter Grundler, “Chemical Sensors — An introduction for Scientists and Engineers”,Springer, New York, 2007.

Course Code	Course Title	L	T	P	C
19UCS108	PROBLEM SOLVING AND PYTHON PROGRAMMING (Common to ALL Branches)	3	0	0	3

OBJECTIVES:

- To impart the concepts in problem solving for computing.
- To familiarize the logical constructs of programming.
- To illustrate programming in Python.

UNIT – I	INTRODUCTION	9

Definition and basic organization of computers – classification of computers – Software – Types ofsoftware – types of programming paradigms – Translators: compiler and interpreter – Problem solving tools: Algorithms – Flowchart – Pseudo code.

UNIT – II	INTRODUCTION TO PYTHON	9

Introduction to python – features of python – modes of working with python. Values and data types:numbers, Boolean, strings; variables, expressions, statements, tuple assignment, precedence of operators, comments – print function – conversion of algorithm in to program – Solving simple problems involving arithmetic computations and sequential logic to solve.

UNIT – III	CONTROL CONSTRUCTS	9

Flow of execution – control structures: conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass – Solving problems involving decision making and iterations.

UNIT – IV	FUNCTIONS AND PACKAGES	9

Functions – function definition and use, flow of execution, parameters and arguments; parameters,local and global scope, function composition – Anonymous or Lambda Function, recursion – packages.

UNIT – V	LISTS, TUPLES, DICTIONARIES AND STRINGS	9

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing – list comprehension – Strings: string slices; immutability, string functionsand methods, string module.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Utilize problem solving tools in solving computing problems**.**	Apply
CO2	Solve mathematical expressions involving sequential logic in python.	Apply
CO3	Solve problems using python using decision structure and looping constructs**.**	Apply
CO4	Write modular programs using functions and packages**.**	Apply
CO5	Manipulate data using List, Tuples, Dictionaries and strings**.**	Apply

TEXT BOOKS:

1. Ashok Namdev Kamthane & Amit Ashok Kamthane, “Problem solving and pythonprogramming”, McGraw Hill Education, 2018 (copyright)
2. Anurag Gupta & G P Biswas, “Python Programming — Problem solving, packages andlibraries”, McGraw Hill Education, 2020 (copyright).

REFERENCES:

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

Course Code	Course Title	L	T	P	C
19UME109	ENGINEERING GRAPHICS (Common to ALL Branches)	3	1	0	4

OBJECTIVES:

- To develop student's graphic skill for communication of concepts, ideas and design of engineering products and expose them to existing national standards related to technical drawings.
- To impart knowledge in development of surfaces and isometric projections.

CONCEPTS AND CONVENTIONS (NOT FOR EXAMINATION)	4

Importance of Graphics in Engineering Applications — Use of Drafting Instruments — BIS Conventions and Specifications – Size, Layout and Folding of Drawing Sheets – Lettering and Dimensioning – Introduction to Plane Curves, Projection of Points, Lines and Plane Surfaces.

UNIT – I	PROJECTION OF SOLIDS	12

Projection of simple solids like prisms, pyramids, cylinder and cone with axis is parallel,perpendicular and inclined to one of the plane.

UNIT – II	SECTION OF SOLIDS	10

Section of solids — simple position with cutting plane parallel, perpendicular and inclined to one of the plane.

UNIT – III	DEVELOPMENT OF SURFACES	10

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

UNIT – IV	ISOMETRIC PROJECTIONS	12

Principles of isometric projection – isometric scale – isometric view – isometric projections of simplesolids and cut solids.

UNIT – V	ORTHOGRAPHIC PROJECTION	12

Representation of Three Dimensional objects – General principles of orthographic projection- Need for importance of multiple views and their placement – First angle projection – layout views – layoutviews – Developing visualization skills of multiple views (Front, top and side views) from pictorial views of objects.

TOTAL : 45 (L) + 15 (T) = 60 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Apply the knowledge of First angle of projection to draw the projection ofdifferent simple solids.	Apply
CO2	Draw the section of solids with true shape of the section.	Apply
CO3	Draw the development of lateral surface of regular and sectioned solids.	Apply
CO4	Draw the isometric view of simple solids and sectioned solids.	Apply
CO5	Sketch the orthographic views from the given pictorial (isometric) view.	Apply

TEXT BOOKS:

1. Natarajan K.V., “A Text book of Engineering Graphics”, Dhanalakshmi Publishers, (2006).
2. Bhatt N.D., “Engineering Drawing”, Charotar Publishing House, (2012).

REFERENCES:

1. Venugopal K., and Prabhu Raja V., “Engineering Graphics”, New Age International (P) Limited, (2008).
2. Gopalakrishnan K.R., “Engineering Drawing” (Vol.I&II), Subhas Publications. (2014).
3. DhananjayA.Jolhe, “Engineering Drawing with an introduction to Auto CAD”, Tata McGrawHill Publishing Company Limited, (2012).
4. Saravanan M, Benson Raj J and Ganesh Kumar S, “Engineering Graphics”, JBR TriseaPublishers, Nagercoil, (2020).

Course Code	Course Title	L	T	P	C
19UCS110	PROBLEM SOLVING AND PYTHON PROGRAMMINGLABORATORY (Common to ALL Branches)	0	0	3	1.5

OBJECTIVES:

- To familiarize with programming environment.
- To familiarize the implementation of programs in Python.

LIST OF EXPERIMENTS:

Problems involve Sequential logic and Decision making:

1. Develop a computing solution to process the mark processing system (Record has thefollowing fields: Name, Reg_no, Mark1, Mark2, Mark3, Mark4, Total, average). Generate student information with total and average marks.
2. Provide a software solution to compute the +2 Cutoff mark, given the Mathematics, physics and Chemistry marks. A college has decided to admit the students with a cut off marks of180. Decide whether the student is eligible to get an admission in that college or not.
3. A pizza in a circular shape with 8 inches and which is placed in a square box whose side length is 10 inches. Find how much of the box is “empty”?
4. A person owns an air conditioned sleeper bus with 35 seating capacity that routes between Chennai to Bangalore. He wishes to calculate whether the bus is running in profit or loss state based on the following scenario:

   Amount he spent for a day for diesel filling is: Rs. 15,000
   Amount he spent for a day for Driver and cleaner beta is: Rs. 3,000Ticket amount for a Single person is Rs: 950
   If all the seats are filled, what would be the result? If only 15 seats are filled, what would be the result?
5. Consider the person ‘X’ has some amount in his hand and the person ‘Y’ has some amount in his hand. If they wish to exchange the amount among them, how they can exchange the amount by using the third party ‘Z’.

Problems involve iterations:

6. A man is blessed with a duck that can lay golden eggs. First day it lays one egg, in second day it lays two eggs, in third day it lays three eggs, and it continues to layeggs in an incremental manner day by day. Now calculate how many golden eggs thatduck lays till ‘n’th day.
7. Four People A,B,C,D are sitting in a Circular arrangement. In how many ways their seating can be arranged.
8. The Greek theater shown at the right has 30 seats in the first row of the center section. Each row behind the first row gains two additional seats. How many seats are in the 5th row in the center section?

Problem involve functions and recursive functions:

9. Develop a solution to identify the right angle triangle while giving the sides of a triangle. (Recall from the Pythagoras theorem that in a right triangle, the square of oneside equals the sum of the squares of other two sides)
10. A game has to be made from marbles of five colors, yellow, blue, green, red andViolet where five marbles has to be kept one upon another. Write a python program using recursion, to find how many ways these marbles can be arranged.
11. Tower of Hanoi is a mathematical puzzle where we have three rods and n disks. The objective of the puzzle is to move the entire stack to another rod, obeying the following simple rules:
    Here is a high-level outline of how to move a tower from the starting pole, to the goalpole, using an intermediate pole:
    1. Move a tower of height-1 to an intermediate pole, using the final pole.
    2. Move the remaining disk to the final pole.
    3. Move the tower of height-1 from the intermediate pole to the final pole usingoriginal pole.

Problems involve List and Nested List:

12. In a class of 50 numbers of students, 6 students are selected for state cricket academy. Sports faculty of this school has to report to the state cricket academyabout the selected students’ physical fitness. Here is one of the physical measures of the selected students’; Height in cm is given for those 6 selected students [153,162,148,167,175,151]. By implementing functions, do the following

operations.

(i) State academy selector has to check whether the given height is present inthe selected students list or not.

(ii) State academy selector has to order the height of students in anincremental manner.

(iii) State academy selector has to identify the maximum height from the list.

Problems involve Dictionary and Tuples:

Dictionary:

13. A university wishes to create and maintain the details of the students such as Rollno, Regno, Name, Dept, Batch, Contact_no, Nativity (Indian/NRI) as key value pairs. Do the following operations:

(i) Display the complete student details on giving Rollno as input.
(ii) Display the complete student details whose nativity belongs to NRI.
(iii) Display the complete student details whose department is CSE.

***Tuples*:**

14. A librarian wishes to maintain books details such as ISBN, Book Name, Author Name, Year published, Publisher Name. He wishes to retrieve the book details in the following scenario:

(i) Retrieve the complete details of the book on giving ISBN.
(ii) Retrieve the details of the book which published after the year 2015.
(iii) Retrieve the details of the book whose author name is 'Andrew'.
(iv) Retrieve the details of the book that name of the book is 'Python'

Problems involve Strings:

15. A musical album company has 'n' number of musical albums. The PRO of thiscompany wishes to do following operations based on some scenarios:

(i) Name of the album starts with 's' or 'S'.
(ii) Name of the album which contains 'jay' as substring.
(iii) Check whether the album name presents in the repository or not.
(iv) Count number of vowels and consonants in the given album name.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Formulate algorithms for simple problems and translate the algorithms to a working program.	Apply
CO2	Formulate algorithms and programs for arithmetic computations and sequential logic.	Apply
CO3	Write iterative programs using control constructs.	Apply
CO4	Develop programs using functions, packages and use recursion to reduce redundancy.	Apply
CO5	Represent data using lists, tuples, dictionaries and manipulate them through a program.	Apply

HARDWARE AND SOFTWARE REQUIRMENTS:

Hardware Requirements:

LAN SYSTEM WITH 30 NODES (OR) STANDALONE PCS – 30 NOS

Software Requirements:

OS – UNIX CLONE (License free Linux)

EDITOR – IDLE

Course Code	Course Title	L	T	P	C
19UCS112	ENGINEERING FUNDAMENTALS LABORATORY (Common to CSE, ECE,IT & BME Branches)	0	0	3	1.5

OBJECTIVES:

- To familiarize the Hardware components of Computer
- To practice the installation of operating systems and other software's

LIST OF EXPERIMENTS:

GROUP A (COMPUTER) **24 Periods**

1. Demonstrating basic components of a personal computer
2. Assembling hardware components of a computer
3. Installation of windows and linux operating systems
4. Installation of software's both in windows and linux operating system
5. Configuring the computer to connect with internet
6. PC trouble shooting and maintenance

GROUP B (ELECTRICAL & ELECTRONICS) **21 Periods**

7. Study of electronic components and equipment's:
   (a) Resistor color coding
   (b) Measurement of AC signal parameter (peak to peak, RMS, period, frequency) using CRO
8. Study of logic gates
9. Soldering practice – components devices and circuits - using general purpose PCB
10. Characteristics of LED
11. Interfacing of PIR sensor with microcontroller
12. Switch control with microcontroller
13. Temperature measurement with microcontroller

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Identify the components of the computer and assemble the hardware components of a computer.	Apply
CO2	Install and uninstall the Operating systems and other software's both in in windows and Linux environment.	Apply
CO3	Demonstrate the basic network settings and make trouble shoot and Maintain the compute.	Apply
CO4	Demonstrate the function of electronics components.	Apply
CO5	Develop code for interfacing sensors with microcontroller.	Apply

HARDWARE AND SOFTWARE REQUIRMENTS:

Sl. No.	Name of the equipment / Software	Quantity required
1	LAN System with 30 Nodes (OR) Standalone PCs	30
2	OS – Unix Clone (License Free Linux)	-
3	Logic Trainer kit	2
4	CRO and AFO	2
5	Small Multipurpose PCBs	5
6	Soldering Guns	5
7	Multimeters	5
8	DC Ammeter	10
9	DC Voltmeter	10
10	Variable DC Power Supply	5
11	Node MCU Development Board	10
12	PIR Sensor (HC-SR501)	5
13	Temperature Sensor (LM35 OR DHT11)	5
14	PC with Windows 7	3
15	Logic Trainer kit	2

Course Code	Course Title	L	T	P	C
19UGS113	BASIC SCIENCES LABORATORY (Common to ALL Branches)	0	0	2	1

PHYSICS LABORATORY

OBJECTIVES:

- To create scientific Temper among the students.
- To know how to execute experiments properly, presentation of observations and arrival of conclusions.
- To view and realize the theoretical knowledge acquired by the students throughexperiments.

LIST OF EXPERIMENTS:

A minimum of FIVE experiments shall be offered – 15 Periods

1. Laser – Determination of particle size and wavelength of Laser source using Diode Laser.
2. Ultrasonic Interferometer - Determination of velocity of sound in liquid and compressibilityof liquid.
3. Poiseuille's method - Determination of Coefficient of viscosity of liquid.
4. Spectrometer – Determination of dispersive power of a prism.
5. Air Wedge method - Determination of thickness of a thin wire.
6. Uniform bending method — Determination of Young's modulus of the given rectangularbeam

CHEMISTRY LABORATORY

OBJECTIVES:

- To impart knowledge on basic concepts in applications of chemical analysis
- Train the students to handle various instruments.
- To acquire knowledge on the chemical analysis of various metal ions.

LIST OF EXPERIMENTS:

A minimum of FIVE experiments shall be offered – 15 Periods

1. Preparation of molar and normal solutions of the following substances — Oxalic acid,Sodium Carbonate, Sodium Hydroxide and Hydrochloric acid.
2. Conductometric Titration of strong acid with strong base
3. Conductometric Titration of Mixture of Acids.
4. Estimation of Iron by Potentiometry
5. Determination of Strength of given acid using pH metry.
6. Determination of molecular weight of polymer by Viscometry.
7. Comparison of the electrical conductivity of two samples - Conductometric method.
8. Estimation of copper in brass by EDTA method.

Laboratory classes on alternate weeks for Physics and Chemistry: TOTAL : 30 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Apply the principles of Optics, Laser physics and Elasticity to determine the Engineering properties of materials	Apply
CO2	Analyze the given liquid sample to determine the viscosity and compressibility of the liquid.	Analyze
CO3	Apply the principles of spectroscopy to determine the properties of materials	Apply
CO4	Apply the knowledge of Molarity and Normality to prepare standard solution for chemical analysis.	Apply
CO5	Analyze the concentration of a given analyte by analytical methods.	Analyze
CO6	Apply the knowledge of electrochemical techniques to study various ions present in the industrial effluents.	Apply

Course Code	Course Title	L	T	P	C
19UGM131	INDUCTION PROGRAM (Common to ALL branches)	3	0	0	3

OBJECTIVES:

- To rejuvenate the Body and Mind.
- To strengthen Attitude and soft skills.
- To practice Moral values of life.

UNIT – I	**PHYSICAL ACTIVITY**	**10**
Zumba - Bokwa Fitness – Yoga – Mediation – Fine Arts.		
UNIT – II	**CREATIVE ARTS**	**5**
Painting – Class Painting – Wall Painting – Art from waste.		
UNIT – III	**UNIVERSAL HUMAN VALUES & EMINENT SPEAKERS**	**5**
Ethical values – Ambition and Family Expectation, Gratitude, Competition and Excellence – Belief – Morality of life – Guest Lecture by Eminent personality.		
UNIT – IV	**LITERARY**	-
Elocution – Essay writing Competition – Impromptu Session – Dance and singing competition.		
UNIT – V	**PROFICIENCY MODULES**	**15**
Toastmaster club meet		
UNIT – VI	**INDUSTRIAL & LOCAL VISIT**	**8**
Vaigai Dam Theni – VOC- Port-Tuticorin – Madurai Radio City-Madurai – Alvin Milk Madurai – NSS Activities.		
UNIT – VII	**FAMILIARIZATION OF THE DEPT. AND INNOVATION**	**2**
Department Introduction and Purpose of Course – Eminent speakers – Scope and Feature of the Course – Latest Innovation.		

TOTAL: 45 PERIODS
(3 Weeks Model curriculum As per AICTE)

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Practice physical activities regularly.	Apply
CO2	Implement creativity in drawing and waste material.	Apply
CO3	Communicate their ideas effectively.	Apply
CO4	Identify inputs and outputs of different industry process.	Apply
CO5	Describe the scope and features of their programme of study.	Apply

REFERENCE:

1. Student Induction Programme: A Detailed Guide by AICTE, New Delhi.

SEMESTER II

S.No.	Course Code	Course Title	Course Category	L	T	P	C
THEORY							
1.	19UEN201	Communication Skills for Professionals (Common to ALL Branches)	HS	1	0	1	1.5
2.	19UMA207	Calculus, Complex Analysis and Transform Techniques (Common to AGRI, CHE, BME & BT)	BS	3	1	0	4
3.	19UPH204	Biomaterial Physics (Common to BME & BT)	BS	3	0	0	3
4.	19UCY204	Environmental Science (Common to ALL Branches)	HS	3	0	0	3
5.	19UBM205	Introduction to Biomedical Engineering	ES	3	0	0	3
6.	19UBM206	Electrical Circuits and Measurements	ES	3	0	0	3
PRACTICAL							
7.	19UGS210	Energy and Environmental Science Laboratory (Common to ALL Branches)	BS	0	0	3	1.5
8.	19UBM211	Electrical Circuits Laboratory	ES	0	0	3	1.5
			Total	16	1	7	20.5
Total Credits : 20.5							

Course Code	Course Title	L	T	P	C
19UEN201	COMMUNICATION SKILLS FOR PROFESSIONALS	1	0	1	1.5

OBJECTIVES:

- Improve their oral expression and thought.
- Develop their confidence and ability to speak in public.
- Develop their capacity for leadership.

5 ORAL PROJECTS

Project – 1 **SELF INTRODUCTION & DELIVER A SPEECH BEFORE AUDIENCE (Time: 5 to 7 minutes)**

- To Speak in front of an audience with courage.
- Make your message clear, with supporting material.
- Create a strong opening and conclusion.

Project – 2 **SPEAK ON THE CHOSEN CONTENT (Time: 5 to 7 minutes)**

- Select a general topic and bring out specific purposes.
- Avoid using notes.
- Use symbolic ideas to develop your ideas.

Project – 3 **USE EFFECTIVE BODY LANGUAGE & INTONATION (Time: 5 to 7 minutes)**

- Use appropriate posture, gestures, facial expressions and eye contact to express yourideas.
- Use proper intonation and adequate speech module.

Project – 4 **PRESENT YOUR TOPIC WITH VISUAL AIDS (Time: 5 to 7 minutes)**

- Persuade your points with suitable illustration, specific facts, examples
- Use suitable visual aids to present your topic with confidence.

Project – 5 **GRASP THE ATTENTION OF THE AUDIENCE (Time: 5 to 7 minutes)**

- Influence your listeners by adopting holistic viewpoint.
- Use emotions, stories, and positive quotes in your speech.

TOTAL : 30 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Apply Language skills to write and speak effectively.	Create
CO2	Select the right words and sentence to communicate ideas clearly and accurately.	Create
CO3	Exhibit good postures and proper attire to present the ideas effectively.	Create
CO4	Present the ideas effectively using visual aids.	Create
CO5	Communicate with clarity and present the ideas effectively to the audience.	Create

TEXT BOOKS:

1. Competent Communication – A Practical Guide to becoming a better speaker, Toastmasters International, USA.
2. Norman Lewis – Word Power Made Easy, Pocket Book Publication, 2019.

Internal and External Assessment plan

Internal Assessment plan			**External Assessment plan** *Prepared speech based on the Toastmasters Projects (5-7 minutes)*		
S.No	**Criteria**	**Marks**	**S.No**	**Criteria**	**Marks**
1.	Submission of 5 Project scripts	5x2= 10 marks	1.	Confident, Eye Contact, Body Language	5 marks
2.	Prepared speech based on the Projects	5x5= 25 marks	2.	Content and clarity	20 marks
3.	Performance in other Roles 1.TMOD 2. Speech Evaluator 3. Table Topic Speaker and Master 4. General Evaluator 5.JIG and TAG Team member	5x3= 15 marks	**3.**	Command over Language	15 marks
			4.	Error free language	10 marks
	Total	**50 marks**		**Total**	**50 marks**

Internal= 50 marks **External= 50 marks** **Total=100 marks** **Minimum Pass Mark= 50 marks**

Course Code	Course Title	L	T	P	C
19UMA207	CALCULUS, COMPLEX ANALYSIS AND TRANFORMTECHNIQUES (Common to CHEMICAL, AGRI, BME & BT)	3	1	0	4

OBJECTIVES:

- To develop an understanding of the basics of vector calculus comprising of gradient, divergence and curl, and line, surface and volume integrals and the classical theorems involving them.
- To acquaint the student with the concepts of analytic functions and their interesting properties which could be exploited in a few engineering areas, and be introduced to the host of conformal mappings with a few standard examples that have direct application.
- To make the student to acquire sound knowledge of Laplace transform techniques and its applications in getting the solution of certain linear differential equations.

UNIT – I	SOLUTIONS OF ORDINARY DIFFERENTIAL EQUATIONS	8 + 3

Higher order linear differential equations with constant coefficients – Method of variation ofparameters – Cauchy's and Legendre's linear equations – Applications of ODE (Bacterial growth, Population growth, Decayed problems).

UNIT – II	VECTOR CALCULUS	8 + 3

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

UNIT – III	COMPLEX VARIABLES	8 + 3

Functions of a complex variable – Analytic function – Necessary and Sufficient Conditions(excluding Proofs) – Harmonic function – Properties of an analytic function – Harmonic conjugate – Construction of analytic functions – Conformal mapping – Simple Transformations: w = z+c, cz, 1/z, and Bilinear transformation.

UNIT – IV	COMPLEX INTEGRATION	9 + 3

Statement and applications of Cauchy's integral theorem, Cauchy's integral formula and Cauchy Residue Theorem – Taylor's and Laurent's expansions – Applications of residue theorem toevaluate real integrals – Unit circle and semi-circular contour (excluding Poles on the real axis).

UNIT – V	LAPLACE TRANSFORM	9 + 3

Existence conditions – Transform of elementary functions – Basic properties – Transform of derivatives and integrals – Transform of unit step function, impulse function and periodic function – Inverse Laplace transform – Convolution theorem (excluding Proof) – Solution of linear ODE of second order with constant coefficients.

SUPPLEMENT TOPIC (for internal evaluation only)	3

Evocation / Application of Mathematics.

TOTAL : 45 (L) + 15 (T) = 60 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Apply the knowledge of higher order ordinary differential equations in real life engineering problems.	Apply
CO2	Apply the concept of vector identities in problem solving and evaluate the line, surface and volume integrals.	Apply
CO3	Apply the knowledge of standard techniques of complex variables and mapping for evaluating analytically.	Apply
CO4	Apply the knowledge of singularities, residues and applying in complex integration.	Apply
CO5	Apply the knowledge concept of Laplace transform and solve the problems with periodic function, convolution and Ordinary Differential Equation.	Apply
CO6	Understand the concept of particular integral, scalar potential, poles and periodic function.	Understand

TEXT BOOKS:

1. Veerarajan, T. “Engineering Mathematics” Tata McGraw Hill Publishing Company, NewDelhi, 2008.
2. Bali, N. P. and Manish Goyal, “Text book of Engineering Mathematics”, Laxmi Publications (P) Ltd., New Delhi, 3rd Edition, 2008.
3. Grewal, B.S, “Higher Engineering Mathematics”, Khanna Publications, New Delhi, 43rdEdition, 2014.

REFERENCES:

1. Ramana, B.V, “Higher Engineering Mathematics”, Tata McGraw Hill Publishing Company,New Delhi, 11th Reprint, 2010.
2. Brown, J.W. and Churchil R.V.” Complex Variable and Applications” 7th Edition McGrawHill Publishing Company 2004.
3. Jain R.K and Iyengar S.R.K, “Advanced Engineering Mathematics”, Narosa PublishingHouse Pvt. Ltd., New Delhi, 3rd Edition, 2007.
4. Ince E.L “Ordinary Differential Equations”, Dover Publications 1958.

Course Code	Course Title	L	T	P	C
19UPH204	BIOMATERIAL PHYSICS (Common to BME & BT)	3	0	0	3

OBJECTIVES:

- To identify the fleet of scientific channels exploring the generation of high-tech Bio materials.
- To enable the students to understand the properties of Implant materials.
- To provide a comprehensive overview of new engineering material's in terms of thesynthesis, characterization, properties, and applications.

UNIT – I	BIO THERMODYNAMICS	13

Introduction – Thermodynamics of living systems – Conservation of energy in living systems – Entropy and Life – Gibbs and Standard free energy – Equilibrium constant – Coupled reactions – Diffusion – Laws of diffusion – Active transport – Facilitated diffusion – Osmosis – Osmoregulation – Viscosity and biological importance – Surface tension – Factors influencing surface tension – Biological importance.

UNIT – II	IMPLANT MATERIALS	10

Introduction – different classes of materials used in medicine – mechanical & thermal properties –Metallic implant materials – stainless steels – co-based alloys – Ti-based alloys – ceramic implant materials – aluminum oxides – glass ceramics – carbons – Applications.

UNIT – III	NEW ENGINEERING MATERIALS	12

Introduction – Metallic glasses – preparation – properties – medical applications – Shape memoryalloys – preparation – properties – medical applications – Bio Materials -- Classification – properties Testing of biomaterials – Application – Nano materials – fabrication methods – Plasma arching –Chemical Vapour deposition – ball milling – sol gel method – Medical applications – Nano medicine Nano sensors – Drug delivery.

UNIT – IV	FIBRE OPTICS IN MEDICINE	10

Introduction – Principle and propagation of optical fibre – Types of optical fibre – Attenuation – Advantages of optical fibre – Remote spectrophotometry – Fibre optic sensors – Body temperature and Blood pressure sensor – Applications – Fibre optic endoscope.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Apply the law of thermodynamics in living system.	Apply
CO2	Interpret the usage of new engineering materials in the area of medical implantation.	Analyze
CO3	Explain the transport properties of biomolecules, mechanical and thermal properties of new engineering materials and the optical properties of fiber in the biotechnology field.	Understand
CO4	Analyze the constructional parameters of optical fibers in endoscopy imaging and various molecular transport phenomenon of biomaterials []	Analyze
CO5	Apply the concept of nanotechnology in biomaterials towards the usage of human body implantation.	Apply
CO6	Apply the principle of propagation of light in optical fiber to study the various prospects in biomedical field.	Apply

TEXT BOOKS:

1. Jeffrey O.Hollinger, "An Introduction to biomaterials", Second Edition, CRC Press. NewDelhi, 2010.
2. Dr. Mani.P ," Physics ", Dhanam Publications, Chennai Revised Edition, 2018.
3. V. Rajendran, Materials Science, Tata McGraw-Hill, New Delhi, 2018.

REFERENCES:

1. Raghavan.V, "Material Science and Engineering", Prentice Hall of India Private Limited,New Delhi, Revised Edition 2018.
2. Palanisamy P.K., "Engineering Physics', Scitech Publication, Chennai, Edition, 2018.

Course Code	Course Title	L	T	P	C
19UCY204	ENVIRONMENTAL SCIENCE (Common to ALL Branches)	3	0	0	3

OBJECTIVES:

- To understand the concepts of Environment and ecosystem.
- To acquire knowledge about the impact of environmental pollution.
- To understand the importance of environmental issues in the society.
- To gain knowledge about the impact of environment related to human health.
- To gain knowledge in alternative energies.

UNIT – I	**ENVIRONMENT AND ECOSYSTEMS**	**9**

Definition, scope and importance of environment – Need for public awareness – Concept of ecosystem – Structure and function of ecosystem – Producers, consumers and decomposers – Food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the (a) Forest ecosystem (b) Aquatic ecosystems (c) Grass land ecosystem.

UNIT – II	**ENVIRONMENTAL POLLUTION**	**9**

Definition — Causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution – pollution case studies – Role of an individual in prevention of pollution – Disaster management: floods, earthquake, cyclone and landslides.

UNIT – III	**SOCIAL ISSUES AND THE ENVIRONMENT**	**9**

Water conservation, rain water harvesting, watershed management — Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies. Environmental laws/Acts, (EPA).

UNIT – IV	**HUMAN POPULATION AND THE ENVIRONMENT**	**9**

Population growth, variation among nations – Population explosion – Human rights – Family welfare programme – Environment and Human Health – Human Rights – Value education – HIV /AIDS – Women and child welfare – Role of information technology in environment and human health.

UNIT – V	**FUTURE POLICY AND ALTERNATIVES**	**9**

Introduction to future policy and alternatives – fossil fuels – nuclear energy-solar energy – wind energy – hydroelectric energy – geothermal energy – tidal energy – sustainability – green power – nanotechnology.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Understand the basic concept of structure and function of ecosystem	Understand
CO2	Apply the knowledge of various pollution types to prevent the ecosystem and Environment	Apply
CO3	Analyze the environmental problem to report the social issues and the environment.	Analyze
CO4	Compare the suitable methods for conservation and sustainable development of natural resources	Analyze
CO5	Apply the principles of value education with respect to human population to preserve environment	Apply
CO6	Analyze the current energy crisis and suggest a suitable sustainable alternatives that promotes social health and environmental prospects.	Analyze

TEXT BOOKS:

1. Anubha Kaushik, kaushik C.P., “Environmental Science and Engineering”, Third Edition,New Age International, New Delhi, 2009.
2. Benny Joseph “Environmental Science and Engineering”, Tata Mc-Graw Hill, New Delhi, 2006.

REFERENCES:

1. Gilbert M. Masters, ‘Introduction to Environmental Engineering and Science’, PearsonEducation, Upper saddle River, New Jersey, 2008.
2. Miller T.G. Jr., Environmental Science”, Wadsworth Publishing Company, Belmont,California, 2005.
3. De A.K., “Environmental Chemistry”, Wiley Eastern Ltd., New Delhi, 2001.
4. Trivedi R.K., Goel P.K., “Introduction to Air Pollution”, Techno-Science Publication, Jaipur,2005.

Course Code	Course Title	L	T	P	C
19UBM205	INTRODUCTION TO BIOMEDICAL ENGINEERING	3	0	0	3

OBJECTIVES:

- To explain the basics of biomedical engineering in healthcare.
- To discuss the opportunities of Biomedical engineering.
- To introduce the scopes and various domains of Biomedical Engineering.

UNIT – I	INTRODUCTION	9

Evolution of modern health care system – Engineering in modern medicine – Definition ofBiomedical Engineering – Roles played by Biomedical Engineers – Professional status of Biomedical Engineering – History of Biomedical Devices.

UNIT – II	BIOLOGY AND ENGINEERING	9

Introduction to human anatomy and physiology related to biomedical devices — Engineering of immunity and pathology – Communication systems in the body and its connection to biomedicalengineering – Medical Electronics – Basis of Bioelectric potential Bio potential electrodes.

UNIT – III	CLINICAL ENGINEERING	9

Evolution of clinical engineering – Clinical engineer Vs Biomedical engineer – Role of clinical engineers – Good clinical practice – Major functions of a clinical engineering – Standards forclinical engineering.

UNIT – IV	DOMAINS IN BIOMEDICAL ENGINEERING	9

Introduction to: Medical devices and Robotics – Bio fabrication and Bio manufacturing – Biomedical Imaging – Bio molecular Science and Engineering – Musculoskeletal Biomechanicsand Mechanobiology – Systems Biology – Tissue Engineering – Rehabilitation Engineering – Biomaterials and Nanotechnology – Neural Engineering.

UNIT – V	RECENT ADVANCES IN BIOMEDICAL ENGINEERING	9

Introduction to: Research Opportunities – Prosthetics: Orthopedic Prosthetics, Neural Prosthetics – Stem cell Research – Virtual Reality – Forensic Science – Regenerative Medicine – Ergonomics – Robotics in Biomedical — IoT in Biomedical — Genetic Engineering — Smart health careEngineering – Technical Societies – Higher Studies opportunities.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Discuss his/her role as a biomedical engineer.	Understand
CO2	Interpret the application of biology in engineering.	Understand
CO3	Examine his/her responsibility as a clinical engineer.	Analyze
CO4	Explain the various domains and recent advances in biomedicalengineering.	Understand

TEXT BOOKS:

1. John D Enderle and Joseph D Bronzino, “Introduction to Biomedical Engineering” ThirdEdition, Academic Press — An Imprint of Elsevier, 2018.

REFERENCES:

1. C. Raja Rao, Sujoy K. Guha, Principles of Medical Electronics and Biomedical Instrumentation, Universities Press, 2001.
2. W. Mark Saltzman, Biomedical Engineering: Bridging Medicine and Technology, Cambridge University Press, 2015.
3. Sundararajan V. Madihally, Principles of Biomedical Engineering, Artech House Publishers, 2010.
4. Azzam F.G. Taktak, Paul Ganney, David Long, Clinical Engineering: A Handbook for Clinical and Biomedical Engineers, Elsevier, 2013.

Course Code	Course Title	L	T	P	C
19UBM206	ELECTRICAL CIRCUITS AND MEASUREMENTS	3	0	0	3

OBJECTIVES:

- To introduce the basic concepts of DC and AC circuits behavior.
- To introduce different methods of circuit analysis using Network theorems.
- To study the transient and steady state response of the circuits.
- To discuss the construction and working of basic electrical instruments.

UNIT – I	INTRODUCTION AND ANALYSIS	9

Voltage and current sources: independent, dependent, ideal and practical – VI characteristics of resistor, inductor, mutual inductance and capacitor – Ohm's Law – Kirchoffs laws – Resistors inseries and parallel circuits – Mesh current and node voltage methods of analysis for D.C circuits.

UNIT – II	NETWORK THEOREMS	9

Network reduction: voltage and current division – source transformation – star delta conversion – Thevenin's Theorem – Norton's Theorem – Superposition Theorem – Maximum power transfertheorem — Reciprocity Theorem.

UNIT – III	RESONANCE AND COUPLED CIRCUITS	9

Series and parallel resonance – their frequency response – Quality factor and Bandwidth – Self and mutual inductance – Coefficient of coupling.

UNIT – IV	TRANSIENTS AND AC CIRCUITS	9

Transient response of RL, RC and RLC Circuits with dc excitation – Peak, average and RMSvalues of ac quantities – apparent, active and reactive powers – phasor analysis – impedance and admittance.

UNIT – V	ELECTRICAL INSTRUMENTS	9

Construction and working of Permanent Magnet Moving Coil instruments — Moving Iron instruments – Dynamometer – DC Potentiometer.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Deduce RLC networks using mesh and nodal method	Apply
CO2	Apply various network theorems for the analysis of electrical circuits.	Apply
CO3	Explain the concept of resonance.	Understand
CO4	Analyze transient response of DC circuits.	Analyze
CO5	Explain the construction and working of PMMC, MI, Dynamometer andDC potentiometer.	Understand

TEXT BOOKS:

1. Sudhakar A and Shyam Mohan S.P., "Circuits and Network Analysis and Synthesis", TataMcGraw Hill, 2007.
2. Sawhney A.K., "Electrical & Electronic Measurement & Instruments", Dhanpat Rai & Co. Publications, 2005.

REFERENCES:

1. Joseph A. Edminister, Mahmood Nahri, "Electric circuits", Schaum's series, Fifth Edition,Tata McGraw-Hill, New Delhi, 2010.
2. Chakrabati A, "Circuits Theory (Analysis and synthesis), Dhanpath Rai & Sons, New Delhi,1999.
3. Charles K. Alexander, Mathew N.O. Sadik, "Fundamentals of Electric Circuits", SecondEdition, McGraw Hill, 2003.
4. Banerjee G. K.", "Electrical and Electronic Measurements", PHI Learning Pvt. Ltd., 2ndEdition, 2016.

Course Code	Course Title	L	T	P	C
19UGS210	ENERGY AND ENVIRONMENTAL SCIENCELABORATORY (Common to ALL Branches)	0	0	3	1.5

PHYSICS LABORATORY

OBJECTIVES:

- To analyze the Band gap, moment of inertia, thermal conductivity and rigidity modulus ofthe materials.
- To gain knowledge in Photonics.

LIST OF EXPERIMENTS:

A minimum of FIVE experiments shall be offered

1. Determination of Energy band gap of a semiconductor.
2. Torsion pendulum — Determination of Moment of inertia of a metallic disc and rigidity modulus of a given metallic wire.
3. Spectrometer - Determination of wavelength of mercury spectrum using grating.
4. Laser – Determination of numerical aperture and acceptance angle of an optical fiber.
5. Newton's rings – Determination of radius of curvature of a convex lens.
6. Lee's Disc - Determination of thermal conductivity of a bad conductor.
7. Determination of Solar cell Characteristics using optical transducers kit.

CHEMISTRY LABORATORY

OBJECTIVES:

- To apply the theoretical concepts to perform lab experiments.
- To assess the water quality parameters.
- To acquire knowledge on water quality parameters for the analysis of industrial effluents

LIST OF EXPERIMENTS:

A minimum of FIVE experiments shall be offered

1. Estimation of hardness of water by EDTA method.
2. Estimation of alkalinity of water sample.
3. Estimation of Chloride in water sample (Argentometric method).
4. Determination of DO in water.
5. Estimation of chromium in tannery wastes.
6. Estimation of available chlorine in bleaching powder.
7. Estimation of iron by Spectrophotometry.
8. Determination of acidity of industrial effluents.

Laboratory classes on alternate weeks for Physics and Chemistry: TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Apply the principles of Light and Elasticity to determine the Engineering properties of materials	Apply
CO2	Analyze the thermal conductivities of different bad conductors	Analyze
CO3	Analyze the Characteristics of a semiconductor	Analyze
CO4	Apply the basic knowledge of water quality testing for environmental sustainability.	Apply
CO5	Analyze the water quality parameters for industrial effluents to prevent water pollution.	Analyze
CO6	Estimate the quality of water that suits for domestic and industrial applications	Apply

Course Code	Course Title	L	T	P	C
19UBM211	ELECTRICAL CIRCUITS LABORATORY	0	0	3	1.5

OBJECTIVES:

- To familiarize the basic electrical laws and network theorems.
- To determine the resonance and transient responses of RLC circuits.

LIST OF EXPERIMENTS:

1. Verification of Ohm's law.
2. Verification of Kirchoff's laws.
3. Verification of Mesh and Nodal Analysis
4. Verification of Thevenin's theorem.
5. Verification of Norton's theorem.
6. Verification of Reciprocity theorem.
7. Verifications of Super Position Theorem
8. Verifications of maximum power transfer
9. Determination of Resonance Frequency of Series & Parallel RLC Circuits.
10. Transient analysis of RL and RC circuits.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Test the basic electrical laws.	Apply
CO2	Verify the theorems using simple circuits.	Apply
CO3	Determine Resonance and Transient responses.	Apply

HARDWARE REQUIREMENTS

Sl. No.	Name of the equipment	Quantity required
1.	Voltmeter	15
2.	Ammeter	15
3.	CRO (30MHz)	4
4.	Function Generators (3MHz)	4
5.	Regulated Power Supplies (0 – 30V)	10
6.	Multimeter	5
7.	DRB	4
8.	DCB	2
9.	Resistor	Required Nos.
10.	Capacitor	Required Nos.
11.	Inductance	Required Nos.
12.	Bread board	10

SEMESTER III

S.No.	CourseCode	Course Title	Course Category	L	T	P	C
THEORY							
1.	19UMA326	Transform Techniques and PartialDifferential Equations (Common to AGRI, CHE & BME)	BS	3	1	0	4
2.	19UBM302	Human Anatomy and Physiology	PC	3	0	0	3
3.	19UBM303	Biochemistry	PC	3	0	0	3
4.	19UBM304	Biomedical Instrumentation	PC	3	0	0	3
5.	19UBM305	Semiconductor Devices and Circuits	PC	3	0	0	3
6.	19UBM306	Sensors and Measuring Techniques	PC	3	0	0	3
PRACTICAL							
7.	19UBM307	Semiconductor Devices and Circuits Laboratory	PC	0	0	3	1.5
8.	19UBM308	Biochemistry and Human Physiology Laboratory	PC	0	0	3	1.5
MANDATORY							
9.	19UGM331	Biology for Engineers (Common to BME & BT)	MC	2	0	0	P/F
			Total	20	1	6	22
Total Credits : 22							

Course Code	Course Title	L	T	P	C
19UMA326	TRANSFORM TECHNIQUES AND PARTIALDIFFERENTIAL EQUATIONS (Common to AGRI, CHEMICAL, BME & BT)	3	1	0	4

OBJECTIVES:

- To make the student knowledgeable in formulating certain practical problems in terms of partial differential equations, solve them and physically interpret the results.
- To familiarize the students to formulate and identify certain boundary value problems encountered in engineering practices, decide on applicability of the Fourier series method of solution, solve them numerically and interpret the results.
- To acquaint the student with the basics of Z - transform in its applicability to discretely varying functions, gained the skill to formulate certain problems in terms of differenceequations and solve them using the Z - transform technique bringing out the elegance of the procedure involved.

UNIT – I	FOURIER SERIES	9 + 3

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series –Half range cosine series – Complex form of Fourier Series – Parseval's identity – Harmonic analysis – Application of Fourier series – Gibb's Phenomenon.

UNIT – II	FOURIER TRANSFORM	9 + 3

Fourier integral theorem (without proof) – Fourier transform pair – Sine and Cosine transforms – Properties — Transforms of simple functions — Convolution theorem — Parseval's identity — Application of Fourier Transform.

UNIT – III	Z-TRANSFORM AND DIFFERENCE EQUATIONS	9 + 3

Organization of nervous system – Neuron – Classification and Properties of nerve fibers – Synapse – Neurotransmitters – Reflex activity – Central Nervous System (CNS): Structure and functions of Brain and Spinal cord – Peripheral Nervous System (PNS): Structure and functions of Sympathetic and Parasympathetic nervous system.

UNIT – IV	PARTIAL DIFFERENTIAL EQUATIONS	9 + 3

Formation of partial differential equations – Singular integrals – Solutions of standard types of firstorder partial differential equations – Lagrange's linear equation – Linear partial differential equations of second and higher order with constant coefficients of both homogeneous and non- homogeneous types.

UNIT – V	APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS	9 + 3

Introduction of Partial differential equations – Solutions of one dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two-dimensional heat equation(Insulated edges excluded) – Fourier series solutions in Cartesian coordinates.

TOTAL : 45 (L) + 15 (T) = 60 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Apply the knowledge of Fourier series for the given function or Discretedata and compute the Periodic function arising in the study of Engineering problems.	Apply
CO2	Apply the knowledge of Fourier transform and its properties which are used to transform signals between time and frequency domain.	Apply
CO3	Apply the acquired knowledge of Z transform and its properties inverse Z transform and difference equations.	Apply
CO4	Apply the knowledge of partial differential equation in solving linear and higher order partial differential equation.	Apply
CO5	Apply the knowledge of PDE in solving linear, higher order and one dimensional Wave, Heat flow equation.	Apply
CO6	Understand the basic concept of periodic, non-periodic function and nature of partial differential equation.	Understand

TEXT BOOKS:

1. Grewal B.S, "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 42ndEdition, (2012).
2. Bali N.P., Manish Goyal and Watains, "Advanced Engineering Mathematics", Firewall Media(An imprint of Laxmi Publication Private limited) New Delhi, 7th Edition, 2009.
3. Veerajan.T, "Higher Engineering Mathematics", Yes Dee Publishing Pvt. Limited, 2015.

REFERENCES:

1. Kandasamy.P, Thilagavathy.K and Gunavathy.K, "Engineering Mathematics III", S.Chand &Company Ltd., New Delhi, 3rd Edition, 1996.
2. Ramana.B.V, "Higher Engineering Mathematics" Tata McGraw Hill, New Delhi, 11th Reprint2010.
3. Glyn James, "Advanced Modern Engineering Mathematics", Pearson Education, New Delhi, 3rd Edition, 2007.
4. Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley India, 10th Edition, 2011.

Course Code	Course Title	L	T	P	C
19UBM302	HUMAN ANATOMY AND PHYSIOLOGY	3	0	0	3

OBJECTIVES:

- To explore the structural and functional elements of human body.
- To explain structure and functions of various types of organ systems of human body.
- To familiarize the fundamental relation between human anatomy and physiology.

UNIT – I	CELL: STRUCTURE AND FUNCTIONS	9

Functional Organization of the Human Body and Control of the Internal Environment. Cell: Different types of cells — Structure and organelles — Functions of each component in the cell — Cell membrane: transport across membrane – Origin of cell membrane potential (Nernst and Goldmanand Katz equations) – Action potential and propagation. Cell division: Mitosis & Meiosis, Cell cycle and its Regulation.

UNIT – II	CARDIOVASCULAR AND RESPIRATORY SYSTEM	9

Cardiovascular System – Heart: Structure of the heart – Functions – Actions of the heart – Propertiesof cardiac muscle – Conducting system of heart – Cardiac cycle – Relationship of the Heart soundsto Heart pumping – classification of circulatory system – Volume and pressure changes and regulation of heart rate. Respiratory system – Lungs: Structure and functions – Types and phasesof respiration – Breathing mechanism – Respiratory tract – Pulmonary ventilation and Pulmonary circulation – Regulation of respiration.

UNIT – III	NERVOUS SYSTEM	9

Organization of nervous system – Neuron – Classification and Properties of nerve fibers – Synapse – Neurotransmitters – Reflex activity – Central Nervous System (CNS): Structure and functions of Brain and Spinal cord – Peripheral Nervous System (PNS): Structure and functions of Sympathetic and Parasympathetic nervous system.

UNIT – IV	DIGESTIVE AND EXCRETORY SYSTEM	9

Digestive system: Gastro Intestinal functions – Motility, Nervous Control and Blood Circulation – Digestion and absorption – Movement of GI tract – Secretion of digestive fluids. Urinary system: Structure and functions of Kidney and Nephron – Mechanism of Urine formation – Regulation of extracellular fluid Osmolarity, Sodium Concentration and other ions – Regulation of Acid – Base balance.

UNIT – V	SKELETAL AND SENSORY SYSTEM	9

Skeletal System: Bone types and functions – Organization of skeletal muscle – physiology of muscle contraction – neuromuscular junction. Joint – Types of Joints – Cartilage and functions. Sensory organs: Auditory (Ear), Olfactory (Nose), Ophthal (Eye), Gustatory (Taste) and Tactile (Touch).

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Use correct terminology to discuss the structure and function of the human body, diseases, disorders and conditions commonly found in human beings.	Understand
CO2	Apply concepts and knowledge of the general terminology, cell structure, histology and gross anatomy of several organ systems to clinical scenarios.	Apply
CO3	Analyse various cell structure at tissue and organ levels to maintain the homeostasis condition.	Analysis
CO4	Investigate the parameters and factors responsible for various vital functions of human body and correlate with the diseased conditions and various disorders.	Analysis
CO5	Evaluate information on human health and medical research related to its social, environmental, and ethical implications as a responsible member of society.	Evaluate

TEXT BOOKS:

1. Arthur C, Guyton, John Hall. E “Textbook of Medical Physiology”, W.B. Saunders Company,Eleventh edition, 2006
2. K Sembulingam, PremaSembulingam “Essentials of Medical Physiology” Jaypee BrothersMedical Publishers (P) Ltd, Sixth edition, 2012.

REFERENCES:

1. Prabhjot Kaur, “Text Book of Anatomy and Physiology”, Lotus Publsihers, 2014.
2. Elaine.N. Marieb, Essential of Human Anatomy and Physiology, Eight Edition, PearsonEducation, New Delhi, 2007.
3. Frederic H. Martini, Judi L. Nath, Edwin F. Bartholomew, Fundamentals of Anatomy andPhysiology. Pearson Publishers, 2014.
4. Gillian Pocock, Christopher D. Richards, The human Body – An introduction for Biomedicaland Health Sciences, Oxford University Press, USA, 2013.

Course Code	Course Title	L	T	P	C
19UBM303	BIOCHEMISTRY	3	0	0	3

OBJECTIVES:

- To learn about fundamentals of chemical foundations of biology.
- To explore the principle of general techniques and study its biomedical applications.
- To study structural & functional properties of carbohydrates, proteins, lipids and nucleicacids.
- To emphasize the overview of metabolic pathways of bio-molecules and their biomedical significance.

UNIT – I	BIOCHEMISTRY : CHEMICAL BASIS OF LIFE	9

Introduction to Biochemistry – Bio-organic Chemistry – Biophysical Chemistry – Tools of Biochemistry – Biomolecules – Study of Metabolic processes – Stabilizing forces in molecules: Covalent and Ionic bonds – Principles of Thermodynamics.

UNIT – II	METABOLISM OF CARBOHYDRATES	9

Nomenclature – Biological Functions – Classification: Monosaccharides, Disaccharides, Oligosaccharides, Polysaccharides, Mucopolysaccharides, Glycoproteins and Mucoproteins – Structure – physical and chemical properties of carbohydrates – Metabolic Pathways of Glucose: Glycogen, Glycogenolysis, Glycogenesis and its hormonal regulation – Metabolic disorders.

UNIT – III	PROTEINS, AMINO AND NUCLEIC ACIDS	9

Proteins: Structure – Primary, Secondary, Tertiary, Quaternary – Properties – Denaturation – Classification — Plasma Proteins — Amino Acids: Structure — Classification — Properties — Metabolism – Peptide bond formation – Nucleic Acids: Structure of purines and pyrimidines, Nucleoside, Nucleotide, DNA act as a genetic material, Chargoffs rule– Watson and crick model of DNA– Structure of RNA and its type – Metabolic disorders.

UNIT – IV	ENZYME AND LIPID METABOLISM	9

Enzymes: Nomenclature and Classification – Chemical Nature and Properties of Enzymes – Factors affecting Enzyme activity – Mechanism of Enzyme Action – Application and Diagnosticimportance of Enzymes. Lipids: Classification of lipids – Fatty acids – Saturated fatty acids – Unsaturated fatty acids – Trans fatty acids – Neutral fats – Phospholipids – Physical and chemicalproperties of lipid – Metabolic pathways – Synthesis and degradation of fatty acid – Hormonal metabolism of fatty acid metabolism – Metabolic disorders.

UNIT – V	ENVIRONMENTAL BIOCHEMISTRY AND GENERAL TECHNIQUES	9

Environmental Biochemistry: Atmospheric Changes – Pollution – Carcinogens – Metabolism of Nitrogen containing compounds: Nitrogen fixation, Amino acids and Nucleotides Photosynthesis: Calvin cycle. General Techniques: Electrophoresis – Chromatography – Radioimmunoassay – ELISA test – Colorimeter – Auto-analyzer – Mass spectrometry.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Explain the structural and functional aspects of bio-molecules and enzymes.	Understand
CO2	Apply the principle of bio-molecules and their characteristics inbiochemical processes	Apply
CO3	Analyze biochemical processes involved in the metabolic pathways ofbio-molecules and its metabolic activity in normal and abnormal conditions.	Analyze
CO4	Investigate metabolic disorders of bio-molecules and enzymes	Evaluate
CO5	Design biochemical devices for the differentiation of normal andabnormal clinical diseases.	Create
CO6	Conduct experiments in laboratories and participate in solving clinical problems with strong foundation in the structure and reactions of bio- molecules.	Apply

TEXT BOOKS:

1. Dr.U.Satyanarayana, “Biochemistry”, 3rd Revised Edition, ArunabhaSen Books & Allied (P) Ltd. 2007.
2. D.M. Vasudevan, “Textbook of Biochemistry for Medical Students”, Jaypee BrothersMedical Publishers (P) Ltd, Seventh Edition, 2013.

REFERENCES:

1. RAFI MD, “Text book of biochemistry for Medical Student”, Second Edition, UniversityPress, 2014.
2. Keith Wilson & John Walker, “Practical Biochemistry – Principles & Techniques”, OxfordUniversity Press, 2009.
3. Pamela. C. Champe & Richard. A. Harvey, “Lippincott Biochemistry Lippincott’s IllustratedReviews”, Raven publishers, 1994.
4. David. W. Martin, Peter. A. Mayes, Victor. W. Rodwell, “Harper’s Review of Biochemistry”, LANGE Medical Publications, 1981.

Course Code	Course Title	L	T	P	C
19UBM304	BIOMEDICAL INSTRUMENTATION	3	0	0	3

OBJECTIVES:

- To explain the basic theory of bio potential electrodes and measurement.
- To design Bio potential amplifiers for acquisition of bio signals.
- To familiarize the various non-electrical physiological parameter measurement and biochemical measurements.

UNIT – I	BIO POTENTIAL ELECTRODES	9

Origin of bio potential and its propagation – Electrode-electrolyte interface – electrode-skin interface – half-cell potential –contact 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 MEASUREMENT	9

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

UNIT – III	SIGNAL CONDITIONING CIRCUITS	9

Need for bio-amplifier – single ended bio-amplifier, differential bio-amplifier – right leg driven ECG amplifier – Impedance matching circuit – Isolation amplifiers – transformer and optical isolation –Isolated DC amplifier and AC carrier amplifier – Power line interference – Band pass filtering – Artifacts and removal.

UNIT – IV	MEASUREMENT OF NON-ELECTRICAL PARAMETERS	9

Temperature, respiration rate and pulse rate measurements–Measurement of blood pressure – direct and indirect methods – Pressure amplifiers – Systolic, diastolic, mean detector circuit – Blood flow measurement: Electromagnetic and ultrasound methods – Cardiac output measurement: Indicator dilution, dye dilution and thermodilution methods.

UNIT – V	BIOCHEMICAL MEASUREMENT AND BIOSENSORS	9

Biochemical sensors – pH, pO2 and pCO2, Ion selective Field effect Transistor (ISFET), Immunologically sensitive FET (IMFET), Blood glucose sensors – Blood gas analyzers – colorimeter, flame photometer, spectrophotometer, blood cell counter, auto analyzer (simplified schematic description) – Bio Sensors – Principles – amperometric and voltometric techniques.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Describe the fundamentals of bio signals recording.	Understand
CO2	Apply the fundamental concepts of bio potential recording to monitorthe clinical instrumentation system.	Apply
CO3	Select the suitable acquisition method for analyzing various vital parameters of bio signals.	Analyze
CO4	Interpret the appropriate parameter monitoring techniques based onthe clinical needs.	Evaluate
CO5	Develop a real-time biomedical data acquisition and processingsystems.	Create
CO6	Design a PCB layout for any bio-amplifier using software.	Apply

TEXT BOOKS:

1. John G.Webster, "Medical Instrumentation Application and Design", John Wiley and Sons,New York, 4th Edition, 2009.
2. Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw Hill, New Delhi, 3rd Edition, 2014.

REFERENCES:

1. Leslie Cromwell, "Biomedical Instrumentation and measurement", 2nd edition, Prentice Hallof India, New Delhi, 2015.
2. Joseph J. Carr and John M. Brown, "Introduction to Biomedical equipment technology",Pearson Education, 4th Edition, 2014.
3. L.A Geddes and L.E.Baker, "Principles of Applied Biomedical Instrumentation", John Wileyand sons, 3rd Edition, Reprint 2008.
4. Myer Kutz, ' Standard Handbook of Biomedical Engineering & Design', McGraw-Hill Publisher, 2003.

Course Code	Course Title	L	T	P	C
19UBM305	SEMICONDUCTOR DEVICES AND CIRCUITS	3	0	0	3

OBJECTIVES:

- To explain the working of various semiconductor devices.
- To explain the concept of amplifiers, regulators and oscillators using transistors.
- To learn the required functionality of positive and negative feedback systems.

UNIT – I	SEMICONDUCTOR DIODES &TRANSISTOR	9

PN Junction — Structure and Operation — Current components in a PN diode — Junction capacitance – Junction diode switching time– Structure and Operation of Zener diode – Varactordiode – Tunnel diode – Schottky diode-Transistor Structure – Basic Transistor operation – Transistor characteristics and parameters – Transistor bias circuits: Voltage divider bias circuits, base bias circuits, emitter bias circuits.

UNIT – II	FET, UJT and SCR	9

JFET – Characteristics and parameters – JFET biasing, self-bias, voltage divider bias – Q point – MOSFET – Characteristics and parameters – Characteristics of UJT and SCR.

UNIT – III	AMPLIFIERS	9

CE,CB and CC amplifiers – Small signal low frequency transistor amplifier circuits – h parameter representation of a transistor – Analysis of single stage transistor amplifier using parameters voltage gain, current gain, input impedance, output Admittance and frequency response – Power amplifiers: Class A,B and AB (Qualitative analysis).

UNIT – IV	FEEDBACK AMPLIFIERS AND OSCILLATORS	9

Advantages of negative feedback – Voltage/current, series/shunt feedback – Positive feedback – Condition for oscillators – Phase shift – Wein Bridge – Hartley-Colpitts and Crystal oscillators.

UNIT – V	PULSE CIRCUITS AND REGULATORS	9

RC wave shaping circuits — Diode clampers and clippers — Multivibrators — Astable and Monostable multivibrators — Schmitt triggers — UJT — Saw tooth oscillators — Single phase rectifiers and analysis of filter circuits – Design of zener and transistor series voltage regulators.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Explain the structure and working of basic electronic devices.	Understand
CO2	Identify various transistor biasing circuit and compensation circuit parameters.	Apply
CO3	Analyze the characteristics of different electronic devices such as diodes, transistors and amplifiers.	Analyze
CO4	Estimate the exact analysis and approximate analysis for amplifiers.	Evaluate
CO5	Design the Oscillator circuits and pulse wave shaping circuits for given specifications.	Create
CO6	Design a power supply, regulator and filter.	Apply

TEXT BOOKS:

1. Millman and Halkias, "Electronic Devices and Circuits", Tata McGraw–Hill, 2007.
2. Floyd, T.L, "Electronic Device" 7th Edition, Pearson Education, 2008.

REFERENCES:

1. Millman, J., PrakashRao., M.S. and Taub, H., "Pulse Digital and Switching Wave Forms",McGraw-Hill, 2nd Edition, 2007.
2. Streetman,B. and Sanjay,B., "Solid State Electronic Devices", Prentice-Hall of India, 5thEdition, 2005.
3. Mottershead, A., "Electronic Devices and Circuits an Introduction", Prentice Hall of India,2003.
4. Boylsted and Nashelsky, "Electronic Devices and Circuit Theory", Prentice Hall of India, 6thEdition, 1999.

Course Code	Course Title	L	T	P	C
19UBM306	SENSORS AND MEASURING TECHNIQUES	3	0	0	3

OBJECTIVES:

- To explain the purpose of measurement, the methods of measurements and errorsassociated with measurements.
- To explore the principle of transduction, classifications and the characteristics ofdifferent transducers and study its biomedical applications.
- To familiarize the different bridges, signal analyzers, display and recording devices.

UNIT – I	MEASUREMENT SYSTEM AND BASICS OF TRANSDUCERS	9

Measurements: Significance and methods – Instrumentation system – Classification of Instruments — Static and dynamic characteristics — Classification and selection of transducers – Errors in measurements and their statistical analysis – Calibration – Primary and secondary standards.

UNIT – II	DISPLACEMENT, PRESSURE AND TEMPERATURE SENSORS	8

Displacement & Pressure Measurement: Strain Gauge – Principle, Gauge factor – Types ofStrain gauges – Strain gauge as displacement & pressure transducers – Capacitivetransducer – Inductive transducer – LVDT – Temperature Measurement: RTD – Thermistor– Thermocouple – Materials, Range and Characteristics.

UNIT – III	PHOTOELECTRIC, PIEZOELECTRIC AND OTHER SENSORS	9

Phototube – Scintillation counter – Photo Multiplier Tube (PMT) – Photovoltaic, Photoconductive cells – Photo diodes – Phototransistor – Comparison of photoelectric transducers – Spectrophotometric applications of photo electric transducers – Piezoelectric activetransducer and biomedical applications as pressure & Ultrasound transducer – Digital Transducers – Introduction to MEMS and Nano sensors.

UNIT – IV	BRIDGE CIRCUITS AND SIGNAL ANALYZERS	9

AC and DC Bridges – Wheat stone bridge, Kelvin, Maxwell, Hay, Wien, Schering bridges – Function generator – Wave analyzer – Spectrum analyzer.

UNIT – V	DISPLAY AND RECORDING DEVICES	10

Digital voltmeter — Multi meter — CRO — block diagram — CRT — vertical & horizontal deflection system – Special purpose oscilloscopes – Dual beam, Dual trace, DSO – LCD and LED displays — Graphic recorders — Magnetic tape recorders — Digital recorders — Photographic, Inkjet, Thermal and Electrostatic recorders.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Discuss the generalized block diagram of an Instrument and discuss the important static and dynamic characteristics of sensors.	Understand
CO2	Explain the working principle of stain gauge, LVDT, RTD, thermistor and thermocouple.	Understand
CO3	Compare contact and noncontact sensors and explain the construction and working of noncontact photoelectric and piezoelectric sensors.	Analyze
CO4	Construct an appropriate bridge circuit for measuring low & medium resistance, Inductance and capacitance measurements respectively and drive the balance equations.	Apply
CO5	Differentiate conventional CRO with dual beam and dual trace CRO based on construction & working and discuss the construction & working of digital recorders.	Apply

TEXT BOOKS:

1. Doebelin E.O. and Manik D.N., “Measurement Systems – Applications and Design”, Tata McGraw-Hill Education Pvt. Ltd., 6th Edition, 2011.
2. 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”, 10th edition, DhanpatRai& Co, New Delhi, 19th Revised edition 2011, Reprint 2014.
2. L.A Geddes and L.E.Baker, “Principles of Applied Biomedical Instrumentation”, JohnWiley and sons, 3rd Edition, Reprint 2008.
3. Khandpur R.S, “Handbook of Biomedical Instrumentation”, Tata McGraw Hill, NewDelhi, 3rd Edition, 2014.
4. Kalsi H.S, “Electronic Instrumentation” Tata McGraw-Hill Education, 3rd edition, 2012.

Course Code	Course Title	L	T	P	C
19UBM307	SEMICONDUCTOR DEVICES AND CIRCUITSLABORATORY	0	0	3	1.5

OBJECTIVES:

To impart knowledge on:

- The characteristics of semiconductor and special purpose electron devices.
- Design of amplifiers, oscillators and regulators.
- Simulation software to implement electronic circuits.

LIST OF EXPERIMENTS:

1. Characteristics of PN Junction Diode.
2. Characteristics of Zener diode.
3. Characteristics of Transistor using CE and CB configurations.
4. Characteristics of JFET
5. Differential amplifier using FET.
6. Characteristics of Thyristor and UJT.
7. Design and Analysis of Feedback Amplifiers.
8. Design of RC Oscillators and LC Oscillators using BJT.
9. Characteristics of Passive filters.
10. Common PCB design and practice for simple circuits.
11. Simulate and study resistance impact under series and parallel connection using Circuit Simulation software.
12. Simulate and study of Common Emitter amplifier using Circuit Simulation software.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Identify, differentiate and construct the circuit amplifiers, oscillators and regulators.	Apply
CO2	Analyze practically the response of various special semiconductor devices.	Analyze
CO3	Relate the circuit models to perform parameter analysis.	Evaluate
CO4	Simulate and analyze circuits using suitable software tool.	Apply

HARDWARE REQUIREMENT:

S.No	Name of the experiment	Range/Specification	Quantity Required
1.	Regulated Power Supply	0-30V.2A	10
2.	Dual Tree CRO (20 MHz)	30MHZ	3
3.	Function Generator	3MHZ	3
4.	31/2 Digit digital multimeter	500mA/250V	8
5.	Bread Boards	-----	20
6.	Transistor	BC107	25
7.	JFET	BFW 10	10
8.	Diode	IN 4007	10
9.	Zener Diode	Z10	5
10.	UJT	ZN 2646	5
11.	Photo Diode	LED55C	5
12.	Photo Transistor	BPX38	5
13.	Milli Ammeter (0-100mA)	0-100mA, 0-50mA, 0-30mA	15
14.	Micro Ammeter (0-50µA)	(0-100mA), (0-50mA)	10
15.	Low range voltmeter (0-30V)	(0-10V), (0-1 V)	10
16.	Resistor	Various ranges	50
17.	Capacitors	Various ranges	50
18.	SCR	TYN616	5

Course Code	Course Title	L	T	P	C
19UBM308	BIOCHEMISTRY AND HUMAN PHYSIOLOGY LABORATORY	0	0	3	1.5

OBJECTIVES:

To impart knowledge on:

- Estimation and quantification of biomolecules.
- Separation of macromolecules.
- Interpretation of metabolic changes in pathological conditions.

LIST OF EXPERIMENTS:

Biochemistry:

1. General tests for carbohydrates, proteins and lipids.
2. Preparation of solutions: Percentage solutions, Molar solutions, and Normal solutions
3. Standardization of pH meter, preparation of buffers, emulsions.
4. Separation of amino acids by thin layer chromatography.
5. Preparation of serum and plasma from blood and estimation of Haemoglobin
6. Estimation of blood glucose & cholesterol.
7. Estimation of creatinine.
8. Estimation of urea and Uric acid
9. Urine physical and chemical examination (protein, reducing substances, ketones, bilirubinand blood)
10. Separation of DNA by agarose gel electrophoresis. (demo)
11. Separation of proteins by SDS electrophoresis. (demo)

Human Physiology:

12. Identification of Blood groups
13. Differential count of Blood cells
14. Total RBC and WBC count.
15. ESR, PCV, MCH, MCV and MCHC estimation.
16. Assay of SGOT/SGPT.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Demonstrate various biochemical reactions using human body fluids or in given samples and quantify the bio-molecules.	Apply
CO2	Examine normal and abnormal biochemical reactions in human body and quantitative analysis of blood glucose, creatinine, urea and cholesterol.	Analyze
CO3	Evaluate the composition of blood and urine samples.	Evaluate
CO4	Implement experimental protocols and adapt to plan and carryout simple investigations.	Create

HARDWARE REQUIREMENT:

Sl. No.	Name of the equipment	Quantity required
1.	Spectrophotometer	1
2.	Colorimeter	2
3.	pH meter	1
4.	Refrigerator	1
5.	Vortex Shaker	2
6.	SDS gel electrophoresis	1
7.	TLC plates	1
8.	Wintrobe tube	2
9.	Centrifuge Normal	1
10.	Microslides	2 packets
11.	Lancet : 5 boxes	5 boxes
12.	Microscope	1
13.	Neubaur's Chamber	1
14.	Heparinized Syringe	1 box
15.	Haemoglobinometer	1

Sl. No.	Name of the equipment	Quantity required
16.	Capillary tubes	1
17.	Blood grouping kit	1
18.	Wax dispenser	1
19.	Slide warming	1
20.	Slides	1 box
21.	Cover slip	1 box
22.	Water bath normal	1
23.	Oven	1
24.	PCV tube	2

Course Code	Course Title	L	T	P	C
19UGM331	BIOLOGY FOR ENGINEERS (For BME & BT)	2	0	0	P/F

OBJECTIVES:

- To explain the essentials of basic biological principles.
- To familiarize the different clinical and industrial applications of biology for solvingsocietal problems with engineering tools.

UNIT – I	INTRODUCTION TO LIFE	5

Characteristics of living organisms — Basic classification — Cell theory–Structure of prokaryotic and eukaryotic cell – Introduction to Bio-molecules: Definition – Generalclassification and important functions of Carbohydrates – Lipids – Proteins – Nucleic acids, Vitamins and Enzymes – Genes and Chromosome.

UNIT – II	BIODIVERSITY	5

Plant System: Basic concepts of Plant growth – Nutrition – Photosynthesis and Nitrogen fixation – Animal System: Elementary study of Digestive, Respiratory, Circulatory, Excretory systems and their functions – Microbial System: History – types of Microbes – Economic importance and control of microbes.

UNIT – III	BASICS OF CELL AND MOLECULAR BIOLOGY	6

Discovery of cell and Cell Theory – Comparison between plant and animal cells – Cell wall –Plasma membrane – Modification of plasma membrane and intracellular junctions – Central Dogma of Molecular biology – Stem cells and Tissue engineering.

UNIT – IV	HUMAN DISEASES	7

Infectious and Non-infectious diseases – Causative agents – Epidemiology – Pathogenicity,Control and prevention – Treatment of AIDS – Tuberculosis – Pathology of non-infectious and genetic diseases and disorders – Cancer, Diabetes mellitus, Cardiac diseases – Neurological disorders – Parkinson's disease.

UNIT – V	BIOLOGY AND ITS INDUSTRIAL AND CLINICAL APPLICATION	7

Transgenic plants and animals – Bioreactors – Bio-pharming – Recombinant vaccines– Cloning– Drug discovery — Artificial memory and neural networks — Bioremediation — Biofertilizer — Biocontrol — Biofilters — Biosensors — Biopolymers — Bioenergy — Biochips — Basic Biomedical Instrumentation – Biostatistics.

TOTAL : 30 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Explain the fundamentals of living things, their classification, cell structure and biochemical constituents.	Understand
CO2	Apply the concept of plant, animal and microbial systems and growth in real life situations.	Apply
CO3	Analyze biological engineering principles, procedures needed to solve societal issues.	Analyze

TEXT BOOKS

1. Satyanarayana, U. "Biotechnology", 4th Edition, Books and Allied Pvt. Ltd. Kolkata,2007.
2. Carol D. Tamparo and Marcia A. "Diseases of the Human Body", Lewis, F.A. Davis Company, 2011.
3. R. Khandpur, "Biomedical instrumentation - Technology and applications", McGraw Hill Professional, 2004.

REFERENCES

1. Lehninger A.L, Nelson D.L, Cox .M.M, Principles of Biochemistry", CBS Publications 2017.
2. Arthur T. Johnson, "Biology for Engineers", CRC Press, Taylor and Francis, 2nd Edition, 2019.
3. Cecie Starr, Ralph Taggart, Christine Evers and Lisa Starr, "Cell Biology and Genetics (Biology: The unity and diversity of life Volume I)", Cengage Learning, 12th Edition, 2008.
4. B.D. Singh, "Biotechnology: Expanding horizon", Kalyani Publishers, 2015.

SEMESTER IV

S.No.	Course Code	Course Title	Course Category	L	T	P	C
THEORY							
1.	19UMA424	Probability and Inferential Statistics	BS	3	1	0	4
2.	19UBM402	Analog and Digital Integrated Circuits	PC	4	0	0	4
3.	19UBM403	Medical Physics	PC	3	0	0	3
4.	19UBM404	Principles of Signals and Systems	PC	3	0	0	3
5.	19UBM405	Pathology and Microbiology	PC	3	0	0	3
6.	19UBM406	Diagnostic and Therapeutic Equipments – I	PC	3	0	0	3
PRACTICAL							
7.	19UBM407	Analog and Digital Integrated Circuits Laboratory	PC	0	0	3	1.5
8.	19UBM408	Sensors and Biomedical Instrumentation Laboratory	PC	0	0	3	1.5
9.	19UBM409	Pathology and Microbiology Laboratory	PC	0	0	3	1.5
10.	19UBM410	Technical Seminar	P	0	0	2	1
MANDATORY							
11.	19UGM431	Gender Equality	MC	1	0	0	P/F
			Total	20	1	11	25.5
Total Credits : 25.5							

Course Code	Course Title	L	T	P	C
19UMA424	PROBABILITY AND INFERENTIAL STATISTICS	3	1	0	4

OBJECTIVES:

- To provide necessary basic probability concepts and standard distributions that candescribe real life phenomena.
- To make the student acquire skills in handling situations involving more than one randomvariable and functions of random variables.
- To make the student understand and characterize phenomena which evolve with respectto time in probabilistic manner.
- To familiarize the student to analyze the response of random inputs to linear time invariantsystems.

UNIT – I	PROBABILITY & STATISTICAL DISTRIBUTIONS	9 + 3

Axioms of probability – Conditional probability – Total probability – Baye's theorem – Discrete and continuous random variables – Moments – Moment generating functions and their properties.Binomial, Poisson, Normal, Geometric, Uniform, Exponential and Gamma distributions.

UNIT – II	TWO DIMENSIONAL RANDOM VARIABLES	9 + 3

Joint probability distributions – Marginal and Conditional distributions – Covariance – Correlation and Regression – Transformation of random variables – Central limit theorem.

UNIT – III	CORRELATION AND SPECTRAL DENSITIES	9 + 3

Random Process – Introduction – Auto Correlation Functions – Cross Correlation Functions – Properties – Power Spectral density – Cross spectral density – Applications of correlations and Spectral Densities.

UNIT – IV	LINEAR SYSTEMS WITH RANDOM INPUTS	9 + 3

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

UNIT – V	TESTING OF HYPOTHESIS	9 + 3

Sampling distributions – Normal, t, Chi-square and F distributions – Tests for single mean, Proportion, Difference of means (large and small samples) – Tests for single variance and equality of variances – Chi-square test for goodness of fit – Independence of attributes.

TOTAL : 45 (L) + 15 (T) = 60 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Apply the knowledge of probability to acquired knowledge of standard distributions.	Apply
CO2	Analyze joint probability distributions, principles of linear correlation and regression and central limit theorem to describe inferences.	Analyze
CO3	Apply the knowledge of correlations and spectral densities in random process.	Apply
CO4	Apply the acquired fundamental knowledge on random process in linear system with random inputs in the areas of communication and signalprocessing.	Apply
CO5	Apply the concept of testing of hypothesis for small and large samples in Real life Problems.	Analyze
CO6	Understand the basic concept of probability, Random Variable and statistics.	Understand

TEXT BOOKS:

1. Veerarajan, "Probability and Random Processes", 4th edition, 2015.
2. Gupta S.C, Kapoor V.K. "Fundamental of Mathematical Statistics" 10th Edition, SultanChand and Sons, New Delhi, 2002.

REFERENCES:

1. Yates. R.D. and Goodman. D.J., "Probability and Stochastic Processes", Wiley India,Bangalore, 2nd Edition, 2012.
2. Stark. H., and Woods. J.W., "Probability and Random Processes with Applications to Signal Processing", Pearson Education, Asia, 3rd Edition, 2002.
3. Walpole. R.E., Myers .R.H., Myers S.L., and YE. K, "Probability and Statistics forEngineers and Scientists", Pearson Education, New Delhi, 8th edition, 2007.
4. Veerarajn.T., "Probability and Statistics", Tata McGraw Hill Publishing company Limited 2008.
5. Oliver C. IBE, "Fundamentals of Applied probability and Random processes", Elsevier,Lowell, Massachusetts, 1st Indian Reprint, 2007.
6. Peebles. P.Z., "Probability, Random Variables and Random Signal Principles", Tata McGraw Hill, New Delhi, 4th Edition, 2002.

Course Code	Course Title	L	T	P	C
19UBM402	ANALOG AND DIGITAL INTEGRATED CIRCUITS	4	0	0	4

OBJECTIVES:

- To outline the design procedure of applications using operational amplifiers, analogmultipliers and PLL.
- To employ op-amp for a variety of engineering applications.
- To familiarize with the design of various combinational digital circuits using logic gates.
- To explain the various semiconductor memories and related technology.

UNIT – I	OPERATIONAL AMPLIFIER FUNDAMENTALS & BASICAPPLICATIONS	12

Introduction — Ideal Op-amp circuit — DC characteristics, AC characteristics — Basic Op-amp applications, Instrumentation amplifier, V to I and I to V converters, Precision rectifier, Peak detector, Clipper, Clamper, Sample and hold, Log & antilog amplifiers, Differentiator, Integrator.

UNIT – II	ADVANCED APPLICATIONS OF OP-AMP	12

Comparator – Multivibrators and Schmitt trigger – Sine wave and Triangular wave generator – First and Second order Low pass and High pass filters – A/D converters: Flash, Dual slope, Successive approximation – D/A converter: weighted resistor type, R-2R ladder – Characteristicsof ADC and DAC (resolution, quantization, significant bits, conversion/settling time).

UNIT – III	SPECIAL ICs	12

IC555 Timer – Functional block description – Monostable & Astable multivibrator operations – PLL – Basics, Phase detector/comparator, Voltage controlled oscillator – IC Voltage regulators –Three terminal fixed and adjustable voltage regulators - IC 723 general purpose regulator – Monolithic switching regulator, Low Drop-Out (LDO) Regulators – F to V and V to F converters –Audio Power amplifier, Video Amplifier, Isolation Amplifier, Opto-couplers and fibre optic IC – Analog multiplier ICs.

UNIT – IV	BOOLEAN ALGEBRA AND COMBINATIONAL CIRCUITS	12

Number Systems – Code conversions – Logic gates – IC families: TTL and CMOS – Truth tables – NOT, AND, OR, NOR, NAND, XOR, XNOR – implementation of combinational logic functions:Boolean Algebra – Demorgans Theorem, SOP, POS, Karnaugh map, Quine-Mclusky method, Half/Full adder, Half/full subtractor, Encoder, Decoder, Multiplexer, Demultiplexer.

UNIT – V	SEQUENTIAL CIRCUITS AND MEMORY DEVICES	12

Sequential Circuits: Flip flops – SR, JK, T, D and Master slave – Characteristic, excitation tables,Level and Edge Triggering – Counters – asynchronous & synchronous – Shift registers – Memory Devices: Classification of memories, RAM organization, ROM organization, Flash memory, Combinational PLD's, PLA, PAL.

TOTAL : 60 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Describe the Characteristics of Op-amp and functional details of various analog special ICs.	Understand
CO2	Analyze the applications of op-amp.	Analyze
CO3	Evaluate the performance of different data converters and memory devices.	Evaluate
CO4	Minimize boolean expressions in different forms and implement them using logic gates	Apply
CO5	Design and Analyze combinational circuits.	Analyze
CO6	Design synchronous and asynchronous sequential circuits for a given specification.	Create

TEXT BOOKS:

1. D.Roy Choudhry, Shail Jain, "Linear Integrated Circuits", New Age International Pvt. Ltd., 5th Edition, 2018.
2. M. Morris Mano and Michael D. Ciletti, "Digital Design", 5th Edition, Pearson, 2014.

REFERENCES:

1. Sergio Franco, "Design with Operational Amplifiers and Analog Integrated Circuits", 4th Edition, Tata McGraw-Hill, 2016
2. Ramakant A. Gayakwad, "OP-AMP and Linear ICs", 4th Edition, Prentice Hall / Pearson Education, 2015.
3. Thomas L. Floyd, "Digital Fundamentals", 10th Edition, Pearson Education Inc, 2011.
4. S.Salivahanan and S.Arivazhagan, "Digital Electronics", 1st Edition, Vikas Publishing House pvt Ltd, 2012.

Course Code	Course Title	L	T	P	C
19UBM403	MEDICAL PHYSICS	3	0	0	3

OBJECTIVES:

- Summarize the principles and effects of ionizing and non-ionizing radiation in human body.
- Explore the effects of radiation in matter and how isotopes are produced
- Understand various detectors for detecting the presence of ionizing radiation.

UNIT – I	NON IONIZING RADIATION AND ITS MEDICAL APPLICATION	9

Overview of non-ionizing radiation effects – Tissue as a leaky dielectric – Low Frequency Effects – Higher frequency effects – Measurement of Tissue Anisotropy – Measurement of Ultraviolet Radiation – Physics of light and sound – Thermography – Application – Ultrasound Transducer –Interaction of Ultrasound with matter, Transmission-Scanning systems – Doppler-Double Doppler shift Clinical Applications.

UNIT – II	PRINCIPLES OF RADIOACTIVE NUCLIDES	9

Radioactive Decay – Spontaneous Emission – Isometric Transition – Gamma ray emission, alpha, beta, Positron decay, electron capture – Sources of Radioisotopes – Natural and Artificial radioactivity – Radionuclide used in Medicine and Technology – Decay series – Production of radionuclides – Cyclotron produced Radionuclide – Reactor produced Radio - nuclide-fission and electron Capture reaction, radionuclide Generator-Milking process (Technetium generator).

UNIT – III	INTERACTION OF RADIATION WITH MATTER	9

Interaction of charged particles with matter — Specific ionization, Linear energy transfer range, Bremsstrahlung, Annihilation, Interaction of X and Gamma radiation with matter- Photoelectric effect, Compton Scattering , Pair production, Attenuation of Gamma Radiation ,Interaction of neutron with matter and their clinical significance.

UNIT – IV	PRINCIPLES OF RADIATION DETECTION AND DOSIMETERS	9

Principles of radiation detection, Properties of dosimeters, Theory of gas filled detectors, Ionization Chamber, Proportional chamber, G.M. Counter, Film dosimetry, luminescence dosimetry, scintillation detectors, Radiation detection instruments, Area survey meters, Personal Radiation monitoring device, Film badge, TLD, OSLD. Electrical Impedance Tomography — biomedical laser beam delivery systems

UNIT – V	BASIC RADIATION QUANTITIES	9

Introduction – exposure – Inverse square law – KERMA and absorbed dose – stopping power – relationship between the dosimetric quantities – Bremsstrahlung radiation, Bragg's curve-concept of LD 50 – Stochastic and Non-stochastic effects, Different radiation Unit, Roentgen, gray, Sievert – Radiation protection.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Explain the effect of non-ionizing radiation in human body and applications in the field of medicine.	Understand
CO2	Apply the suitable methods for detecting and recording the ionizing radiation and its interaction with matter.	Apply
CO3	Analyze the interaction of ionizing and non-ionizing radiation with the human body and it's clinical significance.	Analyze
CO4	Measure and record the radiation exposure to healthcare workers in hospitals and diagnostic centers.	Evaluate
CO5	Design an instrumental setup for measuring the intensity of light.	Create
CO6	Analyze the half-lives of radionuclides using software tools.	Apply

TEXT BOOKS:

1. Gopal B. Saha, "Physics and Radiobiology of Nuclear Medicine", 4th Edition, Springer,2013.
2. B H Brown, R H Smallwood, D C Barber, P V Lawford and D R Hose, "Medical Physics and Biomedical Engineering", 2nd Edition, IOP Publishers, 2001.

REFERENCES:

1. W.J. Meredith & J.B. Massey, Fundamental Physics of radiology, Varghese PublishingHouse, Bombay, 1992.
2. J.P.Woodcock, "Ultrasonic, Medical Physics Handbook series 1", Adam Hilger, Bristol,2002.
3. Hylton B.Meire and Pat Farrant, "Basic Ultrasound" John Wiley & Sons, 1995
4. P.Umadevi, A. Nagarathnam, B S Satish Rao, "Introduction to radiation biology" B.I Churchill Livingstone pvt Ltd, 2000.

Course Code	Course Title	L	T	P	C
19UBM404	PRINCIPLES OF SIGNALS AND SYSTEMS	3	0	0	3

OBJECTIVES:

- To explain classifications and properties of signal & systems
- To introduce Laplace Transform, Fourier transform, Z transform and their properties.
- To characterize LTI systems in the Time domain and various Transform domains.

UNIT – I	**CLASSIFICATION OF SIGNALS AND SYSTEMS**	**9**

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

UNIT – II	**ANALYSIS OF CONTINUOUS TIME SIGNALS**	**8**

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**	**8**

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**	**10**

Baseband signal Sampling — DTFT — Properties of DTFT — Z Transform — Properties of Z Transform.

UNIT – V	**LINEAR TIME INVARIANT-DISCRETE TIME SYSTEMS**	**10**

Difference Equations – Block diagram representation – Impulse response – Convolution sum – Discrete Fourier and Z Transform Analysis of Recursive & Non-recursive systems.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Classify the Signals and Systems using properties.	Understand
CO2	Apply Laplace transform, Fourier transform, Z transform and DTFT in signal analysis.	Apply
CO3	Analyze continuous and discrete time LTI systems using various transforms.	Analysis
CO4	Evaluate and Characterize LTI systems in the time domain and frequency domain.	Evaluate
CO5	Develop realization methods using Z transform.	Create
CO6	Generate and analyze the characteristics of continuous and discrete time signals using software tool.	Analyze

TEXT BOOKS:

1. Allan V.Oppenheim, S.Wilsky and S.H.Nawab, “Signals and Systems”, Pearson, IndianReprint, 2nd Edition, 2015.
2. S. Haykin and B. Van Veen, "Signals and Systems", Wiley, 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”, TataMcGraw Hill, 2012.

Course Code	Course Title	L	T	P	C
19UBM405	PATHOLOGY AND MICROBIOLOGY	3	0	0	3

OBJECTIVES:

- To explain the purpose of structural and functional aspects of living organisms
- To explore the etiology and remedy in treating the pathological diseases
- To familiarize the different types of microscopes and microbial cultures for diagnosingdisease.
- To explain various immunological techniques in diagnosing the pathological diseases

UNIT – I	CELL DEGENERATION, REPAIR AND NEOPLASIA	8

Cell injury and Necrosis, Apoptosis – Intracellular accumulations – Pathological calcification – Cellular adaptations of growth and differentiation – Inflammation and Repair including fracture healing – Neoplasia classification – Benign and Malignant Tumours, Carcinogenesis – Spread oftumours, Autopsy and Biopsy – Demonstration of techniques used in tissue processing.

UNIT – II	FLUID AND HEMODYNAMIC DERANGEMENTS	8

Fluid and hemodynamic derangements: Edema, Normal Hypostasis, Thrombosis, Disseminated Intravascular Coagulation, Embolism, Infarction – Hematological disorders – Bleeding disorders, Leukemia, Lymphomas – Demonstration of bleeding and clotting time for analysis of the fluid inthe body.

UNIT – III	MICROBIAL CULTURES AND MICROSCOPES	10

Morphological and structural organization of Bacteria, Virus, Archea and Eukaryotic microbes such as Yeasts, molds and protozoa – Growth pattern – Culture media and its types– Pure culturetechniques – Enrichment culture techniques for isolation – observation of microorganisms – Biochemical identification techniques for identification of microorganisms – Theory and practice of Sterilization – Light microscope – Bright field, Dark field, Phase contrast, Fluorescence, Electronmicroscope (TEM & SEM) – Preparation of samples for electron microscope – Staining methods:Simple, Gram staining and AFB staining.

UNIT – IV	MICROBIAL GENETICS	10

Types of Mutation: UV and chemical mutagens — Selection of mutants — Ames test for mutagenesis – Bacterial genetic system: Transformation, Conjugation, Transduction, Recombination, Plasmids, Transposons – DNA repair – Regulation of gene expression: Operonmodel — Bacterial genome with special reference to *E.coli* — RNA phages — RNA viruses — Retroviruses – Basic concept of microbial genomics.

UNIT – V	IMMUNOLOGY	9

Natural and artificial immunity — Opsonization — Phagocytosis — Inflammation — Immune deficiency syndrome – Antibodies and its types – Antigen and antibody reactions. Immunological techniques: Immune diffusion, Immuno electrophoresis – Monoclonal antibodies and their production – Disease caused by Bacteria, Fungi, Protozoal, Virus and Helminthes.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Explain the fundamental structural and functional aspects of living organisms.	Understand
CO2	Apply the exploration in the mechanism of disease and solve complex problems in disease diagnosis.	Apply
CO3	Analyze various technological methods used in pathology and microbiology.	Analyze
CO4	Investigate various staining methods and microscopic visualization of microorganisms for disease determination.	Evaluate
CO5	Design standardized staining methods for identification of microorganisms.	Create
CO6	Conduct experiments in laboratories and participate in clinical pathological correlation.	Apply

TEXT BOOKS:

1. Ramzi S Cotran, Vinay Kumar & Stanley L Robbins, “Pathologic Basis of Diseases”,7thedition,WB Saunders Co. 2005
2. Prescott, Harley and Klein, “Microbiology”, 5th edition, McGraw Hill, 2002

REFERENCES:

1. Underwood JCE: General and Systematic Pathology Churchill Livingstone, 3rd edition,2000.
2. Ananthanarayanan&Panicker, “Microbiology” Orientblackswan, 2005.
3. Dubey RC and Maheswari DK. “A Text Book of Microbiology” Chand & Company Ltd,2007.

Course Code	Course Title	T	P	C
15UBM406	DIAGNOSTIC AND THERAPEUTIC EQUIPMENTS – 1	0	0	3

OBJECTIVES:

- To explore the medical equipment used in the measurement of parameters related to cardiology, neurology and musculo-skeletal system.
- To familiarize the patient monitoring and biotelemetry system.
- To understand the function of extra corporeal devices and principle of various diagnostic techniques.

UNIT – I	**CARDIAC EQUIPMENT**	**9**

Electrocardiograph – Normal and Abnormal Waves – Heart rate monitor – Holter Monitor, Phonocardiography – Plethysmography – ECG Machine maintenance and troubleshooting – Cardiac Pacemaker – Internal and External Pacemaker – Batteries, AC and DC Defibrillator – Cardiotocography.

UNIT – II	**NEUROLOGICAL EQUIPMENT**	**9**

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

UNIT – III	**SKELETAL MUSCULAR EQUIPMENT AND SURGICALINSTRUMENTS**	**9**

Generation of EMG – recording and analysis of EMG waveforms – fatigue characteristics – Muscle stimulators – nerve stimulators – Nerve conduction velocity measurement – EMG Bio Feedback Instrumentation –Instruments for surgery – Ultrasonic therapy unit.

UNIT – IV	**PATIENT MONITORING AND BIOTELEMETRY**	**9**

Patient monitoring systems – ICU/CCU Monitoring Equipment's – Electronic monitoring of functional parameter — bed side monitors — cardiac monitor — Central consoling controls — Oximetry – Foetal Monitor – Radio Telemetry (single, multi) – parameters and modes – Portableand Landline Telemetry unit – Applications in ECG and EEG Transmission.

UNIT – V	**EXTRA CORPOREAL DEVICES AND SPECIAL DIAGNOSTIC TECHNIQUES**	**9**

Need for heart lung machine – functioning of oxygenators and its types – bubble, disc type andmembrane type, finger pump, roller pump –. Hemodialysis unit – Lithotripsy– Principles of Cryogenic technique and application – Endoscopy – Laparoscopy – Thermography – Recording and clinical application – Ophthalmic Instruments – Tonometer.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Explain the basic principles of various diagnostic and therapeutic equipments.	Understand
CO2	Apply different medical devices in the measurement of parameters related to cardiology, neurology and musculo-skeletal system.	Apply
CO3	Measure and analyze the bio-signals generated during continuous monitoring and transmission of vital parameters.	Analyze
CO4	Evaluate the suitable diagnostic and therapeutic equipments during the measurement of vital parameter.	Evaluate
CO5	Develop novel approaches to identify and rectify errors in the diagnostic and therapeutic equipments.	Create
CO6	Analyze the heart rhythm using Cardiac Holter monitor software.	Analyze

TEXT BOOKS:

1. Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw Hill, New Delhi,2003.
2. Leslie Cromwell, "Biomedical Instrumentation and Measurement", Pearson Education, New Delhi, 2007.

REFERENCES:

1. L.A Geddes and L.E.Baker, "Principles of Applied Biomedical Instrumentation", 3Edition,2008
2. Antony Y.K.Chan, "Biomedical Device Technology, Principles and design", CharlesThomas Publisher Ltd, Illinois, USA, 2008.
3. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology",Pearson education, 2004.
4. John G.Webster, "Medical Instrumentation Application and Design", third edition, John Wiley and Sons, New York, 2006.

Course Code	Course Title	L	T	P	C
19UBM407	ANALOG AND DIGITAL INTEGRATED CIRCUITS LABORATORY	0	0	3	1.5

OBJECTIVES:

To impart knowledge on:

- The characteristics of operational amplifier and its linear and nonlinear applications.
- The basics of special function ICs.
- Boolean operations, code converters, counters and registers.
- SPICE software for circuit design.

LIST OF EXPERIMENTS:

Analog Circuits Experiments:

1. Design and testing of Inverting, Non inverting and differential amplifiers.
2. Design and testing of Integrator and Differentiator.
3. Design and testing of Instrumentation amplifier.
4. Design and testing of Active low-pass and High-pass filters.
5. Design and testing of Astable & Monostable multivibrators and Schmitt Trigger usingop-amp.
6. Design and testing of Astable and monostable multivibrators using NE555 Timer.
7. Study of VCO and PLL ICs.
   a) Voltage to frequency characteristics of NE/ SE 566 IC.
   b) Frequency multiplication using NE/SE 565 PLL IC.

Digital Circuits Experiments:

8. Implementation of Adder/ Subtractor circuits.
9. Design and implementation of code converters using logic gates (i) BCD to excess-3code and vice versa (ii) Binary to gray and vice-versa.
10. Design and implementation of Multiplexer and De-multiplexer using logic gates.
11. Design and implementation of encoder and decoder using logic gates.
12. Construction and verification of 4 bit ripple counter and Mod-10 / Mod-12 Ripplecounters.
13. Design and implementation of 3-bit synchronous up/down counter.
14. Implementation of SISO, SIPO, PISO and PIPO shift registers using Flip- flops.
15. SPICE Simulation studies.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Design and implement arithmetic circuits for different applications using op-amp.	Apply
CO2	Design combinational and sequential circuits for different applications.	Apply
CO3	Analyze the behavior of a filter circuits using IC741	Analyze
CO4	Create a circuit model for different applications using linear integrated and digital logic circuits.	Create
CO5	Simulate and analyze circuits using software tools.	Analyze

HARDWARE REQUIREMENT:

Sl. No.	Name of the equipment	Quantity required
1	CRO	6
2	Function generator	6
3	Dual Regulated Power Supply (0 – 30) V	6
4	Digital Multimeter	5
5	Digital IC trainer Kit	10
6	Analog IC trainer kit	4
7	Bread boards	10
8	Chip IC – 7400	20
9	Chip IC – 7402	20
10	Chip IC – 7408	20
11	Chip IC – 7432	20
12	Chip IC – 7486	15
13	Chip IC – 7411	5
14	Chip IC – 7410	10
15	Chip IC – 555	10
16	Chip IC – 741	25
17	Chip IC – 74153	10
18	Chip IC – 7474	10
19	Chip IC – 7490	10
20	Chip IC – 7447	10
21	Chip IC – 7476	10
22	Chip IC – 7420	10
23	Chip IC – 7404	20
24	Desktop PC with SPICE software	5

Course Code	Course Title	L	T	P	C
19UBM408	SENSORS AND BIOMEDICAL INSTRUMENTATION LABORATORY	0	0	3	1.5

OBJECTIVES:

To impart knowledge on:

- Characteristics of various sensors.
- Different bridge circuits for the measurement of resistance, capacitance and inductance.
- Recording and analyzing bio signals.
- Comprehension of suitable preamplifiers used for amplifying the bio signals.
- Monitoring and Measurements of physiological parameters.

LIST OF EXPERIMENTS:

Sensors and Measurements:

1. Characteristics of various temperature sensors (RTD and Thermocouple)
2. Characteristics of various light sensors (LDR, Photodiode and Phototransistor)
3. Displacement measurement using LVDT.
4. Measurement of Resistance, Inductance and Capacitance using bridge circuits.

Biomedical Instrumentation:

5. Design of preamplifiers to acquire bio-signals along with impedance matching circuit usingsuitable IC‘s
6. Design of ECG amplifier and Measurement of heart rate.
7. Measurement of pulse-rate using Photo transducer.
8. Design of EEG and EMG amplifiers.
9. Measurement of pH and Conductivity.
10. Measurement of respiration rate.
11. Measurement of blood pressure using sphygmomanometer.
12. Design and study the characteristics of optical Isolation amplifier.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Apply appropriate measurement techniques.	Apply
CO2	Analyze the performance characteristics of various sensors & biomedical equipments and infer their safety aspects.	Analyze
CO3	Evaluate the performance of medical instruments.	Evaluate
CO4	Design portable instruments capable of recording bio signals.	Create

HARDWARE REQUIREMENT:

Sl. No.	Name of the equipment	Quantity required
1	Electric heater & Thermometer	each 1 No.
2	RTD & Thermocouple	each 1 No.
3	Light source and LDR	each 1 No.
4	Photodiode and Phototransistor	each 1 Nos.
5	LVDT 20mm core length movability type	1 No.
6	R L C Bridge kit	3 Nos.
7	pH meter and conductivity meter	1 No.
8	Photo transducer for pulse measurement	1 No.
9	Function Generator	6 Nos.
11	Regulated Power Supply	6 Nos.
12	Sphygmomanometer and Stethoscope	1 No.
13	Pulse Oximeter – Finger tip	1 No.
14	Multiparameter (ECG, EMG, EEG) Simulator	1 No.
15	CRO	5 Nos.
16	DSO	1 No.
17	Bread boards	10 Nos.
18	IC 555 Timer	10 Nos.
19	ICs LM324 AD620	10 Nos.
20	ICs INA series 126 128 etc	10 Nos.
21	Opto Isolator IC: MCT2E	1 No.

Course Code	Course Title	L	T	P	C
19UBM409	PATHOLOGY AND MICROBIOLOGY LABORATORY	0	0	3	1.5

OBJECTIVES:

To impart knowledge on:

- Use of Compound microscope.
- Practice on chemical examinations, Cryoprocessing, Histopathological examinations etc.

LIST OF EXPERIMENTS:

1. Study of parts of compound microscope.
2. Media preparation and sterilization techniques
3. Isolation of microorganisms by plating techniques.
4. Simple stain, Gram stain, AFB stain, Capsule stain.
5. Biochemical techniques for identification of microorganisms.
6. Basic staining – Hematoxylin and eosin staining.
7. Special stains – cresyl fast Blue (CFV)- Trichrome – oil red O – PAS
8. Bleeding time and clotting time
9. Haematology slides of anemia and leukemia
10. Antigen-Antibody reaction : Immuno diffusion and Immuno electrophoresis
11. Histopathological slides of benign and malignant tumours.
12. Manual paraffin tissue processing and section cutting (demonstration)
13. Cryo processing of tissue and cryosectioning (demonstration)

TOTAL : 30 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Demonstrate the defined skill set of microscopy, sample preparation and staining procedures.	Apply
CO2	Differentiate the various cells in the blood smear and analyze physical and chemical composition of urine.	Analyze
CO3	Evaluate physical and chemical examination of urine by conducting suitable experiments.	Evaluate
CO4	Develop in vitro experiments in laboratory to study histopathological examinations.	Create

HARDWARE REQUIREMENT:

Sl. No.	Name of the equipment	Quantity required
1	Wax dispenser	1
2	Slide warming	1
3	Microtome	1
4	Slides	1 box
5	Cover slip	1 box
6	Distillation Unit	1
7	Water bath normal	1
8	Incubator	1
9	Autoclave	1
10	Oven	1
11	Bone marrow charts	1
12	Microscope	4

Course Code	Course Title	L	T	P	C
19UBM410	TECHNICAL SEMINAR	0	0	2	1

OBJECTIVES:

- To encourage the students to study recent innovative advances in biomedical engineering developments in healthcare industry.
- To prepare and present technical reports.
- To encourage the students to use various teaching aids such as overhead projectors(OHP), power point presentation and demonstrative models.

METHOD OF EVALUATION:

- During the seminar session each student is expected to prepare and present a topic on recent innovative advances in biomedical engineering developments in healthcare industry, for a duration of about 8 to 10 minutes.
- Each student is expected to present atleast twice during the semester and the student is evaluated based on that presentation. At the end of the semester, the student can submita report on the selected topic of seminar and marks are given based on the report.
- Faculty will guide and monitor the progress of the student and maintain attendance also.

TOTAL : 30 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Review, prepare and present technological developments in healthcare industry.	Apply
CO2	Participate in national and international level intercollegiate competitions and make them to learn new things and develop new skills.	Analyze
CO3	Face the placement interviews.	Evaluate

Course Code	Course Title	L	T	P	C
19UGM431	GENDER EQUALITY	2	0	0	P/F

OBJECTIVES:

- To introduce basic concepts relating to gender and to provide logical understanding ofgender roles.

UNIT – I	GENDER SENSITIZATION	10

Definition of gender, Perspectives – Gender sensitive approach – Gender and sex – Social construction of gender and gender roles – Socialization – institutions of socialization – changingcontent and context of gender – need for re-socialization. Gender Stereotyping and Gender Discrimination.

UNIT – II	GENDER EQUALITY AND CONSTITUTION	10

Indian constitution related to equality – Fundamental rights – Directive principles of state policy –right to equality — rights against exploitation — cultural and educational rights — the right to constitutional remedy – University Declaration of Human Rights – Enforcement of Human Rightsfor Women and Children — Role of Cells and Counseling Centers — Internal Complaints Committee – Legal AID cells, Help line, State and National level Commission.

UNIT – III	GENDER ROLES & EQUALITY	10

Gender & Morality – Structural and functionalist views of Gender – Gender in the Classroom – Beyond access for girls and boys – Gender equality in schools – Gender equality and adult basiceducation – Developing capacity to achieve gender equality in education – Individuality and removal of gender stereotypes – Respect for each other's – Promote equal opportunity.

TOTAL : 30 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Describe the social construction of gender and sexuality and their influence in social context.	Understand
CO2	Analyze how the concepts of gender equality are created, maintained, and/or challenged.	Analyze
CO3	Apply concepts of gender roles and equality in classroom, school, disciplinary or interdisciplinary creative, scholarly, and/or activist project.	Apply

REFERENCE BOOKS:

1. Sheila Aikman and Elaine Unterhalter, "Practising Gender Equality in Education", OxfamGB, 2007.
2. Pasadena and Hackensack, "Gender roles and Equality", Salem Press, 2011.

SEMESTER V

S.No.	Course Code	Course Title	Course Category	L	T	P	C
THEORY							
1.	19UBM501	Microprocessors and Microcontrollers	PC	3	0	0	3
2.	19UBM502	Diagnostic and Therapeutic Equipments - II	PC	3	0	0	3
3.	19UBM503	Bio Control System	PC	3	1	0	4
4.	13UBM504	Principles of Digital Signal Processing	PC	3	0	0	3
5.	PE - I	Professional Elective – I	PE	3	0	0	3
6.	OE - I	Open Elective – I	OE	3	0	0	3
PRACTICAL							
7.	19UBM507	Creative Thinking and Innovation Project	P	0	0	2	1
8.	19UBM508	Microprocessors and microcontrollers Laboratory	PC	0	0	3	1.5
9.	19UBM509	Diagnostic and Therapeutic Equipments Laboratory	PC	0	0	3	1.5
10.	19UBM510	Signal Processing Laboratory	PC	0	0	2	1
11.	19UGS533	Interpersonal Skills Laboratory	HS	0	0	3	1.5
			Total	18	1	13	25.5
Total Credits : 25.5							

Course Code	Course Title	L	T	P	C
19UBM501	MICROPROCESSORS AND MICROCONTROLLERS	3	0	0	3

OBJECTIVES:

- To impart knowledge in the architectural features and hardware of 8085 and 8086 microprocessors.
- To impart knowledge in the concepts of PIC and ARM processor.

UNIT – I	**ARCHITECTURE OF 8085/8086**	**9**

8085 – Functional Block Diagram – Description – Addressing Modes, Timing diagrams. Introduction to 8086 – Architecture, Instruction set, Addressing Modes.

UNIT – II	**MICROCONTROLLER**	**9**

8051 – Architecture, Special Function Registers (SFRs), I/O Pins Ports and Circuits, Instruction set, Addressing modes, Assembly language programming

UNIT – III	**INTERFACING 8051: MEMORY, I/O, INTERRUPTS**	**9**

Programming 8051 Timers – Serial Port Programming – Interrupts Programming LCD & Keyboard Interfacing – ADC, DAC & Sensor Interfacing, External Memory Interface – RTC Interfacing using I2C Standard – Motor Control – Relay, PWM, DC & Stepper Motor.

UNIT – IV	**PIC MICROCONTROLLER**	**9**

Introduction to PIC microcontrollers - PIC 16FXX architecture-memory organization-comparison of PIC with other CISC and RISC based systems - Register File Structure - Addressing modes - instruction set - Simple Operations.

UNIT – V	**ARMPROCESSOR**	**9**

The ARM architecture - ARM processor family - Co-processors -The ARM instruction set - LCD and Keyboard interfacing

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	Describe the fundamental concepts, addressing modes and instruction sets of 8085/8086 microprocessor, 8051 microcontroller, PIC Microcontroller and ARM processor.	Understand
CO2:	Execute an ALP program using various instruction sets of8085 microprocessor and 8051 Microcontroller	Apply
CO3:	Analyze the features of interfacing devices such as LCD, Keyboard, ADC, DAC and sensors with the microcontroller and ARM processor.	Analyze
CO4:	Explain in detail about architecture 8051 microcontroller and ARM processor with its memory organization, pin diagrams and I/O ports.	Understand
CO5:	Illustrate the functional blocks, addressing modes and development tools of PIC microcontroller and ARM processor.	Apply
CO6:	Design 8051 microcontroller-based control systems for biomedical applications.	Create

TEXT BOOKS:

1. Mohamed Ali Mazidi, Janice GillispieMazidi, RolinMcKinlay, “The 8051 Microcontroller and Embedded Systems: Using Assembly and C”, Second Edition, Pearson education, 2011.
2. Ramesh S Gaonkar, Microprocessor Architecture, Programming and application with 8085, 4 th Edition, Penram International Publishing, New Delhi, 2000

REFERENCES:

1. DoughlasV.Hall, “Microprocessors and Interfacing, Programming and Hardware”,TMH,2012
2. Furber,S., “ARM System on Chip Architecture”, Addison Wesley trade Computer Publication, 2014
3. Peatman,J.B., “Design with PIC Microcontrollers PearsonEducation”,3rdEdition, 2004.
4. Kennith J. Ayala, 8051 Microcontroller, Thomson, 2005.

Course Code	Course Title	L	T	P	C
19UBM502	DIAGNOSTIC AND THERAPEUTIC EQUIPMENTS – II	3	0	0	3

OBJECTIVES:

- To introduce the basics of diagnostics techniques
- To discuss the working and application of diagnostic equipments related to respiratory and sensory system.
- To familiarize the patient safety system.

UNIT – I	ULTRASONIC TECHNIQUE	9

Diagnosis: Basic principles of Echo technique, display techniques A, B and M mode, Application of ultrasound as diagnostic tool – Echocardiogram, Echoencephalogram, abdomen, obstetrics and gynecology, ophthalmology.

UNIT – II	RESPIRATORY MEASUREMENT STSTEM	9

Instrumentation for measuring the mechanics of breathing – Spirometer-Lung Volume and vital capacity, measurements of residual volume, pneumotachometer – Airway resistance measurement, Whole body plethysmography, Intra-Alveolar and Thoracic pressure measurements, Apnea Monitor. Types of Ventilators – Pressure, Volume, Time controlled. Flow, Patient Cycle Ventilators, Humidifiers, Nebulizers, Inhalators.

UNIT – III	SENSORY MEASUREMENT	9

Psycho Physiological Measurements-for testing and sensory Responses, Electro-occulograph, Electro-retinograph, Audiometer-Pure tone, Speech. EGG (Electrogastrograph), Galvanic Skin Resistance (GSR).

UNIT – IV	LASER BASED EQUIPMENTS AND DIATHERMY	9

Lasers in Medicine – Types, Tissue reactions. Lasers in ophthalmology, Flow Cytometry, Laser Microirradiation, Laser Doppler Velocimetry, Neurosurgical Laser Techniques.IR and UV lamp and its application. Short wave diathermy, ultrasonic diathermy, Microwave diathermy, Electro surgery machine - Current waveforms, Tissue Responses, Electro surgical current level, Hazards and safety procedures.

UNIT – V	PATIENT SAFETY	9

Physiological effects of electricity – important susceptibility parameters – Macro shock – Micro shock hazards – Patient's electrical environment – Isolated Power system – Conductive surfaces – Electrical safety codes and standards – Basic Approaches to protection against shock, Protection equipment design, Electrical safety analyzer – Testing the Electric system.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	Describe the concepts of ultrasound equipment and diagnostic techniques.	Understand
CO2:	Explain about measurements of parameters related to respiratory system.	Understand
CO3:	Choose the appropriate method for sensory measurement techniques.	Apply
CO4:	Analyze different types of diathermy units and appreciate the use of advanced laser technology in diagnosis.	Analyze
CO5:	Identify the electrical hazards and implement methods of patient safety.	Analyze
CO6:	Design of the protection circuit in isolation and protection equipment.	Create

TEXT BOOKS:

1. Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw Hill, New Delhi, 3rd Edition 2014.
2. Leslie Cromwell, "Biomedical Instrumentation and Measurement", Pearson Education, New Delhi, 2nd Edition 2015.
3. Leon Goldman, "The Biomedical Laser: Technology and Clinical applications", Springer – Verlag Newyork Inc., 2013.

REFERENCES:

1. L.A Geddes and L.E. Baker, "Principles of Applied Biomedical Instrumentation", 3Edition, 2008
2. Antony Y.K. Chan, "Biomedical Device Technology, Principles and design", Charles Thomas Publisher Ltd, Illinois, USA, 2nd Edition 2016.
3. Laurence J. Street, "Introduction to Biomedical Equipment Technology", CRC Press 3rd Edition 2017.
4. John G. Webster, "Medical Instrumentation Application and Design", third edition, John Wiley and Sons, New York, 4th Edition 2015.

Course Code	Course Title	L	T	P	C
19UBM503	BIO CONTROL SYSTEMS	3	1	0	4

OBJECTIVES:

- To discuss system concept and different mathematical techniques to model engineering systems
- To learn to do the analysis of given system in time domain and frequency domain.
- To practice the techniques of plotting the responses in both domain analysis.
- To apply modeling concepts to biological systems.

UNIT – I	MODELING OF SYSTEMS	7 + 2

System concepts – Open and Closed loop systems – Differential Equations – Transfer Functions – Modeling of Electrical and Mechanical systems – Electrical analogy of Mechanical systems – Block diagram and Signal flow graph representation of systems – Conversion of Block diagram to Signal flow graph – Reduction of Signal flow graphs – Mason's Gain Formula.

UNIT – II	TIME RESPONSE ANALYSIS	11 + 4

Standard test inputs – Type and Order of systems – Step and Impulse response of First order and Second order systems – Time domain specifications – Steady state error and error constants – Effects of adding poles and zeros – Concept of Stability – Routh-Hurwitz criteria of stability – Relative Stability – Root Locus technique.

UNIT – III	FREQUENCY RESPONSE ANALYSIS	9 + 3

Performance specifications in frequency domain – Bode plot, Polar plot and Nyquist plot: Construction, Interpretation and stability analysis – Correlation between time and frequency domain specifications.

UNIT – IV	STATE VARIABLE ANALYSIS	9 + 3

State space representation of Continuous Time systems – State equations – Transfer function from State Variable Representation – Solution of the state equations – Concepts of Controllability and Observability.

UNIT – V	PHYSIOLOGICAL CONTROL SYSTEM	9 + 3

Examples of physiological control system – Difference between Engineering and Physiological control systems – Mathematical Modeling – Generalized system properties – Models with combination of system elements – Linear models of physiological systems: respiratory mechanics, muscle mechanics – Introduction to simulation – Illustration with real time applications.

TOTAL : 45(L)+15(T) = 60 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	Demonstrate the concepts of basic control systems and modeling of basic physiological systems	Understand
CO2:	Develop mathematical models of electrical and mechanical systems	Apply
CO3:	Estimate the time domain and frequency domain specifications	Evaluate
CO4:	Analyze the performance and stability of system through time domain and frequency domain approach	Analyze
CO5:	Develop various types of state space model of a system.	Apply
CO6:	Simulate and analyze the system response and stability of the system using software tools.	Analyze

TEXT BOOKS:

1. M. Gopal "Control Systems Principles and Design", Tata McGraw Hill, 2002
2. Michael C K Khoo, "Physiological Control Systems", IEEE Press, Prentice Hall of India, 2001

REFERENCES:

1. Benjamin. C.Kuo, ' Automatic Control Systems', Prentice Hall of India, 1995.
2. Manfreclyner and John H.Milsum, Bio Medical engineering system, McGraw-Hill and Co., NewYork, 1970.
3. John Enderle Susan Blanchard, Joseph Bronzino "Introduction to Biomedical Engineering", second edition, Academic Press, 2005.
4. Richard C. Dorf, Robert H. Bishop, "Modern control systems", Pearson, 2004.

Course Code	Course Title	L	T	P	C
19UBM504	PRINCIPLES OF DIGITAL SIGNAL PROCESSING	3	0	0	3

OBJECTIVES:

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

UNIT – I	DISCRETE FOURIER TRANSFORM	9

Review of discrete time signals & systems – DFT and its properties, Properties of DFT – Circular Convolution – FFT Algorithms – Decimation in time Algorithms, Decimation in frequency Algorithms – Radix 2 method.

UNIT – II	IIR FILTER DESIGN	9

Structures of IIR – Analog filter design – Discrete time IIR filter from analog filter – IIR filter design by Impulse Invariance, Bilinear transformation, Approximation of derivatives – (LPF, HPF) filter design using frequency translation

UNIT – III	FIR FILTER DESIGN	9

Structures of FIR – Linear phase FIR filter – Fourier Series - Filter design using windowing techniques (Rectangular Window, Hamming Window, Hanning Window), Frequency sampling techniques

UNIT – IV	FINITE WORD LENGTH EFFECTS	9

Representation of numbers – ADC Quantization noise – Coefficient Quantization error – Product Quantization error – truncation & rounding errors – Limit cycle due to product round-off error –Round-off noise power – limit cycle oscillation due to overflow in digital filters – Principle of scaling.

UNIT – V	INTRODUCTION TO DIGITAL SIGNAL PROCESSORS	9

DSP functionalities – circular buffering – DSP architecture – Fixed and Floating point architecture principles – Programming – Application examples.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	Compute DFT of given sequence (maximum 8 point sequence) using DIT and DIF FFT algorithms.	Apply
CO2:	Design of infinite impulse response filters (Butterworth and Chebyshev) for the given specifications	Apply
CO3:	Realize the structure of LTI system in Direct, cascade and parallel form.	Apply
CO4:	Design of finite impulse response filters (using frequency sampling, Windowing methods) for the given specifications	Apply
CO5:	Explain finite word length effects	Understand
CO6:	Explain the generalized architecture of signal processors	Understand

TEXT BOOKS:

1. John G. Proakis & Dimitris G.Manolakis, “Digital Signal Processing – Principles, Algorithms & Applications”, Fourth Edition, Pearson Education / Prentice Hall, 2007.
2. A.V.Oppenheim, R.W. Schafer and J.R. Buck, “Discrete-Time Signal Processing”, 8thIndian Reprint, Pearson, 2004.

REFERENCES:

1. Emmanuel C.Ifeachor, & Barrie.W.Jervis, “Digital Signal Processing”, Second Edition, Pearson Education / Prentice Hall, 2002.
2. Sanjit K. Mitra, “Digital Signal Processing – A Computer Based Approach”, Tata Mc Graw Hill, 2007.
3. Andreas Antoniou, “Digital Signal Processing”, Tata Mc Graw Hill, 2006

Course Code	Course Title	L	T	P	C
19UBM507	CREATIVE THINKING AND INNOVATION PROJECT	0	0	2	1

PREAMBLE:

Creativity is vital in nearly every industry and occupation. Creativity and innovation are key to generation of new ideas and methods of improving goods and services for customer satisfaction. This course enhances the creative thinking and innovation skills of the students. Being creative helps one to be a better problem solver in all areas of life and work.

COURSE OBJECTIVES:

- To develop next generation Entrepreneurs and Creative Leaders to resolve live challenges.
- To transform innovative ideas into successful businesses
- To use a range of creative thinking tools to develop Out of the Box Ideas

COURSE CONTENT:

Introduction to Creativity and Innovation- Creative Techniques - Problem Identification through Brain Storming - Solution Identification through Creative Techniques - Presentation on the Innovative Idea - Market Analysis - Revenue and Business Model - Preparation of promotional aids - Customer Feedback Analysis.

LIST OF ACTIVITIES:

Duration	What does the Faculty do?	What do the students do?
Week 1	Explains creativity and innovation	Team Formation (Team Size: 3)
Week 2	Explains the Creative Techniques (Through Video / Presentation)	Discovering Consumer Need through Need Analysis (Customer Segment)
Week 3	Facilitates the brain storming	Problem Identification through brain storming
Week 4	Facilitates problem solving	Identify the solution for the chosen problem through creative techniques
Week 5	Evaluates the presentation	Presentation on the Innovative Idea and Value Proposition
Week 6	Evaluates the presentation	Presentation on the Innovative Idea and Value Proposition
Week 7	Explains about the Market Research / Competitor Analysis, Revenue Model and Business Model	Market Analysis after the explanation
Week 8	Facilitates the students work	Preparation of Innovation Development Plan, Business Development Plan and Financial Plan
Week 9	Facilitates the students work	Preparing product promotional material
Week 10	Facilitates the students work	Improvement through Feedback

TOTAL : 30 PERIODS

ASSESSMENT PATTERN:

1. Internal Assessment: Presentation on the Innovative Idea
2. End Semester Assessment:
   - Submission of Business Plan
   - Presentation on My Startup Idea (Evaluator : From Industry)

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	Demonstrate the ability to assess societal, health and safety issues and the consequent responsibilities relevant to the professional engineering practice.	Valuing – Affective Domain
CO2:	Examine impact on environment and society in the proposed innovative idea and provide solutions for sustainable development.	Organization – Affective Domain
CO3:	Adapt themselves to work in a group as a member or a leader for efficiently executing the given task.	Organization – Affective Domain

Course Code	Course Title	L	T	P	C
19UBM508	MICROPROCESSORS AND MICROCONTROLLERS LABORATORY	0	0	3	1.5

OBJECTIVES:

- To Introduce ALP concepts, features and Coding methods for 8085 microprocessor and 8051 microcontroller.

LIST OF EXPERIMENTS:

1. Addition / subtraction using 8085 microprocessors.
2. multiplication / division using 8085 microprocessors
3. Finding Maximum / minimum of numbers using 8085 microprocessors
4. Ascending / Descending order.
5. Hex / ASCII code conversions
6. BCD code conversions
7. 8-Bit Microcontroller: Simple arithmetic operations: Addition / subtraction
8. 8-Bit Microcontroller: Simple arithmetic operations / multiplication / division.
9. Parallel port programming with 8051 using port 1 facility: Traffic light controller, Stepper Motor
10. RAM direct addressing, Bit Addressing

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Execute ALP Programs for Arithmetic operations using 8085	Apply
CO2	Execute ALP Programs for code conversion using 8085.	Apply
CO3	Execute Programs in 8051	Apply
CO4	Interface different I/O devices with 8051 controllers	Analyze
CO5	Develop ALP Programs for analyze control instructions	Apply
CO6	Develop ALP Programs for RAM direct addressing	Apply

HARDWARE REQUIREMENTS

Sl. No.	Name of the equipment	Quantity required
1.	8085 Microprocessor Trainer with Power supply	8
2.	8051 Micro controller Trainer Kit with power supply	8
3.	8085 Microprocessor Trainer with Interface facility	6
4.	8255 Interface board	2
5.	8259 Interface board	4
6.	ADC card	4
7.	DAC card	3
8.	Stepper motor Interface kit for Processor	2
9.	Stepper motor Interface kit for Controller	2
10.	Traffic Light Controller kit	2
11.	8-bit LED board	2
12.	8051 Microcontroller trainer kit with flash memory	4

Course Code	Course Title	L	T	P	C
19UBM509	DIAGNOSTIC AND THERAPEUTIC EQUIPMENT LABORATORY	0	0	3	1.5

OBJECTIVES:

- To provide practice on recording and analysis of different Bio potentials
- To demonstrate the function of different Therapeutic equipment

LIST OF EXPERIMENTS:

1. Simulation of ECG – detection of QRS complex and heart rate
2. Simulation of EEG – detection of alpha waves
3. Study of shortwave and ultrasonic diathermy
4. Study of biotelemetry
5. Measurement of Respiratory parameters using spirometer
6. Study of medical stimulator
7. Study of ESU – cutting and coagulation modes
8. Recording of Audiogram using audiometer.
9. Recording Heart sounds using Phonocardiograph
10. Calculation of parameters like Drip rate, Total volume infused using drug infusion pump
11. Recording of Electromyogram
12. Study of Electrical safety measurements
13. Study of Continuous Positive Airway Pressure (CPAP) Ventilator and Humidifier

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Record and analyze bio potentials such as ECG,EMG	Apply
CO2	Record and analyze vital parameter of organs such as Ear, lungs, heart	Apply
CO3	Operate therapeutic equipment like shortwave, ultrasonic diathermy, Spirometer, audiometer, phonocardiograph, drug infusion pump and CPAP Ventilator & Humidifier in appropriate medical applications.	Analyze
CO4	Demonstrate the Shortwave and ultrasonic diathermy unit in human body	Valuing - Affective domain
CO5	Check the electrical safety measures in hospitals emergency units.	Responding - Affective domain
CO6	Propose the different methods of signal parameters analyzing using simulation	Characterization - Affective domain

HARDWARE REQUIREMENTS

Sl.No.	Name of the equipment	Quantity required
1.	Multi output power supply (+15v, -15v, +30V variable, +5V , 2A)	2 Nos
2.	Short wave Diathermy	1 No
3.	Ultrasound Diathermy	1 No
4.	Single parameter biotelemetry system	1 No
5.	Electrical Safety Analyzer	1 No
6.	Spirometer with associated analysis system	1 No
7.	ECG Simulator	1 No
8.	Surgical diathermy with analyzer	1 No
9.	Audiometer	1 No
10.	Phonocardiograph	1 No
11.	CPAP device	1 No
12.	Medical stimulator	1 No
13.	PC with simulation software	1 No

Course Code	Course Title	L	T	P	C
19UBM510	SIGNAL PROCESSING LABORATORY	0	0	2	1

OBJECTIVES:

- To implement generation of sequences
- To realize Linear and Circular Convolution
- To design and realize FIR and IIR filters
- To implement signal processing algorithms using digital signal processor

LIST OF EXPERIMENTS:

Simulation using MATLAB/ Equivalent software:

1. Generation of elementary Discrete-Time sequences
2. Verification of Sampling theorem and effect of aliasing
3. Analysis of Quantization effects in a first order system
4. Linear and Circular convolutions of given two sequences
5. Auto correlation and Cross Correlation of given sequences
6. Frequency Analysis using DFT
7. Design of FIR filters (LPF/HPF/BPF/BSF) and demonstrates the filtering operation
8. Design of Butterworth and Chebyshev IIR filters (LPF/HPF/BPF/BSF) and demonstrate the filtering operations.
9. Implementation of Decimation and Interpolation process
10. ECG Signal generation and Peak detection

DSP Processor based Implementation:

1. Study of architecture of Digital Signal Processor
2. Perform MAC operation using various addressing modes
3. Linear and Circular convolution

TOTAL: 30 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Apply the different tool boxes in MATLAB/ Equivalent software into programming for Signal generation and convolution / correlation of given sequences.	Apply
CO2	Verify the effect of Sampling and quantization.	Apply
CO3	Design IIR and FIR digital filters using different techniques.	Apply
CO4	Analyze Decimation and Interpolation process on DSP systems	Analyze
CO5	Generate biological signals and analyze the characteristics.	Analyze

HARDWARE/ SOFTWARE REQUIREMENTS

Sl.No.	Name of the equipment	Quantity required
1.	PCs with related accessories	15 Nos
2.	MATLAB / Equivalent software with Image processing tool box	15 Nos

Course Code	Course Title	L	T	P	C
19UGS533	INTERPERSONAL SKILLS LABORATORY	0	0	3	1.5

List of Exercises

Part - A : Communication and Leadership Projects

I) Speech Projects

1.The Open up Speech (Prepared Speech)
2.Speech Organizing to the Point (Prepared Speech)
3.Table Topics Speech

II) Evaluation Projects

4.Speech Evaluation
5.TAG (Timer, Ah Counter and Grammarian) Evaluation

III) Leadership Roles

6.Speech Master of the Day
7.General Evaluator
8.Table Topics Master

Part - B : Problem-Solving and Decision- Making Project

IV) Quality Circle Project

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Communicate orally with fluency and clarity in a given contextual situation	Responding - Affective Domain
CO2	Evaluate a speech and offer constructive evaluation of the speech	Evaluating - Cognitive Domain
CO3	Adapt themselves to work in a group as a member or a leader for efficiently executing the given task	Organization – Affective Domain
CO4	Analyze a problem and find appropriate solution	Analyze – Cognitive Domain
CO5	Take decision by organizing relevant information and defining alternatives.	Create – Cognitive Domain

SEMESTER VI

S.No.	Course Code	Course Title	Course Category	L	T	P	C
THEORY							
1.	19UBM601	Medical Imaging Equipments	PC	3	0	0	3
2.	19UBM602	Biomechanics	PC	3	0	0	3
3.	19UIT623	Object Oriented Programming and Data Structures	ES	2	0	3	3.5
4.	PE - II	Professional Elective – II	PE	3	0	0	3
5.	PE - III	Professional Elective – III	PE	3	0	0	3
6.	OE - II	Open Elective – II	OE	3	0	0	3
PRACTICAL							
7.	19UBM607	Product Development Project	P	0	0	8	4
8.	19UGS631	Logical Reasoning and Aptitude	HS	1	0	0	1
9.	19UGS632	Soft skills and Communication Laboratory	HS	0	0	3	1.5
MANDATORY							
10.	19UGM632	Indian Constitution and Essence of Indian Traditional Knowledge (Common to BME, CSE, ECE & IT)	MC	1	0	0	P/F
			Total	19	0	14	25
Total Credits : 25							

Course Code	Course Title	L	T	P	C
19UBM601	MEDICAL IMAGING EQUIPMENTS	3	0	0	3

OBJECTIVES:

- To understand the generation of X-ray and its uses in imaging
- To describe the principle of Computed Tomography.
- To know the techniques used for visualizing various sections of the body.
- To learn the principles of different radio diagnostic equipment in Imaging.
- To discuss the radiation therapy techniques and radiation safety.

UNIT – I	X – RAYS	9

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

UNIT – II	COMPUTED TOMOGRAPHY	9

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

UNIT – III	MAGNETIC RESONANCE IMAGING	9

Fundamentals of magnetic resonance- properties of electromagnetic waves : speed , amplitude, phase, orientation and waves in matter - Interaction of Nuclei with static magnetic field and Radio frequency wave- rotation and precession – Induction of magnetic resonance signals – bulk magnetization – Relaxation processes T1 and T2. Block Diagram approach of MRI system – system magnet (Permanent, Electromagnet and Super conductors), generations of gradient magnetic fields, Radio Frequency coils (sending and receiving), shim coils, Electronic components, fMRI.

UNIT – IV	NUCLEAR IMAGING AND OTHER IMAGING TECHNIQUES	9

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

Microwave imaging – Photo acoustic imaging – Optical coherence tomography – Microscopy imaging techniques.

UNIT – V	RADIATION THERAPY AND RADIATION SAFETY	9

Radiation therapy – linear accelerator, Telegamma Machine. SRS – SRT – Recent Techniques in radiation therapy – 3D CRT – IMRT – IGRT and Cyber knife – radiation measuring instruments Dosimeter, film badges, Thermo Luminescent dosimeters – electronic dosimeter – Radiation protection in medicine – radiation protection principles.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	Describe the working principle of X ray machine and computed tomography and its application.	Understand
CO2:	Interpret the technique used for visualizing various sections of the body using magnetic resonance imaging and nuclear imaging.	Understand
CO3:	Analyze the characteristics of different radiological equipment's.	Analyze
CO4:	Infer the safety precautions while using radiological equipment's	Analyze
CO5:	Analyze different imaging techniques and choose appropriate imaging equipment for better diagnosis.	Analyze

TEXT BOOKS:

1. Isaac Bankman, I. N. Bankman , Handbook Of Medical Imaging: Processing and Analysis(Biomedical Engineering),Academic Press, 2000
2. Jacob Beutel (Editor), M. Sonka (Editor), Handbook of Medical Imaging, Volume 2. Medical Image Processing and Analysis , SPIE Press 2000

REFERENCES:

1. Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw – Hill, New Delhi, 2003.
2. Dougherty, Geoff (Ed.), "Medical Image Processing - Techniques and Applications ",Springer-Verlag New York, 2011
3. Khin Wee Lai, Dyah Ekashanti Octorina Dewi "Medical Imaging Technology", Springer Singapore, 2015
4. Steve Webb, The Physics of Medical Imaging, Adam Hilger, Philadelpia, 1988.
5. R.Hendee and Russell Ritenour "Medical Imaging Physics", Fourth Edition William, Wiley-Liss, 2002.

Course Code	Course Title	L	T	P	C
19UBM602	BIOMECHANICS	3	0	0	3

OBJECTIVES:

- To introduce the fundamental terms and concepts of human factors.
- To discuss anthropometrics, physiological and biomechanical principles.

UNIT – I	INTRODUCTION OF MECHANICS	9

Use of statics, kinetics – rigid and non-rigid bodies – Forces and motion – Newtons laws –Moment of force – Free body Diagram- Static equilibrium – Centre of gravity –Stability of equilibrium – Steps in analyzing a biomechanical problem – Graphical methods – Contact forces – resolution of forces.

UNIT – II	MECHANICAL PROPERTIES OF BONES	9

Bone structure & composition mechanical properties of bone, cortical and cancellous bones, Fracture mechanism and crack propagation in bones, fracture fixators, repairing of bones. Pseudo elasticity, nonlinear stress – strain relationship, viscoelasticity, Maxwell &Voight models, Mechanical properties of skin, ligaments and tendons, Hodgkin-Huxley Model.

Head Injury tolerance, rotational injury, spine injury – Accident reconstruction, Analysis of impact, skid analysis – Damage analysis.

UNIT – III	MECHANICS OF THE JOINTS	9

Skeletal joints, skeletal muscles, basic considerations, assumption and limitations, forces and stresses in human joints, mechanics of the elbow, shoulder, spinal column, hip, knee and ankle. Human locomotion, gait analysis and goniometry, Ergonomics, Foot Pressure measurements – Pedobarograph, Force platform, mechanics of foot.

Total Hip Prosthesis: requirements, different types of components, Stress analysis & instrumentation, Knee Prosthesis

UNIT – IV	ALVEOLI MECHANICS	9

Alveoli mechanics, interaction of blood and lung, P-V curve of lung, breathing mechanism, airway resistance, physics of lung diseases.

UNIT – V	MECHANICAL PROPERTIES OF BLOOD VESSELS	9

Mechanical properties of blood vessels – arteries, arterioles, capillaries, veins, physics of cardio vascular diseases, prosthetic heart valves and replacement. Fluids – density – pressure – blood pressure and gravity – laminar and turbulent flow.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	Describe the basics and fundamentals of biomechanics.	Understand
CO2:	Elucidate the mechanical properties of Skeletal systems.	Understand
CO3:	Apply the knowledge of Biomechanics and Joint mechanics in modelling applications.	Apply
CO4:	Analyze the mechanical properties of physiological systems.	Analyze
CO5:	Create different combinations of materials that could be used as a tissue replacement implant.	Create
CO6:	Give the Illustrations of computational mathematical modelling applied in biomechanics.	Apply

TEXT BOOKS:

1. Frank Bell, “Principles of Mechanics and Biomechanics”, Stanley Thorne (Publishers) Ltd., 1998.
2. Donald R. Peterson and Joseph D. Bronzino, “Biomechanics Principles and applications”, CRC press, Taylor & Francis Group, LLC, 2008.
3. Duane Knudson, “Fundamentals of Biomechanics”, Second Edition, Springer publication, 2000.

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 Press 2007.

Course Code	Course Title	L	T	P	C
19UIT623	OBJECT ORIENTED PROGRAMMING AND DATA STRUCTURES	2	0	3	3.5

OBJECTIVES:

- To understand the principles of object oriented programming
- To explain the systematic way of solving problems using various linear and non-linear data structures
- To demonstrate implement the different linear and non-linear data structures

UNIT – I	PRINCIPLES OF OBJECT ORIENTED PROGRAMMING	10

Introduction – Tokens – Expressions - Control Structures - Functions in C++, Classes and Objects, Constructors and Destructors, Operator Overloading, Inheritance - Extending classes, Virtual Functions and Polymorphism, Exception handling.

UNIT – II	LINEAR DATA STRUCTURES	10

Abstract Data Type – Arrays: Accessing Elements – Operations – List ADT: Memory Allocation and De-allocation – Singly linked lists – Circular linked lists – Doubly linked lists – Applications of lists – Stack ADT: Array & Linked Representation – Applications of Stack, Queue ADT: Array & Linked Representation – Applications of Queue.

UNIT – III	NON-LINEAR DATA STRUCTURES	10

Tree – Basic Terminology – Traversal – Operations: Binary trees – Binary Search tree – AVL tree – Graph Terminology – Representation of Graphs – Graph Traversal – Topological sort – Minimum Spanning Tree – Shortest path algorithm.

LIST OF EXPERIMENTS: **45**

1. Program to implement Operator Overloading.
2. Program to implement Classes with constructor, destructor and copy constructor.
3. Program to implement Classes with inheritance concepts.
4. Program to implement Arrays ADT.
5. Program to implement List ADT.
6. Program to implement stack ADT using array and linked list.
7. Program to implement queue ADT use array and linked list.
8. Program to implement binary search tree.
9. Program to implement insertion and deletion in AVL trees.
10. Program to implement Prim's / Kruskal's algorithm using priority queues to find MST of an undirected graph.

TOTAL : 30 (L) + 45 (P) = 75 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	Explain the use of linear, non-linear data structures and object oriented approaches to solve the problems in real time applications.	Understand
CO2:	Apply the linear, non-linear data structures and object oriented approaches to solve variety of computational problems.	Apply
CO3:	Analyze the efficiency of various algorithmic approach through object oriented programming to solve real world applications with approach	Analyze
CO4:	Design and develop efficient and effective algorithms to solve problems.	Design
CO5:	Evaluate the problems and find solutions using various linear and non-linear applications.	Evaluate
CO6:	Select and apply appropriate data structures to design algorithms using modern tool.	Apply

TEXT BOOKS:

1. E.Balagurusamy,"Object Oriented Programming with C++", Tata McGraw Hill, 6th Edition, 2013.
2. Weiss. M.A, "Data Structures and Algorithm Analysis in C++", Pearson Education, 4th Edition, 2014.

REFERENCES:

1. Bhusan Trivedi, "Programming with ANSI C++ - A Step by Step Approach", Oxford University Press, 2nd Edition, 2014.
2. Stroustrup B, "The C++ Programming Language", Pearson Education, 4th Edition, 2013.
3. Aho V, Hopcroft J E, Ullman.J.D, "Data Structures and Algorithms", Pearson Education, 1st Edition Reprint, 2006.
4. Gilberg R F, Forouzan.B.A, "Data Structures: A Pseudo code Approach with C++", Thomson India Education, 2nd Edition, 2005

HARDWARE / SOFTWARE REQUIREMENTS:

Hardware Requirements:

Computer Required: 30 No's

Minimum Requirement: Processor- Pentium IV, Ram: 1 GB, Hard Disk: 80 GB

Software Requirements

Operating System: Linux (Ubuntu / Fedora / Debian / Mint OS) / Windows

Turbo C Version 3 or GCC Version 4 / Built in Linux / DEVC++

Course Code	Course Title	L	T	P	C
19UBM607	PRODUCT DEVELOPMENT PROJECT	0	0	8	4

OBJECTIVES:

- To develop skills to formulate a technical project.
- To estimate the ability of the student in transforming the theoretical knowledge studied so far into a working model of a Biomedical/ Electronics/ Mechatronics/ Instrumentation system.
- To teach use of new tools, algorithms and techniques required to carry out the projects.
- To give guidance on the various procedures for validation of the product and analyze the cost effectiveness.
- For enabling the students to gain experience in organization and implementation of a small project and thus acquire the necessary confidence to carry out main project in the final year.
- To provide guidelines to prepare technical report of the project.

About the Course:

This course is introduced to enable the students to take up investigative study in the broad field of Biomedical Engineering, involving both theoretical and practical work to solve the real world healthcare problems as a group under the guidance of the allotted faculty. The students shall work in groups (Maximum 3) and focus on research problem and discover solutions by applying the knowledge of subjects that he/she has learnt upto 5th semester. This is expected to provide a good initiation for the student(s) in R&D work. This includes:

- Survey and study of published literature in the selected domain.
- Review and finalization of the approach to the problem relating to the selected topic.
- Preparing an Action Plan for conducting the investigation, including team work.
- Detailed Analysis/Modeling/Simulation/Design/Problem Solving/Experiment as needed.
- Final development of product/process, testing, results, conclusions and future directions.
- Preparing a Report in the standard format for being evaluated by the Department.
- Final Presentation before an Evaluation Committee.

TOTAL: 120 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Formulate a real world problem, identify the requirement and develop the design solutions.	Analyze
CO2	Express the technical ideas, strategies and methodologies	Apply
CO3	Utilize the new tools, algorithms, techniques that contribute to obtain the solution of the project.	Apply
CO4	Test and validate through conformance of the developed prototype and analysis the cost effectiveness.	Create
CO5	Prepare report and present the oral demonstrations	Evaluate

Course Code	Course Title	L	T	P	C
19UGS631	LOGICAL REASONING AND APTITUDE (Common for CIVIL and BME)	1	0	0	1

OBJECTIVES:

- To make the student acquire sound knowledge of the characteristic of quantitative and qualitative aptitude.
- To familiarize the student with various principles involved in solving mathematical problems.
- To develop an understanding of the basic concepts of reasoning skills.

UNIT – I	QUANTITATIVE APTITUDE	8

Ratio and Proportion - Averages – Percentages – Problems on ages – Profit and Loss – Simple and Compound Interest -– Time – Speed –Distance - Time and Work – Permutation and Combination - Alligation or Mixture – Probability – Clocks – Calendars.

UNIT – II	VERBAL AND NON VERBAL REASONING	7

Analytical Reasoning – Circular and Linear arrangement – Direction problems – Blood relations – Analogy – Odd Man Out – Venn Diagrams - Data Sufficiency – Data interpretation –– Syllogism - Coding – Decoding.

TOTAL : 15 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	Select an appropriate technique to solve the quantitative problems within the stipulated time.	Apply
CO2:	Apply Verbal and Non Verbal Reasoning skills to solve the problems based on the logical and analytical reasoning.	Apply
CO3:	Analyze the direction to solve equations involving one are more unknowns.	Analyze

TEXT BOOKS:

1. Dr. R.S.Agarwal, “Quantitative Aptitude”, S. Chand Publications, New Delhi, 20th Edition, (2013).
2. Abijit Guha, “Quantitative Aptitude for Competitive Examinations”, Tata McGraw Hill Publication, New Delhi, 4th Edition, (2011).
3. R.V.Praveen, “Quantitative Aptitude and Reasoning”, PHI Learning Pvt. Ltd., Delhi, 2nd Edition, (2013).

REFERENCES:

1. Ashish Aggarwal, “Quick Arithmetic”, S. Chand Publications, New Delhi, 6th Revised Edition, (2014).
2. Dr.V.A.Sathgurunath’s “A Guide for Campus Recruitment”, Sagarikka Publications, Thiruchirapalli, 3rd Edition, (2011).

WEBSITES:

www.m4maths.com, www.indiabix.com,
www.fresherworld.com, www.campusgate.co.in,
www.indianstudyhub.in, www.tcyonline.com.

Course Code	Course Title	L	T	P	C
19UGS532	SOFT SKILLS AND COMMUNICATION LABORATORY	0	0	3	1.5

OBJECTIVES:

- To develop a requisite knowledge in Communication skills and Soft skills.
- To enhance the students' acumen in honing the skills to meet the Global changes and Industrial needs.

UNIT – I	**SPEAKING SKILLS**	**9**
Conversational Skills - Self Introduction - Group Discussion - Public Speaking - Presentation Skills		
UNIT – II	**WRITING SKILLS**	**9**
Letter Writing – Report Writing – Email Writing – Job Application – Resume Preparation		
UNIT – III	**READING AND LISTENING SKILLS**	**9**
Reading Comprehension – Enriching Vocabulary – Error Spotting – Listening and Note Taking		
UNIT – IV	**SOFT SKILLS**	**9**
Professional Ethics – Interpersonal Skills – Stress Management – Leadership Qualities – Time Management – Conflict Resolution		
UNIT – V	**INTERVIEW SKILLS**	**9**
Types of Interviews – Body Language – Professional Grooming – Basic Etiquette.		
		TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	Answer the queries precisely after carefully listening to the conversation or speech.	Affective domain - Responding
CO2:	Communicate orally with fluency and clarity in each contextual situation	Affective domain - Responding
CO3:	Debate with clarity of thought and expression to convey their ideas politely to others	Affective domain - Valuing
CO4:	Apply correct usage of English grammar in writing, fluent speaking and comprehending.	Cognitive Domain - Apply

REFERENCES:

1. Skills for Success, Listening and Speaking – Level 4 by Brooks and Margret – Oxford University Press, Oxford 2011 Edition.
2. Professional Communication by Raman, Meenakshi and Sangeetha Sharma – Oxford University Press, 2014 Edition.
3. Developing Soft Skills by Sherfield, Robert M, R J Montgomery and Patricia G Moody – Pearson Education Publishers.

Course Code	Course Title	L	T	P	C
19UGM632	INDIAN CONSTITUTION AND ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE (Common to BME, CSE, ECE & IT)	1	0	0	P/F

OBJECTIVES:

- The students will be exposed to fundamental rights & duties in Indian Constitution.
- The students will be given knowledge on the components of the parliamentary system to prepare for the process of their career development.
- The student will have knowledge on powers and functions of Local bodies and Indian polity to appear for various competitive exams such as UPSC, TNPSC and RRB…
- The student will know about the functions of judiciary and electoral process followed in the country.

UNIT – I	INTRODUCTION ON INDIAN CONSTITUTION	4

Preamble - Salient features of the Constitution of India. Fundamental Rights - its restriction and limitations in different Complex Situations. Directive Principles of State Policy (DPSP) - Fundamental Duties: its Scope and significance in Nation building - Constitution components: schedule, parts and articles of constitution- important Amendments of constitution.

UNIT – II	PARLIAMENTARY SYSTEM	4

Parliamentary System – parliamentary system of other countries - Indian parliamentary system-Federal System – LS and RS, Centre-State Relations-Election of member of parliaments - Union Executive - President, Prime Minister, Union Cabinet. State Legislature - State Executives – election of MLA - Governor, Chief Minister, State Cabinet.

UNIT – III	JUDICIARY AND ELECTION COMMISSION	4

Supreme Court of India: Structure, Power and Functions of Supreme Court – Judicial Reviews - Judicial Activism. High Court and Subordinate Courts: Structure, Power and Functions. – Lok adhalats. Elections - Electoral Process - Election Commission of India - Election Laws – Emergency Provisions - types of Emergencies and its consequences.

UNIT – IV	LOCAL ADMINISTRATION	3

Local Administration: Powers and functions of Municipalities and Panchayats System - Panchayat Raj – Co-operative Societies and Constitutional and Non-constitutional Bodies.

TOTAL : 15 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	Apply knowledge of the fundamental rights and duties prescribed by Indian Constitution to prepare for various competitive examinations.	Apply
CO2:	Manage complex societal issues in society with the knowledge of judiciary and local administration.	Analyze
CO3:	Interpret the societal, health, safety, legal and cultural issues with understanding of parliamentary system and electoral process through self-learning skills.	Evaluate
CO4:	Elaborate the ethical responsibilities of municipalities, panchayats and co-operative societies.	Understand
CO5:	Describe and distinguish the functioning of the parliamentary system followed in various countries.	Understand

TEXT BOOKS:

1. Shubham Singles, Charles E. Haries, et al., “Constitution of India and Professional Ethics” by Cengage Learning India Private Limited, 2018.
2. Subhash C. Kashyap,”Our Constitution: An Introduction to India’s Constitution and constitutional Law”, NBT, 2018.
3. Brij Kishore Sharma,“Introduction to the Constitution of India”, PHI Learning Pvt. Ltd., New Delhi, 2011.
4. M.V.Pylee, “An Introduction to Constitution of India”, Vikas Publishing, 2002.
5. Durga Das Basu, “Introduction to the Constitution on India”, Prentice Hall, 2001.

SEMESTERVII

S.No.	Course Code	Course Title	Course Category	L	T	P	C
THEORY							
1.	19UME701	Project Management and Finance	HS	3	0	0	3
2.	19UBM702	Hospital Management	PC	3	0	0	3
3.	19UBM703	Image Processing Techniques	PC	3	0	0	3
4.	PE - IV	Professional Elective – IV	PE	3	0	0	3
5.	PE - V	Professional Elective – V	PE	3	0	0	3
6.	OE - III	Open Elective – III	OE	3	0	0	3
PRACTICAL							
7.	19UBM707	Summer Internship	P	0	0	2	1
8.	19UBM708	Hospital Training	PC	0	0	2	1
9.	19UBM709	Image Processing Laboratory	PC	0	0	3	1.5
MANDATORY							
10.	19UGM731	Professional Ethics and Human Values	MC	2	0	0	P/F
			Total	20	0	5	21.5
Total Credits : 21.5							

Course Code	Course Title	L	T	P	C
19UBM702	HOSPITAL MANAGEMENT	3	0	0	3

OBJECTIVES:

- To introduce the basic planning and organization of Hospitals
- To explain clinical, administrative and HR services
- To discuss the medical ethics and medical regulations
- To analyze the infection control and safety management in hospitals

UNIT – I	**OVERVIEW OF HOSPITAL ADMINISTRATION AND ORGANIZATION OF THE HOSPITALS**	**9**

Distinction between Hospital and Industry – Challenges in Hospital Administration – Hospital Planning – Equipment Planning – Functional Planning – Current Issues in Hospital Management. Roles of hospital in healthcare, Different Departments of Hospital - Effective hospital management.

UNIT – II	**HUMAN RESOURCE MANAGEMENT IN THE HOSPITALS**	**8**

Principles of HRM – Functions of HRM – Profile of HRD Manager – Tools of HRD –Human Resource Inventory – Manpower Planning. Recruitment, Selection, Training Guidelines –Methods of Training – Evaluation of Training – Leadership grooming and Training, Promotion – Transfer.

UNIT – III	**SUPPORTIVE SERVICES IN HOSPITAL AND HOSPITAL INFORMATION SYSTEMS**	**9**

Organization of Ancillary Services: Lab Services – Department of Physiotherapy & Occupational Therapy, Blood Transfusion Services, Radio diagnosis – Medical Transcription – Medical Records Department – Pharmacy – Food Services – Central Sterilization and Supply Department - Laundry and linen service – Housekeeping – Volunteer department – Need for computerization of hospitals - Hospital Information System – Clinical Information Systems – Administrative Information Systems – Technical Information Systems.

UNIT – IV	**MEDICAL ETHICS AND REGULATIONS**	**9**

Definition of Medical ethics, Scope of ethics in medicine, International code of Ethics for occupational health professionals, Bioethics, Evolution of Medical Standards and Regulations - WHO – International Health Regulations (IHR), – IEEE 11073 - HL7 – DICOM – IRMA - LOINC – HIPPA – Healthcare Standard Organizations – JCAHO (Joint Commission on Accreditation of Healthcare Organization) - JCIA (Joint Commission International Accreditation) - Regulatory Standards For Medical Devices.

UNIT – V	**MEDICAL WASTE MANAGEMENT AND QUALITY MEASUREMENT IN HOSPITAL**	**10**

Types of Waste – Importance of infection control – Hand hygiene – Aseptic techniques – Isolation precautions –Disinfection and sterilization – Clinical laboratory standards to infection control –Disposal of biological waste: Incinerator – Hazardous waste, radioactive waste, liquid waste destruction – landfill – Risk management in hospitals - Quality system – Elements, implementation of quality system, Documentation, Quality auditing.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	Explain the principles, practices and areas of application in Hospital Management and Explain the importance of supportive services.	Understand
CO2:	Describe about HRM process in Hospitals and manpower planning.	Remember
CO3:	Incorporate computerization in various departments of Hospital.	Apply
CO4:	Evaluate the Ethics followed in the healthcare laboratories, Standards and regulations followed in the functions and planning of a hospital.	Evaluate
CO5:	Analyze the importance of sterilization and waste management in health care services.	Analyze
CO6:	Assessing the quality measures and systems in health care services.	Apply

TEXT BOOKS:

1. Kunders G D, “Hospitals, facilities planning and management”, Tata McGraw Hill, 2008.
2. R.C.Goyal, “Hospital Administration and Human Resource Management”, PHI – Sixth Edition,2013
3. Sakharkar B M, “Principles of hospital administration and planning”, Jaypee Brothers Medical Publishers Pvt Limited, 2nd edition, 2009.

REFERENCES:

1. Arnold D. Kalcizony& Stephen M.Shortell, “Health Care Management”, 6 th Edition, 2011
2. Communicating in Hospital Emergency Departments - Page iiiDiana Slade, Marie Manidis, Jeannette McGregor · 2015
3. Hospital Information Systems : a Concise Studyy Kelkar S. A. · 2010
4. Healthcare Human Resource ManagementBy Walter J. Flynn, Robert L. Mathis, John H. Jackson, Sean R. Valentine · 2015

Course Code	Course Title	L	T	P	C
19UBM703	IMAGE PROCESSING TECHNIQUES	3	0	0	3

OBJECTIVES:

- To analyze the mathematical transforms necessary for image processing and different image enhancement techniques.
- To analyze image restoration procedures and image segmentation techniques.
- To analyze the image compression procedures.

UNIT – I	DIGITAL IMAGE FUNDAMENTALS	9

Elements of digital image processing systems – Elements of visual perception, brightness, contrast, hue, saturation, mach band effect – Color image fundamentals, RGB, HSI models - Image sampling - Quantization – Basic relationship between pixels - 2-D Image transforms: DFT, DCT, KLT and SVD.

UNIT – II	IMAGE ENHANCEMENT	9

Basic Intensity Transformations – Histogram equalization and specification techniques - Spatial Smoothing Filters, Spatial sharpening Filters – Frequency domain Smoothing and Sharpening Filters – Selective Filtering, Homomorphic filtering.

UNIT – III	IMAGE RESTORATION	9

Model of the Image Degradation/Restoration Process – Noise Models, Estimation of noise parameters – Restoration in the presence of Noise only situation, Mean Filters, Order Statistic Filters (OSF), Adaptive Mean and Median Filters – Periodic Noise Reduction by Frequency Domain Filtering – Linear, Position–Invariant Degradations – Estimating the Degradation Function – Inverse Filtering – Minimum Mean Square Error (Wiener) Filtering –Constrained Least Squares Filtering – Geometric Transformations.

UNIT – IV	IMAGE SEGMENTATION, REPRESENTATION AND DESCRIPTION	9

Point, Line and Edge detection – Edge linking via Hough transform – Thresholding – Region based segmentation, Region growing, Region splitting and Merging – Image representation schemes – Boundary descriptors – Regional descriptors – Relational descriptors.

UNIT – V	IMAGE RECOGNITION AND COMPRESSION	9

Image Recognition: Patterns and Pattern classes –Decision Theoretic Methods, Minimum distance classifier, Matching by correlation, Optimum statistical classifier.

Image Compression: Compression fundamentals – Optimal variable length Coding, Huffman, Arithmetic coding - Near optimal variable length coding– Bit plane coding, Constant area coding, Run Length encoding – Predictive coding – Scalar and Vector Quantization - Transform coding.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	Explain the fundamentals of digital image and its processing.	Understand
CO2:	Apply the various image processing techniques for a given image.	Apply
CO3:	Analyze images in the spatial and frequency domain.	Analyze
CO4:	Evaluate the performance of different image processing algorithms.	Evaluate
CO5:	Develop algorithms for different image processing applications.	Create
CO6:	Use appropriate software tools for image processing.	Apply

TEXT BOOKS:

1. Rafael C. Gonzalez and Richard E. Woods, “Digital Image Processing', 3rd Edition, Pearson Education, 2011.
2. Anil K. Jain, “Fundamentals of Digital Image Processing”, Pearson Education, 2003.

REFERENCES:

1. Kenneth R. Castleman, “Digital Image Processing”, Pearson, 2006.
2. Rafael C. Gonzalez, Richard E. Woods and Steven Eddins, “Digital Image Processing using MATLAB”, Pearson Education, Inc., 2004.
3. D. E. Dudgeon and RM. Mersereau, “Multidimensional Digital Signal Processing”, Prentice Hall Professional Technical Reference, 1990.
4. William K. Pratt, “Digital Image Processing”, 4th Edition, John Wiley", New York, 2007.
5. Milan Sonkaetal, “Image Processing, Analysis and Machine Vision”, 3rd Edition, Vikas Publishing House, 2007.

Course Code	Course Title	L	T	P	C
19UBM707	SUMMER INERNSHIP	0	0	2	1

OBJECTIVES:

The student should be made to:

- Gain a better understanding of the hospital workplace
- Develop and demonstrate knowledge necessary for plant operations, clinical engineering, biomedical engineering, safety technology andhospital information system.
- Solve the rising challenges and specific necessities of modern day hospitals.

COURSE REQUIREMENTS:

Students shall work in groups (Maximum 3) and has to identify and discuss about various activities of departments like out/in patient and nursing critical care departments of hospital like ICCU, ICU and activities of central sterile supply department and also challenges in designing the biomedical equipment. There shall be three reviews for the summer internship during the semester by the internship co-ordinator. The incharge faculty will review the report submitted by the student. The students should make a presentation on the progress made by him/her before the committee. The student should submit the report at the end of the semester. At the end of the internship period, the marks shall be awarded by the same co-ordinator for the report and viva-voce.

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Comprehend professional ethics and legal issues related to hospital engineering and healthcare System	Understand
CO2	Recognize the basics of working model of biomedical equipment and discover the suitable improvements and solutions to specific biomedical technology issues.	Apply
CO3	Interact and network with other healthcare technology managers to point out the best practices and solutions for common issues	Analysis
CO4	Compare and justify better management of information regarding identification of biomedical and hospital technology planning, procurement and operation requirements.	Evaluate

Course Code	Course Name	L	T	P	C
19UBM708	HOSPITAL TRAINING	0	0	2	1

OBJECTIVES:

The student should be made to:

- Observe medical professional at work and the roles of allied health professionals
- Provide access to healthcare professionals to get a better understanding of their work environment.
- Demonstrate patient care in a hospital setting

COURSE REQUIREMENTS:

Students need to complete training in any leading Multi-specialty 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 5 departments. The students can give presentation of the remaining departments during laboratory hours.

S.No	Departments
1	Cardiology
2	ENT
3	Ophthalmology
4	Orthopedic and physiotherapy
5	ICU/CCU
6	Operation theatre
7	Neurology
8	Nephrology
9	Radiology
10	Urology

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Recognize their skills in solving problems in patient centered approach in health care.	Understand
CO2	Reproduce the importance of inter-professional collaboration in healthcare and illustrate the techniques and skills to assess health improvement plan ethically based upon the patient‘s perceived needs.	Apply
CO3	Use the knowledge of their own role and those of other professions and thereby justifying healthcare needs of populations and patients served.	Analyze
CO4	Communicate with other health professionals in a respectful and responsible manner.	Apply
CO5	Predict the faults in the biomedical equipment and demonstrate the working condition of the equipment.	Create

Course Code	Course Title	L	T	P	C
19UBM709	IMAGE PROCESSING LABORATORY	0	0	3	1.5

OBJECTIVES:

- To practice the basic image processing techniques.
- To compute magnitude and phasor representation of images.
- To understand the concepts of image restoration and segmentation.
- To explore the applications of image processing.

LIST OF EXPERIMENTS:

1. Image sampling and quantization levels on image quality.
2. Implement and demonstrate 2-D DFT & DCT Transforms.
3. Implement and demonstrate Histogram Processing.
4. Implement and demonstrate various Point processing techniques.
5. Implement and demonstrate Inverse Filtering and Wiener Filtering.
6. Implement and demonstrate various Mean and Order Statistic Filters.
7. Implement and demonstrate various Line and Edge Detection Techniques and Edge linking.
8. Implement and demonstrate to extract Boundary, Regional and Texture features.
9. Implement and demonstrate various distance measures for classification.
10. Medical Image Enhancement - Spatial filtering.
11. Medical Image Enhancement - Filtering in frequency domain.
12. Implement and demonstrate various thresholding techniques.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	Demonstrate knowledge of a broad range of fundamental image processing, image analysis techniques and concepts.	Understand
CO2:	Apply image processing technique to solve real health care problems.	Apply
CO3:	Identify, Demonstrate and apply their knowledge by analyzing image processing problems and recognizing and proposing effective solutions.	Evaluate
CO4:	Design and create practical solutions to a range of common image processing problems and to critically assess the results of their solutions, including shortcomings.	Create
CO5:	Perform the various image processing techniques for a given real time health care problems.	Articulation (Psychomotor domain)

EQUIPMENTS FOR A BATCH OF 30 STUDENTS (2 students per experiment):

PCs with related accessories – 15

MATLAB/Equivalent software with Image processing tool box

REFERENCE:

1. Rafael C. Gonzalez, Richard E. Woods, Steven Eddins,' Digital Image Processing using MATLAB', Pearson Education, Inc., 2004.

SEMESTER VIII

S.No.	Course Code	Course Title	Course Category	L	T	P	C
THEORY							
1.	PE - VI	Professional Elective – VI	PE	3	0	0	3
2.	OE - IV	Open Elective – IV	OE	3	0	0	3
PRACTICAL							
3.	19UBM801	Project work	P	0	0	16	8
			Total	6	0	16	14
Total Credits : 14							

Course Code	Course Title	L	T	P	C
19UBM804	PROJECT WORK	0	0	16	8

OBJECTIVES:

The student should be made to:

- To investigate the societal issues in the healthcare and develop engineering solutions to human health problems.
- To engage the student in integrated activities of researching the problems in healthcare field and identifying novel solution for the unaddressed technical issues.
- To enrich the communication skills of the student and to create awareness on recent development in the medical field through project work.

COURSE REQUIREMENTS:

In this course, Students shall work in groups (Maximum 3) and focus on research problem and discover solutions by applying the knowledge of subjects that he/she has learnt upto 7thsemester. The project work is also guided by the allocated faculty member for tuning up the report. There shall be three reviews for the project work during the semester by the project review committee. The review committee consisting of the project guide and a senior faculty member, nominated by the Head of the department, in the related field of the project. The students should make a presentation on the progress made by him/her before the committee. The student should submit the report at the end of the semester. The product should be demonstrated at the time of examination. At the end of the project period, the marks shall be awarded by the same committee for the report and viva-voce.

COURSE OUTCOMES:

At the end of the course the student will be able to

CO1	Explain the concepts in design of medical equipment, analysis and interpretation of medical data, and synthesis of the information to provide valid conclusions.	Understand
CO2	Implement technology in education and able to identify the characteristics of different types of dynamic environments in Biomedical Engineering	Apply
CO3	Apply the research knowledge to sustain the societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the healthcare field.	Apply
CO4	Use the knowledge gained in biomedical instrumentation and Analyze unaddressed technical issues and develop prototype model according to the need of the society	Analyze
CO5	Categorize the list of problems in biomedical equipment development using different strategies to state the problem precisely, and point out the possible solutions	Analyze
CO6	Communicate the technical information effectively in oral presentation and technical report writing	Evaluate
CO7	Develop the medical products based on the need for sustainable development and offering the biomedical engineering solutions in societal and environmental contexts.	Create

LIST OF PROFESSIONAL ELECTIVES

S. No.	Course Code	Course Title	L	T	P	C
1.	19UBM901	Bio-MEMS and Nano Electronics	3	0	0	3
2.	19UBM902	Clinical Engineering	3	0	0	3
3.	19UBM903	Principles of Tissue Engineering	3	0	0	3
4.	19UBM904	Biomaterials and Artificial Organs	3	0	0	3
5.	19UBM905	Pattern Recognition and Neural Networks	3	0	0	3
6.	19UBM906	Forensic Science	3	0	0	3
7.	19UBM907	Drug Delivery Systems	3	0	0	3
8.	19UBM908	Nuclear Medicine	3	0	0	3
9.	19UBM909	Medical Radiation Safety Engineering	3	0	0	3
10.	19UBM910	Medical Technology	3	0	0	3
11.	19UBM911	Medical Optics	3	0	0	3
12.	19UBM912	Genetic Engineering	3	0	0	3
13.	19UBM913	Communication Engineering	2	0	2	3
14.	19UBM914	Biometric Systems	3	0	0	3
15.	19UBM915	Medical Informatics	3	0	0	3
16.	19UBM916	Telemedicine	3	0	0	3
17.	19UBM917	Rehabilitation Engineering and Robotics	3	0	0	3
18.	19UBM918	Virtual Bio-Instrumentation	2	0	2	3
19.	19UBM919	Medical Embedded Systems	3	0	0	3
20.	19UBM920	Brain Computer Interface and virtual reality	3	0	0	3
21.	19UBM921	Neuroscience	3	0	0	3
22.	19UBM922	Cancer Biology	3	0	0	3
23.	19UBM923	Human Assist Devices	3	0	0	3
24.	19UBM924	Body Area Networks and Mobile Healthcare	3	0	0	3
25.	19UBM925	Regenerative Medicine and Ergonomics	3	0	0	3
26.	19UBM926	Physiological Modeling	2	0	2	3
27.	19UBM927	Big Data and IOT in Medical Applications	3	0	0	3
28.	19UBM928	VLSI System Design	3	0	0	3
29.	19UBM929	Medical Waste management	3	0	0	3
30.	19UBM930	Digital System Design	3	0	0	3
31.	19UBM931	Bio-Signal Processing	3	0	0	3
32.	19UBM932	Principles of Machine Learning	3	0	0	3
33.	19UBM933	Bio Statistics	3	0	0	3
34.	19UBM934	Electro Magnetic Interference and Compatibility	3	0	0	3
35.	19UBM935	Smart Healthcare Engineering and Artificial Intelligence	3	0	0	3

Course Code	Course Title	L	T	P	C
19UBM901	BIOMEMS AND NANO ELECTRONICS	3	0	0	3

OBJECTIVES:

- To introduce various MEMS fabrication techniques.
- To impart knowledge on different types of sensors and actuators and their principles of operation at the micro scale level.
- To discuss the applications of MEMS in different fields of medicine

UNIT – I	**MEMS MATERIALS AND FABRICATION**	**9**

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

UNIT – II	**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 – micro-plates, 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.
Properties of piezoelectric materials, Piezo-electric sensor and actuator – inchworm motor, inertia sensor, flow sensor.

UNIT – III	**THE PROSPECT OF NANOMEDICINE**	**9**

Current Medical Practice, The Evolution of Scientific Medicine – Volitional Normative Model of Disease – Treatment Methodology – Evolution of Bedside Practice – The Nano medical Perspective, Nano-medicine and Molecular Nanotechnology – Pathways to Molecular Manufacturing- Molecular Transport and Sortation

UNIT – IV	**NANOSENSORS & NANOSCALE SCANNING**	**9**

Nano-sensor Technology – Chemical and Molecular Nano-sensor – Displacement and Motion Sensors – Force Nano-sensor – Thermal Nano-sensor – Electric and Magnetic Sensing – Cellular Bio scanning – Macro-sensing – integrated nano-sensor technologies, genomics & proteomics – real time & in vivo medical monitoring

UNIT – V	**NANODEVICES FOR MEDICINE & SURGERY**	**9**

Nano-devices for Clinical Nano-diagnostics, Nano-endoscopy, Nano-biotechnology and Drug Delivery Devices- Tools for Nano-surgery, Nano-scale Laser Surgery, Nano-robotics for Surgery – Nanotechnology for Detection of Cancer, QDs, Dendrimers for Sensing Cancer Cell Apoptosis, Gold Nanoparticles for Cancer Diagnosis, Nanotubes for Detection of Cancer Proteins, Nanoparticles for the Optical Imaging of Tumors.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	Comprehend and appreciate the significance and role of this course in the present contemporary world.	Understand
CO2:	Elaborate the basics and prospects of Nano medicine.	Understand
CO3:	Apply MEMS in different field of medicine.	Apply
CO4:	Analyze different types of sensors and actuators and their principles of operation at the micro scale level.	Analyze
CO5:	Analyze the various Nano-devices used in medical field for surgery.	Analyze
CO6:	Design MEMS devices for different medical applications.	Create

TEXT BOOKS:

1. Chang Liu," Foundations of MEMS", Pearson Education International, New Jersey, USA, 2nd Edition, 2011.
2. Robert .A. Freital.Jr, " Nanomedicine " Landes Bioscience Press 2010

REFERENCES:

1. Wanjun Wang, Stephen A.Soper,‖BioMEMs: Technologies and applications‖, CRC Press, New York, 2007
2. Marc J. Madou , "Fundamentals of microfabrication: the science of miniaturization", CRC Press, 2002
3. Robert A. Freitas, "Nanomedicine, Volume IIA: Biocompatibility", Landes Bioscience, 2011.
4. Jain.K.K, "Handbook of Nanomedicine" Springer, 2012.

Course Code	Course Title	L	T	P	C
19UBM902	CLINICAL ENGINEERING	3	0	0	3

OBJECTIVES:

- This course will provide a basic understanding of the clinical engineering profession, qualifications, roles, activities, and expectations.
- This course will enhance students to practice medical equipment and analyze challenges with their healthcare technology.
- This course will engage the students to work as a team to address problems and errors in medical devices.
- This course will help students to design better medical devices with computerized approaches.
- This course will expose students to explore the Health Technology Management systems with medical devices and supportive services with advanced application.

UNIT – I	INTRODUCTION	9

Clinical engineering: Definition, Evolution, Role, Responsibilities, Functional status, History of clinical engineering and Technology in Health Care System, Enhancing patient safety.

UNIT – II	MEDICAL TECHNOLOGY MANAGEMENT PRACTICES	9

Strategic Medical Technology Planning, Scope , Clinical necessity operational support, strategic planning process – Technology assessment: Technology audit, Budget strategies, Prerequist for medical technology assessment – Management Practice for Medical Equipment - Device evaluation, Risk reduction, Asset management, ESHTA

UNIT – III	ESSENTIAL HEALTH CARE TECHNOLOGY PACKAGE (EHTP)	9

Introduction – Health care technology management – Package development: Methodology, Logical framework, Implementation, Information promotion and dissemination – EHTP Justification – EHTP matrix – EHTP advantages – Impact Analysis

UNIT – IV	CLINICAL ENGINEERING PROGRAM INDICATOR	9

Clinical engineering: program services, Program database – Clinical Engineering Program management, Program indicator, Managing clinical engineering performance using program indicators – Indicator management process.

UNIT – V	ADVANCED TECHNOLOGY FOR PATIENT SAFETY	9

Factors Contributing to Medical Errors: Heath Care Reimbursement, Health Care Failure Mode and Effect Analysis (HFMEA), Patient Safety Best Practices Model: Bar coding, Computerized Physician Order Entry (CPOE), and Clinical data repositories – Process analysis, Methodology. Computerized medical equipment management systems.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	State the role of clinical engineers and discuss the basic concepts of medical and healthcare technology and working principles of program indicator and equipment management.	Understand
CO2:	Given the program and framework to recognize the errors of medical equipment, program database and medical technology for patient safety and implement the knowledge to solve the issues.	Apply
CO3:	Given the list of problems in management practice to define the problem precisely and examine the possible issues using program indicators.	Analyze
CO4:	Given the specification with essential health care technology package to state the issues or errors in patient safety and formulate patient safety package system.	Design
CO5:	Given the problem description of medical device and patient safety practices to examine its complexity and summarize a set of initial solution and justify their correctness.	Evaluate
CO6:	Demonstrate computer based equipment with automated system by using CPOE method.	Apply

TEXT BOOKS:

1. Ernesto Iadanza, Joseph Dyro, “Clinical Engineering Handbook”, Elsevier Academic Press, 2014
2. Robert Miniati, “Clinical Engineering from Devices to Systems”, Academic Press, 23-Dec-2015 - Technology & Engineering

REFERENCES:

1. Ernesto Iadanza, Clinical Engineering Handbook, 2nd Edition, Elsevier, Academic Press, November 2019, ISBN 9780128134672,
2. Jacobson B and Webster J G Medical and Clinical Engineering – Prentice Hall of India New Delhi 1999
3. Cesar A. Cacere& Albert Zana, The Practice of Clinical Engg. Academic press, New York, 1977.
4. Webster J.G and Albert M.Cook, Clinical Engg, Principles & Practices, Prentice Hall Inc., Engle wood Cliffs, New Jersy, 1979.

Course Code	Course Title	L	T	P	C
19UBM903	PRINCIPLES OF TISSUE ENGINEERING	3	0	0	3

OBJECTIVES:

- To provide a basic understanding of tissue engineering concepts, qualifications, roles, activities, and expectations.
- To enhance students to practice cell or tissue culture technique and analyze challenges with unique approaches.
- To engage the students to work as a team to address problems and errors in tissue engineering.
- To help students to solve medical problems of synthetic materials and design prosthetic devices with biomaterials.
- To expose students to explore key principles or design paradigms of tissue engineering scaffolds for various tissue or organ systems.

UNIT – I	FUNDAMENTALS OF TISSUE ENGINEERING	9

Tissue Engineering: Introduction – Objectives of tissue engineering – the basis of growth and differentiation. Tissue development and Tissue exchange – Cell cycle and differentiation – cell adhesion – cell adhesion molecules – cell migration – cell aggregation and tissue equivalent.

UNIT – II	DEVELOPMENT OF TISSUES	9

In vitro control of tissue development: Engineering functional tissues - Principles of Tissue Culture and Bioreactor Design - Regulation of Cell Behavior by Extracellular Proteins - Growth Factors. In Vivo Synthesis of Tissues and Organs: Models as Precursors for Prosthetic Devices - Quantitative Aspects - Cell Interactions with Polymers - Matrix Effects - Polymer Scaffold Fabrication - Biodegradable Polymers.

UNIT – III	STEM CELLS	9

Definition of stem cells – types of stem cells – differentiation, maturation, proliferation, pleuripotency and immortalization. Sources of stem cells: haematopoetic – fetal -cord blood – placenta – bone marrow – primordial germ cells – cancer stem cells – induced pleuripotent stem cells.

UNIT – IV	TISSUE ENGINEERING PRACTICE	9

Cell Delivery and Recirculation: Cell Movement within the Circulatory - Microchimerism - Cell Penetration into Three-Dimensional Tissues. Delivery of Molecular Agents in Tissue Engineering: Technology for Controlled Release of Agents in Time and Space - Future Applications of Controlled Delivery in Tissue Engineering.

UNIT – V	APPLICATION OF TISSUE ENGINEERING	9

Replacement Engineering: Bone, cartilage, skin, blood, pancreas, kidney, heart valve and liver. Regenerative engineering: peripheral Nerve regeneration – cardiac tissue regeneration – muscle regeneration – Tissue Engineered Food. Regulation, Commercialization and Patenting.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	State the basis of stem cell, cell differentiation, tissue and organ development and discuss the basic of tissue engineering and working concepts of tissue replacement and regeneration.	Understand
CO2:	Given the approach to recognize the development of tissue using pleuripotent techniques and implement the knowledge to manipulate Three-Dimensional Tissues.	Apply
CO3:	Given the list of problems in artificial tissue development using polymers to state the problem precisely, and point out the possible issues through *in vitro* assay.	Analyze
CO4:	Given the specification of biomaterials with cell interaction to tackle the issues in organ development and generate of artificial skin layer.	Design
CO5:	Given the impact of biomaterials on human tissue description to manipulate novel composition of materials, examine its complexity, develop a set of initial solution and justify their correctness for tissue development.	Evaluate
CO6:	Discuss basic concepts of tissue development using biomaterials, and demonstrate interaction of tissue and biodegradable Polymers.	Apply

TEXT BOOKS:

1. Robert Lanza, Robert Langer, Joseph Vacanti - Principles of Tissue Engineering, Academic Press - libgen.lc., 2007.
2. W. Mark Saltzman, “Tissue Engineering – Engineering principles for design of replacement organs and tissue”,Oxford University Press Inc New York, 2004.
3. Stewart Sell - Stem cells. Handbook, Humana Press - libgen. lc., 2010.

REFERENCES:

1. Gary E. Wnek, Gary L Browlin, “Encyclopedia of Biomaterials and Biomedical Engineering”, Marcel Dekker Inc, New York, 2008.
2. R. Lanza, Anthony Atala (Eds), “Essential of Stem Cell Biology”, Academic Press, USA, 2013.
3. R. Lanza, Anthony Atala,” Handbook of Stem Cells””, Academic Press, USA, 2012.

Course Code	Course Title	L	T	P	C
19UBM904	BIOMATERIALS AND ARTIFICIAL ORGANS	3	0	0	3

OBJECTIVES:

- To introduce the characteristics and classification of biomaterials
- To discuss the response of biomaterials in living system and their replacement
- To impart knowledge on compatibility and functioning of artificial organs inside the living system.
- To learn about the polymeric materials and composites in tissue replacements.

UNIT – I	**STRUCTURE OF BIO-MATERIALS, TESTING AND BIO-COMPATIBILITY**	**9**

Definition and classification of bio-materials, performance of biomaterials, mechanical properties, visco elasticity, wound- healing process, body response to implants, Testing of biomaterials: In-vitro, in-vivo preclinical tests, blood compatibility, HLA compatibility

UNIT – II	**IMPLANT MATERIALS**	**9**

Different classes of materials used in medicine - Mechanical & Thermal properties Metallic implant materials, stainless steels, co-based alloys, Ti-based alloys, ceramic implant materials, aluminum oxides, hydroxyapatite, glass ceramics, carbons, medical applications - Dental metals: Dental Amalgam, Gold

UNIT – III	**POLYMERIC IMPLANT MATERIALS**	**9**

Polymerization, polyamides, Acryrilic polymers, rubbers, high strength, thermoplastics, medical applications. Bio polymers: collagen and elastin. Medical Textiles: silica, chitosan, PLA, composites, Sutures, wound dressings. Materials for ophthalmology: contact lens, Intraocular lens. Membranes for plasma separation and blood oxygenation.

UNIT – IV	**TISSUE REPLACEMENT IMPLANTS**	**9**

Small intestinal submucosa and other decellularized matrix biomaterials for tissue repair. Soft- tissue replacements, types of transplant by stem cell, sutures, surgical tapes, adhesive, Percutaneous and skin implants, maxillofacial augmentation, Vascular grafts, hard tissue replacement Implants, joint replacements, Pancreas replacement.

UNIT – V	**ARTIFICIAL ORGANS**	**9**

Introduction to artificial organs, immunological consideration, Artificial blood, Artificial skin, Artificial Heart, eye and ear implants, Prosthetic Cardiac Valves, Artificial lung (oxygenator), Artificial Kidney (Dialyzer membrane), Dental Implants.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	Explain the basic principle and properties of biomaterials	Understand
CO2:	Explain the process of importance of ceramics and polymer used biomedical applications	Understand
CO3:	Analyze various types of metals used in implant applications	Analyze
CO4:	Explain the concepts of different types of biomaterials applied in-vitro and in-vivo biomedical implant applications.	Understand
CO5:	Study the different biomaterials used in artificial organs.	Understand
CO6:	Analyze various types of materials used in tissue replacements.	Analyze

TEXT BOOKS:

1. Joon park, R.S Lakes, “Biomaterials An Introduction ”Springer, 2007
2. Sujata V. Bhat “Biomaterials” springer 2007
3. Larry L. Hench and Julian R. Jones, Biomaterials, artificial organs and tissue engineering, CRC Press 2010

REFERENCES:

1. Myer Kutz, “ “Standard Handbook of Biomedical Engineering & Design”, McGraw-Hill, 2003
2. John Enderle, Joseph D.Bronzino, Susan M.Blanchard, “”Introduction to Biomedical Engineering”, Elsevier, 2005.
3. AC Anand, JF Kennedy, M. Miraftab, S.Rajendran, “Medical Textiles and Biomaterials for Health Care’’, Woodhead Publishing Limited, 2006.
4. Biomaterials for Artificial Organs 1st Edition Michael Lysaght Thomas Webster. 2010
5. Biomedical Membranes and (Bio) Artificial Organs, Dimitrios Stamatialis, 2018

Course Code	Course Title	L	T	P	C
19UBM905	PATTERN RECOGNITION AND NEURAL NETWORKS	3	0	0	3

OBJECTIVES:

- To introduce different neural models to solve regression, classification, feature selection and density estimation problems.
- To explain the learning and adaptation of supervised and unsupervised modes in learning.

UNIT – I	SUPERVISED LEARNING	9

Overview of pattern recognition – Discriminant functions – Supervised learning – Parametric estimation – Maximum likelihood estimation – Bayesian parameter estimation – Perceptron algorithm – LMSE algorithm – Problems with Bayes approach – Pattern classification by distance functions – Minimum distance pattern classifier.

UNIT – II	UNSUPERVISED LEARNING AND CLUSTERING ANALYSIS	9

Clustering for unsupervised learning and classification – Clustering concept – C-means algorithm – Hierarchical clustering procedures – Graph theoretic approach to pattern clustering – Validity of clustering solutions.

UNIT – III	FEATURE EXTRACTION AND SELECTION	9

Entropy minimization – Karhunen – Loeve transformation – Feature selection through functions approximation – Binary feature selection

UNIT – IV	NEURAL NETWORKS	9

Fundamentals of Neural Networks – History – Architectures – Learning methods – XOR problem – Delta rule – derivation – Back propagation – parameters in BPN – Associative memory – Hetero associative – BAM – energy function – problems – Associative memories – ART1 – ART2 – Applications

UNIT – V	FUZZY LOGIC	9

Fuzzy set theory – crisp sets – fuzzy sets – crisp relations – Fuzzy relations – Fuzzy systems – Crisp logic – predicate logic – fuzzy logic – fuzzy based systems – Defuzzification methods – applications

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	Classify patterns using statistical pattern classifier	Apply
CO2:	Perform unsupervised classification using clustering techniques	Understand
CO3:	Describe the feature extraction and selection techniques	Understand
CO4:	Explain the fundamentals of neural networks.	Understand
CO5:	Explain the fundamentals of fuzzy logic	Understand

TEXT BOOKS:

1. Hagan, Demuth and Beale, “Neural network design”, Vikas PublishingHouse Pvt. Ltd., New Delhi , 2002
2. Earl Gose, Richard Johnsonbaugh, Steve Jost, “Pattern Recognition and Image Analysis”, Prentice Hall of India Pvt. Ltd., New Delhi, 1999.
3. Timothy J.Ross, ’’Fuzzy Logic with Engineering applications”, John Wiley and Sons, 2010.

REFERENCES:

1. Robert Schalkoff, “ Pattern recognition, Statistical, Structural and neural approaches” John Wiley and Sons(Asia) Pte. Ltd., Singapore, 2005
2. Laurene Fausett ,” Fundamentals of neural networks –Architectures, algorithms and applications”, Prentice Hall, 1994
3. Duda R.O, Hart P.G, “Pattern classification and scene analysis”, Wiley Edition,2000
4. Rajasekaran.S and VijayalakshmiPai.G.A, “Neural Networks, Fuzzy Logic and Genetic Algorithms”, PHI, 2011.

Course Code	Course Title	L	T	P	C
19UBM906	FORENSIC SCIENCE	3	0	0	3

OBJECTIVES:

- To explain the basic principles of forensic science, crime and criminal justice system, police organization, the role of investigator and tools and techniques used in crime science
- To emphasize the importance of scientific methods in crime identification and detection.
- To deal with the modus operandi and role of modus operandi bureau in crime investigation

UNIT – I	INTRODUCTION TO FORENSIC SCIENCE	9

Introduction – Definition – Principles – Laws of Forensic Science – Historical Background of Forensic Science in India - Need of Forensic Science in present scenario – Organizational set up of Forensic Science Laboratories at state and central level – their types and Divisions – Forensic Examination

UNIT – II	TOOLS AND TECHNIQUES IN FORENSIC SCIENCE	9

Branches of Forensic Science - Forensic science in international perspectives, including set up of INTERPOL and FBI - Duties of Forensic Scientists - Code of conduct for Forensic Scientists - Qualifications of Forensic Scientists - Data depiction - Report writing

UNIT – III	CRIME AND POLICE ORGANIZATION	9

Definition – types of crime – causes of crime, prevention of crime – Difference in blue and white collar crime – Introduction of Cybercrime – Criminal Justice System – Organizational set up of Police at central and state level, Functions of Police – Functions of Police in analyzing a crime scene – Different paramilitary forces in India

UNIT – IV	CRIME SCENE	9

Introduction, Significance-Role of Investigator-Evaluation of crime scene – protection of crime scene – Photography of Crime scene – Tools and techniques – Significance of Photography and Videography-Introduction of Sketching – Purpose of Sketching – Making of Sketches

UNIT – V	FORENSIC EVIDENCES, ANALYSIS AND MODUS OPERANDI	9

Hair analysis – Fiber analysis – Ballistics & Tool marks: Soil, Glass and Paint – Footprints and tire impressions – Bite Marks – Finger prints – Blood Spatter Analysis – DNA analysis – Forensic Anthropology and Entomology - Investigation & examination procedure of various types of cases - Murder – Burglary – Railway & Air Crashes – Road Accidents etc.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	Define the basic principles of forensic science.	Understand
CO2:	Apply the scientific knowledge to the investigation of crimes	Apply
CO3:	Analyze the forensic evidences in crime scene and the role of investigator in sketching and examination of crime scene	Analyze
CO4:	Investigate and examine the modus operandi and role of modus operandi bureau in crime investigation	Evaluate

TEXT BOOKS:

1. W.J. Tilstone, M.L. Hastrup and C. Hald, Fisher"s, Techniques of Crime Scene Investigation, CRC Press, Boca Raton (2013).
2. Saferstein, Richard. "*Criminalistics—An Introduction to Forensic Science"*, 11th ed. Prentice Hall, Saddle River, NJ. 2011

REFERENCES:

1. H.B. Baldwin and C.P. May in, Encyclopedia in Forensic Science, Volume 1, J.A. Siegel, P.J. Saukko and G.C. Knupfer (Eds.), Academic Press, London (2000).
2. V.J. Geberth, Practical Homicide Investigation, CRC Press, Boca Raton (2006).
3. T. Bevel and R.M. Gardner, Bloodstain Pattern Analysis, 3rd Edition, CRC Press, Boca Raton (2008).

Course Code	Course Title	L	T	P	C
19UBM907	DRUG DELIVERY SYSTEM	3	0	0	3

OBJECTIVES:

- To explain the basic principles for development of novel drug delivery systems.
- To emphasize the importance of various drug delivery systems and their usage in hospitals.
- To deal with the formulation and evaluation of Novel drug delivery systems.

UNIT – I	CONTROLLED DRUG DELIVERY	9

Fundamentals of Controlled Release (CR) Drug Delivery – Rationale of sustained/controlled drug delivery – Physicochemical and biological factors influencing design and performance of CR products – therapeutic status of CDDS. Theory of mass transfer – Fick's first and second laws and their applications in drug release and permeation. Pharmacokinetic and pharmacodynamic basis of controlled drug delivery – bioavailibility assessment of CR systems.

UNIT – II	DESIGN AND FABRICATION OF TECHNOLOGY BASED CR SYSTEMS	9

Strategies and design of oral controlled release delivery systems – oral systems based on dissolution, diffusion and dissolution – Ion exchange resins, Ph – independent formulations – altered density formulations – Bucco/mucoadhesive systems. Osmotic controlled oral drug delivery - Feedback regulated Drug Delivery Systems

UNIT – III	PARENTERAL SYSTEM	9

Parenteral systems, biopharmaceutic considerations-design and development- polymeric microspheres – dispersed drug delivery – Implantable therapeutic systems - Biocompatibility of polymers and carriers – Intrauterine devices and intravaginal devices

UNIT – IV	TRANSDERMAL DRUG DELIVERY SYSTEM	9

Transdermal therapeutic systems (TTS): Drug absorption through skin-permeation enhancers, basic components of TTS – Approaches to development and kinetic evaluation – Testing of transdermal patches – pressure sensitive adhesives – Iontophoresis – Sonophoresis and electroporation. Formulation and evaluation of TTS

UNIT – V	TARGETED DRUG DELIVERY	9

History – concept, Types and key elements – ideal carrier system and approach with special reference to organ targeting (e.g. brain, tumor, lung, liver and lymphatics) – Basics of temperature – pH and magnetically induced targeting tactics. Vaccine delivery systems

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	Describe the basic concepts of different types of drug delivery systems	Understand
CO2:	Apply the scientific knowledge to the biopharmaceutical techniques	Apply
CO3:	Analyze the mechanism of action of transdermal and targeted drug delivery systems with the traditional methods	Analyze
CO4:	Investigate targeted drug delivery and its key elements for targeting tactics	Evaluate
CO5:	Design and fabricate the different types of technology based drug delivery system	Create

TEXT BOOKS:

1. Tozer T N, Rowland M, "Introduction of Pharmacokinetics and Pharmacodynamics: The Quantitative Basis of Drug Therapy", Williams & Wilkins, 2006.
2. Howard C. Ansel, NIcholos G. Popvich, Iyold V. Allen , "Pharmaceutical dosage forms and Drug Delivery system", 1st edition, 2014.
3. Jain N.K and Sharma S.N. "A text book of professional pharmacy", 1st edition 1995.

REFERENCES:

1. Samuel Harder and GlennV. Buskirk. "Pilot Plant Scale-Up Techniques. In The Theory and Practice of Industrial Pharmacy". 3rd edition., 1991
2. Remington, "The Science and Practice of pharmacy", 20 th Edn, vol.I, pg.no.903- 913.
3. Lachman et al "Theory and Practice of Industrial Pharmacy". 3rd edition Philadelphia, 1991,
4. S.D. Bruck, "Controlled Drug Delivery", Vol.1 (Basic Concepts) CRC Press. Florida, 1983

Course Code	Course Title	L	T	P	C
19UBM908	NUCLEAR MEDICINE	3	0	0	3

OBJECTIVES:

- To understand the basic of various imaging modalities in nuclear medicine
- Study the diagnostics and therapeutic applications of nuclear medicine and radiation safety procedures and regulations

UNIT – I	NUCLEAR MEDICINE PHYSICS	9

Basic Elementary introduction to structure of matter-elements-molecules and atoms- Radioactivity and interaction of radiation; Alpha, Beta and gamma emission, Laws of radioactive decay, Mechanisms of radioactive delay, Radiation intensity and exposure, Decay schemes and energy levels, Compton scattering, Pair productions, Particle interactions

UNIT – II	RADIOPHARMACEUTICALS	9

Radionuclide production, 99Mo/99mTc generator, Mechanism of localization, Types of radiopharmaceuticals, characteristics of radio pharmaceuticals, Radiopharmaceuticals for diagnosis and treatments in human, Dispensing of radio pharmaceuticals.

UNIT – III	PHYSICS OF NUCLEAR MEDICINE INSTRUMENTATION	9

Construction and principle operation of Gamma camera, Rectilinear scanner, Basic principles of pulse height analyser, Radiation detectors-Ionization chamber, Geiger Muller counter, Semiconductor detectors, Scintillation detectors, Electronic Instrumentation for radiation detection system

UNIT – IV	DIAGNOSTIC AND THERAPEUTIC APPLICATIONS OF RADIONUCLIDE	9

Invitro and Invivo Diagnostic techniques-PET-CT, Single photon emission computed tomography (SPECT), Radio iodine therapy for Thyrotoxicosis , Differentiated thyroid cancers, Palliative treatment for bone metastasis - 32P and 89 Strontium Dosage-Intravascular particulate radio nuclide Therapy, Receptor targeted therapy, 131I- MIBG Therapy, Targeted internal radiation in HCC: 90 Y, Radio-synovectomy using Yttrium

UNIT – V	RADIATION BIOLOGY AND SAFETY	9

Biological effects of radiation-Somatic and hereditary effects of radiation-Radiation protection indifferent nuclear isotope therapy procedures, Management of radiation accidents, Radiation effect on pregnancy and fertility, Diagnosis, evaluation and treatment of radiation overexposure, Instruments used in radiation survey & monitoring, Handling of radioactive patients, Role of national and international bodies in radiation safety, ICRP recommendations, BARC regulations regarding limits of radiation exposure.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	Explain the basics of nuclear radiation and its interactions	Understand
CO2:	Elaborate the types of radiopharmaceuticals	Understand
CO3:	Describe the principle and working of nuclear medicine instruments.	Understand
CO4:	Realize the medical applications in radionuclide.	Understand
CO5:	Apply the radiation safety measurements in healthcare.	Apply

TEXT BOOKS:

1. Simon Cherry, James Sorenson, Michael Phelps. “Physics in Nuclear Medicine”, Elsevier Saunders, 4th Edition, 2012
2. Jerrold T Bushberg, J.Anthony Seibert, Edwin M Leidholdt,John M Boone, Lippincott, “The Essential Physics of Medical Imaging” Williams & Wilkins, 3rd edition, 2011

REFERENCES:

1. Fred A Mettler, Milton J Guiberteau, “Essentials of nuclear Medicine and molecular imaging” 7th Edition, Elseiver, 2018.
2. Gopal B.Saha, Physics and Radiation biology of Nuclear Medicine. 2006

Course Code	Course Title	L	T	P	C
19UBM909	MEDICAL RADIATION SAFETY ENGINEERING	3	0	0	3

OBJECTIVES:

- Describe mechanisms of different types of biological effects following exposure to radiation
- Explain radiation protection in diagnostic radiology

UNIT – I	RADIATION BASICS	9

Atomic structure, characteristics of radiations, types of ionizing & non-ionizing radiations - Radioactive decay constant – half-life period, units of radiation and radioactivity -Units of radiation risk, Relative Biological Effectiveness (RBE) -Motion of electron in a crossed electric and magnetic field, nuclear forces, nuclear model -Radiation shielding principles, use of pocket dosimeters

UNIT – II	BIOLOGICAL EFFECTS	9

Acute biological effects of ionizing radiations, long term biological effects of ionizing radiations. Typical radiation doses – background, medicine, and industry; dose limits for occupationally exposed individuals- Techniques for limiting radiation doses to personnel - Spontaneous mutation rate, effect of radiation on skin and blood forming organs, digestive tract – sterility and cataract formation - Effects of chronic exposure to radiation

UNIT – III	RADIATION PROTECTION IN NUCLEAR MEDICINE AND ONCOLOGY	9

Nuclear medicine, diagnostic & therapeutic nuclear medicine- Positron Emission Tomography (PET), special considerations for handling PET, intensity modulated radiation therapy - Facility design, radiation protection of nuclear medicine staff -Radiation oncology, external beam shielding, brachytherapy, low-dose-rate brachytherapy-Radiation hazards in brachytherapy departments and teletherapy departments and radioisotope laboratories – Particle accelerators

UNIT – IV	RADIATION PROTECTION IN DIAGNOSTIC RADIOLOGY	9

Definition of free radicals and G-value, kinetics of radiation chemical transformations , LET and dose-rate effects -Safety assessment, facility design and shielding-BIR shielding method-Teletherapy machines: reference conditions for measurement, Type of ion chambers, phantom, waterproof sleeve - Unintended and accidental medical exposures, pregnancy procedures, Magnetic Resonance Imaging safety issues - Derivation of an expression for machine timing error, procedure for evaluation of temperature and pressure correction

UNIT – V	RADIATION HAZARDS AND PROTECTIVE MEASURES	9

planning of medical radiation installations - general considerations, design of diagnostic, deep therapy, tele gamma and accelerator installations, -Evaluation of radiation hazards in medical diagnostic, therapeutic installations - Radiation monitoring procedures – protective measures to reduce radiation, exposure to staff and patients, protective equipment – Handling of patients- Radiation accidents in medicine, the role of recommendations and regulations - Waste disposal facilities, radiation safety during source transfer operations, special safety features in accelerators, reactor

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	Explain the characteristics of radiations, biological effects of ionizing radiations, protection from radiations and radiation hazards in hospitals.	Understand
CO2:	Interpret the biological effects of ionizing radiations, guidelines of radiation protection and radiation detectors.	Apply
CO3:	Classify the safety measures related to UV, laser and nuclear medicine	Apply
CO4:	Classify the radiation assessment methods and Radiation monitoring procedures during medical diagnostic, therapeutic installations	Analyze
CO5:	Explain the radiation protection methods for magnetic resonance.	Analyze
CO6:	Design radiation hazards measuring devices.	Create

TEXT BOOKS:

1. Mary Alice StatkiewiczSherer, Paula J. Visconti, E. Russell Ritenour, Kelli Haynes, “Radiation Protection in Medical Radiography”, CRC Press, 7th edition, 2008.
2. Richard J. Vetter,Magdalena S. Stoeva, “Radiation protection in Medical imaging and Radiation oncology”, CRC Press,Taylor and franics group, 1st edition, 2016.
3. GopalB.Saha, “Physics and Radiobiology of Nuclear Medicine”, Springer, 3rd edition, 2006.

REFERENCES:

1. Max H Lombardi, “Radiation Safety in Nuclear Medicine”, CRC Press, 2nd edition, 2007.
2. DanielFarb, Bruce Gordan, “Occupational Radiation Safety Guidebook”, University of Health Care, 2005.
3. Robert J. Emery and Janelle Rios, “Operational Radiation Safety”, Vol. 110, No. 2, February 2016.

Course Code	Course Title	L	T	P	C
19UBM910	MEDICAL TECHNOLOGY	3	0	0	3

OBJECTIVES:

- To understand the quality control
- To study the recent digital and tele-health technologies
- To understand the basic of medical instruments and advances

UNIT – I	MEDICAL TECHNOLOGY	9

Organization of medical technology – Components - Associated branches - Basis of diagnosis - Basics of Quality Control - General approaches - Biomedical Waste Disposal: Introduction - Categories of waste - Standard protocol of waste disposal - Methods of waste disposal - Ethics & Code of Conduct.

UNIT – II	MEDICAL DEVICES: INTRODUCTION	9

History of medical devices - Medical Device terminology - Design of medical devices - Cardiac care technology - Respiratory therapy - dialysis therapy - imaging science technology - clinical lab technology - operation theater – anesthesia technology.

UNIT – III	BIOMEDICAL DEVICES: HOME CARE	9

Medical devices at home and its implementation - Scope of market for home medical devices -Unique challenges to the design & implementation of high - tech home care devices - Infant monitors - Medical alert services - Activity monitors.

UNIT – IV	DIGITAL SUPPORT SYSTEM	9

Video communication to support care delivery to independently living seniors - Establishing an infrastructure for telecare - Implementation of mobile computing in home care programs -. Home medicare management by videophone - Continuous home care through wireless bio-signal monitoring system.

UNIT – V	ADVANCES IN MEDICAL TECHNOLOGIES	9

Dynamic configuration of medical services - Personalized ambient monitoring - Support for mental health at home - Multi model interaction and technologies for care at home - User centered design of technologies to support care at hospital - Applications of :VR-AR-Artificial Intelligence – Robotics – IoT.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	Comprehend and appreciate the significance and role of this course in the present contemporary world.	Understand
CO2:	To design an advanced medical devices	Apply
CO3:	Assign functions appropriately to the human and to the machine.	Understand
CO4:	Analyze & Design a system or process to meet given specifications with realistic engineering constraints.	Evaluate
CO5:	Identify problem statements and function as a member of an engineering design team.	Analyze

TEXT BOOKS:

1. Dac-Nhuong Le, “Emerging technology of health and medicine”,Scrivener publishing,2018
2. A John Wiley, “Medical Devices-surgical and image guided technology”,wiley & sons publication, 2013

REFERENCES:

1. Lodewijk Bos, “Handbook of Digital Homecare: Successes and Failures”, Vol.3, Springer, 2011.
2. Mukherjee,K.L., Medical Laboratory Technology-A procedure manual for routine diagnostic tests-Volume 1,2,3, Tata McGraw Hill Publishing Company ltd.
3. Robyn Rice, “Home care nursing practice: Concepts and Application”, Elsevier, 4th edition, 2006.

Course Code	Course Title	L	T	P	C
19UBM911	MEDICAL OPTICS	3	0	0	3

OBJECTIVES:

- To provide a possibility for the student to acquire knowledge about the impact and interaction of light with biological tissue.
- To understand practical applications of optics related to medicine.

UNIT – I	INSTRUMENTATION IN PHOTONICS	9

Review of basic properties of light – Reflection, Refraction, Scattering, fluorescence and phosphorescence. Instrumentation for absorption, Scattering and emission measurements, excitation light sources – high pressure arc lamp, LEDs, Lasers. Optical filters. Optical detectors - Time resolved and phase resolved detectors, optical tweezers.

UNIT – II	OPTICAL PROPERTIES OF THE TISSUES	9

Light transport inside the tissue, optical properties of tissue. Laser Characteristics as applied to medicine and biology-Laser tissue Interaction-Chemical, Thermal, Electro-mechanical. Photo ablative processes.

UNIT – III	SURGICAL APPLICATIONS OF LASERS	9

Lasers in ophthalmology, Dermatology, Dentistry, Urology, Otolaryngology, Tissue welding and Soldering.

UNIT – IV	NON THERMAL DIAGNOSTIC APPLICATIONS	9

Optical coherence tomography, Elastography, Laser Induced Fluorescence (LIF)-Imaging, FLIM Raman Spectroscopy and Imaging, FLIM – Holographic and speckle application of lasers in biology and medicine.

UNIT – V	DIAGNOSTIC AND THERAPEUTIC APPLICATIONS	9

Near field imaging of biological structures, *In vitro* clinical diagnostics, Phototherapy, Photodynamic therapy (PDT) - Principles and mechanisms - Oncological and non-oncological applications of PDT - Biostimulation effect – applications - Laser Safety Procedures.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	Explain the LASER physics, Light and its working principle with different modes of operation.	Understand
CO2:	Apply fundamental principles of science, engineering, and mathematics to problems of biomedical optics.	Apply
CO3:	Analyze biomedical sensor integration with optical fiber and its emerging various therapeutic, diagnostic as well as imaging applications, advantages, and safety aspects.	Analyze
CO4:	Analyze biological systems and recommend possible photonic techniques/instruments that can be used to probe these systems.	Analyze
CO5:	Appraise and recognize the limitations of current optical imaging technologies and propose new approaches to overcome/improve upon them.	Evaluate

TEXT BOOKS:

1. Markolf H.Niemz, “Laser-Tissue Interaction Fundamentals and Applications”, Springer, 2007.
2. Paras N. Prasad, “Introduction to Bio photonics”, A. John Wiley and sons, Inc. Publications, 2003.

REFERENCES:

1. Tuan Vo Dinh, “Biomedical photonics – Handbook”, CRC Press LLC, 2003.
2. Mark E. Brezinski, “Optical Coherence Tomography: Principles and Applications”, Academic Press, 2006.
3. R. Splinter and B.A. Hooper, “An Introduction to Biomedical Optics”, Taylor and Francis, 2007.
4. Helena Jelinkova, “Lasers for Medical Applications: Diagnostics, Therapy and Surgery’’, Woodhead Publishing, 1st Edition, 2013.

Course Code	Course Title	L	T	P	C
19UBM912	GENETIC ENGINEERING	3	0	0	3

OBJECTIVES:

- To provide a basic understanding the concepts of gene cloning, genome analysis and genetic engineering.
- To enhance students to practice recombinant DNA technologies and analyze challenges with novel approaches.
- To engage the students to work as a team to troubleshoot in PCR and cloning techniques.
- To help students to solve genetic engineering problems and design target gene expression with advanced genetic engineering techniques.
- To expose students to explore with various genetic engineering techniques for cloning target gene or protein expression.

UNIT – I	BASICS OF GENETICS	9

Biomolecules: Carbohydrates, Proteins, Lipid, Amino acid and Nucleic acids. Nucleic acids: Introduction, History, DNA and RNA - genetic material, types, mutation. Chromosome, Gene, Expression of genetic information, Regulation of mRNA stability.

UNIT – II	RECOMBINANT DNA TECHNOLOGY	9

Gene cloning- concept and basic steps; Restriction modification enzymes used in recombinant DNA technology, endonucleases, ligases and other enzymes useful in gene cloning; Vectors: plasmid, bacteriophage and other viral vectors, cosmids, artificial chromosomes, Ti plasmid, shuttle vectors, expression vectors; DNA delivery methods; Construction of genomic and cDNA libraries; Techniques for selection, screening and characterization of transformants.

UNIT – III	ROLE OF POLYMERASE CHAIN REACTION	9

Concept of PCR; DNA polymerases; primer designing, linkers, adapters, setting up PCR reactions; Various types of PCR; Applications of PCR in disease diagnostics, forensic sciences and genetic engineering.

UNIT – IV	ADVANCED APPROACHES IN GENETIC ENGINEERING	9

Gene expression in prokaryotes & eukaryotes, Tissue specific promoter, wound inducible promoters, Strong and regulatable promoters, promoter analysis (EMSA and DNA footprinting), gene expression profiling (real time PCR, SAGE, differential display, Microarray); DNA sequencing methods; Molecular markers: RAPD, RFLP, AFLP, SNP; Site directed mutagenesis, gene silencing techniques.

UNIT – V	APPLICATIONS OF GENETIC ENGINEERING	9

Genetic engineering and Biotechnology; Creation of recombinant microorganisms, transgenic plants and animals; cloning of sheep (Dolly) & other mammals; applications in conservation; therapeutic vs. reproductive cloning; ethical issues and the prospects for human cloning; Gene therapy; DNA drugs and vaccines.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	State the role of PCR, recombinant DNA technologies and discuss the basic and working concepts of cloning, protein expression and gene therapy.	Understand
CO2:	Given the methodology and framework to recognize troubleshoot of gene cloning method and implement the knowledge to interpret the recombinant DNA, PCR and cloning technologies.	Apply
CO3:	Given the list of problems in gene expression to define the problem precisely and examine the possible issues through various gene expression profiles.	Analyze
CO4:	State the issues or errors of stem cell approaches and design various possible genetic approaches using stem cell technology.	Design
CO5:	Given the problem description, examine its complexity and develop a set of initial solution and justify their correctness for human cloning and gene therapy.	Evaluate
CO6:	Interpret both stem cell technology and recombinant DNA technology, and generate model animal cell line.	Apply

TEXT BOOKS:

1. Desmond S. T. Nicholl. An Introduction to Genetic Engineering Volume 2, Cambridge University Press- libgen.lc., 2008.
2. Brown, Terence Austen, Gene cloning and DNA analysis- an introduction, Wiley Blackwell - libgen.lc., 2016.

REFERENCES:

1. Sambrook, J., Fritsch, E.F., Mariatis. Molecular Cloning, A laboratory Manual. 3rd edition, 2001.
2. John M. Walker, Ralph Rapley - Molecular Biology and Biotechnology, Royal Society of Chemistry - libgen.lc., 2009.
3. S.B Primrose. Molecular biotechnology. Panima Publishing corporation, 2nd edition, 2001.
4. SmitaRastogi&DrNeelakPathak, Genetic Engineering, Oxford University Press, 2009.

Course Code	Course Title	L	T	P	C
19UBM913	COMMUNICATION ENGINEERING	2	0	2	3

OBJECTIVES:

- To introduce the fundamentals of analog and digital communication
- To provide the knowledge of various coding techniques for data transmission
- To impart the knowledge of satellite and optical fiber communication

UNIT – I	ANALOG COMMUNICATION	10

Introduction to analog signals, modulation techniques - AM – Frequency spectrum–vector representation–power relations – generation of AM – DSB, DSB/SC, SSB,VSB AM Transmitter & Receiver; FM and PM – frequency spectrum – power relations: NBFM &WBFM, Generation of FM and DM, Armstrong method & Reactance modulations :FM &PM frequency.

UNIT – II	DIGITAL COMMUNICATION	10

Introduction to digital signals, Pulse modulations – concepts of sampling and sampling theorems, PAM, PWM, PPM, PTM, quantization and coding: DCM, DM, slope overload error. ADM, DPCM, OOK systems – ASK, FSK, PSK, BSK, QPSK, QAM, MSK, GMSK, applications of Data communication

UNIT – III	SOURCE CODES, LINE CODES &ERROR CONTROL	10

Primary communication – entropy, properties, BSC, BEC, source coding: Shannon – Fano, Huffman coding: noiseless coding theorem, BW–SNR tradeoff, codes: NRZ, RZ, AMI, HDBP, ABQ, MBnB codes: Efficiency of transmissions, error control codes and applications: convolutions & block codes

LIST OF EXPERIMENTS:	30

1. Generation and Detection of Amplitude Modulation
2. Generation of Frequency Modulation and its Detection
3. Generation and Detection of PAM
4. Generation of BFSK and its Detection
5. Generation of standard inputs using simulation package
6. Simulation using MATLAB : AM / FM Modulator and Demodulator
7. Simulation using MATLAB: Pulse Code Modulation and Demodulation

TOTAL : 30(L) +30(P) = 60 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	Comprehend the various communication methods and techniques	Understand
CO2:	Compare different kind of analog and digital modulation techniques in terms of generation demodulation, power and bandwidth requirement	Apply
CO3:	Summarize various digital modulation techniques	Understand
CO4:	Develop different types of error control codes	Apply
CO5:	Detection of amplitude modulation and frequency modulation techniques	Analyze
CO6:	Analyzing the generation of different modulation techniques	Analyze
CO7	Use the coding techniques to analyze about modulation techniques	Apply
CO8	Compare the different modulation techniques based on various applications	Evaluate

TEXT BOOKS:

1. Taub and Schiling, “Principles of communication systems”, Tata McGrawhill, 2007.
2. J.Das, Mullick,S.K.,Chatterjee P.K., “Principles of digital communication”, New Age International,2012.

REFERENCES:

1. Kennedy and Davis,“Electronic communication systems”, Tata McGrawHill,4th Edition, 1993.
2. Sklar, “Digital communication fundamentals and applications”, Pearson Education, 2001.
3. Bary le,Memuschmidt, “Digital Communication”, Kluwer Publication, 2004.
4. Amitabha Bhattacharya, “Digital Communication”, Tata McGraw hill, 2006.

Course Code	Course Title	L	T	P	C
19UBM914	BIOMETRIC SYSTEMS	3	0	0	3

OBJECTIVES:

- To provide a basic understanding the concepts of fingerprint, iris, face and speech recognition.
- To enhance students to develop biometric systems and analyze challenges with novel approaches.
- To engage the students to work as a team to troubleshoot of personal privacy and security implications of biometrics.
- To help students to solve biometrics related problems and identify possible approaches.
- To expose students to explore biometric system with genetic engineering techniques using DNA fingerprinting technologies.

UNIT – I	BIOMETRIC FUNDAMENTALS	9

Key Biometric terms and Processes –Definitions-verification and identification – matching, Accuracy in Biometric Systems – False match rate -False nonmatch rate – Failure to enroll rate – Derived metrics - An Introduction to Biometric Authentication Systems – taxonomy of application environment, a system model, biometrics and privacy - Performance measures in biometric systems.

UNIT – II	FINGERPRINT IDENTIFICATION TECHNOLOGY	9

Finger-scan – History, Components, working principles, competing technologies, Strengths and Weaknesses. Fingerprint Patterns, Fingerprint Features, Fingerprint Image, width between two ridges - Fingerprint Image Processing – Minutiae Determination - Application of Fingerprints: Criminal Applications, Civil Applications, Commercial Applications. Technology Evaluation of Fingerprint Verification Algorithms.

UNIT – III	IRIS RECOGNITION	9

Introduction, Anatomical and Physiological underpinnings, Components, Sensing, Iris Scan Representation and Matching, Iris Scan -working principles, competing technologies, Strengths and Weaknesses, System Performance, Future Directions.

UNIT – IV	FACE RECOGNITION	9

Introduction, components, Facial Scan Technologies, Face Detection, Face Recognition –Representation and Classification, Kernel – based Methods and 3D Models, Learning the Face Spare, Facial Scan - working principles, competing technologies, Strengths and Weaknesses, Methods for assessing progress in Face Recognition.

UNIT – V	VOICE SCAN	9

Introduction, Components, Features and Models, Addition Method for managing Variability, Measuring Performance, Alternative Approaches, Voice Scan - working principles, competing technologies, Strengths and Weaknesses, NIST Speaker Recognition Evaluation Program, Biometric System Integration. Multibiometric: Introduction – Information Fusion in Biometrics – Issues in Designing a Multibiometric System –Sensor level, Feature level, Rank level, Decision level fusion – Score level Fusion.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	State the role of Biometric Authentication Systems and discuss the basic and working concepts of finger printing technologies.	Understand
CO2:	Given the finger printing methodology and framework, recognize the issues in the application of fingerprinting technology and solve the biometric system using DNA fingerprinting technologies.	Apply
CO3:	Given the problem in biometric system integration, define the problem precisely and examine the possible issues through multi-biomatric system and sensors.	Analyze
CO4:	State the issues of face recognition system and develop novel approach with the combination of facial scan technology and 3D model.	Design
CO5:	Given the problem description, examine its complexity and develop a set of initial solution and justify their correctness and strengthen the efficacy of finger print, face, iris and voice recognition system.	Evaluate
CO6:	Investigate both DNA technology and iris recognition system, and manipulate model for accurate identification system.	Apply

TEXT BOOKS:

1. James Wayman& Anil Jain, “Biometric Systems –Technology, Design and Performance Evaluation”, Springer-verlag London Ltd, USA, 2005
2. SanirNanavati, Michael Thieme, “Biometrics Identity Verification in a Networked world”, Wiley Computer Publishing Ltd, New Delhi,2003.

REFERENCES:

1. Jain, Anil, Ross, Arun A., Nandakumar, Karthik. Introduction to Biometrics, Springer, 2011.
2. Anil K. Jain, Patrick Flynn, and Arun A. Ross, “Handbook of Biometrics”, Springer, 2008.
3. John R. Vacca, ‘Biometric Technologies and Verification Systems’, Elsevier, 2007.
4. Ted Dunstone, Neil Yager, ‘Biometric System and Data Analysis: Design, Evaluation, and Data Mining, Springer Science & Business Media, 2008.

Course Code	Course Title	L	T	P	C
19UBM915	MEDICAL INFORMATICS	3	0	0	3

OBJECTIVES:

- To provide a basic understanding of Information communication technology and its applications in medicine.
- To enhance students to practice adopted in Hospital Information Systems in the light of medical standards, medical data formats and recent trends in Medical Information Systems.
- To engage the students to work as a team to troubleshoot of medical image processing.
- To help students to solve computer assisted medical related problems and identify possible approaches.
- To expose students to explore the medical Informatics approaches and relative supportive services with advanced application.

UNIT – I	MEDICAL INFORMATICS	9

Introduction – Health Informatics – Structure of Medical Informatics – Internet and Medicine – Security issues – Functional capabilities of a computerized Healthcare Information Systems – e-health services – Prospects of Medical Informaticians. Hospital Management And Information Science (HMIS): Introduction, need, Benefits, development, functional areas. HMIS and Internet, health information system, advantages of HMIS.

UNIT – II	COMPUTERISED PATIENT RECORD	9

Introduction – History– Dialogue with the computer – Components and functionality of Computerized Patient Record – Development tools – Intranet – CPR in Radiology – Legal, Security and Privacy Issues – Application server provider.

UNIT – III	COMPUTER ASSISTED MEDICAL EDUCATION	9

Computer Assisted Medical Education: Introduction, Educational software, Simulation, Virtual Reality, Tele-education, Tele-mentoring. Computer Assisted Patient Education: CAPE, patient counseling software. Computer assisted surgery (CAS), Limitations of conventional surgery, 3D navigation system, intra-operative imaging for 3D navigation system, merits and demerits of CAS.

UNIT – IV	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 – V	MEDICAL DATA, STANDARDS AND RECENT TRENDS IN MEDICAL INFORMATICS	9

Medical data storage and retrieval techniques – Steganography – Medical Standards: Health Level 7 – DICOM – IEEE 1073 – IRMA – LOINC – ICD10 – Medical standard organizations. Virtual reality applications in medicine – Computer assisted surgery – Surgical simulation – Telemedicine – Tele surgery computer aids for the handicapped – Computer assisted instrumentation in Medical Informatics.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	Explain the concepts of Medical Informatics and State the role of computerized patient record and discuss the basic and working concepts of medical imaging.	Understand
CO2:	Given the Computer Assisted Medical Education, recognize the issues in the limitations of conventional surgery and solve by improve Computer assisted surgery.	Apply
CO3:	Given the problem in Computerized ECG, define the problem precisely and examine the possible issues through its working principles.	Analyze
CO4:	State the issues on conventional method and develop novel approach with the combination of steganography.	Design
CO5:	Given the problem description, examine its complexity and develop a set of initial solution and justify their correctness of Computer assisted instrumentation.	Evaluation
CO6:	State3D navigation system, intra-operative imaging, and manipulate model for the disabled people using Tele surgery computer aids.	Apply

TEXT BOOKS:

1. R.D.Lele, “Computers in medicine progress in medical informatics”, Tata McGraw Hill Publishing Ltd, 2005
2. Mohan Bansal, “Medical informatics”, Tata McGraw Hill Publishing Ltd, 2003

REFERENCES:

1. OrpitaBosu and SimminderKaurThukral, “Bioinformatics Databases, Tools and Algorithms”, Oxford University press, 2007.
2. Yi Ping Phoebe Chen, “Bioinformatics Technologies”, Springer International edition, New Delhi, 2007.
3. Medical Informatics: Computer Applications in Health Care and Biomedicine by E.H.Shortliffe, G. Wiederhold, L.E.Perreault and L.M.Fagan, 2ndEdition, Springer Verlag, 2000.
4. Handbook of Medical Informatics by J.H.VanBemmel, Stanford University Press/ Springer, 2000.

Course Code	Course Title	L	T	P	C
19UBM916	TELEMEDICINE	3	0	0	3

OBJECTIVES:

- To impart knowledge on the key principles for telemedicine and healthcare application.
- To introduce telemedical standards, mobile telemedicine and it applications
- To Understand the telemedicine technology, and types of data transfer

UNIT – I	TELEMEDICINE AND HEALTH	8

History and Evolution of telemedicine, Definition of Telemedicine by WHO, Functional diagram of telemedicine system, Telemedicine, Telehealth, Tele care, Organs of Telemedicine, Global and Indian scenario, Advances in Telemedicine - Connecting rural India through telemedicine. Introduction to communication system – Input transducers – transmitter - communication channel - receiver – output transducer – communication technology.

UNIT – II	TELEMEDICAL TECHNOLOGY	10

Principles of Multimedia - Text, Audio, Video, data, Data communications and networks, PSTN, POTS, ANT, ISDN, Internet, Air/wireless communications: GSM satellite, and Micro wave, Communication: LAN, WAN, Satellite communication, Mobile hand held devices and Mobile communication, Modulation techniques, Types of Antenna, telemedicine using world wide web (www), Video and audio conferencing. Telemedicine websites.

UNIT – III	TELEMEDICAL STANDARDS	9

Data Security and Standards: Encryption – DES, RSA, Mechanisms and Phases of Encryption – Cryptography – Protocols: TCP/IP, ISO-OSI, Standards: DICOM, HL7, H. 320 series (Video phone based ISBN) T.120, H.324 (Video phone based PSTN).

UNIT – IV	TELEMEDICAL APPLICATIONS	9

Introduction to Robotics surgery – Tele radiology – Basic parts of a Teleradiography System, Image acquisition and display system, Communication and Interpretation – Tele pathology, Telesurgery, Telecardiology, Teleoncology, Telemedicine in neurosciences, Telepsychiatry, Teledermatology, Telehome – Care Home based Applications.

UNIT – V	ETHICAL AND LEGAL ASPECTS OF TELEMEDICINE	9

Confidentiality, Patient rights and consent, Ethical and legal aspects of internet – Administration of local and centralized medical data, Security, Confidentially of medical records and access control, Cyber laws related to telemedicine – Telemedical malpractice – Consent treatment, Jurisdictional issues, Intellectual Property Rights – Constraints linked to economy, social acceptance.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	Describe the overview of communication systems, telemedicine and health	Understand
CO2:	Differentiate the various technologies used in telemedical field, ethical and legal issues in telemedicine	Knowledge
CO3:	Discuss the different medical standards and ethical issues	Analyze
CO4:	Gain knowledge on telemedicine technology and recent applications	Understand
CO5:	Apply the telemedicine technology to the various medical applications	Apply
CO6:	Analyze various ethical issues handling methods	Analyze

TEXT BOOKS:

1. Olga Ferrer-Roca, Marcelo Sosa-Iudicissa, “Handbook of Telemedicine”, IOS press, 2003
2. A. C. Norris, “Essentials of Telemedicine and Telecare”, John Wiley & Sons 2002.

REFERENCES:

1. Brownsell, Simon, et al,. A systematic review of lifestyle monitoring technologies, Journal of telemedicine and telecare 17.4 (2011): 185-189.
2. Ling Guan, “Multimedia image and video processing”, CRC Press 2000.
3. Thorsten M Buzug, Heinz Handels, Dietrich Holz, “Telemedicine: Medicine and Communication”, Springer Verlag 2001.
4. Douglas V.Goldstein, “E Healthcare: Harness the power of Internet, e-commerce and e-care”, Jones and Barlett Publishers
5. Bemmel, J.H. van, Musen, M.A. (Eds.) “Handbook of Medical Informatics”, Heidelberg, Germany: Springer, 1997.
6. Mohan Bansal, “Medical Informatics”, Tata McGraw-Hill, 2004.

Course Code	Course Title	L	T	P	C
19UBM917	REHABILITATION ENGINEERING AND ROBOTICS	3	0	0	3

OBJECTIVES:

- To understand the sensory rehabilitation systems.
- To learn the use of the orthopedic prosthetics and orthotics in rehabilitation.
- To have an understanding of rehabilitation medicine and advocacy.
- To explain the basic concepts of robots and types of robots

UNIT – I	INTRODUCTION TO REHABILITATION	9

Engineering Concepts in Sensory Rehabilitation, Motor Rehabilitation - Rehabilitation Engineering Technologies: The Conceptual Frameworks - The Provision Process - Education and Quality Assurance – Specific Impairments and Relates Technologies - Future Developments - Design Considerations - Sensory augmentation and substitution- Visual system, Auditory system, Tactual system

UNIT – II	PROSTHETIC AND ORTHOTIC DEVICES	9

Engineering concepts in motor rehabilitation, Fundamentals – Amputation - Lower extremity prosthetics - Upper limb prosthetics (transradial), (transhumeral) - Ankle foot orthoses (AFO) - Knee Ankle Foot Orthoses (KAFO) - Truncal and Cervical orthoses – Assistive Devices – Adaptive Devices – Applications

UNIT – III	WHEELED MOBILITY AND THERAPEUTIC EXERCISE TECHNIQUE	9

Introduction - Categories of Wheelchairs - Wheelchair Prescriptions - Wheelchair Structure and Component Design - Ergonomics of Wheelchair Propulsion - Power Wheelchair Electrical Systems - Personal Transportation - Wheelchair Safety, Standards And Testing. Rehab-Therapy - Co-ordination exercises - Frenkels exercises - Gait Training - Relaxation exercises - Strengthening exercises - Mobilization exercises - Endurance exercises

UNIT – IV	INTRODUCTION OF ROBOTICS	9

Introduction to Robotics and its history, Overview of robot subsystems, Degrees of freedom, configurations and concept of workspace, Automation ,Mechanisms and movements, Dynamic stabilization-Applications of robotics in medicine

UNIT – V	REHABILITATION ROBOTICS	9

Fundamentals of Robot Technology - Automation and Robotics - Robot anatomy - Work volume - Precision of movement - End effectors - Sensors. human-robot interaction, Functions of rehabilitation robotics , rehabilitation robotics in recent areas – exoskeletons, Neuroplasticity, robotic therapy

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	Describe the concepts of rehabilitation engineering, rehabilitation robotics	Understand
CO2:	Differentiate the orthotic and prosthetic devices in rehabilitation	Knowledge
CO3:	Connect the rehabilitation engineering with the usage of robotics.	Analyze
CO4:	Relate the designing procedure of various assistive devices	Apply
CO5:	Apply the concepts of rehabilitation engineering for various applications.	Apply
CO6:	Recommend the appropriate designing consideration for the prosthetic and orthotic devices.	Create

TEXT BOOKS:

1. Robinson C.J, “Rehabilitation Engineering”, CRC Press , 2006
2. Rory A Cooper, “Rehabilitation Engineering Applied To Mobility And Manipulation”, IOP Publishing Ltd 1995.
3. Joseph D Bronzino, “The Biomedical Engineering Handbook”. 2nd edition, CRC Press,2000.
4. John Iovine, "Robots, Android and Animatronics", McGraw-Hill, 2nd Edition, 2012.

REFERENCES:

1. Sashi S Kommu, “Rehabilitation Robotics”, 1st edition, CRC Press, 2007.
2. Sunder, “Textbooks of Rehabilitation”, Jaypee Brothers Medical Publishers Pvt. Ltd, New Delhi, 2nd Edition, Reprint 2007.
3. Horia- Nocholai Teodorecu, L.C.Jain, “Intelligent systems and technologies in rehabilitation
4. James Moore, George Zouridakis, “Biomedical Technology and Devices Handbook”, CRC Press 2004.
5. Engineering”, CRC; December 2000.Douglas V.Goldstein, “E Healthcare: Harness the power of Internet, e-commerce and e-care”, Jones and Barlett Publishers
6. Robert J. Schilling, "Fundamentals of Robotics- Analysis and Control", Pearson Education, 2006.
7. Bemmel, J.H. van, Musen, M.A. (Eds.) “Handbook of Medical Informatics”, Heidelberg, Germany: Springer, 1997
8. Mohan Bansal, “Medical Informatics”, Tata McGraw-Hill, 2004

Course Code	Course Title	L	T	P	C
19UBM918	VIRTUAL BIO-INSTRUMENTATION	2	0	2	3

OBJECTIVES:

- To introduce virtual instrumentation concepts and applications.
- To train to program virtual instrumentation software for biomedical applications

UNIT – I	INTRODUCTION TO VIRTUAL INSTRUMENTATION AND LABVIEW	10

Concept of virtual instrumentation– Block diagram and Architecture of Virtual Instruments – Virtual Instruments versus Traditional Instruments – LabVIEW software – LabVIEW basics – LabVIEW environment.

UNIT – II	PROGRAMMING TECHNIQUES	10

Creating, Editing and debugging a VI in LabVIEW – Creating a sub VI – Loops and charts – Case and sequence structures – File I/O – VI customization.

UNIT – III	DATA ACQUISITION AND CONTROL IN VI	10

Plug-in DAQ boards – Organization of the DAQ VI System – Performing analog input and analog output – Scanning multiple analog channels – Driving the digital I/Os – Buffered data acquisition – Simple problems

LIST OF EXPERIMENTS:	30

1. Creating Virtual Instrumentation for simple applications
2. Programming exercises for loops and charts
3. Programming exercises for clusters and graphs.
4. Programming exercises on case and sequence structures, file Input / Output.
5. Data acquisition through Virtual Instrumentation.
6. Biopotential measurement using DAQ.

TOTAL : 60 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	Explain the basics of virtual instrumentation and LabVIEW programming.	Understand
CO2:	Compare the virtual instruments and traditional instruments in terms of calibration and accuracy.	Analyze
CO3:	Explain the various types of structures used in LabVIEW	Analyze
CO4:	Demonstrate the working of LabVIEW for simple arithmetic and logical operations	Apply
CO5:	Demonstrate the working of LabVIEW for loops, charts, sequence structures.	Apply
CO6:	Create a Virtual Instrument using graphical programming for real-time signal acquisition and analysis.	Create
CO7:	Design data acquisition systems for practical applications using LABVIEW.	Apply
CO8:	Sketch the virtual instrumentation using LABVIEW for biomedical signal conditioning and monitoring.	Apply

TEXT BOOKS:

1. Jerome, Jovitha, “Virtual Instrumentation and LABVIEW”, PHI Learning, New Delhi, First Edition, 2010.
2. Sanjay Gupta and Joseph John, “ Virtual Instrumentation using LabVIEW”, Tata Mc Graw – Hill Publishing Company Limited, New Delhi, 1st Edition, 2005.

REFERENCES:

1. Gupta, “Virtual Instrumentation Using Lab View”, Tata McGraw Hill, New Delhi,1st Edition, 2008.
2. Leonard Sokoloff, “Applications in LabVIEW”, Prentice Hall, 0-13-833949-X, 2003.
3. Robert H. Bishop, ‘Learning with Lab-view’, Prentice Hall, 2003.
4. Gary W. Johnson, Richard Jennings, ‘Lab-view Graphical Programming’, McGraw Hill Professional Publishing, 2001.

Course Code	Course Title	L	T	P	C
19UBM919	MEDICAL EMBEDDED SYSTEM	3	0	0	3

OBJECTIVES:

- To impart knowledge in the basic Building Blocks of Embedded System and embedded networking.
- To impart knowledge in the design of embedded system for various medical devices.

UNIT – I	INTRODUCTION TO EMBEDDED SYSTEMS	9

Introduction to Embedded Systems –Structural units in Embedded processor , selection of processor & memory devices- DMA – Memory management methods- Timer and Counting devices, Watchdog Timer, Real Time Clock, In circuit emulator, Target Hardware Debugging

UNIT – II	EMBEDDED NETWORKING	9

Embedded Networking: Introduction, I/O Device Ports & Buses– Serial Bus communication protocols RS232 standard – RS422 – RS 485 - CAN Bus -Serial Peripheral Interface (SPI) – Inter Integrated Circuits (I2C) – need for device drivers.

UNIT – III	EMBEDDED FIRMWARE DEVELOPMENT ENVIRONMENT	9

Embedded Product Development Life Cycle- objectives, different phases of EDLC, Modelling of EDLC; issues in Hardware-software Co-design, Data Flow Graph, state machine model, 78 Sequential Program Model, concurrent Model, object-oriented Model.

UNIT – IV	DESIGN OF PATIENT MONITORING DEVICES	9

Design consideration of patient monitoring systems- Basic block diagram of pulse oximeter, design requirement of device -Circuit implementation of interfacing of oximeter sensors with microcontroller - Software coding and implementation

UNIT – V	DESIGNING OF PACEMAKER	9

System description of pacemaker - Design requirement and basic block diagram of pacemaker - Interfacing of pacemaker elements with processors - Software coding of pacemaker and implementation

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	Describe the basic concepts and the building blocks of embedded system and how a processor is selected for an embedded application.	Understand
CO2:	Explain the timers used in embedded system, memory organization in embedded processors	Analyze
CO3:	Compare the various Communication buses (RS232, RS422, RS485, CAN Bus) in processors.	Analyze
CO4:	Illustrate the functional description about the different phases of embedded design life cycle model.	Apply
CO5:	Design a pulse oximeter with given specifications using microcontroller.	Create
CO6:	Design a pacemaker and develop the software code for implementation.	Create

TEXT BOOKS:

1. James K. Peckol, “Embedded system Design”, John Wiley & Sons, 1st edition, 2010.
2. Lyla B Das,” Embedded Systems-An Integrated Approach”, Pearson, 2011

REFERENCES:

1. Rajkamal, Embedded Systems Architecture, Programming and Design, TATA McGraw-Hill, First reprint Oct. 2003 (UNITS I, IV & V)
2. Elicia White, “Making Embedded Systems”, O’Reilly Series, SPD, 1st edition, 2011.
3. G. Baura, "A Biosystems Approach to Industrial Patient Monitoring and Diagnostic Devices”, Morgan& Claypool, IEEE, 2008.
4. David. E. Simon, “An Embedded Software Primer”, 1st Edition, Fifth Impression, Addison- Wesley Professional, 2007.

Course Code	Course Title	L	T	P	C
19UBM920	BRAIN COMPUTER INTERFACE AND VIRTUAL REALITY	3	0	0	3

OBJECTIVES:

- To understand the basic concepts of brain computer interface
- To study the various signal acquisition methods
- To understand the various machine learning methods of BCI
- To understand virtual reality and using them to build Biomedical engineering applications

UNIT – I	INTRODUCTION TO BCI	9

Fundamentals of BCI – Structure of BCI system – Classification of BCI- Types - Synchronous and Asynchronous -Invasive BCI -Partially Invasive BCI - Non Invasive BCI, Structure of BCI System, BCI Monitoring Hardware, EEG, ECoG, MEG, fMRI.

UNIT – II	BRAIN ACTIVATION	9

Brain activation patterns - Spikes, Oscillatory potential and ERD, Slow cortical potentials, Movement related potentials-Mu rhythms, motor imagery, Stimulus related potentials - Visual Evoked Potentials – P300 and Auditory Evoked Potentials, Potentials related to cognitive tasks.

UNIT – III	MACHINE LEARNING METHODS FOR BCI	9

Classification techniques –Binary classification, Ensemble classification, Multiclass Classification, Evaluation of classification performance, Regression - Linear, Polynomial, RBF's, Perceptron's, Multilayer neural networks, Support vector machine, Graph theoretical functional connectivity analysis

UNIT – IV	VR DEVELOPMENT PROCESS	9

The three I's of virtual reality-commercial VR technology and the five classic components of a VR system - Input and Output Devices- Geometric modeling - kinematics modeling- physical modeling - behaviour modeling - model Management.

UNIT – V	VR ON THE MOBILE AND ITS APPLICATION	9

VR for Android-Scripts, mobile device configuration, building to android-cameras and interaction-teleporting-spatial audio-Assessing human parameters-device development and drivers-Design Haptics- Medical applications-military applications-robotics applications- Advanced Real time Trackingother applications-games, movies, simulations, therapy.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	Comprehend and appreciate the significance and role of this course in the present contemporary world.	Understand
CO2:	Evaluate concept of BCI.	Apply
CO3:	Assign functions appropriately to the human and to the machine.	Apply
CO4:	Analyze & Design a system or process to meet given specifications with realistic engineering constraints.	Evaluate
CO5:	Identify problem statements and function as a member of an engineering design team.	Analyze

TEXT BOOKS:

1. Rajesh.P.N.Rao, "Brain-Computer Interfacing: An Introduction", Cambridge University Press, First edition, 2013.
2. Jonathan Wolpaw, Elizabeth Winter Wolpaw, "Brain Computer Interfaces: Principles and practice", Oxford University Press, USA, Edition 1, January 2012.
3. Jason Jerald,The VR Book: Human-Centred Design for Virtual Reality. Association for Computing Machinery and Morgan & Claypool, New York, NY, USA,2015.

REFERENCES:

1. Ella Hassianien, A &Azar.A.T (Editors), "Brain-Computer Interfaces Current Trends and Applications", Springer, 2015
2. Augmented Reality: Principles and Practice (Usability) by Dieter Schmalstieg & Tobias Hollerer, Pearson Education (US), Addison-Wesley Educational Publishers Inc, New Jersey, United States, 2016. ISBN: 9780321883575
3. Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR (Usability),Steve Aukstakalnis, Addison-Wesley Professional; 1st edition, 2016.

Course Code	Course Title	L	T	P	C
19UBM921	NEUROSCIENCE	3	0	0	3

OBJECTIVES:

- To provide a basic understanding of nervous system and its disorder.
- To enhance students to practice behavior science in animal model.
- To engage the students to work as a team to troubleshoot of neurological disorder by *in vitro* assay.
- To help students to investigate neural disorder and its behavior related science.
- To expose students to explore the neurological science and enhance its efficiency in learning and memory of nervous system.

UNIT – I	INTRODUCTION TO NERVOUS SYSTEM	9

Nervous system: Introduction - Central and peripheral nervous system – Signaling molecules: First growth factor, First Neuro transmitters in brain– functional organization, Synaptic potentials and Receptor potentials.

UNIT – II	NEURO ANATOMY	9

Structures and functions of neurons – Synapse – function, signals produced by neurons – Sensors function – Glial cells – molecular and cellular organization of neuronal differentiation – characterization of neuronal cells.

UNIT – III	NEUROPHYSIOLOGY AND NEUROPHARMACOLOGY	9

Resting and action potentials; Mechanism of action potential conduction; Voltage dependent channels; nodes of Ranvier; Chemical and electrical synaptic transmission. Synaptic transmission, neurotransmitters and their release; fast and slow neurotransmission; characteristics of neurites; hormones and their effect on neuronal function.

UNIT – IV	NEUROLOGICAL DISORDERS	9

Pathogenesis – Genetic basis of neurological disorders – Psychiatric Disorders: Psychiatric epidemiology, Unipolar depression, Bipolar depression, Seasonal affective disorder, Panic disorder, Autism, Stroke, Huntington disease

UNIT – V	BEHAVIOUR SCIENCE	9

Neuronal mechanism of behavior – Animal behavior – Behaviour in various environments.Behavioural and cognitive neuroscience - Behavioural studies using animal model - Testing motor functions, Grip Strength Test, Testing Cognitive Functions – Learning and memory related test

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	Explain the concepts of neuroscience and State the role of behavior science and discuss the basic and working concepts of nervous system.	Understand
CO2:	Discover the given stroke condition, recognize the issues of neurological function and solve by using neurotransmission approach.	Apply
CO3:	Relate the given heart failure problem, define the issue precisely and examine the possible approaches related with nervous system and cellular function.	Analyze
CO4:	State the issues of autism and design novel approach with neuro-sensory devices for monitor neurological disorders in human.	Design
CO5:	Examine the problem description and its complexity to develop a set of initial solution and justify their correctness of cognitive and motor function to enhance neural mechanism.	Evaluate

TEXT BOOKS:

1. Georg Goldenberg, Bruce L. Miller - Neuropsychology and Behavioral Neurology_ Handbook of Clinical Neurology, Elsevier - libgen.lc., 2008.
2. Michael J. Aminoff, “Handbook of Clinical Neurology”, Elsevier, London, 2012

REFERENCES:

1. Mason P., Medical Neurobiology, Oxford University Press, 2011.
2. Mathews G.G. Neurobiology, 2nd edition, Blackwell Science, UK, 2000.
3. Gordon M. Shepherd G.M, and Shepherd Neurobiology, 3rd Edition Oxford University Press, USA, 1994
4. Haynes, “Neuron in Tissue Culture”, 1998.

Course Code	Course Title	L	T	P	C
19UBM922	CANCER BIOLOGY	3	0	0	3

OBJECTIVES:

- To import knowledge on Cancer Biology fundamentals and principles of carcinogenesis.
- To discuss about molecular cancer cell biology and metastasis
- To introduce various therapeutic procedures for treating carcinoma
- To emphasize knowledge of the historical background for the development of the tumor microenvironment

UNIT – I	FUNDAMENTALS OF CANCER BIOLOGY	9

Regulation of cell cycle, Mutations that cause changes in signal molecules, Cancer genes - Tumor suppressor genes, oncogenes and their mutations, Modulation of cell cycle in cancer, Different forms of cancers, Clinical examination, Radiological examination, Biopsy and its type, Prediction of aggressiveness of cancer , tumor markers, Molecular tools for early diagnosis

UNIT – II	PRINCIPLES OF CARCINOGENESIS	9

Theory of carcinogenesis – Chemical carcinogenesis – Metabolism of carcinogenesis, principles of physical carcinogenesis – x-ray radiation – mechanisms of radiation carcinogenesis – Diet and cancer

UNIT – III	PRINCIPLES OF MOLECULAR CELL BIOLOGY OF CANCER	9

Signal targets and cancer – Activation of kinases – Oncogenes – identification of oncogenes, retroviruses and oncogenes, detection of oncogenes, Oncogenes/proto oncogene activity, Growth factors related to transformation, Telomerases.

UNIT – IV	PRINCIPLES OF CANCER METASTASIS	9

Clinical significances of invasion – Heterogeneity of metastatic phenotype – metastatic cascade, basement membrane disruption – Proteinases and tumour cell invasion.

UNIT – V	NEW MOLECULES FOR CANCER THERAPY	9

Different forms of therapy – Chemotherapy – Radiation therapy – Detection of cancers – Use of signal targets towards therapy of cancer – Gene therapy – Cancer resistance to chemotherapy - Advancement in cancer therapy, Nano systems for drug delivery. Enzyme inhibitors in relation to cancer therapy

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	Describe the basic concepts of cell cycle and mutations in pathway that causes cancer	Understand
CO2:	Analyze the molecular mechanisms behind carcinogenesis	Analyze
CO3:	Apply the processes of Mutation of cancer cell genomes of living cells	Apply
CO4:	Investigate the various treatment procedure currently available for cancer.	Evaluate
CO5:	Distinguish scientific explanations that show how the Multi-step tumorigenesis takes place and develop solution for the problem	Create

TEXT BOOKS:

1. Becker's World of the Cell 9th Edition By Jeff Hardin, Gregory Paul Bertoni, and Lewis J. Kleinsmith Pearson (Publisher), 2017.
2. Roger John Benjamin King,, "Cancer Biology", Pearson/Prentice Hall, 2006
3. Dunmock N.J And Primrose S.B., "Introduction to Modern Virology", Blackwell Scientific Publications, Oxford, 1988

REFERENCES:

1. Raymond W Ruddon, "Cancer Biology", Oxford University Press, 4E, 2007.
2. Momna Hejmadi, "Introduction to Cancer Biology", Ventus publishing, 2010
3. Robert A. Weinberg, "Introduction to Cancer Biology", Garland Science, 2E, 2014

Course Code	Course Title	L	T	P	C
19UBM923	HUMAN ASSIST DEVICES	3	0	0	3

OBJECTIVES:

- To introduce various mechanical techniques to rescue failing heart.
- To describe various assist device in hospital practice and explain their usage
- To learn about current trends in assisting devices.

UNIT – I	**CARDIAC ASSIST DEVICES**	**9**

Heart/Lung System – Different types of Oxygenators and Pumps – Pulsatile and Continuous Type – Monitoring Process – Shunting – Blood Handling System – Types and Functions of different types of Heart Intra-Aortic Balloon Pumping (IABP) - Venous Arterial Pumping – Prosthetic Cardio Valves

UNIT – II	**ARTIFICIAL KIDNEY**	**9**

Indication and Principles of Haemodialysis – Membrane – Dialysate – Types of Haemodialyzers – Monitoring Systems – Wearable Artificial Kidney – Implanting types

UNIT – III	**RESPIRATORY AND HEARING AIDS**	**9**

Intermittent Positive Pressure, Breathing Apparatus operating sequence – Electronic IPPB Unit with monitors for all respiratory parameters - CPAP machine –Types of Deafness – Hearing Aids, Construction and Functional Characteristics - Audiogram

UNIT – IV	**COMMON TYPE OF ASSISTIVE DEVICES**	**9**

Mobility devices – positioning devices – prosthetic, orthotic and orthopedic devices – daily living devices – vision, hearing devices – communication devices – cognitive devices

UNIT – V	**ASSISTIVE TECHNOLOGY**	

Assistive technology – selection of assistive devices – Selection of appropriate technology –use of assistive devices in the barrier free environment – Issues in using assistive technology in the community.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	Describe the concepts of assistive devices and their types.	Understand
CO2:	Explain about design and principles of respiratory devices, hearing aids and artificial kidney.	Understand
CO3:	Choose the appropriate method of techniques in assistive technology.	Apply
CO4:	Analyze different types of assistive devices and appreciate the use of advanced mobility devices.	Analyze
CO5:	Identify the barriers and issues in the usage of assistive devices.	Analyze
CO6:	Selection of appropriate technology to design a assistive device	Create

TEXT BOOKS:

1. Levine S.N. (ed), “Advances in Bio-medical engineering and Medical physics”, Vol. I, II, IV, inter university publications, New York, 1968
2. Kolff W.J, “Artificial Organs”, John Wiley and sons, New York, 1976
3. Albert M.Cook and Webster J.G, “Therapeutic Medical Devices”, Prentice Hall Inc., New Jersey, 1982
4. Khandpur R.S, “Handbook of Biomedical Instrumentation”, Tata McGraw Hill, New Delhi, 3rd Edition 2014.

REFERENCES:

1. D.S. Sunder, “Rehabilitation Medicine”, 3rd Edition, Jaypee Medical Publication, 2010
2. James Moore, George Zouridakis, “Biomedical Technology and Devices Handbook”, CRC Press 2004.
3. Community-Based Rehabilitation: CBR Guidelines. Khasnabis C, Heinicke Motsch K, Achu K, et al., editors. Geneva: World Health Organization; 2010
4. The Standard Rules for the Equalization of Opportunities of Persons with Disabilities. New York: United Nations; 1993.
5. WHO. Disability [cited 2018 09-28-2018]. Available from: http://www.who.int/disabilities/technology/en/.

Course Code	Course Title	L	T	P	C
19UBM924	BODY AREA NETWORKS AND MOBILE HEALTHCARE	3	0	0	3

OBJECTIVES:

- To provide an overview of the technical background of Body Area Networks (BAN) and its application in health care using mobile technology
- To know the hardware requirement of BAN
- To understand the communication and security aspects in the BAN
- To know the applications of BAN in the field of medicine

UNIT – I	BODY AREA NETWORKS	9

BAN and healthcare -Technical challenges- sensor design, Biocompatibility, energy supply, energy scavenging methods , optimal node placement, number of nodes, networks for BAN, System security and reliability, standards. BAN Architecture

UNIT – II	HARDWARE FOR BAN	9

Processor-Low Power MCUs, mobile computing MCUs ,Integrated processor with radio transceiver, memory types and ranges ,Antenna types , PCB antenna, wire antenna, ceramic antenna, external antenna, Sensor interface, power sources- batteries and fuel cells for sensor nodes.

UNIT – III	WEARABLE SENSORS AND STANDARDS FOR BAN	9

Wearable's fundamentals and role of wearable sensors, Attributes of wearable, flexible electronics, meta-wearable -Future of wearable, research road map -Wireless personal area network technologies-Zigbee, coexistence issues with BAN.

UNIT – IV	MOBILE DEVICES FOR HEALTHCARE	9

Wearable system for ECG monitoring-Evaluation of night time performance, smart phone based health care monitoring system - Phone based fall risk prediction - RFID based personal mobile medical assistance-Secure medical sensor network

UNIT – V	MOBILE HEALTH TECHNOLOGIES AND APPLICATIONS	9

Mobile nutrition tracking -case study - Accessing existing virtual electronic patient record, mobile personal health records - BME-Engg & Tech - Monitoring hospital patients, sensing vital signs and transmission using wireless networks - Context aware healthcare applications with case study

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	Comprehend technical information and challenges in body area networks (BAN)	Understand
CO2:	Describe the hardware requirements of BAN	Understand
CO3:	Review the wearable sensors and standards for BAN	Analyze
CO4:	Describe the medical devices that are available for health care	Understand
CO5:	Summarize the possible and latest applications of mobile healthcare	Understand

TEXT BOOKS:

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

REFERENCES:

1. Canjun Yang , G.S.Virk, Huayong yang , "Wearable sensors and Robots", Proceeding of international conference on wearable sensors and robots, 2017
2. Zhang, Yuan-Ting, "Wearable Medical Sensors and Systems'', Springer, 2013.
3. Guang-ZhongYang(Ed.), "Body Sensor Networks'', Springer, 2006.
4. Mehmet R. Yuce, Jamil Y.Khan, "Wireless Body Area Networks Technology, Implementation, and Applications", Pan Stanford Publishing Pte. Ltd., Singapore, 2012

Course Code	Course Title	L	T	P	C
19UBM925	REGENERATIVE MEDICINE AND ERGONOMICS	3	0	0	3

OBJECTIVES:

- To understand nature and significance of stem cells and its applications
- To study the Molecular therapy for regeneration
- To understand the basics of Biomechanical, physiological and anthropometric background.
- To impart the knowledge about the user information, controls, relationship between information and operation.

UNIT – I	REGENERATIVE MEDICINE	9

Regenerative Therapy –Introduction-Large scale manufacturing of cells, tissues and organs -Artificial organs – Gene therapy applications-Engineered Tissues and Regenerative Medicine -Molecular therapy for regeneration- Personalized therapies in Regenerative Medicine- Applications of Regenerative Medicine

UNIT – II	STEM CELL BIOLOGY	9

Introduction, Types & sources of stem cell with characteristics: hematopoietic differentiation pathway, Potency and plasticity of stem cells, sources, embryonic stem cells, hematopoietic and mesenchymal stem cells, Stem Cell markers, FACS analysis, Differentiation, Stem cell systems- Liver, neuronal stem cells, cancer stem cells, induced pluripotent stem cells.

UNIT – III	BIOMATERIALS AND HUMAN- ENVIRONMENT INTERACTION	9

Biomaterials: Properties of Biomaterials, Surface, bulk, mechanical and biological properties- Biomechanical, Physiological, Anthropometric background - Posture - Sitting, Standing - Change of posture - Hand and arm postures - Movement – Lifting, carrying, pulling and pushing.

UNIT – IV	ANTHROPOMETRY	9

Anthropometric design principles –work space envelope- factors in design of work space surfaces- principles of seat design –principles of control panel -reducing accidents by altering behavior.

UNIT – V	HUMAN FACTORS AND ERGONOMICS	9

Standards – Applications in healthcare – Neuro-ergonomics in human-system interaction – Case Study Biomedical Application, Design optimization of Medical Equipments.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	Get an insight into different types of stem cells and their applications.	Understand
CO2:	An exposure to the use of stem cells in various clinical applications and injuries.	Apply
CO3:	Appreciate the versatility and potency of stem cells in therapies especially in all the major diseases that affect humans.	Analyze
CO4:	Solve day to day work problem by safe and efficient means.	Evaluate
CO5:	Design biomedical devices.	Create

TEXT BOOKS:

1. HosseinBaharvand (Editor), Nasser Aghdami (Editor). Regenerative Medicine and Cell Therapy (Stem Cell Biology and Regenerative Medicine). Humana Press; 2013 edition
2. Pascale Carayon, Handbook of Human Factors and Engineering, Second Edition, CRC Press, 2011

REFERENCES:

1. Raphael G., Richard S., “Stem Cell-Based Tissue Repair.”, Cambridge/RSC Publishing, 1st Edition, 2011
2. Lanza R., Gearhart J. et al. “Essential of Stem Cell Biology.”, Elsevier/Academic, 1st Edition, 2006.
3. Gavriel Salvendy, ‘Handbook of Human Factors and Ergonomics’, John Wiley & Sons, Fourth Edition 2012.
4. Stephen Pheasant, Christine M. Haslegrave, Bodyspace: Anthropometry, Ergonomics and the Design of Work, CRC Press, Third Edition, 2016

Course Code	Course Title	L	T	P	C
19UBM926	PHYSIOLOGICAL MODELING	2	0	2	3

OBJECTIVES:

- To develop skills to model vital organs and to simulate their physiology
- To discuss the steps to develop dynamic models and simulate their response

UNIT – I	INTRODUCTION	10

Introduction to Resistance mathematical modelling – Analogues models – Characterization of simple physiological systems - Utility of models and analogs in medical studies. System properties - Resistance - the resistive properties – linear resistance analysis – static and dynamic resistance - distributed and lumped systems – Resistance in other systems – thermal resistance

UNIT – II	SYSTEM PROPERTIES: STORAGE OF COMBINED PROPERTIES	10

Introduction - Systems with volume storage -Electrical analog of compliance, Combined hollow elastic elements - Cylindrical elements – Storage in thermal systems – analog study of thermal system response – storage in mechanical system - Step response of resistance - compliant systems – step response data in dye dilution studies - pulse response of first order system (Dye dilution).

UNIT – III	TRANSFER FUNCTION	10

Introduction – systems as operators – simple operations compared with the operation of a First – order system – The first order operator – operator function in terms of ‘s’ – Block diagram of coupled systems – signals to and from operator functions – transfer functions from Input – Output signal information.

LIST OF EXPERIMENTS:	30

1. Simulation and analysis of static resistance property with physiological example.
2. Simulation and analysis using dynamic resistance with suitable biological example.
3. Simulation of thermal system in human body using single source and two source representation.
4. Linear Modeling and simulation of cardiovascular vessel physiology
5. Linear Modeling and simulation of Heart
6. Linear Modeling and simulation of airway mechanics

TOTAL : 60 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	Comprehend the various Physiological components and systems, describe system properties, system response and transfer function.	Understand
CO2:	Compare the resistive, thermal, mechanical systems and response	Apply
CO3:	Analyze the resistive, mechanical, thermal model in the different organs structures	Analyze
CO4:	Connect the Transfer functions of different operators in various signals and systems	Analyze
CO5:	Detect and record the static and dynamic resistance in the suitable physiological system	Apply
CO6:	Choose the source representation of the thermal systems in human body using simulation.	Analyze
CO7	Simulate and visualize dynamic responses by implementing simple physiological models using software	Analyze
CO8	Simulate and visualize responses of heart, airway mechanics and cardiovascular vessel physiology in software.	Analyze

TEXT BOOKS:

1. Willian B.Blesser ,A System Approach to Biomedicine , McGraw Hill Book Co., New York, 1969.
2. Manfreo Clynes and John H.Milsum, Biomedical Engineering System , McGraw Hill and Co.,New York , 1970.

REFERENCES:

1. Micheal C.K.Khoo ,”Physiological Control System Analysis ,Simulation and Estimation “.- Prentice Hall of India , New Delhi , 2001.
2. Richard Skalak and Shu Chien , Hand Book of Biomedical Engineering , McGraw Hill and Co.New York, 1987.
3. Douglas S.Rigg. Control Theory and Physiological Feedback Mechanism, The Wilkliam and Wilkins Co. Baltimore, 1970
4. Ewart Carson, Claudio Cobelli “Modelling Methodology for Physiology and Medicine” Elsevier, 31-Dec-2000

Course Code	Course Title	L	T	P	C
19UBM927	BIG DATA AND IOT IN MEDICAL APPLICATIONS	3	0	0	3

OBJECTIVES:

- To introduce the basics of Internet of things(IoT) and protocols
- To explain the concepts of Web of Things and Cloud of Things
- To discuss the healthcare operations and recent development

UNIT – I	INTRODUCTION TO BIGDATA	9

Introduction to Big Data Platform–Challenges of conventional systems-Web data–Evolution of Analytic scalability, analytic processes and tools, Analysis vs reporting- Modern data analytic tools, Statistical concepts: Sampling distributions, resampling, statistical inference, prediction error.

UNIT – II	DATA ANALYSIS	9

Regression modeling, Multivariate analysis, Bayesian modeling, Inference and Bayesian networks, and Support vector and kernel methods, Analysis of time series: linear systems analysis, nonlinear dynamics– Rule induction – Neural networks: learning and generalization, competitive learning, principal component analysis and neural networks; Fuzzy logic: extracting fuzzy models from data, fuzzy decision trees, and Stochastic search methods.

UNIT – III	INTRODUCTION TO IoT	9

Introduction to Elements of IoT - Basic Architecture of an IoT-Functional blocks of an IoT ecosystem - Applications Sensors & Actuators - Edge Networking (WSN) – Gateways - IoT Communication Model – WPAN & LPWA, Future Trends – Standards

UNIT – IV	IoT IN HEALTH CARE	9

Role of IoT in Health care – Architecture of Health Care in IoT – Integrated framework for operations management – Evidence Based Medicine and Pay for Performance –Hospital business operations – Devices and Mobile apps for health care – Challenges for MIoT& Big Data in Health care.

UNIT – V	RECENT DEVELOPMENTS	9

Techniques and tools – Map Reduce paradigm and the Hadoop system – IoT: Clustering, Synchronization and Software Agents. Applications, Social Media Analytics – IoT in Non Invasive Critical Brain activity monitor, Cardio Diagnostics – Fraud Detection – Big Data in Medicine and Healthcare – Digital companion

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	Explain the role of IOT and Big data in health care.	Understand
CO2:	Identify the various sources of Big Data, new algorithms for collecting Big Data from various sources.	Apply
CO3:	Analyze various protocols for IoT and a middleware for IoT.	Analyze
CO4:	Apply IoT in medicine and health care applications.	Apply
CO5:	Design algorithms for pre-processing Big Data and to extract data from structured and un-structured data for analytics.	Create

TEXT BOOKS:

1. Michael Berthold, David J.Hand, “Intelligent Data Analysis”, Springer, 2007.
2. AnandRajaraman and, Jeffrey David Ullman,”Mining of Massive Datasets”,Cambridge University Press, 2012.
3. Olivier Hersent, David Boswarthick, Omar Elloumi, “The Internet of Things: Key Applications and Protocols”, 2nd Edition, Wiley Publications, 2012.

REFERENCES:

1. Michael Minelli, Michele Chambers, Ambiga Dhiraj, “Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends”, John Wiley & Sons, 2013.
2. Dieter Uckelmann, Mark Harrison, Florian Michahelles, “Architecting the Internet of Things”, Springer Publishing, 2011.
3. Vijay Madisetti and ArshdeepBahga, “Internet of Things (A Hands-on-Approach)”, 1st Edition, VPT, 2014.
4. R.Langabeer “Healthcare Operations Management: A Quantitative Approach to Business and Logistics”, Jones & Bartlett Publishers, First Edition, 2007.

Course Code	Course Title	L	T	P	C
19UBM928	VLSI SYSTEM DESIGN	3	0	0	3

OBJECTIVES:

- To learn the fundamentals of VLSI design
- To understand the IC Manufacturing Process
- To familiarize with VLSI combinational and Sequential logic circuits design

UNIT – I	**MOS TRANSISTOR PRINCIPLES**	**9**

Introduction of MOSFET, Threshold voltage, MOSFET I-V characteristics, CMOS inverter, Characteristics of CMOS inverter, CMOS process flow, Stick diagram, Layout diagrams, Layout and design rules.

UNIT – II	**COMBINATIONAL LOGIC CIRCUITS**	**9**

Static CMOS logic Design, Design techniques to improve the speed, power dissipation of CMOS logic, Circuit Families: Static CMOS, Ratioed Circuits, Cascode Voltage Switch Logic, Dynamic Circuits, Pass Transistor Logic, Transmission Gates, Domino, Dual Rail Domino, CPL, DCVSPG, DPL

UNIT – III	**SEQUENTIAL LOGIC CIRCUITS**	**9**

Static Latches and Registers, Dynamic Latches and Registers, Timing Issues, Pipelines, Pulse and sense amplifier based Registers, Nonbistable Sequential Circuits.

UNIT – IV	**ARITHMETIC BUILDING BLOCKS AND IMPLEMENTATION TECHNIQUES**	**9**

Data path circuits, Architectures for Adders, Accumulators, Multipliers, Barrel Shifters.Full Custom and Semicustom Design, Standard Cell design and cell libraries, FPGA building block architectures, FPGA interconnect routing procedures.

UNIT – V	**VERILOG HDL**	**9**

Verilog HDL Coding Style: Basic Concept - Ports and Modules – Operators - Gate Level Modeling - Data Flow Modeling - Behavioral level Modeling -Tasks & Functions - Test Bench.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	Describe the characteristics of MOS transistor	Understand
CO2:	Design Combinational and sequential circuits	Apply
CO3:	Design the arithmetic logic unit using arithmetic building architectures and techniques	Analyze
CO4:	Analyze the concepts of digital building blocks using MOS transistor.	Apply
CO5:	Design and construct combinational and sequential MOS circuits using HDL	Create

TEXT BOOKS:

1. Jan Rabaey, Anantha Chandrakasan, B.Nikolic, “Digital Integrated circuits: A design perspective”. Second Edition, Prentice Hall of India, 2003.

REFERENCES:

1. N.Weste, K.Eshraghian, “Principles of CMOS VLSI DESIGN”, A system Perspective, Addision Wesley, 2nd Edition, 2004.
2. A.Pucknell, Kamran Eshraghian, “BASIC VLSI DESIGN”, Prentice Hall of India, 3rd Edition, 2007.
3. M.J. Smith, “Application Specific Integrated Circuits”, Addisson Wesley, 1997.
4. R.Jacob Baker, Harry W.LI., David E.Boyee, “CMOS Circuit Design, Layout and Simulation”, Prentice Hall of India, 2005.

Course Code	Course Title	L	T	P	C
19UBM929	MEDICAL WASTE MANAGEMENT	3	0	0	3

OBJECTIVES:

- To provide a basic understanding of healthcare hazard control and accidents.
- To enhance students to practice medical waste management and disposal of the hazardous waste.
- To engage the students to work as a team to solve health issues caused by medical waste.
- To help students to investigate safety aspects and transport of the medical waste.
- To expose students to explore medical waste management and enhance patient safety from infections and hazardous agent.

UNIT – I	HEALTHCARE HAZARD CONTROL AND UNDERSTANDING ACCIDENTS	9

Healthcare Hazard Control: Introduction, Hazard Control: Management & Responsibilities, Hazard Analysis, Hazard Correction, Personal Protective Equipment, Hazard Control Committees, Accident Causation Theories, Accident Reporting, Accident Investigations, Accident Analysis, Accident Prevention, Workers" Compensation, Orientation, Education, and Training.

UNIT – II	BIOMEDICAL WASTE MANAGEMENT	9

Biomedical Waste Management : Types of wastes, major and minor sources of biomedical waste, Categories and classification of biomedical waste, hazard of biomedical waste, need for disposal of biomedical waste, waste minimization, waste segregation and labeling, waste handling and disposal.

UNIT – III	HAZARDOUS MATERIALS	9

Hazardous Materials : Hazardous Substance Safety, OSHA Hazard Communication Standard, DOT Hazardous Material Regulations, Healthcare Hazardous Materials, Medical Gas Systems, Respiratory Protection.

UNIT – IV	FACILITY SAFETY	9

Introduction, Facility Guidelines: Institute, Administrative Area Safety, Slip, Trip, and Fall Prevention, Safety Signs, Colors, and Marking Requirements, Tool Safety, Electrical Safety, Control of Hazardous Energy, Landscape and Ground Maintenance, Fleet and Vehicle Safety.

UNIT – V	INFECTION CONTROL, PREVENTION AND PATIENT SAFETY	9

Healthcare Immunizations, Centers for Disease Control and Prevention, Disinfectants, Sterilants, and Antiseptics, OSHA Bloodborne Pathogens Standard, Tuberculosis, Healthcare Opportunistic Infections, Healthcare-Associated Infections, Medication Safety.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	Describe the concepts of medical waste management and State the impact of medical waste on human health.	Understand
CO2:	Given the hazardous materials condition, recognize the issues on human health and solve by using neutralizing agent.	Apply
CO3:	Given the carcinoma problem, define the issue precisely and examine the possible approaches related with cancer causing agents in medical waste.	Analyze
CO4:	State the issues of blood borne pathogen and design novel approach with biosensor approaches for monitor infectious pathogens in human.	Design
CO5:	Given the problem description, examine its complexity and develop a solution and justify their correctness of waste segregation and labeling, waste handling and disposal to enhance patient safety.	Evaluate
CO6:	Demonstrate the presence of infectious and carcinogenic agent in medical waste and human body using *in vitro* or *in vivo* assay.	Apply

TEXT BOOKS:

1. Tweedy, James T., Healthcare hazard control and safety management-CRC Press_Taylor and Francis (2014).
2. Anantpreet Singh, SukhjitKaur, Biomedical Waste Disposal, Jaypee Brothers Medical Publishers (P) Ltd (2012).

REFERENCES:

1. Khalid Maryam, Evaluation of Biomedical Waste Management System, LAP Lambert Academic Publishing, 2015.
2. Peter A. Reinhardt, Infectious and Medical Waste Management, CRC Press, 1991.
3. Ram Chandra, Environmental Waste Management, CRC Press, 2015.

Course Code	Course Title	L	T	P	C
19UBM930	DIGITAL SYSTEM DESIGN	3	0	0	3

OBJECTIVES:

- To impart knowledge in digital circuits using simplified Boolean functions
- To impart knowledge for design and analysis of combinational circuits

UNIT – I	BOOLEAN ALGEBRA AND LOGIC GATES	9

Number Systems - Arithmetic Operations - Binary Codes - Boolean Algebra and Logic Gates - Theorems and Properties of Boolean Algebra - Boolean Functions - Canonical and Standard Forms - Simplification of Boolean Functions using Karnaugh Map - Logic Gates – NAND and NOR Implementations

UNIT – II	COMBINATIONAL LOGIC	9

Combinational Circuits – Analysis and Design Procedures - Binary Adder-Subtractor - Decimal Adder - Binary Multiplier - Magnitude Comparator - Decoders – Encoders – Multiplexers - Introduction to HDL – HDL Models of Combinational circuits.

UNIT – III	SYNCHRONOUS SEQUENTIAL LOGIC	9

Sequential Circuits - Storage Elements: Latches, Flip-Flops - Analysis of Clocked Sequential Circuits - State Reduction and Assignment - Design Procedure - Registers and Counters - HDL Models of Sequential Circuits.

UNIT – IV	ASYNCHRONOUS SEQUENTIAL LOGIC	9

Analysis and Design of Asynchronous Sequential Circuits – Reduction of State and Flow Tables – Race-free State Assignment – Hazards.

UNIT – V	MEMORY AND PROGRAMMABLE LOGIC	9

RAM – Memory Decoding – Error Detection and Correction - ROM - Programmable Logic Array – Programmable Array Logic – Sequential Programmable Devices.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	Simplify the Boolean Functions using Karnaugh Map and Logic Gates	Understand
CO2:	Compare the combinational logic circuits (Binary Adder-Subtractor - Decimal Adder - Magnitude Comparator - Decoders – Encoders – Multiplexers) and its design procedures.	Analyze
CO3:	Analyze the Sequential Circuits in terms of memory, circuit and truth table.	Analyze
CO4:	Differentiate the Synchronous and Asynchronous sequential circuits in terms of block diagram and circuit diagram.	Analyze
CO5:	Design synchronous sequential Circuits for the given Boolean functions and logic diagram using flip- flops.	Create
CO6:	Design asynchronous sequential Circuits for the given Boolean functions and logic diagram using flip -flops.	Create

TEXT BOOKS:

1. M. Morris R. Mano, Michael D. Ciletti, —Digital Design: With an Introduction to the Verilog HDL, VHDL, and System Verilog‖, 6th Edition, Pearson Education, 2017.

REFERENCES:

1. G. K. Kharate, Digital Electronics, Oxford University Press, 2010
2. John F. Wakerly, Digital Design Principles and Practices, Fifth Edition, Pearson Education, 2017.
3. Charles H. Roth Jr, Larry L. Kinney, Fundamentals of Logic Design, Sixth Edition, CENGAGE Learning, 2013
4. Donald D. Givone, Digital Principles and Design‖, Tata Mc Graw Hill, 2003.

Course Code	Course Title	L	T	P	C
19UBM931	BIO-SIGNAL PROCESSING	3	0	0	3

OBJECTIVES:

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

UNIT – I	INTRODUCTION TO BIOMEDICAL SIGNALS	9

Biosignal Characteristics of Electro Cardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Electrooculogram (EOG), Electroretinogram (ERG), Electrogastrogram (EGG), Electroneurogram (ENG), Event related potentials (ERPs), Phonocardiogram (PCG), Speech signal, Objectives of Biomedical signal analysis, Difficulties in Biomedical signal analysis, Computer-aided diagnosis.

UNIT – II	FILTERING FOR REMOVAL OF ARTIFACTS	9

Structures of IIR – Analog filter design – Discrete time IIR filter from analog filter – IIR filter design by Impulse Invariance, Bilinear transformation, Approximation of derivatives – (LPF, HPF) filter design using frequency translation

UNIT – III	CARDIOVASCULAR APPLICATIONS	9

Noise & Artifacts, ECG Signal Processing: Baseline Wandering, Power line interference, Muscle noise filtering – QRS detection, Adaptive noise canceling in ECG, improved adaptive filtering in FECG, Wavelet detection in ECG – structural features, matched filtering, adaptive wavelet detection, detection of overlapping wavelets. Computation of diagnostic signal parameters of ECG like Heart rate and QRS detection using Multivariate analysis (PCA and ICA). Segmentation of PCG, intensity patterns, Spectral modeling and analysis of PCG signals

UNIT – IV	NEUROLOGICAL APPLICATIONS	9

EEG rhythms & waveforms, EEG applications- Epilepsy, sleep disorders, brain computer interface. Modeling EEG- linear, stochastic models - Nonlinear modeling of EEG - artifacts in EEG & their characteristics and processing – Nonparametric spectral analysis, Model based spectral analysis - EEG segmentation - Joint Time-Frequency analysis - correlation analysis of EEG channels - coherence analysis of EEG channels. Evoked potentials- noise characteristics, Noise reduction by linear filtering.

UNIT – V	ANALYSIS ON WAVESHAPE, SIGNAL CLASSIFICATION AND RECOGNITION	9

Modeling intramuscular EMG-Intramuscular signal decomposition-Fractal analysis of EMG signals. Statistical analysis of VAG signals. Analysis on amplitude and latency of MEG signals. Analysis of ERP effect. Signal classification and recognition – Statistical signal classification, linear discriminant function, direct feature selection and ordering, Back propagation neural network based classification. Analysis of EEG using Empirical mode decomposition (EMD).

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	Draw different types of biomedical signals and identify their spectral components	Understand
CO2:	Use different filters on biomedical signals and judge filter performance.	Analyze
CO3:	Identify physiological interferences and artifacts affecting ECG signal.	Analyze
CO4:	Compute power and correlation spectra of EEG signal.	Analyze
CO5:	Propose an algorithm to classify biomedical signals.	Create

TEXT BOOKS:

1. Rangayyan, “Biomedical Signal Analysis”, Wiley 2002.
2. Semmlow, “Biosignal and Biomedical Image Processing”, Marcel Dekker, 2004

REFERENCES:

1. Arnon Cohen, “Bio-Medical Signal Processing Vol I and Vol II”, CRC Press Inc., Boca Rato, Florida 1999.
2. D.C.Reddy, “Biomedical Signal Processing: Principles and techniques”, Tata McGraw Hill, New Delhi, 2005.
3. Willis J Tompkins, “Biomedical Digital Signal Processing”, Prentice Hall, 1993
4. Bruce, “Biomedical Signal Processing & Signal Modeling,” Wiley, 2001.
5. Sörnmo, “Bioelectrical Signal Processing in Cardiac & Neurological Applications”, Elsevier 2005.

Course Code	Course Title	L	T	P	C
19UBM932	PRINCIPLES OF MACHINE LEARNING	3	0	0	3

OBJECTIVES:

- To discuss different learning techniques.
- To understand various machine learning procedures.
- To learn various algorithms.

UNIT – I	FOUNDATIONS OF MACHINE LEARNING	9

Types of machine learning: Supervised learning – Unsupervised learning – Reinforcement Learning – Machine Learning Process – Terminologies: Weight Space, Curse of Dimensionality, Over fitting, Training, Testing, Validation Sets Performance Measures: Confusion Matrix, Accuracy Metrics, Receiver Operator Characteristic (ROC) Curve, Measurement Precision – Model selection – No free lunch theorem – Bias –Variance Tradeoff.

UNIT – II	SUPERVISED LEARNING	9

Linear Classification – Probability and Bayes learning – Naive Bayes – Bayesian Network – Perceptron – Perceptron Learning – Neural Networks – Back propagation – Support Vector Machines.

UNIT – III	REGRESSION AND TREE BASED MODELS	9

Linear Regression – Multivariate Regression – Logistic Regression – Principal Component Regression – Decision Trees, Regression Trees.

UNIT – IV	ENSEMBLE LEARNING	9

Ensemble Methods – Bagging, Committee Machines and Stacking, Boosting – Gradient Boosting, Adaptive Boosting, Random Forests – Multi-class Classification.

UNIT – V	UNSUPERVISED LEARNING	9

Introduction to Clustering – Partitional Clustering – Hierarchical Clustering – Birch Algorithm – CURE Algorithm – Density based Clustering – Expectation Maximization.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	Differentiate between supervised, unsupervised, semi-supervised machine learning approaches	Understand
CO2:	Apply specific supervised or unsupervised machine learning algorithm for a particular problem	Apply
CO3:	Analyze and suggest the appropriate machine learning approach for the various types of problem	Analyze
CO4:	Design and make modifications to existing machine learning algorithms to suit an individual application	Ceate
CO5:	Provide useful case studies on the advanced machine learning algorithms	Evaluate
CO6:	Identify and apply Machine Learning algorithms to solve real world problems using modern tools.	Apply

TEXT BOOKS:

1. Stephen Marsland, “Machine Learning - An Algorithmic Perspective” 2nd Edition, CRC Press, 2015.
2. EthemAlpaydin, "Introduction to Machine Learning", 3rd Edition, MIT Press, 2014.

REFERENCES:

1. P. Flach, “Machine Learning: The art and science of algorithms that make sense of data”, Cambridge University Press, 2012.
2. K. P. Murphy, “Machine Learning: A probabilistic perspective”, MIT Press, 2012.
3. C. M. Bishop, “Pattern Recognition and Machine Learning”, Springer, 2007.
4. Tom M. Mitchell, “Machine Learning", McGraw Hill Indian Edition, 2013.
5. Yagang Zhang, “Machine Learning”, InTech, 2010.

Course Code	Course Title	L	T	P	C
19UBM933	BIO STATISTICS	3	0	0	3

OBJECTIVES:

- To introduce the techniques used in statistical & regression analysis.
- To compare the various parameters used in statistical significance
- To use the meta analysis for the research activities

UNIT – I	INTRODUCTION	9

Biostatistics - Statistical problems in Biomedical research – Basic concepts: Population, Samples and Variables - Basic probability, likelihood & odds, distribution variability.

UNIT – II	STATISTICAL PARAMETERS	9

Parameterized Distributions, Measurement of Parameters, Statistical parameters p-values, computation and level chi square test and distribution

UNIT – III	CORRELATION AND REGRESSION ANALYSIS	9

Correlation – Correlation coefficient – linear correlation, Regression – Linear regression – Multiple linear regression – Multiple colinearity, Determining Best regression – Non linear regression – Logistic regression – Poison regression

UNIT – IV	INTERPRETING DATA	9

Data interpretation methods - The qualitative and quantitative data interpretation method, Life table: Interpreting life tables clinical trails, epidemical reading and interpreting of epidemical studies, application in community health.

UNIT – V	META ANALYSIS	9

META analysis for research activities, purpose and reading of META analysis, Forest graph, Funnel plots, Radial plots, L'Abbe plots, Criticisms of Meta analysis.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	Describe the concepts of statistical parameters, correlation and regression analysis	Understand
CO2:	Classify common statistical tests and tools.	Knowledge
CO3:	Distinguish between p-values and confidence intervals as measures of statistical significance	Analyze
CO4:	Interpret commonly used correlation and regression analysis	Analyze
CO5:	Explain the data tables and its interpretations in community health.	Apply
CO6:	Evaluate commonly used statistical and epidemiologic measures.	Create

TEXT BOOKS:

1. Joseph A. Ingel finger, Frederick Mosteller, Lawrence A. Thibodeau, James H. Ware 'Biostatistics in Clinical Medicine', Singapore, 3rd Edition, 1994.
2. Gerald van Belle, Lloyd D. Fisher, Patrick J. Heagerty, Thomas Lumley, 'Biostatistics: A Methodology For the Health Sciences', John Wiley & Sons, 2004.

REFERENCES:

1. Julien I.E. Hoffman, 'Biostatistics for Medical and Biomedical Practitioners', Elsevier Press, 2015.
2. James F. Jekel, 'Epidemiology, Biostatistics, and Preventive Medicine', Elsevier Health Sciences, 2007.
3. Ray M. Merrill, 'Fundamentals of Epidemiology and Biostatistics, Jones & Bartlett Learning, 2013.
4. Robert H. Carver and Jane Gradwohl Nash. Doing Data Analysis with SPSS Version 18.0, (Indian Edition), Cengage Learning, New Delhi, 2012.

Course Code	Course Title	L	T	P	C
19UBM934	ELECTRO MAGNETIC INTERFERENCE AND COMPATIBILITY	3	0	0	3

OBJECTIVES:

- To introduce the relevance of this course to the existing technology through demonstrations, case studies, simulations, contributions of scientist, national/international policies with a futuristic vision along with socio-economic impact and issues
- To tutor the basics of EMI, EMC.
- To instill knowledge on the EMI coupling mechanism and its mitigation techniques.
- To impart comprehensive insight about the current EMC standards and about various measurement techniques

UNIT – I	**BASIC CONCEPTS**	**7**

Definition of EMI and EMC; Intra and Inter system EMI; Sources and victims of EMI, Conducted and Radiated EMI emission and susceptibility; Transient & ESD; Case Histories; Radiation Hazards to humans.

UNIT – II	**COUPLING MECHANISM**	**9**

Common made coupling; Differential mode coupling; Common impedance coupling; Ground loop coupling; Field to cable coupling; Cable to cable coupling; Power mains and Power supply coupling.

UNIT – III	**EMI MITIGATION TECHNIQUES**	**10**

Shielding – principle, choice of materials for H, E and free space fields, and thickness; EMI gaskets; Bonding; Grounding – circuits, system and cable grounding; Filtering; Transient EMI control devices and applications; PCB Zoning, Component selection, mounting, trace routing.

UNIT – IV	**STANDARDS AND REGULATION**	**7**

Units of EMI; National and International EMI Standardizing Organizations – IEC, ANSI, FCC, CISPR, BIS, CENELEC; FCC standards; EN Emission and Susceptibility standards and specifications; MIL461E Standards.

UNIT – V	**TEST METHODS AND INSTRUMENTATION**	**12**

EMI test sites - Open area site; TEM cell; Shielded chamber; Shielded Anechoic chamber; EMI test receivers; Spectrum Analyzer; Transient EMI Test wave Simulators; EMI coupling Networks - Line impedance Stabilization Networks; Feed through capacitors; Antennas and factors; Current probes and calibration factor; MIL-STD test methods; Civilian STD Test methods, Government policies.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	To design a EMI free system.	Apply
CO2:	To reduce system level crosstalk.	Apply
CO3:	To design high speed Printed Circuit board with minimum interference.	Evaluate
CO4:	To make our world free from unwanted electromagnetic environment.	Evaluate

TEXT BOOKS:

1. V.P. Kodali, “Engineering EMC Principles, Measurements and Technologies”, IEEE Press,New york, 2nd Edition, 2010
2. Henry W.Ott., “Noise Reduction Techniques in Electronic Systems”, A Wiley Inter Science Publications, John Wiley and Sons, Newyork, 2009.

REFERENCES:

1. Don R.J.White Consultant Incorporate, “Handbook of EMI/EMC”, Vol I-V, 1988
2. Bemhard Keiser, “Principles of Electromagnetic Compatibility”, 3rd Edition, Artech house, Norwood, 1987
3. C.R. Paul, “Introduction to Electromagnetic Compatibility”, John wiley& sons Inc. 2006.

Course Code	Course Title	L	T	P	C
19UBM935	SMART HEALTHCARE ENGINEERING AND ARTIFICIAL INTELLIGENCE	3	0	0	3

OBJECTIVES:

- To explain the introduction of Smart Healthcare system
- To discuss the challenges of AI In Healthcare

UNIT – I	INTRODUCTION TO SMART HEALTHCARE	9

Introduction and Classification of smart Health care-Architectures: Requirements, components, characteristics - Different physical elements to form Healthcare networks - Attributes and configuration of smart Healthcare - Services available through smart healthcare - Using ICT for Healthcare - Domains in Healthcare system.

UNIT – II	TRENDS IN HEALTHCARE SYSTEM	9

Using IOT in Healthcare system: Smart computing-Remote monitoring - Wearable's-connectivity -Big data - Nano Smart Healthcare - AI in healthcare - Industry Trends and Products - Challenges and opportunities of smart Health care system

UNIT – III	ARTIFICIAL INTELLIGENCE IN HEALTHCARE	9

Introduction to Artificial Neural Networks – Characteristics - learning methods – taxonomy – Evolution of neural networks - AI in healthcare – Classification - Technologies of AI in Healthcare -Role of Artificial Intelligence in Healthcare - Applying AI to EHR Data: EHR Data security, Analysis, Transformation, Building models.

UNIT – IV	AI IN MEDICAL IMAGING	9

Clinical fundamentals of medical imaging - Exploratory Data Analysis - Deep Learning Methods - Classification Models of Medical Images - Deploying AI Algorithms in the Real World

UNIT – V	APPLICATIONS OF AI SYSTEM IN HEALTHCARE	9

Aidoc/Maxq - CT brain bleed diagnosis, IDx-DR-Detect signs of Diabetic retinopathy, iCAD-Breast density via mammography, Quantx-Breast Lesions, Coronary calcium scoring, Bay Labs-ECG EF determination, Neural Analytics, Icometrix-MRI brain implementation, Viz.ai-Stroke Diagnosis

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	Understand the concepts of smart Healthcare Engineering system	Understand
CO2:	Apply these techniques in applications which involve perception, reasoning and learning	Apply
CO3:	Explain the goals and methods of Artificial Intelligence	Understand
CO4:	Acquire knowledge to design AI projects models	Understand
CO5:	Planning and reasoning algorithms for solving real life problems.	Create

TEXT BOOKS:

1. Yen-Wei,Howlett, RobertJ.Jain, "Innovation in medicine and healthcare –Proceedings of international conference on innovation in medicine and healthcare",2017.
2. Arvin Agah, "Medical applications of Artificial Intelligence",2013

REFERENCES:

1. Erik R.ranschaert,Sergey Morozov, Paul R.Algra, "Artificial intelligence in medical imaging: opportunities, applications and risk",2019
2. Fernando Koch, Andrew Koster, David Riano, "Artificial Intelligence in health", 2019
3. Robbie Melton, "Emerging technologies and smart health care apps and gadgets innovation",2015
4. Joost van Hoof, George Demiris, Eveline J.M.Wouters, "Handbook of smart homes,Health care and well-being",2017.

LIST OF OPEN ELECTIVES

S.No.	Course Code	Course Title	L	T	P	C
1.	19UBM971	Biomedical Instrumentation Systems	3	0	0	3
2.	19UBM972	Computer Applications in Medicine	3	0	0	3
3.	19UBM973	Forensic Science in Health Care	3	0	0	3
4.	19UBM974	Radiotherapy and Nuclear Medicine	3	0	0	3
5.	19UBM975	Occupational Safety and Health in Public Health Emergencies	3	0	0	3

LIST OF INTER-DISCIPLINARY COURSES

S.No.	Course Code	Course Title	L	T	P	C
1.	19UGM951	Electrical Hazards and Safety In Hospitals	3	0	0	3
2.	19UGM952	Bio-Fluid Mechanics	3	0	0	3

Course Code	Course Title	L	T	P	C
19UBM971	BIOMEDICAL INSTRUMENTATION SYSTEMS	3	0	0	3

OBJECTIVES:

- To provide a possibility for the student to acquire knowledge about the impact and interaction of light with biological tissue.
- To understand practical applications of optics related to medicine.

UNIT – I	BASIC CONCEPTS OF MEDICAL INSTRUMENTATION	9

Medical Instrumentation systems – Classification of Biomedical instruments –Transducers Selection criteria – Bio-potentials – Electrical activity of excitable cells – Bio-potential Electrodes – Types of electrodes - Electrode behavior and circuit models.

UNIT – II	BIOMEDICAL SIGNAL ACQUISITION AND ANALYSIS	9

Types and Classification of biological signals – Electrical parameters acquisition: Origin, recording schemes – ECG, EEG, EMG – Lead systems and recording methods – Typical waveforms – Noise and artifacts – Electrical safety: Physiological Effect of Electrical Current, shock hazards – leakage current.

UNIT – III	MEASUREMENT OF NON ELECTRICAL PARAMETERS	9

Measurement of blood pressure – Cardiac output – Blood flow – Heart rate – Heart sound – Pulmonary function measurements – Spirometer – Photo Plethysmography, Body Plethysmography – Blood Gas analyzers, pH of blood – Measurement of blood pCO2, pO2, fingertip oximeter.

UNIT – IV	MEDICAL IMAGING SYSTEMS AND TELEMETRY	9

X-ray machine - Computer radiography – Computer tomography – Magnetic resonance imaging - Single photo emission computer tomography – Positron emission tomography – Ultrasonography – Endoscopy – Thermal Imaging - Different types of biotelemetry systems.

UNIT – V	LIFE ASSISTING, THERAPEUTIC AND ROBOTIC DEVICES	9

Pacemakers – Defibrillators – Ventilators – Nerve and muscle stimulators – Diathermy – Heart – Lung machine – Audio meters – Dialysers – Lithotripsy - ICCU patient monitoring system - Nano Robots - Robotic surgery –Orthopedic prostheses fixation.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	Measure, detect and analyze the bio-signals, electrical and Non-electical parameters.	Understand
CO2:	Select and apply the appropriate medical instruments for measurement.	Apply
CO3:	Apply safety standards and select disposal method and procedures for electrical diagnostic equipment.	Apply
CO4:	Compare and analyze the operation and characteristics of different medical devices.	Analyze
CO5:	Design a simple medical device for diagnosis/therapeutic applications.	Create

TEXT BOOKS:

1. Markolf H.Niemz, “Laser-Tissue Interaction Fundamentals and Applications”, Springer, 2007.
2. Paras N. Prasad, “Introduction to Bio photonics”, A. John Wiley and sons, Inc. Publications, 2003.

REFERENCES:

1. Tuan Vo Dinh, “Biomedical photonics – Handbook”, CRC Press LLC, 2003.
2. Mark E. Brezinski, “Optical Coherence Tomography: Principles and Applications”, Academic Press, 2006.
3. R. Splinter and B.A. Hooper, “An Introduction to Biomedical Optics”, Taylor and Francis, 2007.
4. Helena Jelinkova, “Lasers for Medical Applications: Diagnostics, Therapy and Surgery’’, Woodhead Publishing, 1st Edition, 2013.

Course Code	Course Title	L	T	P	C
19UBM972	COMPUTERS APPLICATIONS IN MEDICINE	3	0	0	3

OBJECTIVES:

- To teach PC hardware and its related interfacing
- To understand the basics of computerized data acquisition
- To study the concepts of Computer Assisted Instruction and computers in patient education

UNIT – I	PC HARDWARE AND OVERVIEW	9

System Unit – Overview of Mother Boards – Processors, Memory, Adapter cards, Ports, Power supply – BIOS – DOS interaction, POST, Functional and Architecture Block diagram of a PC, Mother Board logics – Memory and I/O map

UNIT – II	PERIPHERAL INTERFACING AND CONTROLLERS	9

Keyboard and Mouse Interfaces – Memory types: RAM, SDRAM and RDRAM, Cache memory, ROM, Flash memory – Adapter Cards – Sound Card, Modem card, Video card, Network Card – I/O slots: ISA, PCI and AGP bus slots – Ports: Serial and Parallel ports, USB, FireWire port, MIDI, SCSI, IRDA, Bluetooth Connectors – System Bus: ISA, EISA, PCI, AGP and PCI bus – Disk controllers.

UNIT – III	DATA ACQUISITION AND MEDICAL INFORMATION RETRIEVAL	9

Plug-in-data acquisition and Control Boards – Data acquisition using GPIB and Serial Interfaces – Medical Information Retrieval – MEDLARS – Unified Medical Language System(UMLS) – Semantics Net – Finding useful information from the Internet

UNIT – IV	COMPUTER ASSISTED INSTRUCTION (CAI) IN MEDICINE	9

Computer Assisted Instruction – Learning Process – Preclinical CAI – Visible Human Project – Active Learning Centre – Clinical Simulations – Virtual Patient Project – Problems with CAI – Interactive Multimedia Education in Medicine – Computer as an Evaluator – Computer Based Testing (CBT)

UNIT – V	COMPUTER ASSISTED PATIENT EDUCATION	9

Computer Prescription – Need for computerized prescription – Health online – Electronic Communication with Patients – Patient Self-Management Education – Computers in the care of critically ill patients – Clinical notes – Clinical Information System - Computers in patient monitoring - Physiological monitoring, Automated ICU, information flow in a clinical lab.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	Describe the overview of PC hardware.	Understand
CO2:	Explain the various peripheral interfaces and controllers.	Understand
CO3:	Analyze the data acquisition and medical information retrieval.	Analyze
CO4:	Apply the computer assisted instruction in medicine.	Apply
CO5:	Discuss the computer assisted patient education and patient monitoring systems.	Analyze

TEXT BOOKS:

1. Ramachandra Lele, “Computers in Medicine Progress in Medical Informatics”, Tata McGraw Hill Publishing Company, New Delhi, 2005
2. N.Mathivanan, “PC Based Instrumentation: Concepts and Practice”, Prentice Hall of India, New Delhi 2007

REFERENCES:

1. B.Govindarajalu, “IBM PC and Clones: Hardware, Trouble shooting and Maintenance”, Tata McGraw Hill Publishing Company, New Delhi, 2005
2. Mohan Bansal, “Medicl informatics”, Tata McGraw Hill Publishing computers Ltd, 2003 New Delhi

Course Code	Course Title	L	T	P	C
19UBM973	FORENSIC SCIENCE IN HEALTH CARE	3	0	0	3

OBJECTIVES:

- To explain the basic principles of forensic science, crime and criminal justice system, police organization, the role of investigator and tools and techniques used in crime science
- To emphasize the importance of scientific methods in crime identification and detection.
- To deal with the modus operandi and role of modus operandi bureau in crime investigation

UNIT – I	FORENSIC SCIENCE	9

Introduction – Definition – Principles – Laws of Forensic Science – Historical Background of Forensic Science in India - Need of Forensic Science in present scenario – Forensic Science Laboratories – their types and Divisions – Forensic Examination – Organizational set up of Forensic Science Laboratories at central and state level - Code of conduct for Forensic Scientists.

UNIT – II	CRIME	9

Definition – types of crime – causes of crime, prevention of crime – Difference in blue and white collar crime – Introduction of Cybercrime – Criminal Justice System – Criminal behavior - Functions of Police in analyzing a crime scene.

UNIT – III	POLICE ORGANIZATION	9

Organizational set up of Police at central and state level, Functions of Police – Relationship of Police and Forensic Scientist – History of different paramilitary forces.

UNIT – IV	CRIME SCENE	9

Introduction, Significance-Role of Investigator-Evaluation of crime scene – protection of crime scene – Photography of Crime scene – Tools and techniques – Significance of Photography and Videography-Introduction of Sketching – Purpose of Sketching – Making of Sketches.

UNIT – V	MODUS OPERANDI & ROLE OF MODUS OPERANDI BUREAU IN CRIME INVESTIGATION	9

Investigation & examination of various types of cases – Murder – Burglary – Railway & Air Crashes – Road Accidents etc.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	Define the basic principles of forensic science.	Understand
CO2:	Apply the scientific knowledge to the investigation of crimes	Apply
CO3:	Analyze the forensic evidences in crime scene and the role of investigator in sketching and examination of crime scene	Analyze
CO4:	Investigate and examine the modus operandi and role of modus operandi bureau in crime investigation.	Evaluate

TEXT BOOKS:

1. W.J. Tilstone, M.L. Hastrup and C. Hald, Fisher"s, Techniques of Crime Scene Investigation, CRC Press, Boca Raton (2013).
2. Saferstein, Richard. "Criminalistics—An Introduction to Forensic Science", 11th ed. Prentice Hall, Saddle River, NJ. 2011

REFERENCES:

1. H.B. Baldwin and C.P. May in, Encyclopedia in Forensic Science, Volume 1, J.A. Siegel, P.J. Saukko and G.C. Knupfer (Eds.), Academic Press, London (2000).
2. V.J. Geberth, Practical Homicide Investigation, CRC Press, Boca Raton (2006).
3. T. Bevel and R.M. Gardner, Bloodstain Pattern Analysis, 3rd Edition, CRC Press, Boca Raton (2008).

Course Code	Course Title	L	T	P	C
19UBM974	RADIOTHERAPY AND NUCLEAR MEDICINE	3	0	0	3

OBJECTIVES:

- To introduce the basic principles radiology, computed tomography and nuclear medicine
- To impart knowledge on radioactivity, radiation measurement techniques and detectors
- To understand the basic physics of various imaging modalities in nuclear medicine.
- To gain knowledge about various detectors used in nuclear medicine.

UNIT – I	BASIC PHYSICS BEHIND RADIOACTIVITY	9

Physics of Radioactivity: Radionuclide Decay Terms and Relationships – Activity – Physical half Life – Fundamental Decay Equation, Nuclear Transformation – Alpha Decay, Beta Decay – Electron Capture – Isomeric Transition-Compton scattering, Pair productions- Particle interactions

UNIT – II	PRODUCTION OF RADIOACTIVE ELEMENTS AND RADIOACTIVITY DETECTORS	9

Radionuclide Production-Radiopharmaceuticals – Characteristics, applications, quality control and regulatory issues in medical imaging, Radiopharmaceutical mechanisms of localization- Radionuclide detection and measurement - Type of detectors - spectroscopy, Gas Filled detectors, Scintillation detectors, Semiconductor detectors, Pulse height spectroscopy

UNIT – III	NUCLEAR IMAGING	9

Planar Nuclear Imaging: Anger Scintillation Camera – Design and principles of operation- performance – design factors, Computers in Nuclear Imaging – Digital image formats – image acquisition – Image processing in nuclear medicine

UNIT – IV	DIAGNOSTIC AND THERAPEUTIC APPLICATIONS OF RADIONUCLIDE	9

DIAGNOSIS - PET, SPECT, Radio iodine therapy for Thyrotoxicosis, Differentiated thyroid cancers, Palliative treatment for bone metastasis - 32P and 89 Strontium Dosage. THERAPY - Intravascular particulate radio nuclide Therapy, Receptor targeted therapy, 131I- MIBG Therapy, Targeted internal radiation in HCC: 90 Y, Radio-synovectomy using Yttrium

UNIT – V	RECENT ADVANCES IN NUCLEAR MEDICINE TECHNIQUES	9

Recent advances in imaging and image processing techniques - image guiding for radiotherapy - Advances in equipments - SPECT, PET-CT, PET-MRI - Recent advances in Radiopharmaceuticals - PET Tracers - Cyclotron - Neuro & cardio Radiopharmaceuticals – Telemedicine - Newer computer application in nuclear medicine

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	Explain the basic principles of radiotherapy and nuclear medicine.	Understand
CO2:	Identify the key principles of nuclear medicine and radioactivity.	Understand
CO3:	Analyze the working principle of advanced nuclear medicine imaging systems.	Analyze
CO4:	Apply the knowledge acquired on radioactivity, radiation measurement techniques and detectors	Apply
CO5:	Acquire knowledge about radiation activity in the living cells	Understand

TEXT BOOKS:

1. Jerrold T Bushberg, J.Anthony Seibert, Edwin M Leidholdt,John M Boone, Lippincott, “The Essential Physics of Medical Imaging” Williams & Wilkins,3 rd edition,2011
2. Webb’s, “Physics of Medical Imaging”, Taylor and Francis Group”, CRC Press,2nd edition, 2012
3. Fred A Mettler, Milton J Guiberteau, “Essentials of nuclear Medicine and molecular imaging” 7th Edition, Elseiver, 2018

REFERENCES:

1. R. S. Khandpur “Handbook of Bio-Medical Instrumentation”, Tata McGraw Hill, 2nd edition, 2003.
2. Gopal B.Saha, Physics and Radiation biology of NuclearMedicine-2006.

Course Code	Course Title	L	T	P	C
19UBM975	OCCUPATIONAL SAFETY AND HEALTH IN PUBLIC HEALTH EMERGENCIES	3	0	0	3

OBJECTIVES:

- To import knowledge on occupational safety and health (OSH) in public health emergencies.
- To discuss about risks faced by emergency responders during disease outbreaks and other emergencies
- To introduce various strategies for managing OSH in emergency situations

UNIT – I	MANAGEMENT ASPECTS	9

Management system approach to occupational safety and health hazards and risks – rights, duties and responsibilities of employers and workers during outbreaks and emergencies – Emergency responders health monitoring and surveillance

UNIT – II	STRATEGIES AND TOOLS	9

International Health Regulations, 2005 – Incident command system for managing outbreaks and emergencies – Occupational safety and health controls – Strategies for infection prevention and control

UNIT – III	COMMON RISKS FOR SAFETY AND HEALTH IN EMERGENCIES	9

Vector-borne diseases, water and food-borne diseases, Vaccine-preventable diseases – Heat stress - Slips, trips and falls - Road traffic injuries – Ergonomic hazards - Violence – Psychological stress during outbreaks and injuries

UNIT – IV	OCCUPATIONAL SAFETY AND HEALTH IN CHEMICAL INCIDENTS	9

Emergencies caused by chemical incidents – occupational safety and health hazards and risks of chemicals – Personal Protective Equipment – Decontamination of emergency response personnel – medical surveillance of emergency responders

UNIT – V	OCCUPATIONAL SAFETY AND HEALTH IN RADIATION INCIDENTS	9

Sources and scenarios of radiation incidents – guidance for protection of emergency responders - Occupational health surveillance of persons occupationally exposed to radiation in emergencies

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	Describe the basic concepts of occupational safety and health (OSH) in public health emergencies	Understand
CO2:	Practice the occupational safety measures by the scientific knowledge to overcome the risks faced by emergency responders	Apply
CO3:	Discuss about risks faced by emergency responders and justify the risks associated with OSH in public health emergencies	Analyze
CO4:	Summarize the health hazards and risks of chemical and radiation accidents and estimate the health status and safety of healthcare workers during emergencies	Evaluate
CO5:	Design the safety measures in different accident scenarios for protection of people working in health facilities	Create

TEXT BOOKS:

1. Emergency responder health monitoring and surveillance. National Response Team technical assistance document. Atlanta (GA): National Institute for Occupational Safety andHealth; 2012.
2. Emergency response framework (ERF). Geneva: World Health Organization; 2013

REFERENCES:

1. Guidelines on occupational safety and health management systems, second edition.Geneva: International Labour Organization; 2009.
2. OSH management system: a tool for continual improvement. Geneva: International Labour Organization; 2011
3. OECD Environmental Outlook to 2050: the consequences of inaction. Paris: Organization for Economic Co-operation and Development; 2012.

Course Code	Course Title	L	T	P	C
19UGM951	ELECTRICAL HAZARDS AND SAFETY IN HOSPITALS	3	0	0	3

OBJECTIVES:

- To gain knowledge in the theory and characteristics of fluid mechanics.
- To study the characteristics of flow.
- To familiarize the concepts of cardiovascular physiology.
- To understand the biomechanics of the human circulation.

UNIT – I	**REVIEW OF BIOPOTENTIAL AND RECORDING**	**9**

Electrodes as bioelectric transducers: The electrode-electrolyte interface; Specification and selection criteria for electrodes; Surface, needle, implanted electrodes; Polarisable and non-polarisable electrodes; Practical considerations for optimum performance; Reduction of interference, grounding, safety.

UNIT – II	**ELECTRICAL STIMULATION AND ITS PARAMETERS**	**9**

Use in generating evoked potentials – therapeutic correction (ECT, pacemakers, defibrillation), Safety limits and precautions; Safety: Hazards associated with the use of electrical /electronic instruments; Provisions for safety; Clinical safety norms.

UNIT – III	**RADIATION HAZARDS & SAFETY**	**9**

Retorted Potentials and concepts of radiation, Radiation from a small current element. Radiation resistance: Introduction to Electromagnetic Interference and Electromagnetic compatibility, EMI coupling modes, Methods of eliminating interference, shielding, grounding, conducted EMI, EMI testing: emission testing, susceptibility testing.

UNIT – IV	**HOSPITAL SAFETY**	**9**

Security & Safety of Hospital -Property, Staff & Patients, Safety precautions, Factors Contributing to Medical Errors: Health Care Reimbursement, Health Care Failure Mode and Effect Analysis (HFMEA).

UNIT – V	**ELECTRICAL & FIRE SAFETY**	**9**

Sources of shocks, macro & micro shocks - Hazards, monitoring and interrupting the operation from leakage current – Elements of fire, causes of fire, Action to be taken in case of fire in a Hospital.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	Explain the different types of hazardous exposure and its biological effects, exposure guidelines and basic work place monitoring.	Understand
CO2:	Identify the electrical hazards and Implement methods of patient safety.	Apply
CO3:	Analyze various hazards, infection, accidents and its control.	Analyze
CO4:	Propose and adopt mandatory regulations and safety norms for improving healthcare delivery.	Evaluate
CO5:	Design different safety facility and control measures in hospitals	Create

TEXT BOOKS:

1. M.J. Aminoff , Electrodiagnosis in Clinical Neurology, 3rd edition, Churchill Livingstone, USA, 1992.
2. J.A. Delisa, H.J. Lee, E.M. Baran, K.S. Lai & N. Spielholz , Manual of Nerve Conduction and Clinical Electrophysiology, 3rd Edition, Academic Press, New York, 1993.

REFERENCES:

1. Sharon Myers “Patient Safety & Hospital Accreditation - A Model for Ensuring Success”, Springer Publishers, 2012.
2. Webster J.G and Albert M.Cook, Clinical Engg, Principles & Practices, Prentic Hall Inc., Engle wood Cliffs, New Jersy, 1979.
3. Cadick, Mary Capelli-Schellpfeffer, and Dennis K. Neitzel ; Electrical Safety Handbook by John 2005 , McGraw-Hill Professional; 3 edition
4. Joseph F Dyro “Clinical Engineering Handbook”, Elsevier Publishers, 2004.

Course Code	Course Title	L	T	P	C
19UGM952	BIOFLUID MECHANICS	3	0	0	3

OBJECTIVES:

- To gain knowledge in the theory and characteristics of fluid mechanics.
- To familiarize the concepts of cardiovascular physiology.
- To understand the biomechanics of the human circulation.
- To study the characteristics of flow.

UNIT – I	BASICS OF FLUID MECHANICS	9

Units and dimensions – Properties of fluids – mass density, specific weight, specific volume, specific gravity, viscosity, Newton law of viscosity, compressibility, vapour pressure, surface tension and capillarity, Types of fluid, Fluid Pressure.

UNIT – II	FLOW CHARACTERISTICS AND FLUID DYNAMICS	9

Types of flow: Laminar, Turbulent, steady, unsteady, uniform, non-uniform flows, stream line, streak line, path line – continuity equation, Reynolds equation of motion,Navier stokes equation.

UNIT – III	FLOW THROUGH CIRCULAR CONDUITS	9

Boundary layer – Boundary layer thickness – Viscous flow – Hagen poiseuille equation – Major loss – Darcy Weisbach equation –friction factor – Moody diagram – minor losses.

UNIT – IV	CARDIOVASCULAR PHYSIOLOGY AND RHEOLOGY OF BLOOD	9

Introduction – Heart – Cardiac Valves – Systemic Circulation – Coronary Circulation – Pulmonary Circulation and Gas Exchange in the Lungs – Cerebral and Renal circulations – Microcirculation, Rheology of blood flow –Regulation of the Circulation – Rheology of Blood – Vascular Mechanics.

UNIT – V	BIOMECHANICS OF THE HUMAN CIRCULATION	9

Static and Steady Flow Models: Introduction – Hydrostatics in the Circulation – Applications of the Bernoulli Equation – Rigid Tube Flow Models – Estimation of Entrance Length and Its Effect on Flow Development in Arteries – Flow in Collapsible Vessels.

Unsteady Flow and Non-uniform Geometric Models: Introduction – Windkessel Models for the Human Circulation – Continuum Models for Pulsatile Flow Dynamics – Hemodynamic Flow through Curved Arteries and Bifurcations.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1:	Explain the basic principles of fluid mechanics.	Understand
CO2:	Analyze the types of flow and fluid dynamics.	Analyze
CO3:	Illustrate the flow of fluids through conduits.	Apply
CO4:	Summarize the cardiovascular physiology and rheology of blood.	Analyze
CO5:	Analyze the steady and unsteady flow of human circulation.	Analyze
CO6:	Develop mathematical models of biological systems with fluids	Apply

TEXT BOOKS:

1. John F. Douglas, Janusz M. Gasiorek, John A. Swaffield, Lynne B. Jack, “Fluid Mechanics” Pearson/Prentice Hall, 2005
2. David Rubenstein, Wei Yin, Mary D. Frame “Biofluid Mechanics: An Introduction to Fluid Mechanics, Macrocirculation, and Microcirculation”, Academic Press, 2015

REFERENCES:

1. A. K. Mohanty, “Fluid Mechanics”, PHI Learning Pvt. Ltd., 1994
2. Shiv Kumar, “Fluid Mechanics: Basic Concepts & Principles”, Ane Books Pvt Ltd, 2010
3. Krishnan B. Chandran, Stanley E. Rittgers, Ajit P. Yoganathan “Biofluid Mechanics: The Human Circulation,” Second Edition CRC Press, 2012.
4. Mazumdar Jagannath, “Biofluid Mechanics” Second Edition, World Scientific, 2015.