KALASALINGAM
ACADEMY OF RESEARCH AND EDUCATION
(DEEMED TO BE UNIVERSITY)
Under sec. 3 of UGC Act 1956.
Anand Nagar, Krishnankoil - 626126. Srivilliputtur (Via), Virudhunagar (Dt), Tamil Nadu | info@kalasalingam.ac.in | www.kalasalingam.ac.in

SCHOOL OF BIO AND CHEMICAL ENGINEERING

DEPARTMENT OF BIOMEDICAL ENGINEERING

B.Tech.

in

BIOMEDICAL ENGINEERING

2018 REGULATION CURRICULUM AND SYLLABUS

KALASALINGAM ACADEMY OF RESEARCH AND EDUCATION

VISION

To be a Centre of Excellence of International Repute in Education and Research.

MISSION

To Produce Technically Competent, Socially Committed Technocrats and Administrators through Quality Education and Research.

DEPARTMENT OF BIOMEDICAL ENGINEERING

VISION

To be a globally recognized Centre of Excellence in the field of Biomedical Engineering for the advancement of human health.

MISSION

To produce skilled Biomedical Engineers, who are technically competent and socially committed, by imparting interdisciplinary education in the field of Biomedical Engineering

Program Educational Objectives (PEOs)

PEO1 Graduates would have attained a basic competency in the field of Biomedical Engineering for pursuing advanced courses in Biomedical Engineering and allied fields

PEO2 Graduates would be successful as entrepreneurs or attain responsible positions in government, biomedical and allied industries and, research centres.

PEO3 Graduates would exhibit effective communication and leadership skills and contribute to the advancement of human healthcare through life-long learning.

ABET Student Outcomes (ASOs)

ASO1: An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.

ASO2: An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.

ASO3: An ability to communicate effectively with a range of audiences.

ASO4: An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.

ASO5: An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.

ASO6: An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.

ASO7: An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Mapping of ABET Student Outcomes and PEOs

ASOs / PEOs	PEO 1	PEO 2	PEO 3
ASO 1 - An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.	✓		
ASO 2 - An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.	✓		
ASO 3 - An ability to communicate effectively with a range of audiences.	✓		✓
ASO 4 - An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.		✓	✓
ASO 5 - An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.		✓	✓
ASO 6 - An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.		✓	
ASO 7 - An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.		✓	

NBA Program Outcomes (POs) and Program Specific Outcomes (PSOs)

PO1 – Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2 – Problem analysis: Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 – Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4 – Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 – Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6 – The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 – Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of need for sustainable development.

PO8 – Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9 – Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10 – Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write

effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11 – Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12 – Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1 - Utilization of Acquired knowledge: The ability of a graduate to utilize the knowledge acquired through the study of Mathematics, Basic Sciences, Biology, Environmental impact and needs, Core-engineering and, Human Anatomy and Physiology constituting the fundamentals of Biomedical Engineering.

PSO2 Recognize and Resolve Complications: The ability of a graduate to Analyze, Interpret, Model, Design, Recognize and Resolve Complications arising in the domain of Biomedical Engineering, and to satisfy the requirements of health-care industries/organizations.

PSO3 - Self-sustainability: The ability of a graduate to be self-sustainable, and to be positioned as a Leader, Administrator, Entrepreneur, or to be a supporter for a multidisciplinary team designated to meet the specified target with standards through an elitist approach.

PSO4 - Well-being of Humanity: The ability of a graduate to be committed with the context of coalescing Pedagogical, Socio-ethical and Professional practices on proceeding with the knowledge gained through Biomedical Engineering for the well-being of Humanity.

POs' Consistency with Department PEOs'

PEO/PO, PSO	PO												PSO			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
PEO1	✓	✓	✓		✓	-	-	-	-	-	-	✓	✓	✓	-	✓
PEO2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
PEO3	-	-	-	-	-	-	-	✓	✓	✓	✓	✓	-	-	✓	✓

DEPARTMENT OF BIOMEDICAL ENGINEERING

2018 REGULATION CURRICULUM

S.No	Category		Credits
I	Basic Science and Mathematics		25
II	Humanities and Social Science	3	12
	Soft Skills	3	
	Humanities Elective	6	
III	Basic Engineering		24
IV	Program Core		61
	a) Core Courses	48	
	b) Community Service Project	3	
	c) Project Work	10	
V	Elective Courses		36
	a) Major Elective	18	
	b) Open Elective	18	
VI	Internship/ Industry Training		2
Total Credits			160

I. BASIC SCIENCE AND MATHEMATICS

S.No	Course Code	Course Name	Course Type	L	T	P	C
1	PHY18R175	Optics, Electromagnetism and Quantum mechanics	IC	3	1	2	5
2	CHY18R171	Chemistry	IC	3	1	2	5
3	MAT18R101	Calculus and Linear Algebra	T	3	1	0	4
4	MAT18R102	Multiple Integration, Ordinary Differential Equations and Complex Variable	T	3	1	0	4
5	MAT18R201	Biostatistics	T	3	1	0	4
6	BIT18R101	Biology for Engineers	T	3	0	0	3

II. HUMANITIES AND SOCIAL SCIENCE COURSES

S.NO	Course Code	Course Name	Course Type	L	T	P	C
1	HSS18R151	English for Technical Communication	TP	2	0	2	3
1	HSS18R101	Soft Skills – I	T	3	0	0	1
2	HSS18R102	Soft Skills – II	T	3	0	0	1
3	HSS18R201	Soft Skills – III	T	3	0	0	1

III - BASIC ENGINEERING

S.No	Course Code	Course Name	Course Type	L	T	P	C
1	EEE18R171	Basic Electrical and Electronics Engineering	IC	3	1	2	5
2	MEC18R151	Engineering Graphics and Design	TP	3	0	2	3
3	MEC18R211	Engineering Mechanics	T	3	1	0	4
4	CSE18R171	Programming for Problem Solving	IC	3	1	2	5
5	MEC18R152	Engineering Practice	TP	3	0	2	3
6	BME18R101	Cell Biology and Genetics	T	3	1	0	4
TOTAL							**24**

IV - PROGRAM CORE

a) CORE COURSES

Code No	Course	Type	L	T	P	C	Pre requisite
THEORY COURSES(T)							
BME18R201	Human Anatomy and Physiology	**T**	3	0	0	3	-
BME18R202	Clinical Biochemistry	**T**	3	0	0	3	-
BME18R301	Diagnostic and Therapeutic Equipment	**T**	3	0	0	3	BME18R252
BME18R401	Biomedical Image Processing and Analysis	**T**	3	0	0	3	BME18R371
THEORY WITH PRACTICE(TP)							
BME18R251	Biocontrol Systems	**TP**	3	0	1	3.5	-
BME18R252	Biomedical Instrumentation	**TP**	3	0	1	3.5	EEE18R171
BME18R351	Biomechanics	**TP**	3	0	1	3.5	BME18R201
BME18R352	Pathology and Microbiology	**TP**	3	0	1	3.5	-
INTEGRATED THEORY WITH PRACTICALS(IC)							
BME18R271	Analog and Digital Electronics	**IC**	3	0	2	4	-
BME18R272	Biosensors and Transducers	**IC**	3	0	2	4	BME18R271
EEE18R371	Microprocessor and Microcontroller	**IC**	3	0	2	4	-
BME18R371	Biomedical Signal Processing	**IC**	3	0	2	4	-
LABORATORY COURSES(L)							
Code No	**Course**	**Type**	**L**	**T**	**P**	**C**	**Co requisite**
BME18R281	Biochemistry and Human Physiology Laboratory	**L**	0	0	3	2	BME18R201, BME18R202
BME18R381	Biomedical Instrumentation and Equipments Laboratory	L	0	0	3	2	BME18R301
BME18R481	Biomedical Image Processing and Analysis	**L**	0	0	3	2	BME18R401
TOTAL CREDITS FOR PROGRAM CORE - 48							

b) COMMUNITY SERVICE PROJECT

Code No	Course	L	T	P	C
BME18R399	Community Service Project	0	0	2	3

c) PROJECT WORK

Code No	Course	L	T	P	C
BME18R499	Project Work	0	0	0	10

V - ELECTIVE COURSES

a) PROFESSIONAL ELECTIVES

MAJOR ELECTIVES							
Code No	**Course**	**Type**	**L**	**T**	**P**	**C**	**Pre-requisite**
BME18R203	Medical Physics	**T**	3	0	0	3	-
BME18R204	Analog and Digital Communication	**T**	3	0	0	3	-
BME18R205	Biomaterials and Artificial Organs	**T**	3	0	0	3	-
BME18R206	Hospital Management	**T**	3	0	0	3	-
BME18R302	Radiological Imaging Systems	**T**	3	0	0	3	BME18R252
BME18R303	Medical Optics and lasers	**T**	3	0	0	3	-
BME18R304	Computers in Medicine	**T**	3	0	0	3	-
BME18R305	Design of Biomedical Instruments	**T**	3	0	0	3	BME18R252
BME18R306	Telemedicine	**T**	3	0	0	3	-
BME18R307	Virtual Reality	**T**	3	0	0	3	BME18R351
BME18R308	Biometric Systems	**T**	3	0	0	3	BME18R272
BME18R309	Neural Network	**T**	3	0	0	3	-
BME18R310	Clinical Engineering	**T**	3	0	0	3	-
BME18R311	Biofluids and Dynamics	**T**	3	0	0	3	BME18R351
BME18R312	Embedded Systems in Medicine	**T**	3	0	0	3	-
BME18R 313	Mechanics of Biological Systems	**T**	3	0	0	3	BME18R351
BME18R402	Human Assist Devices	**T**	3	0	0	3	BME18R201
BME18R403	Rehabilitation Engineering	**T**	3	0	0	3	BME18R351
BME18R404	Modeling of Physiological Systems	**T**	3	0	0	3	BME18R251
BME18R 405	Neural Engineering	**T**	3	0	0	3	-
BME18R406	BioMEMS	**T**	3	0	0	3	-
BME18R407	Tissue Engineering	**T**	3	0	0	3	BME18R101
BME18R408	Nanotechnology in Medicine	**T**	3	0	0	3	-
BME18R409	Advanced Digital Signal Processing	**T**	3	0	0	3	BME18R371

b) OPEN ELECTIVES (ENGINEERING)

Code No	**Course**	**Type**	**L**	**T**	**P**	**C**
BME18R207	Medical Optics and lasers	**T**	3	0	0	3
BME18R314	Computers in Medicine	**T**	3	0	0	3
BME18R315	Biomedical Instrumentation	**T**	3	0	0	3
BME18R316	Rehabilitation Engineering	**T**	3	0	0	3
BME18R317	Telemedicine	**T**	3	0	0	3
BME18R410	Tissue Engineering	**T**	3	0	0	3

BME18R411	Wearable systems	**T**	3	0	0	3
BME18R412	Nanotechnology in Medicine	**T**	3	0	0	3
BME18R413	Biometric Systems	**T**	3	0	0	3
BME18R414	Biomedical Waste Management	**T**	3	0	0	3
BME18R415	Bioethics, IPR and Standards	**T**	3	0	0	3
PHY18R301	Photonics and Optoelectronic Devices	**T**	3	0	0	3

c) HUMANITIES ELECTIVES

S.No	Course Code	Course Name	Type	L	T	P	C
1.	HSS18R001	Management Concepts and Techniques	**T**	3	0	0	3
2.	HSS18R002	Marketing Management	**T**	3	0	0	3
3.	HSS18R003	Organizational Psychology	**T**	3	0	0	3
4.	HSS18R004	Project Management	**T**	3	0	0	3
5.	HSS18R005	Stress Management and Coping Strategies	**T**	3	0	0	3
6.	HSS18R006	Engineering Economics	**T**	3	0	0	3
7.	HSS18R007	Human Resource Management and Labour Law	**T**	3	0	0	3
8.	HSS18R008	Entrepreneurship Development	**T**	3	0	0	3
9.	HSS18R009	Cost Analysis and Control	**T**	3	0	0	3
10.	HSS18R010	Product Design and Development	**T**	3	0	0	3
11.	HSS18R011	Business Process Reengineering	**T**	3	0	0	3
12.	HSS18R012	Political Economy	**T**	3	0	0	3
13.	HSS18R013	Professional Ethics	**T**	3	0	0	3
14.	HSS18R014	Operations Research	**T**	3	0	0	3
15.	HSS18R015	Total Quality Management	**T**	3	0	0	3
16.	HSS18R016	Advanced Softskills	**T**	3	0	0	3

d) OPEN ELECTIVES (SCIENCE)

S.No	Course Code	Course Name	Type	L	T	P	C
1.	OEE18R009	Laser Technology	**T**	3	0	0	3
2.	OEE18R003	Mathematical Biology	**T**	3	0	0	3
3.	OEE18R005	Combinatorics	**T**	3	0	0	3
4.	OEE18R008	Photonics and Optoelectronic Devices	**T**	3	0	0	3
5.	OEE18R006	Industrial Chemistry for Engineers	**T**	3	0	0	3
6.	OEE18R004	Mathematical Modelling	**T**	3	0	0	3

VI - INTERNSHIP/ INDUSTRY TRAINING

S.No	Course Code	Course Name	Credits
1	BME18R397/ BME18R398	Industry Training/ Internship Training	2

SYLLABUS
REGULATION 2018

BASIC SCIENCE AND MATHEMATICS

Subject Code	OPTICS, ELECTROMAGNETISM AND QUANTUM MECHANICS	L	T	P	C
PHY18R175		3	1	2	5
Pre-requisite: Basic Knowledge in Physics		**Course Category:** Program core **Course Type:** Integrated Course			

Course Objectives:

- To understand the basic concepts of optics, quantum physics and its applications.
- To provide the students a firm understanding of the basics of Electricity, Magnetism and its applications.

Course Outcomes:

Upon successful completion of this course, students will be able to

CO1: Understand the concepts of diffraction and polarization.
CO2: Apply the concepts of optics in laser and fiber optics.
CO3: Explore the knowledge on electrostatistics.
CO4: Understand the fundamentals of magnetism.
CO5: Apply the knowledge on solving the wave equations

UNIT I: DIFFRACTION AND POLARISATION

Diffraction: Introduction to interference and example; concept of diffraction, Fraunhofer and Fresnel diffraction, Fraunhofer diffraction at single slit, double slit, and multiple slits; diffraction grating, characteristics of diffraction grating and its applications.

Polarisation: Introduction, polarisation by reflection, polarisation by double refraction, scattering of light, circular and elliptical polarisation, optical activity.

UNIT II: LASER AND FIBER OPTICS

Einstein's theory of matter radiation interaction and A and B coefficients; amplification of light by population inversion, different types of lasers: gas lasers (He-Ne), solid-state lasers (Neodymium), applications of lasers in science, engineering and medicine. Numerical aperture and Acceptance angle of fibre – Types of optical fibre - Active and passive fibre sensors- Endoscope.

UNIT III: ELECTROMAGNETISM AND DIELECTRICS

Laws of electrostatics, electric current and the continuity equation, laws of magnetism. Ampere's Faraday's laws. Maxwell's equations. Polarisation, permeability and dielectric constant, polar and non-polar dielectrics, internal fields in a solid, Clausius-Mossotti equation, applications of dielectrics, Dielectric Breakdown – Types and Remedies.

UNIT IV: MAGNETOSTATICS AND MAGNETIC MATERIALS Magnetostatics: Biot-Savart's law & its applications- straight conductor, circular coil, solenoid carrying current. Divergence and curl of magnetic field. Magnetic vector potential. Ampere's circuital law. Magnetic properties of materials: Magnetic intensity, magnetic induction, permeability, magnetic susceptibility. Brief introduction of dia-, para- and ferro-magnetic materials.

UNIT V: QUANTUM MECHANICS

Introduction to quantum physics, black body radiation, explanation using the photon concept, photoelectric effect, Compton effect, de Broglie hypothesis, wave-particle duality, verification of matter waves, uncertainty principle, Schrodinger wave equation, particle in a box (1D) .

LIST OF EXPERIMENTS

1. To determine the dispersive power of prism using spectrometer and mercury source
2. To determine the wavelength of sodium light by Newton's Ring
3. To determine the wavelength of sodium light using diffraction grating
4. To determine the numeral aperture (NA) of a Optical Fibre.
5. To find the wavelength of He-Ne Laser using transmission diffraction grating.
6. To determine the refractive index of a prism/ liquid using spectrometer.
7. Deflection magnetometer – M and BH – TAN C position
8. To determine the thickness of a material using air wedge method
9. Measurement of field strength B and its variation in a Solenoid (Determine dB/dx).
10. Determination of dielectric constant of liquids / Solids
11. Determination of Magnetic Susceptibility

TEXT BOOK(S)

1. , "Optics" Fith edition, Tata McGraw-Hill Inc, 2012.
2. N. Subrahmanyam and Brij Lal, "A Text Book of Optics", S. Chand Limited, 2015.
3. Marikani Ghatak A. Engineering Physics. PHI Learning Pvt., India, 2009 .
4. Palanisamy P.K. Engineering Physics. SCITECH Publications, 2011
5. Rajagopal K. Engineering Physics. PHI, New Delhi, 2011

REFERENCE BOOKS

1. Kailash K. Sharma Optics: Principles and Applications Elsevier, 2006
2. William T. Silfvast, Laser Fundamentals, Cambridge University Press, New York, 2nd Edition, 2004
3. Gaur R. K, and Gupta S. L, Engineering Physics, Dhanpat Rai & Sons, New Delhi, 7th Edition, 1993
4. Halliday D, Resnick R and Waler J, Fundamentals of Physics, Wiley and Sons, New York, 6th Edition, 2001
5. Rajput B.S, Pragati Prakashan, Advanced Quantum Mechanics, Pragati publications, New Market, Begum Bridge, Meerut, 2009.
6. Practical Physics – S.L. Gupta & V. Kumar (Pragati Prakashan).
7. Advanced Practical Physics – B.L. Workshop and H.T. Flint (KPH)

8. Advanced Practical Physics Vol. I & II – Chauhan & Singh (Pragati Prakashan)
9. Physics Laboratory Manual, prepared by Department of Physics, Kalasalingam University.

CHY18R171	CHEMISTRY	L	T	P	C
		3	1	2	5

UNIT -I: ATOMIC AND MOLECULAR STRUCTURE

Schrodinger wave equation: Derivation of time independent Schrodinger wave equation, Representation of Schrodinger wave equation in polar coordinates - Radial distribution function graphs of s, p, d and f orbitals. Molecular Orbital Theory: MOT concept, MO diagrams of homo-nuclear diatomic molecules (hydrogen, nitrogen and oxygen) and hetero-nuclear diatomic molecules (carbon monoxide and nitric oxide). Crystal field theory: CFT concept, weak and strong ligands, energy level diagrams of transition metal ions (Fe^{2+}& Fe^{3+}) in octahedral and tetrahedral complexes and their magnetic properties. Intermolecular forces - Ionic, dipolar and van der Waals interactions.

UNIT-II: PERIODIC PROPERTIES

Effective nuclear charge - Factors affecting effective nuclear charge: Penetration or shielding of orbitals - Variation of s, p, d and f orbital energies of atoms in the periodic table - Aufbau principle (Building-up principle)**:** Application of Aufbau principle in writing electronic configuration, Deviation from Aufbau principle - Periodicity of properties in a periodic table - Periodic properties: Atomic and ionic sizes, ionization energies, electron affinity and electronegativity - Variation of periodic properties in the periodic table - Hard soft acids and bases: Concept and examples.

UNIT-III: FREE ENERGY AND CHEMICAL EQUILIBRIA

Thermodynamic functions: Definition and mathematical expression for Work, Energy, Enthalpy, Entropy and Free energy - Nernst equation: Derivation, apply Nernst equation to determine of solubility product, pH (glass electrode). Potentiometric titrations: Acid-Base, Redox and precipitation reaction - Water analysis: Hardness by EDTA method and chloride ion by Argentomentric method - Corrosion: Definition, types (dry & wet) and mechanism. and control of Dry and Wet corrosion.

UNIT-IV: ORGANIC REACTIONS

Nucleophilic substitution reactions: Definition, types and examples of nucleophile, Compare nucleophilicity and basicity of a nuceophile - Types of nucleophilic substitution (case RX and ArX): Mechanism of S_N1, S_N2, S_Ni and Benzyne. Electrophilic substitution reactions: Definition, types and examples of electrophile - Electrophilic substitution reactions of hydrocarbons: Halogenation, sulphonation, nitration. Friedel crafts alkylation and acylation reaction. Nucleophilic addition reactions (case aldehydes and ketones): Polarity of C=O bond. General mechanism of nucleophilic addition reactions on aldehydes and ketones: HCN, HOH, ROH and $NaHSO_3$ addition. Electrophilic addition reactions (case alkenes): General mechanism of electrophilic addition reactions on alkene - Addition of HBr [Markownikoff & Anti-Markownikoff (peroxide effect)] - Addition of alkene (polymerization of ethylene). Elimination reactions: Types of elimination reactions (case alkyl halides): Dehydrohalogenation of alkyl

halides - E_1 and E_2 mechanism - Dehydration of alcohols to alkene and ethers. Greener synthesis of drug molecules (Aspirin and Ibuprofen)

UNIT-V: STEREOCHEMISTRY & SPECTROSCOPIC TECHNIQUES

Stereochemistry - Definition with examples: Geometrical isomers (alkene) and stereoisomers, symmetry, chirality, enantiomers, diastereomers, meso and racemic mixture. Representation of 3D structures: Wedge formula, Fischer projections, Newmann and Sawhorse formula (upto 2 carbons) - Conformational analysis: Ethane, butane and cyclohexane - Configurational analysis: Rules of RS nomenclature and application of RS nomenclature to molecules containing one chiral centre. Electronic spectroscopy: Principle, instrumentation, selection rules and medicinal application of fluorescence spectroscopy. Nuclear magnetic resonance spectroscopy (^{1}H-NMR): Principle, instrumentation, chemical shift, coupling constant and application (structural identification of the compound C_3H_6O from ^{1}H-NMR data). X-ray diffraction: Principle, instrumentation and applications X-ray diffraction.

LIST OF EXPERIMENTS (ANY 10):

1. Determination of Viscosity by Ostwald Viscometer.
2. Determination of surface tension by stalagmometer.
3. Adsorption of acetic acid by charcoal.
4. Determination of chloride content of water.
5. Estimation of hardness of water by EDTA method.
6. Determination of the rate constant of a reaction
7. Thin layer chromatography.
8. Determination of the partition coefficient of a substance between two immiscible liquids
9. Determination of Saponification /acid value of oil.
10. Preparation of Aspirin
11. Potentiometric titration of strong acid vs strong base.
12. Potentiometric titration of weak acid vs strong base.
13. Determination of cell constant and conductance of solutions.

TEXT BOOKS

1. Engineering Chemistry, 2nd Edition, Wiley India (P) Ltd., 2018.
2. Stereochemistry of Organic Compounds, Ernest L. Eliel, Samuel H. Wilen Student edition, Wiley India (P) Ltd., 2017.
3. University Chemistry, by B. M. Mahan and R.J.Mayers, Pearson Publishers, 11th Edition, Noida, 2017.
4. Chemistry Laboratory Manual, Department of Chemistry, Kalasalingam University, 2018.

REFERENCE BOOKS

1. Fundamentals of Molecular Spectroscopy, by C. N. Banwell and E.M. McCash, Tata McGraw-Hill Publishers, 4th Edition, New Delhi, 2008.

2. Physical Chemistry, by P. W. Atkins and J.D. Paula, W H Freeman & Co Publishers, 10th Edition, 2014.
3. Modern Inorganic Chemistry, R. D. Madan, 4th Edition S. Chand & Company Ltd., 2009.
4. Organic Chemistry, Paula Y. Bruice, 7th Edition, Pearson (Dorling Kindersley India (P) Ltd.) 2014.
5. Principles of Physical Chemistry, B. R. Puri, L. R. Sharma, M. S. Pathania, 47th Edition, Vishal Publishing Co., 2017.
6. Spectrometric Identification of Organic Compounds, Robert M. Silverstein, Francis X. Webster, David J. Kiemle, David L. Bryce, 8th Edition, Wiley India (P) Ltd., 2010.
7. Inorganic Chemistry, Peter Atkins, Mark Weller, Fraser Armstrong, Jonathan Rourke, Tina Overton, Michael Hangerman 5th Edition, Oxford press, 2015.
8. Organic Chemistry, Volume 1, I. L. Finar, 6th Edition, Pearson (Thomson press India (P) Ltd.) 2014.

MAT18R101	CALCULUS AND LINEAR ALGEBRA	L	T	P	C
		3	1	0	4

Course Objective:

To enable the students to acquire knowledge and skills in basic components of calculus, to handle the situations involving multivariable calculus, and to diagonalize a symmetric matrix using eigenvalues and eigenvectors.

Course Outcomes:

Upon successful completion of this course, students will be able to

- Know the fundamental theorems such as Rolle's theorem, Mean value theorem, Taylor's theorem and its applications.
- Understand the basic concepts of limit, continuity, derivative, partial derivative and total derivative and its applications.
- Solve the real world problems using differentiation and integration.
- Understand the concepts of sequence, convergent of sequences, series and testing of convergent of series using different methods.
- Find the solution of simultaneous linear equations using matrices and to find the eigen values and eigen vectors of a matrix, Cayley-Hamilon theorem and orthogonal transformations.

UNIT 1: CALCULUS

Rolle's Theorem- Mean value theorems - Taylor's and Maclaurin theorems with remainders - indeterminate forms and L'Hospital's rule - Maxima and minima.

UNIT 2: MULTIVARIABLE CALCULUS (DIFFERENTIATION)

Limit, continuity and partial derivatives - directional derivatives - total derivative - Maxima, minima and saddle points - Method of Lagrange multipliers.

UNIT 3: CALCULUS (APPLICATIONS)

Curvature (Cartesian coordinates) - Evolutes and involutes; Evaluation of definite and improper integrals; Beta and Gamma functions and their properties; Applications of definite integrals to evaluate surface areas and volumes of revolutions.

UNIT 4: SEQUENCES AND SERIES

Convergence of sequence and series, tests for convergence; Power series, Taylor's series, series for exponential, trigonometric and logarithm functions;

UNIT 5: MATRICES

System of linear equations; Symmetric, skew-symmetric and orthogonal matrices; Determinants; Eigenvalues and eigenvectors; Cayley-Hamilton Theorem - Diagonalization of matrices - Orthogonal transformation- Reduction of Quadratic form to Canonical form.

TEXT BOOKS

1. Grewal, B.S., Grewal, J.S., Higher Engineering Mathematics, Khanna Publishers, New Delhi, 43rd Edition, 2015.

REFERENCE BOOKS

1. Kreyszig, E, Advanced Engineering Mathematics, John Wiley and Sons (Asia) Limited,
2. Singapore , 10th Edn., 2001.
3. Ramana B. V., Engineering Mathematics, Tata McGraw-Hill Publishing Company Limited,
4. New Delhi, Edition 2005.
5. Veerarajan,T., Engineering Mathematics (For First Year), Tata McGraw-Hill publishing company Limited, 2008.

		L	T	P	C
MAT18R102	**MULTIPLE INTEGRATION, ORDINARYDIFFERENTIAL EQUATIONS AND COMPLEX VARIABLE**	**3**	**1**	**0**	**4**

Course Objective:

To enable the students to understand the concepts of multiple integrations, their applications, and to handle analytic functions on complex plane and perform complex integration.

Course Outcomes:

Upon successful completion of this course, students will be able to

- Understand the concepts of double and triple integral and its applications.
- Know about the applications of double and triple integral in vector calculus.

- Know the methods of solving differential equations of first and second orders.
- Understand the concepts of analytic functions, conformal mappings and bilinear transformations.
- Understand the concepts of singularity, residues and evaluation of certain improper integrals.

UNIT 1: MULTIVARIABLE CALCULUS (INTEGRATION)

Multiple Integration: Double integrals (Cartesian), change of order of integration in double integrals, Change of variables (Cartesian to polar), Applications: areas and volume; Triple integrals (Cartesian), orthogonal curvilinear coordinates, Simple applications involving cubes, sphere and rectangular parallelepipeds.

UNIT 2: INTEGRAL THEOREMS

Gradient, curl and divergence. Scalar line integrals, vector line integrals, scalar surface integrals, vector surface integrals, Theorems of Green, Gauss and Stokes.

UNIT 3: ORDINARY DIFFERENTIAL EQUATIONS

Exact, linear and Bernoulli's equations, Euler's equations, Equations not of first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type. Second order linear differential equations with variable coefficients, method of variation of parameters, Cauchy-Euler equations.

UNIT 4: COMPLEX VARIABLE – DIFFERENTIATION

Differentiation, Cauchy-Riemann equations, analytic functions, harmonic functions; elementary analytic functions (exponential, trigonometric, logarithm) and their properties; Conformal mappings, Mobius transformations and their properties.

UNIT 5: COMPLEX VARIABLE – INTEGRATION

Contour integrals, Cauchy Integral formula (without proof); Taylor's series, zeros of analytic functions, singularities, Laurent's series; Residues, Cauchy Residue theorem (without proof), Evaluation of definite integral involving sine and cosine, Evaluation of certain improper integrals (Integration around small semicircles and rectangular contours).

TEXT BOOKS

1. Grewal, B.S., Grewal, J.S., Higher Engineering Mathematics, Khanna Publishers, New Delhi, 43rd Edition, 2015.

REFERENCE BOOKS

1. Kreyszig, E, Advanced Engineering Mathematics, John Wiley and Sons (Asia) Limited, Singapore , 10th Edn., 2001.
2. Ramana B. V., Engineering Mathematics, Tata McGraw-Hill Publishing Company Limited, New Delhi, Edition 2005.
3. Veerarajan,T., Engineering Mathematics (For First Year), Tata McGraw-Hill publishing company Limited, 2008.

MAT18R201	BIO-STATISTICS	L	T	P	C
		3	1	0	4

Course Objective:

To enable the students to understand the concepts of probability and statistics and to solve real world problems using statistical tools.

Course Outcomes:

Upon successful completion of this course, students will be able to

- Know the methods of finding averages, deviations, moments and skewness and kurtosis.
- Understand the concepts of probability and to know about the discrete and continuous distributions.
- Understand the concepts of correlation and regression and its applications.
- Fit the curve of first and second degree equations by least square method and know the method of analysis of variance.
- Study about the testing of hypothesis of small and large samples.

UNIT 1: STATISTICAL AVERAGES

Introduction – Diagrammatic representation of data – Graphic representation of data – Measures of central tendency: Arithmetic mean, Geometric mean, Harmonic mean, Median and Mode – Measures of dispersion: Range, Mean deviation and Standard deviation – Moments, Skewness and Kurtosis.

UNIT 2: PROBABILITY

Introduction – Probability – Theorems on probability - Addition Rule – Multiplication rule – Probability distributions: Binomial, Poisson and Normal distributions.

UNIT 3: CORRELATION AND REGRESSION

Introduction – Types of correlation – coefficient of correlation – Rank correlation – Regression – Difference between correlation and regression – Regression equations – Applications of regression.

UNIT 4: FITTING OF CURVES AND ANALYSIS OF VARIANCE

Principles of least square techniques – Fitting a straight line – Fitting a second degree parabola – Fitting a curve of the types $y = bx^a$, $y = ae^{bx}$, $y = ka^{bx}$ - Analysis of variance (ANOVA) – one criterion and two criterion of classification.

UNIT 5: TESTING OF HYPOTHESES

Test for single mean- mean difference – proportion – difference of proportions- small sample tests: based on t and F distributions – chi-square test for population variance – Chi-square test to goodness of fit.

TEXT BOOKS

1. Khan and Khanum, Fundamentals of Biostatistics, Ukaaz Publications, Reprint 2004.
2. Arumugam and Issac, Statistics, New Gamma Publishers, July 2013.

BIT18R101	BIOLOGY FOR ENGINEERS	L	T	P	C
		3	0	0	3

Course outcomes

CO1: Describe the fundamentals of cell structure and cell cycle

CO2: Understand the classification and functions of biomolecules

CO3: Elaborate the basic cellular mechanisms such as replication, transcription and translation

CO4: Describe the underlying concepts of infection and immunity.

CO5: Explain various applications of biology

Unit I: INTRODUCTION **9 hours**

Fundamental difference between science and engineering- comparison between eye and camera, Bird flying and aircraft; major discoveries in biology- ; Classification based on: Cellularity- Unicellular and Multicellular; Ultra structure - prokaryotes and eukaryotes; three major kingdoms of life; Cell structure, intracellular organelles and their functions, comparison of plant and animal cells- Overview of Cell cycle and cell division

Unit II: BIOMOLECULES **9 hours**

Chemistry of biomolecules: Carbohydrates, Lipids, Proteins; classification of amino acids; classification of proteins based on structure and functions; Nucleic acids -types, structure and function of DNA and RNA

Unit III: GENES TO PROTEINS **9 hours**

Gene, Genome and chromosome; Central dogma of molecular biology; Classical experiments of DNA: Griffith and, Avery, McCarty and MacLeod, Meselson and Stahl - DNA replication, Transcription and Translation.

Unit IV: MICROBIOLOGY **9 hours**

Microscopy; Microbes as infectious agents - malaria, tuberculosis, typhoid, polio, dengue, AIDS;; cultivation of bacteria. Immunity - innate and acquired immunity - organs and cells of the immune system - classification of antibodies - types of T cells - transplantation, autoimmunity overview.

Unit V: APPLICATIONS OF BIOLOGY **9 hours**

Healthcare-antibiotics, vaccines, monoclonal antibodies, insulin and interferons; Beneficial bacteria - probiotic bacteria, nitrogen fixing bacteria, fermentation and fermented foods and products Environmental

- waste water treatment, bioremediation; Biomaterials and biopolymers for medical and environmental applications; Biosensors.

TEXT BOOKS

1. De Robertis, E.D.P. and De Robertis, E.M.F. - Cell and Molecular Biology- Lippincott Williams & Wilkins- Philadelphia- USA- 8th Edition- 2010.
2. Voet, D., Voet, G., - Biochemistry - John Wiley and Sons, Singapore - 3rd Edition- 2001.
3. Pelczar MJ, Chan ECS and Krieg NR - Microbiology - Tata McGraw Hill, India- 7th Edition- 2010.

REFERENCES

1. Friefelder. D. -Molecular Biology- McGraw-Hill Companies- New York, USA- 5th Edition- 2013.

HSS18R151	ENGLISH FOR TECHNICAL COMMUNICATION	L	T	P	C
		2	0	2	3

1 UNIT I – VOCABULARY BUILDING

1.1 The concept of word formation
1.2 Root words from foreign languages and their use in English
1.3 Prefixes and suffixes; word derivatives using them
1.4 Synonyms, Antonyms and standard Abbreviations

2 UNIT II – BASIC WRITING SKILLS

2.1 Sentence structures
2.2 Use of phrases and clauses in sentences
2.3 Creating Coherence
2.4 Techniques for Writing Precisely

3 UNIT III – IDENTIFYING COMMON ERRORS IN WRITING

3.1 Tenses
3.2 Subject – verb agreement
3.3 Noun –Pronoun Agreement
3.4 Verbs – Transitive, Intransitive
3.5 Misplaced Modifiers
3.6 Articles
3.7 Prepositions
3.8 Redundancies and Clichés
3.9 Direct, Indirect speech
3.10 Infinitives, Gerunds
3.11 Comparison of adjectives

4 UNIT IV NATURE AND STYLE OF SENSIBLE WRITING

4.1 Describing
4.2 Defining
4.3 Classifying
4.4 Providing examples or evidence
4.5 Writing introduction or conclusion

5 WRITING PRACTICES

5.1 Comprehension
5.2 Precis writing
5.3 Essay writing
5.4 Letter writing
5.5 Instructions
5.6 Paragraph development

6 UNIT VI – ORAL COMMUNICATION

6.1 Listening comprehension
6.2 Pronunciation, intonation, stress and rhythm
6.3 Common everyday situations: Conversations and dialogues
6.4 Interviews
6.5 Formal presentations

EEE18R171 BASIC ELECTRICAL AND ELECTRONICS ENGINEERING	**Credits**			
	L	**T**	**P**	**Total**
	3	**1**	**2**	**5**
Pre-requisite: --	**Course Category:** Basic Engineering **Course Type:** Integrated Course			

Course Objectives:

To focus the fundamental ideas of the Electrical and Electronics Engineering by providing wide exposure to the basic concepts of Electrical and Electronics Engineering such as DC Circuits, AC Circuits, electrical machines, measuring instruments, Basic Electronic Devices and various electronic circuits such as rectifiers, amplifiers, oscillators, etc.

Course Outcomes:

After completing this course, the student will be able to:

CO1: Apply the basic laws of electricity in DC and AC circuits
CO2: Describe the construction and operation of static and rotating electrical machines
CO3: Explain the functioning of measuring instruments and Develop the basic domestic wiring circuit.
CO4: Describe the constructional features and operation of fundamental electronic devices
CO5: Explain the characteristics of electronic circuits

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	M	M		M	M	L		L	L	L					
CO2	M	M		M	M	L		L	L	L					
CO3	M			M	M	L		L	L	L					
CO4	H	M													
CO5	H	H	L	M	M	L	L	L	L	L					

Course Topics:

UNIT 1: DC CIRCUITS AND AC CIRCUITS 12 HOURS

Electrical quantities - resistors - inductors - capacitors - Ohm's Law - Kirchhoff's Laws - series and parallel circuits - analysis of DC circuits - mesh, nodal - simple problems- Sinusoidal functions - phasor representation - RMS and Average values - form and peak factors - RLC series circuits - power and power factor-concept of three phase system.

UNIT 2: ELECTRICAL MACHINES 12 HOURS

Construction and principle of operation of DC machines - generator, motor - single phase transformers - alternators - three phase and single phase induction motors.

UNIT 3: MEASUREMENT INSTRUMENTS AND WIRING CIRCUITS12 HOURS

Moving coil and moving iron instruments - dynamometer type wattmeter - induction type energy meter, Domestic wiring - accessories - types - staircase wiring - fluorescent tube circuits - simple layout – grounding.

UNIT 4: ELECTRONIC DEVICES 12 HOURS

Basic concepts of PN junction diodes - Zener diode - bipolar junction transistor - unipolar devices - FET, MOSFET, UJT - Thyristor–SCR and Triac, Photoelectric Devices-Photo diode and Photo transistor.

UNIT 5: ELECTRONIC CIRCUITS 12 HOURS

Half wave and full wave rectifier –Transistor as an amplifier –RC- phase shift oscillator - RC integrator and differentiator circuits - diode clampers and clippers - multivibrators - Schmitt trigger

TEXT BOOKS:

1. V.K. Mehta, "Principles of Electrical Engineering and Electronics", S. Chand & Company Ltd, 2012
2. Kothari D P and Nagrath I J, "Basic Electrical Engineering", McGraw Hill, 2009.
3. Mithal G K, Electronic Devices & Circuits, Khanna Publications, 1997.

REFERENCES:

1. T.Thyagarajan, “Fundamentals of Electrical and Electronics Engineering”, SciTech publications (Ind.) Pvt. Ltd., 3rd Edition, 2015.
2. Muraleedharan K.A, Muthususbramanian R and Salivahanan S, "Basic Electrical, Electronics and Computer Engineering" Tata McGraw Hill,2006.
3. Shantha kumar S.R.J, Basic Mechanical Engineering, Third Revised Edition (Reprint 2009), Anuradha Publications, Kumbakonam, 1999.
4. Rajput R. K., Basic Mechanical Engineering, Fourth edition, Tata McGraw Hill Publishing Co., New Delhi, 2007.

LIST OF EXPERIEMENTS

1. Verification of Kirchoff’s Laws.
2. Verification of AC voltage measurements
3. Demonstration of DC Motor
4. Demonstration of Transformer
5. Demonstration of Induction Motor
6. Measurement of Voltage, Current and Power in AC Circuit
7. Wiring layout for Staircase
8. Wiring layout for Fluorescent lamp
9. Conduct a suitable experiment to demonstrate the VI characteristics of characteristics PN diode and Zener Diode
10. Design a diode based Half wave and Full wave rectifier

MEC18R151 ENGINEERING GRAPHICS & DESIGN	**Credits**			
	L	**T**	**P**	**Total**
	3	**0**	**2**	**3**
Pre-requisite: Nil	**Course Category:** Basic Engineering **Course Type**: Theory with Practical			

Course Objective(s):

This course aims to introduce the concept of graphic communication, develop the drawing skills for communicating concepts, ideas and designs of engineering products, Demonstrate skills in interpreting, and producing engineering drawings accurately and to give exposure to national standards relating to engineering drawing.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Create the projection of points in all quadrants and straight lines

CO2: Construct the projections of planes and solid objects with refer to reference planes

CO3: Illustrate the true shape of truncated solids in both the manual and computerized manner

CO4: Develop surfaces of truncated solids in both the manual and computerized man

CO5: Apply orthographic and isometric projections in both the manual and computerized man.

Mapping of Course Outcome(s):

CO/ PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2		2												
CO2		3										1			
CO3	2		3		3		3					2			
CO4	1	2			3		3					3			
CO5	3		3		3		3					3			

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:

UNIT 1: PROJECTION OF POINTS AND STRAIGHT LINES 9 HOURS

Importance of graphics – use of drafting instruments – BIS conventions and specifications – size, layout and folding of drawing sheets – lettering dimensioning and scales - Projection of points, located in all quadrants - projection of straight lines located in the first quadrant, determination of true lengths and true inclinations.

UNIT 2: PROJECTION OF PLANES AND SOLIDS 9 HOURS

Projection of polygonal surface and circular lamina located in first quadrant inclined to one or both reference planes-Projection of solids like prisms, pyramids, cylinder and cone when the axis is inclined to one reference plane by change of position method.

UNIT 3: SECTION OF SOLIDS 9 HOURS

Section of simple solids like prisms, pyramids, cylinder and cone in vertical position by cutting planes inclined to any one of the reference planes, obtaining true shape of section.

UNIT 4: DEVELOPMENT OF SURFACES 9 HOURS

Development of lateral surfaces of simple and truncated solids – prisms, pyramids, cylinders and cones.

UNIT 5: ORTHOGRAPHIC AND ISOMETRIC PROJECTION 9 HOURS

Orthographic principles – missing view - free hand sketching in first angle projection from pictorial views. Principles of isometric projection – isometric view and projections of simple solids, truncated prisms, pyramids, cylinders and cones. Introduction to CAD software – menus and tools – drafting platform demonstration.

PRACTICAL MODULES

1. Construction of conic sections using CAD software
2. Construction of simple planes using exclusive commands like extend, trim etc.,
3. Construction of 3D model – solids and sectional views
4. Generating 2D orthographic blue prints from 3D part models
5. Vectorization of simple building plan and elevation.

TEXT BOOK(S):

1. Basant Aggarwal and C. Aggarwal, Engineering Drawing, McGraw-Hill, 2013.
2. N.S. Parthasarathy, Vela Murali, Engineering Drawing, Oxford University Press, 2015.
3. K. Venugopal, Engineering Drawing + AutoCAD, New Age; Fifth edition, 2011.

REFERENCE(S):

1. Shah, M.B., and Rana, B.C., Engineering Drawing, Pearson 2009
2. Natarajan, K.V., A Text Book of Engineering Graphics, 21st Edition, Dhanalakshmi Publishers, Chennai, 2012.
3. Paul Richard, Jim Fitzgerald., Introduction to AutoCAD 2017: A Modern Perspective, Pearson, 2016.
4. Bhatt, N.D., Engineering Drawing, Charotar publishing House, New Delhi, 53trd Edition, 2014.
5. Luzadder and Duff, "Fundamentals of Engineering Drawing", Prentice Hall of India Pvt. Ltd., 2009.
6. Venugopal, K., Engineering Graphics, New Age International (P) Limited, 2009.

MEC18R211 ENGINEERING MECHANICS	**Credits**			
	L	**T**	**P**	**Total**
	3	**1**	**0**	**4**
Pre-requisite: Nil	**Course Category:** Basic Engineering **Course Type:** Theory			

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Explain the vectorial and scalar representation of forces and moments of particles and rigid bodies both in two dimensions and in three dimensions.

CO2: Apply the knowledge of trusses in frames, beams and machine components.

CO3: Contrast the effect of friction on equilibrium.

CO4: Illustrate the importance of properties of surfaces and solids.

CO5: Demonstrate the dynamic equilibrium equation.

Mapping of Course Outcome(s):

COs/ POs/PSOs	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2	1											
CO2	3	2	2	1											
CO3	3	3	2	1											
CO4	3	2	2	1											
CO5	3	1	1	1											

3-StrongCorrelation-2-MediumCorrelation-1–LowCorrelation

UNIT 1. STATICS OF PARTICLES AND RIGID BODIES (9+3)

Six Fundamental principles and concepts - vector algebra - Force Systems Basic concepts, Particle equilibrium in 2-D & 3-D - System of Forces, Coplanar Concurrent Forces, Components in Space – Resultant - Equations of Equilibrium of Coplanar Systems and Spatial Systems.

Rigid Body equilibrium in 2-D & 3-D - Moment of Forces and its Application - Couples and Resultant of Force System - Equilibrium of System of Forces, Free body diagrams - Equations of Equilibrium of Coplanar Systems and Spatial Systems.

UNIT 2. ANALYSIS OF TRUSSES (9+3)

Basic Structural Analysis- Equilibrium in three dimensions - Method of Sections- Method of Joints- How to determine if a member is in tension or compression- Simple Trusses- Zero force members- Beams & types of beams- Frames & Machines.

UNIT 3. FRICTION (9+3)

Types of friction, Limiting friction, Laws of Friction, Static and Dynamic Friction - Motion of Bodies, simple contact friction, sliding block, wedge friction, screw jack & differential screw jack, rolling resistance.

UNIT 4. PROPERTIES OF SURFACES AND SOLIDS (9+3)

Centroid of simple figures from first principle, centroid of composite sections - Centre of Gravity and its implications - Area moment of inertia - Definition, Moment of inertia of plane sections from first principles, Theorems of moment of inertia, Moment of inertia of standard sections (T section and I section) - Mass moment inertia of circular plate, Cylinder, Cone, Sphere- Principal moment of inertia.

UNIT 5. DYNAMICS (9+3)

Review of particle dynamics - Displacements, velocity and acceleration, their relationship - Equations of motions - Rectilinear motion- Plane curvilinear motion - Newton’s 2nd law- Impulse, momentum, impact - D’Alembert’s principle and its applications in plane motion and connected bodies - Work energy principle and its application in plane motion of connected bodies - Virtual Work and Energy Method - Virtual displacements, principle of virtual work for particle and ideal system of rigid bodies.

TEXT BOOK(S):

1. Beer, F.P., and Johnson, E.R., Vector Mechanics for Engineers – Statics and Dynamics, McGraw Hill, Tenth Edition in SI units.

REFERENCE(S):

1. Merriam, J.L., Engineering Mechanics, Volume I – Statics, and Volume – II, Dynamics 2/e, Wiley International, Seventh Edition.
2. Irving, H., Shames, Engineering Mechanics, Statics and Dynamics, Prentice Hall of India Ltd., Fourth Edition.

CSE18R171	PROGRAMMING FOR PROBLEM SOLVING	L	T	P	Credit
		3	1	2	5
Pre-requisite : NIL		**Course Category :** Basic Engineering **Course Type :** Integrated Course			

Course Objectives:

To make the students to understand the basic concepts of programming language, rules to be followed while writing a program and how to compile and execute C programs.

Course Outcomes:

CO1 : Understand the basic programming concepts and syntax of C language
CO2 : Develop efficient code using pointers, arrays and dynamic memory allocation
CO3 : techniques
CO4 : Create user defined data types and functions to solve given problems.
CO5 : Design an efficient algorithm for a given problem
CO6 : Build efficient code to solve the real world problem
CO7 : Elucidate the programming constructs of C during interviews

CO, PO and PSO Mapping:

COs/POs/PSOs	POs												PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO 1	S	S		S					M	M			S	S		
CO 2		S		S		M	M						S	S		
CO 3	S	S			M		S	S	M		M	M			S	
CO 4	S	S	S								S	S	S	M	S	M
CO 5		S		S	S		M						S		S	M
CO 6	S	S		M		S					S	M				S

UNIT 1: INTRODUCTION TO PROGRAMMING **12 hours**

Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.), Idea of Algorithm: steps to solve logical and numerical problems. Representation of Algorithm: Flowchart/ Pseudocode with examples, From algorithms to programs; source code, variables (with data types) variables and memory, locations, Syntax and Logical Errors in compilation, object and executable code, Arithmetic expressions and precedence, Conditional Branching and Loops, Writing and evaluation of conditionals and consequent branching, Iteration and loops.

UNIT 2: ARRAYS AND STRINGS **12 hours**

Introduction - One dimensional and two dimensional arrays – Declaration of arrays – Initializing and Accessing array elements – Strings: One dimensional character arrays - Declaration and String Initialization - String Manipulation - Multidimensional Arrays - Arrays of Strings

UNIT 3: BASIC ALGORITHMS **12 hours**

Searching, Basic Sorting Algorithms (Bubble, Insertion and Selection), Finding roots of equations, notion of order of complexity through example programs (no formal definition required).

UNIT 4: FUNCTION **12 hours**

Functions (including using built in libraries), Parameter passing in functions, call by value, Passing arrays to functions: idea of call by reference, Recursion, Recursion, as a different way of solving problems. Example programs, such as Finding Factorial, Fibonacci series, Ackerman function etc. Quick sort or Merge sort.

UNIT 5: STRUCTURE, POINTERS & FILE HANDLING **12 hours**

Structures, Defining structures and Array of Structures, Idea of pointers, Defining pointers, Use of Pointers in self-referential structures, notion of linked list (no implementation), File handling (only if time is available, otherwise should be done as part of the lab).

TEXT BOOKS:

(i) Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill
(ii) E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill

REFERENCES:

(i) Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall of India

LIST OF EXPERIMENTS **15 hours**

Tutorial 1: Problem solving using computers:
Lab1: Familiarization with programming environment
Tutorial 2: Variable types and type conversions:
Lab 2: Simple computational problems using arithmetic expressions

Tutorial 3: Branching and logical expressions:
Lab 3: Problems involving if-then-else structures
Tutorial 4: Loops, while and for loops:
Lab 4: Iterative problems e.g., sum of series
Tutorial 5: 1D Arrays: searching, sorting:
Lab 5: 1D Array manipulation
Tutorial 6: 2D arrays and Strings
Lab 6: Matrix problems, String operations
Tutorial 7: Functions, call by value:
Lab 7: Simple functions
Tutorial 8 &9: Numerical methods (Root finding, numerical differentiation, numerical integration):
Lab 8 and 9: Programming for solving Numerical methods problems
Tutorial 10: Recursion, structure of recursive calls
Lab 10: Recursive functions
Tutorial 11: Pointers, structures and dynamic memory allocation
Lab 11: Pointers and structures
Tutorial 12: File handling:
Lab 12: File operations

MEC18R152	**ENGINEERING PRACTICE**	**Credits**			
		L	**T**	**P**	**Total**
		3	**0**	**2**	**3**
Pre-requisite: Nil		**Course Category:** Basic Engineering **Course Type:** Theory with Practical			

Lectures & videos:

Detailed contents

1. Manufacturing Methods- casting, forming, machining, joining, advanced manufacturing methods **(3 lectures)**
2. CNC machining, Additive manufacturing **(1 lecture)**
3. Fitting operations & power tools **(1 lecture)**
4. Carpentry **(1 lecture)**
5. Plastic moulding, glass cutting **(1 lecture)**
6. Metal casting **(1 lecture)**
7. Welding (arc welding & gas welding), brazing **(1 lecture)**

Suggested Text/Reference Books:

(i) Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., "Elements of Workshop Technology", Vol. I 2008 and Vol. II 2010, Media promoters and publishers private limited, Mumbai.

(ii) Kalpakjian S. And Steven S. Schmid, "Manufacturing Engineering and Technology", 4th edition, Pearson Education India Edition, 2002.
(iii)Gowri P. Hariharan and A. Suresh Babu,"Manufacturing Technology – I" Pearson Education, 2008.
(iv) Roy A. Lindberg, "Processes and Materials of Manufacture", 4th edition, Prentice Hall India, 1998.
(v) Rao P.N., "Manufacturing Technology", Vol. I and Vol. II, Tata McGrawHill House, 2017.

Course Outcomes

Upon completion of this course, the students will gain knowledge of the different manufacturing processes which are commonly employed in the industry, to fabricate components using different materials.

Workshop Practice:

1. Machine shop **(10 hours)**
2. Fitting shop **(8 hours)**
3. Carpentry **(6 hours)**
4. Welding shop **(8 hours (Arc welding 4 hrs + gas welding 4 hrs)**
5. Casting **(8 hours)**
6. Smithy **(6 hours)**
7. Plastic moulding & Glass Cutting (6 hours)

Examinations could involve the actual fabrication of simple components, utilizing one or more of the techniques covered above.

Laboratory Outcomes

- Upon completion of this laboratory course, students will be able to fabricate components with their own hands.
- They will also get practical knowledge of the dimensional accuracies and dimensional tolerances possible with different manufacturing processes.
- By assembling different components, they will be able to produce small devices of their interest.

BME18R101	**CELL BIOLOGY AND GENETICS**	**L**	**T**	**P**	**Credit**
		3	**1**	**0**	**4**
Pre-requisite: Nil		**Course Category:** Basic Engineering **Course Type:** Theory			

Objective(s): To understand the basic concepts of cell, microscopes and genetics

Course Outcome(s)

CO1 Distinguish prokaryotic cell from eukaryotic cell and describe the structure and function of different parts of a eukaryotic cell

CO2 Explain the mitosis and meiosis cell division and the consequences

CO3 Explain different types of microscopes and their main uses

CO4 Appreciate the discovery of Mendelian laws

CO5 Describe the culture media for cell and tissue culture and the growth of new tissues invitro.

Mapping of COs, POs and PSOs:

COs	POs												PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	H	M											M			
CO2	M	L					L	L					M			
CO3		M			M	L								L		
CO4	M					L	L	L						M		L
CO5		M			M											

UNIT I - STRUCTURE AND FUNCTION OF CELL ORGANELLES (9 HOURS)

History of cell - Development of cell theory - General organization of eukaryotic cell - Organization of cell membrane, Cell permeability, Differentiations of the cell membrane -Intercellular communications and Gap junctions, Cytoskeleton and cell motility - Microtubules, microfilaments and intermediate filaments, Endoplasmic reticulum and protein segregation, Golgi complex and cell secretion - Lysosomes, endocytosis, coated vesicles, endosomes and peroxisomes, Mitochondria and Oxidative Phosphorylation, nucleus, ribosomes- nucleolus, chromatin and chromosomes.

UNIT II - CELL CYCLE AND CELL DIVISION (9 HOURS)

The cell cycle, Regulation - Role of cyclins and Cdks, Cell cycle check points, General description and different stages of mitosis and meiosis, Functional role of mitotic apparatus, Consequences of meiosis and types of meiosis, difference between mitosis and meiosis.

UNIT III – CELL SIGNALING (9 HOURS)

Signaling molecules and their receptors, functions of cell surface receptors, Pathways of intracellular signal transduction, Role of Cytoskeleton in signal transduction.

UNIT IV - HUMAN GENETICS (9 HOURS)

The human chromosome, Mendelian Laws, chromosome abnormalities - Genotype and allelic frequencies-Inborn-errors of metabolism - polygenic and multifactorial inheritance, Sex determination - Role of Y chromosome - Mutation - Gene mutation.

UNIT V - CELL AND TISSUE CULTURE (9 HOURS)

Introduction, primary and established cell lines, Kinetics of cell growth, Interaction among cells, genetics of cultured cells, Metabolism, Animal cell and tissue culture, Animal tissue culture media, biology of Stem cells, apoptosis, cell to cell interaction and communication.

TEXT BOOKS

1. De Robertis, E.D.P. and De Robertis, E.M.F., Cell and Molecular Biology, Lippincott Williams & Wilkins, Philadelphia, USA, 8th Edition, 2010.

2. Gerald Karp, Cell and Molecular Biology - Concepts and Experiments, John Wiley & Sons, USA, 7th Edition, 2013.
3. Gardner, E.J., Simmons, M.J. Snustad, D.P. Principles of Genetics Wiley-India Ltd, New Delhi , 8th Edition, 2008.
4. John Kuo, Electron Microscopy: Methods and Protocols, Humana Press, 3rd Edition 2013
5. Strachan, T., and Read A.P. Human Molecular Genetics, Garland Publishing, 3rd Edition, 2004.
6. Gupta.M.L, and Jangir.M.L.,Cell biology – fundamentals and Applications, 2nd edition, 2001

THEORY COURSES

BME18R201 HUMAN ANATOMY AND PHYSIOLOGY	L	T	P	Credit
	3	0	0	3
Pre-requisite: Nil	**Course Category:** Program core			
	Course Type: Theory			

Objective(s)

- Know basic structural and functional elements of human body.
- Learn organs and structures involving in system formation and functions.
- Understand all systems in the human body.

Course Outcome(s)

At the end of this course, students will be able to

CO1 Describe basic building blocks of human body and can identify the anatomical position of each organs.

CO2 Explain different types and properties of muscular and skeletal system

CO3 Categorize the organs and its functions associated with circulation of blood

CO4 Demonstrate the passage of neural signals within the human body

CO5 Compare the physiology of the special senses and can describe the mechanism involved in Urinary system.

Mapping of CO and PO:

	POs												PSO			
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**
CO1	M	M											M			
CO2	M	M											M			
CO3	M	M											M			
CO4	M	M											M			
CO5	M	M											M			

UNIT I - CELL, TISSUE AND ORGANS (9 HOURS)

Membrane potential, Nernst equation, GHK equation, Action Potential. Introduction to human body, Anatomical position: terminology, regions and planes. Blood Cells - RBC, WBC, Platelets, Blood grouping and Blood Transfusion, Immune Response.

UNIT II - MUSCULAR AND SKELETAL SYSTEM (9 HOURS)

Muscular System: Type of muscles, properties of muscles (excitability and contractility, all or none law, refractory period, fatigue and elasticity)

Skeletal System & Joints: Types of bones, classification, Structure and composition of bone, cartilage, tendon, ligament, Classification of joints, structure of synovial joint, major joints of the body

UNIT III - CARDIAC AND RESPIRATORY SYSTEM (9 HOURS)

Circulatory System: Structure and function of heart, blood vessels, Heart valves and sounds, Cardiac cycle, Cardiac output, Coronary, systematic and pulmonary circulation, Blood Pressure and feedback control

Respiratory system: Respiratory pathways (upper and lower), Mechanism of respiration, respiratory membrane and gaseous exchange, Pulmonary function test, feedback control mechanism of respiration.

UNIT IV - NERVOUS SYSTEM (9 HOURS)

Structure of a Neuron - Types of Neuron. Synapses and types. Conduction of action potential in neuron.

Brain – Divisions of brain lobes and its functions - EEG.

Spinal cord – Tracts of spinal cord - Reflex mechanism - Types of reflex. Autonomic nervous system and its functions.

UNIT V - URINARY AND SPECIAL SENSORY SYSTEM (9 HOURS)

Urinary system: Structure of Kidney and Nephron. Mechanism of Urine formation and acid base regulation - Urinary reflex - Skin and sweat glands - Homeostasis

Special senses: Structure of Eye - Retina - Photochemistry of Vision - Accommodation Neurophysiology of Vision - EOG. Structure and functions Internal Ear - Mechanism of Hearing - Auditory pathway, Hearing Tests.

TEXT BOOKS:

1. Ross and Wilson,"Anatomy and Physiology in Health and Illness", ELBS pub, 2010.
2. Guyton and Hall,"Textbook of Medical Physiology, 12th ed.", Saunders, 2011.
3. Tortora and Grabowski,"Principles of Anatomy and Physiology", Wiley, 2011.

REFERENCES:

1. Gillian Pocock, Christopher D. Richards, The human Body – An introduction for Biomedical and Health Sciences, Oxford University Press, USA, 2009
2. William F.Ganong, "Review of Medical Physiology", 22nd Edition, Mc Graw Hill, New Delhi, 2005
3. Eldra Pearl Solomon, "Introduction to Human Anatomy and Physiology", W.B. Saunders Company, Harcourt Brace Jovanovich, 2003.

BME18R202	CLINICAL BIOCHEMISTRY	L	T	P	Credit
		3	0	0	3
Pre-requisite: Nil		**Course Category:** Program core **Course Type**: Theory			

Objective(s)

Introduce the students about applying the principles of chemistry with carbohydrates, lipids, protein, nucleic acids, hormones, and enzymes in the biological systems.

Course Outcome(s)

The Student will be able to

CO1 Describe the principles governing the complex interactions of chemicals in living system

CO2 Understand the importance of carbohydrates and vitamins in cellular machinery

CO3 Describe the structure of proteins and elucidate the clinical significance of biological catalysts

CO4 Understand the structure of various lipids and its derivatives with their implications in physiology

CO5 Elucidate the different bonds and structural components of nucleic acids

	POs												PEOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	M	M				M							H	M		L
CO2	M	M				M							H	M		L
CO3	M	M				M							H	M		L
CO4	M	M				M							H	M		L
CO5	M	M				M							H	M		L

UNIT I - BASIC PRINCIPLES AND CHEMISTRY OF LIFE (9 HOURS)

Solution of non electrolytes & Electrolytes: Concentration expressions, ideal solutions, colligative properties. Arrhenius theory, Bonds: ionic bonding, Ion-dipole, covalent, H-bonds, Vander Waal's interaction, Hydrophobic and hydrophilic interactions. Water as a biological solvent; Calculation of pH, Henderson-Hasselbalch equation, concept and strength of buffer, acid-base balance; isotopes and their use in medicine and medical imaging.

UNIT II - CARBOHYDRATES AND VITAMINS (9 HOURS)

Classification and structure of monosaccharides, disaccharides, Polysaccharides: structural polysaccharides and storage polysaccharides. Reactions of monosachharides.–Disorders of carbohydrate metabolism. Diagnosis of diabetes mellitus. Carbohydrate chemistry in blood typing. Vitamins, Fat soluble and water soluble vitamins; Classification, structures and physiological functions.

UNIT III – AMINOACIDS, PROTEINS AND ENZYMES (9 HOURS)

Structure and characteristics of amino acids. Peptide bond. Structural organization of proteins - primary, secondary, tertiary, quaternary and subunit structure of protein - Conformation of proteins: Globular and fibrous proteins. Disorders of amino acid metabolism. Diagnostic enzymes: Clinical significance of Asparatate aminotransferase, Alanine aminotransferase, Lactate dehydrogenase.

UNIT IV – LIPIDS AND HORMONES (9 HOURS)

Structure, and properties classification of lipids, fatty acids, triglycerides, waxes, phospholipids, cerebrosides, lipoproteins and gangliosides- Prostaglandins and their physiological implications- Steroids and bile acids. Disorders of lipid metabolism. Hormones and their biological functions.

UNIT V - NUCLEIC ACIDS (9 HOURS)

Structure of purines, pyrimidine, nucleosides and nucleotides - phosphodiester and hydrogen bonds. Histones - Watson and Crick model of DNA, Types of RNA. Disorders of purine and pyrimidine metabolism, diagnosis of genetic disorders.

TEXT BOOKS:

1. Nelson.D.L, Cox. M. M., Lehningers Principle of biochemistry, 5th ed. Freeman, 2008.
2. Murray. R.K., Granner, D.K., Mayes. P. A. and Rodwell, V.W., Harpers Biochemistry, McGraw Hill, 27th Edition, 2006.

REFERENCES:

1. Berg. J.M., Tymoczko.J.L., Stryer, L., Biochemistry, Freeman, 6th edition, 2006.
2. Harper's Biochemistry 26th edition. McGraw Hill,2003
   Voet, D., Voet, G., Biochemistry, John Wiley and Sons, Singapore, 3rdEdition, 2001.
3. Berg. J.M., Tymoczko.J.L., Stryer, L., Biochemistry, Freeman, 6th edition, 2006.
4. Harper's Biochemistry 26th edition. McGraw Hill,2003
5. Voet, D., Voet, G., Biochemistry, John Wiley and Sons, Singapore, 3rdEdition, 2001.

BME18R301 DIAGNOSTIC AND THERAPEUTIC EQUIPMENTS	**L**	**T**	**P**	**Credit**
	3	**0**	**0**	**3**
Pre-requisite: BME18R252 **Course Category:** Program core **Course Type**: Theory				

Objective(s)

To know the various bio-potential recordings so as to enable students to record various bio-signals.

Course Outcome(s)

CO1 To know the various functional blocks present is cardiac care units so that the students can handle these equipments with care and safety.

CO2 Understand the medical devices applied in measurement of parameters related to cardiology, neurology and the methods of continuous monitoring and transmitting them.

CO3 Learn to measure the signals generated by muscles

CO4 Apply the knowledge of communication engineering in medical field.

CO5 Understand the need and use of some of the extracorporeal devices, thermography and laser equipments.

Mapping of Co and Po:

COs	POs												PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1		L	L											L		
CO2		M		M										M		
CO3		L														
CO4	L	H	M		M	H	M					L	L	M		L
CO5	M	M	M	M	H		M					L	M	H		L

UNIT I CARDIAC EQUIPMENT (9 HOURS)

Electrocardiograph, Normal and Abnormal Waves, Heart rate monitor, Holter Monitor, Phonocardiography, Plethysmography. Cardiac Pacemaker- Internal and External Pacemaker– Batteries, AC and DC Defibrillator- Internal and External.

UNIT II NEUROLOGICAL EQUIPMENT (9 HOURS)

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

UNIT II SKELETAL MUSCULAR EQUIPMENT (9 HOURS)

Generation of EMG, recording and analysis of EMG waveforms, fatigue characteristics, Muscle stimulators, nerve stimulators, Nerve conduction velocity measurement, EMG Bio Feedback Instrumentation.

UNIT IV PATIENT MONITORING AND BIOTELEMETRY (9 HOURS)

Patient monitoring systems, ICU/CCU Equipments, Infusion pumps, bed side monitors, Central consoling controls. Radio Telemetry (single, multi), Portable and Landline Telemetry unit, Applications in ECG and EEG Transmission.

UNIT V EXTRA CORPOREAL DEVICES AND SPECIAL DIAGNOSTIC TECHNIQUES (9 HOURS)

Need for heart lung machine, functioning of bubble, disc type and membrane type oxygenerators, finger pump, roller pump, electronic monitoring of functional parameter. Hemo Dialyser unit, Lithotripsy, Principles of Cryogenic technique and application, Endoscopy, Laproscopy. Thermography – Recording and clinical application, ophthalmic instruments.

TEXT BOOKS

1. Khandpur R.S, “Handbook of Biomedical Instrumentation”, Tata McGraw Hill, New Delhi, 2014.

REFERENCES

1. Myer Kutz, “Standard Handbook of Biomedical Engineering & Design”, Mc Graw Hill, 2003.
2. L.A Geddes and L.E.Baker, “Principles of Applied Biomedical Instrumentation”, 3rd Edition, 2008

3. Leslie Cromwell, "Biomedical Instrumentation and Measurement", Pearson Education, New Delhi, 2007.
4. Antony Y.K.Chan, "Biomedical Device Technology, Principles and design", Charles Thomas
5. Publisher Ltd, Illinois, USA, 2008.
6. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", Pearson education, 2004.
7. John G.Webster, "Medical Instrumentation Application and Design", third edition, John Wiley and Sons, New York, 2006.

BME18R401 BIOMEDICAL IMAGE PROCESSING AND ANALYSIS	**L**	**T**	**P**	**Credit**
	3	**0**	**0**	**3**
Pre-requisite: Biomedical Signal Processing BME18R371	**Course Category:** Program core **Course Type**: Theory			

Objective(s) It presents a systematic overview of principles and systems of biomedical imaging and fundamental image processing and visualization methods. equip with knowledge to select proper imaging modalities for specific clinical and research purposes, with the understanding of their strengths and limitations.

Course Outcome(s)

CO1 Understand x-ray, ultrasound, and magnetic resonance interactions with tissue and the various components of imaging systems.

CO2 Use fundamentals of mathematics and physics to analyze image data.

CO3 Understand modern imaging devices and their application in medicine and industry.

CO4 Demonstrate understanding of image data collection, resolution, reconstruction, storage, processing, visualization, fusion, and communication.

CO5 Develop a competence in the Fundamental analytical and computational tools used in medical imaging.

Mapping of Co and Po:

	POs												**PSOs**			
	1	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**3**	**4**
CO1	H	H			L								H			
CO2	H	H											H			
CO3					H	L	L							M		L
CO4			L	M	H	M						L		M		L
CO5	H	L	M	M	H	M							H			

UNIT I DIGITAL IMAGE FUNDAMENTAL (15 HOURS)

Elements of digital image processing systems, Elements of Visual perception, Image sampling and quantization, – Some Basic relationships between pixels, Matrix and Singular Value representation of discrete images.

UNIT II IMAGE TRANSFORMS (15 HOURS)

1D DFT, 2D DFT, Cosine, Sine Hadamard, Haar, Slant, KL transform and their properties.

UNIT III IMAGE ENHANCEMENT (15 HOURS)

Histogram – Modification and specification techniques, Enhancement by point processing Image smoothening,Image sharpening, generation of spatial masks from frequency domain specification, Homomorphic filtering,and color image processing.

UNIT IV IMAGE RESTORATIONAND RECONSTRUCTION OF MEDICAL IMAGES

(15 HOURS)

Image degradation models, Unconstrained and Constrained restoration, inverse filtering, Least mean square filter, Image reconstruction from projections – Radon transforms, Filter back projection algorithm, 3D tomography, Fourier reconstruction of MRI Images.

UNIT V MEDICAL IMAGE COMPRESSION TECHNIQUES (15 HOURS)

Run length, Huffman coding, arithmetic coding, Pixel coding, transform coding, JPEG Standard, predictive techniques, Application of image processing techniques in thermography, SPECT, PET images.

TEXT BOOKS

1. Rafael C., Gonzalez and Richard E. Woods, Digital Image Processing, Pearson Education Asia, 2001
2. Anil K. Jain, Fundamentals of Digital Image Processing, Prentice Hall of India, 1997.

REFERENCE BOOKS

1. William K. Pratt, Digital Image Processing, John Wiley, NJ, 1987.
2. Albert Macouski, Medical Imaging systems, Prentice Hall, New Jersey.1983.
3. Sid Ahmed M.A., Image Processing Theory, Algorithm and Architectures, McGraw Hill, 1995.

THEORY WITH PRACTICE

BME18R251	BIOCONTROL SYSTEMS	L	T	P	Credit
		3	0	1	3.5

Pre-requisite: NIL

Course Category: Program core

Course Type: Theory with practical

Objective(s)

Analyze the time and frequency domains of the given system using different mathematical techniques.

Course Outcome(s)

CO1 Demonstrate an understanding of mathematical techniques applied in realizing any physical system

CO2 Analyze and evaluate any given system in the time domain by applying time-domain specifications

CO3 Understand the various methodologies followed in state-space representation of a system

CO4 Understand and perform complex frequency domain analysis/response of a higher order control system, with the virtue of analyzing the gain and stability of the system

CO5 Model physiological control system using generalized system properties and elements.

Mapping of COs and POs

	POs												PSO			
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**
CO1	H												H			
CO2	H	H			M				H	H			H	L	H	
CO3	H	H							H	H			H		H	
CO4	H	H			M				H	H			H	L	H	
CO5	M												L			

UNIT I MODELING OF SYSTEMS (12 HOURS)

Terminology and basic structure of control system, example of a closed loop system. Laplace transforms - Definition-Properties-Laplace transform of periodic functions-Laplace transform of unit step function, Impulse function -Inverse Laplace transform. Transfer functions, modeling of electrical systems, translational and rotational mechanical systems, and electromechanical systems, block diagram and signal flow graph

representation of systems, conversion of block diagram to signal flow graph, reduction of block diagram and signal flow graph.

UNIT II TIME RESPONSE ANALYSIS (12 HOURS)

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

UNIT III STABILITY AND STATE SPACE ANALYSIS (12 HOURS)

Definition of stability, Routh- Hurwitz criteria of stability, root locus technique, construction of root locus and study of stability, definition of dominant poles and relative stability. State Space Theory: Introduction, State & state variables, Selection of state variables, state model, Non-homogenous solution, converting a transfer function to a state model.

UNIT IV FREQUENCY RESPONSE ANALYSIS (12 HOURS)

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

UNIT V PHYSIOLOGICAL CONTROL SYSTEM (12 HOURS)

Example of physiological control system: Thermoregulatory system, muscle stretch reflex, difference between engineering and physiological control systems, generalized system properties, models with combination of system elements, linear models of physiological systems-Examples

TEXT BOOKS

1. M. Gopal "Control Systems Principles and Design", Tata McGraw Hill, 2002 (Units I, II, III & IV).
2. Michael C K Khoo, "Physiological Control Systems", IEEE Press, Prentice Hall of India, 2001(Unit V).

REFERENCES

1. Benjamin C.Kuo, "Automatic control systems", john wileys's and sons, 9th edition 2009. ISBN: 9788126552337.
2. John Enderle Susan Blanchard, Joseph Bronzino "Introduction to Biomedical Engineering", second edition, Academic Press, 2005.
3. Richard C. Dorf, Robert H. Bishop, "Modern control systems", Pearson, 2004.

PRACTICAL

- Closed loop control of ac,dc servo motor, tachogenerator and synchros using MATLAB Software.
- Time Response using MATLAB Software.
- Root locus technique by MATLAB Software.
- Bode plot using MATLAB Software.

- Frequency response analysis using MATLAB Software.

BME18R252 BIOMEDICAL INSTRUMENTATION	L	T	P	Credit
	3	0	1	3.5
Pre-requisite: Basic Electrical and Electronics Engineering EEE18R171 **Course Category:** Program core **Course Type**: Theory with Practice				

Objective(s)

To gain basic knowledge about Bio potentials, Bio electrodes and bioamplifiers and to give a complete exposure of various recording mechanism and to understand the basic principles, working of biomedical instruments.

Course Outcome(s)

CO1 To learn several signals that can be measured from the human body.
CO2 To study different types of electrodes used in bio-potential recording.
CO3 To understand how noise from the environment, instruments and other physiologic systems can create artifacts in instrumentation.
CO4 To understand the theory of how several sensors operate and use these sensors in practical.
CO5 To design the medical instrument to measure non electrical and analytical parameters.

Mapping of Cos and POs

COs	POs												PEOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	L												L			
CO2	L	L											L			
CO3	M	M											M	L		
CO4	M	M											M	L		
CO5	H	H	H	M		L	L	L						H		

UNIT I BIOPOTENTIAL AND ELECTRODES (9 HOURS)

Components of Medical Instrumentation System- Basic Cell Functions, Origin of Biopotentials, Electrical Activity of Cells, Electrode-Electrolyte interface, half cell potential, Polarization- polarizable and non-polarizable electrodes, Ag/AgCl electrodes, Electrode and Skin interface and motion artifact. Body Surface recording electrodes for ECG, EMG, EEG.

UNIT II BIOELECTRIC SIGNALS RECORDING AND BIOAMPLIFIERS

(9 HOURS)

Recording of ECG, EEG and EMG - Einthoven triangle, Standard 12-lead configurations - ECG Machine - EMG machine – 10-20 electrodes placement system for EEG - EEG machine. Bioamplifiers- Carrier Amplifier, - Isolation Amplifier - Differential amplifier - Chopper Amplifier - Instrumentation Amplifier

UNIT III MEASUREMENT OF NON-ELECTRICAL PARAMETERS (9 HOURS)

Human body Temperature, Measurement of blood pressure – Cardiac output – Heart rate – Heart sound – Pulmonary function measurements – spirometer – Photo Plethysmography, Body Plethysmography – Blood Gas analysers : finger-tip oxymeter - ESR, GSR measurements.

UNIT IV LIFE SUPPORT INSTRUMENTS (9 HOURS)

Pacemaker-Types of Pacemaker, mode of pacing and its application, Defibrillator-AC and DC Defibrillators and their application, Heart Lung machine and its application during surgery, Haemodialysis system and the precautions to be taken during dialysis.

UNIT V ANALYTICAL INSTRUMENTAION AND ELECTRICAL SAFETY

(9 HOURS)

Principle of colorimetry, photometry and pH measurement. Spectrophotometer; Spectro fluoro meter; pH meter. Blood Cell counter; Biochemical analyzers; Na-K analyzer Physiological effects of electrical current, Shock Hazards from electrical equipment and methods of accident prevention

TEXT BOOK

1. Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw Hill, New Delhi, 2014.

REFERENCES

1. Leslie Cromwell, "Biomedical Instrumentation and Measurement", Prentice Hall of India, New Delhi, 2007
2. John G. Webster, "Medical Instrumentation Application and Design", John Willey and Sons, 2009.
3. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", Pearson Education, 2004.
4. L.A Geddas and L.E.Baker "Principles of Applied Biomedical Instrumentation" 2004.
5. John G. Webster, "Bioinstrumentation", John Willey and sons, New York, 2004.
   Myer Kutz "Standard Handbook of Biomedical Engineering & Design", McGraw-Hill Publisher, 2003.

PRACTICALS

- Recording of ECG, EEG and EMG.
- Design of Biological preamplifier.
- Optical Isolation amplifier.
- Recording of various physiological parameters using patient monitoring system.
- pH measurement.

BME18R351 BIOMECHANICS	L	T	P	Credit
	3	0	1	3.5
Pre-requisite: BME18R201	**Course Category:** Program core **Course Type**: Theory with practical			

Objective(s)

- Be exposed to principles of mechanics of physiological systems.
- Be familiar with the mathematical models used in the analysis of biomechanical systems.

Course Outcome(s)

At the end of this course, students will be able

CO1 To describe movement (kinematics) and to consider the role of force in movement (kinetics)
CO2 Analyze the mechanical principles of biofluids
CO3 Illustrate the techniques behind Biosolid mechanics
CO4 Design devices to meet the orthopaedic applications.
CO5 Model new devices to meet many applications considering ergonomics.

Mapping of COs and POs

Cos	POs												PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	M	L	H	H		M	M	L				M	M	H		L
CO2	M	M	H	M	M	H	L				L	M	M	H		M
CO3	L	L	M		M		M						L	M		
CO4	M	H	H		M	H	L					L		H		L
CO5	M	M	H		H	H						M	M	H		M

UNIT I INTRODUCTION TO MECHANICS (12 HOURS)

Principles of Mechanics, Vector mechanics, Mechanics of motion - Newton's laws of motion, Kinetics, Kinematics of motion, Fluid mechanics – Euler equations and Navier Stoke's equations, Viscoelasticity, Constitutive equations, Stress transformations, Strain energy function.

UNIT II BIOFLUID MECHANICS (12 HOURS)

Introduction, viscosity and capillary viscometer, Rheological properties of blood, laminar flow, Couette flow and Hagen-poiseuille equation, turbulent flow. Cardiovascular system - biological and mechanical valves development, artificial heart valves testing of valves, Structure, functions, material properties and modeling of Blood vessels.

UNIT III BIOSOLID MECHANICS (12 HOURS)

Hard Tissues: Bone structure & composition mechanical properties of bone, cortical and cancellous bones, viscoelastic properties, Maxwell & Voight models – anisotropy. Soft Tissues: Structure, functions, material properties and modeling of Soft Tissues: Cartilage, Tendon, Ligament, Muscle.

UNIT IV BIOMECHANICS OF JOINTS AND IMPLANTS (12 HOURS)

Skeletal joints, forces and stresses in human joints, Analysis of rigid bodies in equilibrium, free body diagrams, types of joint, biomechanical analysis of elbow, shoulder, spinal column, hip knee and ankle. Design of orthopedic implant, specifications for a prosthetic joint, biocompatibility, requirement of a biomaterial, characteristics of different types of biomaterials, manufacturing process of implants, fixation of implants.

UNIT V MODELLING AND ERGONOMICS (12 HOURS)

Introduction to Finite Element Analysis, Analysis of bio mechanical systems using Finite element methods, Graphical design. Ergonomics- Gait analysis, Design of work station, Sports biomechanics, Injury mechanics.

TEXT BOOKS

1. Duane Knudson, "Fundamentals of Biomechanics", Second Edition Springer Science+Business Media, 2007
2. Marcelo Epstein, "The Elements of Continuum Biomechanics", ISBN: 978-1-119-99923-2, 2012.
3. Fung, Y.C. "Biomechanics Mechanical Properties of Living Tissues", New age international, ISBN: 978-81-8128-811-0, 2007

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.

PRACTICAL

- Tissue Mechanics
- Biomaterial Testing
- Posture Analysis
- Gait Analysis
- Cardiovascular Implant Testing
- Exercise Biomechanics

BME18R352 PATHOLOGY AND MICROBIOLOGY	L	T	P	Credit
	3	0	1	3.5
Pre-requisite: NIL	**Course Category:** Program core			
	Course Type: Theory			

Objective(s)

1. Attain knowledge on the structural and functional aspects of microorganisms that interferes with the health of living organisms.
2. Know the etiology and remedy in treating the pathological diseases.

Course Outcome(s)

At the end of this course, students will be able to

CO1 Illustrate the different types of Cell degeneration, how and when it gets repaired

CO2 Demonstrate the different pathologic conditions related to the body fluids

CO3 Compare the structure and function of different types of microorganisms.

CO4 Demonstrate the various culture techniques for growing microbes and to visualize them through staining

CO5 Interpret the response of human body when a microbe enters the human system and the techniques to confirm the presence of microbe.

Mapping of COs and POs

	POs												PSOs			
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**
CO1	M	M											M			
CO2	M	M											M			
CO3	M	M											M			
CO4					M	H								M		
CO5					M	H								M		

UNIT I - CELL DEGENERATION, REPAIR AND NEOPLASIA (9 HOURS)

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 tumors, carcinogenesis, spread of tumors. Autopsy and biopsy.

UNIT II - FLUID AND HEMODYNAMIC DERRANGEMENTS (9 HOURS)

Edema, normal hemostasis, thrombosis, disseminated intravascular coagulation, embolism, infarction, shock. Hematological disorders - Bleeding disorders, Leukaemias, Lymphomas.

UNIT III - STRUCTURE AND FUNCTION OF MICRO ORGANISMS (9 HOURS)

Structure of the bacterial cell wall, appendages of bacteria - Pili and flagella, capsule, slime and bacterial endospores, Over view of Viruses, Structure and classification, multiplication of fungi, Life history of yeast and bacteriophages.

UNIT IV - MICROBIAL GROWTH (9 HOURS)

Growth curve of bacteria, identification of bacteria , culture media and its types , culture techniques and observation of culture. Principle of Light and electron Microscope. Staining techniques: Simple, Gram and AFB staining.

UNIT V - IMMUNOLOGY (9 HOURS)

Natural and artificial immunity; Innate and acquired immunity, opsonization, phagocytosis, inflammation, Immune deficiency syndrome, antibodies and its types; antigen and antibody reactions, immunological techniques: immune diffusion, immuno electrophoresis, RIA and ELISA, monoclonal antibodies. Disease caused by bacteria, fungi, protozoal, virus and helminthes.

TEXT BOOKS

1. Ramzi S Cotran, Vinay Kumar & Stanley L Robbins, "Pathologic Basis of Diseases", 7th edition, WB Saunders Co. 2005 (Units I & II).
2. Prescott, Harley and Klein, "Microbiology", 7th edition, McGraw Hill, 2007 (Units III, IV and V).

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.

PRACTICALS

- Urine physical and chemical examination (protein, reducing substances, ketones, bilirubin and blood)
- Histopathological slides of benign and malignant tumours.
- Haematology slides of anemia and leukemia
- Slides of malarial parasites, micro filaria and leishmania donovani.
- Various staining techniques: Simple, Gram and AFB staining.
- Manual paraffin tissue processing and section cutting (demonstration)

INTEGRATED THEORY WITH PRACTICAL

BME18R271 ANALOG AND DIGITAL ELECTRONICS	L	T	P	Credit
	3	0	2	4
Pre-requisite: Nil	**Course Category: Program core**			
	Course Type: Integrated Course			

Objective(s)

1. To provide an overview of principle, operation and application of analog building blocks like BJT, FET and MOSFET for performing various functions.
2. To understand, analyze and design new circuit based medical devices utilizing both analog and digital integrated circuits.

Course Outcome(s)

At the end of this course, students will be able

CO1 To analyze the characteristics and various configurations of BJT, FET and MOSFET
CO2 To discuss the principles of feedback amplifiers and utilization of oscillators
CO3 To study the circuit configuration and practical applications of linear integrated circuits
CO4 To learn the number systems and to design various combinational digital circuits using logic gates
CO5 To design sequential logic circuit using state table and state diagram.

Mapping of COs and POs

	POs												PSO			
COs	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	M	M	H			L	M	M	H	M	M		M	L		
CO2	M	H	H	H		L	M	L	H	M	M	M	M	L		
CO3	M	H	H	H		L	L	L	H	M	M	M	M	H		
CO4	M	H	H	M		L	L	L	H	M	M	M	M	H		
CO5	M	H	H	H									M	H		

UNIT I BJT & FET AMPLIFIERS (9 Hours)

Fundamentals of Diodes and Transistors - biasing circuits for BJT - DC - AC Load linear stability factor analysis - temperature compensation methods - biasing circuits of FET's - MOSFET's - FET - MOSFET amplifiers - analysis & design of CC - CE - CB configurations - RC coupled & transformer coupled multistage amplifiers - frequency response of amplifiers - analysis & design of CS, CD, CG amplifier, thermal runaway in BJT & FET amplifiers.

UNIT II OSCILLATORS APPLICATIONS (12 Hours)

Introduction-Low pass and High pass filters- Design of first and second order Butterworth low pass and high pass filters Band pass, Band reject and all pass filters- Oscillator types and principle of operation – RC, Wien bridge oscillators triangular, saw-tooth, square wave and VCO- Introduction to voltage regulators, features of 723, Three Terminal IC regulators- DC to DC Converter- Switching Regulators- UPS-SMPS.

UNIT III OPERATIONAL AMPLIFIERS (12 Hours)

The characteristics of Ideal Operation – slew rate, offset voltage, bias current, CMRR, bandwidth - equivalent circuit of an op-Amp – virtual ground concept – Linear applications of op-amp – inverting and non inverting amplifier, summing, subtracting, averaging amplifier - voltage to current converter – current to voltage converter – Differential amplifiers – differentiator and integrator. Nonlinear applications – comparator – Schmitt Triggers – Precision Diode, Half wave and full wave rectifiers – Average detectors – peak detector.

UNIT IV NUMBER SYSTEMS AND LOGIC GATES (12 Hours)

Decimal, Binary, Octal and Hexadecimal Numbers.-Conversion between these number systems.- Complements r's and (r-1)'s complements.- subtraction using complements – Encoding numbers and characters using Binary digits. –Binary coded Decimal –Gray code - Binary to Gray code conversion – ASCII Code.

Logic gates – Truth tables – NOT, AND, OR, NOR, NAND, XOR, XNOR - Boolean Laws and theorems – Solving Boolean expressions, Truth Tables and Logic circuits – The Karnaugh Map – half adder, full adder, Multiplexers and Demultiplexers - Decoders and encoders.

UNIT V REGISTERS AND COUNTERS (12 Hours)

Flip Flops – RS, D, T, JK Flip Flops – Characteristic equations, exciting tables – JK Master – Slave flip-flop – Universal shift register. Design of modulo-N counters – counter design using state diagram.

TEXT BOOKS

1. Jacob Millman and Christos C. Halkias, Electronic Devices and Circuits, Tata McGraw–Hill, 3rd edition, 2010.
2. David A. Bell., Electronic Devices and Circuits, Prentice Hall of India, 5th Edition, 2008.
3. M. Morris Mano , "Digital Logic and Computer design " Prentice Hall 2004.
4. Ramakant A. Gayakwad , "Op-AMP and Linear ICs", 4th Edition, Prentice Hall, 2000.

REFERENCES

1. Donald A .Neaman, Semiconductor Physics and Devices, Tata McGraw-Hill, 3rd edition, 2002
2. Salivahanan. S., et al., Electronic Devices and Circuits, Tata McGraw Hill , 1st edition, Reprint 2001.
3. Robert B.Northrop, "Analysis and Application of Analog Electronic Circuits to Biomedical Instrumentation", CRC Press, 2004.

4. Sergio Franco, “Design with Operational Amplifiers and analog Integrated circuits”, McGraw- Hills, 2003.
5. Millman J and Halkias .C. “Integrated Electronics”, TMH, 2007.
4. John. F. Wakerly, “Digital Design Principles and Practices”, Fourth Edition, Pearson Education, 2007.
6. Charles H. Roth, Jr, “Fundamentals of Logic Design”, Fourth Edition, Jaico Books, 2002

LIST OF EXPERIMENTS

1. Study the static input and output characteristics of CB, CC and CE transistor.
2. Study the drain and Transfer Characteristics of JFET.
3. Determine the frequency of RC phase shift oscillator.
4. Inverting, non-inverting amplifier.
5. Integrator and Differentiator.
6. Current to Voltage convertor and Voltage to Current Convertor.
7. Comparator, Peak detector and Average detector.
8. Multivibrator using IC555 Timer.
9. Verify the Truth Table of all Basic, Universal and Special gates.
10. Design a Half Adder using EX-OR, AND and NOT gate verify the Truth Table.
11. Study Full Adder and Subtractor and verify the Truth Table.
12. Design RS, JK, D and T Flip-Flop and verify the Truth Table.
13. Study and design Multiplexer and Demultiplexer.

Mini Project has to be done by students based on the laboratory techniques studied. Assessment will be done based on the Project report and functioning of the design.

BME18R272 **BIOSENSORS AND TRANSDUCERS**	**L**	**T**	**P**	**Credit**
	3	**0**	**2**	**4**
Pre-requisite: Analog and Digital Electronics BME18R271 **Course Category: Program core** **Course Type: Integrated Course**				

Objective(s)

1. Understand the purpose of measurement, the methods of measurements, errors associated with measurements.
2. Know the principle of transduction, classifications and the characteristics of different transducers and study its Biomedical applications.

Course Outcome(s)

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

CO1 Describe the different types of transducers and its purposes.

CO2 Explain variety of photoelectric transducers.

CO3 Describe the principle and operation of inductive and capacitive transducers.
CO4 Discuss about various chemical biosensors and smart sensors.
CO5 Discuss about signal conditioning, display and recording devices.

Mapping of COs and POs

COs	POs												PSO			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	L	L	L										L			
CO2	M	M	M	M								M	M	M		
CO3	M	M	H	H								M	M	M		
CO4	L	L	L	L								M	L	M		
CO5	L	L	L	L												

UNIT I SCIENCE OF MEASUREMENTS AND CLASSIFICATION OF TRANSDUCERS (15 HOURS)

Units and standards –Calibration methods –Static calibration –Classification of errors:-Limiting error and probable error –Error analysis:–Statistical methods –Odds and uncertainty –Classification of transducers – Selection of transducers – Characteristics of transducers: Static characteristics, Dynamic characteristics.

UNIT II VARIABLE RESISTANCE AND PHOTOELECTRIC TRANSDUCERS (15 HOURS)

Principle of operation, construction details, characteristics and applications of potentiometer- strain gauge- resistance thermometer- Thermistor- Thermocouple Piezoelectric transducer -Hall Effect transducer - piezo-resistive sensor - Photoelectric transducers: photovoltaic cells and photoemissive cells.

UNIT III VARIABLE INDUCTANCE AND VARIABLE CAPACITANCE TRANSDUCERS (15 HOURS)

Inductive transducers: Principle of operation, construction details, characteristics and applications of LVDT, induction potentiometer - characteristics of capacitive transducers – Different types - Applications: Capacitor microphone, Capacitive pressure sensor, Proximity sensor.

UNIT IV CHEMICAL BIOSENSORS AND SMART SENSORS (15 HOURS)

Biochemical sensors - enzymatic biosensors, 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 analyser - Smart sensors -Fibre optic sensors-Introduction to MEMS and Nano sensors.

UNIT V SIGNAL CONDITIONING, DISPLAY AND RECORDING DEVICES (15 HOURS)

AC and DC Bridges –wheat stone bridge, Kelvin, Maxwell, Hay, Schering- Multi meter – CRO – DSO-LCD monitor- Recorders –Analog and Graphic Recorders-Strip Chart Recorder-X-Y Recorder-photographic recorder-Magnetic tape recorder.

TEXT BOOKS

1. A.K.Sawhney, "Electrical & Electronics Measurement and Instrumentation", 10th edition, Dhanpat Rai & Co, New Delhi, 2010.
2. Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw-Hill, New Delhi, 2003.

REFERENCES

1. Leslie Cromwell, "Biomedical Instrumentation and measurement", Prentice hall of India, New Delhi, 2007.
2. John G. Webster, "Medical Instrumentation Application and Design", John Wiley and sons, New York, 2004.
3. Neubert H.K.P., Instrument Transducers –An Introduction to their Performance and Design, Oxford University Press, Cambridge, 2003.
4. Doebelin E.O. and Manik D.N., Measurement Systems –Applications and Design, Special Indian Edition, Tata McGraw Hill Education Pvt. Ltd., 2007.
5. D. Patranabis, Sensors and Transducers, 2nd edition, Prentice Hall of India, 2010.E.A.
6. Murthy, D.V.S., Transducers and Instrumentation, 2nd Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2010.

LIST OF EXPERIMENTS

1. Measurement of Pulse Rate using photo transducer
2. Measurement of Respiratory Rate using temperature transducer
3. Measurement of displacement using capacitive transducer and Inductive transducer
4. Measurement of SpO2 using optical transducer
5. Measurement of skin temperature by both contact and non-contact method
6. Measurement of chemical compounds using Load Cell
7. Measurement of blood glucose measurement using amperometric sensor
8. Non-invasive gas analyzer as an electronic nose
9. Measurement of blood P^H using P^H electrode
10. Study of electronic stethoscope.

EEE18R371 MICROPROCESSOR AND MICROCONTROLLER	L	T	P	Credit
	3	0	2	4
Pre-requisite: NIL	**Course Category: Program core**			
	Course Type: Integrated Course			

Course Objective(s):

To develop an in-depth understanding of the operation of microprocessors and microcontrollers, machine language programming & interfacing techniques. Developing of assembly level programs and providing the basics of the processors.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Describe fundamental of Microprocessor and Microcontrollers

CO2: Illustrate the architecture and analyze the instruction sets, programming of 8-bit microprocessor 8085.

CO3: Study the different peripheral devices and their interfacing to 8085

CO4: Illustrate the architecture of 8051 microcontroller.

CO5: Study the interrupt and timers of 8051 microcontroller and design the microcontroller based control circuit for electrical and electronics applications.

Mapping of Co and Po:

COs	POs												PSO			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	H						H					H	H			
CO2		L	M	M	M		L	L				M				
CO3			L	L	M		L					L				
CO4	H	L	L		L								H			
CO5	L	L	H	L	H		L	L				L	L			

UNIT I FUNDAMENTALS OF MICROPROCESSORS AND MICROCONTROLLER (9 HOURS)

Fundamentals of Microprocessor Architecture. 8-bitMicroprocessor and Microcontroller architecture, Comparison of 8-bit microcontrollers, 16-bit and 32-bit microcontrollers. Definition of embedded system and its characteristics, Role of microcontrollers in embedded Systems. Overview of the 8051 family.

UNIT II 8085 MICROPROCESSOR (9 HOURS)

8085 architecture - Instruction set - Addressing modes- Timing diagram – Assembly Language Programming - Counters time delays – Interrupts - Memory Interfacing - Interfacing I/O devices.

UNIT III MICROPROCESSOR INTERFACING TECHNIQUES (9 HOURS)

Interfacing serial I/O (8251) – Parallel I/O (8255) – ,RS232,SPI, I2C,Introduction and interfacing to protocols like Blue-tooth and Zig-bee. Keyboard and display controller (8279) - ADC/DAC interfacing – 8257 programmable DMA controller – 8259A programmable interrupt controller.

UNIT IV 8051 MICROCONTROLLER (9 HOURS)

8051 microcontroller hardware – I/O Pins, Ports and circuits – external memory, 8051 Instruction set – Addressing Modes – – counters and timers – serial data input and output – interrupts – Interfacing to external memory and 8255.

UNIT V 8051 PROGRAMMING AND APPLICATIONS (9 HOURS)

Assembly Language Programming – I/O Port Programming – Timer and counter Programming – Serial Communication – Interrupt Programming – 8051 Interfacing, LED, ADL, Sensors – Stepper Motor - keyboard and DAC,C language programs. Assemblers and compilers. Programming and debugging tools**.**

LIST OF EXPERIMENTS (15 Hours)

1. Simple arithmetic operations
2. ADC and DAC interfacing
3. Arithmetic operation with 8051 micro controller execution.
4. Sine wave and Square wave generation
5. ADC and DAC interfacing
6. Stepper motor control
7. Servomotor control
8. Traffic light control
9. Seven segment display
10. Basic programming using keil.

Additional Experiments

1. Simple Digital Voltmeter using 8051.
2. Digital lock using AT89C2051 with LCD and keypad assembly.
3. Data acquisition system using 8051.
4. Temperature controlled Fan.
5. Microcontroller based caller ID.
6. Bio medical monitoring system.
7. Auto Control of 3-phase Induction Motor.

TEXT BOOK(s):

1. Gaonkar, R.S., Microprocessor Architecture Programming and Application, Wiley Eastern Ltd., New Delhi, 2005.
2. M. A.Mazidi, J. G. Mazidi and R. D. McKinlay, “The8051Microcontroller and Embedded Systems: Using Assembly and C”,Pearson Education, 2007.

REFERENCE(s):

1. Hall, D.V., Microprocessor and Interfacing Programming and Hardware, Tata McGraw Hill Publishing Company, 2nd edition, 2012.
2. YuCheng Liu & Glenn A Gibson, Microcomputer System, 8086/8088 Family, 2nd edition, Prentice Hall of India, 2005.
3. Rafiquzzaman M., Microprocessor Theory and Application – Intel and Motorola, Prentice Hall of India, 2007.

BME18R371 **BIOMEDICAL SIGNAL PROCESSING**	**L**	**T**	**P**	**Credit**
	3	**0**	**2**	**4**
Pre-requisite: NIL **Course Category: Program core** **Course Type**: **Integrated Course**				

Objective(s)

This course introduces various bio-signal representations, various filter design and applications of adaptive filters.

Course Outcome(s)

CO1 To understand the characteristics, basis and utility of a variety of signals
CO2 To discuss Z Transform and Discrete Fourier transform
CO3 To discuss about IIR filter design.
CO4 To discuss about FIR filter design using various windowing techniques.
CO5 To understand finite word length effects in digital Filters and applications of adaptive filters.

Mapping of COs and POs

	POs												**PSO**			
COs	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	M	H	H	H	H	M	M	M					M	H		M
CO2	M	H	H	H	H	M	M	M					M	H		M
CO3	M	H	H	H	H	M	M	M					M	H		M
CO4	M	M	H	H	H	M	M	M					M	H		M
CO5	M	H	H	H	H	M	M	M					M	H		M

UNIT I SIGNALS AND SYSTEMS (15 HOURS)

Introduction and Classification of signals: Definition of signal and systems, communication and control systems as examples. Sampling of analog signals, Continuous time and discrete time signal, Classification of signals as even, odd, periodic and non-periodic, deterministic and non-deterministic, energy and power. Elementary signals/Functions: exponential, sine, impulse, step and its properties, ramp, rectangular,

triangular, signum, sync functions. Operations on signals: Amplitude scaling, addition, multiplication, time scaling, time shifting and time folding.

Systems: Definition, Classification: linear and nonlinear, time variant and invariant, causal and noncausal, static and dynamic, stable and unstable, invertible.

UNIT II Z TRANSFORM AND DISCRETE FOURIER TRANSFORMS (15 HOURS)

Z-Transform: Direct Z-Transform, Properties of the Z-Transform, Examples, Inverse Z- Transform by Partial- Fraction Expansion method - Causality and Stability.

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

UNIT III IIR FILTER DESIGN (15 HOURS)

Structures of IIR systems: Direct form, Cascade form, Parallel form structures – Analog filter design – Discrete time IIR filter from analog filter – IIR filter design by Impulse Invariance, Bilinear transformation, Approximation of derivatives – (LPF, HPF, BPF, BRF) filter design using frequency translation.

UNIT IV FIR FILTER DESIGN (15 HOURS)

Structures of FIR – Linear phase FIR filter – Fourier Series - Filter design using windowing techniques (Rectangular Window, Hamming Window, Hanning Window), Frequency sampling techniques – Implementation of FIR filters by direct form and Single-stage lattice structure.

UNIT V FINITE WORD LENGTH EFFECTS IN DIGITAL FILTERS AND ADAPTIVE FILTER (15 HOURS)

Finite word length effects in digital Filters: Errors, Limit Cycle, Noise Power Spectrum - Multirate Digital Signal Processing: Decimation and Interpolation process

Adaptive filters – Principle noise canceller model – 50 Hz adaptive cancelling using a sine wave model – Maternal ECG cancellation in fetal electrocardiography – ECG cancellation in EMG recording – High frequency noise cancellation in Electro surgery. Signal averaging – Basics and limitations.

TEXT BOOKS:

1. John G. Proakis & Dimitris G.Manolakis, "Digital Signal Processing – Principles, Algorithms & Applications", Fourth Edition, Pearson Education / Prentice Hall, 2007.
2. DC Reddy, Biomedical Signal Processing – Principles and Techniques, Tata McGraw Hill Publishing company Ltd., 2005 (UNITS IV & V)

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. A.V.Oppenheim, R.W. Schafer and J.R. Buck, “Discrete-Time Signal Processing”, 8th Indian Reprint, Pearson, 2004.
4. Andreas Antoniou, “Digital Signal Processing”, Tata Mc Graw Hill, 2006.

LIST OF EXPERIMENTS:

1. Representation of basic discrete time signals
2. IIR filters design-digital Butterworth filter and Chebyshev filter
3. Designing an FIR filter using window techniques in MATLAB
4. Signal Averaging of ECG
5. Noise removal in EEG signal using Chebychev filter.
6. Noise removal in EMG signal using Butterworth filter
7. Design of Notch filter for elimination of 50Hz from ECG signal.
8. EMG processing using MATLAB –Rectification and Signal Averaging.
9. Time frequency domain properties of different windows using MATLAB.
10. Estimation of bio-signals using Parametric Method and Non Parametric method
11. Detection of QRS complex of ECG signal
12. Estimation of ST segment and R-R interval.
13. Implementation of the Double-Precision Complex FFT for ECG signal.

LABORATORY COURSES

BME18R281 BIOCHEMISTRY AND HUMAN PHYSIOLOGY LABORATORY	L	T	P	Credit
	0	0	3	2
Co-requisite: Clinical Biochemistry BME18R233	**Course Category:** Program core **Course Type**: Laboratory			

Objective(s)

To provide practical knowledge of biological macromolecules in clinical settings.

Course Outcome(s)

Upon completion of the course, students will be able to

CO1 Apply the acquired knowledge on carbohydrates, proteins, neucleic acids and lipids by conducting various qualitative and quantitative analytical methods for the diagnosis of diseases

CO2 Analyse the blood for its abnormalities in diseased conditions

CO3 Performing advanced experiments by applying the knowledge of routine laboratory tests.

Mapping of Cos and Pos:

COs	POs												PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	M															
CO2		H		H	M	H						M				
CO3				H	M	H						M				

LIST OF EXPERIMENTS:

1. General tests for carbohydrates, proteins and lipids.
2. Preparation of serum and plasma from blood.
3. Estimation of blood glucose.
4. Estimation of creatinine
5. Estimation of urea
6. Estimation of cholesterol
7. Assay of SGOT/SGPT
8. Separation of amino acids by thin layer chromatography (paper chromatography)
9. Separation of proteins by SDS electrophoresis
10. Separation of DNA by agarose gel electrophoresis
11. ESR, PCV, MCH, MCV, MCHC, total count of RBCs and hemoglobin estimation
12. Differential count of different WBCs
13. Blood group identification

BME18R381	BIOMEDICAL INSTRUMENTATION AND EQUIPMENTS LABORATORY**	L	T	P	Credit
		0	0	3	2

Corequisite: Biomedical Instrumentation-BME18R252 **Course Category:** Program core
Course Type: Laboratory

Objective(s)

To provide hands on training on Measurement of physiological parameters, biochemical parameters measurement and bio-signal analysis.

Course Outcome(s)

Upon completion of the course, students will be able to

CO1 Understand the various bio-signal processing units like amplifiers, filters

CO2 Measure various electrical, non-electrical, chemical biological parameters.

CO3 Record, analysis and interrupt various bio-parameters.

CO4 Understand, analyse, and apply theoretical knowledge for a particular application by implementing in a mini project.

Mapping of COs and POs:

COs	POs												PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	H	L											H			
CO2	L	L											L			
CO3				H										H		
CO4	H	M											H			

LIST OF EXPERIMENTS

1. Study of Biological Preamplifiers.
2. Recording of ECG signal and detection of QRS complex.
3. Audiometer.
4. Recording of EMG.
5. Recording of various physiological parameters using patient monitoring system and telemetry units.
6. Measurement of pH, pO2 and conductivity.
7. Study and analysis of functioning and safety aspects of surgical diathermy.
8. Measurement and recording of peripheral blood flow.
9. Measurement of visually evoked potential.
10. Study of Characteristics of optical isolation amplifier.
11. Galvanic skin response (GSR) measurement.
12. Study of short wave and ultrasonic diathermy.
13. Measurement of Respiratory parameters using spirometry.
14. Design of ECG amplifier, recording and analysis using LabVIEW**.**

15. Study of medical stimulator.
16. Electrical safety measurements.

BME481	BIOMEDICAL IMAGE PROCESSING AND ANALYSIS LABORATORY**	L	T	P	C
		0	0	3	2
Co-requisite:BME18R401		**Course Category:** Program core **Course Type**: Laboratory			

Objective(s)

To provide hands on training on various Medical image processing techniques.

Course Outcome(s)

Upon completion of the course, students will be able to

CO1 Understand the various concepts in medical image processing.

CO2 Learn to remove noise in the medical images.

CO3 To compress the image for data storage and long distance transmission.

Mapping of COs and POs:

COs	POs												PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	H	M	L				L		H			M	H	L		M
CO2				H	H	M					L	M	M	H		M
CO3		M			H	H				L	L	H	M	L		M

LIST OF EXPERIMENTS:

1. Digital image Fundamentals – Sampling and quantization.
2. Image Enhancement - Spatial filtering, Filtering in frequency domain
3. Removal of noise in medical images.
4. Image Transformation in spatial domain and frequency domain.
5. Edge detection and boundary tracing techniques.
6. Region based processing
7. Color image processing
8. Basic Morphological operations.
9. Image compressions.
10. Image segmentation by thresholding.

MINI PROJECTS:

1. Applications to Biometric and security
2. Applications to Medical Images
3. Texture analysis with statistical properties
4. Boundary detection

BME18R399 COMMUNITY SERVICE PROJECT	L	T	P	Credit
	0	0	3	10
Pre-requisite: All Biomedical Courses	**Course Category:** Program core **Course Type**: Project			

Objective(s)

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

Course Outcome(s)

Upon completion of the course, students will be able to

CO1 Work in a team to design and develop effective engineering solutions with the consideration of the open ended, real time issues of public, safety and welfare for a societal problem considering global, environmental, and economical aspects.

Mapping of COs and POs:

COs	POs												PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	H	M	H	M	H	H	H	M	M	H	L	L	H	H	L	L

- The students in a group of 3 to 4 works on a topic will be approved by the head of the department under the guidance of a faculty member and prepares a comprehensive project report after completing the work to the satisfaction of the supervisor.
- The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department.
- A project report is required at the end of the semester.
- The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

PROJECT WORK

BME18R499	PROJECT WORK	L	T	P	Credit
		0	0	0	10
Pre-requisite: All Biomedical Courses		**Course Category:** Program core **Course Type**: Project work			

Objective(s)

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

Course Outcome(s)

Upon completion of the course, students will be able to

CO1 Apply engineering knowledge and skills to identify problems and design solutions with recognition of ethical and professional responsibilities .

CO2 Function as a professional in a team with leadership qualities including effective communication

Mapping of COs and POs

COs	POs												PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	H	H	H	H	H	H	H	H				M	H	M		M
CO2									H	H	H				H	

- The students in a group of 3 to 4 works on a topic will be approved by the head of the department under the guidance of a faculty member and prepares a comprehensive project report after completing the work to the satisfaction of the supervisor.
- The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department.
- A project report is required at the end of the semester.
- The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

PROFESSIONAL ELECTIVES

BME18R203	MEDICAL PHYSICS	L	T	P	Credit
		3	0	0	3
Pre-requisite: Nil		**Course Category:** Professional electives			
		Course Type: Theory			

Objective(s)

- To obtain knowledge of the normal structure and function of the body and its major organ systems with emphasis on content applicable to clinical diagnostic imaging and/or radiation oncology.
- To understand radiation and radioactivity, its properties, units of measure, dosimetry measurement concepts and methods.

Course Outcome(s)

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

CO1 Interpret the non-ionizing radiation and its application in medical field
CO2 Relate the utilization of ultrasound in medicine
CO3 Illustrate the production of radioactive nucleotides
CO4 Classify the different radiations and its interactions with matter
CO5 Compare the effects of radiation and its units.

Mapping of COs and POs:

COs	POs												PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	M	M	M	H								L	M			
CO2	M		L		M							M	M			M
CO3	M	H	M		M	M	M					M	M			M
CO4	M	H		L								L	M			
CO5	M	M	L	L		H	M					H	M			H

UNIT I NON IONIZING RADIATION AND ITS MEDICAL APPLICATION (9 HOURS)

Non-ionizing Electromagnetic Radiation: Overview of non-ionizing radiation effects-Low Frequency Effects- Higher frequency effects. Physics of light, Measurement of light and its unit- limits of vision and color vision an overview, Thermography– Application

UNIT II SOUND IN MEDICINE (9 HOURS)

Physics of sound, Normal sound levels –ultrasound fundamentals – Generation of ultrasound (Ultrasound Transducer) - Interaction of Ultrasound with matter; Cavitations, Reflection, Transmission-Scanning systems – Artefacts- Ultrasound- Doppler-Double Doppler shift-Clinical Applications.

UNIT III PRINCIPLES OF RADIOACTIVE NUCLIDES (9 HOURS)

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 radionuclide – Cyclotron produced Radionuclide- Reactor produced Radio- nuclide-fission and electron Capture reaction, radionuclide Generator-Technetium generator.

UNIT IV INTERACTION OF RADIATION WITH MATTER (9 HOURS)

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 V BASIC RADIATION QUANTITIES (9 HOURS)

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

TEXT BOOKS

1. John R Cameran , James G Skofronick "Medical Physics", 2nd edition, John-Wiley & Sons. 2012
2. W.J.Meredith and J.B. Massey "Fundamental Physics of Radiology" 3rd edition, Varghese Publishing house. 2013
3. Paul Davidovits "Physics in biology and Medicine" 4th edition, Academic Press Inc. 2012
4. P.Uma Devi, A.Nagarathnam , B S SatishRao , "Introduction to Radiation Biology" B.I Chur Chill Livingstone pvt Ltd, 2000

REFERENCES

1. "Webb's Physics of Medical Imaging, Second Edition**",** M.A.FLOWER, 2012.
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, 2000

BME18R204	ANALOG AND DIGITAL COMMUNICATION	L	T	P	C
		3	0	0	3

Pre-requisite: Nil **Course Category:** Professional electives

Course Type: Theory

Objective(s)

To understand analog and digital communication techniques and to gain knowledge on multi-user radio communication.

Course Objectives

The student should be able to

- Apply analog and digital communication techniques.
- Learn data and pulse communication techniques.
- Learn digital modulation and transmission techniques.
- Analyze source and error control coding.
- Gain knowledge on multi-user radio communication.

Mapping of COs and POs

	POs												PSOs			
COs	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	M	M	H					L					M	M		
CO2	H	M	M					L					M			
CO3	M	M	M										M			
CO4	M	H	M					L					M	H		
CO5	M	M	M										M	M		

UNIT - I ANALOG MODULATION **9**

Amplitude Modulation – AM, DSBSC, SSBSC, VSB – PSD, modulators and demodulators – Angle modulation – PM and FM – PSD, modulators and demodulators – Superheterodyne receivers

UNIT - II PULSE MODULATION **9**

Low pass sampling theorem – Quantisation – PAM – Line coding – PCM, DPCM, DM, ADPCM and ADM, Channel Vocoder - Time Division Multiplexing, Frequency Division Multiplexing 57

UNIT - III DIGITAL MODULATION AND TRANSMISSION TECHNIQUES 9

Phase shift keying – BPSK, DPSK, QPSK – Principles of M-ary signaling M-ary PSK & QAM – Comparison, ISI – Pulse shaping – Duo binary encoding – Cosine filters – Eye pattern, equalizers

UNIT - IV INFORMATION THEORY AND CODING 9

Measure of information – Entropy – Source coding theorem – Shannon–Fano coding, Huffman Coding, LZ Coding – Channel capacity – Shannon-Hartley law – Shannon‟s limit – Error control codes – Cyclic codes, Syndrome calculation – Convolutional Coding, Sequential and Viterbi decoding

UNIT – V SPREAD SPECTRUM AND MULTIPLE ACCESS 9

PN sequences – properties – m-sequence – DSSS – Processing gain, Jamming – FHSS – Synchronisation and tracking – Multiple Access – FDMA, TDMA, CDMA,

TEXT BOOKS

1. H Taub, D L Schilling, G Saha, “Principles of Communication Systems” 3/e, TMH 2007
2. S. Haykin “Digital Communications” John Wiley 2005

REFERENCES

1. B.P.Lathi, “Modern Digital and Analog Communication Systems”, 3/e, Oxford University Press, 2007
2. H P Hsu, Schaum Outline Series – “Analog and Digital Communications” TMH 2006
3. B.Sklar, Digital Communications Fundamentals and Applications” 2/e Pearson Education 2007.

BME18R205 BIOMATERIALS AND ARTIFICIAL ORGANS	**L**	**T**	**P**	**Credit**
	3	**0**	**0**	**3**
Pre-requisite: NIL	**Course Category:** Professional electives			
	Course Type: Theory			

Objective(s)

To understand and analyze the different types of Biomaterials and design new materials and organs to meet the medical needs.

Course Outcome(s)

Upon completion of this course, the students will be able to

CO1 Experiment with the classes of materials that can be used for medical applications

CO2 Illustrate the response of human body towards the application of biomaterial and the characterization methodologies for biomaterials

CO3 Apply the Biomaterials as drug delivery systems and in ophthalmology

CO4 Perform combination of materials that could be used as a tissue replacement implants to meet

desired needs within the realistic constraints.

CO5 Understand and design artificial organs

Mapping of COs and POs:

CO	POs												PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1						H	M	M						M		
CO2							M									
CO3			M			M	L	L					L	L		
CO4			M		L	H	H	H						M		H
CO5			H		M	H	M	M						M		M

UNIT I CLASSES OF MATERIALS USED IN MEDICINE (9 HOURS)

Classification of Biomaterials: Metals and alloys; stainless steel, cobalt based alloys, titanium based materials – ceramics – bioinert ceramics – carbon, alumina, zircona and titania – bioactive ceramics – bioactive glass and glass ceramics, calcium phosphate ceramics – polymers – PMMA bone cement, articulating component – UHMWPE – composites, matrix and filter components, Surface properties and Bulk mechanical properties.

UNIT II BIOLOGICAL PERFORMANCE OF MATERIALS (9 HOURS)

Biocompatibility-Tissue Compatibility – material response:– deformation and failure – friction and wear – Host response – Inflammatory process – capsule formation – coagulation and hemolysis – approach to thromboresistant material development –carcinogenesis. Biocompatibility testing:-in vitro and in vivo studies of biocompatibility.

UNIT III OPHTHALMOLOGIC APPLICATIONS AND DRUG DELIVERY SYSTEMS (9 HOURS)

Materials for ophthalmology – contact lens and intraocular lens materials – Corneal Implants-Implants for Glaucoma-Implants for Retinal Detachment surgery- drug delivery systems-Diffusion Controlled-Water penetration controlled –Chemically Controlled-Regulated Systems.

UNIT IV TISSUE REPLACEMENT IMPLANTS (9 HOURS)

Small intestinal submucosa and other decellularized matrix biomaterials for tissue repair. Soft tissue replacements, sutures, surgical tapes, adhesive, Percutaneous and skin implants, maxillofacial augmentation, Vascular grafts, hard tissue replacement Implants, joint replacements, Dental Implants, Pancreas replacement.

UNIT V ARTIFICIAL ORGANS (9 HOURS)

Artificial blood, artificial skin, Artificial Heart, Prosthetic Cardiac Valves, Artificial lung (oxygenator), Artificial Kidney (Dialyzer membrane)

TEXT BOOKS

1. Buddy D.Ratner and Allan S.Hoffman Biomaterials Science "An Introduction to Material in Medicine" Third Edition, 2013.
2. Jonathan Black, Biological Performance of materials, Fundamentals of Biocompatibility, Marcel Dekker Inc., 4th edition New York, 2005
3.Joon Park, R S Lakes, Biomaterials: An Introduction, Springer science and Business Media, 2007
4. Sujatha.V..Bhat, Biomaterials,II Edition Alpha Science 2005

REFERENCES

1. Amit Bandhyopadhya, Susmita Bose, Characterization of Biomaterials, Newnes, 2013

BME18R206 **HOSPITAL MANAGEMENT**	**L**	**T**	**P**	**Credit**
	3	**0**	**0**	**3**
Pre-requisite: Nil	**Course Category:** Professional electives **Course Type**: Theory			

Objective(s)

Understand the principles, practices and areas of application in Hospital management.

Course Outcome(s)

CO1 To understand the principles, staffing and marketing processes, discussing their significance.
CO2 To manage their role in effective and efficient management of health care organizations.
CO3 To analyse the various regulations and standards to be followed in hospitals for safety.
CO4 To evaluate various aspects of equipment maintenance.
CO5 To apply the aspects of managing the hospital in terms of staff, marketing and the use of computers.

Mapping of COs and POs:

COs	**POs**												**PSOs**			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1						L			M		M			H		
CO2									H	H	H				M	H
CO3			M			H		H		M	L			M	M	H
CO4						L		M	M	L	M			H	M	H
CO5									H	M	L				M	

UNIT I HEALTH SYSTEM **(9 HOURS)**

Health organisation of the country, the state, the cities and the region, Health Financing System, Organisation of Technical Section.

UNIT II HOSPITAL ORGANISATION AND MANAGEMENT (9 HOURS)

Management of Hospital organisation, Nursing section Medical Sector, Central Services, Technical Department, Definition and Practice of Management by Objective, Transactional Analysis Human relation in Hospital, Importance to Team Work, Legal aspect in Hospital Management.

UNIT III REGULATORY REQUIREMENT AND HEAI TH CARE CODES (9 HOURS)

FDA Regulation, joint commission of Accreditation for Hospitals, National Fire Protection Association Standard, IRPC.

UNIT IV EQUIPMENT MAINTENANCE MANAGEMENT (9 HOURS)

Organising Maintenance Operations, Paper Work Control, Maintenance Job, Planning Maintenance Work Measurement and Standards, Preventive Maintenance, Maintenance Budgeting and Forecasting, Maintenance Training, Contract Mainframe.

UNIT V TRAINED TECHNICAL PERSONNEL (9 HOURS)

Function of Clinical Engineer, Role to be performed in Hospital, Man power Market, Professional Registration, Structure in hospital.

REFERENCE BOOKS

1. Cesar A. Caceres and Albert Zara, The practice of Clinical Engineering, Academic Press, 1977.
2. Webster, J.G. and Albert M. Cook, Clinical Engineering Principles and Practices, Prentice Hall Inc. Englewood Cliffs, 1979.
3. Antony Kelly, Maintenance planning and control, Butterworths London, 1984.
4. Hans Pfeiff, Vera Dammann (Ed.) Hospital Engineering in Developing Countries, Z report Eschborn, 1986.
5. Jacob Kline, Handbook of Bio Medical Engineering, Academic Press, San Diego 1988.
6. R.C. Goyal, Handbook of Hospital Personal Management, Prentice Hall of India, 1993.

BME18R302 RADIOLOGICAL IMAGING SYSTEMS	**L**	**T**	**P**	**Credit**
	3	**0**	**0**	**3**
Pre-requisite: BME18R252	**Course Category:** Professional electives			
	Course Type: Theory			

Objective(s)

To understand various types of radiological sources, equipments contruction and working with precaution measures to be taken.

Course Outcome(s)

CO1 Learn different types of radio diagnostic techniques

CO2 Understand generation of x-rays and its uses in imaging.

CO3 Know techniques used for visualizing different sections of the body
CO4 Acquire knowledge in various nuclear source and measuring devices
CO5 Learn radiation therapy methodologies and the radiation safety

Mapping of COs and POs:

COs	POs												PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	M	L	M		M	H	H	L	M			M	M	L	H	H
CO2	M	M	H	L	M	H	M	M	M	L	H	L	M	H	H	M
CO3	H	M	H	L	M	H	M	M	M	L	H	L	H	M	H	M
CO4	H	H	M		M	H	M	L	M		M	L	H	M	M	M
CO5	M	L	L		M	H	H	M	M		M	L	H	M	M	M

UNIT I MEDICAL X-RAY EQUIPMENT (9 HOURS)

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 HOURS)

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

UNIT III MAGNETIC RESONANCE IMAGING (9 HOURS)

Fundamentals of magnetic resonance- 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 MEDICINE SYSTEM (9 HOURS)

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

UNIT V RADIATION THERAPY AND RADIATION SAFETY (9 HOURS)

Radiation therapy – linear accelerator, Telegamma Machine. SRS –SRT,-Recent Techniques inradiation therapy - 3DCRT – IMRT – IGRT and Cyber knife- radiation measuring instruments-Dosimeter, film

badges, Thermo Luminescent dosimeters- electronic dosimeter- Radiation protectionin medicine-radiation protection principles.

TEXT BOOKS

1. Steve Webb, The Physics of Medical Imaging, Adam Hilger, Philadelpia, 1988 (Units I, II, III & IV).
2. R.Hendee and Russell Ritenour "Medical Imaging Physics", Fourth Edition William, Wiley-Liss, 2002.

REFERENCES

1. Gopal B. Saha "Physics and Radiobiology of Nuclear Medicine"- Third edition Springer, 2006.
2. B.H.Brown, PV Lawford, R H Small wood , D R Hose, D C Barber, "Medical physics and biomedical Engineering", - CRC Press, 1999.
3. Myer Kutz, "Standard handbook of Biomedical Engineering and design", McGraw Hill, 2003.
4. P.Ragunathan, "Magnetic Resonance Imaging and Spectroscopy in Medicine.

BME18R303 **MEDICAL OPTICS AND LASERS**	**L**	**T**	**P**	**Credit**
	3	**0**	**0**	**3**
Pre-requisite: --	**Course Category:** Professional electives			
	Course Type: Theory			

Objective(s)

To acquire adequate knowledge in physics of light in biological tissues and its application in diagnostic and therapeutic applications.

Course Outcome(s)

Upon completion of the course, the students should be able to

CO1 Be familiar with property of light in tissues
CO2 Acquire knowledge in source and detectors of light.
CO3 Application of light in diagnostic practices.
CO4 Be exposed to Optical Holography.
CO5 Understand the concept of LASER in therapeutic applications

Mapping of COs and POs

	POs												**PSO**			
COs	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	H	M	M					H					M	L		
CO2	M	H	M					M					M	H		
CO3	H	M	M					H					M			
CO4	M	M	M					H					M	M		
CO5	H	M	M					M					M			

UNIT-I OPTICAL PROPERTIES OF THE TISSUES (9 HOURS)

Refraction, scattering, absorption, light transport inside the tissue, tissue properties, Light interaction with tissues, optothermal interaction, fluorescence, speckles.

UNIT II INSTRUMENTATION IN PHOTONICS (9 HOURS)

Instrumentation for absorption, scattering and emission measurements, excitation light sources – high pressure arc lamp, solid state LEDs, optical filters, polarisers, time resolved and phase resolved detectors.

UNIT III APPLICATIONS OF LASERS (9 HOURS)

Laser in tissue welding, lasers in dermatology, lasers in ophthalmology, otolaryngology, urology. LASERS in surgery.

UNIT IV OPTICAL HOLOGRAPHY (9 HOURS)

Wave fronts, interference patterns, principle of hologram, optical hologram, applications.

UNIT V SPECIAL TECHNIQUES (9 HOURS)

Near field imaging of biological structures, in-vitro clinical diagnostic, fluorescent spectroscopy, photodynamic therapy.

TEXT BOOKS

1. Leon Goldman, M.D., & R.James Rockwell, Jr., "Lasers in Medicine", Gordon and Breach, Science Publishers Inc., 1975.
2. Abraham Katzir, "Lasers and Optical Fibers in Medicine", Academic Press Edition, 1998.

REFERENCES

1. Tuan Vo Dirh, "Biomedical Photonics – Handbook", CRC Press, Bocaraton,2003 (Unit I – III, V)
2. Glasser, O., "Medical Physics -- Vol 1, 2, 3 "Adam Hilgar Brustol Inc, 1987.
3. G.David Baxter "Therapeutic Lasers – Theory and practice", Churchill Livingstone Publications Edition- 2001.

BME18R304 COMPUTERS IN MEDICINE	L	T	P	Credit
	3	0	0	3
Pre-requisite: Nil	**Course Category:** Professional electives			
	Course Type: Theory			

Objective(s)

To discuss the various aspects of informatics applied in health industry so that quality of health care is improved.

Course Outcome(s)

CO1 To understand the system of information managed in the hospital.
CO2 To demonstrate the application of softwares employed in medical data management.
CO3 To examine medical imaging data with an assist of computers.
CO4 To understand the concept of maintaining digital patient records.
CO5 To acquire knowledge in delivering instructions in medicine using computers.

Mapping of COs and POs

	POs												PSO			
COs	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	M				M								L			
CO2	L				M								L			
CO3	L	L			M								L			
CO4	M	L			M								L			
CO5	L	M			M								L			

UNIT I HOSPITAL INFORMATION SYSTEM (9 HOURS)

Introduction –Historical review of the development of computers and informatics –Foundation ontology – use of internet in medicine –Internet vs online services-computer based medical information retrieval.

UNIT II COMPUTERISED PATIENT DATABASE MANAGEMENT (9 HOURS)

Data base approach -Automated clinical laboratories – automated method in hematology – chromosome analysis by computer –computerised cytology and histology- Automatic scanning for cervical cancer – computer assisted semen analysis-Radio immuno assays-Intelligent laboratory information system-computerized ECG-computer aided analysis of ECG-computerised EEG and EMG. Computer assisted medical imaging-ultrasound –CT Radiation therapy planning-NMR.

UNIT III COMPUTER ASSISTED MEDICAL IMAGING AND DECISION MAKING (9 HOURS)

Computer Assisted Medical Decision Making-Model of CMD-Approaches-Decision Support Systems Algorithms –Analysis –CBR-Production Rule Systems-Cognitive Models-Somantic Networks – Decision Analysis in Clinical Medicine –Hospital Information System-Functional Capabilities –Need-Security-Cost Effectiveness. Clinical Information System –Benefits –Sources of Data-Modes Of Decision –CIS in Obestrics and Gynecology-Clinical Decision Support.

UNIT IV COMPUTERISED PATIENT RECORD (9 HOURS)

Computerised Patient Record –Introduction-History Taking By Computer-Dialogue With The Computer - Computerised Prescriptions For Patients-Introduction-Adverse Drug Reactions-Computer Assisted Patient Education And Health Care Information –Introduction –Health Online –Electronic Communication With Patients-Importance Of Behaviour Modification –Patient Self Management

Education-Computers In Case Of Critically Ill Patients- Introduction –Cognitive System, Engineering – Automated Computer Assisted Fluid And Metabolic Balance –Pulmonary Function Evaluation-Computer Aids For The Handicapped-Computer Assisted Surgery.

UNIT V COMPUTER ASSISTED INSTRUCTION IN MEDICINE (9 HOURS)

Computer Assisted Drug Discovery And Development, Molecular Modelling By Computer-Computational Representation Of Molecules-Modelling GPCRS-Pharmacophores-New Drugs For Cancer-0 from Gene To Screen –Combinational Chemistry-Metabolomics-Knowledge Based Drug Discovery-Pharmaco Metabolomics Role Of PET And SPECT In Drug Discovery. Computer Assisted Instruction In Medicine.

TEXT BOOK

1. R. D. Lee, Computers in Medicine, Tata McGraw Hill Publishing Company Limited, New Delhi, 1993.

REFERENCE BOOKS

1. Harold Sackamn, Biomedical Information Technology, Academic Press, New York.
2. S.K.Chachan, PC Organisation, S.K. Kataria and Sons, Delhi 2000.

BME18R305 DESIGN OF BIOMEDICAL INSTRUMENTS	**L**	**T**	**P**	**Credit**
	3	**0**	**0**	**3**
Pre-requisite:- BME18R252	**Course Category: Professional Electives**			
	Course Type: Theory			

Objective(s)

To introduce the students to the application of biomedical instrumentation and to familiarize the students with the analysis and design of different instrument to measure biosignals. It also includes brief study of different medical instrument and their use in physiological measurements

Course Outcome(s)

Up on completion of the course, the students will be able to

CO 1 Understand the basic building blocks of Medical instrumentation system.
CO 2 Learn several signals and design parameters of ECG, EEG, EMG, ERG and MEG.
CO 3 Understand the various blood flow measurement systems.
CO 4 Design a respiratory system model and various techniques to measure air flow.
CO 5 Understand different assisting and therapeutic equioments.

Mapping of COs and POs

CO	**POs**												**PSOs**			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	L		M	L		M	M							L	M	

CO2	L		L			L	M	M				L			M	
CO3	M	L	M				L						L			L
CO4	M	M	M	M									M	L		L
CO5	M	H	H	H	M	M	L	L			M	L	M	H	M	M

UNIT I - BASIC CONCEPTS OF MEDICAL INSTRUMENTATION (9 HOURS)

General Medical Instrumentation System, Medical Measurement Constraints, Alternative Operation modes, Classification of Biomedical Instruments, Interfering and Modifying inputs, Compensation techniques, Design Criteria.

UNIT II - THE ORIGIN OF BIOPOTENTIAL (9 HOURS)

Electrical Activity of Excitable Cells, Volume Conductor fields, Functional orgsnizatoin of the peripheral nervous system, Electroneurogram, Electromyogram, Electrocardiogram, Electroretinogram, Electroencephalogram, Magnetocepahalogram.

UNIT III - MEASUREMENT OF BLOOD PRESSURE, FLOW AND VOLUME (9 HOURS)

Direct measurement, Harmonic analysis of Blood Pressure, Indicator Dilution method that uses continuous Infusion and rapid injection, Electromagnetic flowmeters, Ultrasonic flowmeters, Chamber Plethysmography, electrical Impedance Plethysmography, Photoplethysmography.

UNIT IV - MEASUREMENT OF RESPIRATORY SYSTEM (9 HOURS)

Modeling the respiratory system, measurement of pressure, measurement of gas flow, lung volume, respiratory plethysmography.

UNIT V - THERAPEUTIC AND PROSTHETIC DEVICE (9 HOURS)

Cardiac Pacemakers and other Electric Simulators, Defibrillators and Cardioverters, Mechanical Cardiovascular orthotic and prosthetic devices, hemodialysis, Lithotripsy, Ventilators, Infant Incubators, Surgical Instruments

TEXT BOOKS

1. J.Webster, "Medical Instrumentation: application and Design", John Wiley & Sons; 4th Revised edition 2009

REFERENCES

1. Leslie Cromwell, "Biomedical Instrumentation and Measurement", Prentice Hall of India, New Delhi, 2007
2. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", Pearson Education, 2004.
3. L.A Geddas and L.E.Baker "Principles of Applied Biomedical Instrumentation" 2004.
4. John G. Webster, "Bioinstrumentation", John Willey and sons, New York, 2004.

5. Myer Kutz "Standard Handbook of Biomedical Engineering & Design", McGraw-Hill Publisher, 2003.

BME18R306	TELEMEDICINE	L	T	P	C
		3	0	0	3
Pre-requisite: Nil		**Course Category:** Professional electives			
		Course Type: Theory			

Objective(s)

Apply telemetry in healthcare

Course Outcome(s)

CO1 Apply multimedia technologies in telemedicine
CO2 Understand telemedical technology.
CO3 Learn the key principles for telemedicine and health.
CO4 Explain Protocols behind encryption techniques for secure transmission of data.
CO5 Know telemedical standards, mobile telemedicine and it applications.

Mapping of COs and POs

COs	POs												PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	H				H								H			
CO2							M				M				M	
CO3		L												L		
CO4	M	L													M	
CO5		M											L			

UNIT I TELEMEDICINE AND HEALTH

History and Evolution of telemedicine, Functional diagram of telemedicine system, Telemedicine, Telehealth, Tele care, Organs of telemedicine, Global and Indian scenario, Ethical and legal aspects of Telemedicine - Confidentiality, Social and legal issues, Safety and regulatory issues, Advances in Telemedicine.

UNIT II TELEMEDICAL TECHNOLOGY

Principles of Multimedia - Text, Audio, Video, data, Data communications and networks, PSTN,POTS, ANT, ISDN, Internet, Air/ wireless communications: GSM satellite, and Micro wave, Modulation techniques, Types of Antenna, Integration and operational issues, Communication infrastructure for telemedicine – LAN and WAN technology. Satellite communication. Mobile hand held devices and mobile

communication. Internet technology and telemedicine using world wide web (www). Video and audio conferencing. Clinical data – local and centralized.

UNIT III TELEMEDICAL STANDARDS

Data Security and Standards: Encryption, Cryptography, Mechanisms of encryption, phases of Encryption. Protocols: TCP/IP, ISO-OSI, Standards to followed DICOM, HL7, H. 320 series (Video phone based ISBN) T. 120, H.324 (Video phone based PSTN), Video Conferencing, Real-time Telemedicine integrating doctors / Hospitals, Clinical laboratory data, Radiological data, and other clinically significant biomedical data, Administration of centralized medical data, security and confidentially of medical records and access control, Cyber laws related to telemedicine.

UNIT IV MOBILE TELEMEDICINE

Tele radiology: Definition, Basic parts of teleradiology system: Image Acquisition system Display system, Tele pathology, multimedia databases, color images of sufficient resolution, Dynamic range, spatial resolution, compression methods, Interactive control of color, Medical information storage and management for telemedicine- patient information medical history, test reports, medical images diagnosis and treatment. Hospital information system - Doctors, paramedics, facilities available. Pharmaceutical information system.

UNIT V TELEMEDICAL APPLICATIONS

Telemedicine access to health care services – health education and self care. Introduction to robotics surgery, telesurgery. Telecardiology, Teleoncology, Telemedicine in neurosciences, Electronic Documentation, e-health services security and interoperability., Telemedicine access to health care services – health education and self care, Business aspects - Project planning and costing, Usage of telemedicine.

TEXT BOOK:

1. Norris, A.C. “Essentials of Telemedicine and Telecare”, Wiley, 2002.

REFERENCES:

1. Wootton, R., Craig, J., Patterson, V. (Eds.), “Introduction to Telemedicine. Royal Society of Medicine” Press Ltd, Taylor & Francis 2006
2. O'Carroll, P.W., Yasnoff, W.A., Ward, E., Ripp, L.H., Martin, E.L. (Eds), “Public Health Informatics and Information Systems”, Springer, 2003.
3. Ferrer-Roca, O., Sosa - Iudicissa, M. (Eds.), Handbook of Telemedicine. IOS Press (Studies in Health Technology and Informatics, Volume 54, 2002.
4. Simpson, W. Video over IP. A practical guide to technology and applications. Focal Press Elsevier, 2006.
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.

BME18R307	VIRTUAL REALITY	L	T	P	Credit
		3	0	0	3

Pre-requisite: BME18R351 **Course Category:** Professional Elective

Course Type: Theory

Objective(s)

Design a system or process to meet given specifications with realistic engineering constraints.

Course Outcome(s)

CO1 Explore the potential of a virtual world for delivering application.

CO2 Determine possible instructional designs.

CO3 Understand the limitations.

CO4 Applying software in virtual reality.

CO5 Understand the barriers, solutions, and costs associated, including required training.

Mapping of COs and POs

	POs												PSOs			
COs	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1		M											L	M		
CO2		H											L	M		
CO3	M	M											L	M		
CO4		M			M								L	M		
CO5		M											L	M		

UNIT I INTRODUCTION (9 HOURS)

The three I's of virtual reality-commercial VR technology and the five classic components of a VR system - Input Devices: (Trackers, Navigation, and Gesture Interfaces): Three-dimensional position trackers, navigation and manipulation-interfaces and gesture interfaces-Output Devices: Graphics displays-sound displays & haptic feedback.

UNIT II MODELING (9 HOURS)

Geometric modeling - kinematics modeling- physical modeling - behaviour modeling - model management.

UNIT III HUMAN FACTORS (9 HOURS)

Methodology and terminology-user performance studies-VR health and safety issues-Usability of virtual reality system- cyber sickness -side effects of exposures to virtual reality environment

UNIT IV VR PROGRAMMING (9 HOURS)

Introducing Java 3D-loading and manipulating external models-using a lathe to make shapes. 3D Sprites- animated 3D sprites-particle systems.

UNIT V APPLICATIONS (9 HOURS)

Medical applications-military applications-robotics applications- Advanced Real time Tracking-other applications- games, movies, simulations, therapy.

TEXT BOOKS

1. C. Burdea & Philippe Coiffet, "Virtual Reality Technology", Second Edition, Gregory, John Wiley & Sons, Inc.,2008.
2. Andrew Davison, "Killer Game Programming in Java", Oreilly SPD, 2005.

REFERENCES

1. William R.Sherman, Alan Craig, "Understanding Virtual Reality, interface, Application and Design", Elsevier, Morgan Kaufmann, 2002.
2. Bill Fleming ,"3D Modeling and surfacing", Elsevier, Morgan Kauffman, latest edition
3. David H.Eberly, "3D Game Engine Design Practical Approach to Real-Time Computer Graphics", Elsevier, 2007.
4. John Vince, "Virtual Reality Systems", Pearson Education, 2007.

BME18R308	BIOMETRIC SYSTEMS	L	T	P	C
		3	0	0	3
Pre-requisite: BME18R272		**Course Category:** Professional electives			
		Course Type: Theory			

Objective(s)

To understand the existing biometric systems and to develop novel Biometric systems utilizing unique features of the human body.

Course Outcome(s)

Upon completion of the course, the student will be able to

CO1 Understand the concept of Biometrics and its applications
CO2 Illustrate the various methodologies involved in fingerprint technology
CO3 Develop techniques for face recognition and hand geometry biometrics
CO4 Demonstrate the multimodal biometrics and the methods for evaluating the performance
CO5 Distinguish the authentication mechanism of the biometric systems

Mapping of COs and POs:

COs	POs												PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	L	L											L			
CO2	M												M			
CO3		H											H			
CO4						M								M		
CO5					L									L		

UNIT I INTRODUCTION TO BIOMETRICS

Introduction and back ground – biometric technologies – passive biometrics – active biometrics -Biometric systems – Enrollment – templates – algorithm – verification – Biometric applications –biometric characteristics- Authentication technologies –Need for strong authentication – Protecting privacy and biometrics and policy – Biometric applications – biometric characteristics.

UNIT II FINGERPRINT TECHNOLOGY

History of fingerprint pattern recognition - General description of fingerprints - Finger print feature processing techniques - fingerprint sensors using RF imaging techniques – fingerprint quality assessment – computer enhancement and modeling of fingerprint images – fingerprint enhancement – Feature extraction – fingerprint classification – fingerprint matching.

UNIT III FACE RECOGNITION AND HAND GEOMETRY

Introduction to face recognition, Neural networks for face recognition – face recognition from correspondence maps – Hand geometry – scanning – Feature Extraction - Adaptive Classifiers -Visual-Based Feature Extraction and Pattern Classification - feature extraction – types of algorithm –Biometric fusion.

UNIT IV MULTIMODAL BIOMETRICS AND PERFORMANCE EVALUATION

Voice Scan – physiological biometrics –Behavioral Biometrics - Introduction to multimodal biometric system – Integration strategies – Architecture – level of fusion – combination strategy –training and adaptability – examples of multimodal biometric systems – Performance evaluation- Statistical Measures of Biometrics – FAR – FRR – FTE – EER – Memory requirement and allocation.

UNIT V BIOMETRIC AUTHENTICATION

Introduction - Biometric Authentication Methods - Biometric Authentication Systems – Biometric authentication by fingerprint -Biometric Authentication by Face Recognition. -. Expectation- Maximization theory - Support Vector Machines. Biometric authentication by fingerprint –biometric authentication by hand geometry- Securing and trusting a biometric transaction – matching location – local host - authentication server – match on card (MOC) – Multibiometrics and Two-Factor Authentication

TEXT BOOKS:

1. James Wayman, Anil Jain, Davide Maltoni, Dario Maio, "Biometric Systems, Technology Design and Performance Evaluation", Springer, 2005 (Units I, II, III & IV)
2. S.Y. Kung, S.H. Lin, M.W.Mak, "Biometric Authentication: A Machine Learning Approach"Prentice Hall, 2005(Unit V).

REFERENCES:

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

BME18R309	**NEURAL NETWORK**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Pre-requisite: Nil		**Course Category:** professional electives **Course Type**: Theory			

Objective(s):

- The course will introduce the basic neural network architectures and learning algorithms, for applications in pattern recognition, image processing, and computer vision.
- The course also covers the fundamentals of pattern recognition and its application.
- The major focus of this course will be on the use of Pattern and Neural Classifiers for classification applications

Course Outcome(s):

Upon completion of the course, the student will be able to

CO1 Understand the basic concepts of artificial neural networks (ANN)
CO2 Familiarize about various ANN models
CO3 Obtain knowledge about the self organizing maps and competitive networks
CO4 Design and apply different types of pattern classification techniques
CO5 Analyze about the application of AI in medical field and use feature extraction based on clustering.

Mapping of COs and POs

	POs												**PSO**			
COs	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	M												M			
CO2	M	M		M									M			

CO3	M			L									M			
CO4	M	M	H	M									M	H		
CO5	M	M		M									M			

UNIT I INTRODUCTION AND SIMPLE NEURAL NET (9 HOURS)

Elementary neurophysiology and biological neural network- Artificial neural network- Architecture, biases and thresholds, Hebb net, Perceptron, Adaline and Madaline.

UNIT II BACK PROPAGATION AND ASSOCIATIVE MEMORY (9 HOURS)

Back propagation network, generalized delta rule, Bidirectional Associative memory Hopfield Network

UNIT III NEURAL NETWORKS BASED ON COMPETITION (9 HOURS)

Kohonen Self organizing map, Learning Vector Quantisation, Counter Propagation network.

UNIT IV INTRODUCTION AND SUPERVISED LEARNING (9 HOURS)

Overview of Pattern recognition, Types of Pattern recognition, Parametric and Nonparametric approach, Bayesian classifier, Discriminant function, non parametric density estimation, histograms, kernels, window estimators, k- nearest neighbor classifier, estimation of error rates.

UNIT V UNSUPERVISED LEARNING AND CLUSTERING ANALYSIS (9 HOURS)

Unsupervised learning- Hierarchial clustering- Single-linkage Algorithm, Complete –linkage Algorithm, Average-linkage algorithm and Ward‟s method. Partitional clustering- Forgy‟s Algorithm, k-means algorithm and Isodata Algorithm

TEXT BOOKS

1. Duda R.O,Hart P.G, “Pattern Classification and scene analysis”, Wiley Edition 2000
2. Earl Gose, Richard Johnsonbaugh Steve Jost, “Pattern Recognition and Image Analysis”, Prentice Hall of India Pvt Ltd., New Delhi, 1999
3. Hagan, Demuth and Beale, “Neural network design”, Vikas Publishing House Pvt Ltd., New Delhi, 2002
4. Freeman J.A., and Skapura B.M, “Neural networks, algorithms, applications and programming techniques”, Addison- Wesley, 2003.

REFERENCES

1. Robert Schalkoff, “Pattern recognition, Statistical, Structural and neural approaches” John Wiley and Sons(Asia) Pvt Ltd., Singapore, 2005.
2. Laurene Fausett, “Fundamentals of neural networks- Architectures, algorithms and applications”, Prentice Hall, 1994.

BME18R310	CLINICAL ENGINEERING	L	T	P	Credit
		3	0	0	3
Pre-requisite: Nil		**Course Category:** Professional electives			
		Course Type: Theory			

Objective(s)

To perform the role as a Biomedical engineer in the hospital understanding all the modules involved in hospitals.

Course Outcome(s)

Upon completion of the course, the student will be able to

CO1 Classify the architecture and types of hospitals

CO2 Understand how an electrical system should be in a hospital

CO3 Understand the air conditioning and gas systems

CO4 Know about the importance of Biomedical Engineer

CO5 Attain knowledge about the hospital informations.

Mapping of COs and POs

COs	POs												PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	M	M				M							H	M		L
CO2	M	M				M							H	M		L
CO3	M	M				M							H	M		L
CO4	M	M				M							H	M		L
CO5	M	M				M							H	M		L

UNIT I CLASSIFICATION OF HOSPITAL & ARCHITECTURE (9 HOURS)

General hospital, specialized hospital, primary health care – their role and functions. Aspects of hospital services – inpatient, outpatient and emergency. Location and environment of hospital, Hierarchy of medical and paramedical staff & their functions and responsibilities. Modern Hospital Architecture-space in a hospital building, design of ward, intensive care units, air conditioning, plumbing & sanitation, gas supply, waste disposal, cleaning, dietary, sterilizing, laundry, storage and operation theatre systems, Radiology, Central labs, Blood banks, OPD, Causality, etc.

UNIT II ELECTRICAL POWER SYSTEMS IN HOSPITALS (9 HOURS)

Safety of electrical systems, Protective systems - interference of patient's protection grounding. Design of sub stations, breakers, Surge protectors, EMI filters, voltage stabilizers, generator sets and UPS. Uninterrupted power supply for ICU and computerized monitoring units. Specification & estimation for hospital wiring - small case study.

UNIT III AIR CONDITIONING & GAS SUPPLY SYSTEMS (9 HOURS)

Air conditioning and refrigeration systems for small and large areas. Air changes, filtering and sterility. Deodorization, disinfection, dehumidification and cryogenic systems. Centralized supply of air, oxygen, nitrous oxide & vacuum - Principle of production of liquid oxygen. Management lifts fire fighting equipments.

UNIT IV HOSPITAL ENGINEERING & MANAGEMENT (9 HOURS)

Definition of biomedical Engineering, clinical engineering & hospital engineering. Importance of BME department – servicing and maintenance, testing, acceptance & maintenance protocols, Computerized preventive maintenance planning, MROs. Training of men for medical equipments preventive and periodical maintenance procedures. Preparation of estimates, specifications, tender details etc. Importance of ISO 9000 Certificates - Obtaining ISO certificates in hospitals. Proposed protocols.

UNIT V HOSPITAL INFORMATION SYSTEM (9 HOURS)

Role of database in HIS. Need of Networking in HIS. Overview of Networking, topologies and its configuration. Structuring medical records to carry out functions like admissions, discharges, treatment history etc. Computerization in pharmacy & billing. Automated clinical laboratory systems & radiology information system.

TEXT BOOK

1. Harold E. Smalley, "Hospital Management Engineering – A guide to the improvement of hospital management system", PHI. Latest Edition.

REFERENCES

1. Sharma, Essentials for Hospital Support Services and Physical Infrastructure, 1/e, Jaypee Medical Publishers 2003
2. Hospital Engineering And Facilities Management 2007 - Report, Fifth official report of the International Federation of Hospital Engineering (IFHE), January 2007
3. Gupta, Kant, Chandrashekhar, Satpathy, Modern Trends in Planning and Designing of Hospitals Principles and Practice with CD-ROM, Jaypee Medical publishers, 1/e, 2007
4. Sakharkar, Principles of Hospital Administration and Planning, Jaypee Medical publishers 1/e, Reprint 2004

BME18R311 BIOFLUIDS AND DYNAMICS	L	T	P	Credit
	3	0	0	3
Pre-requisite: BME18R351	**Course Category:** Professional Elective			
	Course Type: Theory			

Objective(s)

• An understanding on the physiology and anatomy of studied systems.

• A capability to analyse cardiac, respiratory, soft tissue and orthopedic mechanics.

Course Outcome(s)

CO1 To understand the concept of mechanics of bio-fluids.
CO2 To study the nature of blood flow in different vessels.
CO3 To understand mechanical activity of heart.
CO4 To understand mechanical activity of soft tissues.
CO5 To understand mechanical activity of bones and joints.

Mapping of COs and POs

	POs												**PSO**			
COs	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1		L				H							M	M		
CO2	M	M				H							M	M		
CO3	M	M				H							M	M		
CO4	M	M				H							M	M		
CO5	M	M				H							M	M		

UNIT I BIO**-FLUID MECHANICS (9 HOURS)**

Newton's laws, Stress, Strain, Elasticity, Hooks-law, viscosity, Newtonian fluid, Non-Newtonian fluid, Viscoelastic fluids, vascular tree, Relationship between diameter, velocity and pressure of blood flow, Resistance against flow. Bioviscoelastic fluid: Viscoelasticity - Viscoelastic models, Maxwell, Voigt and Kelvin Models, Response to Harmonic variation, Use of viscoelastic models, Bio- Viscoelastic fluids: Protoplasm, Mucus, Saliva, Synovial fluids.

UNIT II FLOW PROPERTIES OF BLOOD (9 HOURS)

Physical, Chemical and Rheological properties of blood. Apparent and relative viscosity, Blood viscosity variation: Effect of shear rate, hematocrit, temperature, protein contents of blood. Casson's equation, Problems associated with extracorporeal blood flow. Rheology of Blood In Microvessels: Fahraeus - Lindquist effect and inverse effect, distribution of suspended particles in a narrow rigid tube. Nature of red blood cells in tightly fitting tubes, hematocrit in very narrow tube.

UNIT III CARDIAC MECHANICS (9 HOURS)

Cardiovascular system. Mechanical properties of blood vessels: arteries, arterioles, capillaries and veins. Blood flow: Laminar and Turbulent, Physics of cardiovascular diseases, Prosthetic heart valves and replacements. Respiratory Mechanics: Alveoli mechanics, Interaction of Blood and Lung P-V curve of Lung: Breathing mechanism, Airway resistance, Physics of Lung diseases.

UNIT IV SOFT TISSUE MECHANICS (9 HOURS)

Pseudo elasticity, non-linear stress-strain relationship, Viscoelasticity, Structure, function and mechanical properties of skin, ligaments and tendons.

UNIT V ORTHOPEDIC MECHANICS (9 HOURS)

Mechanical properties of cartilage, diffusion properties of Articular cartilage, mechanical properties of bone, kinetics and kinematics of joints, lubrication of joints.

TEXT BOOK

1. Y.C Fung, "Biomechanics- Mechanical properties of living tissues", 2nd Edition, Springer-Verlag,1993.

REFERENCES

1. David A. Rubenstein, Weiyin, Mary D. Frame, "Biofluid Mechanics- An Introduction to fluid
2. Mechanics, Macrocirculation and Microcirculation", Springer, 2013.
3. Silver Frederick H. Biomaterials, Medical Devices & Tissue Engineering: Chapman & Hall,London, 1994
4. Nihanth ozkai, D.A Mc Donald ,"Biomechanics, Blood flow in arteries", Edward Arnold ltd, 1998.
5. D.O Cooney, Biomedical Engineering Principles. Marcel Dekker, INC New York.1976.

BME18R312	EMBEDDED SYSTEMS IN MEDICINE	L	T	P	C
		3	0	0	3
Pre-requisite: Nil		**Course Category:** Professional elective			
		Course Type: Theory			

Objective(s)

To introduce students to the modern embedded systems and to show how to understand and program such systems using a concrete platform built around.

Course Outcome(s)

CO1 Describe the differences between the general computing system and the embedded system, also recognize the classification of embedded systems.

CO2 To acquire knowledge in various processors employed in embedded systems

CO3 Implementation of concurrent process and data flow models.

CO4 Design real time embedded systems using the concepts of RTOS

CO5 Apply the concept of embedded system in various medical applications.

Mapping of COs and POs

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
CO1	H	H											M			
CO2	H				H		H	H	H	H				H	H	H
CO3	H	H	L	L	M		M	M	M	M			M	L		
CO4	H	H	H	H	M		L	M	M	M			H	H		
CO5			H	L	M		L	M	M	M						

UNIT I INTRODUCTION TO EMBEDDED SYSTEM

Introduction, design challenge, processor technology, IC technology, Design technology, Trade-offs, Single purpose processors, RT-level combinational logic, sequential logic (RT-level), custom single purpose processor design (RT-level) and optimization techniques.

UNIT II GENERAL PURPOSE PROCESSORS, STATE MACHINE

Basic architecture, operation, Pipelining, Programmer's view, development environment, Application Specific Instruction-Set Processors (ASIPs) – Micro Controllers and Digital Signal Processors, models Vs. languages, finite state machines with data path model (FSMD), using state machines, program state machine model (PSM),

UNIT III CONCURRENT PROCESS MODELS

Concurrent process model, concurrent processes, communication among processes, synchronization among processes, implementation, data flow model, real-time systems.

UNIT IV COMMUNICATION INTERFACES

Need for communication interfaces, RS232 / UART, RS422 / RS485, USB, Infrared, IEEE 1394 Firmwire, Ethernet, IEEE 802.11, Blue tooth.

UNIT V APPLICATIONS

Real-Time Embedded Software Development, Sending a Message over a Serial Link, Simulation of a Process Control System, Controlling an Appliance from the RT Linux System, Embedded Database Applications, Embedded medical applications: Ophthalmology - Glaucoma screening device, Medical Imaging Acquisition User Interface, Drug delivery systems, Patient monitoring Systems.

TEXT BOOKS

1. Frank Vahid, Tony D. Givargis, "Embedded System Design – A Unified Hardware/Software Introduction", John Wiley, 2002.
2. K.V.K.K. Prasad, "Embedded / Real Time Systems", Dreamtech Press, 2005.
3. Sri Ram V Iyer - Pankaj Gupta, "Embedded Real Time Systems Programming", Tata McGraw Hill, 2005.
4. Steve Heath, "Embedded System Design", Elsevier, Second Ed., 2004.

BME18R313 MECHANICS OF BIOLOGICAL SYSTEMS	L	T	P	Credit
	3	0	0	3
Pre-requisite: BME18R351	**Course Category: Professional electives**			
	Course Type: Theory			

Objective(s)

To understand about the needs of a sports person met by a Biomedical Engineer.

Course Outcome(s)

Upon completion of the course, the student will be able to

CO1 Illustrate the basics of soft tissue mechanics

CO2 Analyze the mechanics of head and neck after having an injury

CO3 Distinguish the mechanics of different joints of the body

CO4 Interpret the gait analysis

CO5 Discuss the functions of organs during sports and exercise

Mapping of COs and POs

COs	POs												PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	H	L		L	L							L	H	L		
CO2	M	H	L	M	M	M	L	M	M	M		L	M	M		L
CO3	M	L		L				L	M				M	L		
CO4	M	M	M	H	H	M		M	H	M	M	M	M	H	M	L
CO5	M			M		L			M	L			H			

UNIT I - SOFT TISSUE BIOMECHANICS (9 HOURS)

Fundamentals of Soft Tissue Mechanics: Muscle Architecture, Max Muscle Stress, Max Muscle Contraction Velocity, Muscle Force-Length Relationship, Muscle Force-Velocity Relationship, Tendon Biomechanics.

UNIT II - MECHANICS OF HEAD AND NECK (9 HOURS)

Injury Mechanisms, Mechanical Response, Regional Tolerance, Biomechanics of Chest and Abdominal Impact, Biomechanical Responses During Impact, Injury Risk Assessment.

UNIT III-BIOMECHANICS OF DIFFERENT JOINTS OF HUMAN BODY (9 HOURS)

Geometry of Articulating Surfaces, Joint Contact, Axes of Rotation of (Ankle, Knee, Hip, Shoulder, Elbow, Wrist, Hand), Tribology (Friction, Wear and Surface Damage), Hydrodynamic Lubrication Theories, Boundary Lubrication, Synovial Joints.

UNIT IV - GAIT ANALYSIS (9 HOURS)

Clinical Gait Analysis Information, Data Collection Protocol, Measurement Approaches and Systems (Stride and Temporal Parameters, Motion Measurement, Ground Reaction Measurement, Dynamic Electromyography).

UNIT V - PHYSIOLOGY IN SPORTS AND EXERCISE (9 HOURS)

Muscle Energetic, Cardiovascular Adjustments, Maximum Oxygen Uptake, Respiratory Responses, Optimization Techniques, Thermal Response, Applications.

TEXT BOOKS

1. J. D. Bronzino, "Biomedical Engineering Handbook", 3rd ed,CRC Press, 2006.
2. Nordine-Frankel, "Basic Biomechanics of the Musculoskeletal System", Lea & Febiger, 2012.
3. Arthur T. Johnson, "Biomechanics and Exercise Physiology", 2nd edition, John Wiley and Sons, 2007.

REFERENCES

1. Duane Knudson, "Fundamentals of Biomechanics", Springer, 2nd Edition, 2007.
2. Donald R.Peterson, Joseph D.Brozino, "Biomechanics –Principles and Applications", 2nd Edition, CRC press, 2007.
3. Ross Ethier, Craig A.Simmons, "Introductory Biomechanics-from cells to organisms", 1st edition, Cambridge University Press, 2007.
4. Cees Oomens, Marcel Brekelmens, Frank Baaijens, "Biomechanics: Concepts and Computation", 1st edition, Cambridge University Press, 2010

BME18R402	HUMAN ASSIST DEVICES	L	T	P	C
		3	0	0	3
Pre-requisite: BME18R201		**Course Category:** Professional electives			
		Course Type: Theory			

Objective(s)

- To understand the principle, design and application of various human assist devices which include extracorporeal devices, cardiac assist devices, respiratory devices and hearing aids.
- This course also includes a brief introduction to design aspects of prosthetic and orthotic devices for the disability.

Course Outcome(s)

Upon completion of the course, the student will be able to

CO1 Illustrate the various building blocks of Heart lung Machine and its working principle.
CO2 Understand the principle and working of various cardiac assist devices.
CO3 Understand the role and working of artificial kidney.
CO4 Ability to specify the type of assistive devices for rehabilitation.
CO5 Categorize the different types of respiratory assist devices and hearing aids.

Mapping of COs and POs:

	POs												PSO			
COs	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	M	L	M										M	M		
CO2	M	L	M										M	M		
CO3	M	L	M			H							M	H		
CO4	M	L	M					H					M	M		
CO5	M	L	M			M		H					M	M		

UNIT I HEART LUNG MACHINE AND ARTIFICIAL HEART (9 HOURS)

Condition to be satisfied by the H/L System. Different types of Oxygenators, Pumps, Pulsatile and Continuous Types, Monitoring Process, Shunting, The Indication for Cardiac Transplant, Driving Mechanism, Blood Handling System, Functioning and different types of Artificial Heart, Mock test setup for assessing its Functions.

UNIT II CARDIAC ASSIST DEVICES (9 HOURS)

Synchronous Counter pulsation, Assisted through Respiration Right Ventricular Bypass Pump, Left Ventricular Bypass Pump, Open Chest and closed Chest type, Intra Aortic Balloon Pumping Veno Arterial Pumping, Prosthetic Cardio Valves, Principle and problem, Biomaterials for implantable purposes, its characteristics and testing.

UNIT III ARTIFICIAL KIDNEY (9 HOURS)

Indication and Principle of Haemodialysis, Membrane, Dialysate, Different types of heamodialysers, Monitoring Systems, Wearable Artificial Kidney, Implanting Type.

UNIT IV PROSTHETIC AND ORTHOTIC DEVICES (9 HOURS) Hand and Arm Replacement - Different Types of Models Externally Powered Limb Prosthesis, Lower Limb and Upper limb orthotic devices, Functional Electrical Stimulation, Sensory Assist Devices, Materials for Prosthetic and orthotic devices, Haptic Devices.

UNIT V RESPIRATORY AND HEARING AIDS (9 HOURS)

Ventilator and its types-Intermittent positive pressure, Breathing Apparatus Operating Sequence, Electronic IPPB unit with monitoring for all respiratory parameters. Types of Deafness, Hearing Aids, Construction and Functional Characteristics

REFERENCES

1. Andreas.F.Von racum, Hand book of bio material evalution, Mc-Millan publishers, 1980.
2. Albert M.Cook and Webster J.G., Therapeutic Medical Devices, Prentice Hall Inc.,New Jersey,1982
3. Gray E Wnek, Gray L Browlin – Encyclopedia of Biomaterials and Biomedical Engineering –Marcel Dekker Inc New York 2004.
4. John. G . Webster – Bioinstrumentation - John Wiley & Sons (Asia) Pvt Ltd - 2004.
5. Kolff W.J., Artificial Organs, John Wiley and Sons, New York, 1979.

BME18R403 **REHABILITATION ENGINEERING**	**L**	**T**	**P**	**Credit**
	3	**0**	**0**	**3**
Pre-requisite: BME18R351	**Course Category:** Professional electives			
	Course Type: Theory			

Objective(s)

Discuss the broad area of rehabilitation engineering and its application to assist people with impairments in sensing, communication, seating, manipulation, and mobility

Course Outcome(s)

CO1 Study the principles of rehabilitation.

CO2 Describe the features of human movement in health and disability and discuss the application of these properties in rehabilitation engineering design.

CO3 Learn therapeutic Exercise Techniques.

CO4 Discuss the various rehabilitation communication techniques.

CO5 Understand orthopedic prosthetics and orthotics in rehabilitation.

Mapping of COs and POs:

	POs												**PSO**			
COs	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	L							H					L			
CO2	M	M	M					M					M	M		
CO3		M	H			H								M		
CO4		H						M						H		
CO5	M	M				H		H					M	M		

UNIT I INTRODUCTION TO REHABILITATION & REHABILITATION TEAM

(9 HOURS)

What is Rehabilitation, Epidemiology of Rehabilitation, Health, Levels of Prevention, Preventive Rehabilitation, Diagnosis of Disability, Functional Diagnosis, Importance of Psychiatry in Functional diagnosis, Impairment disability handicap, Primary & secondary Disabilities, Rehabilitation team-Classification of members,

UNIT II PRINCIPLES OF REHABILITATION (9 HOURS)

Introduction, The Human Component, Principles of Assistive Technology Assessment, Principles of Rehabilitation Engineering- Key Engineering Principles, Key Ergonomic Principles - Practice of Rehabilitation and Assistive Technology.

UNIT III THERAPEUTIC EXERCISE TECHNIQUE (9 HOURS)

Co-ordination exercises, Frenkels exercises, Gait analyses-Pathological Gaits, Gait Training, Relaxation exercises-Methods for training Relaxation, Strengthening exercises-Strength training, Types of Contraction, Mobilization exercises, Endurance exercises.

UNIT IV PRINCIPLES IN MANAGEMENT OF COMMUNICATION (9 HOURS)

Impairment-introduction to communication, Aphasia, Types of aphasia, Treatment of aphasic patient, Augmentative communication-general form of communication, types of visual aids, Hearing aids, Types of conventional hearing aid, Writing aids.

UNIT V ORTHOTIC & PROSTHETIC DEVICES: (9 HOURS)

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

Prosthetic devices: Hand and arm replacement, Body powered prosthetics, Myoelectric controlled prosthetics and Externally powered limb prosthetics.

TEXT BOOKS

1. Dr. S. Sunder, Rehabilitation Medicine-, 3rd Edition, Jaypee Medical Publications, New Delhi. 2010 (Units I, III, IV & V)
2. Joseph D.Bronzino, The Biomedical Engineering Handbook, Third Edition: Three Volume Set, CRC Press, 2006 (Units II & V).

REFERENCES

1. Rory A Cooper, An Introduction to Rehabilitation Engineering, Taylor & Francis, CRC press, 2006.
2. Susan B O'Sullivan, Thomas J Schmitz, Physical Rehabilitation. 5th Edition, Davis publications, 2007.

BME18R404 MODELING OF PHYSIOLOGICAL SYSTEM	L	T	P	Credit
	3	0	0	3
Pre-requisite: BME18R251	**Course Category:** Professional electives **Course Type**: Theory			

Objective(s)

Demonstrates the application of Physiological models.

Course Outcome(s)

CO1 Understand and appreciate the value and application of Physiological models and Vital organs.

CO2 Implement the transfer function for various physiological organs.

CO3 Model dynamically varying physiological system.

CO4 Understand methods and techniques for analysis and synthesis of dynamic models.

CO5 Develop differential equations to describe the dynamic models, simulate and visualize, dynamic responses of physiological models using software.

Mapping of COs and POs:

	POs												PSOs			
COs	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	M	M				M							M	H		
CO2	M	M	H			M							M	H		
CO3	M	M	H			M							M	H		
CO4	M	H	M			M							M	H		
CO5	M	M	H			M							M	H		

UNIT I SYSTEM CONCEPT (9 HOURS)

Review of physiological system modeling- system properties- different configurations of tracheal network, static and dynamic resistance, Thermal resistance in human systems, System with volume storage capacity and its electrical analog, Simplified model of respiratory system, Simulation of aortic segments ,Comparison of muscle model isotonic response, Step response of resistant / compliant systems –Dye dilution study of circulation, pulse response of first order system.

UNIT II TRANSFER FUNCTION (9 HOURS)

System as an operator and use of Transfer function, Bio Engineering of coupled systems, Examples of transformed signals and circuits for transfer function with impedance concept- Development of lung model, Impedance of a two stage ladder network, Measurement of airway resistance.

UNIT III PERIODIC SIGNALS (9 HOURS)

Sinusoidal Functions, Analysis of Instrumentation to measure air flow system, second order system – representation of a respiratory system, Evaluation of Transfer function from frequency response for muscle response modes, Relationship between Phase lag and Time Delay-closed loop aspects of pupillary control system , Transient Response of an Undamped Second order system, General Description of Natural Frequency Damping, Physical Significance of under damped responses of post systolic operations in aortic arch.

UNIT IV FEEDBACK (9 HOURS)

Characterization of Physiological Feedback systems- Hypophysis adrenal systems, pupillary hippus, Uses and Testing of System Stability, Simulation-Hodgkin-Huxley model, Model of cardiovascular variability.

UNIT V SIMULATION OF BIOLOGICAL SYSTEM (9 HOURS)

Simulation of thermal regulation, pressure and flow control in circulation, occulo motor system, Endocrinal system, functioning of receptors, introduction to digital control system.

TEXT BOOKS

1. Johnny T.Ottesen, Mette S.Olufsen, Jesper K.Larsen, " Applied Mathematical Models of Human physiology" 1st Edition, SIAM: Society for Industrial and Applied Mathematics, 2004.
2. Willian B. Blesser, "A System Approach to Biomedicine", Mc Graw Hill Book Co., New York, 1981 (Units I, II, III, IV).
3. Micheal C.K.Khoo, "Physiological Control System" Analysis, Simulation and Estimation".- Prentice Hall of India , New Delhi , 2001(Unit V).

REFERENCES

1. Richard Skalak and Shu Chien, "Hand Book of Biomedical Engineering", Mc Graw Hill and Co. New York, 1987.
2. Douglas S.Rigg., "Control Theory and Physiological Feedback Mechanism", The Wilkliam and Wilkins Co. Baltimore, 1970.

BME18R405 NEURAL ENGINEERING	L	T	P	Credit
	3	0	0	3
Pre-requisite: Nil	**Course Category:** Professional electives **Course Type**: Theory			

Objective(s)

The student should be made to:

- Be familiar with the nervous system development
- Be exposed to neuronal diseases and disorders

- Be familiar with nerve reconstruction and repairing.

Course Outcome(s)

Upon Completion of the course, the students will be able to

CO1 Explain the structure of neuron and nervous system development.

CO2 Discuss about the brain and Spinal cord

CO3 Describe the electrical conduction happens in nervous system.

CO4 Explain various neuro degenerative, demyelinated and injury related disorders associated with nervous system.

CO5 Apply neural tissue engineering for rehabilitation Regenerate nervous system.

Mapping of COs and POs:

	POs												PSOs			
COs	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
CO1	M	M											M			
CO2	M	M											M			
CO3	M	M											M			
CO4	M	M											M			
CO5	M	M											M			

UNIT I - BASICS OF NEURON STRUCTURE AND FUNCTIONS (9 HOURS)

Nervous system development. Trophic factors, extra cellular matrix components in nervous system development.

Neuron: structure –function –classification. Glial cells – myelination - Neurotransmitter – types and functions. Synapses - Transport of materials and impulse in neurons; Blood Brain barrier.

UNIT II - BRAIN, BRAIN STEM AND SPINAL CORD (9 HOURS)

Brain: structures –lobes – functional areas. Brain stem: structures –functional areas. Spinal cord: structure –functions. Concepts of nuclei -Tracts - Reticular formation. Blood supply of Brain and spinal cord.

UNIT III - NEUROPHYSIOLOGY & NEURORADIOLOGY (9 HOURS)

Physiology of nerve conduction. Peripheral nerves – structure & Functions. Synaptic transmission and cellular signaling of Neurons. Electrical activity of the Brain and recording of brain waves. Evoked potentials. Visualization of nervous system.

UNIT IV - NEURONAL DISEASES AND DISORDERS (9 HOURS)

Neuro degeneration: Degenerative, Demyelinated and injury related disorders associated with nervous system. Wallerian Degeneration. Neuronal plasticity - CNS acting drugs and their pharmacokinetics.

UNIT V - NERVE RECONSTRUCTION AND REPAIRING (9 HOURS)

Regeneration of the nervous system. Nerve graft; Neural tissue engineering; Drug delivery system in CNS. Cognitive & neurobehavioral rehabilitation.

TEXT BOOKS

1. Mathews G.G. "Neurobiology", 2nd edition, Blackwell Science, UK, 2000.
2. Malcom Carpenter, "Neuroanatomy", Mc Graw Hill 4thEdition.

REFERENCES

1. W. Mark Saltzman Tissue Engineering –Engineering principles for design of replacement organs and tissue –-Oxford University Press Inc New York 2004.
2. Park J.B., "Biomaterials Science and Engineering", Plenum Press, 2005

BME18R406	Bio MEMs	L	T	P	C
		3	0	0	3
Pre-requisite: Nil		**Course Category:Professional** electives **Course Type**: Theory			

Objective(s)

To understand the principles of MEMS and to design medical devices utilizing the principles.

Course Outcome(s)

Upon completion of the course, the student will be able to

CO1 Understand about the materials of MEMs and Microsystems
CO2 Gain knowledge about microsensors and actuators
CO3 Understand the fundamentals of MEMs technology
CO4 Analyze the microfluidic systems
CO5 Apply the MEMs technology in biological applications.

Mapping of COs and POs:

COs	POs												PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1			M			M	M					L	L			L
CO2	M				M									M		
CO3	M					L	L	L					M			
CO4	M	L	M		H	M	M	M				M	M	M		M
CO5	M		H	M	M	M	H	M				M	M	M		M

UNIT I MEMS AND MICROSYSTEMS

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

UNIT II MICROSENSORS AND ACTUATORS

Mechanics for MEMs design- static bending of thin plates, mechanical vibration, thermo mechanics, fracture and thin film mechanics. Mechanical sensors and actuators – beam and cantilever – microplates, strain, pressure and flow measurements, gyroscope, piezo actuator. Thermal sensors and actuators- micro machined thermocouple probe, Peltier effect hat pumps, thermal flow sensors.

UNIT III MICRO OPTO ELECTRO MECHANICAL SYSTEMS

Fundamental principle of MOEMS technology, light modulators, beam splitter, micro lens, digital micro mirror devices, light detectors, grating light valve, optical switch.

UNIT IV MICROFLUIDIC SYSTEMS

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

UNIT V BIOMEMS

CAD for MEMs, Drug delivery, micro total analysis systems (MicroTAS) detection and measurement methods, microsystem approaches to polymerase chain reaction (PCR), DNA hybridization**.**

TEXT BOOKS:

1. Nitaigour Premch and Mahalik, " MEMS", Tata McGraw Hill Publishing Company, New Delhi, 2007
2. Tai Ran Hsu , "MEMS and Microsystems design and manufacture", Tata McGraw Hill Publishing Company, New Delhi, 2002
3. Wanjun Wang, Stephen A.Soper, "BioMEMs: Technologies and applications", CRC Press, New York, 2007.

BME18R407	TISSUE ENGINEERING	L	T	P	Credit
		3	0	0	3
Pre-requisite: **BME18R101**		**Course Category:** Professional electives			
		Course Type: Theory			

Objective(s)

To understand the concepts of molecular biology and to aid in new tissue generation and organ transplantation.

Course Outcome(s)

Upon completion of the course, the student will be able to

CO1 Have a basic knowledge in tissue engineering

CO2 Culture cells

CO3 Analyze the molecular biology in tissue engineering

CO4 Understand the transplantation

CO5 Get a clear idea on how the tissue engineering applicable for real life.

Mapping of COs and POs:

COs	POs												PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	H	L			M	M	L	H			M	H	H	L	L	M
CO2	H	L		M	M	M	L	H		L	M	H	H	M	L	M
CO3	H	M			L	M	L	M		L	L	M	H	M	L	M
CO4	H	H	M	M	M	M	M	M	M	H	M	M	H	H	M	M
CO5	M	L		H	M	M	L	M	M	L	L	M	M	M	L	M

UNIT I INTRODUCTION (9 HOURS)

Basic definition, Structural and organization of tissues: Epithelial, connective; vascularity and angiogenesis, basic wound healing, cell migration, current scope of development and use in therapeutic and in-vitro testing.

UNIT II CELL CULTURE (9 HOURS)

Different cell types, progenitor cells and cell differentiations, different kind of matrix, cell-cell interaction. Aspect of cell culture: cell expansion, cell transfer, cell storage and cell characterization, Bioreactors.

UNIT III MOLECULAR BIOLOGY ASPECTS (9 HOURS)

Cell signaling molecules, growth factors, hormone and growth factor signaling, growth factor delivery in tissue engineering, cell attachment: differential cell adhesion, receptor-ligand binding, and Cell surface markers.

UNIT IV SCAFFOLD AND TRANSPLANT (9 HOURS)

Engineering biomaterials for tissue engineering, Degradable materials (collagen, silk and polylactic acid), porosity, mechanical strength, 3-D architecture and cell incorporation. Engineering tissues for

replacing bone, cartilage, tendons, ligaments, skin and liver. Basic transplant immunology stems cells: introduction, hepatopoiesis.

UNIT V CASE STUDY AND REGULATORY ISSUES (9 HOURS)

Case study of multiple approaches: cell transplantation for liver, musculoskeletal, cardiovascular, neural, visceral tissue engineering. Ethical, FDA and regulatory issues of tissue engineering.

TEXT BOOK

1. Clemens van Blitterswijk, Tissue Engineering", Academic Press, 2008.

REFERENCES

1. Bernhard O.Palsson, "Tissue Engineering", Pearson Education, 1st Edition, 2016
2. John P.Fisher, antonios G.Mikos, Joseph D.Bronzino, "Tissue Engineering", CRC Press, 2007
3. Endarle, Blanchard &Bronzino, "Introduction to Biomedical Engineering" Academic press.4th Edition, 2015
4. Robert Lanza, Robert Langer, Joseph P.vacanti, "Principles of Tissue Engineering", Academic Press, 2011.

BME18R408 NANOTECHNOLOGY IN MEDICINE	**L**	**T**	**P**	**Credit**
	3	**0**	**0**	**3**
Pre-requisite: Nil **Course Category:** Professional electives **Course Type**: Theory				

Objective(s)

To gain knowledge on nanosystems and to apply the techniques for health care industry.

Course Outcome(s)

Upon completion of the course, the student will be able to

CO1 Improvise the knowledge in physics of solid state
CO2 Understand the fundamentals of nanoscience
CO3 Demonstrate the preparation of nanosystems
CO4 Characterize different nanosystems
CO5 Apply the knowledge acquired in medicine

Mapping of COs and POs:

	POs												**PSO**			
COs	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	H	M											H			
CO2	M	L											M			

CO3		M	M											M		
CO4		M												M		
CO5	M	M												M		

UNIT I INTRODUCTION TO PHYSICS OF SOLID STATE (9 HOURS)

Intermolecular forces: thermodynamic aspects - Quantum Mechanical Treatment of the Many-Particle Problem - Potential Energy Surface - Pair Potential Approximation - Advantages and Limitations of the Pair Potential Approximation - Phenomenological Potentials - Pseudo-Potentials - Many-Body Potentials.

UNIT II FUNDAMENTALS OF NANOSCIENCE (9 HOURS)

Size dependence of properties - Particle size determination - Bulk to nano transition - Semiconducting nanoparticles - Carbon nanostructures - Mechanical properties (hardness, ductility, elasticity) - Optical properties of nanotubes - Electrical properties of nanotubes.

UNIT III PREPARATION OF NANOSYSTEMS (9 HOURS)

Introduction to nanolithography - Carbon nanotubes: preparation - Synthesis and preparation of nanomaterials (crystalline and thinfilm) - Physical and chemical methods - Control and stability (size, shape, composition).

UNIT IV CHARACTERIZATION OF NANOSYSTEMS (9 HOURS)

Thermal Stability - Basic Material Properties - Mean Values and Correlation Functions - X-ray diffraction - Scanning Electron Microscopy - Scanning Tunneling Microscopy – Transmission Electron Microscopy - X-ray absorption spectroscopy – Photoelectron emission spectroscopy.

UNIT V APPLICATIONS: POTENTIAL OF NANOTECHNOLOGY IN MEDICINE (9 HOURS)

Nanotubes, nanowires, and nanodevices-introduction - Functional Nanostructures – Introduction to molecular electronics - Field emission and Shielding - Microelectromechanical systems (MEMs) - Nanoelectromechanical systems (NEMs) - Molecular and Supramolecular Switches – Biosensors – Qdots – Nanoshells – Nanobiotix – Cancer detection – Drug Delivery using Nanoparticles and Molecular Carriers.

TEXT BOOKS

1. Di Ventra, Massimiliano; Evoy, Stephane; Heflin, James R., Introduction to Nanoscale Science and Technology, Springer publications, 2004
2. Vinod Labhasetwar, Diandra L. Leslie-Pelecky, Biomedical Applications Of Nanotechnology, Wiley-Interscience A John Wiley & Son, Inc., Publication, 2007

REFERENCES

1. Chattopadhyay, Introduction to Nanoscience and Naotechnology, PHI, 2009
2. B.k. Parthasarathy, Nanoscience and Nanotechnology, Gyan Books, 2007
3. Vicki H. Grassian, Nanoscience and Nanotechnology: Environmental and Health Impacts (Hardcover - 2008), John Wiley & Sons
4. T. Pradeep, Nano – The essentials, McGraw-Hill publishers, 2008
5. Bhushan, Bharat (Ed.), Springer Handbook of Nanotechnology, Springer publications, 2007
6. Tuan Vo-Dinh, Nanotechnology in Biology and Medicine: Methods, Devices, and Applications, CRC Press, Jan 2007

BME18R409 ADVANCED DIGITAL SIGNAL PROCESSING	**L**	**T**	**P**	**Credit**
	3	**0**	**0**	**3**
Pre-requisite: BME18R371	**Course Category:** Professional electives **Course Type**: Theory			

Objective(s)

To strengthen students' knowledge of DSP fundamentals and familiarize them with practical aspects of DSP algorithm development and implementation.

Course Outcome(s)

Up on completion of the course, the students will be able to

CO 1 Know the analysis of discrete time signals.

CO 2 Understand the modern digital signal processing algorithms and estimate unknown parameters from the measured data.

CO 3 Design a filter to remove different types of noises.

CO 4 Design a model for speech signal and estimate parameters using modern algorithms.

CO 5 Understand different types of transforms.

Mapping of COs and POs

	POs												**PSOs**			
COs	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
CO1	M												M			
CO2		M											M			
CO3			H	H	H									H		
CO4			H	H	H									H		
CO5	H												H			

UNIT I - DISCRETE RANDOM PROCESS (9 HOURS)

Discrete Random Processes- Expectation- Variance- Co-Variance- Uniform- Gaussian and Exponentially distributed noise - Hilbert space and inner product for discrete signals -Energy of Discrete Signals- Parseval's Theorem- Wiener Khintchine Relation- Power Spectral Density- Sum Decomposition Theorem- Spectral Factorization Theorem - Discrete Random Signal Processing by Linear Systems - Simulation of White Noise - Low Pass Filtering of White Noise-

UNIT II - POWER SPECTRUM ESTIMATION (9 HOURS)

Sample auto correlation–Periodogram- Use of DFT in power spectrum estimation- Non– parametric methods:-Bartlett- Welch and Blackman-Tukey method- Parametric methods:- Model based Approach - AR- MA- ARMA Signal Modeling-Parameter Estimation using Yule-Walker Method- Solutions using Durbin's algorithm.

UNIT III - ADAPTIVE & MULTIRATE SIGNAL PROCESSING (9 HOURS)

FIR adaptive filters – steepest descent adaptive filter – LMS algorithm – convergence of LMS algorithms – Application: noise cancellation – channel equalization – adaptive recursive filters – recursive least squares- Decimation by a factor D – Interpolation by a factor I – Filter Design and implementation for sampling rate conversion: Direct form FIR filter structures – Polyphase filter structure.

UNIT IV - SPEECH SIGNAL PROCESSING (9 HOURS)

Digital models for speech signal : Mechanism of speech production – model for vocal tract- radiation and excitation – complete model – time domain processing of speech signal:- Pitch period estimation – using autocorrelation function – Linear predictive Coding: Basic Principles – autocorrelation method – Durbin recursive solution.

UNIT V - ADVANCED TRANSFORMS (9 HOURS)

Fourier Transform : Its power and Limitations – Short Time Fourier Transform – The Gabor Transform - Discrete Time Fourier Transform and filter banks – Continuous Wavelet Transform – Wavelet Transform Ideal Case – Perfect Reconstruction Filter Banks and wavelets – Recursive multi-resolution decomposition – Haar Wavelet – Daubechies Wavelet-

REFERENCES

1. Monson H-Hayes – Statistical Digital Signal Processing and Modeling- Wiley- 20002.
2. John G-Proakis- Dimitris G-Manobakis- Digital Signal Processing- Principles- Algorithms and Applications- Third edition- (2000) Pearson/PHI.
3. Roberto Crist- Modern Digital Signal Processing- Thomson Brooks/Cole (2004).
4. Raghuveer- M- Rao- Ajit S-Bopardikar- Wavelet Transforms- Introduction to Theory and applications- Pearson Education- Asia- 2000.

OPEN ELECTIVES

BME18R207 MEDICAL OPTICS AND LASERS	L	T	P	Credit
	3	0	0	3

Objective(s)

To acquire adequate knowledge in physics of light in biological tissues and its application in diagnostic and therapeutic applications.

Course Outcome(s)

Upon completion of the course, the students should be able to

CO1 Be familiar with property of light in tissues
CO2 Acquire knowledge in source and detectors of light.
CO3 Application of light in diagnostic practices.
CO4 Understand the concept of LASER in therapeutic applications.
CO5 Be exposed to Optical Holography

Mapping of COs and POs:

	POs												PSO			
COs	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	H	M	M					H					M	L		
CO2	M	H	M					M					M	H		
CO3	H	M	M					H					M			
CO4	M	M	M					H					M	M		
CO5	H	M	M					M					M			

UNIT I - OPTICAL PROPERTIES OF THE TISSUES (9 HOURS)

Refraction, scattering, absorption, light transport inside the tissue, tissue properties, Light interaction with tissues, optothermal interaction, fluorescence, speckles.

UNIT II - INSTRUMENTATION IN PHOTONICS (9 HOURS)

Instrumentation for absorption, scattering and emission measurements, excitation light sources – high pressure arc lamp, solid state LEDs, optical filters, polarisers, time resolved and phase resolved detectors.

UNIT III -APPLICATIONS OF LASERS (9 HOURS)

Laser in tissue welding, lasers in dermatology, lasers in ophthalmology, otolaryngology, urology. LASERS in surgery.

UNIT IV- OPTICAL HOLOGRAPHY (9 HOURS)

Wave fronts, interference patterns, principle of hologram, optical hologram, applications.

UNIT V - SPECIAL TECHNIQUES (9 HOURS)

Near field imaging of biological structures, in-vitro clinical diagnostic, fluorescent spectroscopy, photodynamic therapy.

TEXT BOOKS

1. Leon Goldman, M.D., & R.James Rockwell, Jr., "Lasers in Medicine", Gordon and Breach, Science Publishers Inc., 1975.
2. Abraham Katzir, "Lasers and Optical Fibers in Medicine", Academic Press Edition, 1998.

REFERENCES

1. Tuan Vo Dirh, "Biomedical Photonics – Handbook", CRC Press, Bocaraton,2003 (Unit I – III, V)
2. Glasser, O., "Medical Physics -- Vol 1, 2, 3 "Adam Hilgar Brustol Inc, 1987.
3. G.David Baxter "Therapeutic Lasers – Theory and practice", Churchill Livingstone Publications Edition- 2001.

BME18R314 COMPUTERS IN MEDICINE	L	T	P	Credit
	3	0	0	3

Objective(s)

To discuss the various aspects of informatics applied in health industry so that quality of health care is improved.

Course Outcome(s)

CO1 To understand the system of information managed in the hospital.
CO2 To demonstrate the application of softwares employed in medical data management.
CO3 To examine medical imaging data with an assist of computers.
CO4 To understand the concept of maintaining digital patient records.
CO5 To acquire knowledge in delivering instructions in medicine using computers.

Mapping of COs and POs

	POs												PSO			
COs	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	M				M								L			
CO2	L				M								L			
CO3	L	L			M								L			
CO4	M	L			M								L			

CO5	L	M			M								L			

UNIT I - HOSPITAL INFORMATION SYSTEM (9 HOURS)

Introduction –Historical review of the development of computers and informatics –Foundation ontology – use of internet in medicine –Internet vs online services-computer based medical information retrieval.

UNIT II - COMPUTERISED PATIENT DATABASE MANAGEMENT (9 HOURS)

Data base approach -Automated clinical laboratories – automated method in hematology – chromosome analysis by computer –computerised cytology and histology- Automatic scanning for cervical cancer – computer assisted semen analysis-Radio immuno assays-Intelligent laboratory information system-computerized ECG-computer aided analysis of ECG-computerised EEG and EMG. Computer assisted medical imaging-ultrasound –CT Radiation therapy planning-NMR.

UNIT III - COMPUTER ASSISTED MEDICAL IMAGING AND DECISION MAKING (9 HOURS)

Computer Assisted Medical Decision Making-Model of CMD-Approaches-Decision Support Systems Algorithms –Analysis –CBR-Production Rule Systems-Cognitive Models-**Semantic** Networks – Decision Analysis in Clinical Medicine –Hospital Information System-Functional Capabilities –Need-Security-Cost Effectiveness. Clinical Information System –Benefits –Sources of Data-Modes Of Decision –CIS in Obestrics and Gynecology-Clinical Decision Support.

UNIT IV - COMPUTERISED PATIENT RECORD (9 HOURS)

Computerised Patient Record –Introduction-History Taking By Computer-Dialogue With The Computer - Computerised Prescriptions For Patients-Introduction-Adverse Drug Reactions-Computer Assisted Patient Education And Health Care Information –Introduction –Health Online –Electronic Communication With Patients-Importance Of Behaviour Modification –Patient Self Management Education-Computers In Case Of Critically Ill Patients- Introduction –Cognitive System, Engineering – Automated Computer Assisted Fluid And Metabolic Balance –Pulmonary Function Evaluation-Computer Aids For The Handicapped-Computer Assisted Surgery.

UNIT V - COMPUTER ASSISTED INSTRUCTION IN MEDICINE (9 HOURS)

Computer Assisted Drug Discovery And Development, Molecular Modelling By Computer-Computational Representation Of Molecules-Modelling GPCRS-Pharmacophores-New Drugs For Cancer-0 from Gene To Screen –Combinational Chemistry-Metabolomics-Knowledge Based Drug Discovery-Pharmaco Metabolomics Role Of PET And SPECT In Drug Discovery. Computer Assisted Instruction in Medicine.

TEXT BOOK

1. R. D. Lee, Computers in Medicine, Tata McGraw Hill Publishing Company Limited, New Delhi, 1993.

REFERENCE

1. Harold Sackamn, Biomedical Information Technology, Academic Press, New York.
2. S.K.Chachan, PC Organisation, S.K. Kataria and Sons, Delhi 2000

BME18R315 BIOMEDICAL INSTRUMENTATION	L	T	P	Credit
	3	0	0	3

Objective(s)

To gain basic knowledge about Bio potentials, Bio electrodes and bioamplifiers and to give a complete exposure of various recording mechanism and to understand the basic principles, working of biomedical instruments.

Course Outcome(s)

CO1 To learn several signals that can be measured from the human body.

CO2 To study different types of electrodes used in bio-potential recording.

CO3 To understand how noise from the environment, instruments and other physiologic systems can create artifacts in instrumentation.

CO4 To understand the theory of how several sensors operate and use these sensors in practical.

CO5 To design the medical instrument to measure non electrical and analytical parameters.

Mapping of COs and POs

COs	POs												PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	L												L			
CO2	L	L											L			
CO3	M	M											M	L		
CO4	M	M											M	L		
CO5	H	H	H	M		L	L	L						H		

UNIT I - BIOPOTENTIAL AND ELECTRODES (9 HOURS)

Components of Medical Instrumentation System- Basic Cell Functions, Origin of Biopotentials, Electrical Activity of Cells, Electrode-Electrolyte interface, half cell potential, Polarization- polarizable and non-polarizable electrodes, Ag/AgCl electrodes, Electrode and Skin interface and motion artifact. Body Surface recording electrodes for ECG, EMG, EEG.

UNIT II - BIOELECTRIC SIGNALS RECORDING AND BIOAMPLIFIERS (9 HOURS)

Recording of ECG, EEG and EMG - Einthoven triangle, Standard 12-lead configurations - ECG Machine - EMG machine – 10-20 electrodes placement system for EEG - EEG machine. Bioamplifiers- Carrier Amplifier, - Isolation Amplifier - Differential amplifier - Chopper Amplifier - Instrumentation Amplifier.

UNIT III - MEASUREMENT OF NON-ELECTRICAL PARAMETERS (9 HOURS)

Human body Temperature, Measurement of blood pressure – Cardiac output – Heart rate – Heart sound – Pulmonary function measurements – spirometer – Photo Plethysmography, Body Plethysmography – Blood Gas analysers : finger-tip oxymeter - ESR, GSR measurements.

UNIT IV - LIFE SUPPORT INSTRUMENTS (9 HOURS)

Pacemaker-Types of Pacemaker, mode of pacing and its application, Defibrillator-AC and DC Defibrillators and their application, Heart Lung machine and its application during surgery, Haemodialysis system and the precautions to be taken during dialysis.

UNIT V - ANALYTICAL INSTRUMENTAION AND ELECTRICAL SAFETY: (9 HOURS)

Principle of colorimetry, photometry and pH measurement. Spectrophotometer; Spectrofluorometer; pH meter. Blood Cell counter; Biochemical analyzers; Na-K analyzer

Physiological effects of electrical current, Shock Hazards from electrical equipment and methods of accident prevention

TEXT BOOK

1. Khandpur R.S, “Handbook of Biomedical Instrumentation”, Tata McGraw Hill, New Delhi, 2014

REFERENCES

1. Leslie Cromwell, “Biomedical Instrumentation and Measurement”, Prentice Hall of India, New Delhi, 2007
2. John G. Webster, “Medical Instrumentation Application and Design”, John Willey and Sons, 2009.
3. Joseph J. Carr and John M. Brown, “Introduction to Biomedical Equipment Technology”, Pearson Education, 2004.
4. L.A Geddas and L.E.Baker “Principles of Applied Biomedical Instrumentation” 2004.
5. John G. Webster, “Bioinstrumentation”, John Willey and sons, New York, 2004.
6. Myer Kutz “Standard Handbook of Biomedical Engineering & Design”, McGraw-Hill Publisher, 2003.

BME18R316 REHABILITATION ENGINEERING	L	T	P	Credit
	3	0	0	3

Objective(s)

Discuss the broad area of rehabilitation engineering and its application to assist people with impairments in sensing, communication, seating, manipulation, and mobility.

Course Outcome(s)

CO1 Study the principles of rehabilitation.

CO2 Describe the features of human movement in health and disability and discuss the application of these properties in rehabilitation engineering design.

CO3 Learn therapeutic Exercise Techniques.

CO4 Discuss the various rehabilitation communication techniques.

CO5 Understand orthopedic prosthetics and orthotics in rehabilitation.

Mapping of COs and POs

	POs												**PSO**			
COs	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	L							H					L			
CO2	M	M	M					M					M	M		
CO3		M	H			H							M	H		
CO4		H						M					M			
CO5	M	M				H		H					M	M		

UNIT I - INTRODUCTION TO REHABILITATION & REHABILITATION TEAM (9 HOURS)

What is Rehabilitation, Epidemiology of Rehabilitation, Health, Levels of Prevention, Preventive Rehabilitation, Diagnosis of Disability, Functional Diagnosis, Importance of Psychiatry in Functional diagnosis, Impairment disability handicap, Primary & secondary Disabilities, Rehabilitation team-Classification of members.

UNIT II - PRINCIPLES OF REHABILITATION (9 HOURS)

Introduction, The Human Component, Principles of Assistive Technology Assessment, Principles of Rehabilitation Engineering- Key Engineering Principles, Key Ergonomic Principles - Practice of Rehabilitation and Assistive Technology.

UNIT III - THERAPEUTIC EXERCISE TECHNIQUE (9 HOURS)

Co-ordination exercises, Frenkels exercises, Gait analyses-Pathological Gaits, Gait Training, Relaxation exercises-Methods for training Relaxation, Strengthening exercises-Strength training, Types of Contraction, Mobilization exercises, Endurance exercises.

UNIT IV - PRINCIPLES IN MANAGEMENT OF COMMUNICATION (9 HOURS)

Impairment - introduction to communication, Aphasia, Types of aphasia, Treatment of aphasic patient, Augmentative communication-general form of communication, types of visual aids, Hearing aids, Types of conventional hearing aid, Writing aids.

UNIT V - ORTHOTIC & PROSTHETIC DEVICES (9 HOURS)

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

Prosthetic devices: Hand and arm replacement, Body powered prosthetics, Myoelectric controlled prosthetics and Externally powered limb prosthetics.

TEXT BOOKS

1. Dr. S. Sunder, Rehabilitation Medicine-, 3rd Edition, Jaypee Medical Publications, New Delhi. 2010 (Units I, III, IV & V)
2. Joseph D.Bronzino, The Biomedical Engineering Handbook, Third Edition: Three Volume Set, CRC Press, 2006 (Units II & V).

REFERENCES

1. Rory A Cooper, An Introduction to Rehabilitation Engineering, Taylor & Francis, CRC press, 2006.
2. Susan B O'Sullivan, Thomas J Schmitz, Physical Rehabilitation. 5th Edition, Davis publications, 2007.

BME18R317	**TELEMEDICINE**	**L**	**T**	**P**	**Credit**
		3	**0**	**0**	**3**

Objective(s)

Apply telemetry in healthcare.

Course Outcome(s)

CO1 Apply multimedia technologies in telemedicine
CO2 Understand telemedical technology.
CO3 Learn the key principles for telemedicine and health.
CO4 Explain Protocols behind encryption techniques for secure transmission of data.
CO5 Know telemedical standards, mobile telemedicine and it applications.

Mapping of COs and POs

COs	**POs**												**PSOs**			
	1	2	3	4	5	6	7	8	9	10	11	1	1	2	3	4
CO1	H				H								H			
CO2							M				M				M	

CO3		L											L		
CO4	M	L												M	
CO5		M										L			

UNIT I - TELEMEDICINE AND HEALTH (9 HOURS)

History and Evolution of telemedicine, Functional diagram of telemedicine system, Telemedicine, Telehealth, Tele care, Organs of telemedicine, Global and Indian scenario, Ethical and legal aspects of Telemedicine - Confidentiality, Social and legal issues, Safety and regulatory issues, Advances in Telemedicine.

UNIT II - TELEMEDICAL TECHNOLOGY (9 HOURS)

Principles of Multimedia - Text, Audio, Video, data, Data communications and networks, PSTN, POTS, ANT, ISDN, Internet, Air/ wireless communications: GSM satellite, and Micro wave, Modulation techniques, Types of Antenna, Integration and operational issues, Communication infrastructure for telemedicine – LAN and WAN technology. Satellite communication. Mobile hand held devices and mobile communication. Internet technology and telemedicine using world wide web (www). Video and audio conferencing. Clinical data – local and centralized.

UNIT III - TELEMEDICAL STANDARDS (9 HOURS)

Data Security and Standards: Encryption, Cryptography, Mechanisms of encryption, phases of Encryption. Protocols: TCP/IP, ISO-OSI, Standards to followed DICOM, HL7, H. 320 series (Video phone based ISBN) T. 120, H.324 (Video phone based PSTN), Video Conferencing, Real-time Telemedicine integrating doctors / Hospitals, Clinical laboratory data, Radiological data, and other clinically significant biomedical data, Administration of centralized medical data, security and confidentially of medical records and access control, Cyber laws related to telemedicine.

UNIT IV - MOBILE TELEMEDICINE (9 HOURS)

Tele radiology: Definition, Basic parts of teleradiology system: Image Acquisition system Display system, Tele pathology, multimedia databases, color images of sufficient resolution, Dynamic range, spatial resolution, compression methods, Interactive control of color, Medical information storage and management for telemedicine- patient information medical history, test reports, medical images diagnosis and treatment. Hospital information system - Doctors, paramedics, facilities available. Pharmaceutical information system.

UNIT V - TELEMEDICAL APPLICATIONS (9 HOURS)

Telemedicine access to health care services – health education and self care. Introduction to robotics surgery, telesurgery. Telecardiology, Teleoncology, Telemedicine in neurosciences, Electronic Documentation, e-health services security and interoperability. Telemedicine access to health care services – health education and self care, Business aspects - Project planning and costing, Usage of telemedicine.

TEXT BOOK

1. Norris, A.C. "Essentials of Telemedicine and Telecare", Wiley, 2002

REFERENCES

1. Wootton, R., Craig, J., Patterson, V. (Eds.), "Introduction to Telemedicine. Royal Society of Medicine" Press Ltd, Taylor & Francis 2006
2. O'Carroll, P.W., Yasnoff, W.A., Ward, E., Ripp, L.H., Martin, E.L. (Eds), "Public Health Informatics and Information Systems", Springer, 2003.
3. Ferrer-Roca, O., Sosa - Iudicissa, M. (Eds.), Handbook of Telemedicine. IOS Press (Studies in Health Technology and Informatics, Volume 54, 2002.
4. Simpson, W. Video over IP. A practical guide to technology and applications. Focal Press Elsevier, 2006.
5. Bemmel, J.H. van, Musen, M.A. (Eds.) Handbook of Medical Informatics. Heidelberg, Germany: Springer, 2002.
6. Mohan Bansal, "Medical Informatics", Tata McGraw-Hill, 2004.

BME18R410	**TISSUE ENGINEERING**	**L**	**T**	**P**	**Credit**
		3	**0**	**0**	**3**

Objective(s)

To understand the concepts of molecular biology and to aid in new tissue generation and organ transplantation.

Course Outcome(s)

Upon completion of the course, the student will be able to

CO1 Have a basic knowledge in tissue engineering
CO2 Culture cells
CO3 Analyze the molecular biology in tissue engineering
CO4 Understand the transplantation
CO5 Get a clear idea on how the tissue engineering applicable for real life

Mapping of POs and COs:

COs	**POs**												**PSOs**			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	H	L			M	M	L	H			M	H	H	L	L	M
CO2	H	L		M	M	M	L	H		L	M	H	H	M	L	M
CO3	H	M			L	M	L	M		L	L	M	H	M	L	M
CO4	H	H	M	M	M	M	M	M	M	H	M	M	H	H	M	M
CO5	M	L		H	M	M	L	M	M	L	L	M	M	M	L	M

UNIT I - INTRODUCTION (9 HOURS)

Basic definition, Structural and organization of tissues: Epithelial, connective; vascularity and angiogenesis, basic wound healing, cell migration, current scope of development and use in therapeutic and in-vitro testing.

UNIT II - CELL CULTURE (9 HOURS)

Different cell types, progenitor cells and cell differentiations, different kind of matrix, cell-cell interaction. Aspect of cell culture: cell expansion, cell transfer, cell storage and cell characterization, Bioreactors.

UNIT III - MOLECULAR BIOLOGY ASPECTS (9 HOURS)

Cell signaling molecules, growth factors, hormone and growth factor signaling, growth factor delivery in tissue engineering, cell attachment: differential cell adhesion, receptor-ligand binding, and Cell surface markers.

UNIT IV - SCAFFOLD AND TRANSPLANT (9 HOURS)

Engineering biomaterials for tissue engineering, Degradable materials (collagen, silk and polylactic acid), porosity, mechanical strength, 3-D architecture and cell incorporation. Engineering tissues for replacing bone, cartilage, tendons, ligaments, skin and liver. Basic transplant immunology stems cells: introduction, hepatopoiesis.

UNIT V - CASE STUDY AND REGULATORY ISSUES (9 HOURS)

Case study of multiple approaches: cell transplantation for liver, musculoskeletal, cardiovascular, neural, visceral tissue engineering. Ethical, FDA and regulatory issues of tissue engineering.

TEXT BOOK

1. Clemens van Blitterswijk, Tissue Engineering", Academic Press, 2008

REFERENCES

1. Bernhard O.Palsson, "Tissue Engineering", Pearson Education, 1st Edition, 2016
2. John P.Fisher, antonios G.Mikos, Joseph D.Bronzino, "Tissue Engineering", CRC Press, 2007
3. Endarle, Blanchard &Bronzino, "Introduction to Biomedical Engineering" Academic press.4th Edition, 2015
4. Robert Lanza, Robert Langer, Joseph P.vacanti, "Principles of Tissue Engineering", Academic Press, 2011.

BME18R411	WEARABLE SYSTEMS	L	T	P	Credit
		3	0	0	3

Objective(s) To design new medical devices based on wearable sensors

Course Outcome(s)

Upon completion of the course, the student will be able to

CO1 Differentiate the sensors that can be used for wearable systems

CO2 Process the signals picked by the wearable sensors

CO3 Utilize different sources of energy to be used for wearable systems

CO4 Analyze the technical aspects of wireless health systems

CO5 Apply the wearable sensors into novel medical applications.

Mapping of COs and POs

	POs												PSOs			
COs	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	L												M	M		
CO2		M	M										M	M		
CO3		H	M										M	M		
CO4		H	H			M		M					M	M		
CO5		H	M			H		H					M	M		

UNIT I - SENSORS (9 HOURS)

Need for wearable systems, Sensors for wearable systems-Inertia movement sensors, Respiration activity sensor, Inductive plethysmography, Impedance plethysmography, pneumography, Wearable ground reaction force sensor, GSR, Radiant thermal sensor, Wearable motion sensors, CMOS – Based Biosensors, E-Textiles, Bio compatibility.

UNIT II - SIGNAL PROCESSING (9 HOURS)

Wearability issues -physical shape and placement of sensor, Technical challenges - sensor design, signal acquisition, Constraint on sampling frequency for reduced energy consumption, light weight signal processing, Rejection of irrelevant information, Data mining.

UNIT III - ENERGY HARVESTING FOR WEARABLE DEVICES (9 HOURS)

Solar cell, Vibration based, Thermal based human body as a heat source for power generation, Hybrid thermoelectric photovoltaic energy harvests, Thermopiles.

UNIT IV - WIRELESS HEALTH SYSTEMS (9 HOURS)

Need for wireless monitoring, Definition of Body area network, BAN and Healthcare, Technical Challenges- System security and reliability, BAN Architecture – Introduction, Wireless communication techniques.

UNIT V APPLICATIONS OF WEARABLE SYSTEMS (9 HOURS)

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

TEXT BOOKS

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

REFERENCES

1. Hang,Yuan-Ting,"wearable medical sensors and systems",Springer-2013
2. Mehmet R. Yuce,Jamil Y.Khan, "Wireless Body Area Networks Technology, Implementation and Applications",Pan Stanford Publishing Pvt.Ltd, Singapore, 2012
3. Guang-Zhong Yang(Ed.), "Body Sensor Networks, "Springer, 2006
4. Andreas Lymberis, Danilo de Rossi ,'Wearable eHealth systems for Personalised Health Management - State of the art and future challenges ' IOS press, The Netherlands, 2004.

BME18R412 NANOTECHNOLOGY IN MEDICINE	L	T	P	Credit
	3	0	0	3

Objective(s)

To gain knowledge on nanosystems and to apply the techniques for health care industry.

Course Outcome(s)

Upon completion of the course, the student will be able to

CO1 Improvise the knowledge in physics of solid state

CO2 Understand the fundamentals of nanoscience

CO3 Demonstrate the preparation of nanosystems

CO4 Characterize different nanosystems

CO5 Apply the knowledge acquired in medicine.

Mapping of COs and POs

	POs												PSO			
COs	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	H	M											H			
CO2	M	L											M			
CO3		M	M											M		
CO4		M												M		
CO5	M	M												M		

UNIT I - INTRODUCTION TO PHYSICS OF SOLID STATE (9 HOURS)

Intermolecular forces: thermodynamic aspects - Quantum Mechanical Treatment of the Many-Particle Problem - Potential Energy Surface - Pair Potential Approximation - Advantages and Limitations of the Pair Potential Approximation - Phenomenological Potentials - Pseudo-Potentials - Many-Body Potentials.

UNIT II - FUNDAMENTALS OF NANOSCIENCE (9 HOURS)

Size dependence of properties - Particle size determination - Bulk to nano transition - Semiconducting nanoparticles - Carbon nanostructures - Mechanical properties (hardness, ductility, elasticity) - Optical properties of nanotubes - Electrical properties of nanotubes.

UNIT III - PREPARATION OF NANOSYSTEMS (9 HOURS)

Introduction to nanolithography - Carbon nanotubes: preparation - Synthesis and preparation of nanomaterials (crystalline and thinfilm) - Physical and chemical methods - Control and stability (size, shape, composition).

UNIT IV - CHARACTERIZATION OF NANOSYSTEMS (9 HOURS)

Thermal Stability - Basic Material Properties - Mean Values and Correlation Functions - X-ray diffraction - Scanning Electron Microscopy - Scanning Tunneling Microscopy - Electron Microscopy - X-ray absorption spectroscopy – Photoelectron emission spectroscopy.

UNIT V - APPLICATIONS: POTENTIAL OF NANOTECHNOLOGY IN MEDICINE (9 HOURS)

Nanotubes, nanowires, and nanodevices-introduction - Functional Nanostructures – Introduction to molecular electronics - Field emission and Shielding - Microelectromechanical systems (MEMs) - Nanoelectromechanical systems (NEMs) - Molecular and Supramolecular Switches – Biosensors – Qdots – Nanoshells – Nanobiotix – Cancer detection – Drug Delivery using Nanoparticles and Molecular Carriers.

TEXT BOOKS

1. Di Ventra, Massimiliano; Evoy, Stephane; Heflin, James R., Introduction to Nanoscale Science and Technology, Springer publications, 2004
2. Vinod Labhasetwar, Diandra L. Leslie-Pelecky, Biomedical Applications Of Nanotechnology, Wiley-Interscience A John Wiley & Son, Inc., Publication, 2007.
3.

REFERENCES

1. Chattopadhyay, Introduction to Nanoscience and Naotechnology, PHI, 2009
2. B.k. Parthasarathy, Nanoscience and Nanotechnology, Gyan Books, 2007

3. Vicki H. Grassian, Nanoscience and Nanotechnology: Environmental and Health Impacts (Hardcover - 2008), John Wiley & Sons
4. T. Pradeep, Nano – The essentials, McGraw-Hill publishers, 2008
5. Bhushan, Bharat (Ed.), Springer Handbook of Nanotechnology, Springer publications, 2nd rev. and extended ed., 2007
6. Tuan Vo-Dinh, Nanotechnology in Biology and Medicine: Methods, Devices, and Applications, CRC Press, Jan 2007

BME18R413	BIOMETRIC SYSTEMS	L	T	P	Credit
		3	0	0	3

Objective(s) To understand the existing biometric systems and to develop novel Biometric systems utilizing unique features of the human body

Course Outcome(s)

Upon completion of the course, the student will be able to

CO1 Understand the concept of Biometrics and its applications
CO2 Illustrate the various methodologies involved in fingerprint technology
CO3 Develop techniques for face recognition and hand geometry biometrics
CO4 Demonstrate the multimodal biometrics and the methods for evaluating the performance
CO5 Distinguish the authentication mechanism of the biometric systems.

Mapping of COs and POs

COs	POs												PEOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	L	L											L			
CO2	M												M			
CO3		H											H			
CO4						M								M		
CO5					L									L		

UNIT I - INTRODUCTION TO BIOMETRICS (9 HOURS)

Introduction and back ground – biometric technologies – passive biometrics – active biometrics -Biometric systems – Enrollment – templates – algorithm – verification – Biometric applications –biometric characteristics- Authentication technologies –Need for strong authentication – Protecting privacy and biometrics and policy – Biometric applications – biometric characteristics.

UNIT II - FINGERPRINT TECHNOLOGY (9 HOURS)

History of fingerprint pattern recognition - General description of fingerprints - Finger print feature processing techniques - fingerprint sensors using RF imaging techniques – fingerprint quality assessment –

computer enhancement and modeling of fingerprint images – fingerprint enhancement – Feature extraction – fingerprint classification – fingerprint matching.

UNIT III - FACE RECOGNITION AND HAND GEOMETRY (9 HOURS)

Introduction to face recognition, Neural networks for face recognition – face recognition from correspondence maps – Hand geometry – scanning – Feature Extraction - Adaptive Classifiers -Visual-Based Feature Extraction and Pattern Classification - feature extraction – types of algorithm - Biometric fusion.

UNIT IV - MULTIMODAL BIOMETRICS AND PERFORMANCE EVALUATION (9 HOURS)

Voice Scan – physiological biometrics –Behavioral Biometrics - Introduction to multimodal biometric system – Integration strategies – Architecture – level of fusion – combination strategy –training and adaptability – examples of multimodal biometric systems – Performance evaluation- Statistical Measures of Biometrics – FAR – FRR – FTE – EER – Memory requirement and allocation.

UNIT V - BIOMETRIC AUTHENTICATION (9 HOURS)

Introduction - Biometric Authentication Methods - Biometric Authentication Systems – Biometric authentication by fingerprint -Biometric Authentication by Face Recognition. Expectation- Maximization theory - Support Vector Machines. Biometric authentication by fingerprint –biometric authentication by hand geometry- Securing and trusting a biometric transaction – matching location – local host - authentication server – match on card (MOC) – Multibiometrics and Two-Factor Authentication

TEXT BOOKS

1. James Wayman, Anil Jain, Davide Maltoni, Dario Maio, "Biometric Systems, Technology Design and Performance Evaluation", Springer, 2005 (Units I, II, III & IV)
2. S.Y. Kung, S.H. Lin, M.W.Mak, "Biometric Authentication: A Machine Learning Approach"Prentice Hall, 2005(Unit V)

REFERENCES

1. Paul Reid, "Biometrics for Network Security", Pearson Education, 2004.
2. Nalini K Ratha, Ruud Bolle, "Automatic fingerprint Recognition System", Springer, 2003

BME18R414 BIOMEDICAL WASTE MANAGEMENT	L	T	P	Credit
	3	0	0	3

Objective(s)

To understand the hazards of biomedical waste and to dispose it in a right way as per the guidelines

Course Outcome(s)

Upon completion of the course, the student will be able to

CO1 Distinguish the different types of hazardous biomedical waste, its handling and disposal methodologies
CO2 Enumerate the hazards caused by non disposal of medical waste
CO3 Analyze the various treatment techniques of processing biomedical waste
CO4 Illustrate the laws for handling the biomedical waste
CO5 Demonstrate the guidelines provided by WHO for management of hospital waste.

Mapping of COs and POs

UNIT I - INTRODUCTION (9 HOURS)

Definition of general and hazardous health care waste, Infectious waste, geno-toxic waste, waste sharps, categorization and composition of Biomedical waste, major and minor sources of biomedical waste, Segregation of waste, Color coding, waste handling and disposal.

UNIT II - HAZARD OF BIOMEDICAL WASTE (9 HOURS)

Need for disposal of biomedical waste, Specifically Communicable diseases, Diseases epidemiology and mode of transmission of disease, Environmental pollution by biomedical waste - causes, consequences, mitigation and remedies.

UNIT III - TREATMENT TECHNOLOGIES FOR WASTES (9 HOURS)

Mechanical Treatment & Chemical Disinfections, Conventional Treatment Technologies: Wet thermal technology, Incineration, Microwave Technology, Autoclave system, Hydro clave system, Electro Thermal Reactivation (ETP), Treatment Process Electron beam Technology, Plasma Pyrolysis/ Gasificaton systems.

UNIT IV - LAWS OF BIOMEDICAL WASTE HANDLING (9 HOURS)

Legislation, policies and law regarding environment on Health care waste management, Biomedical waste management and handling rules 1998 and its amendment.

UNIT V - GUIDELINES (9 HOURS)

CPCB guidelines. World Health Organization guidelines on Management of wastes from Hospital wastes

REFERENCES

1. Anantpreet Singh, Sukhjit Kaur, "Biomedical Waste Disposal", 1st ed., Jaypee Publishers (P) Ltd, India, 2012.
2. Sushma Sahai, "Bio-Medical Waste Management", APH Publishing Corporation, India, 2009.
3. Sanskriti Sharma, "Hospital Waste Management and Its Monitoring", Jaypee Publishers (P) Ltd, India, 2002.

BME18R415 BIOETHICS, IPR AND STANDARDS	L	T	P	Credit
	3	0	0	3

Objective(s)

To understand the standards to be maintained while designing biomedical devices considering bioethics

Course Outcome(s)

Upon completion of the course, the student will be able to

CO1 Understand the biomedical ethics

CO2 Analyze the issues arise in biomedical devices

CO3 Know about the basic principles of IPR law

CO4 Describe about the safety measures in order to use a biomedical device

CO5 Understand the biomedical standards.

Mapping of COs and POs:

	POs												PSO			
COs	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1								H								M
CO2			H					H								M
CO3								H								M
CO4								H								M
CO5								H								M

UNIT I - BIOMEDICAL ETHICS (9 HOURS)

Principles, rules and moral decisions of biomedical ethics, respect for autonomy, voluntariness information and informed consent, competency, non-maleficence, the rule of the double effect, beneficence, paternalism, justice.

UNIT II - ETHICAL ISSUES IN DESIGN AND MANUFACTURE OF MEDICAL DEVICES (9 HOURS)

Cost benefit analysis, professional restrictions and responsibility, rights of engineers, conflict of interest, codes of ethics for biomedical engineers, ethics of implant use and marketing.

UNIT III - BASIC PRINCIPLES OF IPR LAWS (9 HOURS)

History of IPR-GATT,WTO,WIPO & TRIPs, Role of IPR in Research & Development, Concept of property, Different forms of IPR – copyright, trade mark, Industrial Designs, Layout designs of Integrated circuits, Patents, Geographical Indications, Traditional Knowledge, Plant varieties, Trade secrets.

UNIT IV - SAFETY (9 HOURS)

Regulatory Authorities for medical device regulation in India (CDSCO), Global Harmonization Task Force for device regulation abroad, Quality management system for medical devices (ISO 9001 and ISO13485)

UNIT V STANDARDS (9 HOURS)

Safety and standardization for risk management (ISO 14971), European standard conformity (CE marking), FDA guidelines for medical devices approval and classification based on risk assessment.

REFERENCES

1. Daniel A Vallero, "Biomedical ethics for Engineers", Academic Press, New York, 2007.
2. PrabuddghaGanguli, "Intellectual Property Rights", TMH Publishing Co. Ltd., 2001.
3. Patents by N.R. Subbaram, Pharma Book Syndicate, Hyderabad, India, 2006.

PHY18R301	Photonics and Optoelectronic Devices	L	T	P	C
		3	0	0	3

Course Outcomes:

CO-1: Know the fundamentals of fibre based optical devices
CO-2: Understand the basic of integrated optical devices
CO-3: Learn about the opto electronic devices
CO-4: Understanding of nanostructured materials
CO-5: Understanding of quantum devices with applications.

UNIT – I : OPTICAL FIBRE BASED DEVICES

Fused single mode fibre directional coupler, Polished single mode fibre directional coupler ;Fibre polariser; Polarisation splitters based on fibre; Single mode fibre filter; Polarisation controller; Wavelength multiplexer and demultiplexer; Optical fibre switches and intensity modulators; Optical fibre phase modulator; Optical fibre frequency modulator; Optical fibre amplifiers.

UNIT – II : INTEGRATED OPTIC BASED DEVICES

Optical directional coupler: directional coupler wavelength filter, polarisation splitting directional coupler; Polarisers : leaky mode polariser , metal clad polariser; Phase modulator; Optical switch; Acousto-optic devices : mode converter , tunable wavelength filter, Bragg type modulator , Bragg type deflector; Magneto-optic devices : TE-TM mode converter, modulators and switches, SiO2 / Si based thin film devices , Ti / LiNbO3 based optical devices, Proton exchange based optical devices.

UNIT – III : OPTOELECTRONIC DEVICES

Semiconductor Lasers: heterojunction and surface emitting lasers , quantum well lasers; Modulation of lasers; Photodetectors: PIN, MSM, Avalanche photodiodes; Optoelectronic modulation and switching devices ; Electro-optic Devices; Optoelectronic Integrated circuits.

UNIT – IV: NANOSTRUCTURES

Nanocrystals: Electronic states, properties and fabrication; Nanomaterials – preparation methods - Chemical vapour deposition- Sol-gel methods - Optical properties of nanostructures; nano photodetector, nano transistor.

UNIT – V :QUANTUM DEVICES

Low-dimensional structures: Quantum wells, Quantum wires, and Quantum dots; Density of states in low-dimensional structures; Resonant tunneling phenomena and applications in diodes and transistors; Applications of quantum devices: quantum well and quantum dot lasers, ultra-fast switching devices, high density memories, dc and rf squids, multi-state logic circuits, long wavelength detectors

REFERENCES

1. Joachim Piprek, Semiconductor optoelectronic devices, Academic press Hardbound, 2003
2. A.K. Ganguly, Optoelectronic devices and circuits, Narosa publication, 2007
3. Shun Lien Chuang, Physics of Optoelectronic Devices, Wiley-Interscience; 1st ed., 1995
4. Goure and I Verrier, Optical Fibre Devices, Taylor & Francis; 1st ed., 2001
5. Ray Tricker, Optoelectronics and Fiber Optic Technology, Newnes, 2002
6. K Krishna Reddy M Balakrishna Rao, Nanostructures & Quantum Devices, Campus Books International,2007
7. Rahman Faiz, Nanostructures in Electronics and Photonics, pan stallion press
8. Guozhong Cao, Nano structures & nano materials: synthesis, properties & applications, Imperial College Press, 2004
9. Todd D. Steiner, Semiconductor nanostructures for optoelectronic application, Artech House, INC.,2004
10. Jia- Ming Liu, Photonic Devices, Cambrige University Press, 2005

HUMANITIES ELECTIVES

HSS18R001 MANAGEMENT CONCEPTS AND TECHNIQUES	L	T	P	Credit
	3	0	0	3
Pre requisite: NIL	**Course Category:** Humanities electives **Course Type**: Theory			

Course Description:

This course addresses the definition of management, its characteristics, evolution and importance as well as the functions performed by manages-planning, organizing, directing and controlling. The course also intends to show students the applications of management functions in various enterprises such as marketing, finance, personnel, production, etc.

Course Outcomes:

The students will be able

CO's	Course Outcomes
CO1	To Explain the historical backdrop and fundamentals of Management thoughts vital for derstanding the conceptual frame work of Management as a discipline.
CO2	To Discuss about the various concepts of planning, Decision making and controlling to help solving managerial problems
CO3	To Understanding concepts of Ethics, Delegation, Coordination and Team work
CO4	To Study and understand the management concepts and styles in Global context
CO5	To develop an understanding about emerging concepts in management thought and philosophy

Mapping of Cos and POs

	POs											
COs	1	2	3	4	5	6	7	8	9	10	11	12
CO1	M											
CO2												
CO3		M										
CO4		M										
CO5										M		

UNIT I : DEVELOPMENT OF MANAGEMENT THOUGH (9 HOURS)

Scientific Management Movement - Administrative Movement - Human Relations Movement -Decision Movement - Behavioral Science Movement - Systems Movement - Contingency Movement.

UNIT II : ESSENTIALS OF PLANNING (9 HOURS)

Planning Objectives – Goals - Programmed Decisions and Unprogrammed Decisions; Decision – Making - Creativity in Decision - Making, Forecasting and Strategy to Formulation.

UNIT III : EFFECTIVE ORGANIZING (9 HOURS)

Span of Control – Departmentation - Authority; Responsibility – Bureaucracy and Adhocracy; Group Dynamics.

UNIT IV : STAFFING AND DIRECTING (9 HOURS)

Staffing: Manpower Planning – Recruitment Sources – Selection Procedure – Training Methods – Performance Evaluation Methods – Executive Development Programs - Directing: Communication Process and Barriers – Motivation Techniques – Financial and Non – Financial Motivation- Leadership Qualities and Styles.

UNIT V : CONTROLLING AND RECENT CONCEPTS (9 HOURS)

Controlling: Meaning and Process - Requisites of Effective Control - Control Techniques. Emerging Issues in Management: Japanese and American Management – Management by Objectives – Knowledge Management – Technology Management – Business Process Outsourcing- Social Responsibility and Business Ethics.

TEXT BOOKS

1. Harold Koontz & Heinz Weihrich, Essentials of Management: An International, Innovation and Leadership Perspective, 10th Edition, McGraw Hill Education (India) Private Ltd. New Delhi, 2016.
2. Stephen P. Robbins, Mary A. Coulter, Management, 13th Edition, Pearson Education Limited, New Delhi, 2016.

REFERENCE BOOKS

1. C.B.Gupta, Management Theory and Practice, 19th Revised Edition, Sultan Chand & Sons, New Delhi.2017.
2. L.M.Prasad, Principles and Practices of Management, 9th Edition, Sultan Chand and Sons Private Limited, 2015.
3. K.Aswathappa, Essentials of Business Environment: Text Cases and Exercises 12th, edition, Himalaya Publishing House, Mumbai, 2014.
4. Tripathi & Reddy, Principles of Management, 5th Edition, Tata McGraw Hill publishing company Ltd, New Delhi, 2012.

HSS18R002 MARKETING MANAGEMENT	L	T	P	Credit
	3	0	0	3
Pre requisite: NIL	**Course Category:** Humanities electives **Course Type**: Theory			

Course Description:

This course develops students understanding of how organizations match the requirements of consumers in competitive environments, and develop strategies to create the competitive edge. It covers areas such as analysis, planning, implementation, and control, as well as the marketing mix, exportation, and the social aspects of marketing.

Course Outcomes:

CO's	Course Outcomes
CO1	To Develop understanding of marketing concepts, philosophies and historical background.
CO2	To Develop understanding of marketing operations and complexities for students to apply in practical business situations.
CO3	To Understand concepts related to Segmentation, Targeting and Positioning, product attributes, and pricing strategies prevalent in domestic and international scenario.
CO4	To Study various tools and techniques of promoting the products in ethical manner.
CO5	To Understand emerging concepts of marketing in the emerging global markets

Mapping of COs and POs

	POs											
COs	1	2	3	4	5	6	7	8	9	10	11	12
CO1	M								M			
CO2												
CO3		M										
CO4									M			
CO5		M										

UNIT I: MARKETING (9 HOURS)

Meaning - concept - functions - marketing Planning & implementation marketing Programmes - Marketing environment – Market Segmentation and consumer behaviour – Influencing factors, Decision process – Marketing mix – Marketing department.

UNIT II: PRODUCT (9 HOURS)

Meaning - Product planning - policies - positioning - New product development Product life cycle – BCG Matrix - branding. Packing, labelling.

UNIT III: PRICING (9 HOURS)

Pricing objectives – Setting and modifying the price – Different pricing method Product line pricing and new product pricing.

UNIT IV: DISTRIBUTION (9 HOURS)

Nature of Marketing channels - Types of Channel flows – Channel functions - Channel co-operation, conflict and competition - Direct Marketing Telemarketing, Internet shopping.

UNIT V: PROMOTION (9 HOURS)

Promotion Mix - Advertisement - Message - copy writing – Advertisement - budgeting - Measuring advertisement effectiveness - Media strategy - sales promotion - Personal selling steps, publicity and direct marketing.

TEXT BOOKS

1. Philip.T.Khotler, Kevin Lane Keller, Marketing Management, 15th Edition, Pearson Education, New Delhi, 2016.
2. Ramaswamy.VS & Namakumari. S, Marketing Management – Global Perspective, Indian Context, McGraw Hill Education (India) Private Limited, New Delhi, 2013.

REFERENCE BOOKS

1. Rajan Saxena, Dorector, Jain S.P., Marketing Management, 1st edition, Tata McGraw Hill, New Delhi, 2006.
2. K.S.Chandrasekar, Marketing Management, Text & Cases, 1st edition, Tata McGraw hill Education Pvt. Ltd. 2013.
3. Tapan K.Panda, Marketing Management Text and Cases, 2nd Edition, Excel Books.2008.

HSS18R003	ORGANIZATIONAL PSYCHOLOGY	L	T	P	Credit
		3	0	0	3
Pre requisite: NIL		**Course Category:** Humanities electives **Course Type**: Theory			

Couse description:

This course aims to clarify the principles and basic concepts of organizational psychology. Including organizations and understanding its business design based on efficiency and quality of employee life. It also aims at enhancing the quality of life of employees. When organization's aspects are gauged in terms of psychological assessment, personnel decisions in line with training and development, organizational change and organizational health in specific the intrinsic problems are understood paving way towards standards that are high.

Course outcomes:

The students will be able

S.NO	DESCRIPTION
CO1	To learn basic concepts of industrial and organizational psychology
CO2	To illustrate different ways of achieving organizational effectiveness through individual behaviour.
CO3	To learn the concepts relating to individual behavior to achieve group target and achieve leadership position in organization.
CO4	To understand the organizational changes and means to evaluate based on nature of orgnizations.
CO5	To learn implications of changes aligning the interest of individual, group and organization as a whole.

Mapping of Cos and POs

	POs											
COs	1	2	3	4	5	6	7	8	9	10	11	12
CO1	M											
CO2												
CO3	M											
CO4		M										
CO5										M		

UNIT I: FOCUS AND PURPOSE (9 HOURS)

Organizational Behaviour - Need and importance, nature and scope, framework.

UNIT II : INDIVIDUAL BEHAVIOUR (9 HOURS)

Personality – types – factors influencing personality – theories – learning – types of learners – learning theories – organizational Behaviour modification. Attitudes – characteristics –components – formation – measurement. Perceptions – importance – factors influencing perception – interpersonal perception.

UNIT III: GROUP BEHAVIOUR (9 HOURS)

Organization structure – formation – groups in organizations – influence – group dynamics – emergence of informal leaders and working norms – group decision making techniques – interpersonal relations – communication process and Group Communication.

UNIT IV : LEADERSHIP (9 HOURS)

Leadership styles – theories – Qualities - leaders Vs managers – sources of power – power centers – power and Organisational Politics- Motivation.

UNIT V: ORGANISATIONAL DEVELOPMENT (9 HOURS)

Organizational development - Importance, characteristics, objectives, stability Vs change, proactive vs reaction change , the change process, resistance to change, managing change, team building - Organizational effectiveness, perspective, effectiveness Vs efficiency, approaches, the time dimension, achieving organizational effectiveness.

TEXT BOOKS

1. Stephen P.Robins and Timothy A . Judge, Organisational Behavior, Peason Education, 17th edition, 2017.
2. Fred Luthans, Organisational Behavior, McGraw Education, 12th Edition, 2010.

REFERENCES

1. Aswathappa, Organisational Behavior, Himalaya Publishing House, 12th edition, 2016.
2. P.Subba Rao, Management and Organisational behavior: Text, Cases and Games, Himalaya Publishing House, 1st edition, 2010.
3. Mullins, Organisational Behavior, Pearson Education Limited, 9th edition, 2010.
4. L.M.Prasad, Organisational Behaviour, 5th edition, Sultan Chand and Sons, New Delhi, 2014.

HSS18R004	PROJECT MANAGEMENT	L	T	P	Credit
		3	0	0	3
Pre requisite: NIL		**Course Category:** Humanities electives **Course Type**: Theory			

Course Description

This course describes concepts relating to project management and enable students to evolve project objectives appropriately with relevance to business proposals. It covers the required dimensions relating to evaluation of project by testing the technical feasibility, financial viability, market acceptability and social desirability of projects. It gives an account on risk and profitability analysis that facilitates the making of the effective project proposal and guides learners in project planning, implementation and control. It also emancipates the scope of project management in undertaking foreign collaboration projects.

Course Outcomes

CO1	Familiarizes the concept of project and steps in project management.
CO2	Understand the basics stages involved in preparing business proposals.
CO3	Evaluate the technical feasibility, financial viability, market acceptability and social sirability of projects.

CO4	Enabled to analyse the Risk and profitability of the project proposals
CO5	Act effectively as project managers and as part of project teams.

Mapping of COs and POs

	POs											
COs	1	2	3	4	5	6	7	8	9	10	11	12
CO1						M						
CO2		M										
CO3			M									
CO4												
CO5									M			

UNIT I: INTRODUCTION TO PROJECT MANAGEMENT (9 HOURS)

Projects - Project ideas and preliminary screening. Developments - Project planning to Project completion - Pre-investment phase, Investment phase, operational phase - Governmental Regulatory framework. Capital Budgeting .

UNIT II: STAGES OF PROJECT MANAGEMENT (9 HOURS)

Opportunity studies - prefeasibility studies, functional studies or support studies, feasibility study expansion projects, data for feasibility study. Market and Technical Appraisal : Market and Demand analysis, Market Survey, Demand forecasting. Technical analysis- Materials and inputs, Choice of Technology, Product mix, Plant location, capacity, Machinery and equipment.

UNIT III: APPRAISAL PROCESS (9 HOURS)

Concepts. Time value of money - Present and future value. Appraisal criteria - Urgency, Payback period, Rate of return, Debt service coverage ratio, Net present value, Benefit cost ratio, Internal rate of return, Annual capital charge, Investment appraisal in practice.

UNIT IV: RISK AND PROFITABILITY ANALYSIS (9 HOURS)

Risk analysis- Measures of risk, Sensitivity analysis, and Decision tree analysis. Means of financing, Term Loans, Financial Institutions. Cost of capital. Profitability - Cost of Production, Break-even analysis. Assessing the tax burden and financial projections.

UNIT V: PROJECT PLANNING, IMPLEMENTATION, AND CONTROL (9 HOURS)

Forms of Project Organization, Project Planning, Implementation, and Control - Network construction, CPM, PERT, Development of Project schedule, Crashing of Project Network. Introduction to Foreign collaboration projects - Governmental policy framework, Need for foreign technology, Royalty payments, Foreign investments and procedural aspects.

TEXT BOOKS

1. Prasanna Chandra, Projects: Planning, Analysis, Selection, Financing, Implementation, 8th Edition, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2014.
2. M.R. Gopalan, Project Management Core Textbook,(Paper Back) 2nd edition, Wiley India, 2015.

REFERENCES

1. Harold Kerzne, Project Management - Best Practices: Achieving Global Excellence, 3edition, Wiley Publications, 2013
2. George Ritz, Sidney Levy, Project Management in Construction, Sixth Edition, Mc. Graw Hill Education, 2011.
3. Gary Heerkens, Project Management, Second Edition, Mc. Graw Hill Education, 2013
4. P.Gopalakrishnan and V.E.Rama Moorthy Text Book of Project Management,1st Edition, Macmillan India Ltd., New Delhi, 2014.
5. John M. Nicholas, Herman Steyn, Project Management for Engineering, Business and Technology, 5th Edition, Routledge, 2016.

HSS18R005 STRESS MANAGEMENT AND COPING STRATEGIES	**L**	**T**	**P**	**C**
	3	**0**	**0**	**3**
Pre requisite: NIL	**Course Category:** Humanities electives			
	Course Type: Theory			

Couse description

Stress has become an integral part of every professional's life. Approaching the stress in the right manner has become imperative as it has become an unavoidable one. The stress and its effect over performance has also become notable in today's organization. In order to cope well and to sustain in market, for that the skills are required to understand and to overcome the same. This course helps in understanding the intricacies of stress and overcoming the stress through appropriate approaches.

Course outcomes

S.NO	**DESCRIPTION**
CO1	The students understand the responsibility of tackling stress
CO2	The students identify and modify the approaches of stress accordingly while dealing with team in workplace.
CO3	Those students who are prone to face high- pressure working conditions will be in a position to tackle stress appropriately without ignoring.
CO4	The students will implement a stress -free work environment.
CO5	The students will enrich their way of behavior and personality as a whole and ensure professional working condition and balanced quality of life.

Mapping of COs and POs

	POs											
COs	1	2	3	4	5	6	7	8	9	10	11	12
CO1		M										
CO2			M									
CO3												
CO4												
CO5												

UNIT I - UNDERSTANDING STRESS (9 HOURS)

Meaning - Symptoms: Biological and Behavioural - Work Related Stress - Individual Stress – Reducing Stress – Burnout.

UNIT II - COMMON STRESS FACTORS TIME (9 HOURS)

Common Sources of Stress Biological, Personality and Environmental – Time Management – Techniques – Importance of planning the day – Time management schedule – Developing concentration – Organizing the Work Area - Prioritizing – Beginning at the start – Techniques for conquering procrastination – Sensible delegation – Taking the right breaks – Learning to say 'No'.

UNIT III - CRISIS MANAGEMENT (9 HOURS)

Implications – People issues – Structure issues, environmental issues, psychological fall outs – Learning to keep calm – Preventing interruptions – Controlling crisis – Importance of good communication – Taking advantage of crisis – Pushing new ideas – Empowerment.

UNIT I V - WORK PLACE HUMOUR (9 HOURS)

Developing a sense of Humour – Learning to laugh, role of group cohesion and team spirit, using humour at work, reducing conflicts with humour. Coping Styles Defensive Behaviours and Problem-Solving.

UNIT V - SELF DEVELOPMENT (9 HOURS)

Improving Personality – Leading with Integrity, enhancing creativity – Effective Decision Making – Sensible Communication – The Listening Game – Managing Self - Meditation for Peace – Yoga for Life.

TEXT BOOKS

1. D. Girdano and G. Everly., "Controlling Stress and Tension", 9 th Edition, Prentice-Hall, 2013.
2. Greenberg Jerrold S., Comprehensive Stress Management, 14th Edition, McGraw Hill Education, 2017.

REFERENCES

1. Dr. P.K.Dutta, "Stress Management" Himalaya Publishing House, First Edition 2010.
2. Schafer, Stress Management, 4th Edition, Cengage Learning, Delhi, 2008

3. Wolfgang Linden, Stress Management, Sage Publication, 1st Edition 2005.
4. Daniel Girdano, Dorothy Dusek and George S. Everly, Controlling Stress and Tension, 8th Edition, Pearson Education, 2009.
5. Brian Luke Seaward, Essentials of managing Stress, 1st edition, Jones & Bartlett Publishers, 2013.

HSS18R006	**ENGINEERING ECONOMICS**	**L**	**T**	**P**	**Credit**
		3	**0**	**0**	**3**
Pre requisite: NIL		**Course Category:** Humanities electives			
		Course Type: Theory			

Course Description:

This course provides an introduction to a broad range of economic concepts, theories and analytical techniques. It considers both microeconomics - the analysis of choices made by individual decision-making units (households and firms) - and macroeconomics - the analysis of the economy as a whole. Demand and market structure will be analysed at the firm level. Macroeconomic issues regarding National Income, Inflation, labour and money at an aggregate level will be modelled. The role of government policy to address microeconomic market failures and macroeconomic objectives will be examined.

Course Outcomes:

The students will be able to

CO 1. Identify and learn economic concepts into market economies.

CO 2. Understand the pricing methods, interpret the market factors to determine the price for products or services and to making decisions based on demand factors.

CO 3. Understand the major characteristics of different market structures and the implications for the behavior of the firm.

CO 4. Measure living standards, inflation, and unemployment for use as economic indicators. Understand the role of international trade,

CO 5. Analyze the determinants of the relative strengths of monetary policy for sustainable growth of our nation and International Trade.

Mapping of COs and POs

	POs											
COs	1	2	3	4	5	6	7	8	9	10	11	12
CO1	M											
CO2		M										
CO3		M										
CO4												
CO5									M			

UNIT I: DEFINITION AND SCOPE OF ECONOMIC (9 HOURS)

Definitions by A. Smith, A. Marshal and L. Robbins, P.Samuels on and their critical examination - Nature and scope of Economics - Micro-economics in relation to other branches of Economics.

UNIT :II PRICING AND LAW OF DEMAND (9 HOURS)

Demand, Factors influencing demand, Elasticity of demand - price, income and cross, concepts and measurement - Break Even Analysis – Law of Demand - Price, income and substitution effects - Giffen goods- Pricing Methods.

UNIT III: MARKET STRUCTURE (9 HOURS)

Definition of market. Concepts of product and factor markets. Different types of market: perfect competition, monopoly, imperfect competition, monopolistic, competition and oligopoly. Demand and Supply schedules. Price determination under perfect competition in long and short run. Price determination under monopoly. Discriminating monopoly.

UNIT IV: MACRO-ECONOMIC (9 HOURS)

Meaning, Macro-economic Policy and Its Objectives and Instruments - National Income and Social Accounting - Concepts, components, and measurement - Basic circular flow of income model, Unemployment, trade cycle, Inflation - causes, types, effects and control.

UNIT V: COMMERCIAL AND CENTRAL BANKS (9 HOURS)

Credit creation, monetary policy and tools - Balance of payments - Items in the balance of payments account, equilibrium in the balance of payments.

TEXT BOOKS

1. Gupta, S.B., Monetary Economics, S. Chand & Co., New Delhi, 2nd Edition, 2009.
2. Ruddar Datt and K.P.M.Sundharam, Indian Economy, 70th Edition, S.Chand & Company Ltd., New Delhi, 2013.

REFERENCES

1. D.N.Dewedi, Managerial Economics, 8th Edition, S.Chand & Company Ltd., New Delhi, 2005.
2. Gupta, G.S. Macroeconomics, Theory and Applications, 2nd edition, Tata McGraw-Hill publishing company Ltd., New Delhi, 2004.
3. Macroeconomic –Theory and policy, 3rd Edition, Tata McGraw-Hill publishing company Ltd., New Delhi, 2010.
4. Micro Economics, Mas Colell, 1st edition, Oxford Press, Delhi, 2012.

HSS18R007 HUMAN RESOURCE MANAGEMENT AND LABOUR LAW	L	T	P	C
	3	0	0	3
Pre requisite: NIL	**Course Category:** Humanities electives			
	Course Type: Theory			

Course Description:

This course aims at exploring key issues related to the management, performance, and development of human resources in the workplace. It places special emphasis on making decisions and developing plans that will enable managers to make the best possible use of their human resources, and covers areas such as: manpower planning, analysis and evaluation, recruitment and selection, wages and salaries, training and management development, performance appraisal, and industrial relations.

Course Outcomes:

CO's	Course Description
CO1	To provide the basic knowledge on developing the employment relations and knowledge to resolve the issues.
CO2	To design an appropriate and suitable role of HR specialist for implementing Human Resource Management policies.
CO3	To Manage the manpower to motivate and attract them to retain in the organization.
CO4	To Develop the responsibility of employer and legal system to manage the employment relations
CO5	To Provide more insights on the applicability of business law on various functional domains this in turn enhances a strong human relation.

Mapping of COs and POs

	POs											
COs	1	2	3	4	5	6	7	8	9	10	11	12
CO1												
CO2				M								
CO3												
CO4												
CO5										M		

UNIT – I FUNDAMENTALS OF HRM (9 HOURS)

Human Resource Development Systems-HR environment in India-Functions and Operations of a Personnel Office - Emerging HR Trends - HR information system

UNIT – II HRM FUNCTIONS (9 HOURS)

Job analysis and job design - HR planning – Recruitment - selection and induction- Staff Training and Development-Career planning and Development- Job Evaluation-Performance Appraisal and Potential Evaluation-Wage determination; salary structure-Wage policies and Regulations-Employee benefits and services

UNIT – III MOTIVATING HUMAN RESOURCES (9 HOURS)

Team and Team work - Collective Bargaining Employee Morale – Participative Management – Quality Circle – Empowerment –counseling and mentoring.

UNIT – IV MAINTENANCE OF WORKERS (9 HOURS)

Compensation Management- Reward system – Labour relations –Employee Welfare, Safety and Health – Employee benefits and services – Promotion , Transfers and separation – Ethical issues in HR Management and International Human Resource Management - Legal Aspect of Labour

UNIT – V BUSINESS LAW (9 HOURS)

Factories Act, 1948 - Industrial Dispute Act, 1947 – Industrial employment – Standing Orders Act, 1946 – Trade Union Act, 1926 - Workmen Compensation Act, 1923, Employees State Insurance Act, 1948, Employees Provident Fund and Miscellaneous Provision Act, 1952, Payment of Gratuity Act, 1972. Payment of Wages Act 1936, Minimum wages Act, 1948– Payment of Bonus Act, 1965.Tamil Nadu Shops and Establishments Act.

TEXT BOOKS

1. Decenzo and Robbins, Human Resource Management, Wilsey, 12th edition, 2015.
2. Prasad L.M., Human Resource Management, 3rd edition, Sultan Chand, New Delhi, 2014.

REFERENCES

1. Biswajeet Pattanayak, Human Resource Management, 3rd edition, Eastern Economy Edition, New Delhi, 2010.
2. C.B. Gupta, Human Resource Management, 13th Edition, Sultan Chand, New Delhi 2011.
3. V.S.P. Rao, Human Resource Management, 3rd edition, Excel Books, New Delhi, 2010.
4. Frank B. Cross and Roger LeRoy Miller, The Legal Environment of Business Text and cases, 9th Edition, Cengage Learning, 2015.

HSS18R008 ENTREPRENEURSHIP DEVELOPMENT	L	T	P	Credit
	3	0	0	3
Pre requisite: NIL	**Course Category:** Humanities electives **Course Type**: Theory			

Course Description:

This course focuses on the entrepreneurial process and the different kinds of entrepreneurial outcomes. Topics covered include opportunity identification through analysis of industry niches, skills needed in order to turn an opportunity into reality, business plans, launch decisions, and obtaining risk capital. This course deals with the problems and challenges facing the management of businesses in raising funds, marketing products and services, improving effectiveness and flexibility, and achieving growth.

Course Outcomes:

CO's	Course Outcomes
CO1	It provides more insights into the concept of entrepreneurship and which in turn leads to think creatively for new business opportunities to sustain individual as well as social goals.
CO2	It provides and promotes entrepreneurial spirit and provides a framework of successful business world with relation to agencies to promote employment opportunities.
CO3	It focuses on women entrepreneurship and promotes a successful business models and explains operational implementations for investment details.
CO4	It provides the role of government in promoting the entrepreneurship among the individuals and organizations as a whole
CO5	To Understand emerging concepts of marketing in the emerging global markets and provide more insights into project management and venture promotion

Mapping of COs and POs

	POs											
COs	1	2	3	4	5	6	7	8	9	10	11	12
CO1												
CO2									M			
CO3									M			
CO4												
CO5		M										

UNIT – I INTRODUCTION (9 HOURS)

Concepts of entrepreneur, entrepreneurship and entrepreneur - Characteristics and competencies of a successful entrepreneur - General functions of an entrepreneur - Type of entrepreneurs - Role of entrepreneur in economic development - Distinction between an entrepreneur and a manager - Entrepreneur and Intrepreneur.

UNIT – II GROWTH OF ENTREPRENEURSHIP (9 HOURS)

Emergence of entrepreneurship - Economic and non economic factors for stimulating entrepreneurship development - Obstacles to entrepreneurship development in India - Growth of entrepreneurship in India.

UNIT – III WOMEN AND ENTREPRENEURSHIP (9 HOURS)

Concept of women entrepreneurship - Reasons for growth of woman entrepreneurship - Problems faced by them and remedial measures.

UNIT–IV ROLE OF THE GOVERNMENT IN ENTREPRENEURSHIP DEVELOPMENT (9 HOURS)

Concept and meaning of entrepreneurship development - Need for entrepreneurship development programmes (EDPs) - Objectives of EDPs - Organizations for EDPs in India; NIESBUD, SISI – their roles and activities.

UNIT – V VENTURE PROMOTION AND PROJECT FORMULATION (9 HOURS)

Concept of projects classification of projects and project report - Project identification and selection - Constraints in project identification - Techniques of Project Identification, Significance – contents - formulation of project report - Need for Project Formulation - Elements of project Formulation

TEXT BOOKS

1. Michael H Morris, Corporate Entrepreneurship and Innovation in Corporations, 7th Edition, CENGAGE Learning, Delhi, 2010
2. Jerry Katz, Entrepreneurship Small Business, 5th edition, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2007.

REFERENCES

1. Khanka S.S., Entrepreneurial Development, 1st edition, S.Chand and Company Limited, New Delhi, 2013.
2. Prasama Chandra, Projects: Planning, Analysis, Selection, Implementation and Reviews, 2nd edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1996.
3. Robert D. Hisrich, Entrepreneurship, 10th edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2017

HSS18R009 COST ANALYSIS AND CONTROL	L	T	P	Credit
	3	0	0	3
Pre requisite: NIL	**Course Category:** Humanities electives **Course Type**: Theory			

Course Description:

This course in meant to exhibit the concepts on costing by describing its elements, types and cost sheet preparation. It also encompasses the analytical framework that can be applied in cost analysis like Marginal costing, CVP analysis, Break even analysis, etc enabling the students to make decisions on cost parameters. Students are enabled to apply techniques like standard costing, activity based costing, etc to manage and control cost effectively.

Course Outcomes

CO1	Understand the basics of Costing and preparation of Cost sheet.
CO2	Analyse the cost by applying tools like Marginal costing, CVP analysis and other applications.
CO3	Enabled to use Budgets for controlling cost in Manufacturing or Production Centres.
CO4	Defining cost standards and critically examining the application of Standard costing in a Production Centre.
CO5	Understanding the application of various strategic cost alternatives including Activity based costing.

Mapping of COs and POs

	POs											
COs	1	2	3	4	5	6	7	8	9	10	11	12
CO1		M										
CO2	M											
CO3												
CO4									M			
CO5		M										

UNIT I INTRODUCTION TO COSTING (9 HOURS)

Costing, Elements of costing, Types of cost, Preparation of cost sheet.

UNIT II COST ANALYSIS (9 HOURS)

Marginal costing, Cost - volume – Profit analysis, Break-Even- Analysis, Break –Even - Chart, Applications.

UNIT III CONTROL TECHNIQUES (9 HOURS)

Budgeting and Budgetary control, Types of Budgets , Preparation of purchase Budget, Flexible budgets, Cash Budget, Sales Budget, Materials Budget, Master Budget, Zero based Budgeting.

UNIT IV STANDARD COSTING (9 HOURS)

Types of Standards, Setting up of standards, Advantages and Criticism of Standard Costing –Control through variances.

UNIT V ACTIVITY BASED COSTING (9 HOURS)

Transfer Pricing, Target costing, Life Style Costing, Activity Based Costing (only theory).

TEXT BOOKS

1. K.Saxena & C.D. Vashist, Advanced Cost Accounting and Cost Systems, 2nd Edition, V.Sultan Chand & Sons Publishers. 2014
2. S.P. Jain & K. L. Narang, Advances Cost Accounting Kalyani Publishers, 1st Edition, 2017.

REFERENCES

1. J. Blocher, K. H. Chen, G. Cokins and T. W. Lin., Cost Management: A Strategic Emphasis, Irwin/McGraw-Hill, 3d edition, 2008
2. Don R. Hansen, Maryanne M. Mowen, Cornerstones of Cost Management, 6th Edition,Cengage Learning, 2015
3. Roger Hussey, Audra Ong, Strategic Cost Analysis, Business Expert Press, 2012

HSS18R010 PRODUCT DESIGN AND DEVELOPMENT	L	T	P	Credit
	3	0	0	3
Pre requisite: NIL	**Course Category:** Humanities electives			
	Course Type: Theory			

COURSE OBJECTIVES:

- To understand the basic characteristics of design of product and its evolution.
- To be aware of the various approaches related to new product development process.
- The student will learn about the need for industrial design and its impact on the market.
- To gain insights about Failure Mode Effective Analysis.
- To understand the methodologies and tools related to design of new product and the concepts associated to Value engineering.

COURSE OUTCOMES

S.NO	DESCRIPTION
CO1	To learn basic concepts related to design and development of New product
CO2	To understand the structured approach towards incorporating quality, safety, and reliability into design.
CO3	To learn the concepts relating to simulating product performance and manufacturing processes.
CO4	To understand the technologies related to computer aided group technology
CO5	To learn implications of changes related to Economic analysis.

Mapping of COs and POs

	POs											
COs	1	2	3	4	5	6	7	8	9	10	11	12
CO1		M										
CO2		M										
CO3												
CO4		M										
CO5		M										

UNIT – I NEW PRODUCT IDEA (9 HOURS)

Definition – Design by Evolution and by Innovation - factors to be considered for product design – Production-Consumption cycle – The morphology of design – Primary design Phases and flowcharting. Role of Allowance, Process Capability, and Tolerance in Detailed Design and Assembly Product strategies, Market research – identifying customer needs – Analysis of product – locating ideas for new products, Selecting the right product, creative thinking, curiosity, imagination and brain storming - product specification.

UNIT – II NEW PRODUCT DESIGNING (9 HOURS)

Task - Structured approaches – clarification – search – external and internal – systematic exploration – conception, selection - methodology benefits. The value of appearance - principles and laws of appearance – incorporating quality, safety, and reliability into design. Man-machine considerations – Designing for ease of maintenance.

UNIT – III ROLE OF TECHNOLOGY IN DESIGNING (9 HOURS)

Integrating CAE, CAD, CAM tools – Simulating product performance and manufacturing process – Needs for industrial design-impact – Industrial design process – Technology driven products - user driven products – assessing the quality of the product.

UNIT – IV METHODS AND PRINCIPLES OF DESIGNING (9 HOURS)

Methodologies and tools - Design axioms - Design for assembly and evaluation - Minimum part assessment - Taguchi Method - Robustness assessment - Manufacturing process rules - Designer's tool kit - Computer aided group process rules - Designer's tool kit - Computer aided group technology - Failure Mode Effective Analysis – Design for minimum number of parts – Development of modular design – Minimising part variations – Design of parts to be multifunctional, multi-use, ease of fabrication – Poka Yoka principles. (12 hours)

UNIT – V FEASIBILITY ANALYSI (9 HOURS)

Estimation of manufacturing cost – cost procedures – Value Engineering - reducing the component cost and assembly cost – minimizing the system complexity – Basics and Principals of prototyping – Economic Analysis: Break even analysis. Classes of exclusive rights – Patents – Combination versus aggregation – Novelty and Utility – Design patents – Paten disclosure – Patent application steps - Patent Office prosecution - Sales of patent rights - Trademarks – copy rights. (12 hours)

TEXT BOOKS

1. Karl.T.Ulrich, Steven D.Eppinger, Product Design and Development, McGraw Hill International, 6th Edition, 2016.
2. A.K.Chitale and R.C.Gupta, Product Design and Manufacturing, 3rd edition, Prentice Hall of India Private Limited, New Delhi, 2005.

REFERENCES

1. Richard Crowson, Product Design and Factory Development, **2nd Edition, crc Press, 2005.**
2. Thomke, Stefan, and Ashok Nimgade. "IDEO Product Development." Boston, MA: Harvard Business School Case 9-600-143, June 22, 2000.
3. George E.Dieter, Linda C.Schmidt, "Engineering Design", McGraw-Hill Higher Education, 4th Edition, 2012.
4. Kevin Otto, Kristin Wood, "Product Design", Indian Reprint 2004, Pearson Education

HSS18R011 BUSINESS PROCESS REENGINEERING	**L**	**T**	**P**	**Credit**
	3	**0**	**0**	**3**
Pre requisite: NIL	**Course Category:** Humanities electives			
	Course Type: Theory			

Couse description:

- This course aims to clarify the principles and basic concepts of Business Process Engineering.
- This course focuses on both quantitative and qualitative analytical skills and models essential to operations process design, management, and improvement in both service and manufacturing oriented

companies. The main objective of the course is to prepare the student to play a significant role in the management of a world class company which serves satisfied customers through empowered employees, leading to increased revenues and decreased costs.

Course outcomes:

S.NO	DESCRIPTION
CO1	To learn the basic concepts related to Business Process Reengineering.
CO2	To understand the methodologies and tools used for Business Process Reengineering.
CO3	To learn the concepts relating to benefit/cost analysis and its impact on the business organizations.
CO4	To understand the need for assessment of business re-engineering and the factors contributing to its success.
CO5	To learn the best practices used in Business Process Reengineering with illustrations from corporate world.

Mapping of COs and POs

	POs											
COs	1	2	3	4	5	6	7	8	9	10	11	12
CO1												
CO2		M										
CO3		M										
CO4									M			
CO5										M		

UNIT – I BASIC CONCEPTS (9 HOURS)

Introduction to BPR Definition; the paradigm shifts in production; the positioning concept; the re-engineering visions; the benefits of business re-engineering.

UNIT – II METHODOLOGIES FOR BPR (9 HOURS)

Methodologies and Tools for BPR, Process management; dynamic business re-engineering change framework; steps to reengineer the process.

UNIT – III MODELLING THE BUSINESS (9 HOURS)

Tools used in Modelling the Business: flow-charting, business activity maps, relational diagrams, benefit/cost analysis. The enabling role of information technology in business re-engineering.

UNIT – IV CHANGE MANAGEMENT (9 HOURS)

Change Management, Planned changes in business re-engineering projects; challenges of business change; business change development. Success factors in re-engineering. The assessment of business re-engineering.

UNIT– V BEST PRACTICES IN BPR (9 HOURS) Best Practices in BPR, Case studies: Bell Atlantic, Nissan, Chrysler, Xerox, and Hewlett Packard etc.

TEXTBOOKS

1. Ali K. Kamrani, Maryam Azimi (2011). New Methods in Product Design: New Strategies in Reengineering (Engineering and Management Innovation). CRC Press. 1st ed.
2. Bassam Hussein (2008). PRISM: Process Reengineering Integrated Spiral Model. VDM Verlag Dr. Mueller e.K.

REFERENCES

1. Harmon, P. (2007), Business Process Change : A Guide for Business Managers and BPM and Six Sigma Professionals, Elsevier/Morgan Kaufmann Publishers.
2. R. Anupindi et al. (2006), Managing Business Process Flows: Principles of Operations Management, Pearson Education Inc.

HSS18R012	POLITICAL ECONOMY	L	T	P	Credit
		3	0	0	3
Pre requisite: NIL		**Course Category:** Humanities electives **Course Type**: Theory			

Course Description

This course provides an introduction to the political economy of India. It examines the interplay of politics and economics. Some of the key themes to be explored are globalization, economic reform, poverty, redistribution, federalism, political protest, public goods delivery, gender, and ethnic politics. Although this class focuses specifically on India, a number of the themes discussed in this course are functions of institutions, rights, Party Systems and challenges.

Course outcomes

The students will be able to

S.NO	DESCRIPTION
CO1	Explain the key concepts of political economy analyse the significant developments in the political ideologies.
CO2	Describe the salient features of the constitution of India and its functions and also interpret,

	integrate and critically analyse the fundamental rights duties and responsibilities.
CO3	Understand the Political party system their evolution and role in the economy
CO4	Understand the various ideological of Indian Political Thoughts
CO5	have a deep understanding and appreciation of India undergoing major economic and social transformation

Mapping of POs and COs

Mapping of Course Outcome(s):												
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M											
CO2												
CO3		M										
CO4		M										
CO5									M			

UNIT I -INTRODUCTION TO POLITICAL ECONOMY (9 HOURS)

Political Economy as a Method, perspectives, Politics as Reproduction of Social Relations, State and Social Opportunity, Politics of Rent Seeking -Evolution of State in India: Historical Roots of planning, Redistribution.

UNIT II - INDIAN CONSTITUTION (9 HOURS)

The Pre-ample- Fundamental rights and duties, Directive Principles- Offices of the President, Prime Minister, Cabinet Government, Chief Election Commissioner, and Governor – Parliamentary system and Procedures - The Judiciary system.

UNIT III - PARTY SYSTEM (9 HOURS)

National and regional political parties, ideological and social bases of parties; patterns of coalition politics; Pressure groups, trends in electoral behaviour; changing socio- economic profile of Legislators.

UNIT IV - INDIAN POLITICAL THOUGHT: (9 HOURS)

Political Ideologies**:** Liberalism, Socialism, Marxism, Fascism, Gandhism and Feminism - Dharamshastra, Arthashastra and Buddhist traditions; Sir Syed Ahmed Khan, Sri Aurobindo, M.K. Gandhi, B.R. Ambedkar, M.N. Roy.

UNIT V - CHALLENGES TO INDIAN DEMOCRACY (9 HOURS)

Uneven Development of Regions in India – Communalism – Regionalism – Violence – Corruption – environmental degradation- illiteracy –Population.

TEXT BOOKS

1. Charles Sackrey, Geoffrey Schneider, Janet Knoedler, Introduction to Political Economy, Dollars & Sense, 8th Edition, 2016.
2. Robert.S.Dimand, Review of Political Economy: An Introductory Text, 1st Edition, Routledge, 2008.

REFERENCES

1. Barry R. weingast and Donald a.Wittman, Handbook of Political Economy, 1st Edition, Oxford University Press, New York, 2006.
2. Ed. Sanjay Ruparelia; Sanjay Reddy; John Harriss & Stuart Corbridge, Understanding India's New Political Economy: A Great Tranformation, Routledge 1st Edition edition 2011.
3. M.Laxmikanth, Indian Polity, 4th Edition, McGraw Hill Education, New Delhi,2017.
4. Niraja Gopal Jayal, Pratap Bhanu Mehra, The Oxford Companion to Politics in India: Student Edition, Oxford Press, 2011.

HSS18R013	PROFESSIONAL ETHICS	L	T	P	Credit
		3	0	0	3
Pre requisite: NIL		**Course Category:** Humanities electives			
		Course Type: Theory			

Couse description:

It is essential for professionals in any field to have an understanding of the ethical problems and principles in their field. The general principles of professional ethics will be examined, as well as the distinctive problems. This course is presented in three parts: theory; case studies; and research and presentation. Theory includes ethics and philosophy of engineering. Historical cases are taken primarily from the scholarly literatures on engineering ethics, and hypothetical cases are written by students. It will allow students to explore the relationship between ethics and engineering and apply classical moral theory and decision making to engineering issues encountered in academic and professional careers.

Course outcomes:

S.NO	DESCRIPTION
CO1	identify the multiple ethical interests at stake in a real-world situation or practice
CO2	assess their own ethical values and the social context of problems
CO3	Develop critical thinking skills and professional judgement and understand practical difficulties of bringing about change
CO4	demonstrate knowledge of ethical values in non-classroom activities, such as service learning, internships, and field work
CO5	Manage differing opinions on complex ethical scenarios. It's important for those confronted with

	ethical challenges to be able to hold multiple conflicting points of view, without necessarily adhering to any of them.

Mapping of COs and POs

	POs											
COs	1	2	3	4	5	6	7	8	9	10	11	12
CO1	M											
CO2												
CO3		M										
CO4												
CO5									M			

UNIT I - ENGINEERING ETHICS (9 HOURS)

Functions of Being a Manager – Stock holder and stakeholder management – Ethical treatment of employees - ethical treatment of customers- supply chain management and other issues.

UNIT II - ENGINEERING AS SOCIAL EXPERIMENTATION (9 HOURS)

Senses of Ethics – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Professions and Professionalism – Professional ideals and virtues – Theories about right action – Self-interest – Customs and religion – Use of Ethical Theories.

UNIT III - ENGINEER RESPONSIBILTY FOR SAFETY (9 HOURS)

Corporate social responsibility - Collegiality and loyalty – Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Discrimination.

UNIT IV - RESPONSIBILITY AND RIGHTS (9 HOURS)

Moral imagination, stake holder theory and systems thinking - One approach to management Decision – making Leadership.

UNIT V - GLOBAL ISSUES (9 HOURS)

Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership – Sample code of conduct.

TEXT BOOKS

1. Mike Martin and Roland Schinzinger, Introduction to Engineering Ethics, 2nd Edition, McGraw Hill Higher Education, New Delhi, 2010.

2. Charles D Fledderman, Engineering Ethics, 4th Edition, Pearson Education, Delhi, 2011.

REFERENCES

1. R.S.Naagarazan, Text book on Professional Ethics and Human Values, New Age International, 2007.
2. Gail Baura, Engineering Ethics- An Industrial Perspective, 1st Edition, Academic Press, 2006.
3. Charles e. Harris , Michael s. Pritchard and Michael J. Rabins Texas , Engineering Ethics- Conecpts and Cases, 4th Edition, Cengage Learning, 2009.
4. Charles Byms Fleddermann, Engineering Ethics, 3rd Edition, Pearson Prentice Hall, 2008.
5. Govindarajan M, Natarajan S, Senthil Kumar V. S, "Engineering Ethics", Prentice Hall of India, New Delhi, 2013.
6. Dr.V.Jeyakumar, Professional Ethics in Engineering, Lakshmi Publication, Chennai, 2014.

HSS18R014	OPERATIONS RESEARCH	L	T	P	Credit
		3	0	0	3
Pre requisite: NIL		**Course Category:** Humanities electives **Course Type**: Theory			

Couse description:

This subject will provide students with ability to understand and analyze managerial problems in industry so that they are able to use resources (capitals, materials, staffing, and machines) more effectively. It also provides the knowledge of formulating mathematical models for quantitative analysis of managerial problems in industry. It enhances the skills in the use of Operations Research approaches and computer tools in solving real problems in industry.

Course outcomes:

The students will be able to

S.NO	DESCRIPTION
CO1	to identify and develop operational research models from the verbal description of the real System.
CO2	Be able to build and solve Transportation Models and Assignment Models
CO3	Use mathematical software to solve the proposed models.
CO4	Develop a report that describes the model and the solving technique, analyse the results and propose recommendations in language understandable to the decision making processes in Management Engineering.
CO5	Be able to design new simple models, like: CPM, MSPT to improve decision –making and develop critical thinking and objective analysis of decision problems.

Mapping of COs and POs

	POs											
COs	1	2	3	4	5	6	7	8	9	10	11	12
CO1	M											
CO2												
CO3		M										
CO4								M				
CO5									M			

UNIT I - INTRODUCTION TO LINEAR PROGRAMMING (9 HOURS)

Introduction to applications of operations research in functional areas of management - Linear Programming - formulation, solution by graphical and simplex methods (Primal - Penalty, Two Phase), Special cases - Dual simplex method.

UNIT II - TRANSPORTATION MODELS AND ASSIGNMENT MODELS (9 HOURS)

Transportation Models (Minimising and Maximising Cases) – Balanced and unbalanced cases – Initial Basic feasible solution by N-W Corner Rule, Least cost and Vogel's approximation ethods - Check for optimality - Solution by MODI / Stepping Stone method - Cases of degeneracy - Transshipment Models - Assignment Models (Minimising and Maximising Cases) – Balanced and Unbalanced Cases - Solution by Hungarian and Branch and Bound Algorithms - Travelling Salesman problem - Crew Assignment Models.

UNIT III - INTEGER LINEAR PROGRAMMING AND GAME THEORY (9 HOURS)

Solution to pure and mixed integer programming problem by Branch and Bound and cutting plane algorithms - Game Theory - Two person Zero sum games - Saddle point, Dominance Rule, graphical and LP solutions.

UNIT IV - REPLACEMENT MODELS AND DECISION THEORY (9 HOURS)

Replacement Models-Individuals replacement Models (With and without time value of money) – Group Replacement Models - Decision making under risk – Decision trees – Decision making under uncertainty.

UNIT V - PROJECT MANAGEMENT METHOD AND SIMULATION (9 HOURS)

PERT / CPM – Drawing the network, computation of processing time, floats and critical path. Resource leveling techniques - Application of simulation techniques for decision making.

TEXT BOOKS

1. Kalavathy S, Operations Research, Vikas Publishing House, 4TH Edition, 2013.
2. Paneerselvam R., Operations Research, Prentice Hall of India, 2ND Edition, 2006.
3. Tulsian P.C, Vishal Pandey, Quantitative Techniques (Theory and Problems), Pearson Education, Asia, First Indian Reprint 2002.

REFERENCES

1. D.S.Hira, Problems in Operations Research, Kindle Edition, S.Chand, 2010.
2. Prem Kumar Gupta and D.S. Hira, Operations Research,S.Chand, 2016.
3. R.C.Mishra,Principles of Operations Research, 1st Edition, New Age International 2011.
4. Kanti Swarup, P.K.Gupta and Man Mohan, Operations Research, 15th Edition, Sultan Chand and Sons 2010.

HSS18R015 TOTAL QUALITY MANAGEMENT	L	T	P	Credit
	3	0	0	3
Pre requisite: NIL	**Course Category:** Humanities electives			
	Course Type: Theory			

Couse description:

This subject provides students with the knowledge to understand the philosophy and core values of Total Quality Management (TQM). It helps to determine the voice of the customer and the impact of quality on economic performance and long-term business success of an organization; apply and evaluate best practices for the attainment of total quality. Students who complete this course will be able to critically appraise management techniques, choose appropriate statistical techniques for improving processes and write reports to management describing processes and recommending ways to improve them.

Course outcomes:

S.NO	DESCRIPTION
CO1	Understand the role and nature of quality in evolving international economic conditions
CO2	Apply the Principles of Quality Management for real time problems.
CO3	the quality encounter process, including supporting facilities and customer requirements/characteristics
CO4	Classify quality measurement methods and continuous improvement process
CO5	Frame Management strategy methods, including identification, development, implementation and feedback processes

Mapping of COs and POs

	POs											
COs	1	2	3	4	5	6	7	8	9	10	11	12
CO1	M											
CO2		M										
CO3									M			

CO4												
CO5										M		

UNIT I - INTRODUCTION TO QUALITY MANAGEMENT (9 HOURS)

Definitions – TOM framework, benefits, awareness and obstacles - Quality – vision, mission and policy statements - Customer Focus – customer perception of quality, Translating needs into requirements, customer retention. Dimensions of product and service quality. Cost of quality.

UNIT II - PRINCIPLES AND PHILOSOPHIES OF QUALITY MANAGEMENT (9 HOURS)

Overview of the contributions of Deming, Juran Crosby, Masaaki Imai, Feigenbaum, Ishikawa, Taguchi, Shingeo and Walter Shewhart - Concepts of Quality circle, Japanese 5S principles and 8D methodology.

UNIT III - STATISTICAL PROCESS CONTROL AND PROCESS CAPABILITY (9 HOURS)

Meaning and significance of statistical process control (SPC) – construction of control charts for variables and attributed - Process capability – meaning, significance and measurement – Six sigma concepts of process capability - Reliability concepts – definitions, reliability in series and parallel, product life characteristics curve - Business process re-engineering (BPR) – principles, applications, reengineering process, benefits and limitations.

UNIT IV - TOOLS AND TECHNIQUES FOR QUALITY MANAGEMENT (9 HOURS)

Quality functions development (QFD) – Benefits, Voice of customer, information organization, House of quality (HOQ), building a HOQ, QFD process. Failure mode effect analysis (FMEA) – requirements of reliability, failure rate, FMEA stages, design, process and documentation.

UNIT V -TAGUCHI TECHNIQUES (9 HOURS)

Taguchi techniques – introduction, loss function, parameter and tolerance design, signal to noise ratio - Seven old (statistical) tools - Seven new management tools - Bench marking and POKA YOKE.

TEXT BOOKS

1. Poornima M.Charantimath., Total quality management, Pearson Education, 2ND Edition, 2011.
2. Dale H.Besterfield et al, Total Quality Management, Perarson Education, Thrid edition, (First Indian Reprints 2004).

REFERENCES

1. Shridhara Bhat K, Total Quality Management – Text and Cases, Himalaya Publishing House, First Edition, 2002.
2. Jams R. Evans, Total Quality: Management, Organisation and strategy, 4th Edition, South- Western College, 2004.
3. Vincent K.Omachonu, Joel E.Ross, Principles of Total Quality, 3rd Edition, CRC Press, 2004.
4. S.Rajaram, M.Sivakumar, Total Quality Management, Wiley Publishers, 1st Edition, 2008.

HSS18R 016	ADVANCED SOFT SKILLS	L	T	P	Credit
		3	0	0	3
Pre requisite: NIL		**Course Category:** Humanities electives **Course Type**: Theory			

EFFECTIVE COMMUNICATION

Comprehending Ability, Business Vocabulary, Speed Reading, Non-Verbal Communication, Cross Cultural Communication, Meeting Management, Technology trend awareness

QUANTITATIVE ABILITY

Time & Work, Time-Speed-Distance, Permutation & Combination Probability, Geometry & Mensuration, Number Properties, Ratio & Proportion, Mixtures & Alligation, Percentages, Profit-Loss-Discount, Averages, Progression, Higher Mathematics

LOGICAL ABILITY

Non-Verbal Reasoning, Deductive & Inductive Reasoning, Binary Logic, Number Series, Clocks, Calendars

VERBAL ABILITY

Reading Comprehension, Parajumbles, Critical Reasoning, Subject-Verb Agreement, Synonyms & Antonyms, Grammar Reading Comprehension & Logic Miscellaneous Verbal questions

DATA INTERPRETATION

Line Charts, Bar Charts, Pie Charts, Venn diagrams, Caselets, Data tables.

Open Elective Courses Offered by Arts and Science Departments

It is mandatory for the students studying Engineering programs to choose minimum two open elective courses from basic Science and Mathematics.

OEE18R001	SCIENCE FICTION	L	T	P	C
		3	0	0	3

Syllabus

1. **Brave New World** - Aldous Huxley

   Publisher: Aldous Huxley; Perennial, Reprint edition, 1 September 1998; ISBN 0-06-092987-1

2. **Hyperion** - Dan Simmons

   Publisher: Doubleday, 1989, ISBN-0-385-24949-7

3. **The Handmaid's Tale** -Margaret Atwood

   Publisher: McClelland and Stewart, 1985, ISBN-0-7710-0813-9

4. **Jurassic Park** -Michael Crichton

   Publisher: Alfred A.Knopf, November 20, 1990, ISBN: 0-394-58816-9

5. **The Art of Story Telling** -Know your audience – Make them care – Set the scene – Be creative with chronology – Know your punchline – Engage your audience – Use tension – End with a grand finale – Don't be limited by words – Enjoy the process.

OEE18R002	PHONETICS FOR EFFECTIVE COMMUNICATION	L	T	P	C
		3	0	0	3

Unit I An Overview of Articulatory Phonetics

The Airstream Mechanism, The Organs of Speech

Unit II The Consonants of English Classification of Consonants Sounds, Place of

Articulation, Manner of Articulation, Description of Consonants.

Unit III The Vowel Sounds of English

Articulation of Vowels, Cardinal Vowels, Classification and Description of Vowels, Vowel Length, Diphthongs or Vowel Glides

Unit IV Phonology and Phonetic Description
The Phonology of English, Transcription of Words

Unit V The Syllable and Consonant Clusters in English

Composition of the Syllable, Consonant Clusters in English; Accent in English

-Segment English, Word Accent, Accent and Rhythm, Strong and Weak Forms

Practical Classroom Interaction

Texts Prescribed:

Daniel Jones. **An Outline of English Phonetics.** New York, G.E Stechert & Co. 1922.

Daniel Jones. **The Pronunciation of English.** New York, G.E Stechert & Co. 1932.

Colin McIntosh:**Cambridge Advanced Learner's Dictionary**. Fourth Edition.

T.Balasubramanian: English Phonetics for Indian Students.Third Edition,2013.

OEE18R003	Mathematical Biology	L	T	P	C
		3	1	0	3

Course Objective:

To enable the students to understand the concepts of models for single species, interacting populations and dynamics of marital interaction.

Course Outcomes:

Upon successful completion of this course, students will be able to

CO1. learn continuous population models for single species

CO2. learn discrete population models for a single species

CO3. understand models for interacting populations

CO4. Analyze the various competitive models..

CO5. model the dynamics of marital interaction.

Unit-I: Continuous Population Models for Single Species

Continuous Growth Models, Insect Outbreak Model: Spruce Budworm, Delay Models. Linear Analysis of Delay Population Models: Periodic Solutions, Real Life Problems related to Growth Model.

Unit-II: Discrete Population Models for a Single Species

Introduction: Simple Models, Cob webbing: A Graphical Procedure of Solution, Discrete Logistic-Type Model: Chaos, Stability, Periodic Solutions. Discrete Delay Models, Tumor Cell Growth.

Unit-III: Models for Interacting Populations

Predator-Prey Models: Lotka-Volterra Systems, Complexity and Stability, Realistic Predator-Prey Models, Analysis of Predator-Prey Model with Limit Cycle, Periodic Behavior: Parameter Domains of Stability.

Unit-IV: Competitive Models

Competition Models: Competitive Exclusion Principle, Mutualism or Symbiosis, General Models and Cautionary Remarks, Threshold Phenomena, Discrete Growth Models for Interacting Populations, Predator- Prey Models : Detailed Analysis.

Unit-V: Modelling the Dynamics of Marital Interaction: Divorce Prediction and Marriage Repair

Psychological Background and Data: Gottman and Levenson Methodology, Maital Typology and Modelling Motivation, Modelling Strategy and the Model Equations, Steady States and Stability.

Text Book:

1. J. D. Murray, Mathematical Biology: I. An Introduction, Third Edition, *Springer-verlag Berlin Heidelberg,* 2002.

REFERENCE BOOKS:

1. R.M. Anderson and R. M. May, editors, Infectious Disease of Humans : Dynamics and Control. *Oxford University Press, Oxford*, 1991..
2. O. Diekmann and J. A. P. Heesterbeek. Mathematical Epidemiology of Infectious Diseases: Model Building, *Analysis and Interpretation. John Weily, New York*, 2000.

OEE18R004	MATHEMATICAL MODELLING	L	T	P	C
		3	1	0	3

Course Objective:

To make the students to be capable of doing simple mathematical modelling using differential equations and difference equations.

Course Outcomes:

Upon successful completion of this course**,** Students will be able to

CO1: understand the mathematical modelling of ordinary differential equation of first order.

CO2:know about the concepts of mathematical modelling in difference equations and Linear difference equations.

CO3: know mathematical modelling through partial differential equation and study about the mass-balance equations.

CO4: know the first and second methods of obtaining partial differential equation models.

CO5: Study about the mathematical modelling through delay differential and functional equations.

Unit I:

Review of ODE and System of First Order ODE - Mathematical modelling in population dynamics-Epidemics through systems of ODE of first order - Mathematical modelling through systems of ordinary differential equations of the first order.

Unit II:

Difference Equation and its solution - Mathematical modelling through difference equations - The need for mathematical modeling through difference equations some simple models-Basic theory of linear difference equations with constant coefficients.

Unit III:

Review of PDE and solution of simple linear PDEs, Mathematical modelling through Partial differential equation -situation giving rise to Partial differential equation models-Mass-balance equations.

Unit IV:

First method of getting Partial differential equation models-Momentum balance equations the second method of obtaining PDE models.

Unit V:

Integral Equations - Solution of Simple Integral Equations - Mathematical modelling through functional Integral , delay differential and differential difference equations.

Text Book:

J.N. Kapur, Mathematical modelling, *New age international publishers,* 2005 (Reprint).

Reference Book: Frank R. Giordano, William P. Fox, Steven B. Horton , A First Course in Mathematical Modelling , *Cengage Learning Publishers, 5th Edition*, 2013.

OEE18R005	COMBINATORICS	L	T	P	C
		3	1	0	3

Course Objectives:

To enable the students to understand the concepts of permutation, combination and inclusion and exclusion principle.

Course outcomes:

Upon successful completion of this course, students will be able to

CO1. understand the rules of sum and product of permutations and combinations.

CO2. analyze the concepts of pigeonhole principle and its applications.

CO3. identify solutions by the technique of generating functions

CO4. understand the concepts of Pascal's triangle, the binomial Theorem and unimodality of binomial Coefficients.

CO5. understand the concepts of the principle of inclusion-exclusion and their applications.

Unit I - Permutations and Combinations

Four Basic Counting Principles, Permutations of sets, Combinations (Subsets) of Sets, Permutations of Multi-sets, Combinations of Multi-sets.

Unit II - The Pigeonhole Principle:

Pigeonhole Principle: Simple Form, Pigeonhole Principle: Strong Form, A Theorem of Ramsey.

Unit III - Generating Permutations and Combinations:

Generating Permutations, Inversions in Permutations, Generating Combinations, Generating r-Subsets**.**

Unit IV - The Binomial Coefficients:

Pascal's Triangle, The Binomial Theorem, Unimodality of Binomial Coefficients, The Multinomial Theorem, Newton's Binomial Theorem.

Unit V - The Inclusion-Exclusion Principle and Applications: The Inclusion-Exclusion Principle, Combinations with Repetition, Derangements, Permutations with Forbidden Positions, Another Forbidden Position Problem.

Text Book : Richard A. Brualdi, Introductory Combinatorics, Pearson Education, Inc, China machine press, Fifth Edition, 2009

References :

1. Miklos Bona, A walk through Combinatorics, (Second Edition), *World Scientific Publ. Co.,* 2008.
2. C. L. Liu, Introduction to Combinatorial Mathematics*, Mc Graw Hill Book Company, New York,* 1968.

OEE18R006	Industrial Chemistry for Engineers	L	T	P	C
		3	0	0	3

Course Outcome(s)

CO1 To apply the knowledge of electrochemistry to understand the working mechanism of batteries and sensors.

CO2 To understand the process involved in refining of petroleum, cracking of crude oil and manufacturing of fuel gases and to analyze the flue gas.

CO3 To understand the process of adsorption and colloidal state of materials.

CO4 To understand the formulation of protective coatings and to know the process of manufacturing and cleansing action of soaps.

CO5 To know the constituents, composition and manufacturing process of cement, glass and ceramics.

Unit - I: Energy Storage Devices and Sensors

Batteries - primary and secondary cells. Primary cell - Dry cell, Mercury cell. Secondary cell - Lead acid battery, Lithium battery. Solar cells & fuel cells (H_2-O_2, PEFC and SOFC) - principle, construction, working and application. Electrochemical sensors - working, application and merits.

Unit - II: Fuels and Combustion

Petroleum: Origin, refining, cracking - thermal and catalytic, reforming – thermal and catalytic, knocking and octane number, synthetic petrol - Fischer-Tropsch and Bergius method.

*Fuel Gases***:** Large scale production, storage, hazards and uses of LPG, coal gas, water gas, producer gas, and oil gas. Combustion (Problems). Mass analysis from volume analysis and vice versa. Analysis of flue gas (Orsat's apparatus).

Unit- III: Applications of Adsorption and Colloidal State

Adsorption: Classification of Adsorption – Adsorption of Gases on Solids – Adsorption from Solutions – Applications of Adsorption.

Colloidal state: Types of colloidal solution –Preparation and purification of colloidal solutions – Characteristics of colloidal solution –Coagulation of sols – Origin of charge on colloids – Stability of colloids – Applications of Colloids – Protective colloids – Emulsions – Gels – Micelles.

Unit - IV: Organic Protective Coatings and Soaps

*Paints & Varnishes***:** Requirements of a good paint. Primary constituents of paints, dispersion medium (solvent), binder, pigments, formulation of paints and varnishes.

Soaps: Classification of soap, manufacture of soaps by hot and cold process, cleansing action of soap and classification of detergents (anionic and cationic).

Unit - V: Siliceous Materials

Cement: Manufacture - Wet Process and Dry process, types, analysis of major constituents, setting of cement, reinforced concrete.

Glass: Composition and manufacture of glass .Types of glasses- optical glass, coloured glasses and lead glass.

Ceramics: Types- raw materials - white wares, manufacture and uses.

Reference Books:

1) Jain and Jain, *Engineering Chemistry*, 15th Edition, .Dhanpat Rai Publishing Company, New Delhi, 2005.
2) B.N. Chakrabarty, *Industrial Chemistry*, Oxford & IBH Publishing Co, New Delhi, 1981.
3) B.K. Sharma, *Industrial Chemistry*, 11th Edition, Goel Publishing House, Meerut, 2000.
4) P.P. Singh, T.M. Joesph, R.G. Dhavale, *College Industrial Chemistry*, 4th Edition, Himalaya Publishing House, Bombay, 1983.

OEE18R007	ANALYTICAL METHODS IN MATERIALS SCIENCE	L	T	P	C
		3	0	0	3

Course Outcome:

At the end of the course, the students will be able to

CO-1: knowledge about the crystallography to identify the structure of crystals

CO-2: gain depth knowledge about the Production of X-rays, X- ray diffraction methods

CO-3: an ability to develop the knowledge about the surface analytical techniques

CO-4: study the various structural properties of materials using various spectroscopical methods

CO-5: Impart knowledge on thermo gravimetric analyses and their usages in selected materials

Unit – I: Materials

Classification of Materials- Crystalline and amorphous- Crystal structure and their types-Lattice directions and planes – Miller indices –determination of Miller indices – symmetry and systematic absent-Polymers, Ceramics, Nanomaterials: Types, Properties and applications;

Unit – II: X-Ray Diffraction Methods

X-ray diffraction, Bragg's law, Laue method, rotating crystal method, powder method, Debye-Scherrer camera, Scherrer formula for estimation of particle size, single crystal XRD-instrumentation

Unit – III: Morphological and Elemental study

Introduction to electron microscope - Surface techniques: SEM, X-ray photoelectron spectroscopy (XPS). Electron beam techniques: Transmission electron microscopy (TEM), Atomic Force microscopy (AFM), X-ray Fluorescence (XRF)

Unit – IV: Atomic And Molecular Spectroscopy

Atomic Absorption and Atomic Fluorescence Spectrometry-X-Ray Fluorescence - Principles - Instrument Components – Methods. Molecular spectroscopy: UV/Visible Molecular Absorption Spectrometry - Photo acoustic Spectroscopy. IR, Raman Spectroscopy – principles, Instrumentation, Applications

Unit – V: Heat treatment methods and thermal analytical techniques

Heat treatment methods: Calcination-sintering-annealing-quenching - Principle of differential thermal analysis, differential scanning calorimetry and thermo gravimetric analysis –instrumentation and applications

Text Books

1. Elements of X-ray diffraction, B. D. Cullity, S.R. Stock, Prentice Hall, 3rd Edition, New York, 2001.
2. Atomic and Molecular Spectroscopy: Basic concepts and Applications, Rita Kakkar, Cambridge India, 2017.

Reference Books

1. Outline of Crystallography for Biologists, David Blow, Oxford University Press, oxford, 2004
2. Surface Analysis: Principle Techniques, John C. Vickerman, Ian Gilmore, John Wiley & Sons, 2nd Edition, 2009
3. Principles of Instrumental Analysis, D.A. Skoog, F.J.Holler, S.R. Crouch, Cengage Learning US, 2017.
4. Instrumental Methods of Analysis, Hobarth Willard, Lynne Merritt, John , Wadsworth Publishing Company, 7 Sub edition, California, 1988.
5. Atomic spectroscopy, J. W. Robinson, 2nd Edition, CRC Press, Florida 1996.
6. Molecular spectroscopy, Banwell & McCash, 4th Edision, McGraw-Hill India, 2017.

OEE18R008	**PHOTONICS AND OPTOELECTRONIC DEVICES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Outcomes:

At the end of the course, the students will be able to

CO-1: Have the knowledge on fundamental of fibre based optical devices

CO-2: Basics of Integrated optical devices

CO-3: Learn about the opto-electronic devices

CO-4: Understanding of nanostructured materials

CO-5: Understanding of quantum devices with applications

Unit – I: Optical Fibre based Devices

Introduction to optical Fibre - Fused single mode fibre directional coupler, Polished single mode fibre directional coupler - Fibre polariser; Wavelength multiplexer and demultiplexer - Optical fibre switches and intensity modulators - Optical fibre phase modulator - Optical fibre frequency modulator - Optical fibre amplifiers

Unit – II: Integrated Optics based Devices

Optical directional coupler - directional coupler wavelength filter, polarisation splitting directional coupler - Polarisers: leaky mode polariser , metal clad polariser; Phase modulator - Optical switch - Acousto-optic devices : mode converter , tunable wavelength filter, Bragg type modulator, Bragg type deflector - Magneto-optic devices : TE-TM mode converter, modulators and switches, Ti/$LiNbO_3$ based optical devices.

Unit – III: Optoelectronic Devices

Semiconductor Lasers: homojunction, heterojunction and surface emitting lasers, quantum well lasers - Modulation of lasers - Photodetectors: PIN, Avalanche photodiodes - Optoelectronic modulation and switching devices - Electro-optic Devices - Optoelectronic Integrated circuits - SiO_2 / Si based optoelectronic devices.

Unit – IV: Nanophotonics

Nanocomposites: Nanocomposite Waveguides, Random Lasers, Nanocomposites for optoelectronics-Basics of nano-photonics-Introduction to MEMS and NEMS-Working principles: as micro sensors-biosensors, chemical sensors and optical sensors. MEMS/NEMS applications: Applications in automotive industry-health care-aerospace-industrial product-consumer products.

Unit – V: Quantum Devices

Low-dimensional structures: Quantum wells, Quantum wires, and Quantum dots - Density of states in low-dimensional structures - Resonant tunneling phenomena in diodes and transistors - Applications of quantum devices: quantum well and quantum dot lasers, ultra-fast switching devices, high density memories, dc and rf squids, multi-state logic circuits, long wavelength detectors - Quantum Computing (Qualitative)

Text Books:

1. Niloy K Dutta, Xiang Zhang , Optoelectronic Devices, World Scientific Publishing Company, Singapore, 2018.
2. Arthur McGurn, Nanophotonics, 1st Edition, Springer, 2018.

Reference Books:

1. Joachim Piprek, Semiconductor optoelectronic devices:Introduction to Physics and Simulation, Academic Press, United States, 2003.
2. A.K. Ganguly, Optoelectronic devices and circuits, Narosa Publications, New Delhi, 2012
3. Ray Tricker, Optoelectronics and Fiber Optic Technology, Newnes, United States, 2002
4. K Krishna Reddy M Balakrishna Rao, Nanostructures & Quantum Devices, Campus, Books International, India, 2007
5. Rahman Faiz, Nanostructures in Electronics and Photonics, Pan Stallion press,Uinted Kingdom, 2008.
6. Guozhong Cao, Nano structures & nano materials: synthesis, properties & applications, Imperial College Press, United Kingdom, 2004
7. Todd D. Steiner, Semiconductor nanostructures for optoelectronic application, Artech House, INC., USA, 2004
8. Jia- Ming Liu, Photonic Devices, Cambrige University Press, United States, 2010 (Online publication).

OEE18R009	LASER TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Outcomes:

At the end of the course, the students will be able to

CO-1: enhance the modern technological aspects in laser

CO-2: correlate the basic concept of theoretical principles in laser

CO-3: an ability to improve the knowledge of various types of laser

CO-4: enormous interest to study the various properties of laser.

CO-5: knowledge of laser applications in various engineering fields

Unit - I: Absorption and Emission of Radiation

Concept of coherence – spatial and temporal - Conditions for Producing Laser - spontaneous and stimulated emission - Population Inversion-different methods-Einstein coefficients – negative absorption – Gain and Gain saturation - Saturation intensity - shape and width of spectral lines.

Unit - II: Threshold Condition and Resonators

Rate equations – optical excitation in three and four level lasers – standing waves in laser – cavity theory – dichroic filter – modes, diffraction theory of the Fabry – Perot interferometer – Types of resonators – stability diagram

Unit - III: Types of Lasers

Principle, construction, working- Gas lasers : He-Ne laser, CO_2 laser - Liquid lasers: dye lasers - Solid state laser: Ruby laser, Nd-YAG laser.

Unit - IV: Ultrafast Photonics and Laser Q Switching

Introduction to ultrashort pulse lasers and amplifiers – wavelength conversion – time-resolved experiments – applications of ultrashort pulses – Mode locking – second harmonic generation – theory and experiment – materials for optical second harmonic generation

Unit - V: Applications

Measurement of distance, velocity, rotation with lasers – laser in communications and computer technology– holography – industrial applications – cutting, drilling & welding – lasers in medicine – lasers in research and development.

Text Books:

1. M N Avadhanulu and P S Hemne, An Introduction to Laser Physics, 1st Edition, S. Chand Publication, India, 2012.
2. Leon Goldman, Applications of Laser, 1st Edition, CRC Press, United States, 2018.

Reference Books:

1. Simon Hooker & Colin Webb “Laser Physics” Oxford Press, United Kingdom, 2010.
2. William T. Silfvast “Laser Fundamentals” Cambridge University Press, Second Edition, United Kingdom, 2008.
3. William S. C. Chang “Principles of Lasers and Optics” Cambridge University Press, United Kingdom, 2007.
4. Yehoshua Y. Kalisky “The Physics and Engineering of Solid State Lasers” SPIE Press, United States, 2006.
5. Mark Csele “ Fundamentals of light sources and lasers” John Wiley and sons, New Jersey, 2004

OEE18R010	PRINCIPLES OF TAXATION	L	T	P	C
		3	1	0	3

Unit-1

Meaning of Tax – Definition of Tax - Types of Tax- Objectives of Taxation - Difference between Direct tax and Indirect Tax – Tax Authorities.

Unit-2

Characteristics of tax -Canons of taxation- Characteristics of good tax system - Tax Avoidance - Tax Evasion - Tax Planning - Impact of tax - Incidence of Tax.

Unit-3

Income tax - Important Definitions - Residential status of Assessee - Incomes Exempt from tax –Deductions - Advance tax - PAN.

Unit-4

Heads of Income of Individual – Income from Salary – Income from House property – Income from Business or Profession – Income from Capital gain – Income from other Sources – Filing of Returns.

Unit-5

Service Tax - Custom Duty – Entry Tax (Octroi) - Purchase Tax - GST - Goods & Services Tax Act 2017 (GST) – Registration - Accounts & Records –Assessment - Payment of tax & Refund - Search &Seizure-Appeals &Revision.

Reference Books:

1. Income tax Law and Practice – V.P.Gaur, D.B.Narang, Puja Gaur and Rajeev Puri, Kalyani Publications.
2. Business Taxation –T.S.Reddy and Y.Hariprasad Reddy, Margham Publications.
3. Direct Taxes -Dr.Vinod Singhania.
4. Business Taxation – Dinakar Pagare, Sultan Chand Publications.
5. Taxman, Basis of GST
6. Hand book of GST in India-Rakesh Garg, Sandeep Garg

OEE18R011	CYBER SECURITY	L	T	P	C
		3	1	0	3

UNIT- I: Introduction to Cybercrime: Introduction, Cybercrime, and Information Security, Who are Cybercriminals, Classifications of Cybercrimes, And Cybercrime: The legal Perspectives and Indian Perspective, Cybercrime and the Indian ITA 2000, A Global Perspective on Cybercrimes.

UNIT – II: Cyber Offenses: How Criminals Plan Them: Introduction, How Criminals plan the Attacks, Social Engineering, Cyber stalking, Cyber cafe and Cybercrimes, Botnets: The Fuel for Cybercrime, Attack Vector, Cloud Computing.

UNIT – III: Cybercrime: Mobile and Wireless Devices: Introduction, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Organizational Security Policies an Measures in Mobile Computing Era, Laptops.

UNIT IV: Tools and Methods Used in Cybercrime: Introduction, Proxy Servers and Anonymizers, Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Trojan Horse and Backdoors, Steganography, DoS and DDoS attacks, SQL Injection, Buffer Overflow.

UNIT V: Cyber Security: Organizational Implications Introduction, Cost of Cybercrimes and IPR issues, Web threats for Organizations, Security and Privacy Implications, Social media marketing: Security Risks and Perils for Organizations, Social Computing and the associated challenges for Organizations.

TEXT BOOK:

Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Nina Godbole and Sunil Belapure, Wiley INDIA.

REFERENCE BOOKS:

1. Cyber Security Essentials, James Graham, Richard Howard and Ryan Otson, CRC Press.

2. Introduction to Cyber Security, Chwan-Hwa(john) Wu,J.David Irwin.CRC Press T&F Group

OEE18R012	CLOUD COMPUTING AND SERVICES	L	T	P	C
		3	1	0	3

Unit-I:

Understanding Cloud Computing: Beyond the Desktop: An Introduction to Cloud Computing – Are you ready for Computing the Cloud – Developing Cloud Services.

Unit-II:

Cloud Computing for Everyone: Cloud Computing for the Family – Cloud Computing for the Community– Collaborating on Group Projects and Events – Cloud Computing for the Corporation.

Unit-III:

Using Cloud Services: Collaborating on Calendars, Schedules and Task Management – Collaborating on Event Management – Collaborating on Contact Management – Collaborating on Project Management.

Unit-IV:

Collaborating on Word Processing - Collaborating on Spreadsheets - Collaborating on Databases – Collaborating on Presentations – Storing and Sharing Files and other Online Content – Sharing Digital Photographs – Controlling it all with Web-Based Desktops.

Unit-V:

Outside the Cloud: Other Ways to Collaborate Online: Collaborating via Web-Based Communication Tools - Collaborating via Social Networks and Groupware - Collaborating via Blogs and Wikis.

Text Book:

"Cloud Computing" Michael Miller, Pearson publication, 2013

Reference;

"Cloud Computing" , Dr.Kumar Saurabh ,Wiley India ,2011

OEE18R013	ANIMATION TECHNIQUES	L	T	P	C
		3	0	0	3

Prerequisite: Basic Knowledge in Computer Graphics.

Course Description:

An introduction to the practice, theory, and history of animation within art and independent media through labs, lecture, readings and project critiques.

Course Outcome:

CO1: Understanding the need of animation.

CO2: Understanding the techniques in 2D Animation.

CO3: Understanding the techniques in 3D Animation.

CO4: Understanding the formats in motion caption, software's and script animation language.

CO5: Understanding the content developing, story developing and 3D Animation Movies.

UNIT I:

What is mean by Animation – Why we need Animation – Types of Animation 2D & 3D – Theory of 2D Animation – Theory of 3D Animation – Difference between Graphics & Animation – Application of 2D & 3D Animation – History of Animation – Software's.

UNIT II:

Traditional 2D Animation Concept – Types of 2D Animation – Techniques of 2D Animation – Color – Text – Formation – Size – Script Animation – Timeline Effects – Application of 2D Animation – Characterization 2D – Principle of 2D Animation – Concept Development.

UNIT III:

3D Animation & its Concepts – Types of 3D Animation – Cycle & Non-Cycle Animation – Theory of Character 3D Animation – 3D Transition Animation – Skeleton & Kinetic 3D Animation – Texturing & Lighting of 3D Animation – 3D Camera Tracking – Applications & Software of 3D Animation.

UNIT IV:

Motion Caption – Formats – Methods – Usages – Motion Capture Software – Merge with Software – Expression – Formats – Methods – Usages – Expression Capture Software's

– Script Animation Usage – Different Language of Script Animation Among the Software.

UNIT V:

Concept Development – Scripting – Story Developing – Output Formats – Audio Formats & Video Formats – Colors – Color Cycle – Color Formats – 3D Production Budjets – 3D Animated Movies – Fields in 3D Animation.

TEXT BOOK:

1. Tom Meade, ShinsakuArima, Maya 8.0: The Complete Reference, Tata McGraw Hill, 2016.

REFERENCE BOOK:

1. Adobe Creative Team, Adobe Flash Professional CS6 Classroom in a Book, Adobe Systems Incorporation, USA, 2012 .
2. Paul Wells, Basics Animation 03: Drawing for Animation, AVA Publishing, Switzerland, 2009.
3. Tony White, How to Make Animated Films, Focal Press, USA, 2009.

OEE18R014	INTRODUCTION TO WEB DESIGN AND APPLICATIONS	L	T	P	C
		3	0	0	3

Prerequisite: Basic Knowledge in Internet and Designing Skills.

Course Description:

An introduction to the Internet and Designing of web pages.

Course Outcome:

CO1: Understanding the basics of mailing features.

CO2: Understanding the concept of Internet.

CO3: Ability to know the working of Search engines.

CO4: Able to create web pages using HTML.

CO5: Understanding the applications of Internet.

UNIT I:

Fundamentals of Electronic Mail : Introduction - Email :Advantages and Disadvantages – User ids, Passwords and Email addresses - Message Components - Message Composition - Mailer Features - E mail Inner Workings - Email Management - MIME Types . Browsing and Publishing ; Introduction – Browser bare bones – Coast – to – Coast surfing – Hyber Text Markup Languages – Web page installation – Web page set up – HTML formatting and hyper link creation .

UNIT II:

The internet: Introduction – internet defined – internet history – the way the internet works – internet congestion – Internet culture – Business culture and the internet – collaborative computing and the internet. World Wide Web: introduction the web defined – web browser details – web writing styles – web presentation outline, design , and management – registering web pages.

UNIT III:

Searching the World Wide Web: introduction – directories, search engines and Meta search engines – search fundamentals – search strategies – how does a search engine works. Telnet and FTP : introduction – telnet and remote login – File transfer – Computer Viruses .

UNIT IV:

Basic HTML: introduction – semantic versus syntactic – based style types – headers and footers – lists – tables – debugging. Advanced HTML: introduction – frames – html forms – CGI scripts – dynamic documents – html tools – next generation html – cascading style sheets.

UNIT V:

News groups, Mailing Lists, Chat rooms and MUDs: introduction – news groups and mailing lists history – mailing list fundamentals – newsgroups and mailing lists availability – chat-rooms – MUDs. Electronic Publishing: introduction – electronic publishing advantages and disadvantages – copy right issues – project Gutenberg and on-line books – electronic journals, magazines and news papers – miscellaneous publishing issues.

TEXT BOOK: Raymond Greenlaw, Ellen Hepp , Fundamentals of the INTERNET and the World Wide Web, Second Edition , Tata McGRAW –Hill Edition, 2005.