ANNA UNIVERSITY, CHENNAI
UNIVERSITY DEPARTMENTS
M.E. BIOMEDICAL ENGINEERING
REGULATIONS – 2019
CHOICE BASED CREDIT SYSTEM
CURRICULA AND SYLLABI

VISION

The Department of ECE shall strive continuously to create highly motivated, technologically competent engineers, be a benchmark and a trend setter in Electronics and Communication Engineering by imparting quality education with interwoven input from academic institutions, research organizations and industries, keeping in phase with rapidly changing technologies imbibing ethical values.

MISSION

- Imparting quality technical education through flexible student centric curriculum evolved continuously for students of ECE with diverse backgrounds.
- Providing good academic ambience by adopting best teaching and learning practices.
- Providing congenial ambience in inculcating critical thinking with a quest for creativity, innovation, research and development activities.
- Enhancing collaborative activities with academia, research institutions and industries by nurturing ethical entrepreneurship and leadership qualities.
- Nurturing continuous learning in the state-of-the-art technologies and global outreach programmes resulting in competent world class engineers.

Attested

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Centre for Academic Courses
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PROGRAMME EDUCATIONAL OBJECTIVES (PEOs) :

I. Train the students to posses good scientific and engineering knowledge in the field of biomedical engineering.
II. To understand the principles and recent trends in physiological measurements, diagnosis and therapy procedures followed in hospital.
III. To introduce the concepts of hospital architecture, planning and organization.
IV. To impart knowledge on the management of equipment, finance, human recourses and waste related to hospital.
V. Ability to practice engineering in biological, medical and health care system related fields and excel as biomedical professionals in hospitals.

PROGRAMME OUTCOMES (POs):

PO#	Graduate Attribute	Programme Outcome
1.	**Research aptitude**	An ability to independently carry out research /investigation and development work to solve practical problems
2.	**Technical documentation**	An ability to write and present a substantial technical report/document
3.	**Technical competence**	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program
4.	**Engineering Design**	Apply knowledge of mathematics, science, and engineering to design, experiment, analyze and interpretation of health care devices
5.	**Hospital Management**	Design of Hospital management system and apply knowledge in procurement, monitoring, quality maintenance and management of equipments in hospital.
6.	**Environment and Society**	Demonstrate leadership in their respective careers in biomedical engineering or interrelated areas of industry, government, academia, and clinical practice and understanding of professional and ethical responsibility

PROGRAM SPECIFIC OUTCOMES (PSOs)

By the completion of M.E. - Biomedical Engineering program the student will have following Program specific outcomes.

i. Apply advanced technology for measurement and interpretation of data acquired from biological system addressing the problems associated with the interaction between living and non-living materials and systems
ii. Apply software tools for modeling, designing, analyzing and realizing biomedical engineering devices, systems, components, or processes for precise diagnosis and therapeutic applications in compliance with appropriate global standards.
iii. Exhibit the professional communication and team building skills absorbing the socio-ethical values.
iv. Work professionally and continue learning in multidisciplinary areas of Biomedical Engineering through research and innovation

MAPPING OF PROGRAMME EDUCATIONAL OBJECTIVES WITH PROGRAMME OUTCOMES

A broad relation between the programme objective and the outcomes is given in the following table

PROGRAMME EDUCATIONAL OBJECTIVES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
I	✓	✓	✓	✓	✓	✓
II		✓	✓	✓		
III		✓	✓		✓	✓
IV				✓	✓	✓
V	✓	✓		✓	✓	✓

YEAR	SEMESTER	COURSE TITLE	PO1	PO2	PO3	PO4	PO5	PO6
YEAR 1	SEM 1	Advanced Applied Mathematics				✓		
		Human Biology			✓			
		Diagnostic and Therapeutic Equipment		✓	✓	✓	✓	✓
		Medical Imaging Systems			✓	✓		
		Signal and Image Processing for Biological Systems	✓	✓	✓	✓	✓	✓
		Research Methodology and IPR						
		Audit Course I						
		Clinical Instrumentation Lab	✓	✓	✓	✓	✓	✓
		Biosignal and Medical Image Processing Laboratory	✓	✓	✓	✓		
	SEM 2	Rehabilitation Engineering	✓	✓	✓	✓	✓	✓
		Health Care, Hospital and Equipment Management	✓	✓	✓	✓	✓	✓
		Health Informatics	✓	✓	✓	✓	✓	✓
		Program Elective I						
		Program Elective II						
		Audit Course II						
		Hospital Information System Lab	✓	✓	✓	✓	✓	✓
		Advanced Biomedical Engineering Laboratory	✓	✓	✓	✓	✓	✓
		Mini Project with Seminar	✓	✓	✓	✓	✓	✓
YEAR 2	SEM 3	Program Elective III						
		Program Elective IV						
		Open Elective I						
		Hospital Training		✓	✓		✓	✓
		Dissertation - I	✓	✓	✓	✓	✓	✓
	SEM 4	Dissertation - II	✓	✓	✓	✓	✓	✓

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M.E. BIOMEDICAL ENGINEERING

REGULATIONS – 2019

CHOICE BASED CREDIT SYSTEM

I - IV SEMESTER CURRICULA AND SYLLABI

SEMESTER – I

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MA5159	Advanced Applied Mathematics	FC	3	1	0	4	4
2.	BO5101	Human Biology	PCC	3	0	0	3	3
3.	BO5102	Diagnostic and Therapeutic Equipment	PCC	3	0	0	3	3
4.	BO5103	Medical Imaging Systems	PCC	3	0	0	3	3
5.	BO5104	Signal and Image processing for Biological Systems	PCC	3	0	0	3	3
6.	RM5151	Research Methodology and IPR	RMC	2	0	0	2	2
7.		Audit Course I*	AC	2	0	0	2	0
PRACTICALS								
8.	BO5111	Clinical Instrumentation Laboratory	PCC	0	0	4	4	2
9.	BO5112	Biosignal and Medical Image Processing Laboratory	PCC	0	0	4	4	2
			TOTAL	**19**	**1**	**8**	**28**	**22**

*Audit course is optional

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SEMESTER - II

S. NO.	COURSE CODE	COURSETITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	BO5252	Rehabilitation Engineering	PCC	3	0	0	3	3
2.	BO5251	Health Care, Hospital and Equipment Management	PCC	3	0	0	3	3
3.	BO5201	Health Informatics	PCC	3	0	0	3	3
4.		Program Elective I	PEC	3	0	0	3	3
5.		Program Elective II	PEC	3	0	0	3	3
6.		Audit Course II*	AC	2	0	0	2	0
PRACTICALS								
7.	BO5211	Hospital Information System Laboratory	PCC	0	0	4	4	2
8.	BO5212	Advanced Biomedical Engineering Laboratory	PCC	0	0	4	4	2
9.	BO5213	Mini Project with Seminar	EEC	0	0	4	4	2
			TOTAL	**17**	**0**	**12**	**29**	**21**

*Audit course is optional

SEMESTER - III

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.		Program Elective III	PEC	3	0	0	3	3
2.		Program Elective IV	PEC	3	0	0	3	3
3.		Open Elective I	OEC	3	0	0	3	3
PRACTICALS								
4.	BO5311	Hospital Training	EEC	0	0	0	0	2
5.	BO5312	Dissertation I	EEC	0	0	12	12	6
			TOTAL	**9**	**0**	**12**	**21**	**17**

SEMESTER – IV

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	BO5411	Dissertation II	EEC	0	0	24	24	12
			TOTAL	**0**	**0**	**24**	**24**	**12**

TOTAL NO. OF CREDITS: 72

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FOUNDATION COURSES (FC)

SL. NO	COURSE CODE	COURSE TITLE	CATE GORY	L	T	P	CONTACT PERIODS	CREDITS
1.	MA5159	Advanced Applied Mathematics	FC	3	1	0	4	4

PROGRAM CORE COURSE (PCC)

SL. No	COURSE CODE	COURSE TITLE	CATE GORY	L	T	P	CONTACT PERIODS	CREDITS
1.	BO5101	Human Biology	PCC	3	0	0	3	3
2.	BO5102	Diagnostic and Therapeutic Equipment	PCC	3	0	0	3	3
3.	BO5103	Medical Imaging Systems	PCC	3	0	0	3	3
4.	BO5104	Signal and Image processing for Biological Systems	PCC	3	0	0	3	3
5.	BO5201	Health Informatics	PCC	3	0	0	3	3
6.	BO5251	Health Care, Hospital and Equipment Management	PCC	3	0	0	3	3
7.	BO5252	Rehabilitation Engineering	PCC	3	0	0	3	3
8.	BO5111	Clinical Instrumentation Laboratory	PCC	0	0	4	4	2
9.	BO5112	Biosignal and Medical Image Processing Laboratory	PCC	0	0	4	4	2
10.	BO5211	Hospital Information System Laboratory	PCC	0	0	4	4	2
11.	BO5212	Advanced Biomedical Engineering Laboratory	PCC	0	0	4	4	2

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PROGRAM ELECTIVE COURSES (PEC)

SL. No	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	CONTACT PERIODS	C
1.	BO5072	Biomechanics	PEC	3	0	0	3	3
2.	BO5001	Bio Statistics	PEC	3	0	0	3	3
3.	BO5002	Finance Management in Hospital	PEC	3	0	0	3	3
4.	BO5003	Finite Element Analysis for Biomedical Engineering	PEC	3	0	0	3	3
5.	BO5004	Health Policy and Equipment Management	PEC	3	0	0	3	3
6.	BO5005	Hospital Architecture	PEC	3	0	0	3	3
7.	BO5006	Hospital Planning, Organization and Management	PEC	3	0	0	3	3
8.	BO5007	Hospital Waste Management	PEC	3	0	0	3	3
9.	BO5008	Human Resources Management in Hospital	PEC	3	0	0	3	3
10.	BO5009	Physics in Medicine	PEC	3	0	0	3	3
11.	BO5010	Quality Assurance and Safety in Hospitals	PEC	3	0	0	3	3
12.	BO5071	Biomaterials	PEC	3	0	0	3	3
13.	BO5011	Nanotoxicology	PEC	3	0	0	3	3
14.	MD5074	Brain Computer Interface	PEC	3	0	0	3	3
15.	MD5071	Advanced Neural Computing	PEC	3	0	0	3	3
16.	MD5081	Neuroscience and Neural Engineering	PEC	3	0	0	3	3
17.	MD5072	Bio MEMS	PEC	3	0	0	3	3
18.	MD5075	Computer Based Medical Instrumentation	PEC	3	0	0	3	3
19.	MD5077	Medical Ethics and Standards	PEC	3	0	0	3	3
20.	MD5078	Medical Optics	PEC	3	0	0	3	3
21.	MD5080	Nanomedicine Principles and Applications	PEC	3	0	0	3	3
22.	MD5082	Pattern Recognition Techniques and Applications	PEC	3	0	0	3	3
23.	MD5083	Physiological Systems Modeling and Simulation	PEC	3	0	0	3	3
24.	MD5084	Principles of Genetic Analysis	PEC	3	0	0	3	3
25.	MD5085	Telehealth Technology	PEC	3	0	0	3	3
26.	MD5086	Tissue Engineering	PEC	3	0	0	3	3
27.	MD5087	Ultrasound Principles and Applications in Medicine	PEC	3	0	0	3	3
28.	MD5088	Wearable Body Area Networks	PEC	3	0	0	3	3
29.	MD5073	Biomedical Product Design and Development	PEC	3	0	0	3	3
30.	MD5079	Medical Robotics	PEC	3	0	0	3	3
31.	MD5076	Medical Embedded Systems	PEC	3	0	0	3	3

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OPEN ELECTIVE COURSES (OEC)

*(out of 6 courses one course must be selected)

SI. NO	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			CONTACT PERIODS	CREDITS
				L	T	P		
1.	OE5091	Business Data Analytics	OEC	3	0	0	3	3
2.	OE5092	Industrial Safety	OEC	3	0	0	3	3
3.	OE5093	Operations Research	OEC	3	0	0	3	3
4.	OE5094	Cost Management of Engineering Projects	OEC	3	0	0	3	3
5.	OE5095	Composite Materials	OEC	3	0	0	3	3
6.	OE5096	Waste to Energy	OEC	3	0	0	3	3

AUDIT COURSES (AC)

Registration for any of these courses is optional to students

SL. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			Lecture	Tutorial	Practical	
1.	AX5091	English for Research Paper Writing	2	0	0	0
2.	AX5092	Disaster Management	2	0	0	0
3.	AX5093	Sanskrit for Technical Knowledge	2	0	0	0
4.	AX5094	Value Education	2	0	0	0
5.	AX5095	Constitution of India	2	0	0	0
6.	AX5096	Pedagogy Studies	2	0	0	0
7.	AX5097	Stress Management by Yoga	2	0	0	0
8.	AX5098	Personality Development Through Life Enlightenment Skills	2	0	0	0
9.	AX5099	Unnat Bharat Abhiyan	2	0	0	0
					TOTAL CREDITS	0

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	CONTACT PERIODS	C
1.	BO5213	Mini Project with Seminar	EEC	0	0	4	4	2
2.	BO5311	Hospital Training	EEC	0	0	0	0	2
3.	BO5312	Dissertation I	EEC	0	0	12	12	6
4.	BO5411	Dissertation II	EEC	0	0	24	24	12

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MA5159 **ADVANCED APPLIED MATHEMATICS** **L T P C**
3 1 0 4

OBJECTIVES:

- To encourage students to develop a working knowledge of the central ideas of linear algebra.
- To enable students to understand the concepts of probability and random variables.
- To make students understand the notion of a Markov chain, and how simple ideas of conditional probability and matrices can be used to give a thorough and effective account of discrete-time Markov chains.
- To familiarize the students with the formulation and construction of a mathematical model for a linear programming problem in real life situation.
- To introduce the Fourier Transform as an extension of Fourier techniques on periodic functions and to solve partial differential equations.

UNIT I LINEAR ALGEBRA 12

Vector spaces – norms – Inner Products – Eigenvalues using QR transformations – QR factorization - generalized eigenvectors – Canonical forms – singular value decomposition and applications - pseudo inverse – least square approximations --Toeplitz matrices and some applications.

UNIT II ONE DIMENSIONAL RANDOM VARIABLES 12

Random variables - Probability function – moments – moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Function of a Random Variable.

UNIT III RANDOM PROCESSES 12

Classification – Auto correlation - Cross correlation - Stationary random process – Markov process –- Markov chain - Poisson process – Gaussian process.

UNIT IV LINEAR PROGRAMMING 12

Formulation – Graphical solution – Simplex method – Two phase method - Transportation and Assignment Models

UNIT V FOURIER TRANSFORM FOR PARTIAL DIFFERENTIAL EQUATIONS 12

Fourier transforms: Definitions, properties-Transform of elementary functions, Dirac Delta functions – Convolution theorem – Parseval‘s identity – Solutions to partial differential equations: Heat equations, Wave equations, Laplace and Poisson‘s equations.

TOTAL: 45+15=60 PERIODS

OUTCOMES:

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

- Apply the concepts of linear algebra to solve practical problems.
- Use the ideas of probability and random variables in solving engineering problems.
- Classify various random processes and solve problems involving stochastic processes.
- Formulate and construct mathematical models for linear programming problems and solve the transportation and assignment problems.
- Apply the Fourier transform methods of solving standard partial differential equations.

REFERENCES:

1. Andrews, L.C. and Philips.R.L., “Mathematical Techniques for engineering and scientists”, Prentice Hall of India, New Delhi, 2006.
2. Bronson, R., “Matrix Operation”, Schaum‘s outline series, Tata McGrawHill, New York, 2011.
3. O‘Neil P.V., “Advanced Engineering Mathematics”, Cengage Learning, 8th Edition, India, 2017.
4. Oliver C. Ibe, “Fundamentals of Applied Probability and Random Processes”, Academic Press, Boston, 2014.
5. Sankara Rao, K., “Introduction to partial differential equations”, Prentice Hall of India, pvt, Ltd, 3rd Edition, New Delhi, 2010.
6. Taha H.A., “Operations Research: An introduction”, Ninth Edition, Pearson Education, Asia, 10th Edition, New Delhi, 2017.

BO5101 **HUMAN BIOLOGY** **L T P C**
3 0 0 3

OBJECTIVES:

- To focus on the underlying concepts and mechanism in basic science.
- To enhance student's knowledge and critical thinking about the development of drugs based on basic biological science and medicine.
- To improve students skills in knowing the strategies of drug development for human diseases from basic to application level.
- To provide an underlying cause of the health issues that pose unique challenges in society.

UNIT I BASICS OF LIVING CELLS 9

Cell: Structure and organelles structure – Functions of each component in the cell. Cell membrane Transport, Resting membrane potential and ionic basis of potentials. Cell Chemistry: Physical, structural and functional properties of carbohydrates, lipids, nucleic acids and proteins. Metabolic pathways and disorders related to carbohydrates, lipids and proteins.

UNIT II INTRODUCTION TO HUMAN BODY 8

Organization of human body: Tissues – Body Cavities – Homeostasis – Anatomical planes, positions and sections. Musculoskeletal System: Muscle, types and functions – Bone structure and function - Axial and Appendicular skeleton – Joints - Skin and Appendages.

UNIT III CARDIOVASCULAR, DIGESTIVE, RESPIRATPORY AND URINARY SYSTEM 10

Digestive System: Organization of GI tract – Digestion, Absorption and Elimination of food - Respiratory System: Structures involved in Respiration – Mechanism of Breathing - Urinary System: Organs of Urinary system – Mechanism of Urine formation - Cardiovascular System: Blood vessels, Heart and Blood.

UNIT IV NERVOUS, SPECIAL SENSORY AND IMMUNE SYSTEM 9

Organization of Nervous system: Central Nervous system, Peripheral Nervous system and Autonomic Nervous system - Special Senses: Structure of Eye and Ear – Immune System: Innate and Acquired Immunity.

UNIT V REGENERATIVE MEDICINE 9

Introduction to regeneration in different tissues, role of biomolecules in tissue regeneration, stem cells and its types, isolation procedures and applications of stem cells. Biomaterials Tissue Replacements - Types, biocompatibility, characterization, fabrication, modification and applications of biomaterials in different tissues.

TOTAL: 45 PERIODS

OUTCOMES:

COURSE OUTCOMES:

By successfully completing this course, students will be able to:

CO1 Acquire knowledge in cell biology and used to elucidate both the function of cells and their organization into tissues.

CO2 Understand the basic components and architecture of the human system.

CO3 Understand different systems and its functions in human body.

CO4 Understand the structural importance and functions of sensory organs.

CO5 Acquire the underlying knowledge in the molecular mechanism of disease development.

REFERENCES:

1. Fundamentals of Biochemistry, Donald Voet, Akif Uzman, Judith G. Voet, Charlotte W. Pratt, John Wiley and Sons, New York, 2008
2. An introduction to Materials in medicine: BD Ratner, AS Hoffmann, FJ Schoen, JE Lemmons, Academic Press 1996.
3. Elaine.N. Marieb,—Essential of Human Anatomy and Physiology, Eight edition, Pearson Education NewDelhi, 2007.

4. Gillian Pocock, Christopher D. Richards, "The Human Body An introduction for Biomedical and Health Sciences", 1st Edition, Oxford University Press, USA, 2009.
5. William F. Ganong,"Review of Medical Physiology, 22nd edition, Mc Graw Hill New Delhi,
6. Eldra Pearl Solomon. "Introduction to Human Anatomy and Physiology", W.B.Saunders Company, 2003.
7. Arthur C. Guyton, "Text book of Medical Physiology", 11 th Edition, Elsevier Saunders, 2006
8. Anatomy & Physiology, Gary A.Thibodeau, Kevin T.Patton – 7 th Edition, Mosby Publisher 2009.
9. Ranganathan T S,Text Book of human Anatomy S. Chand and company New Delhi – 1994.

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1			✓			
CO2			✓			
CO3			✓			
CO4			✓			
CO5			✓			

BO5102 DIAGNOSTIC AND THERAPEUTIC EQUIPMENT L T P C
3 0 0 3

OBJECTIVES:

- To study the measurement of various biopotential and non-electrical parameters.
- To explore the various functional blocks present is cardiac care units and various assist devices
- To develop an understanding of the physiotherapy and diathermy equipment
- To study the electrical safety in the hospital environment

UNIT I BIO POTENTIAL RECORDING 9

Cell Potential-Half-cell potential, Electrodes-types of electrodes, Signal Conditioning circuits-Characteristics of Amplifiers, Differential Amplifiers, Filters, Isolation Amplifier, Design concepts. ECG, EEG, EMG, PCG, EOG, lead system and recording methods, typical waveform, frequency spectrum, abnormal waveforms. Evoked response.

UNIT II MEASUREMENT OF NON ELECTRICAL PARAMETER 9

Measurements of Respiration Rate, Temperature, Pulse rate, Blood pressure Measurements-Direct, Indirect. Blood flow Measurements – In vitro, In vivo, Gas flow measurements. Lung volume measurement – Spirometer.

UNIT III CARDIAC CARE UNITS 9

Pace makers - different types, batteries for pace makers, Design Concept. DC defibrillators, asynchronous and synchronous types, patient monitoring system, principles of bio telemetry.

UNIT IV ASSIST DEVICES 9

Heart Lung Machine-Condition to be satisfied by the H/L System. Different types of Oxygenators, Pumps, Pulsatile and Continuous Types, Monitoring Process. Hemodialyser-Indication and Principle of Hemodialysis, Membrane, Dialysate, Different types of hemodialysers, Monitoring Systems, Wearable Artificial Kidney, Implanting Type. Respiratory aids- Types of Ventilators – Pressure, Volume, and Time controlled.

UNIT V DIATHERMY, STIMULATOR AND PATIENT SAFETY 9

Diathermy-Physiological effects of HF radiation, Depth of Penetration, short wave, Ultrasonic and microwave diathermy, Surgical diathermy, Hazards and safety procedures. **Medical Stimulators** – Intensity Duration Curve, Current waveforms - Galvanic, Faradic, surged faradic, exponential, biphasic, TENS, Interferential therapy. **Electrical Safety**-Leakage current, Micro and macro electric shock, GFI units, Earthing Scheme, Electrical safety Analyser.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

By successfully completing this course, students will be able to:

CO1 Design and analyze the bioamplifiers.

CO2 Measure vital and non-electrical parameters

CO3 Design and demonstrate the pacemaker and defibrillator.

CO4 Demonstrate the function of assist devices.

CO5 Design stimulators and test the electrical safety of medical equipment in the hospital environment.

REFERENCES:

1. L.A Geddes and L.E.Baker, Principles of Applied Biomedical Instrumentation, 3rd Edition, John Wiley and Sons, Reprint 2008
2. John G.Webster, Medical Instrumentation Application and Design, 4th Edition, John Wiley and Sons, New York, 2009.
3. Khandpur R.S, Handbook of Biomedical Instrumentation, Tata McGraw Hill, New Delhi, 3rd Edition, 2014.
4. Joseph J. Carr and John M. Brown, Introduction to Biomedical equipment technology, Pearson Education, 4th Edition, 2014.
5. Richard S.Cobbold, Transducers for Biomedical Measurements; Principle and applications- John Wiley and sons, 1992.

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1				✓		
CO2			✓	✓		
CO3		✓		✓		
CO4		✓			✓	
CO5		✓				✓

BO5103 MEDICAL IMAGING SYSTEMS L T P C
3 0 0 3

OBJECTIVES:

- To Study the Production of X-rays and its applications to different medical Imaging techniques
- To study the different types of Radio diagnostic techniques.
- To study the special imaging techniques used for visualizing the cross sections of the body.
- To study the imaging of soft tissues using ultrasound technique

UNIT I PRINCIPLES OF RADIOGRAPHIC EQUIPMENT 8

X-Ray tubes, cooling systems, removal of scatters, Fluoroscopy- construction of image Intensifier tubes, angiographic setup, mammography, digital radiography, DSA.

UNIT II COMPUTED TOMOGRAPHY 10

Need for sectional images, Principles of sectional scanning, Generation in CT, CT detectors, Methods of Reconstruction-Iterative, Back projection, convolution and Back-Projection and central slice theorem. Artifacts, Principle of 3D imaging

UNIT III RADIO ISOTOPIC IMAGING 9

Alpha, Beta and Gamma radiation, Radiation detectors, Radio isotopic imaging equipment, Radio nuclides for imaging, Gamma camera, scanners, Positron Emission tomography, SPECT, PET/CT.

UNIT IV ULTRASOUND IMAGING SYSTEMS 9

Wave propagation and interaction in Biological tissues, Acoustic radiation fields, continuous and pulsed excitation, Transducers and imaging systems, Scanning methods, Imaging Modes, Principle and theory of image generation, Applications. Doppler Ultrasound, Ultrasound Image Quality and Artifacts.

UNIT V MAGNETIC RESONANCE IMAGING 9

NMR, Principle of MRI, Relaxation processes and their measurements, Pulse sequencing and MR image acquisition, MRI Instrumentation, MR Artifacts, Magnetic Resonance Spectroscopy, Functional MRI. Case Study.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

By successfully completing this course, students will be able to:

CO1 Discuss the principle and working of various radiography equipment.

CO2 Explain the tomography concept and image reconstruction techniques.

CO3 Explain the concept of nuclear imaging techniques and radiation detectors

CO4 Describe the basic principle involved in Ultrasound Imaging technique.

CO5 Describe the basic principle and working of Magnetic resonance imaging technique

REFERENCES:

1. Jerrold T. Bushberg, J.Anthony Seibert, Edwin M. Leidholdt, John M. Boone, The Essential Physics of Medical Imaging, Lippincott Williams and Wilkins; Third Edition, 2012.
2. D.N.Chesney and M.O.Chesney, Radio graphic imaging, CBS Publications, New Delhi, 1987.
3. Peggy, W., R.D.Ferimarch, MRI for Technologists, 2nd Edition, McGraw Hill Medical, 2000.
4. Steve Webb, The Physics of Medical Imaging, Taylor & Francis, New York.1988.
5. Donald W.McRobbice, Elizabeth A.Moore, Martin J.Grave and Martin R.Prince, MRI from picture to proton, 2nd Edition, Cambridge University press, New York 2006.
6. Jerry L.Prince and Jonathan M.Links, Medical Imaging Signals and Systems- Pearson Education Inc. 2014.

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1			✓			
CO2			✓	✓		
CO3			✓	✓		
CO4			✓	✓		
CO5			✓	✓		

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BO5104	SIGNAL AND IMAGE PROCESSING FOR BIOLOGICAL SYSTEMS	L T P C 3 0 0 3

OBJECTIVES:

- To introduce the basics of digital signal processing and fundamentals of image processing with its applications to biological systems
- To introduce mathematical foundation for manipulation for signal processing and digital image processing fundamentals.
- To gain practical knowledge using simulation tools in signal and image processing techniques.

UNIT I INTRODUCTION TO SIGNALS AND SYSTEM 9

Review of Signals and Systems, sampling theorem, anti-aliasing filter, DFT, FFT, Introduction to biosignals, Noises, FIR and IIR filters, Spectrum, power spectral density function, cross spectral density and coherence function.

UNIT II PROBABILITY AND RANDOM SIGNALS 9

Introduction to random variables and probability density functions, Random signal -time averages, ensemble averages, autocorrelation functions, cross correlation functions. Random signals and linear systems- Wiener filters. PCA, ICA for filtering. Case Study-Random signal, PCA applied to biological signal.

UNIT III FILTERING FOR REMOVAL OF ARTIFACTS 9

Noises- random, structured and physiological noises, Frequency domain filters, Optimal filtering-Wiener filter – LMS adaptive filter, RLS adaptive filter. Case study – Removal of noises and filtering applied to biological signals.

UNIT IV DIGITAL IMAGE FUNDAMENTALS 9

Elements of Digital Image Processing, Image sampling and Quantization, color image fundamentals - RGB, HSI model, histogram, Image enhancement - histogram equalization and specification techniques, noise distributions, spatial averaging, and sharpening, non-linear filters, Image Transforms - DFT, DCT, KL and SVD.

UNIT V IMAGE SEGMENTATION AND COMPRESSION 9

Image Segmentation - edge detection, edge linking via Hough transform, Thresholding, region based segmentation - region growing, region splitting and merging. Feature Extraction and Representation-Statistical, Shape, Texture features. Statistical and Neural Network based image classification. Image compression – need, huffman, run length encoding, arithmetic coding, transform coding, JPEG standard, MPEG.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

By successfully completing this course, students will be able to:

- **CO1** Analyse signals in time series domain & estimate the spectrum
- **CO2** Design filters for the analysis of random signals
- **CO3** Design pre-processing techniques for removal of artifacts and enhancement of images
- **CO4** Implement basic medical image processing algorithms
- **CO5** Design and implement image processing applications that incorporates different concepts of medical Image Processing

REFERENCES:

1. Arnon Cohen, Bio-Medical Signal Processing Vol I and Vol II, CRC Press Inc., Boca Rato, Florida 1999.
2. Rangaraj M. Rangayyan, Biomedical Signal Analysis – A case study approach, Wiley, 2nd Edition, 2009.
3. Willis J.Tompkins, Biomedical Digital Signal Processing, Prentice Hall of India, New Delhi, 2006.

4. Rafael C.Gonzalez and Richard E.Woods, Digital Image Processing, 4th Edition, Pearson Education, 2018.
5. Anil K Jain, Fundamentals of Digital Image Processing, 1st Edition, Pearson Education India, 2015.
6. Kavyan Najarian and Robert Splerstor, Biomedical signals and Image processing, 2nd Edition, CRC Press, 2012.
7. Geoff Dougherty, Digital Image Processing for Medical Applications, 1st Edition, Cambridge University Press, 2010.

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1					✓	
CO2			✓	✓	✓	
CO3			✓	✓		
CO4	✓		✓			✓
CO5	✓	✓	✓	✓		✓

RM5151 RESEARCH METHODOLOGY AND IPR LT P C
2 0 0 2

OBJECTIVES:

- Extract research problem formulation
- Illustrate research related information
- Follow research ethics
- Summarize that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity
- Infer about IPR for further research work and investment in R & Dfor economic growth and social benefits.

UNIT I RESEARCH PROBLEM FORMULATION 6

Meaning of research problem- Sources of research problem, criteria characteristics of a good research problem, errors in selecting a research problem, scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentations

UNIT II RESEARCH ANALYSIS 6

Effective literature studies approaches, analysis, plagiarism, and research ethics.

UNIT III RESEARCH ETHICS 6

Effective technical writing, how to write report, paper, developing a research proposal, format of research proposal, a presentation and assessment by a review committee.

UNIT IV INFORMATION TECHNOLOGY IN RESEARCH 6

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT V INTELLECTUAL PROPERTY RIGHTS (IPR) 6

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc.
Traditional knowledge Case Studies, IPR and IITs.

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TOTAL: 30 PERIODS

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OUTCOMES:

CO1: Able to understand research problem formulation
CO2: Able to analyze research related information
CO3: Able to follow research ethics
CO4: Able to understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity
CO5: Able to understand about IPR for further research work and investment in R & D for economic growth and social benefits.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓										
CO2	✓											
CO3	✓							✓				
CO4	✓				✓							
CO5	✓					✓						✓

REFERENCES:

1. Asimov, "Introduction to Design", Prentice Hall, 1962.
2. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
3. Mayall, "Industrial Design", McGraw Hill, 1992.
4. Niebel, "Product Design", McGraw Hill, 1974.
5. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners" 2010

BO5111 CLINICAL INSTRUMENTATION LABORATORY L T P C
0 0 4 2

OBJECTIVES:

- To study the various aspects of bio signals and amplifiers
- To understand the performance of surgical diathermy.
- To study practically the concepts of audiometer
- To gain knowledge about the measurement of the vital and non-electrical parameters.
- To understand the importance of the electrical safety analyzer.

LIST OF EXPERIMENTS

1. Design and analysis of bioamplifier using circuit simulation tools.
2. Design and testing of Bio-Amplifiers
3. Recording and analysis of Electrocardiogram
4. Recording and analysis of Electroencephalogram
5. Recording and analysis of Electromyogram
6. Study of Patient monitoring system and biotelemetry
7. Respiratory analysis using spirometer
8. Bio-chemical measurements
9. Performance and testing of surgical diathermy unit using diathermy analyzer
10. Plotting of human auditory response using audiometer.
11. Electrical safety testing of medical equipment.
12. Study of Multi parameter simulator

TOTAL: 60 PERIODS

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COURSE OUTCOMES:

By successfully completing this course, students will be able to:

CO1 Design and develop the various bio signal amplifiers.

CO2 Perform the measurement of various bio signals and physiological parameters.

CO3 Test and analyze the various measurements related to the electrical safety of medical equipment.

CO4 Analyze the Surgical diathermy unit.

CO5 Measure and analyze the function of human auditory and respiratory systems.

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓	✓	✓		
CO2		✓	✓	✓		
CO3		✓	✓	✓	✓	✓
CO4		✓	✓	✓		
CO5		✓	✓	✓		

BO5112 BIOSIGNAL AND MEDICAL IMAGE PROCESSING LABORATORY

L	T	P	C
0	0	4	2

OBJECTIVES:

- To understand the analysis of biosignals
- To understand the extraction of features in biosignals.
- To develop algorithms for power spectral density and classification of bio signals.
- To enhance the medical images by applying various filters.
- To segment the region of interest using various image processing algorithms

LIST OF EXPERIMENTS

1. Preprocessing of Biosignals
2. Determination of Heart rate using Pan-Tompkins algorithm.
3. Arrhythmia detection in ECG.
4. Analysis of EEG bands.
5. Feature extraction in EMG signals
6. Preprocessing of medical images.
7. Denoising of medical images.
8. Image Enhancement using Python
9. Medical Image Segmentation.
10. Medical Image Compression.
11. Study of DICOM standards.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

By successfully completing this course, students will be able to:

CO1 Develop algorithms for preprocessing of Biosignals.

CO2 Analyze the spectral characteristics of Biosignals.

CO3 Develop algorithm for enhancement of medical images.

CO4 Extract the region of interest from medical images.

CO5 Perform the compression of medical images.

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1		✓		✓		
CO2		✓	✓	✓		
CO3		✓		✓		
CO4	✓	✓	✓	✓		
CO5	✓	✓	✓	✓		

BO5252 **REHABILITATION ENGINEERING** **L T P C**
3 0 0 3

OBJECTIVES:

- To develop an understanding of the various rehabilitation aid principle and its working.
- To give various information about rehabilitation medicine and Advocacy.

UNIT I INTRODUCTION **9**

Definition - Impairments, disabilities and handicaps, Primary and secondary disabilities, Activities of daily living, Appropriate Technology, Residual function. Rehabilitation. Rehabilitation team-members and their function. Epidemiology of Rehabilitation, Health, Levels of Prevention, Preventive Rehabilitation. Rehabilitation care –Need for proper delivery of rehabilitation care, Community based rehabilitation and its aspects.

UNIT II PROSTHETIC AND ORTHOTIC DEVICES **9**

Types of body powered and externally powered limb prosthetics, Lower limb, Upper limb orthotics, materials for prosthetic and orthotic devices, mobility aids, wheel chair. Functional Electrical Stimulation – restoration of upper limb and lower limb functions. Hybrid Assistive Systems (HAS). Gait analysis, Assessment of mobility rehabilitation, Bionic arm

UNIT III AUDITORY AND SPEECH ASSIST DEVICES **9**

Types of deafness, hearing aids, application of DSP in hearing aids, Cochlear implants, Voice synthesizer, speech trainer. Brain plasticity, Sensory Substitution systems for auditory and speech impairment

UNIT IV VISUAL AIDS **9**

Sensory Substitution systems for visual impairment, Ultra sonic and laser canes, Intra ocular lens, Braille Reader, Tactile devices for visually challenged, Text voice converter, screen readers. Low vision aids.

UNIT V REHABILITATION MEDICINE AND ADVOCACY **9**

Architectural design features for motor and visual disability for day-to-day life. Physiological aspects of Function recovery, Psychological aspects of Rehabilitation therapy, Legal aspects of rehabilitation – Disability evaluation, provision available in education, job and in day-to-day life.

TOTAL:45 PERIODS

COURSE OUTCOMES:

On completion of this course the student will be able to:

CO1 Define various terms related to rehabilitation engineering and their importance

CO2 Understand the need and functioning of prosthetic and orthotic devices

CO3 Appreciate the need and method of designing sensory substitution systems

CO4 Understand the stages of functional recovery and the provisions provided by the government for the differently abled people

CO5 Design rehabilitation aids

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REFERENCES:

1. Rory A Cooper, An Introduction to Rehabilitation Engineering, CRC Press, 1st Edition, 2006
2. Joseph D.Bronzino, The Biomedical Engineering Handbook, Four Volume Set, 4th Edition: CRC Press, 2015.
3. Levine.S.N.., Advances in Bio Medical Engineering and Medical Physics, Inter University Publication, New York 1968.
4. Albert M Cook and Webster J G, Therapeutic Medical Devices, Application and Design, Prentice Hall New York 1982
5. Reswick.J, What is Rehabilitation Engineering, Annual review of Rehabilitation-volume2, Springer- Verlag, New York 1982

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1		✓	✓			✓
CO2			✓			✓
CO3			✓	✓	✓	✓
CO4		✓				✓
CO5	✓	✓	✓	✓	✓	✓

BO5251 HEALTH CARE, HOSPITAL AND EQUIPMENT MANAGEMENT L T P C
3 0 0 3

OBJECTIVES:

To develop an understanding of the various setups of hospital, health care codes and equipment management in the hospital environment.

UNIT I HEALTH SYSTEM 9

Health organisation of the country, the State, the Cities and the Region, Health Financing System, Health services, Functions of Hospitals, Types of Hospitals, Primary Health Care –An Introduction, Ambulatory care.

UNIT II HOSPITAL ORGANISATION AND MANAGEMENT 9

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

UNIT III REGULATORY REQUIREMENT AND HEALTH CARE CODES 9

FDA Regulation, Joint Commission of Accreditation for Hospitals, National Fire Protection Association Standard, IRPQ.

UNIT IV TRAINED TECHNICAL PERSONNEL 9

Function of Clinical Engineer, Role to be performed in Hospital, Manpower requirement for different types of hospitals, Professional Registration, Structure in Hospital.

UNIT V EQUIPMENT MAINTENANCE MANAGEMENT 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course the student will be able to:

CO1 Basics about Health system and their services

CO2 Apprehend the organisation structure in hospitals

CO3 Knowledge about the regulation of health care codes

CO4 Understand the duties of technical personnel

CO5 Analyse the standards and the training required for technical work for equipment management.

REFERENCES:

1. Cesar A.Caceres and Albert Zara, The Practice of Clinical Engineering, Academic Press, New York,1977.
2. Webster.J.G. and Albert M.Cook, Clinical Engineering Principles and Practices Prentice Hall Inc., Englewood Cliffs, New Jersey, 1979.
3. Hans Pfeiff, Vera Dammann (Ed.), Hospital Engineering in Developing Countries, Z Report, Eschbom,1986
4. Jacob Kline, Handbook of Bio Medical Engineering, Academic Press Inc. San Deigo 1988
5. R.C.Goyal, Human Resource Management in Hospital, Prentice Hall of India, 3rd Edition, 2000.
6. Syed Amin Tabish, Hospital and Health Services Administration Principles and Practices Oxford Press New Delhi 2001.
7. G D Kunders, Hospitals, Facilities planning and Management, Tata McGraw Hill Education Private Ltd, New Delhi 2004.

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓		✓		✓	✓
CO2						✓
CO3		✓	✓		✓	
CO4			✓			
CO5		✓	✓	✓	✓	✓

BO5201 **HEALTH INFORMATICS** **L T P C**
3 0 0 3

OBJECTIVES

- To prepare the students in development, implementation, and use of modern health care information systems.
- To provide knowledge in interdisciplinary and integrated approach to health care IT.
- To study both the fundamental concepts and the cutting-edge IT technologies used in the design, implementation, and management of health care IT applications

UNIT I INTRODUCTION **9**

Historical highlights and Evolution of Health informatics, Hospital Information System – its characteristics and functional online and offline modules, Health Informatics, Bioinformatics, Medical Informatics, Clinical Informatics, imaging Informatics, Nursing Informatics, Public Health Informatics, e – health services, Evidence Based Medicine, Bioethics, Virtual Hospital, Consumer Health Informatics and Healthcare Data Analytics.

UNIT II ELECTRONICS PATIENT RECORDS AND STANDARDS 9

Electronic Patient Record, Medical data formats, – Medical Standards and Organizations – HL7 – DICOM - IRMA - LOINC - PACS - Medical Standards for Vocabulary - ICD 10, DRGs, MeSH, UMLS, SNOMED – JCAHO – HIPAA.

UNIT III BIOINFORMATICS AND TECHNOLOGIES 9

Bio-information technologies, Semantic web and Bioinformatics, Genome projects - Education and Training - Nano technology in Healthcare - Nanomedicine, Nanopharma, CNT based Nano sensor, BioCom chip, Medical Nanorobo - Virtual Reality and Multimedia Applications in Medicine.

UNIT IV JAVA PROGRAMMING 9

Design and Development of Hospital Information Systems – Developing front-end, back-end and Client – Server interface programs in Java Environment – SQL.

UNIT V INTERNET AND WEB 9

Medical Networks - Java script programming - Web Design and programming - Design of Web portal services in medicine

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course the student will be able to:

CO1 Explore how technology can be used to improve health care delivery in health care organizations and in public health.

CO2 Acquire breadth of knowledge of the principles of health informatics.

CO3 Develop basic skills in using health informatics principles to improve practice.

CO4 Acquire a conceptual and theoretical framework of the design, development, and implementation of health information systems.

CO5 Programming skills in Java and script languages

REFERENCES:

1. Robert E Hoyt, Ann Yoshihashi, Health Informatics: Practical Guide for Healthcare and Information Technology Professionals, 6th Edition, lulu.com, 2014.
2. Ramachandra Lele, Computers in Medicine Progress in Medical Informatics, Tata McGraw Hill Publishing Company, New Delhi, 2005
3. Mohan Bansal M S, Medical Informatics, Tata McGraw Hill Publishing Company, New Delhi, 2005.
4. Yi-Ping Phoebe, Bioinformatics Technologies, Springer International, New Delhi, 2007.
5. Orpita Bosu, Bioinformatics – Databases, Tools and Algorithms, Oxford University Press, 2007.
6. H M Dietel, Internet and World Wide Web, AB Goldberg publishers, New Delhi, 2007
7. Herbert Schildt, The Complete Reference – JAVA, Tata McGraw Hill Publishing Company, New Delhi, 2005

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1			✓		✓	✓
CO2		✓	✓		✓	
CO3	✓	✓	✓		✓	
CO4	✓	✓	✓	✓	✓	
CO5	✓	✓	✓	✓	✓	

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BO5211 HOSPITAL INFORMATION SYSTEM LABORATORY

L	T	P	C
0	0	4	2

OBJECTIVES:

- To study about the basics of Java programming, web designing and to develop a hospital information system.

LIST OF EXPERIMENTS

1. HTML, XHTML, XML programming
2. Java script programming
3. PHP Programming
4. Design and Development of interactive HIS
5. Basics of Java programming
6. Server interface programming in SQL and Java environment
7. Storage of bio signal and medical image databases in their approved standard data formats and their handling
8. Study and implementation of medical standards - HL7, DICOM, LOINC, ICD 10 and IRMA
9. Programming and practicing of Evidence based Medicine
10. Mini Project – A case study

TOTAL: 60 PERIODS

COURSE OUTCOMES:

On completion of this course the student will be able to:

CO1 Demonstrate the basics of Java programming.
CO2 Design of web page using Java programming
CO3 Design and development of Hospital information system
CO4 Understanding the medical standards concept for image and biosignal storage
CO5 Gain sufficient knowledge to develop a standard data base for biosignals and medical image

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓	✓	✓		
CO2	✓	✓	✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓	✓
CO4	✓	✓	✓	✓	✓	✓
CO5	✓	✓	✓	✓	✓	✓

BO5212 ADVANCED BIOMEDICAL ENGINEERING LABORATORY

L	T	P	C
0	0	4	2

OBJECTIVES:

- To study practically the concepts of physiological modeling.
- To understand the basic experimental tools and techniques used in musculoskeletal biomechanics
- To acquire software programming skills for processing of medical images using OpenCV.

LIST OF EXPERIMENTS

1. Modelling of cardiovascular system
2. Modelling of lung mechanics
3. Simulation and kinematic analysis of musculoskeletal model
4. Design of Hospital Architecture.

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5. LabVIEW based biosignal analysis.
6. Development of face recognition system
7. Analysis of thermal images using OpenCV

TOTAL: 60 PERIODS

COURSE OUTCOMES:

On completion of this course the student will be able to:

CO1 Model the various physiological system using software tools
CO2 Demonstrate proficiency in developing a musculoskeletal biomechanics.
CO3 Develop algorithms for processing of medical images.
CO4 Design the hospital information system
CO5 Analyse the bio signals using software tools.

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓	✓	✓		
CO2	✓	✓	✓	✓		
CO3	✓	✓	✓	✓		
CO4	✓	✓	✓	✓	✓	✓
CO5	✓	✓	✓	✓		

BO5072 **BIOMECHANICS** **L T P C**
3 0 0 3

OBJECTIVES:

- To get the clear understanding of application of mechanics in medicine.
- To study the properties of blood, bone and soft tissues like articular cartilage tendons and ligaments
- To gain necessary knowledge about accident and injuries.

UNIT I INTRODUCTION **9**

Introduction to bio-mechanics, relation between mechanics and Medicine, Newton's laws, stress, strain, shear rate, viscosity, visco elasticity, non-Newtonian viscosity, soft tissue mechanics, mechanical properties of soft biological tissues. Anthropometry.

UNIT II MECHANICS OF CIRCULATION **9**

Flow properties of blood, effect of shear rate, hematocrit, temperature and protein Content of blood, rheology of blood and micro vessels, dynamics of circulatory system, turbulence flow around prosthetic heart valves.

UNIT III MECHANICS APPLIED TO ORTHOPAEDICS **9**

Orthopedic biomechanics, mechanical properties of bones, stress induced bone growth, kinematics and kinetics of joints, lubrication of joints, gait analysis, spatio-temporal parameters of gait. Analysis of force in orthopedic implants.

UNIT IV MECHANISM OF BIOLOGICAL SYSTEMS **9**

Skeletal muscles servo mechanism, Cardio vascular control mechanism, respiratory control mechanism, Finite element analysis in Biomechanics - case study.

UNIT V BIO MECHANICAL ASPECT OF ACCIDENT INVESTIGATION 9

Experimental and Analytical method of analysis, Clinical evaluation, Head Injury tolerance, rotational injury, spine injury – Accident reconstruction, Analysis of impact, skid analysis – Damage analysis.

TOTAL:45 PERIODS

COURSE OUTCOMES:

On completion of this course the student will be able to:

CO1 To get the clear understanding of application of mechanics in medicine.

CO2 To study the properties of blood, bone and soft tissues like articular cartilage tendons and ligaments

CO3 Acquire knowledge of evaluating the force in implants

CO4 Analysis on different injuries from accident investigation

CO5 Acquired a conceptual and theoretical framework of the design, development, and implementation of orthopedic implants.

REFERENCES:

1. Y.C.Fung, Biomechanics: Mechanical properties in living tissues, Springer Verlag, New York 1981.
2. Susan J.Hall, Basics Bio Mechanics 4th Edition, McGraw-Hill Publishing Co, 2002.
3. Subrata pal, Text book of Biomechanics, Viva education private limited, 2009.
4. C.R Ethier and C.A.Simmons , Biomechanics from cells to organisms, Cambridge University Press, 2007.
5. D.Dawson and Right, Introduction to Bio-mechanics of joints and joint replacement, Mechanical Engineering, publications Ltd. 1989.
6. Jacob Kline, Head book of Bio Medical Engineering, Academic Press

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1		✓	✓			
CO2	✓	✓	✓			
CO3	✓	✓	✓	✓	✓	
CO4	✓	✓	✓	✓	✓	
CO5	✓	✓	✓	✓	✓	✓

BO5001 BIO STATISTICS L T P C

3 0 0 3

OBJECTIVES:

- To introduce strengths and limitations of measures of central tendency and measures of variability.
- Classify common statistical tests and tools.
- Distinguish between p-values and confidence intervals as measures of statistical significance.
- Interpret commonly used regression analysis.
- Evaluate commonly used statistical and epidemiologic measures.

UNIT I INTRODUCTION 9

Introduction to probability, likelihood & odds, distribution variability.

UNIT II STATISTICAL PARAMETERS 6

Statistical parameters p-values, computation and level chi square test and distribution.

UNIT III REGRESSION ANALYSIS 6

Regression, correction use of regression, multiple regression.

UNIT IV INTERPRETING DATA 12

Interpreting life tables clinical trails, epidemical reading and interpreting of epidemical studies, application in community health.

UNIT V META ANALYSIS 12

META analysis for research activities, purpose and reading of META analysis, kind of data used for META analysis

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course the student will be able to:

- **CO1** Demonstrate and understand the central concepts of modern statistical theory and their probabilistic foundation.
- **CO2** Compare the various parameters used in statistical significance.
- **CO3** Explain the techniques used in regression analysis.
- **CO4** Interpret results of the principal methods of statistical inference and design.
- **CO5** Use a statistical approach to combine the results from multiple studies.

REFERENCE:

1. Joseph A. Ingelfinger, Frederick Mosteller, Lawrence A. Thibodeau, James H. Ware Biostatistics in Clinical Medicine (third edition), Singapore, 1994.

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓		✓	✓		
CO2	✓		✓	✓		
CO3	✓		✓	✓		
CO4	✓		✓	✓		
CO5	✓		✓	✓		

BO5002 FINANCE MANAGEMENT IN HOSPITALS L T P C

3 0 0 3

OBJECTIVES:

- The objective of this subject is to expose the students to decision making by corporate board in the areas of finance function.
- To provide an understanding of the basic principles and processes involved in the accounting system of a hospital.

UNIT I INTRODUCTION 4

Finance Function – Meaning – Definition - scope of finance function- Executive functions & Incidental functions - Scope and goal of Financial Management in Hospitals – Profit

maximization & Wealth maximization.

UNIT II ACCOUNTING TECHNIQUES 10

Types of Accounting, Hospital accounting - Financial Book Keeping, Book keeping obligations. Accounting Concepts & Conventions – Final Accounts: Trading – Profit & Loss Accounts - Balance Sheet.

UNIT III COSTING IN HOSPITALS 10

Nature & Scope of Cost Accounting – Cost analysis & Classification - Cost Calculation, significance of internal billing in Hospital -Necessary for internal & external controlling cost, cost unit calculation.

UNIT IV MANAGEMENT ACCOUNTING 11

Budgeting & Budgetary control – Cost – Volume – Profit analysis.

UNIT V FINANCING DECISIONS 10

Cost of capital & Capital Structure – Sources of Short term finance: Management of Working Capital –Sources of Long term finance: share capital, debentures - corporate debit capacity.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course the student will be able to:

- **CO1** Understand the scope and applications of Financial Management.
- **CO2** Discuss the Accounting principles, Book keeping and Reporting concepts
- **CO3** Understand the techniques used in Costing and costing as a control Tool.
- **CO4** Explain the types and techniques of budgetary control.
- **CO5** Understand the types of Financial decisions.

REFERENCES:

1. James C. Vanhorne, Fundamentals of Financial Management, Prentice Hall of India Pvt. Ltd., New Delhi, 8th Edition, 1993.
2. James C.Vanhorne, Financial Management and Policy, Prentice Hall of India Pvt. Ltd., New Delhi, 9th Edition, 1995.
3. Prasannachandra, Financial Management, Tata McGraw Hill Publishing Co. Ltd., New Delhi, First Revised edition
4. Financial Management IM Pandey Vikas Publishing Co. 1999.

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1			✓		✓	
CO2		✓			✓	
CO3			✓		✓	
CO4		✓	✓		✓	
CO5			✓		✓	

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BO5003 FINITE ELEMENT ANALYSIS FOR BIOMEDICAL ENGINEERING **L T P C 3 0 0 3**

OBJECTIVES:

- To introduce the basic concepts of finite element analysis
- To study about the application to Field Problems in Bio mechanics
- To gain ideas about the materials used in the field of biomedical engineering

UNIT I GENERAL INTRODUCTION **10**

Historical Background – Mathematical Modeling of field problems in Engineering – Governing Equations – Discrete and continuous models – Boundary, Initial and Eigen Value problems – Variational Formulation of Boundary Value Problems – Ritz Technique –Natural and Essential Boundary conditions - Basic concepts of the Finite Element Method. One Dimensional Second Order Equations – Discretization – element types- Linear and Higher order Elements – Derivation of Shape functions and Stiffness matrices and force vectors - Assembly of Matrices - solution of problems from solid and bio mechanics- Structural, stress, and strain analysis of the human body and/or artifical implants.

UNIT II BEAM ELEMENTS AND SCALAR PROBLEM IN 2D **9**

Fourth Order Beam Equation –Transverse deflections - Natural frequencies of beams and Longitudinal vibration. Second Order 2D Equations involving Scalar Variable – Variational formulation –Finite Element formulation – Triangular elements – Shape functions and element matrices and vectors. Application to Field Problems in Bio mechanics - Quadrilateral elements

UNIT III APPLICATIONS TO FIELD PROBLEMS **9**

Higher Order Elements. Natural co-ordinate systems – Isoparametric elements – Shape functions for isoparametric elements – One, two and three dimensions – Serendipity elements – Numerical integration and application to plane stress problems transformation in and coordinates-Jacobian of transformation-order of convergence- numerical integration –example problems-shape functions in natural coordinates- rectangular elements- Lagrange family- Serendipity family- rectangular prisms- tetrahedral elements

UNIT IV ISOPARAMETRIC FORMULATION AND MISCELLANEOUS TOPICS **8**

Introduction to elasticity equations – stress strain relations – plane problems of elasticity – element equations Plane stress, plane strain and axisymmetric problems – stress-strain-time or constitutive equations for soft connective tissue components Modelling and force analysis of musculoskeletal systems– Stress calculations - Plate and shell elements – Introduction to flow problems- solution of problems in fluid mechanics- numerical examples -plates and shells

UNIT V NON-LINEAR ANALYSIS **9**

Introduction to Non-linear problems - some solution methods- computational procedure- simple material nonlinearity, stress stiffening, contact interfaces- problems of gaps and contact- geometric non-linearity- modeling considerations- Impact analysis. Mechanical properties of biological and commonly used biomedical engineering materials - Critical reviews of finite element analysis in biomechanical research.

TOTAL :45 PERIODS

COURSE OUTCOMES:

On completion of this course the student will be able to:

CO1 Understands the concept of Finite Element Method and realize its limitations
CO2 Formulate simple problems into finite elements and develop 2D models
CO3 Identify mathematical model for solution of biomedical engineering problems.
CO4 Use professional-level finite element software to solve problems in biological system.
CO5 Effectively use the tools of the analysis for solving problems in Bio-mechanical Engineering

TEXT BOOKS:

1. Seshu. P., Textbook of Finite Element Analysis Prentice Hall of India, 2003.
2. J.N. Reddy, Finite Element Method, Tata McGraw Hill, 2003.
3. S.S. Rao, The Finite Element Method in Engineering -Butter worth heinemann, 2001.
4. Reddy, J.N, An Introduction to the Finite Element Method, McGraw – Hill, 1985.

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓		✓			✓
CO2				✓		
CO3				✓	✓	
CO4				✓	✓	
CO5				✓	✓	✓

BO5004 HEALTH POLICY AND EQUIPMENT MANAGEMENT L T P C
3 0 0 3

OBJECTIVES:

- To expose the students for planning and operation of hospitals in a detailed manner which will include all facts of hospital planning activities covering every department that is involved both in clinical care as well as supportive services.
- To introduce the equipment maintenance management skills and how to protect equipment from electromagnetic interferences.

UNIT I HEALTH SYSTEM 9

Health organization of the country, the state and cities, health financial system, teaching cum research hospitals, General Hospital, PHC reference system, Ambulatory Care.

UNIT II NATIONAL HEALTH POLICY 9

Need for evaluating a health policy, need for providing primary health care, Health education, health insurance, health legislation, inter sectoral cooperation.

UNIT III EQUIPMENT MAINTENANCE MANAGEMENT 9

Organizing the maintenance operation, biomedical equipment procurement procedure, proper selection, compatibility, testing and installation, purchase and contract procedure, trained medical staff, on proper use of equipment and operating instructions. Maintenance job planning, preventive maintenance, maintenance budgeting, contract maintenance.

UNIT IV LOGISTIC SUPPORT & RELIABILITY 9

Maintenance equipment and Tools, failure analysis, spare parts and maintenance materials. Reliability fundamentals.

UNIT V EMI IN HOSPITAL EQUIPMENT 9

Principles of EMI, computation of EMI, Method of suppressing and isolating the unit from interference.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course the student will be able to:

- **CO1** Discuss the basics of health organization
- **CO2** Explain the various national health policies
- **CO3** Perform equipment installation, service & calibration needs and Planning activities at health care centres
- **CO4** Repair methods for Material handling equipment
- **CO5** Minimizing equipment failures and to increase patient safety

REFERENCES:

1. Antony Kelly, Maintenance Planning & control, Butterworth, London 1984.
2. Hans Pleiff veradammann (ed), Hospital Engineering in developing countries, GTZ report Eschborn, 1986.
3. R.C.Goyal, Human Resource Management in Hospitals, Prentice Hall of India, New Delhi, 2000.

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1		✓		✓		
CO2	✓		✓	✓		
CO3					✓	✓
CO4		✓			✓	✓
CO5			✓		✓	✓

BO5005 HOSPITAL ARCHITECTURE L T P C
3 0 0 3

OBJECTIVES:

To expose the students to planning and operation of hospitals in a detailed manner which will include all facets of hospital planning activities covering every department that is involved both in clinical care as well as supportive services.

UNIT I INTRODUCTION TO HEALTH CARE SYSTEM 9

International and National level policy framework for healthcare facilities – Types of healthcare facilities based on public and private ownership, bed size and type of health care services based on outpatient, inpatient and diagnostic care - Organizational, function and structure of the hospital.

UNIT II HOSPITAL PLANNING 9

Principles of planning, regionalization, hospital planning team, planning process, size of the hospital, site selection, hospital architect, architect report, equipping a hospital, interiors & graphics, construction & commissioning, planning for preventing injuries, electrical safety.

UNIT III PLANNING & DESIGNING OF DIFFERENT SERVICES IN HOSPITALS 9

Planning and designing of administrative services, medical and ancillary services, nursing services, supportive services, public areas and staff services, hospital services

UNIT IV STANDARDS AND NORMS FOR HOSPITALS 9

Design and construction standards for the hospitals namely BIS –India and JCAHO, AIA and NHS– general guidelines and standard for out-patient area, in-patient area and diagnostic area in the hospitals. Voluntary & Mandatory standards, General standards, Mechanical standards, Electrical Standards, Standard for centralized medical gas system, Standards for biomedical waste.

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UNIT V FACILITIES FOR SUPPORTIVE SERVICES **9**

Transport, Information system, Communication, Food services, Mortuary, Heating Ventilation and Air Conditioning, Medical gases, House Keeping, Laundry.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course the student will be able to:

CO1 Understand the overall structure of hospital.

CO2 Focus on overall customer safety provisions.

CO3 Understand the different services offered by the hospitals.

CO4 Discuss the specification fixed by hospitals with guidelines of Medical Council.

CO5 Discuss the concepts of supporting services provided by the hospital.

REFERENCES:

1. G.Kunders Hospitals- Facilities Planning & Management, Tata Mcgraw - Hill education- 2004.
2. S.K.Gupta, S.kant, R.Chandrashekhar, S.Satpathy - Modern trends in planning and designing of hospitals: Principles and practice Jaypee Brothers-Medical publishers, New Delhi, 2007.
3. Sa Tabish., - Hospital and Nursing Homes planning, Organisation and Management, Jaypee Brothers-Medical publishers, New Delhi, 2003
4. Purnima Sharma, Sangeet Sharma, Nerendra Malhotra, Jaideep Malhotra. - Step by Step Hospital Designing and Planning, 2nd Edition, Jaypee Brothers-Medical publishers, New Delhi, 2010.

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1		✓			✓	
CO2					✓	✓
CO3					✓	✓
CO4			✓	✓	✓	
CO5			✓	✓	✓	✓

BO5006 **HOSPITAL PLANNING, ORGANIZATION AND MANAGEMENT** **L T P C 3 0 0 3**

OBJECTIVES:

- With an objective of imbibing a professional approach amongst students towards hospital management.
- The subject encompasses management principles, staffing and marketing processes, discussing their significance and role in effective and efficient management of health care organizations.

UNIT I FORMS OF ORGANISATION **8**

Sole proprietorship, Partnership, Company-public and private sector enterprises, Principles of management, Evolution of management.

UNIT II PRINCIPLE OF HOSPITAL MANAGEMENT: **10**

Importance of management and Hospital, Management control systems. Forecasting techniques decision-making process

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UNIT III STAFFING **6**

Staffing pattern in hospitals, Selection, Recruiting process, Training of staff, Organizational structures, Career development

UNIT IV MARKETING AND MANAGEMENT **10**

Basic concepts marketing, Principles of social marketing, Social marketing in health sector, Consumer behavior and research health, Advertising in Health Sector, Relevance of e-marketing of Health care services

UNIT V COMPUTER IN HOSPITAL **11**

System Development life cycle, Reasons to use computers in hospital, main categories of information systems in hospitals

TOTAL :45 PERIODS

COURSE OUTCOMES:

On completion of this course the student will be able to:

- **CO1** Understand the Roles and types of establishment.
- **CO2** Discuss the functions of hospital management.
- **CO3** Understand the concepts of HR Management practices.
- **CO4** Discuss the methods and tools of marketing.
- **CO5** Understand the impacts of Information technology in hospital management.

REFERENCES:

1. Goyal R.C., Human Resource Management in Hospital, Prentice Hall of India Pvt. Ltd., New Delhi, 2000.
2. Nauhria R.N. and Rajnish Prakash, Management & systems, New Delhi Wheeler publishing, 1995.
3. Koontz, Essentials of Management, McGraw Hill, 1995.

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1			✓		✓	
CO2			✓		✓	
CO3			✓		✓	
CO4			✓		✓	✓
CO5			✓		✓	

BO5007 HOSPITAL WASTE MANAGEMENT **L T P C**
3 0 0 3

OBJECTIVES :

- To understand the significance of infections, biomedical waste and its proper disposal.
- To teach the students about the controls applied to waste management.

UNIT I INTRODUCTION **9**

Medical waste stream, different types of medical waste, its source of origin. Waste management elements – categories of bio-medical waste, different colour codes and symbols –rules and regulation includes state and national level bodies.

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UNIT II PRINCIPLES OF STERILIZATION 9

Disease and its mode of transmission - Disinfection methods- concept and mechanism – physical sterilization and chemical sterilization – Large scale autoclave - Microwave (Non-burn treatment technology).

UNIT III DISPOSAL OF WASTE 9

Disposal methods – Incinerator and its types-hazardous waste, radioactive waste, liquid waste destruction – landfill and rules governing landfill.

UNIT IV CONTROLS APPLIED TO WASTE MANAGEMENT 9

Air pollution and emission control, rules governing pollution, instrumentation and monitoring, emission filters and its types, crematories- gas emission control device. Case studies related air pollution.

UNIT V ENVIRONMENTAL SAFETY, RISKS & PUBLIC ISSUES. 9

Risk management in hospitals - Environment issues in hospitals - Risk analysis

TOTAL : 45 PERIODS

COURSE OUTCOMES:

On completion of this course the student will be able to:

- **CO1** Get the clear understanding of regulations framed for waste management
- **CO2** Understand the significance of infections and the transmission of diseases.
- **CO3** Acquire knowledge on proper disposal of waste
- **CO4** Acquire a conceptual idea about the controls applied to waste management.
- **CO5** Gain sufficient knowledge on Risk analysis and management of public issues.

REFERENCES:

1. C.R. BRUNNER, Medical Waste Disposable Handbook, Incentrated, Consultant in Corporated, Virginia, 2000.
2. C.R. BRUNNER, Incentrated Consultant in Corporated Incentration System Hand Book, Virginia.

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓	✓		✓	✓
CO2	✓	✓	✓		✓	✓
CO3	✓	✓	✓		✓	✓
CO4	✓	✓	✓	✓	✓	✓
CO5	✓	✓	✓	✓	✓	✓

BO5008 HUMAN RESOURCES MANAGEMENT IN HOSPITAL L T P C

3 0 0 3

OBJECTIVES:

- This subject acquaints the students with major functions of HRM aligned with the business strategy.
- The subject encompasses the concept of best fit employee, training & executive development, sustaining employee interest and performance appraisal.

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UNIT I PERSPECTIVES OF HUMAN RESOURCE MANAGEMENT 9

Evolution of Human Resource Management - Importance of Human factor, Objectives of Human Resource Management - Human Resource Policies - Need for HRD/HRM in Healthcare Organisation - Computer Applications in Human Resource Management.

UNIT II THE CONCEPT OF BEST FIT EMPLOYEE 9

Organisational Job Design - job description - job analysis - job rotation-job evaluation- Man-power planning- Importance of Human Resource Planning, Forecasting of Human Resource Requirements - Selection procedures - test, Validation, Interviews, Recruitment, Medical Examination.

UNIT III TRAINING & EXECUTIVE DEVELOPMENT 9

Types of Training methods and their benefits - Executive development Programme - common practices - Benefits, self-development - knowledge Management.

UNIT IV SUSTAINING EMPLOYEE INTEREST 9

Wage and Salary Administration – concept of incentives and its operational implications – Participative decision making – Concept of Collective Bargaining – Compensation plans – Rewards – Motivation – Theories of motivation - Grievances and redressal methods.

UNIT V PERFORMANCE APPRAISAL 9

Importance of Performance Appraisal - Methods of Performance Evaluation, - Traditional methods – Modern methods – Feedback – Promotion – Demotion – transfer. Implications of jobs change. The control process, Methods and Requirements of Effective control system.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course the student will be able to:

CO1 Discuss the scope and significance of HRM.
CO2 Understand the concepts of recruitment and selection process.
CO3 Understand the procedure of training and carrier development.
CO4 Understand the employee conflicts and administrative system.
CO5 Discuss the methods and techniques of appraisal system.

REFERENCES:

1. R.C.Goyal, Human Resource Management in Hospitals, Prentice Hall of India, 2000.
2. Mamoria C.B. and Mamoria S.Personnel Management, Himalaya Publishing Company, 1997.
3. Decenzo and Robbins, Human Resource Management, Wiley & Sons, Singapore, 1999.

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1			✓		✓	
CO2			✓		✓	
CO3			✓		✓	
CO4			✓		✓	
CO5			✓		✓	

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BO5009 **PHYSICS IN MEDICINE** **L T P C**
3 0 0 3

OBJECTIVES:

To develop an understanding of physics involved in various imaging modalities and the effect of radiation on human body.

UNIT I PRINCIPLES OF NUCLEAR PHYSICS 9

Traditional definition of atom, periodic system of elements, mechanical properties of atom, emission of light and its frequencies. Electromagnetic spectra, Laws of equilibrium - Theory of decay- electron capture - internal conversion - nuclear isomerism- Natural radioactivity, Decay series, type of radiation and their applications, accelerator principles; reactor and cyclotron produced isotopes - fission products- artificially produced isotopes and its application - Radionuclides used in Medicine and technology.

UNIT II PHYSICS OF INFRARED , MICROWAVE AND RADIO FREQUENCY 9

Production and properties - interaction mechanism of RF and mirocwaves with biological systems: Thermal and non-thermal effects on whole body, lens and cardiovascular systems - tissue characterization and Hyperthermia and other applications. Biomagnetism – Effects - Applications - Infrared detectors - thermographic equipments - quantitative medical thermography - pyroelectric video camera - applications of thermography.

UNIT III LASER PHYSICS AND PHOTOMEDICINE 9

Characteristics of laser radiation, Laser speckle, biological effects, laser safety management Synthesis of vitamin D in early and late cutaneous effects, Phototherapy, photo hemotherapy, exposure level, hazards and maximum permissible exposures. Optical characteristics of biomolecules from the point of spectroscopy – principles of UV – Visible absorption – IR and FTIR absorption – Raman and Fluorescence spectroscopy – application with regard to characterization of biomolecules – blood oxygen, glucose measurements, monitoring drug concentration, cancer

UNIT IV DIAGNOSTIC ULTRASOUND 9

Ultrasonic waves – generation and detection of ultrasound – Beam characteristics - attenuation of ultrasound – specific acoustic impedance - reflection at body interfaces - Coupling medium - interaction ultrasound with tissues - deleterious effects of Ultrasound - Safety levels of Ultrasound - real time scanners image clarity – Resolution - axial and lateral resolution - Artifacts - Pulse echo imaging - Obsterics abdominal investigations - Echo cardiograph (UCG) - The Doppler Effect-Doppler Shift - continuous wave Doppler system - Pulsed wave Doppler systems - duplex scanning-display devices for ultrasonic imaging

UNIT V RADIOBIOLOGICAL EFFECT OF RADIATION 9

Target theory, single hit and multi target theory, cellular effects of radiation, DNA damage, chromosomal damage, Somatic effect: Radio sensitivity protocol of different tissues in human, LD 50/30 effect, Genetic effect: Threshold of linear dose effect, relationship factors affecting frequency of radiation induced mutation, biological effect of microwave, Rf wave and UV radiation.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course the student will be able to:

- **CO1** Understand and appreciate the phenomena of nuclear physics
- **CO2** Discuss about the effects of IR, microwave and RF
- **CO3** Understand the effects and medical applications of light
- **CO4** Obtain the in-depth knowledge about the use of ultrasound for diagnostic applications
- **CO5** Specify the biological effects especially due to ionising radiation

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REFERENCES:

1. Moselley, Non ionizing Radiation, Adam Hilgar Brustol 1998
2. Branski.S and Cherski.P, Biological effects ofmicrowave, Hutchinson & ROSS Inc.Stondsburg 1980
3. Glasserr.O., Medical Physics Vol.1, 2,3-year Book Publisher Inc Chicago, 1980
4. Eric. J.Hall, and Amato J.Giaccia , Radiobiology for radiologist, Lippincott Williams and Wilkins., 2006
5. Sorenson James A, Physics in Nuclear Medicine, W.B. Saunder‘s Company, 1987.
6. Diagnostic Ultrasound applied to OBG, Sabbahaga-Maryland -1980
7. Basic Ultrasound, Hylton B Meire and Pat Farrant-John Wiley & Sons –NY-1994.
8. MRI in Practice, Catherine Westbrrok
9. The essential Physics for Medical Imaging – Jerrold T Bushberg

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1			✓			✓
CO2		✓	✓			✓
CO3	✓	✓	✓			✓
CO4	✓	✓	✓			✓
CO5		✓	✓	✓	✓	✓

BO5010 QUALITY ASSURANCE AND SAFETY IN HOSPITALS L T P C
3 0 0 3

OBJECTIVES:

- To provide basic knowledge on the concept of Healthcare Quality management towards continuous improvement of patient care.
- To make the students aware of the role of biomedical engineer in hospitals, especially in the management of electrical supply, maintenance of electrical safety.

UNIT I STANDARDIZATION OF QUALITY MEDICAL CARE IN HOSPITALS 9

Define Quality- Need for Standarization & Quality Management**,** TQM in Health care organization-Quality assurance methods, QA in (Medical Imaging & Nuclear medicine) Diagnostic services – Classification of equipments

UNIT II REGULATORY REQUIREMENT FOR HEALTH CARE 9

FDA regulations, Accreditation for hospitals - JCI, NABH and NABL, Other regulatory Codes.

UNIT III HOSPITAL SAFETY 9

Security & Safety of Hospital -Property, Staff & Patients**,** Radiation safety, Safety precautions, hazardous effects of radiation, allowed levels of radiation, ICRP regulations for radiation safety, Disposal of Biological waste.

UNIT IV ELECTRICAL & FIRE SAFETY 9

Sources of shocks, macro & micro shocks -Hazards, monitoring and interrupting the Operation from leakage current- Elements of fire, causes of fire , Action to be taken in case of fire in a Hospital.

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UNIT V ASSESSING QUALITY HEALTH CARE 9

Patient Safety Organization- Governmental & Independent, Measuring Quality care – Evaluation of hospital services – six sigma way, Quality Assurance in Hospitals Sop's – Patient Orientation for Total Patient Satisfaction. 5S techniques

TOTAL :45 PERIODS

COURSE OUTCOMES:

On completion of this course the student will be able to:

CO1 Understand the scope of Need and significance of quality practices in health care industry.

CO2 Discuss the system of regulatory measures and accreditation.

CO3 Differentiate the level of safety and security measures and significance.

CO4 Understand the concepts of Electrical and Fire Safety Hazards Mitigations.

CO5 Understand the assessing quality practices using tools.

REFERENCES:

1. Cesar A. Cacere & Albert Zana, The Practice of Clinical Engg. Academic press, New York, 1977.
2. Webster J.G and Albert M.Cook, Clinical Engg, Principles & Practices, Prentice Hall Inc., Engle wood Cliffs, New Jersy, 1979.
3. B.M.Sakharkar, Principles of Hospital administration and Planning, JAYPEE Brothers, Medical Publishers (P) Ltd.
4. K.Shridhara Bhat, Quality Management, Himalaya Publishing House.
5. Karen Parsley, Karen Parsley Philomena Corrigan - Quality improvement in Healthcare, 2nd edition ,Nelson Thrones Pub, 2002
6. Sharon Myers - Patient Safety & Hospital Accreditation - A Model for Ensuring Success Springer Publishers 2012
7. Joseph F Dyro -clinical Engineering Handbook– Elsevier Publishers, 2004

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1		✓	✓		✓	✓
CO2		✓	✓		✓	✓
CO3		✓	✓		✓	✓
CO4		✓	✓		✓	✓
CO5		✓	✓		✓	✓

BO5071 BIOMATERIALS L T P C

3 0 0 3

OBJECTIVES:

- To introduce concepts of materials and interaction of surface towards biomaterials.
- To learn about the polymeric materials and composites in tissue replacements.
- To study the various techniques involved in controlling the microbial growth on the surfaces.
- To understand diverse elements controlling biological responses to materials.
- To know the compatibility and functioning of artificial organs inside the living system.

UNIT I INTRODUCTION 10

Definition of biomaterials, mechanical properties, surface chemistry of materials, surface modification, Tissue Reaction, Wound Kinetics, Bio Compatibility.

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UNIT II MATERIALS IN MEDICAL DEVICES 10

Metals, Ceramics, Polymers and Biomimetic Materials, Composites. Material preparation, chemical composition, Properties, uses in medicine and biosciences and failure mechanisms.

UNIT III STERILIZATION OF BIOMATERIALS 7

Sterilization techniques: Process and mechanism of action of steam sterilization, radiation sterilization, electron beam sterilization, ethylene oxide, chlorine dioxide and plasma gas sterilization.

UNIT IV TESTING OF MATERIALS 8

Testing with Tissue Culture – in vitro and in vivo assessment of biocompatibility, Testing with Soft Tissues and testing at non Thrombogenic surface – biood compatibility and thromobogenicity, ISO 10993- standard for assessment of biocompatibility.

UNIT V HARD AND SOFT REPLACEMENT 10

Cardiac Implants, Orthopedic Implants, Neuro Muscular Implants, Transcutaneous Implants, Intraocular lenses.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course the student will be able to:

- **CO1** Understand the basic principles in material science and their contribution towards Biomedical engineering.
- **CO2** Analyze different types of materials and apply in designing a device.
- **CO3** Select the materials for designing an implants in tissue replacement.
- **CO4** Identify significant gap required to overcome challenges and further developments.
- **CO5** Critically review papers from the scientific journals and identify areas of research opportunities.

REFERENCES:

1. J.H.U.Brown (Ed), Advances in Bio Medical Engineering, Academic Press 1975.
2. Andrew F.Von Racum, Hand Book of Bio Medical Evaluation, Mc-Millan Publishers, 1980.
3. Jacob Cline, Hand Book of Bio Medical Engineering, Academic Press in Sandiego, 1988.
4. Jonathan Black, Biological Performance of Materials- Fundamentals of bio compatibility, 4th Edition, CRC Press 2005.
5. Larry L. Hench and Julian R.Jones, Biomaterials, Artificial organs and Tissue Engineering, 2005.
6. Buddy D.Ratner,Allan S .Hoffman, Frederick J. Schoen, Jack E. Lemons, Biomaterial Science; An Introduction to Materials in Medicine,2nd Edition, Elsevier Academic Press,San Diego, 2004.

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1			✓	✓		
CO2				✓		
CO3	✓			✓		
CO4	✓		✓	✓		✓
CO5	✓	✓		✓		✓

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BO5011 **NANOTOXICOLOGY** **L T P C**
3 0 0 3

OBJECTIVES:

- To learn and understand social impact and health issues of environmental pollution caused due nanoindustries.
- To develop various analytical techniques and to identify and solve the problems
- To understand the socio-ethical responsibility.

UNIT I INTRODUCTION TO NANOMATERIALS 9

Sources of nanoparticles, effect of size and surface charges, entry routes into the human body, nanoparticles surface and body distribution, cellular uptake of nanoparticles, blood-brain barrier. Thrombosis and Lung Inflammation.

UNIT II ENVIRONMENTAL TOXICOLOGY 9

Air Pollution, air borne pollution particles, adverse effects of PM in epidemiological Studies, role of nanoparticles in mediating pulmonary effects, effects of nanoparticles on the nervous system, gastrointestinal system, liver and cardiovascular system. Endothelial dysfunction and endogenous fibrinolysis- coagulation and thrombosis.

UNIT III NANOTOXICITY 9

Nanoparticles in the Environment, nanoparticles in mammalian systems, health threats. Toxicity of iron oxide, titanium dioxide, dark Studies, UV irradiation studies, other metal oxides. Toxicological studies of manufactured CNTs- case study, occupational exposure risk, toxicity of MWCNTs/SWCNTs and impact on environmental Health.

UNIT IV NANOREMEDIATION 9

Nanomaterials for water treatment, nanosensor for environmental applications, nanoparticle based remediation materials - acid-base chemistry - redox chemistry - absorption chemistry - hybrid nanostructured remediation materials - self-assembled monolayers on mesoporous supports (SAMMS) -functional CNTs.

UNIT V ETHICAL AND SAFETY ISSUES IN NANOTECHNOLOGY 9

Health impact, safety and toxicological effects of nanomaterials. Societal impact & ethical issues in nanoscience and nanotechnology. Integrated concept of risk assessment of nanoparticles, dosimetry. Regulation of engineered nanomaterials and Green nanotechnology.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course the student will be able to:

CO1 Know the basic concepts of nanoparticles.
CO2 Understand the toxicology effects of nanoparticles in living organisms.
CO3 Acquire the underlying knowledge in developing toxic free nanoscale products.
CO4 Understand the remedial techniques and their relevance in the constructing risk-free environment.
CO5 Aware of ethical issues and develop societal responsibilities in handling nanoproducts.

REFERENCES:

1. Mark Wiesner, Jean-Yves Bottero - Environmental Nanotechnology: Applications and Impacts of Nanomaterials: McGraw Hill Professional 2007.
2. Challa S.S. R. Kumar, Nanomaterials - Toxicity, Health and Environmental Issues, Wiley-VCH publisher 2006.
3. Nancy A. Monteiro - Riviere, C. Lang Tran, Nanotoxicology: Characterization, Dosing and Health Effects,Informa healthcare (2007).
4. Drobne, Nanotoxicology for safe and Sustainable Nanotechnology, Dominant publisher 2007
5. M.Zafar Nyamadzi, A Reference handbook of nanotoxicology, Dominant publisher 2008.

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COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1			✓			
CO2			✓			
CO3			✓	✓		
CO4	✓		✓	✓		✓
CO5	✓	✓		✓		✓

MD5074 **BRAIN COMPUTER INTERFACE** **L T P C**
3 0 0 3

OBJECTIVES:

- To introduce the basic concepts of brain computer interface
- To study the various signal acquisition methods
- To study the signal processing methods used in BCI

UNIT I INTRODUCTION TO BCI **9**

Fundamentals of BCI – Structure of BCI system – Classification of BCI: Invasive, Non-invasive and Partially invasive BCI- Brain signal acquisition, Signal Preprocessing, Artifacts removal

UNIT II ELECTROPHYSIOLOGICAL SOURCES **9**

Sensorimotor activity –Neuronal activity in motor cortex and related areas- Electric and magnetic fields produced by the brain- signals reflecting brain metabolic activity- Mu rhythm, Movement Related Potentials – Slow Cortical Potentials - P300 Event related potential - Visual Evoked Potential - Activity of Neural Cells - Multiple Neuromechanisms

UNIT III FEATURE EXTRACTION METHODS **9**

Time/Space Methods – Fourier Transform, Wavelets, AR, MA, ARMA models, Bandpass filtering, Template matching, Kalman filter, PCA, Laplacian filter – Linear and Non-Linear Features

UNIT IV FEATURE TRANSLATION METHODS **9**

Linear Discriminant Analysis –Nearest neighbours, Support Vector Machines - Regression – Learning Vector Quantization – Gaussian Mixture Modeling – Hidden Markov Modeling – Neural Networks

UNIT V APPLICATIONS OF BCI **9**

Study of BCI Competition III – Dataset I, II, III, IV and V, Functional restoration using Neuroprosthesis - Functional Electrical Stimulation, Visual Feedback and control - External device controllers, Case study: Brain actuated control of mobile Robot. Ethical issues in BCI research

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Acquire the brain signal in the format required for the specific application
CO2 Well prepared for preprocessing the signal for signal enhancement
CO3 Extract the dominant and required features
CO4 Classify and derive the control signals for BCI applications
CO5 Extend the BCI knowledge for medical applications

REFERENCES:

1. Jonaan Wolpaw, Elizabeth Winter Wolpaw, Brain Computer Interfaces: Principles and practice, Edition 1, Oxford University Press, USA, January 2012
2. Special Issue on Brain Control Interfaces, IEEE Transactions on Neural Systems and Rehabilitation Engineering, Vol 14, June 2006.
3. R. Spehlmann, EEG Primer, Elsevier Biomedical Press, 1981.
4. Bernhard Graimann, Brendan Allison, Gert Pfurtscheller, Brain-Computer Interfaces: Revolutionizing Human-Computer Interaction", Springer, 2010
5. Ali Bashashati, Mehrdad Fatourechi, Rabab K Ward, Gary E Birch, A survey of signal Processing algorithms in brain–computer interfaces based on electrical brain signals, JOURNAL OF NEURAL ENGINEERING, VOL.4, 2007, PP.32-57
6. Arnon Kohen, Biomedical Signal Processing, Vol I and II, CRC Press Inc, Boca Rato, Florida.
7. Bishop C.M., Neural networks for Pattern Recognition, Oxford, Clarendon Press, 1995.
8. Andrew Webb, Statistical Pattern Recognition, Wiley International, Second Edition, 2002.
9. Torsten Felzer, On the possibility of Developing a Brain Computer Interface, Technical Report, Technical University of Darmstadt, Germany,2001.
10. Wolpaw J. R, N.Birbaumer et al, Brain control interface for Communication and control, Clinical Neurophysiology, 113, 2002.
11. Jose del R.Millan et al, Non-invasive brain actuated control of a mobile robot by human EEG, IEEE Transactions on biomedical Engineering, Vol 51, No.6, 2004 June.
12. S.Coyle, T.Ward et al, On the suitability of near infra-red systems for next generation Brain Computer interfaces, Physiological Measurement, 25, 2004.
13. Carlo Tomasi, Estimating Gaussian Mixture Densities with EM - A Tutorial, Duke University, 2000.
14. R.Dugad, U.B Desai, A Tutorial on Hidden Markov Modeling, Signal Processing and Artificial Neural Networks Laboratory, IIT Bombay, 1996.
15. http:://ida.first.fhg.de/projects/bci/competition_iii

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1			✓		✓	✓
CO2	✓	✓		✓	✓	✓
CO3			✓	✓	✓	
CO4	✓	✓		✓	✓	✓
CO5	✓	✓		✓	✓	✓

MD5071 **ADVANCED NEURAL COMPUTING** **L T P C**

3 0 0 3

OBJECTIVES:

The course will teach a variety of contemporary approaches to neural networks and introduce the theory underlying these approaches. The approaches to be covered will include such things as biological and statistical foundations of neural networks, Perception, MLPs, RBFN, SVM and competitive learning. Additionally, a brief introduction of Deep learning concept and Optimization techniques using Genetic algorithm and its applications is introduced.

Attested

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UNIT I INTRODUCTION TO ARTIFICIAL NEURAL SYSTEMS 8

Biological Neurons and their Artificial models, Models of Artificial Neural Networks, Learning and Adaptation, Neural Network Learning Rules, Single Layer Perceptron Classifiers.

UNIT II BPN AND BAM 9

Back Propagation Network, Generalised Delta Rule, BPN Application, Associative Memory Definition, BAM, Hopfield Memory, Simulated Annealing-Boltzmann Machine.

UNIT III OTHER NETWORKS 10

Counter Propagation Network, Feature Mapping, Self Organising Feature Maps, Adaptive Resonance Theory (ART) Network Descriptions.

UNIT IV GENETIC ALGORITHMS & IMPLEMENTATION TECHNIQUES 8

The Appeal of Evolution, Search Spaces and Fitness Landscapes, Elements of Genetic Algorithms, Data Structures, Adaptive Encoding. Selective Methods, Genetic Operators, Fitness Scaling, GA applications

UNIT V ADVANCES AND APPLICATIONS 10

Support Vector Machines, RBF Network. Introduction to Deep Learning – Convolutional Neural Network. Case Study – Neural Network based Classification of Biosignal and Medical Images.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course the student will be able to:

- **CO1** Architecture of neural networks and its learning rules
- **CO2** Design neural networks like BPN and BAM and its applications
- **CO3** Design competitive neural networks and its applications
- **CO4** Apprehend the principles of genetic algorithms as well as techniques used in its implementation.
- **CO5** Deep learning concept that can be used for biomedical signal analysis and Medical image analysis

REFERENCES:

1. Laurene V. Fausett, Fundamentals of neural networks, Pearson, 1st Edition, 2004.
2. Philip D.Wasermann, Advanced Methods in neural Computing, Van Nostrand Reinhold, New York 1993.
3. Simon Haykins, Neural Networks, Prentice Hall International Inc, 1999.
4. James A Freeman and David M. Skapura, Neural Networks, Addison - Wesley, India 1999.
5. David Goldberg, Genetic Algorithms in Search, Optimization and Machine Learning, Addison -Wesley USA,1997.
6. Melanie Mitchell, An Introduction to Genetic Algorithms: Prentice Hall of India, New Delhi 1998.
7. Francois Chollet, Google AI researcher and creator of the popular Keras deep learning library, published his book, Deep Learning with Python in October 2017.
8. Neural Networks and Deep Learning by Michael Nielsen., March 2017.

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1			✓	✓		
CO2	✓	✓	✓	✓		
CO3	✓		✓	✓		
CO4		✓	✓	✓	✓	✓
CO5	✓	✓	✓	✓	✓	✓

MD5081 NEUROSCIENCE AND NEURAL ENGINEERING L T P C
3 0 0 3

OBJECTIVES:

- Neural engineering and rehabilitation research applies neuroscience and engineering methods to analyze central and peripheral nervous system function and to design clinical solutions to neurological disorders or injury.
- To study the basics of Nervous system
- To understand the development and arrangement of neural tissue
- To study the neuronal disorders and injuries
- To study the repairing and reconstruction mechanism of nervous system.

UNIT I BASICS OF NERVE 9

Development of Nervous system – Neurotrophic Factors, Extracellular Matrix components in Nervous system development – Neuron & Glial cells Structure, Classifications and Functions – Myelination – Neurotransmitter; types & functions – Action potential - Transport of impulse and materials in neurons – NMJ - Neural control of movement – Sensory Feedback Mechanism.

UNIT II BRAIN, BRAIN STEM AND SPINAL CORD 9

Brain: Lobes - Cortical Areas – Brain Circuits – Memory – Sleep - Brain Stem: Structure and Control areas – Cerebellum - dyslexia. Spinal cord: Structure and Functions. Concepts of Nuclei, Ganglia and tracts - Reticular formation – Plexus formation – Visual, Auditory & Olfactory Pathway. Neurophysiology and neural control of genitourinary function.

UNIT III NEURON TRACING 9

Physiology of Nerve conduction - Visualization of nervous system – Synaptic transmission and cellular signaling of Neurons - Electrical activity of the brain and recording of brain waves - Cortical mapping - Voltage sensitive dyes - Fluorescent tracing of neural tissue. Synchronization and control of neural activity in-vivo and in-vitro - Spinal neural circuits – Neural cell markers.

UNIT IV NERVE INJURY AND DISORDERS 9

Blood Brain Barrier - Neurological dysfunctions - Neuro degeneration – Demyelination – Neuronal injury - Neural plasticity- Wallerian degeneration – Drugs acting on CNS and their Pharmacokinetics. Alzheimer's, Parkinson's and Prion diseases. Sleep Disorder – Schizophrenia

UNIT V NEURAL ENGINEERING 9

Regeneration of the Nervous system - Axon guidance - Retinal regeneration - Neuron & Neuroglial culture - Nerve graft: Neural Tissue Engineering –Peripheral Nerve Reconstruction - Drug Delivery system in CNS. Cognitive & neurobehavioral rehabilitation.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course the student will be able to:

CO1 Understand basics of nervous system

CO2 Describe neural mechanisms, circuit formations and plexus.

CO3 Explain cortical areas and recording of cortical lobe.

CO4 Describe pharmacokinetics in neural system.

CO5 Understand the mechanism of neural regeneration

REFERENCES:

1. Mathews G.G., Neurobiology, 2nd Edition, Blackwell Science, UK, 2000.
2. Malcom Carpenter, Textbook of Neuroanatomy, McGraw hill Edition.
3. Park J.B., Biomaterials Science and Engineering, Plenum Press, 1984.
4. W. Mark Saltzman, Tissue Engineering – Engineering principles for design of replacement organs and tissue, Oxford University Press Inc. New York, 2004.

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓			✓	✓
CO2	✓	✓			✓	✓
CO3	✓	✓	✓		✓	✓
CO4	✓	✓			✓	✓
CO5	✓	✓	✓	✓	✓	✓

MD5072 **BIO MEMS** **L T P C**
3 0 0 3

OBJECTIVES:

To understand

- Various MEMS fabrication techniques.
- Different types of sensors and actuators and their principles of operation at the micro scale level.
- Application of MEMS in different field of medicine.

UNIT I MEMS MATERIALS AND FABRICATION 9

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

UNIT II MECHANICAL AND THERMAL SENSORS AND ACTUATORS 9

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

UNIT III ELECTROSTATIC AND PIEZOELECTRIC SENSORS AND ACTUATORS 9

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

UNIT IV MICROFLUIDIC SYSTEMS 9

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

UNIT V APPLICATIONS OF MEMS IN MEDICINE 9

CAD for MEMs, Biological MEMS materials, polymer based gas sensor, micro total analysis systems (MicroTAS) detection and measurement methods, microsystem approaches to polymerase chain reaction (PCR), DNA sensor, Drug delivery - Types of reservoirs, CardioMEMS. **Case study**: Design of BP sensor. Intraocular pressure sensor, Intracranial pressure sensor Introduction to 3D printing.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course the student will be able to:

- **CO1** Understand the MEMS fabrication processes and characteristics of various materials
- **CO2** Specify the design issues related to different types of sensors and actuators at micro scale level
- **CO3** Understand the methods of actuation of fluids at micro level
- **CO4** Capable of applying the concepts to the design of different types of micro systems with the help of CAD tools
- **CO5** Apply these procedures for the design of MEMS devices for healthcare applications

REFERENCES:

1. Chang Liu, Foundations of MEMS, Pearson Education International, New Jersey, USA, 2006
2. Nitaigour Premchand Mahalik, MEMS, Tata McGraw Hill Publishing Company, New Delhi, 2007
3. Tai Ran Hsu, MEMS and Microsystems design and manufacture, Tata McGraw Hill Publishing Company, New Delhi, 2002
4. Wanjun Wang, Stephen A.Soper, Bio MEMs: Technologies and applications, CRC Press, New York, 2007
5. Marc J. Madou, Fundamentals of micro fabrication: the science of miniaturization, CRC Press, 2002.
6. Nadim Maluf, Kirt Williams, An introduction to Microelectro mechancial Systems Engineering, Second Edition, Artech House Inc, MA, 2004
7. Ellis Meng, Biomedical Microsystems, CRC Press, Boca Raton, FL, 2011
8. Victor.C.Yang, That.T.Ngo, Biosensors and their applications, Springer, 2006.

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1			✓		✓	
CO2	✓	✓	✓	✓	✓	
CO3			✓	✓	✓	
CO4	✓		✓	✓	✓	
CO5	✓	✓	✓	✓	✓	✓

MD5075 COMPUTER BASED MEDICAL INSTRUMENTATION L T P C
3 0 0 3

OBJECTIVES:

- To teach PC hardware and its related interfacing
- To give a complete overview of 80186, 80286, 80386 and 80486 microprocessors.
- To understand the basics of computerized data acquisition and programming.
- To enrich the students knowledge with biometrics and network security.

UNIT I PC HARDWARE AND OVERVIEW 9

System Unit - Overview of Mother Boards - Processors, Memory, Adapter cards, Ports, Power supply - BIOS – DOS interaction, POST, Functional and Architecture Block diagram of a PC, Mother Board logics - Memory and I/O map

UNIT II PERIPHERAL INTERFACING AND CONTROLLERS 9

Keyboard and Mouse Interfaces - Memory types - RAM - SDRAM and RDRAM, Cache memory, ROM and its types, Flash memory, CMOS semiconductor memory - Adapter Cards - Sound Card, Modem card, Video card, Network Card - I/O slots - ISA, PCI and AGP bus slots - Ports - Serial and Parallel ports, USB, FireWire port, MIDI, SCSI, IrDA, Bluetooth – Connectors - System Bus, ISA, EISA, PCI, AGP and PCI bus - Disk controllers

UNIT III PROCESSORS AND MEMORY MANAGEMENT 9

80X86 Processors - Architectures and Memory management - Overview of 80X86 based Mother boards

UNIT IV COMPUTERISED DATA ACQUISITION AND PROGRAMMING 9

Plug-in-data acquisition, AGC and Control Boards - Data acquisition using GPIB and Serial Interfaces and Programming in C - DSP in Medical applications

UNIT V CAD IN MEDICAL INSTRUMENTATION 9

FPGA Design Logics - Virtual Bio-Instrumentation in LABVIEW - Multisim Simulation with bio-amplifiers - Mixed signal SoC applications in biomedical application

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course the student will be able to:

CO1 Understand various PC hardware
CO2 Discuss the working of peripheral interfacing and controllers.
CO3 Demonstrate the functions of Intel 80X86 family of microprocessors
CO4 Develop computerized data acquisition devices.
CO5 Design the medical instrumentation in CAD

REFERENCES:

1. N.Mathivanan, PC Based Instrumentation: Concepts and Practice, Prentice Hall of India, New Delhi 2007.
2. B.Govindarajalu, IBM PC and Clones: Hardware, Trouble shooting and Maintenance, Tata McGraw Hill Publishing Company, New Delhi, 2005
3. Stephen J Bigelow, Trouble shooting, Maintaining and Repairing of PCs, Tata McGraw Hill Publishing Company, New Delhi, 2005
4. H M Dietel, Internet and World Wide Web, AB Goldberg publishers, New Delhi, 2007

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1			✓			
CO2			✓			
CO3		✓	✓	✓	✓	
CO4	✓		✓	✓	✓	
CO5	✓	✓	✓	✓	✓	

MD5077 MEDICAL ETHICS AND STANDARDS L T P C
3 0 0 3

OBJECTIVES:

- Achieve familiarity with some basic ethical framework& understand how these ethical frameworks can help us to think through contemporary questions in medical ethics.
- Students will be able to know about the legal and ethical principles
- To apply these principles in health care settings & gain knowledge about the medical standards that to be followed in hospitals.

UNIT I INTRODUCTION TO MEDICAL ETHICS 8

Definition of Medical ethics, Scope of ethics in medicine, American medical Association code of ethics, CMA code of ethics- Fundamental Responsibilities, The Doctor and The Patient, The Doctor and The Profession, Professional Independence, The Doctor and Society.

UNIT II ETHICAL THEORIES & MORAL PRINCIPLES 9

Theories-Deontology & Utilitarianism, Casuist theory, Virtue theory, The Right Theory. Principles-Non- Maleficence, Beneficence, Autonomy, Veracity, Justice. Autonomy & Confidentiality issues in medical practice, Ethical Issues in biomedical research, Bioethical issues in Human Genetics & Reproductive Medicine

UNIT III HOSPITAL ACCREDITATION STANDRADS 9

Accrediation- JCI Accreditation & its Policies. Patient centered standards, Healthcare Organization management standards.

UNIT IV HOSPITAL SAFETY STANDARDS 10

Life Safety Standards- Protecting Occupants, Protecting the Hospital from Fire, Smoke, and Heat, Protecting Individuals from Fire and Smoke, Providing and Maintaining Fire Alarm Systems, Systems for Extinguishing Fires Environment of Care Standards-Minimizing EC Risks, Smoking Prohibitions, Managing Hazardous Material and Waste, Maintaining Fire Safety Equipment, Features, Testing, Maintaining, and Inspecting Medical Equipment.

UNIT V MEDICAL EQUIPMENT SAFETY STANDARDS 9

General requirements for basic safety & essential performance of medical equipment. IEC 60601 standards, Indian and International standards, ISO standards - Base Standard-general requirement of electrical medical devices, Collateral Standards- EMC radiation protection &programmable medical device system, Particular Standards-type of medical device.

TOTAL: 45 PERIODS

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COURSE OUTCOMES:

On completion of this course the student will be able to:

CO1 Describe the Social responsibility in healthcare systems
CO2 Discuss the Bioethics and engineers role
CO3 Apply Legal and professional guidelines for the hospital accreditation
CO4 Understand hospital safety aspects
CO5 Comprehend the medical equipment safety standards and medical device maintenance.

REFERENCES:

1. Domiel A Vallero, Biomedical Ethics for Engineers, Elsevier Pub.1st edition, 2007
2. Johnna Fisher, Biomedical Ethics: A Canadian Focus., Oxford University Press Canada, 2009.
3. Robert M Veatch, The Basics of Bio Ethics, 3rd Edition. Routledge, 2011.
4. Physical Environment Online: A Guide to The Joint Commission's Safety Standards is published by HCPro, Inc. 2010
5. Joint Commission Accreditation Standards for Hospitals, 6th Edition 2018.
6. Ben Mepham, Bioethics-An Introduction for the biosciences, 2nd Edition, Oxford University Press, 2008.

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1		✓	✓			✓
CO2		✓	✓			✓
CO3		✓	✓			✓
CO4		✓	✓			✓
CO5		✓	✓			✓

MD5078 **MEDICAL OPTICS** **L T P C**
3 0 0 3

OBJECTIVES:

The objectives of this course are to:

- Provide a possibility for the student to acquire knowledge about the impact and interaction of light with biological tissue
- Gain knowledge about the fiber optic sensors
- Understand the engineering and practical applications of optics related to diagnostics, sensing and therapeutics of the human body

UNIT I INSTRUMENTATION IN PHOTONICS **9**

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

UNIT II OPTICAL PROPERTIES OF THE TISSUES **9**

Optical properties of tissue- melanin, bilurubin, tissue and their spectrum, optical characteristics of constituents of blood – RBC, hemoglobin properties, plasma, oxygenated and deoxygenated hemoglobin, Laser tissue Interaction-Chemical, Thermal, Electromechanical. Photo ablative processes. Laser safety procedures

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UNIT III DIAGNOSTIC APPLICATIONS 9

Wood's lamp, Imaging techniques - Optical coherence tomography, Elastography, Fluorescence Imaging, FLIM, FRAP, FRET, Raman Imaging, NIRS – Applications

UNIT IV THERAPEUTIC AND SURGICAL APPLICATIONS OF LIGHT 9

Laser in tissue welding, lasers in dermatology, lasers in ophthalmology, otolaryngology, urology, neurology, orthopedics, gastroenterology. Phototherapy, Photodynamic therapy (PDT) - Principle and mechanism - Oncological and non- oncological applications of PDT. Biostimulation effect – applications.

UNIT V FIBER OPTIC SENSORS AND APPLICATIONS 9

Light transport in the optical fiber - Total internal reflection, Numerical aperture, Angle of acceptance. losses in fiber, Optical sensors based on polarization, magnetic sensors, Medical applications of fiber optic sensors in measuring temperature, pressure, flow and chemical activities

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course the student will be able to:

- **CO1** Know the photonics instruments
- **CO2** Know the various optical properties of tissue
- **CO3** Know application of diagnostic applications of lasers in medical fields
- **CO4** Know application of therapeutic and surgical applications of lasers in medical fields
- **CO5** Types of fiber optic sensors used In medical application.

REFERENCES

1. Markolf H.Niemz, Laser-Tissue Interaction Fundamentals and Applications, Springer, 2007.
2. Paras N. Prasad, Introduction to Biophotonics, A. John Wiley and sons, Inc. Publications, 2003.
3. Tuan Vo Dinh, Biomedical photonics – Handbook, CRC Press LLC, 2003.
4. Mark E. Brezinski, Optical Coherence Tomography: Principles and Applications, Academic Press, 2006.
5. R. Splinter and B.A. Hooper, An Introduction to Biomedical Optics, Taylor and Francis, 2007.

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓			✓	✓	
CO2	✓		✓	✓	✓	
CO3	✓		✓	✓	✓	✓
CO4	✓		✓	✓	✓	✓
CO5	✓		✓	✓		

Attested

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MD5080	NANOMEDICINE PRINCIPLES AND APPLICATIONS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the essential features of biology and nanotechnology that are converging to create the new areas of bionanotechnology and nanomedicine.
- To understand the principles behind nanomedicine and the applications of nanomaterials in medicine.
- To understand the need, problem and solutions for polymeric, lipidous and solid nanosized drug delivery systems.
- To impart the knowledge to apply the nanomaterials in different medical applications.
- To know the underlying concept in engineering and implement in nanocentric applications

UNIT I INTRODUCTION OF NANOPARTICLES 9

Overview of nanotechnology from medical perceptive, different types of nanobiomaterials and nanostructure interactions. Synthesis and characterization of smart nanomaterials, surface modification, biofunctionalization of nanomaterials.

UNIT II NANOMATERIALS AND NANOENGINEERING 9

Lipid- based (liposomes, micelles, solid lipid nanoparticles) and magnetic based particles and their delivery for biomedical applications. Inorganic nanoparticles, carbon- based (fullerenes, bucky balls and carbon nanotubes), biodistribution and its fate.

UNIT III NANOTECHNOLOGY IN DRUG DELIVERY 9

Nanoshells, nanopores,Tectodendrimers, active and passive cell targeting, viral based drug delivery system-nanoparticle drug system for oral administration, drug system for nasal administration, drug system for ocular administration, nanotechnology in diagnostic application. Preformulation studies: on various dosage forms such as tablets, capsule, suspension, creams, emulsion, injectables ophthalmic and aerosols etc.

UNIT IV NANOTECHNOLOGY IN IMAGING, DIAGNOSTIC AND DETECTION 9

Nuclear imaging systems –SPECT and PET, advanced MR imaging, optical imaging and CT. Ultra sound imaging and therapy, nanoimaging systems, micro/nano fluidics, diagnostics and biosensors.

UNIT V APPLICATION IN CANCER THERAPY 9

Introduction and rationale for nanotechnology in cancer therapy -- passive targeting of solid tumors and active targeting strategies in cancer, Pharmacokinetics of nanocarrier-mediated drug and gene delivery - multifunctional nanoparticles for cancer therapy- neutron capture therapy of cancer: Nanoparticles and high molecular weight boron delivery agents. NanoOncology, nanoneurology, nanocardiology, nano-orthopedics and nano-Ophthalmology.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course the student will be able to:

- **CO1** Understand latest scientific developments and discoveries in the field of Nanomedicine.
- **CO2** Understand the toxicological aspects of Nano sized particles.
- **CO3** Understand basic stem cell biology and corresponding requirement for tissue engineering
- **CO4** Follow the new findings in the area of Nanomedicine and implement the perspectives in own research.
- **CO5** Understand new approaches in nanotechnology that can be used in biomedical therapies.

REFERENCES:

1. CM, Niemeyer C.A. Mirkin., Nanobiotechnology – Concepts, Applications and Perspectives – 2004, Wiley – VCH.
2. Nicholas A. Kotov, Nanoparticle Assemblies and Superstructures. 2006 -CRC.
3. Nano: The Essentials: T. Pradeep. McGraw – Hill education – 2007.
4. Challa, S.S.R. Kumar, Josef Hormes, Carola Leuschaer, Nanofabrication towards Biomedical Applications, Techniques, Tools, Applications and Impact.2005, Wiley –VCH.
5. Kewal K. Jain, The Handbook of Nanomedicine. Humana Press, (2008).
6. Zhang, Nanomedicine, A Systems Engineering Approach 1st Ed., Pan Stanford Publishing, (2005).
7. Robert A. Freitas Jr., Nanomedicine Volume IIA: Biocompatibility, Landes Bioscience Publishers, (2003).

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1			✓			
CO2			✓			
CO3			✓	✓		✓
CO4	✓	✓	✓	✓		
CO5	✓	✓		✓		✓

MD5082 PATTERN RECOGNITION TECHNIQUES AND APPLICATIONS L T P C 3 0 0 3

OBJECTIVES:

- The objective of this course is to enable the students to understand the fundamentals of Pattern recognition.
- The students should learn to choose an appropriate feature, pattern classification algorithm for a pattern recognition problem, properly implement the algorithm.
- To enrich the students knowledge with fuzzy systems and its applications

UNIT I OVERVIEW OF PATTERN RECOGNITION 9

Discriminant functions- Supervised learning - Parametric Estimation-Maximum Likelihood estimation - Bayesian parameter estimation – Problems with Bayes Approach. Non Parametric techniques, Perceptron Algorithm-LMSE Algorithm- Pattern classification by distance functions - minimum distance Pattern classifier.

UNIT II UNSUPERVISED CLASSIFICATION 9

Clustering for unsupervised learning and classification, clustering concepts hierarchical clustering, Partitional clustering, k- means algorithm - Validity of clustering solutions.

UNIT III FEATURE EXTRACTION AND STRUCTURAL PATTERN RECOGNITION 9

KL Transforms, Regression-Linear, Non-linear and Logistic, Prediction, Elements of formal grammars, syntactic description, stochastic grammars, Structural representation.

UNIT IV FUZZY SYSTEMS 9

Fuzzy sets and fuzzy reasoning- fuzzy matrices-fuzzy functions-decomposition –Fuzzy inference systems - Mamdani and Sugeno model, Fuzzy clustering- fuzzy c- means algorithm- fuzzy control method- fuzzy decision making.

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UNIT V RECENT ADVANCES AND APPLICATIONS 9

Principle of neuro fuzzy techniques, Application of PR in image segmentation – CAD system in Breast cancer detection, ECG signal analysis, Fingerprint identification - Cell cytology classification.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course the student will be able to:

CO1 Perform classification using Baye's approach
CO2 Implement clustering algorithms for classification
CO3 Perform Feature extraction, feature reduction and structural pattern recognition.
CO4 Apply fuzzy models for classification
CO5 Apply pattern recognition techniques for biosignal and medical image applications.

REFERENCES:

1. Domiel A Vallero, Biomedical Ethics for Engineers, Elsevier Pub.1st edition, 2007
2. Johnna Fisher, Biomedical Ethics: A Canadian Focus., Oxford University Press Canada, 2009.
3. Robert M Veatch, The Basics of Bio Ethics, 3rd Edition. Routledge, 2011.
4. Physical Environment Online: A Guide to The Joint Commission's Safety Standards is published by HCPro, Inc. 2010
5. Joint Commission Accreditation Standards for Hospitals, 6th Edition 2018.
6. Ben Mepham, Bioethics-An Introduction for the biosciences, 2nd Edition, Oxford University Press, 2008.
7. Timothy Ross, Fuzzy Logic with Engineering applications, 3rd Edition, Wiley India, 2011.

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1				✓	✓	
CO2				✓	✓	
CO3	✓		✓	✓		
CO4	✓		✓	✓		
CO5	✓		✓	✓		✓

MD5083 PHYSIOLOGICAL SYSTEMS MODELING AND SIMULATION L T P C
3 0 0 3

OBJECTIVES:

- To understand the fundamental engineering aspects of modelling Physiological systems
- To utilize concepts derived from biomedical research to aid in the design of engineering systems.
- To apply system techniques and methods to biomedical problems.

UNIT I INTRODUCTION TO SYSTEM CONCEPTS 9

The Model and Analog, System Properties – Resistance and Storage, Concept of Energy Storage and Dissipation in physiological systems, Thermal System with Combined System properties, Step response of a Resistance/Compliant Systems, pulse response of a first order system.

UNIT II TRANSFER FUNCTION 9

System as an Operator, Transfer Function of First and Second Order system, Transfer Function and Concept of Impedance – Circuits into transfer function, Circuit Analog from transfer function.

UNIT III SYSTEM RESPONSE CHARACTERISTICS 9

Characteristics of Physiological System, Sinusoidal Analysis of Instrumentation System, Frequency Response Characteristics – Semicircular Canals, Visual Tracking System, Evaluation of Transfer Function from Frequency Response, Transient Response Characteristics – Transient input functions, Under-damped Response of physiological system – example - post synaptic aortic arch.

UNIT IV FEEDBACK 9

Feedback and Homeostasis, Review of system stability concepts, Hypophysis – Adrenal Feedback Control System, Thermoregulation, Pupil Control System.

UNIT V SIMULATION OF BIOLOGICAL SYSTEMS 9

Introduction to Simulation, Simulation of Respiratory mechanics, Cardiovascular Control System, Skeletal muscle servo mechanism, Oculomotor System, Hodgkin Huxley Model.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course the student will be able to:

- **CO1** Perceive knowledge about different types of physiological models for first order system
- **CO2** Concepts of transfer function for first and second order system
- **CO3** Various response characteristics of physiological system
- **CO4** Apprehend in feedback control system
- **CO5** Analog simulation of different types of physiological models in the field of biological systems.

REFERENCES:

1. William B. Blesser, A System Approach to Biomedicine, McGraw Hill Book Co, New York, 1969.
2. Manfreo Clynes and John H. Milsum, Biomedical Engineering System, McGraw Hill and Co, New York, 1970.
3. Michael C.K. Khoo, Physiological Control System - Analysis, Simulation and Estimation, Prentice Hall of India, New Delhi, 2001
4. Douglas S. Rigg, Control Theory and Physiological Feedback Mechanism, The William and Wilkins Co, Baltimore, 1970.
5. Richard Skalak and Shu Chien, Hand Book of Biomedical Engineering, McGraw Hill and Co, New York, 1987.

COURSE OUTCOMES	PROGRAM OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓			✓	✓	
CO2				✓	✓	
CO3		✓	✓	✓	✓	
CO4		✓	✓	✓	✓	
CO5	✓	✓	✓	✓	✓	✓

Attested

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MD5084 **PRINCIPLES OF GENETIC ANALYSIS** **L T P C**
3 0 0 3

OBJECTIVES:

- To understand fundamental principles of cell division, chromosome segregation and Mendelian inheritance.
- To gain better knowledge in both prokaryotes & eukaryotes about the gene mutation and repair mechanisms.
- To know the underlying concept behind the manipulation of genetic material for a diverse beneficial purpose via Recombinant DNA Technology.
- To know the importance of human genome project and various techniques in gene mapping.
- To understand of the basic concepts of population genetics leading to important aspects concerning evolution.

UNIT I GENETIC INHERITANCE **9**

Organisation of DNA, Chromosomal inheritance, Eukaryotic genomes – repetitive and non-repetitive sequence, Genetic mapping - restriction cleavage, RFLP and SNPs.

UNIT II DNA AND PHENOTYPE **9**

DNA structure and replication, DNA sequencing, amplification and hybridisation. DNA Polymorphism, RNA transcription and processing, translation and its post translation modification. Regulation of gene expression.

UNIT III ENGINEERING OF GENES **9**

Gene isolation and manipulation, mutations, repair and recombination, site directed mutagenesis, in vivo techniques of genetic manipulation, tools for analysing gene expression and genetically modified organisms.

UNIT IV HUMAN GENOME PROJECT **9**

Human Genome Project (HGP) – an overview of the project, goals of the project, major scientific strategies & approaches used in HGP, physical mapping, gene ontology, gene annotation, techniques in HGP – microsatellite markers, STS, EST, DNA sequencing and DNA microarray, scientific & medical benefits of this project.

UNIT V IMPACT OF GENETIC VARIATION **9**

Population Genetics, Quantitative Genetics, Evolution Genetics

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course the student will be able to:

CO1 Interpret different forms of inheritance patterns and identify them in genetic data acquire in depth knowledge in evolutionary analysis of genetic sequence.

CO2 Acquire a wide knowledge in gene arrangement, the mechanisms and regulation involved in gene amplification

CO3 Explain the techniques in gene manipulation and to understand genetically modified organisms, its impact on the society.

CO4 Interpret and critically evaluate the outcomes of statistical analysis associated with the research project

CO5 Exploit relevant molecular genetic information with skill and confidence to conduct a research project involving the analysis of real molecular genetic data with minimal supervision.

REFERENCES:

1. Watson. J. etal, - Molecular Biology of the Gene -, 5th Edition, Pearson Publication, 2004.
2. Griffiths, Wesslers, Lewontin, Bart Gel, Suzuki, Miller, Introduction to Genetics Analysis, W.H Freeman & company, New York 8th Edition - 2005.
3. Glick, B. R and J.J Pasternak, Molecular Biotechnology, Principles and application of Recombinant DNA, 3rd Edition ASM Press, 2003
4. Karp, Gerald, Cell and Molecular Biology. Concepts and Experiments, 4th Edition, John Wiley Sons, 2005.
5. Weaver. R.F., Molecular Biology, 3rd Edition, McGraw – Hill, 2005.
6. Tom Strachan, Andrew P Read, Human molecular Genetics 3rd Edition, Garland Publishing – 2004.

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1			✓			
CO2			✓			
CO3			✓	✓		✓
CO4	✓	✓	✓			
CO5	✓	✓				

MD5085 TELEHEALTH TECHNOLOGY L T P C
3 0 0 3

OBJECTIVES:

- To teach the key principles for telemedicine and health.
- To make student understand telemedical technology.
- To introduce the students with the knowledge of telemedical standards
- To design and develop m-Health platforms for telemedical applications.

UNIT I TELEMEDICINE AND TELEHEALTH 9

History and Evolution of telemedicine, Purposes and its organization, Medical assistance of remote patients: Problems and Potentialities Lessons from maritime Telemedicine, Teleconsultation, Tele health, Organs of Telemedicine, Global and Indian scenario, Advances in Telemedicine, Benefits and Challenges

UNIT II TELEMEDICAL TECHNOLOGY 9

Principles of Multimedia: Text, Audio, Video, data - Data communications and networks, Internet, Body centric wireless communication: Wireless Body Area Networks (WBAN), Wireless Sensor Networks (WSN) and Wireless Personal Area Networks (WPAN) and their design concepts Antenna design considerations for in-body and on-body electronics - Communication infrastructure for Telemedicine - Telemedicine through world wide web (WWW).

UNIT III TELEMEDICAL STANDARDS 9

Real-time Telemedicine integrating doctors / Hospitals, Access to health care services – Health education and self-care, Telesurgery, Teleradiology, Telecardiology, Teleoncology, Telemedicine in neurosciences, Telepathology, Business aspects - Project planning and costing, Usage of telemedicine. Telemedicine and in loco assistance of patients, Interactive videoconferencing consults, Store and forward consults, Remote monitoring and home care, Home Telehealth Protocols and Procedure

UNIT IV m-HEALTH AND TELEMEDICINE 9

Mobile Devices : Smart phones, Tablet PCs, iPads, PDAs, Wearable computers – m-Health technology and communication infrastructure - Healthcare Apps – m-Health applications: Education and awareness, Remote data collection, Remote monitoring, Communication and training for healthcare workers, Disease and epidemic outbreak tracking, Diagnostic and treatment support – m-Health and the Transformation of Clinical Trials - Harnessing data, advanced analytics, and the Internet of Things to optimize digitized clinical trials

UNIT V SECURITY AND LEGAL ISSUES 9

International regulations in e-health and telemedicine, Ethical and legal aspects of Telemedicine - Confidentiality, Social and legal issues, Safety and regulatory issues, Informed consent in Telemedicine, Data Security and Standards, security and confidentially of medical records and access control, TCP/IP, ISO-OSI, DICOM, HL7, H. 320 series (Video phone based ISBN) T. 120, H.324 (Video phone based PSTN), Video Conferencing, Cyber laws related to telemedicine. Patient Rights

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course the student will be able to:

CO1 Describe the key principles for telemedicine and health.
CO2 Understand telemedical technology.
CO3 Introduce the students with the knowledge of telemedical standards
CO4 Design and develop m-Health platforms for telemedical applications
CO5 Acquire knowledge of evaluating the force in implants

REFERENCES:

1. Wootton, R., Craig, J., Patterson, V. (Eds.), Introduction to Telemedicine. Royal Society of Medicine Press Ltd (ISBN 1853156779), 2006
2. David Dagan Feng, Biomedical Information Technology, Academic Press Series in Biomedical Engineering, Elsevier Inc, USA, 2008
3. Ilias G. Maglogiannis, Kostas Karpouzis and Manolis Wallace, Image and Signal Processing for Networked E-Health Applications, Morgan & Claypool Publishers' series, USA, 2006

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓	✓			✓
CO2	✓	✓	✓		✓	✓
CO3	✓	✓	✓		✓	✓
CO4	✓	✓	✓	✓	✓	✓
CO5	✓	✓	✓	✓	✓	✓

MD5086 TISSUE ENGINEERING L T P C
3 0 0 3

OBJECTIVES:

- To understand basics of Tissue Engineering
- To understand fundamentals of cell mechanisms
- To teach the Physical & biological principles that serve as the scientific basis for understanding the interactions of biological molecules and cells with biomaterials employed for the fabrication of permanent implantable prostheses and as matrices for tissue engineering.
- To understand application of Tissue Engineering

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UNIT I BASICS OF TISSUE ENGINEERING 9

Introduction to Tissue Engineering - Objectives of Tissue Engineering - Basic definitions - Structure and organization of Tissues – Development of Tissue – Tissue exchange and diffusion of simple metabolites – Tissue Equivalent - Wound Healing Process - Biocompatibility and toxicity assessment.

UNIT II FUNDAMENTALS OF CELL MECHANISMS 9

Cell adhesion, Cell migration and Cell aggregation – Cell growth and Cell cycle. Cellular Interactions: Cell – Cell and Cell – Matrix. Control of Cell migration in Tissue Engineering –Cell delivery and Recirculation – Cell Culture in vitro – 3D culture in Tissue Engineering - In vitro Organogenesis - Cell transplantation.

UNIT III BIOMATERIALS IN TISSUE ENGINEERING 9

Definition – Biological vs Nonbiological materials – Extra Cellular Matrix – Collagen, Chitin & Degradable and Nondegradable materials – Polymer, Ceramics and Metals – Cell interaction with different materials –- Scaffolds - Control releaser agents in Tissue Engineering – Cell interaction with suspension and gels – Tissue response to implants.

UNIT IV STEM CELLS IN TISSUE ENGINEERING 9

Introduction of Stem cells – Hem poetic Stem cells - Embryonic Stem cells - Adult stem cells – Cancer Stem cells – Cord Blood cells – Induced Pluripotent Stem cells - Stem cell identification - Surface markers & FACS analysis – Differentiation, Dedifferentiation and Immortalization – Application of stem cells in tissue Engineering.

UNIT V TISSUE ENGINEERING APPLICATIONS 9

Synthetic components – Artificial organs – Joints and dental prostheses - Connective Tissue Engineering – Cardiovascular Tissue Engineering – Neural Tissue Engineering - Cell and Drug Delivery systems

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course the student will be able to:

- **CO1** Identify the importance of tissue engineering in the field of biomedical engineering
- **CO2** Explain the mechanisms involved in interaction of different materials with cells and tissues
- **CO3** Explain different methods involved in characterization and preparation of biomaterials in tissue engineering.
- **CO4** Analyse different types of stem cells and its application in tissue engineering
- **CO5** Apply the knowledge in creating new models in drug delivery systems using synthetic and natural scaffolds

REFERENCES:

1. W. Mark Saltzman Tissue Engineering – Engineering principles for design of replacement organs and tissue, Oxford University Press Inc. New York, 2004.
2. Gray E Wnek, Gray L Browlin, Encyclopaedia of Biomaterials and Biomedical Engineering – Marcel Dekker Inc. New York, 2004.
3. R.Lanza, J.Gearhart et.al,(Eds), Essential of Stem cell Biology, Elsevier Academic Press, 2006.
4. Sujata V.Bhatt, Biomaterials (2nd Edition), Narosa Publishing House, 2005.
5. Develop new approaches to build new tissues using tissue engineering techniques

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓				✓	✓
CO2	✓				✓	✓
CO3	✓				✓	✓
CO4	✓				✓	✓
CO5	✓				✓	✓

MD5087 ULTRASOUND PRINCIPLES AND APPLICATIONS IN MEDICINE L T P C
3 0 0 3

OBJECTIVES:

- To teach the principles of Ultrasonics and its interaction with tissue.
- Students will be able to know about the scanning techniques and real time scanners
- Principles and application of these principles in health care settings & gain knowledge about the various applications of ultrasound in medicine.

UNIT I PRINCIPLES OF ULTRASONICS 9

Principle of Piezo Electric transducers and Magnetostrictive transducers, Ultrasound transducers, Construction of ultrasonic probe - Continuous mode and pulsed mode. Measurement of ultrasonic energy, Manipulation of ultrasonic beam – Beam profile and intensity distribution in different axes, single transducer, transducer array, focusing, Beam steering and Dynamic focusing by electronic methods.

UNIT II TISSUE-ULTRASOUND INTERACTION 9

Interaction of ultrasound and tissue – propagation of ultrasound through tissue, dependence of speed on tissue characteristics, reflection and acoustic impedance, refraction, scattering, absorption in different tissues, compression and rarefaction, thermal effect. Cavitation, biological effects, Definition of Acoustic pressure and intensity and their relation to tissue properties. Structural contribution to bulk and shear acoustic properties of tissues. Relevance to tissue characterization

UNIT III ULTRASOUND SCANNERS 9

Different modes of display-A mode, B mode, M mode, applications of A mode and M mode in medicine, B-scan System, Real time scanners- types of transducers, transducer motion for scanning, Scan converters, Signal processing, signal controls- TGC, Flares and acoustic shadows, artifacts.

UNIT IV REAL TIME SCANNER APPLICATIONS AND ADVANCEMENTS 9

Ultrasonic diagnosis in Abdomen, Breast, Thyroid, Heart, Chest, Eye, Kidney, Skull, Pregnant and Non Pregnant uterus, 3-Dimensional Ultrasonic Imaging of the Fetus, Advantages and Limitations of 3-Dimensional Ultrasound, Tissue Elasticity and Echo Strain Imaging and advantages, Use of Contrast Media, Contrast-enhanced ultrasound (CEUS). Real Time 3-D Scanners, Image guided surgery. Cleaners in hospitals using cavitation effect

UNIT V ULTRASOUND DOPPLER TECHNIQUES 9

CW Doppler, Pulsed wave Doppler and types of transducers, Techniques for direction detection – Envelope Fluctuation Methods, Phase Tracking Methods, Envelope Tracking Techniques. Spectral analysis. Ultrasound Imaging Systems- Pulse Transmission and Range Gating, Duplex Scanning, Color Flow Imaging. Applications of Doppler technique - fetal heart rate detection, blood flow detection using Doppler signal and imaging technique, Color Doppler.

Attested

TOTAL: 45 PERIODS

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COURSE OUTCOMES:

On completion of this course the student will have:

CO1 An in-depth knowledge about the concepts of ultrasound

CO2 The capability to understand the interaction of ultrasound with matter especially the living systems.

CO3 In-depth knowledge about the Ultrasound imaging systems

CO4 Ability to specify method of ultrasonic scanning method for imaging different organs and the possible artifacts introduced during scanning.

CO5 Proficient knowledge about Real Time Scanners for blood flow studies

REFERENCES:

1. Shirley Blackwell Cusick, Farman and Vicary, A User's Guide to Diagnostic Ultrasound; Pitman Medical Publishing Co Ltd; Kent, England. (1978).
2. C.R.Hill, Jeff C.Bamber, Gail Haa, Physical Principles of medical Ultrasonics; John Wiley & Sons Ltd; 2nd Edition, 2004.
3. W.N.McDicken, Churchill Livingstone, Diagnostic Ultrasonics – Principles and use instruments – New York, 3rd Edition, 1991.
4. Timothy J.Hall, AAPM/RSNA, Physics Tutorial For Residents: Elasticity Imaging With Ultrasound, Radio Graphics, Vol.23, No.5, Nov-Dec 2003. (RSNA 2003).
5. T.Rago, F.Santini, M.Scutari, A. Pinchera and P.Vitti, Elastography: New developments in Ultrasound for Predicting Malignancy in Thyroid Nodules, Journal of Clinical Endocrinology and Metabolism, August 2007, 92(8) : 2917 – 2922.
6. James Revell, Majid Mirmehdi and Donal McNally, Computer Vision Elastography: Speckle Adaptive Motion Estimation for Elastography using Ultrasound Sequences, IEEE Transactions on Medical Imaging, Vol.24, No.6, June 2005.
7. Hassan Rivaz, Emad Boctor, Pezhman Foroughi, Richard Zellars, Gabor and Gregory Hager, Ultrasound Elastography: A Dynamic Programming Approach, IEEE Transactions on Medical Imaging, 2008
8. Khandpur R.S Hand Book of Biomedical Instrumentation, Tata Mc Graw Hill publication, New Delhi 2nd Edition 2003
9. M.A.Flower, Webb's Physics of Medical Imaging, 2nd Edition, CRC Press ,Boca Raton, FL, 2012
10. Thomas L.Szabo, ‖Diagnostic ultrasound imaging Inside out‖, Elsevier Academic Press, London, 2004

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1			✓	✓	✓	
CO2			✓		✓	
CO3	✓		✓	✓	✓	✓
CO4	✓	✓	✓	✓	✓	
CO5	✓	✓	✓	✓	✓	

MD5088 **WEARABLE BODY AREA NETWORKS** **L T P C**
3 0 0 3

OBJECTIVES:

The student should be made to:

- Learn about wireless body area networks" and different hardware related to it
- Study about sensors and its application in wearable systems

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UNIT I INTRODUCTION **9**

Definition, BAN and Healthcare, Technical Challenges- Sensor design, biocompatibility, Energy Supply, optimal node placement, number of nodes, System security and reliability, BSN Architecture – Introduction

UNIT II HARDWARE FOR BAN **9**

Processor-Low Power MCUs, Mobile Computing MCUs, Integrated processor with radio transceiver, Memory, Antenna-PCB antenna, Wire antenna, Ceramic antenna, External antenna, Sensor Interface, Power sources- Batteries and fuel cells for sensor nodes.

UNIT III WEARABLE SENSORS **9**

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 IV SIGNAL PROCESSING **9**

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 V APPLICATIONS **9**

Monitoring patients with chronic disease, Hospital patients, Elderly patients, Cardiac arrhymias monitoring, Multi patient monitoring systems, Multichannel Neural recording, Gait analysis, Sports Medicine, Electronic pill

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course the student will be able to:

- **CO1** Define the need for WBAN and the challenges involved in the design
- **CO2** Explain about the working of wireless Body Area Network and discuss about the hardware required for the implementation
- **CO3** Describe about the types of wearable sensors and their suitability for BAN
- **CO4** Discuss and implement the suitable signal processing technique and thus the ways of reducing power consumption
- **CO5** Explain the need of wireless health systems and the design an application of wearable systems

REFERENCES:

1. Annalisa Bonfiglio, Danilo De Rossi,"Wearable Monitoring Systems", Springer, 2011. (Unit I, II, III & V).
2. Sandeep K.S. Gupta,Tridib Mukherjee,Krishna Kumar Venkata Subramanian, Body Area Networks Safety, Security, and Sustainability, Cambridge University Press, 2013. (Unit IV).
3. Zhang, Yuan-Ting, Wearable Medical Sensors and Systems, Springer, 2013.
4. Guang-Zhong Yang(Ed.), Body Sensor Networks, -Springer, 2006.
5. Mehmet R. Yuce, Jamil Y.Khan, -Wireless Body Area Networks Technology, Implementation, and Applications‖, Pan Stanford Publishing

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1			✓		✓	
CO2		✓	✓		✓	✓
CO3	✓		✓	✓	✓	
CO4	✓		✓	✓	✓	
CO5	✓		✓	✓	✓	✓

Attested

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MD5073 BIOMEDICAL PRODUCT DESIGN AND DEVELOPMENT L T P C
3 0 0 3

OBJECTIVES:

- To understand the global trends and development methodologies of various types of products and services
- To conceptualize, prototype and develop product management plan for a new product based on the type of the new product and development methodology integrating the hardware, software, controls, electronics and mechanical systems
- To understand requirement engineering and know how to collect, analyze and arrive at requirements for new product development and convert them in to design specification
- To understand system modeling for system, sub-system and their interfaces and arrive at the optimum system specification and characteristics
- To develop documentation, test specifications and coordinate with various teams to validate and sustain up to the EoL (End of Life) support activities for engineering customer

UNIT I PRODUCT DESIGN 9

Definition, History and Modern Practice – Designs; Design and Product Life Cycle; Design Process; What is a medical device, Challenges in medical device, Understanding the innovation cycle, Good Design Practice. Understanding, analyzing and validating user needs, Screening Needs, Technical Requirements, Concept Generation – Innovation Survey Questionnaire, Morphological Matrix, QFD, Concept Analysis and validation, Concept Modelling, Concept Screening & Validation.

UNIT II PRODUCT DEVELOPMENT AND REGULATORY 9

Breakthrough Products, Platform Products, Front End of Innovations / Fuzzy Front End, Generic Product Development Process (Concept Development, System Design, Detailed Design, Test & Refinement, Production Ramp-up), Variants of Development Processes (Market Pull, Technology Push, Platform, Process-Intensive, Customized, High-Risk, Quick Build, Complex Systems), Good Documentation Practice, Prototyping Specifications, Prototyping, Medical Device standards, Quality management systems, Medical Device Classification, Design of Clinical Trials, Design Control & Regulatory Requirements, Documentation in Medical Devices, Regulatory pathways

UNIT III CALABLE PRODUCT DEVELOPMENT 9

Design for manufacturing, Design for assembly, Design for Serviceability, Design for usability, Medical Device Verification & Validation, Product Testing & Regulatory compliance, Clinical trial & validation, Device Certification

UNIT IV MANUFACTURING AND BUSINESS STRATEGIES 9

Lean Manufacturing – Toyota Production System, Good Manufacturing Practices, Framework for Product Strategy – Core Strategic Vision (CSV), Characteristics of good CSV, Opportunity Identification Process & Generating Opportunities, Quality of Opportunities – Real-Win-Worth It (3M RWW), Product Planning Process, Technology S-Curve, Evaluating and Prioritizing Projects, Product-Process Change Matrix, Resource Planning, Total Available Market (Segmentation, Targeting & Positioning), Served Available Market, Product Platform Strategy, Market Platform Plan (Product Platform Management, Product Line Strategy).

UNIT V PRODUCT ECONOMICS AND MARKET INFUSIONS 9

Economics/Finance in Product Development (Sales Forecasting – ATAR Model/ Bases Model, Pricing the product, Cash flow in Product Development, Categorizing the costs, Structuring Manufacturing Costs, Prototyping Costs, Development Costs, Cost Volume Profit Analysis, Breakeven Analysis, Common Return Metrics – Payback/ NPV/ IRR, Common Comparison Metrics – WACC/ RRR/ MARR).

Business Model Canvas, Marketing Channels, Sales Models, Post Commercialization Surveillance, End of Life support

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course the student will be able to:

CO1 Define, formulate and analyze a problem for the product design.

CO2 Obtain the domain knowledge of product development and regulatory requirements for the design of prototype.

CO3 Explain the process of manufacturing, testing and validation for scalable product development.

CO4 Gain knowledge of the Innovation & Product Development process in the Business Context.

CO5 Discuss the economics in product development and business strategies for turnover from commercialization.

REFERENCES:

1. Jones, J.C., Design Methods, John Wiley, 1981.
2. Cross, N., Engineering Design Methods, John Wiley, 1994.
3. Pahl, G., and Beitz, W., Engineering Design, Design Council, 1984.
4. Michael E. McGrath, Product Strategy for High-Technology Companies, 2nd Edition, McGraw Hill
5. Ulrich, K.T., and Eppinger, S.D., Product Design and Development, Tata McGraw Hill, India
6. Ehrelspiel. K, and Lindemann U Cost Efficient Design, Springer,2007
7. Paul H king, Richard C. Fries, Arthur T. Johnson, Design of Biomedical Devices and Systems. Third edition, ISBN 9781466569133,
8. Peter J. Ogrodnik, Medical Device Design: Innovation from Concept to Market, Academic Press Inc; edition (2012), ISBN- 10:0123919428
9. Stefanos Zenios, Josh Makower, Paul Yock, Todd J. Brinton, Uday N. Kumar, Lyn Denend, Thomas M. Krummel, Biodesign: the Process of Innovating Medical Technologies, Cambridbge University press; Edition (2009), ISBN- 10:0521517427.

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓	✓
CO4	✓	✓	✓	✓	✓	✓
CO5	✓	✓	✓	✓	✓	✓

MD5079 **MEDICAL ROBOTICS** **L T P C**
3 0 0 3

OBJECTIVES

- To explain the basic concepts of robots and types of robots
- To discuss the designing procedure of manipulators, actuators and grippers.
- To impart knowledge on various types of sensors and power sources.
- Explore various applications of Robots in Medicine.

UNIT I INTRODUCTION TO ROBOTICS **9**

Introduction to Robotics, Overview of robot subsystems, Degrees of freedom, configurations and concept of workspace, Dynamic Stabilization

Sensors and Actuators
Sensors and controllers, Internal and external sensors, position, velocity and acceleration sensors, Proximity sensors, force sensors Pneumatic and hydraulic actuators, Stepper motor control circuits, End effectors, Various types of Grippers, PD and PID feedback actuator models

UNIT II MANIPULATORS & BASIC KINEMATICS 9
Construction of Manipulators, Manipulator Dynamic and Force Control, Electronic and pneumatic manipulator, Forward Kinematic Problems, Inverse Kinematic Problems, Solutions of Inverse Kinematic problems

Navigation and Treatment Planning
Variable speed arrangements, Path determination – Machinery vision, Ranging – Laser – Acoustic, Magnetic, fiber optic and Tactile sensor.

UNIT III SURGICAL ROBOTS 9
Da Vinci Surgical System, Image guided robotic systems for focal ultrasound based surgical applications, System concept for robotic Tele-surgical system for off-pump, CABG surgery, Urologic applications, Cardiac surgery, Neuro-surgery, Pediatric and General Surgery, Gynecologic Surgery, General Surgery and Nanorobotics. Case Study.

UNIT IV REHABILITATION AND ASSITIVE ROBOTS 9
Pediatric Rehabilitation, Robotic Therapy for the Upper Extremity and Walking, Clinical-Based Gait Rehabilitation Robots, Motion Correlation and Tracking, Motion Prediction, Motion Replication. Portable Robot for Tele rehabilitation, Robotic Exoskeletons – Design considerations, Hybrid assistive limb. Case Study.

UNIT V WEARABLE ROBOTS 9
Augmented Reality, Kinematics and Dynamics for Wearable Robots, Wearable Robot technology, Sensors, Actuators, Portable Energy Storage, Human–robot cognitive interaction (cHRI), Human–robot physical interaction (pHRI), Wearable Robotic Communication - case study.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
On completion of this course the student will be able to:

CO1 Describe the configuration, applications of robots and the concept of grippers and actuators.
CO2 Explain the functions of manipulators and basic kinematics.
CO3 Describe the application of robots in various surgeries
CO4 Design and analyze the robotic systems for rehabilitation.
CO5 Design the wearable robots.

REFERENCES:

1. Nagrath and Mittal, “Robotics and Control”, Tata McGraw Hill, First edition, 2003.
2. Spong and Vidhyasagar, “Robot Dynamics and Control”, John Wiley and Sons, First edition, 2008.
3. Fu.K.S, Gonzalez. R.C., Lee, C.S.G, “Robotics, control”, sensing, Vision and Intelligence, Tata McGraw Hill International, First edition, 2008.
4. Bruno Siciliano, Oussama Khatib, Springer Handbook of Robotics, 1st Edition, Springer, 2008.
5. Shane (S.Q.) Xie, Advanced Robotics for Medical Rehabilitation - Current State of the Art and Recent Advances, Springer, 2016.
6. Sashi S Kommu, Rehabilitation Robotics, I-Tech Education and Publishing, 2007.
7. Jose L. Pons, Wearable Robots: Biomechatronic Exoskeletons, John Wiley & Sons Ltd, England, 2008.
8. Howie Choset, Kevin Lynch, Seth Hutchinson, “Principles of Robot Motion: Theory, Algorithms, and Implementations”, Prentice Hall of India, First edition, 2005.

9. Philippe Coiffet, Michel Chirouze, “An Introduction to Robot Technology”, Tata McGraw Hill, First Edition, 1983.
10. Jacob Rosen, Blake Hannaford & Richard M Satava, “Surgical Robotics: System Applications & Visions”, Springer 2011.
11. Jocelyn Troccaz, Medical Robotics, Wiley, 2012.
12. Achim Schweikard, Floris Ernst, Medical Robotics, Springer, 2015.

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1				✓		
CO2				✓		
CO3	✓	✓	✓	✓	✓	
CO4	✓	✓	✓	✓	✓	
CO5	✓	✓	✓	✓	✓	✓

MD5076 MEDICAL EMBEDDED SYSTEMS L T P C
3 0 0 3

OBJECTIVES:

- To know the various functional blocks present is cardiac care units so that the students can handle these equipment with care and safety.
- To understand the different types of neurology equipment.
- To develop an understanding of the physiotherapy and diathermy equipment so that the student can learn to operate.

UNIT I REVIEW OF DIGITAL ELECTRONICS AND INTRODUCTION TO ARM PROCESSORS 9

Number systems and codes, logic gates, Arithmetic circuits: Half and Full adder, substractor; Combinational circuits: Multiplexers, Demultiplexers, Decoders, Encoders; Latches and Flip-flops, Counters, Registers, A/D and D/A converters.
Introduction to ARM Cortex-M Processors, Introduction to Embedded Software Development.

UNIT II HARDWARE AND SOFTWARE FOR ARM PROCESSOR 9

ARM architecture, ARM Instruction Set, Memory System, Exceptions and Interrupts.
The C language: The evolution of C, An overview of C programming, C operators, identifiers, keywords and constants; The C preprocessor: commands, definition and replacement, File inclusion, Conditional compilation; storage classes, variable types, expressions and precedence, statements, functions.

UNIT III DATA ACQUISITION SYSTEMS 9

Analog signals: amplitude, bandwidth; Analog multiplexing, Anti-aliasing filters, Analog to Digital converter, Sensor interfacing, sampling theorem, Digital filters, UART to USB converters, Bluetooth, Zigbee and Wi-fi Communication protocols.

UNIT IV EMBEDDED SYSTEM ARCHITECTURE - ARM CORE 9

ARM organization and implementation, The Thumb Instruction Set, Architectural Support for High-Level Languages.
Introduction to Arduino Due; Arduino integrated development environment and programming.

UNIT V PROTOTYPE PRODUCT DEVELOPMENT 9

Basics of Printed Circuit Boards: Evolution, components, classification, Manufacturing and challenges; Layout planning and design: General PCB Design Considerations, Electrical Design Considerations, Component Placement Rules, Fabrication and Assembly Considerations, Layout Design and Assembly.

Design of single channel and multi-channel ECG and EMG amplifier systems incorporating analog, digital and communication.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course the student will be able to:

- **CO1** Obtain the domain knowledge of digital electronics and ARM processors.
- **CO2** Develop hardware and software for ARM processor.
- **CO3** Demonstrate the various subsystems of data acquisition system for acquisition of biosignals.
- **CO4** Use the ARM core in the design of medical embedded system.
- **CO5** Design the layout planning for bioamplifiers and prototype product in PCB.

REFERENCES:

1. S. Salivahanan, S. Arivazhagam, "Digital circuits and Design", 4th Edition, Vikas Publishing House, 2012.
2. Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D. McKinlay, "The 8051 microcontroller and embedded systems using assembly and C", 2nd Edition, Pearson, 2005.
3. Brian W. Kernighan, Dennis M. Ritchie, "The C programming language", 2nd Edition, Prentice Hall, Englewood Cliffs, New Jersey, 1988.
4. R. S. Khandpur, "Printed Circuit Boards Design - Fabrication, Assembly and Testing", 1st Edition, McGraw Hill Education, 2017.
5. Andrew Sloss, Dominic Symes, Chris Wright, ARM system developer's guide: designing and optimizing system software, Morgan Kaufmann, 2004.

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1		✓				
CO2			✓	✓		
CO3			✓	✓		
CO4		✓	✓	✓	✓	
CO5		✓	✓	✓	✓	

OE5091 BUSINESS DATA ANALYTICS L T P C

3 0 0 3

OBJECTIVES:

- To understand the basics of business analytics and its life cycle.
- To gain knowledge about fundamental business analytics.
- To learn modeling for uncertainty and statistical inference.
- To understand analytics using Hadoop and Map Reduce frameworks.
- To acquire insight on other analytical frameworks.

UNIT I OVERVIEW OF BUSINESS ANALYTICS 9

Introduction – Drivers for Business Analytics – Applications of Business Analytics: Marketing and Sales, Human Resource, Healthcare, Product Design, Service Design, Customer Service and Support – Skills Required for a Business Analyst – Framework for Business Analytics Life Cycle for Business Analytics Process.

Suggested Activities:

- Case studies on applications involving business analytics.
- Converting real time decision making problems into hypothesis.
- Group discussion on entrepreneurial opportunities in Business Analytics.

Suggested Evaluation Methods:

- Assignment on business scenario and business analytical life cycle process.
- Group presentation on big data applications with societal need.
- Quiz on case studies.

UNIT II ESSENTIALS OF BUSINESS ANALYTICS 9

Descriptive Statistics – Using Data – Types of Data – Data Distribution Metrics: Frequency, Mean, Median, Mode, Range, Variance, Standard Deviation, Percentile, Quartile, z-Score, Covariance, Correlation – Data Visualization: Tables, Charts, Line Charts, Bar and Column Chart, Bubble Chart, Heat Map – Data Dashboards.

Suggested Activities:

- Solve numerical problems on basic statistics.
- Explore chart wizard in MS Excel Case using sample real time data for data visualization.
- Use R tool for data visualization.

Suggested Evaluation Methods:

- Assignment on descriptive analytics using benchmark data.
- Quiz on data visualization for univariate, bivariate data.

UNIT III MODELING UNCERTAINTY AND STATISTICAL INFERENCE 9

Modeling Uncertainty: Events and Probabilities – Conditional Probability – Random Variables – Discrete Probability Distributions – Continuous Probability Distribution – Statistical Inference: Data Sampling – Selecting a Sample – Point Estimation – Sampling Distributions – Interval Estimation – Hypothesis Testing.

Suggested Activities:

- Solving numerical problems in sampling, probability, probability distributions and hypothesis testing.
- Converting real time decision making problems into hypothesis.

Suggested Evaluation Methods:

- Assignments on hypothesis testing.
- Group presentation on real time applications involving data sampling and hypothesis testing.
- Quizzes on topics like sampling and probability.

UNIT IV ANALYTICS USING HADOOP AND MAPREDUCE FRAMEWORK 9

Introducing Hadoop – RDBMS versus Hadoop – Hadoop Overview – HDFS (Hadoop Distributed File System) – Processing Data with Hadoop – Introduction to MapReduce – Features of MapReduce – Algorithms Using Map-Reduce: Matrix-Vector Multiplication, Relational Algebra Operations, Grouping and Aggregation – Extensions to MapReduce.

Suggested Activities:

- Practical – Install and configure Hadoop.
- Practical – Use web based tools to monitor Hadoop setup.
- Practical – Design and develop MapReduce tasks for word count, searching involving text corpus etc.

Suggested Evaluation Methods:

- Evaluation of the practical implementations.
- Quizzes on topics like HDFS and extensions to MapReduce.

UNIT V OTHER DATA ANALYTICAL FRAMEWORKS 9

Overview of Application development Languages for Hadoop – PigLatin – Hive – Hive Query Language (HQL) – Introduction to Pentaho, JAQL – Introduction to Apache: Sqoop, Drill and Spark, Cloudera Impala – Introduction to NoSQL Databases – Hbase and MongoDB.

Suggested Activities:

- Practical – Installation of NoSQL database like MongoDB.
- Practical – Demonstration on Sharding in MongoDB.
- Practical – Install and run Pig
- Practical – Write PigLatin scripts to sort, group, join, project, and filter data.
- Design and develop algorithms to be executed in MapReduce involving numerical methods for analytics.

Suggested Evaluation Methods:

- Mini Project (Group) – Real time data collection, saving in NoSQL, implement analytical techniques using Map-Reduce Tasks and Result Projection.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the student will be able to:

- Identify the real world business problems and model with analytical solutions.
- Solve analytical problem with relevant mathematics background knowledge.
- Convert any real world decision making problem to hypothesis and apply suitable statistical testing.
- Write and Demonstrate simple applications involving analytics using Hadoop and MapReduce
- Use open source frameworks for modeling and storing data.
- Apply suitable visualization technique using R for visualizing voluminous data.

REFERENCES:

1. Vignesh Prajapati, “Big Data Analytics with R and Hadoop”, Packt Publishing, 2013.
2. Umesh R Hodeghatta, Umesha Nayak, “Business Analytics Using R – A Practical Approach”, Apress, 2017.
3. Anand Rajaraman, Jeffrey David Ullman, “Mining of Massive Datasets”, Cambridge University Press, 2012.
4. Jeffrey D. Camm, James J. Cochran, Michael J. Fry, Jeffrey W. Ohlmann, David R. Anderson, “Essentials of Business Analytics”, Cengage Learning, second Edition, 2016.
5. U. Dinesh Kumar, “Business Analytics: The Science of Data-Driven Decision Making”, Wiley, 2017.
6. A. Ohri, “R for Business Analytics”, Springer, 2012
7. Rui Miguel Forte, “Mastering Predictive Analytics with R”, Packt Publication, 2015.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	2	3	1
CO2	2	1	1	2	1	1
CO3	1	1	2	3	3	1
CO4	2	2	1	2	1	1
CO5	1	1	2	2	1	1
CO6	1	1	1	3	2	1

OE5092 **INDUSTRIAL SAFETY** **LT P C**
3 0 0 3

OBJECTIVES:

- Summarize basics of industrial safety
- Describe fundamentals of maintenance engineering
- Explain wear and corrosion
- Illustrate fault tracing
- Identify preventive and periodic maintenance

UNIT I INTRODUCTION **9**

Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

UNIT II FUNDAMENTALS OF MAINTENANCE ENGINEERING **9**

Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT III WEAR AND CORROSION AND THEIR PREVENTION **9**

Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

UNIT IV FAULT TRACING **9**

Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

UNIT V PERIODIC AND PREVENTIVE MAINTENANCE **9**

Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

Attested

TOTAL: 45 PERIODS

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OUTCOMES:

Students will be able to:

CO1: Ability to summarize basics of industrial safety

CO2: Ability to describe fundamentals of maintenance engineering

CO3: Ability to explain wear and corrosion

CO4: Ability to illustrate fault tracing

CO5: Ability to identify preventive and periodic maintenance

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓											
CO3	✓	✓	✓									
CO4	✓	✓	✓									
CO5	✓	✓	✓									

REFERENCES:

1. Audels, Pump-hydraulic Compressors, Mcgrew Hill Publication, 1978.
2. Garg H P,Maintenance Engineering, S. Chand and Company,1987.
3. Hans F. Winterkorn, Foundation Engineering Handbook, Chapman & Hall London, 2013.
4. Higgins & Morrow, Maintenance Engineering Handbook, Eighth Edition,2008

OE5093 **OPERATIONS RESEARCH** **L T P C**

3 0 0 3

OBJECTIVES:

- Solve linear programming problem and solve using graphical method.
- Solve LPP using simplex method
- Solve transportation, assignment problems
- Solve project management problems
- Solve scheduling problems

UNIT I LINEAR PROGRAMMING 9

Introduction to Operations Research – assumptions of linear programming problems - Formulations of linear programming problem – Graphical method

UNIT II ADVANCES IN LINEAR PROGRAMMING 9

Solutions to LPP using simplex algorithm- Revised simplex method - primal dual relationships – Dual simplex algorithm - Sensitivity analysis

UNIT III NETWORK ANALYSIS – I 9

Transportation problems -Northwest corner rule, least cost method, Voges's approximation method - Assignment problem -Hungarian algorithm

UNIT IV NETWORK ANALYSIS – II 9

Shortest path problem: Dijkstra's algorithms, Floyds algorithm, systematic method -CPM/PERT

UNIT V NETWORK ANALYSIS – III 9

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models

TOTAL: 45 PERIODS

OUTCOMES:

Students will be able to:

CO1: To formulate linear programming problem and solve using graphical method.

CO2: To solve LPP using simplex method

CO3: To formulate and solve transportation, assignment problems

CO4: To solve project management problems

CO5: To solve scheduling problems

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓											
CO3	✓	✓	✓									
CO4	✓	✓	✓									
CO5	✓	✓	✓									

REFERENCES:

1. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010
2. Hitler Libermann, Operations Research: McGraw Hill Pub. 2009
3. Pant J C, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Pannerselvam, Operations Research: Prentice Hall of India 2010
5. Taha H A, Operations Research, An Introduction, PHI, 2008

OE5094 COST MANAGEMENT OF ENGINEERING PROJECTS L T P C
3 0 0 3

OBJECTIVES:

- Summarize the costing concepts and their role in decision making
- Infer the project management concepts and their various aspects in selection
- Interpret costing concepts with project execution
- Develop knowledge of costing techniques in service sector and various budgetary control techniques
- Illustrate with quantitative techniques in cost management

UNIT I INTRODUCTION TO COSTING CONCEPTS 9

Objectives of a Costing System; Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost; Creation of a Database for operational control.

UNIT II INTRODUCTION TO PROJECT MANAGEMENT 9

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities, Detailed Engineering activities, Pre project execution main clearances and documents, Project team: Role of each member, Importance Project site: Data required with significance, Project contracts.

Attested

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UNIT III PROJECT EXECUTION AND COSTING CONCEPTS 9

Project execution Project cost control, Bar charts and Network diagram, Project commissioning: mechanical and process, Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis, Various decision-making problems, Pricing strategies: Pareto Analysis, Target costing, Life Cycle Costing.

UNIT IV COSTING OF SERVICE SECTOR AND BUDGETERY CONTROL 9

Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis, Budgetary Control: Flexible Budgets; Performance budgets; Zero-based budgets.

UNIT V QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT 9

Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Learning Curve Theory.

TOTAL: 45 PERIODS

OUTCOMES:

Students will be able to:

CO1 – Understand the costing concepts and their role in decision making

CO2–Understand the project management concepts and their various aspects in selection

CO3–Interpret costing concepts with project execution

CO4–Gain knowledge of costing techniques in service sector and various budgetary control techniques

CO5 - Become familiar with quantitative techniques in cost management

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓		✓			✓	✓		✓	✓
CO2	✓	✓	✓		✓				✓		✓	✓
CO3	✓	✓	✓		✓	✓					✓	✓
CO4	✓	✓	✓		✓		✓				✓	✓
CO5	✓	✓	✓		✓	✓	✓				✓	✓

REFERENCES:

1.Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher, 1991

2. Charles T. Horngren and George Foster, Advanced Management Accounting, 1988

3. Charles T. Horngren et al Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi, 2011

4. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting, 2003

5. Vohra N.D., Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd, 2007

OE5095 COMPOSITE MATERIALS L T P C
3 0 0 3

OBJECTIVES:

- Summarize the characteristics of composite materials and effect of reinforcement in composite materials.
- Identify the various reinforcements used in composite materials.
- Compare the manufacturing process of metal matrix composites.
- Understand the manufacturing processes of polymer matrix composites.
- Analyze the strength of composite materials.

UNIT I INTRODUCTION **9**

Definition – Classification and characteristics of Composite materials - Advantages and application of composites - Functional requirements of reinforcement and matrix - Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

UNIT II REINFORCEMENTS **9**

Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers - Properties and applications of whiskers, particle reinforcements - Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures - Isostrain and Isostress conditions.

UNIT III MANUFACTURING OF METAL MATRIX COMPOSITES **9**

Casting – Solid State diffusion technique - Cladding – Hot isostatic pressing - Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving - Properties and applications.

UNIT IV MANUFACTURING OF POLYMER MATRIX COMPOSITES **9**

Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method –Filament winding method – Compression moulding – Reaction injection moulding - Properties and applications.

UNIT V STRENGTH **9**

Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

TOTAL: 45 PERIODS

OUTCOMES:

Students will be able to:

- CO1 - Know the characteristics of composite materials and effect of reinforcement in composite materials.
- CO2 – Know the various reinforcements used in composite materials.
- CO3 – Understand the manufacturing processes of metal matrix composites.
- CO4 – Understand the manufacturing processes of polymer matrix composites.
- CO5 – Analyze the strength of composite materials.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓	✓	✓								
CO2		✓	✓	✓	✓						✓	
CO3			✓	✓	✓		✓				✓	
CO4			✓	✓	✓		✓				✓	
CO5			✓	✓	✓		✓					

REFERENCES:

1. Cahn R.W. - Material Science and Technology – Vol 13 – Composites, VCH, West Germany.
2. Callister, W.D Jr., Adapted by Balasubramaniam R, Materials Science and Engineering, An introduction, John Wiley & Sons, NY, Indian edition, 2007.
3. Chawla K.K., Composite Materials, 2013.
4. Lubin.G, Hand Book of Composite Materials, 2013.

OE5096 **WASTE TO ENERGY** **L T P C**
3 0 0 3

OBJECTIVES:

- Interpret the various types of wastes from which energy can be generated
- Develop knowledge on biomass pyrolysis process and its applications
- Develop knowledge on various types of biomass gasifiers and their operations
- Invent knowledge on biomass combustors and its applications on generating energy
- Summarize the principles of bio-energy systems and their features

UNIT I INTRODUCTION TO EXTRACTION OF ENERGY FROM WASTE 9

Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

UNIT II BIOMASS PYROLYSIS 9

Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

UNIT III BIOMASS GASIFICATION 9

Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

UNIT IV BIOMASS COMBUSTION 9

Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

UNIT V BIO ENERGY 9

Properties of biogas (Calorific value and composition), Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production -Urban waste to energy conversion - Biomass energy programme in India.

TOTAL: 45 PERIODS

OUTCOMES:

Students will be able to:

CO1 – Understand the various types of wastes from which energy can be generated

CO2 – Gain knowledge on biomass pyrolysis process and its applications

CO3 – Develop knowledge on various types of biomass gasifiers and their operations

CO4 – Gain knowledge on biomass combustors and its applications on generating energy

CO5 – Understand the principles of bio-energy systems and their features

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓									✓
CO2	✓		✓									✓
CO3	✓	✓	✓		✓							✓
CO4	✓	✓	✓		✓		✓					✓
CO5	✓	✓	✓		✓							✓

Attested

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REFERENCES:
1. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
2. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.

AUDIT COURSES (AC)

AX5091 ENGLISH FOR RESEARCH PAPER WRITING L T P C
2 0 0 0

OBJECTIVES

- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

UNIT I INTRODUCTION TO RESEARCH PAPER WRITING 6

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II PRESENTATION SKILLS 6

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction

UNIT III TITLE WRITING SKILLS 6

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

UNIT IV RESULT WRITING SKILLS 6

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT V VERIFICATION SKILLS 6

Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first- time submission

TOTAL: 30 PERIODS

OUTCOMES

CO1 –Understand that how to improve your writing skills and level of readability
CO2 – Learn about what to write in each section
CO3 – Understand the skills needed when writing a Title
CO4 – Understand the skills needed when writing the Conclusion
CO5 – Ensure the good quality of paper at very first-time submission

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										✓		✓
CO2										✓		✓
CO3										✓		✓
CO4										✓		✓
CO5										✓		✓

Attested

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REFERENCES

1. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
2. Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006
3. Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006
4. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 1998.

AX5092 DISASTER MANAGEMENT L T P C
2 0 0 0

OBJECTIVES

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

UNIT I INTRODUCTION 6

Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II REPERCUSSIONS OF DISASTERS AND HAZARDS 6

Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT III DISASTER PRONE AREAS IN INDIA 6

Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

UNIT IV DISASTER PREPAREDNESS AND MANAGEMENT 6

Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT V RISK ASSESSMENT 6

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival

TOTAL : 30 PERIODS

OUTCOMES

CO1: Ability to summarize basics of disaster
CO2: Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
CO3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
CO4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
CO5: Ability to develop the strengths and weaknesses of disaster management approaches

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓											
CO3	✓	✓	✓									
CO4	✓	✓	✓									
CO5	✓	✓	✓									

REFERENCES

1. Goel S. L., Disaster Administration And Management Text And Case Studies",Deep & Deep Publication Pvt. Ltd., New Delhi,2009.
2. NishithaRai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'NewRoyal book Company,2007.
3. Sahni, PardeepEt.Al. ," Disaster Mitigation Experiences And Reflections", Prentice Hall OfIndia, New Delhi,2001.

AX5093 SANSKRIT FOR TECHNICAL KNOWLEDGE L T P C
2 0 0 0

OBJECTIVES

- Illustrate the basic sanskrit language.
- Recognize sanskrit, the scientific language in the world.
- Appraise learning of sanskrit to improve brain functioning.
- Relate sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power.
- Extract huge knowledge from ancient literature.

UNIT I ALPHABETS 6

Alphabets in Sanskrit

UNIT II TENSES AND SENTENCES 6

Past/Present/Future Tense - Simple Sentences

UNIT III ORDER AND ROOTS 6

Order - Introduction of roots

UNIT IV SANSKRIT LITERATURE 6

Technical information about Sanskrit Literature

UNIT V TECHNICAL CONCEPTS OF ENGINEERING 6

Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

TOTAL: 30 PERIODS

OUTCOMES

- CO1 - Understanding basic Sanskrit language.
- CO2 - Write sentences.
- CO3 - Know the order and roots of Sanskrit.
- CO4 - Know about technical information about Sanskrit literature.
- CO5 - Understand the technical concepts of Engineering.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										✓		✓
CO2										✓		✓
CO3												✓
CO4												✓
CO5												✓

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REFERENCES
1. “Abhyaspustakam” – Dr. Vishwas, Samskrita-Bharti Publication, New Delhi
2. “Teach Yourself Sanskrit” Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3. “India’s Glorious Scientific Tradition” Suresh Soni, Ocean books (P) Ltd., New Delhi, 2017.

AX5094 **VALUE EDUCATION** **L T P C**
2 0 0 0

OBJECTIVES
Students will be able to
- Understand value of education and self-development
- Imbibe good values in students
- Let the should know about the importance of character

UNIT I
Values and self-development–Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non-moral valuation. Standards and principles. Value judgements

UNIT II
Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature, Discipline

UNIT III
Personality and Behavior Development-Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour. Universal brother hood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature

UNIT IV
Character and Competence–Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively.

TOTAL: 30 PERIODS

OUTCOMES
Students will be able to
- Knowledge of self-development.
- Learn the importance of Human values.
- Developing the overall personality.

SUGGESTED READING
1. Chakroborty, S.K.“Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi

AX5095 **CONSTITUTION OF INDIA** **L T P C**
2 0 0 0

OBJECTIVES

Students will be able to:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional
- Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolutionin1917and its impact on the initial drafting of the Indian Constitution.

UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION

History, Drafting Committee, (Composition & Working)

UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION

Preamble, Salient Features

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES

Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT IV ORGANS OF GOVERNANCE

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT V LOCAL ADMINISTRATION

District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy(Different departments), Village level:Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT VI ELECTION COMMISSION

Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to:

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization
- of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party[CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

SUGGESTED READING

1. The Constitution of India,1950(Bare Act),Government Publication.
2. Dr.S.N.Busi, Dr.B. R.Ambedkar framing of Indian Constitution,1st Edition, 2015.
3. M.P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis,2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

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AX5096 **PEDAGOGY STUDIES** **L T P C**
2 0 0 0

OBJECTIVES

Students will be able to:

- Review existing evidence on there view topic to inform programme design and policy
- Making under taken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

UNIT I INTRODUCTION AND METHODOLOGY:

Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions **-** Overview of methodology and Searching.

UNIT II INTRODUCTION AND METHODOLOGY:

Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions **-** Overview of methodology and Searching.

UNIT III THEMATIC OVERVIEW

Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education.

UNIT IV EVIDENCE ON THE EFFECTIVENESS OF PEDAGOGICAL PRACTICES

Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches - Teachers' attitudes and beliefs and Pedagogic strategies.

UNIT V PROFESSIONAL DEVELOPMENT

Professional development: alignment with classroom practices and follow up support - Peer support - Support from the head teacher and the community - Curriculum and assessment - Barriers to learning: limited resources and large class sizes

UNIT VI RESEARCH GAPS AND FUTURE DIRECTIONS

Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment - Dissemination and research impact.

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to understand:

- What pedagogical practices are being used by teachers informal and informal classrooms in developing countries?
- What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
- How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

SUGGESTED READING

1. Ackers J, HardmanF (2001) Classroom interaction in Kenyan primary schools, Compare, 31(2): 245-261.
2. Agrawal M (2004)Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36(3):361-379.
3. Akyeampong K (2003) Teacher training in Ghana-does it count? Multi-site teacher education research project (MUSTER) country report 1.London:DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33(3): 272–282.

5. Alexander RJ(2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M(2003) Read India: Amass scale, rapid, 'learning to read' campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf

AX5097 **STRESS MANAGEMENT BY YOGA** **L T P C**
2 0 0 0

OBJECTIVES

- To achieve overall health of body and mind
- To overcome stress

UNIT I

Definitions of Eight parts of yoga.(Ashtanga)

UNIT II

Yam and Niyam - Do`s and Don't's in life - i) Ahinsa, satya, astheya, bramhacharya and aparigraha, ii) Ahinsa, satya, astheya, bramhacharya and aparigraha.

UNIT III

Asan and Pranayam - Various yog poses and their benefits for mind & body - Regularization of breathing techniques and its effects-Types of pranayam

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to:

- Develop healthy mind in a healthy body thus improving social health also
- Improve efficiency

SUGGESTED READING

1. 'Yogic Asanas for Group Tarining-Part-I":Janardan Swami Yoga bhyasi Mandal, Nagpur
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

AX5098 **PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS** **L T P C**
2 0 0 0

OBJECTIVES

- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality and determination
- To awaken wisdom in students

UNIT I

Neetisatakam-holistic development of personality - Verses- 19,20,21,22 (wisdom) - Verses- 29,31,32 (pride & heroism) – Verses- 26,28,63,65 (virtue) - Verses- 52,53,59 (dont's) - Verses- 71,73,75,78 (do's)

UNIT II

Approach to day to day work and duties - Shrimad Bhagwad Geeta: Chapter 2-Verses 41, 47,48 - Chapter 3-Verses 13, 21, 27, 35 Chapter 6-Verses 5,13,17,23, 35 - Chapter 18-Verses 45, 46, 48.

UNIT III

Statements of basic knowledge - Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68 Chapter 12 - Verses 13, 14, 15, 16,17, 18 - Personality of role model - shrimad bhagwad geeta - Chapter2-Verses 17, Chapter 3-Verses 36,37,42 - Chapter 4-Verses 18, 38,39 Chapter18 – Verses 37,38,63

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to

- Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
- The person who has studied Geeta will lead the nation and mankind to peace and prosperity
- Study of Neet is hatakam will help in developing versatile personality of students.

SUGGESTED READING

1. Gopinath, Rashtriya Sanskrit Sansthanam P, Bhartrihari's Three Satakam, Niti-sringar-vairagya, New Delhi,2010
2. Swami Swarupananda , Srimad Bhagavad Gita, Advaita Ashram, Publication Department, Kolkata, 2016.

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