ANNA UNIVERSITY, CHENNAI
UNIVERSITY DEPARTMENTS
M.E. MEDICAL ELECTRONICS
REGULATIONS – 2019
CHOICE BASED CREDIT SYSTEM

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 stat-of-the-art technologies and global outreach programmes resulting in competent world class engineers.

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PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):
I. To integrate concepts in mathematics, science and engineering to solve the problems at the interface of engineering and biology.
II. To gain knowledge about sensors and measurement techniques to acquire and analyse various vital physiological parameters.
III. To understand and analyse the principles of biomedical equipments used in health care.
IV. To prepare the students to apply their knowledge in design, development, simulation, modeling and research related to biomedical systems.
V. To motivate students to become entrepreneurs to develop indigenous biomedical solutions.

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**	Analyze, model, design and realize biomedical devices, systems, components or processes.
5.	**Development of Healthcare Systems**	Apply mathematical foundations, science and engineering to provide solutions for health care systems.
6.	**Environment and Society**	Obtain broad education necessary to understand the impact of biomedical engineering solutions in global, economic, environmental and social context.

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PROGRAM SPECIFIC OUTCOMES (PSOs)

By the completion of M.E. – Medical Electronics 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.   Specify, architect and prototype health-care solutions by applying biosignal and medical image processing techniques on modern hardware and software platforms for applications with real time constraints.

   iii.   Provide sustainable solutions in health care and its allied fields by imbibing managerial and techno-social values.

   iv.   Knowledge of social & environmental awareness along with ethical responsibility to achieve a successful career addresses the real world applications using optimal resources as an entrepreneur.

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				✓	✓	✓

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YEAR	SEMESTER	COURSE TITLE	PO1	PO2	PO3	PO4	PO5	PO6
YEAR 1	SEM 1	Advanced Applied Mathematics				✓	✓	
		Human Anatomy and Physiology	✓	✓			✓	✓
		Biomedical Instrumentation	✓		✓	✓	✓	
		Biosignal Processing	✓		✓	✓	✓	
		Medical Equipment			✓	✓	✓	✓
		Research Methodology and IPR						
		Audit Course I						
		Biomedical Instrumentation Laboratory		✓	✓	✓	✓	✓
		Biosignal Processing Laboratory	✓	✓	✓	✓	✓	
	SEM 2	Medical Image Processing	✓	✓	✓	✓	✓	✓
		Medical Embedded Systems		✓	✓	✓	✓	
		Medical Imaging Systems and Radio Therapy	✓		✓	✓	✓	✓
		Program Elective I						
		Program Elective II						
		Audit Course II						
		Medical System Design and Analysis Laboratory	✓	✓		✓	✓	✓
		Medical Image Processing 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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ANNA UNIVERSITY, CHENNAI

UNIVERSITY DEPARTMENTS

M.E. MEDICAL ELECTRONICS

REGULATIONS – 2019

CHOICE BASED CREDIT SYSTEM

I - IV SEMESTERS CURRICULA AND SYLLABI

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MA5159	Advanced Applied Mathematics	FC	3	1	0	4	4
2.	MD5101	Human Anatomy and Physiology	PCC	3	0	0	3	3
3.	MD5102	Biomedical Instrumentation	PCC	3	0	0	3	3
4.	MD5103	Biosignal Processing	PCC	3	0	0	3	3
5.	MD5104	Medical Equipment	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.	MD5111	Biomedical Instrumentation Laboratory	PCC	0	0	4	4	2
9.	MD5112	Biosignal Processing Laboratory	PCC	0	0	4	4	2
			TOTAL	19	1	8	28	22

* Audit Course is optional

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MD5201	Medical Image Processing	PCC	3	0	0	3	3
2.	MD5076	Medical Embedded Systems	PCC	3	0	0	3	3
3.	MD5202	Medical Imaging Systems and Radio Therapy	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.	MD5211	Medical System Design and Analysis Laboratory	PCC	0	0	4	4	2
8.	MD5212	Medical Image Processing Laboratory	PCC	0	0	4	4	2
9.	MD5213	Mini Project with Seminar	PCC	0	0	4	4	2
			TOTAL	**17**	**0**	**12**	**29**	**21**

* Audit Course is optional

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			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	OEC	3	0	0	3	3
PRACTICALS								
4.	MD5311	Hospital Training	EEC	0	0	0	0	2
5.	MD5312	Dissertation I	EEC	0	0	12	12	6
			TOTAL	**9**	**0**	**12**	**21**	**17**

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SEMESTER IV

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	MD5411	Dissertation II	EEC	0	0	24	12	12
			TOTAL	**0**	**0**	**24**	**12**	**12**

TOTAL NO. OF CREDITS: 72

FOUNDATION COURSES (FC)

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	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	CATEGORY	L	T	P	CONTACT PERIODS	CREDITS
1.	MD5101	Human Anatomy and Physiology	PCC	3	0	0	3	3
2.	MD5102	Biomedical Instrumentation	PCC	3	0	0	3	3
3.	MD5103	Biosignal Processing	PCC	3	0	0	3	3
4.	MD5104	Medical Equipment	PCC	3	0	0	3	3
5.	MD5201	Medical Image Processing	PCC	3	0	0	3	3
6.	MD5076	Medical Embedded Systems	PCC	3	0	0	3	3
7.	MD5202	Medical Imaging Systems and Radio Therapy	PCC	3	0	0	3	3
8.	MD5111	Biomedical Instrumentation Laboratory	PCC	0	0	4	4	2
9.	MD5112	Biosignal Processing Laboratory	PCC	0	0	4	4	2
10.	MD5211	Medical System Design and Analysis Laboratory	PCC	0	0	4	4	2
11.	MD5212	Medical Image Processing Laboratory	PCC	0	0	4	4	2
12.	MD5213	Mini Project with Seminar	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	CREDITS
1.	MD5001	Advances in Electronics Applied to Hospital Engineering	PEC	3	0	0	3	3
2.	MD5074	Brain Computer Interface	PEC	3	0	0	3	3
3.	BO5251	Health Care, Hospital and Equipment Management	PEC	3	0	0	3	3
4.	MD5002	Human Assist Devices	PEC	3	0	0	3	3
5.	MD5003	Medical Informatics	PEC	3	0	0	3	3
6.	MD5004	Wavelet Transforms and its Applications	PEC	3	0	0	3	3
7.	BO5071	Biomaterials	PEC	3	0	0	3	3
8.	BO5072	Biomechanics	PEC	3	0	0	3	3
9.	BO5252	Rehabilitation Engineering	PEC	3	0	0	3	3
10.	MD5071	Advanced Neural Computing	PEC	3	0	0	3	3
11.	MD5081	Neuroscience and Neural Engineering	PEC	3	0	0	3	3
12.	MD5072	Bio MEMS	PEC	3	0	0	3	3
13.	MD5075	Computer Based Medical Instrumentation	PEC	3	0	0	3	3
14.	MD5077	Medical Ethics and Standards	PEC	3	0	0	3	3
15.	MD5078	Medical Optics	PEC	3	0	0	3	3
16.	MD5080	Nanomedicine Principles and Applications	PEC	3	0	0	3	3
17.	MD5082	Pattern Recognition Techniques and Applications	PEC	3	0	0	3	3
18.	MD5083	Physiological Systems Modeling and Simulation	PEC	3	0	0	3	3
19.	MD5084	Principles of Genetic Analysis	PEC	3	0	0	3	3
20.	MD5085	Telehealth Technology	PEC	3	0	0	3	3
21.	MD5086	Tissue Engineering	PEC	3	0	0	3	3
22.	MD5087	Ultrasound Principles and Applications in Medicine	PEC	3	0	0	3	3
23.	MD5088	Wearable Body Area Networks	PEC	3	0	0	3	3
24.	MD5073	Biomedical Product Design and Development	PEC	3	0	0	3	3
25.	MD5079	Medical Robotics	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	CREDITS
1.	MD5311	Hospital Training	EEC	0	0	0	0	2
2.	MD5312	Dissertation I	EEC	0	0	12	12	6
3.	MD5411	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.

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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.

MD5101	HUMAN ANATOMY AND PHYSIOLOGY	L T P C
		3 0 0 3

OBJECTIVES:
- To understand basics of Human Anatomy and Physiology.
- To study the organs and systems involved in body functions.
- To apply this knowledge into Biomedical Engineering field.

UNIT I   INTRODUCTION TO HUMAN BODY   8

Organization of human body, tissue and cavities – Anatomical planes, positions and sections - Cell: Structure and organelles structure – Functions of Each components in the cell. Cell membrane Transport, Resting membrane potential and ionic basis of potentials, Recording of Action potentials, Homeostasis.

UNIT II   MUSCULOSKELETAL SYSTEM   8

Skeletal System: Bones, types and functions - Axial and Appendicular Skeleton. Joints: Definition, Types and functions. Cartilage: An overview - types and functions. **Muscular System:** Types of Muscle - Skeletal Muscle structure - Action potential and functions - Skin and Appendages.

UNIT III   RESPIRATORY, GASTROINTESTINAL AND URINARY SYSTEM   10

GI Tract: Organization of GI tract – Mouth, Pharynx, Esophagus, Stomach, Small Intestine and Large Intestine - Accessory Organs: Salivary glands, Liver, Pancreas, Gall bladder, Teeth and Tongue. **Respiratory System:** The Nose, Pharynx, Larynx, Trachea, Primary Bronchi, Lungs – Mechanism of Breathing – Respiratory Volumes and Measurements. **Urinary System:** Structure of Kidney, Nephron, Ureter and Urinary bladder. Urine formation and Micturition reflex- Homeostasis and blood pressure regulation by urinary system.

UNIT IV   CARDIOVASCULAR, LYMPHATIC AND ENDOCRINE SYSTEM   9

Cardiovascular System: Blood vessel, Types and internal structure - Cardiac Muscle: Structure and Action potential – Structure and Components of Heart - Conducting System of Heart – Heart Sounds – Blood Pressure. **Lymphatic System:** Lymphatic vessel – Lymph fluid – Lymph nodes - **Endocrine System:** Hormones – Anterior and Posterior Pituitary Gland Hormones.

UNIT V   NERVOUS SYSTEM AND SPECIAL SENSES   10

Organization of Nervous system: Structure, Types and Properties of Neurons - Neuroglial Cells – Central Nervous System and Peripheral Nervous System organization – Brain, Lobes and Cortical Areas – Spinal cord – Spinal tract and Spinal nerve formation - Autonomic Nervous System: Divisions and control on each system - Reflex Mechanism. **Special Senses:** Structure of Eye and Ear.

TOTAL: 45 PERIODS

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COURSE OUTCOMES:
By successfully completing this course, students will be able to:
CO1 Describe and explain specific parts and key terms applied in anatomy and physiology
CO2 Describe important physiological mechanisms involved in cell, tissue, and organ
CO3 Understand organisation and functions of each organs and systems in human body
CO4 To explain mechanisms in human body
CO5 Describe physiological modifications and changes in human system.

REFERENCES:
1. Elaine.N. Marieb, "Essential of Human Anatomy and Physiology", Eight edition, Pearson Education New Delhi, 2007.
2. Gillian Pocock, "Christopher D. Richards, "The Human Body An introduction for Biomedical and Health Sciences", 1st Edition, Oxford University Press, USA, 2009.
3. William F. Ganong,"Review of Medical Physiology, 22nd edition, Mc Graw Hill New Delhi
4. Eldra Pearl Solomon. "Introduction to Human Anatomy and Physiology", W.B.Saunders Company, 2003.
5. Gary A. Thibodeau, Kevin T.Patton, Anatomy & Physiology, 7th Edition, Mosby Publisher 2009.
6. The Human Body, Gillian Pocock & Christopher D.Richards, Oxford University Press, 2009.
7. Guyton, Text book of Medical Physiology – WB Jaunder company Philadelphia 10th edition 2002
8. 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	✓	✓			✓	✓

MD5102	**BIOMEDICAL INSTRUMENTATION**	**L T P C**
		3 0 0 3

OBJECTIVES:
- To know the various functional blocks present in biosignal acquisition system
- To understand the various biosignal characteristics and recording methods.
- To gain knowledge about the nonelectrical parameters measurement.
- To study about the biochemical measurements and biosensors.

UNIT I   BIOMEDICAL TRANSDUCERS AND AMPLIFIERS   9
Categories and Characteristics of Transducer, Signal conditioning units. Origin of Biopotential, half-cell potential, polarization effects. Different types of electrode and its equivalent circuits. Differential amplifier. Bioamplifier – Characteristics - Instrumentation amplifier - active filter. Isolation Amplifier, Chopper amplifier, Carrier Amplifier. Multichannel data acquisition system, various types of recorders.

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UNIT II BIOPOTENTIAL RECORDING 9

ECG, EEG, EMG, PCG, EOG, ERG lead system, block diagram and recording methods, typical waveform, frequency spectrum, abnormal waveform, artifacts and its removal, Design of Bioamplifier. Introduction to Wearable Technology in healthcare - Design challenges, smart wearable sensors, smart wearable textiles.

UNIT III NON ELECTRICAL PARAMETER MEASUREMENTS 9

Respiration rate, Pulse rate, Temperature, Blood Pressure, Pulse oximetry, Respiratory volume measurement, BMR measurement, Plethysmography technique, Detection of various physiological parameters using impedance technique. Case Study – Design of instrumentation for non-electrical parameters.

UNIT IV BLOOD FLOW METER AND BLOOD CELL COUNTER 9

EM and ultrasonic blood flow meters, Indicator dilution method, Dye dilution, Thermodilution method. Manual and Automatic Counting of RBC, WBC and Platelets.

UNIT V BIO-CHEMICAL MEASUREMENTS & BIOSENSORS 9

pH, pCO_2, pO_2 and electrophoresis, colorimeter, spectrophotometer, flame photometer, auto analyser. Biosensors - Ion Selective Field Effect Transistor (ISFET), Immunologically sensitive FET (IMFET). Blood glucose sensors - Continuous glucose monitoring and closed-loop systems. e-Nose. Case study.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
By the completion of this course the student will to

- **CO1** Design bioamplifiers.
- **CO2** Record and analyze the various biosignals.
- **CO3** Measure various vital and non-electrical parameters.
- **CO4** Obtain the blood cell counts and measure blood flow velocity
- **CO5** Perform biochemical measurement.

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				✓	✓	

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MD5103	**BIOSIGNAL PROCESSING**	**L T P C**
		3 0 0 3

OBJECTIVES:
- To introduce the characteristics of different biosignals
- To discuss linear and non-linear filtering techniques to extract desired information
- To introduce techniques for automated classification and decision making to aid diagnosis

UNIT I   SIGNAL, SYSTEM AND SPECTRUM   9
Characteristics of some dynamic biomedical signals, Noises- random, structured and physiological noises. Filters- IIR and FIR filters. Spectrum – power spectral density function, cross-spectral density and coherence function, cepstrum and homomorphic filtering. Estimation of mean of finite time signals.

UNIT II   TIME SERIES ANALYSIS AND SPECTRAL ESTIMATION   9
Time series analysis – linear prediction models, process order estimation, non-stationary process, fixed segmentation, adaptive segmentation, application in EEG, PCG and HRV signals, model based ECG simulator. Spectral estimation – Blackman Tukey method, periodogram and model based estimation. Application in Heart rate variability, PCG signals,

UNIT III   ADAPTIVE FILTERING AND WAVELET DETECTION   9
Filtering – LMS adaptive filter, adaptive noise canceling in ECG, improved adaptive filtering in FECG, EEG and other applications in Biosignals, Wavelet detection in ECG – structural features, matched filtering, adaptive wavelet detection, detection of overlapping wavelets.

UNIT IV   BIOSIGNAL CLASSIFICATION AND RECOGNITION   9
Signal classification and recognition – Statistical signal classification, linear discriminant function, direct feature selection and ordering, Back propagation neural network based classification. Application in Normal versus Ectopic ECG beats and other Biomedical applications

UNIT V   TIME FREQUENCY AND MULTIVARIATE ANALYSIS   9
Time frequency representation, spectrogram, Time-scale representation, scalogram, wavelet analysis – Data reduction techniques, ECG data compression, ECG characterization, Feature extraction- Wavelet packets, Multivariate component analysis-PCA, ICA.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon the completion of this course, the students are able
- **CO1**   To analyse the different types of signals & systems
- **CO2**   To analyse signals in time series domain & estimate the spectrum
- **CO3**   To demonstrate the significance of wavelet detection applied in biosignal processing.
- **CO4**   To perform classification of biosignals.
- **CO5**   To extract the features using multivariate component analysis.

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. Emmanuel C. Ifeachor, Barrie W.Jervis, Digital Signal processing- A Practical Approach, Pearson education Ltd., 2nd Edition, 2002
5. Raghuveer M. Rao and Ajith S.Bopardikar, Wavelets transform – Introduction to theory and its applications, Pearson Education, India 2000.

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

MD5104 **MEDICAL EQUIPMENT** **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 **CARDIAC CARE UNIT** **9**

Pacemakers – Need, different types, electrode types and placement, batteries for pacemakers, Design. AC defibrillators, DC defibrillators - asynchronous and synchronous, Types of waveforms, electrode types and placement, precautions, Patient monitoring system. Case study.

UNIT II **NEUROLOGY EQUIPMENT** **9**

Evoked response - Auditory, Visual and Somatosensory, Depth recording, Stereotaxy, EEG controlled Anesthetic monitor, Biofeedback equipment, Spinal reflex Measurement, Transcutaneous nerve stimulator. Case study.
Introduction to Brain Computer Interface-Need, types, Event Related Potential, P300, Mu rhythm, ERD/ERS, Rehabilitation applications of BCI - External device controllers, Functional restoration using Neuroprosthesis - Functional Electrical Stimulation. Case study.

UNIT III **PHYSIOTHERAPY AND DIATHERMY EQUIPMENT** **9**

Physiological effects of HF radiation, Depth of Penetration, short wave, Ultrasonic and microwave diathermy, Surgical diathermy, Galvanic, Faradic Stimulators, Interferential therapy, Electrical safety-IEC-60601 standard, Physiological effects of current, Leakage current, Micro and macro electric shock, GFI units, Earthing Scheme, Electrical safety Analyzer.

UNIT IV **FIBER OPTICS AND LASER APPLICATIONS** **9**

Fiber optic cables- Principles, Types. Principles of Laser action, Different types- CO_2, Nd-YAG, Argon, Helium-Neon, Clinical applications of laser, Endoscopy, Laparoscopy.

UNIT V **RECENT TRENDS** **9**

Principles of cryogenic Technique and application, Thermograph- Principle, sensors, system and applications. Bio telemetry- Need, Frequency selection, Modulation schemes, Single channel, Multichannel, Multipatient telemetry, principles of Lithotripsy. Fluorescence imaging – FLIM and applications. Applications of IoT in Healthcare.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
On completion of this course the student will be able to:
- **CO1** Describe the working of pacemakers and defibrillator and related circuits.
- **CO2** Obtain the domain knowledge of Neurological equipment and the application of these for BCI based rehabilitation application
- **CO3** Understand the application of physiotherapy equipment and Laser equipment
- **CO4** Identify the electrical hazards in the hospital environment and make it shock free zone
- **CO5** Discuss the recent trends in field of diagnostic and therapeutic equipment

REFERENCES:
1. Albert M Cook and Webster J G – Therapeutic medical devices Prentice Hall New York 1982
2. Khandpur R.S, Handbook of Biomedical Instrumentation, Tata McGraw Hill, New Delhi, 3rd Edition, 2014.
3. Leslie Cromwell, Fred J.Weibell and Erich A.Pfeiffer - Biomedical Instrumentation Prentice Hall New Delhi 2000
4. Jacobson B and Webster J G Medical and Clinical Engineering – Prentice Hall of India New Delhi 1999.
5. Wolbasrsht.M. L, Laser Application in Medicine and Biology plenum press New York, 1989.
6. Heinz Kresse – Handbook of Electro medicine. John Wiely & Sons – Chrchester – 1989.

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

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

PROGRESS THROUGH KNOWLEDGE

OBJECTIVES:
To impart knowledge and skills required for research and IPR:
- Problem formulation, analysis and solutions.
- Technical paper writing / presentation without violating professional ethics
- Patent drafting and filing patents.

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   LITERATURE REVIEW   6
Effective literature studies approaches, analysis, plagiarism, and research ethics.

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UNIT III TECHNICALWRITING /PRESENTATION 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 INTRODUCTION TO INTELLECTUAL PROPERTY RIGHTS (IPR) 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, IPR of Biological Systems, Computer Software etc.
Traditional knowledge Case Studies, IPR and IITs.

TOTAL: 30 PERIODS

OUTCOMES:
1. Ability to formulate research problem
2. Ability to carry out research analysis
3. Ability to follow research ethics
4. Ability to understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity
5. Ability to understand about IPR and filing patents in R & D.

	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

MD5111 **BIOMEDICAL INSTRUMENTATION LABORATORY** **L T P C**
0 0 4 2

OBJECTIVES:
- To understand the design of Bioamplifier and to analyze its characteristics.
- To understand the performance of surgical diathermy.
- To gain knowledge about the measurement of the vital and non-electrical parameters
- To develop an understanding of the Medical equipment.

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LIST OF EXPERIMENTS
1. Design and analysis of bioamplifier using circuit simulation tools.
2. Design of instrumentation amplifier using Opamp and single IC
3. Design of bioamplifier for acquiring biosignals.
4. Recording of ECG in standard lead systems.
5. Recording and analysis of Electromyogram signals.
6. Recording of EEG signal.
7. Measurement of respiratory parameters using spirometer
8. Plotting of human auditory response using audiometer.
9. Performance and testing of surgical diathermy unit using diathermy analyser.
10. Measurement of blood flow velocity using ultrasound technique.
11. Measurement of Vital parameters using patient monitoring system and biotelemetry.
12. Electrical safety testing of medical equipment.
13. Study of different types of muscle stimulator waveforms.
14. Study of multi parameter simulator.

TOTAL: 60 PERIODS

COURSE OUTCOMES:
Upon the completion of this course, the students are able to
CO1 Design, record and analyze the various biosignals.
CO2 Perform the measurement of various vital and non-electrical parameters.
CO3 Perform testing of surgical diathermy
CO4 Perform electrical safety test of medical equipment.
CO5 Identify the auditory level of humans.
CO6 Demonstrate the function of medical equipment.

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1		✓		✓	✓	
CO2		✓	✓	✓		
CO3		✓	✓	✓		
CO4		✓				✓
CO5		✓		✓		
CO6		✓	✓			

MD5112   **BIOSIGNAL PROCESSING LABORATORY**   **L T P C**
                                                                  0 0 4 2
OBJECTIVES:
- To understand the analysis of biosignals
- To know the various methods for denoising of biosignals.
- To understand the extraction of features in biosignals
- To gain knowledge about biosignal compression.
- To detect and classify the abnormalities in biosignals.

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LIST OF EXPERIMENTS

1. Preprocessing of Biosignals
2. QRS detection using Pan-Tompkins algorithm in ECG signals.
3. Heart rate variability analysis in ECG signals.
4. Development of algorithm for ECG arrhythmia detection.
5. Band separation and spectrum of EEG signals
6. Autoregressive modelling of biosignals.
7. Feature extraction in EMG signals
8. Noise cancellation using Adaptive filters.
9. Denoising of Biosignals using wavelets
10. Biosignal analysis in virtual instrumentation platform.
11. Biosignal compression.
12. Feature extraction and dimensionality reduction using PCA.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

Upon the completion of this course, the students are able to

CO1 Develop algorithms for preprocessing of Biosignals.
CO2 Perform denoising and also analyze the spectral characteristics of Biosignals.
CO3 Implement feature extraction and classification techniques.
CO4 Perform biosignal compression.
CO5 Analyze the biosignals in virtual instrumentation platform.

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

PROGRESS THROUGH KNOWLEDGE

MD5201   **MEDICAL IMAGE PROCESSING**   **L T P C**
                                                          3 0 0 3

OBJECTIVES:

- To provide information about various medical imaging modalities
- To understand the basic concepts of image enhancement, image restoration, morphological image processing, image segmentation, feature recognition in medical images
- To provide information about classification and image visualization in medical image processing projects
- To familiarize the student with the image processing facilities in Matlab and its equivalent open source tools

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UNIT I FUNDAMENTALS OF IMAGE PROCESSING 9
Image perception, MTF of the visual system, Image fidelity criteria, Image model, Image sampling and quantization – two dimensional sampling theory, Image quantization, Optimum mean square quantizer, Image transforms – 2D-DFT and other transforms.

UNIT II BIO-MEDICAL IMAGE PREPROCESSING 9
Image Enhancement operations – Image noise and modeling, Image restoration – Image degradation model, Inverse and Wiener filtering, Geometric transformations and correction.

UNIT III MEDICAL IMAGE RECONSTRUCTION 9
Mathematical preliminaries and basic reconstruction methods, Image reconstruction in CT scanners, MRI, fMRI, Ultrasound imaging. 3D Ultrasound imaging, Nuclear Medical Imaging modalities – SPECT, PET, Molecular Imaging.

UNIT IV IMAGE ANALYSIS AND CLASSIFICATION 9
Image segmentation- pixel based, edge based, region based segmentation. Active contour models and Level sets for medical image segmentation, Image representation and analysis, Feature Extraction and Representation-Statistical, Shape, Texture features. Statistical and Neural Network based image classification.

UNIT V IMAGE REGISTRATIONS AND VISUALIZATION 9
Image Registration: Rigid body transformation – Affine transformation, Principal axes registration, Iterative principal axes registration, Feature based registration, Elastic deformation based registration, Registration of Images from Different modalities, Evaluation of Registration Methods. **Image visualization**: 2-D display methods, 3-D display methods, surface and volume based 3-D display methods – Surface Visualization and Volume visualization, 3-D Echocardiography, 3D+time Echocardiography, virtual reality based interactive visualization.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon Completion of the course, the students should be able to:

- **CO1** Implement basic medical image processing algorithms
- **CO2** Image pre-processing applications that incorporates different concepts of filters for medical Image Processing
- **CO3** Knowledge about medical imaging and reconstruction for high dimensionality visualization
- **CO4** Analysis of image segmentation, feature extraction and image classification
- **CO5** Explore the knowledge in image registration and visualization and possibility of applying Image processing concepts in modern hospitals

REFERENCES:

1. Atam P.Dhawan, Medical Image Analysis, 2nd Edition, John Wiley & Sons, Inc., Hoboken, New Jersey, 2011.
2. Rafael C.Gonzalez and Richard E.Woods, Digital Image Processing, 4th Edition, Pearson Education, 2018.
3. Anil K Jain, Fundamentals of Digital Image Processing, 1st Edition, Pearson Education India, 2015.
4. Geoff Dougherty, Digital Image Processing for Medical Applications, 1st Edition, Cambridge University Press, 2010.

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5. Jerry L.Prince and Jonathan M.Links, Medical Imaging Signals and Systems, 2nd Edition, Pearson Education, 2014.
6. Kavyan Najarian and Robert Splerstor, Biomedical signals and Image processing, 2nd Edition, CRC Press, 2012.
7. Ravikanth Malladi, Geometric Methods in Bio-Medical Image Processing (Mathematics and Visualization), 1st Edition, Springer-Verlag Berlin Heidelberg 2002.
8. A. Ardeshir Goshtasby, Image Registration Principles, Tools and Methods (Advances in Computer Vision and Pattern Recognition), Springer 2014.
9. Joseph V. Hajnal, Derek L.G. Hill and David J. Hawkes, Medical Image Registration, CRC Press, 2001.

COURSE OUTCOMES	PROGRAM 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.

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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 Edistion, 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		✓	✓	✓	✓	

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MD5202	**MEDICAL IMAGING SYSTEMS AND RADIO THERAPY**	**L T P C**
		3 0 0 3

OBJECTIVES:
- To study the production of x-rays and its application in medical imaging.
- 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 understand the Radiation therapy techniques and also Radiation safety.

UNIT I   X – RAYS AND COMPUTED TOMOGRAPHY   9

Principle and production of X – Rays, Selection of anodes, heel pattern, Scattered Radiation, Porter-Bucky systems, Digital Radiography, principles of Angiography and Fluoroscopic Techniques, Image Intensifiers, digital subtraction angiography, mammography, dental X- ray units. Computerised Axial Tomography, Principle, Detectors, image reconstruction, Spiral CT, 3D Imaging.

UNIT II   EMISSION IMAGING   9

Alpha, Beta, Gamma Emission, different types of Radiation Detectors, G.M. & Proportional Counters, Pulse Height Analyzers, Isotopic, Scanners, Principle of PET and SPECT, PET/CT.

UNIT III   MAGNETIC RESONANCE IMAGING   9

Principle of MRI, Relaxation processes and their measurements, Pulse sequencing and MR image acquisition, MRI instrumentation, Magnets, gradient coils, Imaging Different Sections of the Body, Tissue Characterization, MR Spectroscopy, Functional MRI.

UNIT IV   ULTRASOUND IMAGING AND THERMOGRAPHY   9

Wave propagation and interaction in Biological tissues, Acoustic radiation fields, continuous and pulsed excitation, Transducers and imaging systems, Scanning methods, Imaging Modes-A, B & M, Principles and theory of image generation. Thermography- Principle, detectors and applications.

UNIT V   THERAPY USING X – RAYS AND ISOTOPES   9

Direct and Indirect effects of high energy radiation, Units for radiation Exposure, Depth Dose curves, Linear Accelerator Betatron, Cobalt and Cesium Therapy, Computation of Absorbed Dose Level, Automatic Treatment Planning, ICRP regulation, Hazardous Effects of Radiation, Radiation measuring units, Allowed Levels, Protection Methods.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
On completion of this course the student will be able to:
- **CO1** Discuss the principle and working of various radiography and tomography concept and image reconstruction techniques.
- **CO2** Explain the concept of nuclear imaging techniques and radiation detectors
- **CO3** Describe the basic principle and working of Magnetic resonance imaging technique.
- **CO4** Describe the basic principle involved in Ultrasound Imaging technique and Thermography.
- **CO5** Discuss the effects of radiation, radiation safety and the principle of Radio therapy techniques.

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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. Alexander, Kalender and Linke, Computed Tomography: Assessment Criteria, Ct System Technology, Clinical Applications, John Wiley, Chichster, 1986.
4. Steve Webb, The Physics of Medical Imaging, Adam Hilger, Philadelpia,1988.
5. Peggy. W, Roger.D.Ferimarch, MRI for Technologists, 2nd Edition, Mc Graw Hill Medical, New York, 2000.
6. Donald Graham, Paul Cloke, Martin Vosper, Principles of Radiological physics, Churchill Livingston, 6th Edition, 2011.
7. 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.
8. Jerry L.Prince and Jnathan 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			✓	✓	✓	✓

MD5211   **MEDICAL SYSTEM DESIGN AND ANALYSIS LABORATORY**   **L T P C**
                                                                          0 0 4 2

OBJECTIVES:
- To develop the ability of designing m-health platform for acquisition of biosignals
- To develop the ability of acquiring, processing, and analyzing the biosignals.
- To study practically the concepts of physiological modeling.

LIST OF EXPERIMENTS
1. Monitoring of ECG signal in m-health platform.
2. Design of real time heart rate measurement system.
3. Preprocessing of medical images using FPGA.
4. Cardiovascular modelling
5. Simulation of musculoskeletal model
6. Design of sensors and actuators using MEMS software

TOTAL: 60 PERIODS

COURSE OUTCOMES:
On completion of this course the student will be able to:
- **CO1** Apply the knowledge of science and engineering to solve a given medical system design.
- **CO2** Design and conduct experiments, as well as to analyze and interpret data
- **CO3** Model any of the physiological system.
- **CO4** Develop medical devices in m-health platform.
- **CO5** Implement image processing algorithm in FPGA.

Attested

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

MD5212   **MEDICAL IMAGE PROCESSING LABORATORY**   **L T P C**
                                                          0 0 4 2

OBJECTIVES:

- To enhance the medical images by applying various filters.
- To segment the region of interest using various image processing algorithms
- To acquire software programming skills for processing of medical images using Python and OpenCV
- To provide an appreciation of how medical image analysis contributes to current practice and research in medical imaging.

The following experiments should be performed in OpenCV / Python / Scilab / Matlab Octave / other Open source software.

LIST OF EXPERIMENTS
1. Preprocessing of medical images.
2. Filtering of medical images.
3. Edge detection using Python
4. Analysis of medical images using DWT
5. Segmentation of ROI in medical images.
6. Feature extraction in medical images
7. Steganography using OpenCV.
8. Medical Image Compression techniques.
9. Medical image registration.
10. Medical image fusion.
11. Statistical analysis of features.
12. Neural network based classification.
13. Study of DICOM standards.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

  CO1 Develop algorithm for enhancement of medical images.
  CO2 Extract the region of interest from medical images.
  CO3 Develop an image processing algorithm which combines a range of image processing operations to solve a given medical image task
  CO4 Develop an image registration and fusion algorithm for medical images
  CO5 Design algorithm to Extract, analyze and classify various features from medical images

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

MD5001   ADVANCES IN ELECTRONICS APPLIED TO HOSPITAL ENGINEERING   L T P C
                                                                     3 0 0 3

OBJECTIVES:
- To study about the aspects of clinical engineering
- To study about the various aspects of electronics used in hospitals

UNIT I   CLINICAL ENGINEERING   9
Role of clinical engineer- Procurement of equipment in the hospital, Equipment control and asset management. Need for Standardization, Medical standards and recalibration, Hospital design, Hospital safety Regulations, hospital Management and Legal aspects.

UNIT II   NETWORKING   9
Importance of networking, Types of networking, LAN features, network topologies, LAN components, network operating system, basic data communication concept, application, LAN and multi-user system, planning and installing LAN in hospital set up, PACS. Introduction about Wireless Medical Telemetry Service

**UNIT III   FIBRE OPTIC SENSORS FOR MEASURING PHYSIOLOGICAL
               PARAMETERS   9**
Different optical sources, optical detectors, principle of fiber optic cables, single mode, multi-mode, step index and graded index type, sensors based on polarisation, interferometer principle, magnetic sensors, application of the sensors in measuring pressure, temperature, flow, rotation and chemical activities, principles of smart sensors.

UNIT IV   EMI AND EMC APPLIED TO HOSPITAL EQUIPMENTS   9
Principles of EMI, sources of EMI, effects of EMI on medical devices, computation of EMI, measuring techniques to quantify the level of interference, method of suppressing and isolating the unit from interference.

UNIT V   VIRTUAL REALITY APPLICATION   9
Need for virtual reality in medicine, Basic concepts and types of Virtual Environment, Human Factors and Human Perception, Computer graphics principles used in VR, Modeling of a Virtual Environment Existing tools, Avatars, Sensors for Perception, Tracking, Camera, Head mount display used in VR, Applications of Virtual Reality in Medicine

                                                              TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the student will be able to:
- **CO1** Know the role and importance of clinical engineer in the management of the hospital
- **CO2** Know the importance of calibration of medical devices
- **CO3** Specify the type of networking facility to be provided in the hospital
- **CO4** Identify the electromagnetic effects on medical devices and to make the devices electromagnetically compatible
- **CO5** Specify the type of optic sensor for physiological measurement

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REFERENCES:
1. Syed Amin Tabish, Hospital and Health Services Administration Principles and Practices, Oxford Press New Delhi 2001
2. Jacob Kline – Handbook of Biomedical Engineering Academe press INC Sandiego 1981.
3. Bernhard Keiser, Principles of Electromagnetic Compatibility, Artech House, 3rd Edition, 1986.
4. Eric Udd, Fibre Optic Sensors and introduction for engineers and scientists, Wiley Interscience Publication, New Delhi, 1991.
5. SK Basandia, Local Area Network, Golgotia Publishing Pvt. Ltd., New Delhi, 1995
6. R.C.Goyal, Hospital administration and human resource management, 4th edition, Prentice Hall of India, New Delhi, 2006.
7. Roberto Miniati, Ernesto Iadanza,Fabrizio Dori, Clinical Engineering from devices to systems, 1st Edition, Academic Press, 2013

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

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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. Jonathan Wolpaw, Elizabeth Winter Wolpaw, BrainComputer 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 Recognitionll, 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

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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.

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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		✓	✓	✓	✓	✓

MD5002 **HUMAN ASSIST DEVICES** **L T P C**
3 0 0 3

OBJECTIVES:
The objective of this to know the principle, design and application of various human assist devices which includes extracorporeal devices, artificial heart, cardiac assist devices, respiratory devices and hearing aids. Additionally, a brief introduction to design aspects of prosthetic and orthotic devices for the disability will be given.

UNIT I   HEART LUNG MACHINE AND ARTIFICIAL HEART   9
Condition to be satisfied by the H/L System. Different types of Oxygenators, Pumps, Pulsatile and Continuous Types, Monitoring Process, Shunting, The Indication for Cardiac Transplant, Driving Mechanism, Blood Handling System, Functioning and different types of Artificial Heart, Mock test setup for assessing its functions

UNIT II   CARDIAC ASSIST DEVICES   9
Synchronous Counter pulsation, Assisted through Respiration Right Ventricular Bypass Pump, Left Ventricular Bypass Pump, Open Chest and closed Chest type, Intra-Aortic Balloon Pumping Veno Arterial Pumping, Prosthetic Cardio Valves, Principle and problem, Biomaterials for implantable purposes, its characteristics and testing.

UNIT III   ARTIFICIAL KIDNEY   9
Indication and Principle of Haemodialysis, Membrane, Dialysate, Different types of heamodialysers, Monitoring Systems, Wearable Artificial Kidney, Implanting Type.

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UNIT IV   PROSTHETIC AND ORTHOTIC DEVICES   9

Spinal orthotics and Prosthesis, Splint – Static and Dynamic. Hand and Arm Replacement - Different Types of Models Externally Powered Limb Prosthesis, Lower Limb and Upper limb orthotic devices, Functional Electrical Stimulation, Sensory Assist Devices, Materials for Prosthetic and orthotic devices, Haptic Devices

UNIT V   RESPIRATORY AND HEARING AIDS   9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- **CO1** Knowledge about the importance of Heart lung machine and artificial Heart.
- **CO2** Knowledge about the importance of different types of assist devices and related issues.
- **CO3** Understand about the implantation of artificial kidney
- **CO4** Explore the different types of models for Prosthethic and orthotic purpose
- **CO5** Perceive the knowledge in different types of respiratory and hearing aids

REFERENCES:

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

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

MD5003   **MEDICAL INFORMATICS**   **L T P C**
                                                                3 0 0 3

OBJECTIVES

- To develop in-depth understanding of Medical Informatics(MI), its goals, standards, applications, and uses in demanding clinical environment
- To identify and solve MI problems in the best possible ways; build, run and optimize complex healthcare processes
- To do MI research

UNIT I   INTRODUCTION   9

Historical highlights and Evolution, Hospital Information System (HIS) – its characteristics and functional online and offline modules, Health Informatics, Medical Informatics and its six levels of interfaces - Hardware and software requirements, Radiological Information Systems (RIS), Picture Archiving and Communication System (PACS), Integrating the Healthcare Enterprise (IHE)

UNIT II   MEDICAL DATA AND STANDARDS   9

Electronic Patient Record (EPR) - Integrated Clinical Multimedia data - Biosignal and Medical image formats - Medical data storage and retrieval techniques – Steganography - Medical Standards –   HL7 – DICOM - IRMA - LOINC - ICD10 – HIPPA - IEEE 1073 – IEC standards - Medical standard organizations

UNIT III   VIRTUAL REALITY APPLICATIONS IN MEDICINE   9

Modeling and simulation, Clinical modeling and performance optimization, Virtual Reality applications in medicine, Visualization as tools for diagnosis and therapy

UNIT IV   e – HEALTH SERVICES   9

Patient flow analysis, Scheduling problems, Workflow integration, User interfaces in health care, Health Grid, Big Data in hospitals, Networking and e-Health services, Fault-tolerance, scalability, and robustness, Security and confidentiality in medicine, Clinical decision support, Clinical software development, Medical startups

UNIT V   INTERNET AND WEB   9

Java script programming – PHP - Design of Web portal – Development of e-Health services with few case studies

TOTAL: 45 PERIODS

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

- **CO1** Develop in-depth understanding of Medical Informatics(MI), its goals, standards, applications, and uses in demanding clinical environment
- **CO2** Identify and solve problems in the best possible ways; build, run and optimize complex healthcare processes
- **CO3** Gain sufficient knowledge in modeling and simulation for medical applications.
- **CO4** Acquired a conceptual and theoretical framework of the design, development, and implementation of Medical information systems.
- **CO5** Programming skills in Java and script languages

INSTRUCTION

Lectures, Project work in groups, Guest lectures, Study visits, Tutoring of group work

REFERENCES:

1. Ramachandra Lele, Computers in Medicine Progress in Medical Informatics, Tata McGraw Hill Publishing Company, New Delhi, 2005
2. Mohan Bansal M S, Medical Informatics, Tata McGraw Hill Publishing Company, New Delhi, 2005
3. Shortliffe et al., BIOMEDICAL INFORMATICS, Computer Applications in Health Care and Biomedicine, (Third Edition), Springer-Verlag, 2006.

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

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MD5004   **WAVELET TRANSFORMS AND ITS APPLICATIONS**   **L T P C**
                                                                   3 0 0 3

OBJECTIVES:
- To introduce the fundamentals concepts of wavelet transforms.
- To study system design using Wavelets
- To learn the different wavelet families & their applications.

UNIT I   INTRODUCTION TO WAVELETS   9
Introduction to Multirate signal processing- Decimation and Interpolation, Quadrature Mirror Filters, Subband coding, Limitations of Fourier transform, Short time Fourier transform and its drawbacks, Continuous Wavelet transform, Time   frequency representation, Wavelet System and its characteristics, Orthogonal and Orthonormal functions and function space

UNIT II   MULTIRESOLUTION CONCEPT AND DISCRETE WAVELET
**   TRANSFORM   9**
Multiresolution formulation of wavelet systems- signal spaces, scaling function, wavelet function and its properties, Multiresolution analysis, Haar scaling and wavelet function, Filter banks- Analysis and Synthesis, 1D and 2D Discrete wavelet transform, Wavelet Packets, Tree structured filter bank, Multichannel filter bank, Undecimated wavelet transform.

UNIT III   WAVELET SYSTEM DESIGN   9
Refinement relation for orthogonal wavelet systems, Restrictions on filter coefficients, Design of Daubechies orthogonal wavelet system coefficients, Design of Coiflet and Symlet wavelets.

UNIT IV   WAVELET FAMILIES   9
Continuous Wavelets- Properties of Mexican hat wavelet, Morlet, Gaussian and Meyer wavelets. Orthogonal wavelets- Properties of Haar wavelets, Daubechies wavelets, Symlets, Coiflets and Discrete Meyer wavelets. Properties of Biorthogonal wavelets, Applications of wavelet families.

UNIT V   WAVELET APPLICATIONS   9
Denoising of Signals and Images, Image enhancement, Edge detection, Image Fusion, Image compression, Wavelet based feature extraction, Analysis of phonocardiogram signals, Analysis of EEG signals, Speech enhancement for hearing aids
                                                              TOTAL: 45 PERIODS

COURSE OUTCOMES:
On completion of this course the student will be able to:
- **CO1** Apply STFT and CWT on biosignals and medical images.
- **CO2** Perform multiresolution analysis of biosignals and medical images
- **CO3** Design wavelet functions.
- **CO4** Identify appropriate wavelet function to be used for an application.
- **CO5** Perform denoising, image analysis, image fusion and image compression using wavelet transforms

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REFERENCES:
1. M.Vetterli and J. Kovacevic, Wavelets and sub band coding, Prentice Hall, 1995.
2. C.Sidney Burrus, Ramesh Gopinath & Haito Guo, Introduction to wavelets and wavelet transform, Prentice Hall, 1998.
3. Metin Akay, Time frequency and wavelets in biomedical signal processing, Wiley-IEEE Press, October 1997.
4. Raguveer M Rao & Ajith S. Bopardikar, Wavelet transforms - Introduction to theory and applications, Addison Wesley, 1998
5. S.Mallet, A Wavelet tour of signal processing, Academic Press 1998
6. G.Strang and T.Nguyen, Wavelet and filter banks, Wesley and Cambridge Press.
7. P.P.Vaidyanathan, Multi rate systems and filter banks, Prentice Hall 1993.

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.

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.

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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	✓	✓		✓		✓

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.

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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	✓	✓	✓	✓	✓	✓

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| 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

REFERENCES:
1. Rory A Cooper, An Introduction to Rehabilitation Engineering, CRC press, 2006
2. Joseph D.Bronzino,The Biomedical Engineering Handbook, Third Edition: Three Volume Set,CRC Press,2006
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, Prentice Hall Inc., New Jersy,1982.
5. Reswick.J, What is Rehabilitation Engineering, Annual review of Rehabilitation-volume2, Springer- Verlag, New York 1982

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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.

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

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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 - Brains 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.

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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 Engineeringl, 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	✓	✓	✓	✓	✓	✓

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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	PROGRAMME OUTCOMES					
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

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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	✓	✓	✓	✓	✓	

PROGRESS THROUGH KNOWLEDGE

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.

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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   9
STANDRADS

Accreditation- 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

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		✓	✓			✓

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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

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

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

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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.

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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.

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 HC Pro, 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	✓		✓	✓		✓

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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.

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

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

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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. et. al, - 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

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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	PROGRAMME OUTCOMES					
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

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

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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	✓				✓	✓

PROGRESS THROUGH KNOWLEDGE

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.

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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.

                                TOTAL: 45 PERIODS

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.

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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

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

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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	✓		✓	✓	✓	✓

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 SCALABLE 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 ~~Attested~~ strategies for turnover from commercialization.

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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

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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.
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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.

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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

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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.
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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

PROGRESS THROUGH KNOWLEDGE

OE5092   **INDUSTRIAL SAFETY**   **L T 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.

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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

TOTAL: 45 PERIODS

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

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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

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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.

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	✓	✓	✓		✓	✓	✓				✓	✓

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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.

UNITI   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.

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	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

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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	✓	✓	✓		✓							✓

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										✓		✓

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

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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

	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												✓

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

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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

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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.

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   THEMATIC OVERVIEW

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

UNIT III   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.

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UNIT IV   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 V   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**   **L T P C**
              LIFE ENLIGHTENMENT SKILLS   **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.

Attested

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