ANNA UNIVERSITY, CHENNAI
UNIVERSITY DEPARTMENTS
M.E. MEDICAL ELECTRONICS (R-2023)
REGULATIONS 2023
CHOICE BASED CREDIT SYSTEM
DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

VISION

To be recognized as a benchmark and trend setter in Electronics and Communication Engineering domain keeping in phase with rapidly changing technologies through effective partnership with reputed academic institutions, research organizations, industries and community.

MISSION

- Create highly motivated, technologically competent human resource by imparting high quality technical education through flexible student centric updated curricula suited to students with diverse backgrounds
- Adopt best teaching and learning practices and establish state-of-the-art facilities to provide quality academic ambience for innovativeness, research and developmental activities
- Enhance collaborative activities with academic institutions and industries for evolving indigenous technological solutions to meet societal needs and nurture leadership and entrepreneurship qualities with ethical means.
- Facilitate adequate exposure to the students, faculty and staff through training in the state-of-the-art technologies, efficient administration, global outreach and benchmarking against referential institutions

ANNA UNIVERSITY, CHENNAI
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1. PROGRAMME EDUCATIONAL OBJECTIVES(PEOs):

I. Acquire technical and intellectual skill required to solve complex technical and scientific problems at the interface of engineering and medicine.
II. Gain up-to-date expert knowledge in Medical Electronics discipline with transdisciplinary perspective.
III. Highly competent to formulate, design and carryout research in self-reflexive manner in a diverse team.
IV. Exhibit good leadership, make decisions with societal and ethical responsibilities, function and communicate effectively in a multidisciplinary environment.
V. Excel to become entrepreneurs to develop indigenous biomedical solutions.

2. 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 Medical Electronics program. The mastery should be at a level higher than the requirements in the appropriate bachelor Program.
4.	**Engineering Design**	Apply mathematical, science and engineering concepts to design and develop biomedical systems.
5.	**Development of Healthcare Systems**	Provide healthcare solutions using advanced computational techniques.
6.	**Environment and Society**	Provide biomedical engineering applications in global, economical, environmental, and social context.

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4. PEO/PO Mapping:

PEO	PO					
	1	2	3	4	5	6
I.			2	3		
II.	2				3	
III.	3		2	3		
IV.		2				3
V.					2	3

PROGRAM ARTICULATION MATRIX OF PG MEDICAL ELECTRONICS

		COURSE NAME	PO1	PO2	PO3	PO4	PO5	PO6
YEAR I	SEMESTER I	Advanced Applied Mathematics						
		Human Anatomy and Physiology	3	1	3			
		Advanced Biomedical Instrumentation	3	3	3	3	1	1
		Biosignal Processing	3	3	3	3	1	
		Medical Equipment	3	3	3	3	1	1
		Research Methodology and IPR						
		Advanced Biomedical Instrumentation Laboratory	2	2	3	3	3	
	SEMESTER II	Medical Image Processing	3	2	3	3	2	2
		Medical Embedded Systems	3	2	3	3	3	1
		Medical Imaging systems and Radio Therapy		1	3	1		1
		Professional Elective I						
		Professional Elective II						
YEAR II	SEMESTER III	Professional Elective III						
		Professional Elective IV						
		Professional Elective V						
		Hospital Training (4 weeks Training)	2	2	3	3	3	2
		Project Work I	2	2	3	3	3	2
	SEMESTER IV	Project Work II	2	2	3	3	3	2
		Average	3	2	3	3	2	2

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REGULATIONS – 2023
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CURRICULA AND SYLLABI
SEMESTER I

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MA3152	Advanced Applied Mathematics	FC	4	0	0	4	4
2.	RM3151	Research Methodology and IPR	RMC	2	1	0	3	3
3.	MD3101	Human Anatomy and Physiology	PCC	3	0	0	3	3
4.	MD3102	Advanced Biomedical Instrumentation	PCC	3	0	0	3	3
5.	MD3103	Biosignal Processing	PCC	3	0	4	7	5
6.	MD3104	Medical Equipment	PCC	3	0	0	3	3
PRACTICALS								
7.	MD3111	Advanced Biomedical Instrumentation Laboratory	PCC	0	0	4	4	2
			TOTAL	**18**	**1**	**8**	**27**	**23**

SEMESTER II

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MD3201	Medical Image Processing	PCC	3	0	4	7	5
2.	MD3202	Medical Embedded Systems	PCC	3	0	4	7	5
3.	MD3203	Medical Imaging Systems and RadioTherapy	PCC	3	0	0	3	3
4.		Professional Elective I	PEC	3	0	0	3	3
5.		Professional Elective II	PEC	3	0	0	3	3
			TOTAL	**15**	**0**	**8**	**23**	**19**

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SEMESTER III

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.		Professional Elective III	PEC	3	0	0	3	3
2.		Professional Elective IV	PEC	3	0	0	3	3
3.		Professional Elective V	PEC	3	0	0	3	3
PRACTICALS								
4.	MD3311	Hospital Training (4 weeks Training)	EEC	0	0	0	0	2
5.	MD3312	Project Work I	EEC	0	0	12	12	6
			TOTAL	**9**	**0**	**12**	**21**	**17**

SEMESTER IV

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	MD3411	Project Work II	EEC	0	0	24	24	12
			TOTAL	**0**	**0**	**24**	**24**	**12**

TOTAL NO. OF CREDITS: 71

FOUNDATION COURSES (FC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			L	T	P		
1.	MA3152	Advanced Applied Mathematics	4	0	0	4	1

PROFESSIONAL CORE COURSES (PCC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			L	T	P		
1.	MD3101	Human Anatomy and Physiology	3	0	0	3	1
2.	MD3102	Advanced Biomedical Instrumentation	3	0	0	3	1
3.	MD3103	Biosignal Processing	3	0	4	5	1
4.	MD3104	Medical Equipment	3	0	0	3	1
5.	MD3111	Advanced Biomedical Instrumentation Laboratory	0	0	4	2	1
6.	MD3201	Medical Image Processing	3	0	4	5	2
7.	MD3202	Medical Embedded Systems	3	0	4	5	2
8.	MD3203	Medical Imaging Systems and Radio Therapy	3	0	0	3	2
TOTAL CREDITS						**29**	Attested

RESEARCH METHODOLOGY AND IPR COURSES (RMC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			L	T	P		
1.	RM3151	Research Methodology and IPR	2	1	0	3	1
TOTAL CREDITS						3	

PROFESSIONAL ELECTIVES

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MD3001	Medical Informatics	PEC	3	0	0	3	3
2.	MD3002	Wavelet Transforms and its Applications	PEC	3	0	0	3	3
3.	MD3003	Human Assist Devices	PEC	3	0	0	3	3
4.	MD3004	Neural Networks and Deep Learning	PEC	3	0	0	3	3
5.	MD3005	Advances in Electronics Applied to Hospital Engineering	PEC	3	0	0	3	3
6.	MD3052	Brain Control Interface	PEC	3	0	0	3	3
7.	MD3057	Medical Device Regulations and Standards	PEC	3	0	0	3	3
8.	MD3062	Ultrasound Principles and Applications in Medicine	PEC	3	0	0	3	3
9.	MD3056	Medical Device Design and Development	PEC	3	0	0	3	3
10.	MD3053	IoMT Architecture and Applications	PEC	3	0	0	3	3
11.	MD3054	Machine Learning Techniques	PEC	3	0	0	3	3
12.	MD3051	Bio MEMS and its Applications	PEC	3	0	0	3	3
13.	MD3061	Telehealth Technology	PEC	3	0	0	3	3
14.	MD3006	Wearable Body Area Networks	PEC	3	0	0	3	3
15.	MD3059	Microfluidic Devices for Biomedical Applications	PEC	3	0	0	3	3
16.	MD3055	Medical Data Analytics	PEC	3	0	0	3	3
17.	MD3060	Physiological Systems Modeling and Simulation	PEC	3	0	0	3	3
18.	MD3058	Medical Robotics and Automation	PEC	3	0	0	3	3
19.	BO3051	Biomechanics and its Applications	PEC	3	0	0	3	3
20.	BO3251	Rehabilitation Engineering and Assistive Technology	PEC	3	0	0	3	3
21.	BO3053	Finite Element Analysis for Biomedical Engineering	PEC	3	0	0	3	3
22.	BO3054	Photonics in Medicine	PEC	3	0	0	3	3
23.	BO3052	Cognitive Function Analysis	PEC	3	0	0	3	3

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EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			L	T	P		
1.	MD3311	Hospital Training	0	0	0	2	3
2.	MD3312	Project Work I	0	0	12	6	3
3.	MD3411	Project Work II	0	0	24	12	4
TOTAL CREDITS						**20**	

SUMMARY

	Name of the Programme: M.E MEDICAL ELECTRONICS					
	SUBJECT AREA	CREDITS PER SEMESTER				CREDITS TOTAL
		I	II	III	IV	
1.	FC	4				4
2.	PCC	16	13			29
3.	PEC		6	9		15
4.	RMC	3				3
5.	EEC			8	12	20
6.	**TOTAL CREDIT**	**23**	**19**	**17**	**12**	**71**

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MA3152 ADVANCED APPLIED MATHEMATICS L T P C
4 0 0 4

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

COURSE OUTCOMES:

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

CO1 Apply the concepts of linear algebra to solve practical problems.
CO2 Use the ideas of probability and random variables in solving engineering problems.
CO3 Classify various random processes and solve problems involving stochastic processes.
CO4 Formulate and construct mathematical models for linear programming problems and solve the transportation and assignment problems.
CO5 Apply the Fourier transform methods of solving standard partial differential equations.

REFERENCES:

1. Andrews, L.C. and Philips.R.L., “Mathematical Techniques for engineering and scientists”, Printice 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.

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CO-PO Mapping:

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	2	2
CO2	3	3	3	3	2	2
CO3	3	3	3	3	2	2
CO4	3	3	3	3	2	2
CO5	3	3	3	3	2	2
Avg	3	3	3	3	2	2

RM3151 RESEARCH METHODOLOGY AND IPR L T P C
2 1 0 3

UNIT I RESEARCH PROBLEM FORMULATION 9

Objectives of research, types of research, research process, approaches to research; conducting literature review- information sources, information retrieval, tools for identifying literature, Indexing and abstracting services, Citation indexes, summarizing the review, critical review, identifying research gap, conceptualizing and hypothesizing the research gap

UNIT II RESEARCH DESIGN AND DATA COLLECTION 9

Statistical design of experiments- types and principles; data types & classification; data collection - methods and tools

UNIT III DATA ANALYSIS, INTERPRETATION AND REPORTING 9

Sampling, sampling error, measures of central tendency and variation,; test of hypothesis- concepts; data presentation- types of tables and illustrations; guidelines for writing the abstract, introduction, methodology, results and discussion, conclusion sections of a manuscript; guidelines for writing thesis, research proposal; References – Styles and methods, Citation and listing system of documents; plagiarism, ethical considerations in research

UNIT IV INTELLECTUAL PROPERTY RIGHTS 9

Concept of IPR, types of IPR – Patent, Designs, Trademarks and Trade secrets, Geographical indications, Copy rights, applicability of these IPR; , IPR & biodiversity; IPR development process, role of WIPO and WTO in IPR establishments, common rules of IPR practices, types and features of IPR agreement, functions of UNESCO in IPR maintenance.

UNIT V PATENTS 9

Patents – objectives and benefits of patent, concept, features of patent, inventive steps, specifications, types of patent application; patenting process - patent filling, examination of patent, grant of patent, revocation; equitable assignments; Licenses, licensing of patents; patent agents, registration of patent agents.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon completion of the course, the student can

CO1: Describe different types of research; identify, review and define the research problem

CO2: Select suitable design of experiment s; describe types of data and the tools for collection of data

CO3: Explain the process of data analysis; interpret and present the result in suitable form
CO4: Explain about Intellectual property rights, types and procedures
CO5: Execute patent filing and licensing

REFERENCES:

1. Cooper Donald R, Schindler Pamela S and Sharma JK, “Business Research Methods”, Tata McGraw Hill Education, 11e (2012).
2. Soumitro Banerjee, “Research methodology for natural sciences”, IISc Press, Kolkata, 2022,
3. Catherine J. Holland, “Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets”, Entrepreneur Press, 2007.
4. David Hunt, Long Nguyen, Matthew Rodgers, “Patent searching: tools & techniques”, Wiley, 2007.
5. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, “Professional Programme Intellectual Property Rights, Law and practice”, September 2013.

MD3101 HUMAN ANATOMY AND PHYSIOLOGY L T P C

3 0 0 3

UNIT I BASIC ORGANIZATION OF HUMAN BODY 8

Human Body organization: Cell, Tissue, Organs and Systems. Body Cavities, Membranes and Coverings. Anatomical positions, planes and sections. Homeostasis and maintenance for homeostasis. Cell: cell wall structure, organelles and functions of each component. Transport mechanisms in the cell. Tissue: Types, modifications and functions of tissue.

UNIT II MUSCULOSKELETAL SYSTEM 8

Skeletal System: Bone, Types of bone, structure, bone cells, functions of bone. Axial skeleton- skull, sinuses, Fontanelles, vertebral column characteristics of typical vertebra, different parts of vertebral column (parts only), features of vertebral column, movements and functions of vertebral column, sternum, ribs, shoulder girdle and upper limb, pelvic girdle and lower limb Bones: types and functions - Axial and Appendicular Skeleton. Types of joint- Fibrous, Cartilaginous, Synovial, characteristics of synovial joints, shoulder joint, elbow joint, radioulnar joint, wrist joint, Hip joint, Knee joint, ankle joint. Cartilage- Hyaline cartilage, Fibrocartilage, Elastic cartilage Muscular System: Types of Muscle - Skeletal Muscle, cardiac muscle and smooth muscle structure and functions.

UNIT III RESPIRATORY, GASTROINTESTINAL AND URINARY SYSTEM 10

Gastrointestinal System: Organs of the digestive system – mouth, tongue, teeth, pharynx, esophagus, stomach, gastric juice and functions of stomach, small intestine-structure, chemical digestion in small intestine, large intestine – structure, functions of the large intestine. Accessory organs of GI tract: Salivary glands, Pancreas and Liver. Respiratory System: Upper Respiratory tract - Lower respiratory tract. Respiration – muscles of respiration, cycle of respiration, variables affecting respiration, lung volumes and capacity 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 ofHeart – 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. Skin and Appendages.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Describe internal environment of human body and explain the fundamental concept of homeostasis.

CO2 Explain the structure and functioning of various types of tissues.

CO3 Describe the structure of various nervous system, cardiovascular system, respiratory system, digestive system and musculoskeletal system.

CO4 Demonstrate and analyze various physiological parameters in normal and abnormal conditions.

CO5 Explain the functioning of various nervous system, cardiovascular system, respiratory system, digestive system and musculoskeletal system.

REFERENCES:

1. Ross & Wilson's, Anne Waugh and Allison Grant, "Anatomy and Physiology in Health and Illness", Churchill Livingstone Publications, 14th Edition, 2022.
2. Sujit K. Chaudhuri, "Concise Medical Physiology", New Central Book Agency Pvt. Ltd, 5th Edition, 2016.
3. K. Sembulingam and Prema Sembulingam, "Essentials of Medical Physiology", 8th Edition, Jaypee Publications, 2019.
4. Lauralee Sherwood, "Human Physiology: From Cells to Systems", 9th Edition, Thomson India Edition, 2015.
5. Gillian Pocock, Christopher D. Richards, "The Human Body An introduction forBiomedical and Health Sciences", Oxford University Press, USA, 1st Edition, 2009.
6. Gillian Pocock & Christopher D. Richards, "The Human Body", Oxford University Press, 2009.
7. Guyton, "Text book of Medical Physiology", WB Jaunder company Philadelphia, 10th edition 2020.

CO-PO MAPPING:

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1			3			
CO2		1	3			
CO3		1	3			
CO4	3	1	3		1	
CO5	3	1	3		1	
Avg	3	1	3		1	

MD3102 ADVANCED BIOMEDICAL INSTRUMENTATION L T P C

3 0 0 3

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 electrodes and itsequivalent circuits. Differential amplifier. Bio amplifier — Characteristics - Instrumentation amplifier - active filter. Isolation Amplifier, Chopper amplifier, Carrier Amplifier. Multichannel data acquisition system.

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 Bio amplifier. Introduction to Wearable Technology in healthcare – A case study on 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

Electromagnetic Blood Flow meters – Principles, AC current, DC Current Flow meters, Probe design, ultrasonic blood flow meters- Transducers, transit time Flowmeter, Continuous wave Doppler Flowmeter, Laser Doppler Blood Flow meter, Cardiac output measurement- Indicator dilution method, Dye dilution, Thermodilution method. Blood cell counting- Manual and Automatic Counting of RBC, WBC and Platelets.

UNIT V BIO-CHEMICAL MEASUREMENTS & BIOSENSORS 9

Blood Gas Analyzers -pH, pCO_2, pO_2 measurement, Chemical Fibro sensors, Intra Vascular measurement of oxygen saturation, Fluorescence sensor, Intra-arterial Blood gas measurement and electrophoresis, colorimeter, spectrophotometer, flame photometer, auto analyzer. 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 on Wearable Glucose sensor.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Understand the principle of Biosignal acquisition.
CO2 Identifying the functional blocks of various biomedical systems.
CO3 Design and analyse analog circuits and systems for biomedical sensing
CO4 Understanding the concepts of various biosensors.
CO5 Characterize and analyze the wearable devices.

REFERENCES:

1. L.A Geddes and L.E. Baker, “Principles of Applied Biomedical Instrumentation”, John Wiley and Sons, 3rdEdition, Reprint 2008
2. John G. Webster, “Medical Instrumentation Application and Design”, JohnWiley and Sons, New York, 5th Edition, 2020.

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.
6. Joseph Bronzino and Donal R. Peterson, “Handbook of Biomedical Engineering”, 2015, 4th Edition, CRC Press, Florida.
7. Myer Kutz, “Standard Handbook of Biomedical Engineering and Design”, McGraw Hill Publisher, 2003.

CO-PO MAPPING:

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1			3			
CO2				3		
CO3	3	3	3	3		
CO4	3	3	3			
CO5	3		3	3	1	1
Avg	3	3	3	3	1	1

MD3103 BIOSIGNAL PROCESSING L T P C
3 0 4 5

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 Bio signals, 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, Backpropagation neural network based classification. Applicationin Normal versus Ectopic ECG beats and other Biomedical applications. Case studies on Biosignal classification.

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UNIT V TIME FREQUENCY AND MULTIVARIATE ANALYSIS 9

Time frequency representation, spectrogram, Time-scale representation, scalogram, wavelet analysis, Wavelet Denoising — Data reduction techniques, ECG data compression, ECG characterization, Feature Extraction-Wavelet packets, Multivariate component analysis-PCA, ICA. Case studies on Applications of wavelets in Biosignal.

LAB EXPERIMENTS: 60

1. Preprocessing of Bio signals.
2. QRS Detection using Pan-Tompkin's 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 bio signals.
7. Feature extraction in EMG signals.
8. Noise cancellation using Adaptive filters.
9. Denoising of Bio signals using wavelets.
10. Feature extraction and dimensionality reduction using PCA.

TOTAL: 45T+60P=105 PERIODS

COURSE OUTCOMES:

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

CO1 Design and evaluate digital sampling and filtering systems.

CO2 Apply frequency-domain techniques in the analysis and obtain power spectral densities for bio signals.

CO3 Analyze and perform Time series modelling and extract features from bio-signals.

CO4 Design and perform Adaptive filtering to eliminate noise and artifacts from Bio-signals

CO5 Perform Biosignal analysis for various applications

CO6 Apply wavelet transform techniques in the analysis of bio-signals.

CO7 Classify the bio-signals using optimal features

REFERENCES:

1. Arnon Cohen, "Biomedical signal processing Vol 1 Time and Frequency Domain Analysis", CRC Press, 1986.
2. Arnon Cohen, "Biomedical Signal Processing Vol 2: Compression and automatic recognition",CRC Press Inc., 2021.
3. Rangaraj M. Rangayyan, "Biomedical Signal Analysis – A case study approach, Wiley, 2nd Edition, 2009.
4. Willis J. Tompkins, "Biomedical Digital Signal Processing – C Language Examples and Laboratory Experiments for the IBMR PC", Prentice Hall of India, 1998.
5. Emmanuel C. Ifeachor, Barrie W. Jervis, "Digital Signal processing-A Practical Approach", Pearson education Ltd., 2nd Edition, 2002
6. Raghuveer M. Rao and Ajith S. Bopardikar, "Wavelets transform – Introduction to
7. theoryand its applications", Pearson Education, India 2012
8. Benjamin Griffel, John L. Semmlow, "Bio-signal and Medical Image Processing", CRC PressInc, 3rd Edition, 2014.

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CO-PO MAPPING:

COURSE OUTCOMES	PROGRAMMEOUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1			3	3		
CO2			3	3		
CO3	3		3	3		
CO4	3		3	3		
CO5	3	3	3	3	1	
CO6	3	3	3	3	1	
CO7	3	3	3	3	1	
Avg	3	3	3	3	1	

MD3104 MEDICAL EQUIPMENT L T P C

3 0 0 3

UNIT I CARDIAC CARE UNIT 8

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 on design of Pacemaker.

UNIT II NEUROLOGY AND SENSORY EQUIPMENT 12

Evoked response - Auditory, Visual and Somatosensory, Depth recording, Stereotaxy, EEG controlled Anesthetic monitor, Measurement of Basal Skin response and Galvanic skin response - Instruments for testing Motor responses - Biofeedback Instrumentation. Biofeedback equipment, Spinal reflex Measurement, Transcutaneous nerve stimulator. 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.

UNIT III PHYSIOTHERAPY AND DIATHERMY EQUIPMENT 9

Physiological effects of HF radiation, Depth of Penetration, short wave, Ultrasonic and microwave diathermy, Surgical diathermy, Electrodes used with surgical diathermy, Safety aspects in electronic surgical units, Stimulators -Galvanic, Faradic Stimulators, Interferential therapy, TENS.
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 7

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

Ophthalmic equipment- slit Lamp, Tonometer, Retinal response Plotter, 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, Case study on FLIM and applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Have knowledge of how different types of medical equipment work, advantages, and disadvantages of different methods.

CO2 Interpret the different modes and operations of medical equipment

CO3 Identify the engineering standards and controls to ensure the to ensure safety and proper operation of medical devices.

CO4 Comprehend the working principle and applications of the analytical equipment used in medical field.

CO5 Understand the concepts of new equipment and its applications in health care.

REFERENCES:

1. Albert M Cook and Webster J G, "Therapeutic medical devices", Prentice Hall NewYork 1982.
2. John G. Webster, "Medical Instrumentation Application and Design", JohnWiley and Sons, New York, 5th Edition, 2020.
3. Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw Hill, New Delhi, 3rd Edition, 2014.
4. Leslie Cromwell, Fred J. Weibell and Erich A.P Feiffer, " Biomedical Instrumentation", Prentice Hall, New Delhi, 2000
5. Jacobson B and Webster J G, "Medicine and Clinical Engineering", Prentice Hall of India New Delhi, 1999.
6. Wolbasrsht. M. L, "Laser Application in Medicine and Biology plenum", press New York, 1989.
7. Joseph Bronzino and Donal R. Peterson, "Handbook of Biomedical Engineering", 4th Edition, CRC Press, Florida, 2015.

CO-PO MAPPING:

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		3	3		
CO2	3			3		
CO3		3	3			1
CO4		3		3	1	
CO5	3		3			
Avg	3	3	3	3	1	1

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MD3111 ADVANCED BIOMEDICAL INSTRUMENTATION LABORATORY L T P C

0 0 4 2

LIST OF EXPERIMENTS

1. Design and analysis of bio amplifier using circuit simulation.
2. Design of instrumentation amplifier using Opamp and single IC
3. Design of bio amplifier for acquiring bio signals.
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 analyzer.
10. Measurement of Vital parameters using patient monitoring system and biotelemetry.
11. Electrical safety testing of medical equipment.
12. Design and development of Biosensor.
13. Study of different types of muscle stimulator waveforms.
14. Study of multi parameter simulator.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1 Design, record and analyze various bio signals.
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.

CO-PO MAPPING:

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	3	3	3	
CO2			3	3	3	
CO3				3		
CO4		2		3		
CO5				3		
CO6				3		
Avg	2	2	3	3	3	

MD3201 **MEDICAL IMAGE PROCESSING** **L T P C**

3 0 4 5

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-DFTandothertransforms.

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. Case studies on Denoising in Medical images

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, Image classification using Deep Learning neural networks. Case studies on classification of medical images.

UNIT V IMAGE REGISTRATIONS AND VISUALIZATION 9

Image Registration: Rigid body transformation –Affine transformation, Principal axes registration, Iterative principal axes registration, feature based registration, Elasticdeformation-based registration, Registration of Images from Different modalities, Evaluation of Registration Methods, Medical Image Fusion, Case studies in Image Registration and Image Fusion. Image visualization: 2-D display methods,3-Ddisplay 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.

LAB EXPERIMENTS: 60

1. Preprocessing of medical images.
2. Edge detection using Python
3. Analysis of medical images using DWT
4. Segmentation of ROI in medical images.
5. Feature extraction in medical images
6. Steganography using OpenCV.
7. Medical Image Compression techniques.
8. Medical image registration.
9. Medical image fusion.
10. Statistical analysis of features.
11. Neural network-based classification using Deep Learning.
12. Medical Image Reconstruction.

TOTAL: 45T+60P=105 PERIODS

COURSE OUTCOMES:

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

CO1 Apply and perform image processing techniques for Denoising, enhancement and restoration of medical images.

CO2 Apply reconstruction techniques in medical images.

CO3 Perform and validate Segmentation algorithm, Feature Extraction for medical images.

CO4 Understand the Classification technique and perform classification in medical images using Machine learning techniques.

CO5 Implement and validate Image registration algorithm and Fusion techniques in Medical Images.

CO6 Apply 3D Visualization techniques in Medical Images

REFERENCES:

1. Atam P. Dhawan, "Medical Image Analysis", 2nd Edition, Wiley – IEEE Press, 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", South Asian Edition, Cambridge University Press, 2010.
5. Jerry L. Prince and Jonathan M. Links, "Medical Imaging Signals and Systems", 2nd Edition, Pearson Education, 2014.
6. Ravikanth Malladi, "Geometric Methods in Bio-Medical Image Processing (Mathematics and Visualization)", 1st Edition, Springer, 2002.
7. A. Ardeshir Goshtasby, "Image Registration Principles, Tools and Methods (Advances in Computer Vision and Pattern Recognition)", Springer, 2014.

CO-PO MAPPING:

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1			3	3		
CO2			3	3		
CO3	3		3	3		
CO4	3	2	3	3	2	2
CO5	3	2	3	3	2	
CO6	3	2	3	3	2	2
Avg	3	2	3	3	2	2

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MD3202 **MEDICAL EMBEDDED SYSTEMS** **L T P C**

3 0 4 5

UNIT I INTRODUCTION TO ARM PROCESSORS 9

Review of digital electronics, Introduction to ARM Cortex-M Processors, Introduction to Embedded Software Development. ARM organization and implementation, The Thumb Instruction Set, Architectural Support for High-Level Languages**.**

UNIT II HARDWARE AND SOFTWARE FOR ARM PROCESSOR 9

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

UNIT III DATA ACQUISITION SYSTEMS 9

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

UNIT IV EMBEDDED SYSTEM ARCHITECTURE - ARM CORE 9

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

UNIT V PROTOTYPE DESIGN AND 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.

LAB EXPERIMENTS: 60

1. Design of logic circuits using Arm processor
2. Design of Vital Sign Monitors (Heart rate) using ARM processor
3. Design of Vital Sign Monitors (Pulse rate) using RaspberryPi
4. Simulation in C and Embedded C programming.
5. Data acquisition of bio signals using Arduino integrated development environment and interfacing with communication protocols.
6. Design an m – health platform for measurement of heart rate and pulse rate by interfacing with communication protocols.
7. Simulation and Design of single channel and multi-channel ECG amplifier systems.
8. Simulation and Design of single channel and multi-channel EMG amplifier systems.
9. Develop a prototype product development for single channel and multi-channel ECG and EMG amplifier systems using printed circuit boards.

TOTAL: 45T+60P=105 PERIODS

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COURSE OUTCOMES:

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

CO1 Understand the domain knowledge with analysis and synthesis of digital logic circuits in ARM processor kits.

CO2 Acquire knowledge in ARM core architecture hardware system

CO3 Gain knowledge in simulation of various low to high level programming.

CO4 Ability to understand and apply the concept of data acquisition systems and to interface with communications protocols using ARM processor

CO5 Able to handle projects for measurement of vital parameters in health care applications and validate it using ARM processor.

CO6 Able to analyze and validate the hardware design and software simulation for bio amplifiers and prototype product in PCB.

REFERENCES:

1. Andrew Sloss, Dominic Symes, Chris Wright, "ARM system developer's guide: Designing and optimizing system software", Morgan Kaufmann, 2004.
2. Wayne Wolf, "Computers as Components, principles of Embedded computing system Design", Prinston University, 2001.
3. Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D. McKinlay, "The 8051 microcontroller and embedded systems using assembly and C", 2nd Edition,Pearson, 2005.
4. Brian W. Kernighan, Dennis M. Ritchie, "The C programming language", 2nd Edition,Prentice Hall, Englewood Cliffs, New Jersey, 1988.
5. R. S. Khandpur, "Printed Circuit Boards Design - Fabrication, Assembly and Testing",1st Edistion, McGraw Hill Education, 2017.
6. S. Salivahanan, S. Arivazhagam, "Digital circuits and Design", 4th Edition, VikasPublishing House, 2012.

CO-PO MAPPING:

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1				3	3	
CO2	3		3	3	3	
CO3	3		3	3	3	
CO4	3	2	3	3	3	
CO5	3	2	3	3	3	1
CO6	3		3	3	3	1
Avg	3	2	3	3	3	1

MD3203 MEDICAL IMAGING SYSTEMS AND RADIO THERAPY L T P C

3 0 0 3

UNIT I X-RAY PROJECTION RADIOGRAPHY AND TOMOGRAPHY 10

Physics of Radiography. X-ray Tube- Principle and production of X-rays, Line Focus Principle, Anode Heel effect, X-ray Machine- filter, collimator, Bucky Diaphragm, Cassette, film. Digital Radiography. mammography, dental X- ray. Fluoroscopic Technique- Image Intensifiers, Angiography- Cine Angiography, Digital Subtraction Angiography. Computed Tomography - Principles of tomography, CT Generations, Gantry, Detectors, Slip rings, CT Numbers, Imaging Artifacts, Spiral CT, Ultra-fast CT Scanners, 3D Imaging. Image reconstruction techniques- back projection, Fourier slice Theorem and iterative method. Case studies on recent development in CT.

UNIT II EMISSION IMAGING 8

Radioactivity- Radioactivity decay law, Alpha, Beta, Gamma Emission, Radiotracers, different types of Radiation Detectors- Gas-filled, Scintillation and Semiconductor detectors. Planar Scintigraphy- Collimators, Scintillation Crystal, Photomultiplier Tubes, Positioning Logic, Pulse Height Analyzer, Gating Circuit, Image Capture. PET and SPECT- Principle and Instrumentation, Combined PET/CT Systems.

UNIT III MAGNETIC RESONANCE IMAGING 9

Principle of MRI- Precession, NMR, Longitudinal and transverse magnetization, Relaxation processes and their measurements, Spin echo, Pulse sequencing. MR image acquisition, Imaging parameters- TE, TR and image contrast, Slice selection, frequency encoding and phase encoding, MRI instrumentation- Magnets, gradient coils, Radio Frequency coils and shim 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, Reflection and Refraction at Plane Interfaces, Transmission and Reflection Coefficient, Attenuation, Scattering, Doppler effect, 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. Case studies on 3D, 4D ultrasound imaging

UNIT V EFFECTS AND THERAPEUTIC APPLICATIONS OF RADIATION 9

Biological effects of Radiation- DNA, Cellular, tissue, organ and Whole-body level. Radiation Therapy- Linear accelerator, Stereotactic radiosurgery, IGRT, IMRT, Cyberknife, Tele gamma Machine, Brachytherapy, Proton beam therapy. Radiation Dosimetry- Exposure, Dose, Kerma, Absorbed, Equivalent and Effective dose. Automatic Treatment Planning, ICRP regulation, Allowed Levels, Protection Methods.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- **CO1** Describe the physics of various medical imaging techniques.
- **CO2** Demonstrate the Instrumentation of different imaging techniques
- **CO3** Understand and apply the image reconstruction concepts.
- **CO4** Explain the principle of different Radiation therapy equipment and radiation detectors.
- **CO5** Discuss the effects of radiation, radiation safety and the principle of Radio therapy Techniques.
- **CO6** Discuss the recent developments in medical imaging technology

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. Jerry L. Prince and Jonathan M. Links, “Medical Imaging Signals and Systems”, Pearson Education Inc. 2014.
3. D.N. Chesney and M.O. Chesney, “Radio graphic imaging”, CBS Publications, New Delhi, 1987.
4. Alexander, Kalender and Linke, “Computed Tomography: Assessment Criteria, Ct System Technology, Clinical Applications”, John Wiley, Chichster, 1986.
5. Steve Webb, “The Physics of Medical Imaging”, Adam Hilger, Philadelpia,1988.
6. Donald Graham, Paul Cloke, Martin Vosper, “Principles of Radiological physics”, Churchill Livingston, 6th Edition, 2011.
7. Donald W. Mc Robbice, Elizabeth A. Moore, Martin J. Grave and Martin R. Prince, “MRI from picture to proton”, 2nd Edition, Cambridge University press, New York 2006.

CO-PO MAPPING:

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1			3			
CO2			3			
CO3			3	1		
CO4			3			
CO5			3			1
CO6		1	3			
Avg		1	3	1		1

MD3001 MEDICAL INFORMATICS L T P C

3 0 0 3

UNIT I INTRODUCTION TO MEDICAL INFORMATICS 9

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

UNIT II MEDICAL DATA ACQUISITION AND FORMATS 9

Plug-in-data acquisition, AGC and Control Boards - Data acquisition using GPIB and Serial Interfaces and Programming in C - Medical Data formats – Signal, Image and Video Formats – Medical Databases - Electronic Patient Record (EPR) - Integrated Clinical Multimedia data - Medical data storage and retrieval techniques, A study on Data Acquisition Systems.

UNIT III BIG DATA ANALYTICS AND DECISION SUPPORT SYSTEMS 9

Essential Concepts for Biomedical Computing and Coding Systems for Biomedical Data – Automation, Algorithms and Analysis of medical data, Clinical software development, Big Data

Analytics and Reporting - Clinical Decision Support Systems and Diagnosis applying Artificial Intelligence tools. A report on Big Data Analysis in Healthcare.

UNIT IV MEDICAL TECHNOLOGIES 9

Cloud Computing and Big Data Analytics, Mobile Health - Telemedicine and Patient Monitoring, Point of Care Telemedicine - Role of Artificial Intelligence in Medical Technology - Understanding machine learning, deep learning, artificial intelligence, and data science - Artificial Neural Network (ANN) Networking and e-Health services.

UNIT V INTERNET AND WEB 9

HTML and Java script programming – PHP – SQL – Design of HIS, LIS, RIS – e-Health services - Design of Web portal.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Understand the different sub-disciplines of Medical Informatics.

CO2 Comprehend how to acquire, store and maintain, retrieve, analyze, and meaningfully use biomedical data in various formats

CO3 Apply biomedical and computational tools and technologies to solve problems in biomedicine and healthcare

CO4 Understand how technology, including health information systems and medical devices, can improve or limit the ability to provide clinical care

CO5 Critically think and develop own perspectives on ethical and legal considerations in use of contemporary technology and informatics in health care

CO6 Conceptualize and utilize informatics-based tools for clinical practice and research

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”, 3rd Edition, Springer-Verlag, 2006.
4. William R. Hersh, Robert E. Hoyt, “Health Informatics: Practical Guide”, Seventh Edition, Lulu.com, 2018
5. Zholos O.V., Moroz O.F., Ogloblia O.V., Artemenko O.Y. Kyiv, “Practical Guide to Medical Informatic**s”**, 2019
6. Ramesh Sharda, Stefan University, “Medical Informatics Knowledge Management and Data Mining in Biomedicine” Springer, 2005.
7. Pentti Nieminen, “Medical Informatics and Data Analysis,” MDPI, 2021.

CO-PO MAPPING:

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1			3			
CO2	2	2	3	3		

CO3			3	3	3	
CO4			3	3	3	
CO5						1
CO6	2	2			3	
Avg	2	2	3	3	3	1

MD3002 WAVELET TRANSFORMS AND ITS APPLICATIONS L T P C

3 0 0 3

UNIT I INTRODUCTION TO WAVELETS 9

Introduction to Multirate signal processing- Decimation and Interpolation, QuadratureMirror 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. Case studies on wavelet analysis of bio signals and medical images.

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. Case studies on applications of wavelets.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Understand the characteristics of various wavelet functions

CO2 Apply STFT and CWT on bio-signals and medical images

CO3 Perform multiresolution analysis of bio-signals and medical images

CO4 Design wavelet functions

CO5 Identify appropriate wavelet function to be used for an application

CO6 Apply wavelets for various applications in bio-signal and medical images

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REFERENCES:

1. M.Vetterli and J. Kovacevic, “Wavelets and subband coding”, Prentice Hall, 1995.
2. C.Sidney Burrus, Ramesh Gopinath & Haito Guo, “Introduction to wavelets and Wavelet transform”, Prentice Hall, 1997.
3. Metin Akay, “Time frequency and wavelets in biomedical signal processing”, Wiley-IEEE Press, 1997.
4. Raguveer M Rao & Ajith S.Bopardikar, “Wavelet transforms Introduction to Theory and applications”, Pearson Education,2012
5. S. Mallet, “A Wavelet tour of signal processing – The Sparse”, 3rd Edition, Academic Press, 2008
6. G. Strang and T. Nguyen, “Wavelet and filter banks”, Wesley and Cambridge Press, 2nd Edition, 1996
7. P.P. Vaidyanathan, “Multi rate systems and filter banks”, Prentice Hall, 1993.

CO-PO MAPPING:

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1			3	3		
CO2	3		3	3		
CO3	3	3	3	3		
CO4			3	3		
CO5	3		3	3		
CO6	3	3	3	3	1	
Avg	**3**	**3**	**3**	**3**	**1**	

MD3003 HUMAN ASSIST DEVICES L T P C

3 0 0 3

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 Hemodialysis, Membrane, Dialysate, Different types of hemodialyzers, 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, Basic Audiometer- Pure tone audiometer-Bekesy audiometer system, hearing aids - types, tonometer, Hearing Aids, Construction and Functional Characteristics.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Get knowledge about the importance of Heart lung machine and artificial Heart.

CO2 Familiarize 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 Prosthetic 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 Evaluation”, Mc-Millan publishers, 1980.
3. Albert M. Cook and Webster J.G., “Therapeutic Medical Devices”, Prentice Hall Inc., New Jersey,2020
4. Gray E Wnek, Gray L Browlin, “Encyclopedia of Biomaterials and biomedical Engineering” Marcel Dekker Inc New York 2004.
5. Gerr M. Craddock, “Assistive Technology-Shaping the future”, IOS Press, 1st edition, 2003.
6. Tracy, K, Willem Kolff and the Invention of the Dialysis Machine. Mitchell Lane Pub, 2003.
7. Yadin David, Wolf W. von Maltzahn, Michael R. Neuman, Joseph.D, Bronzino, “Clinical Engineering,” CRC Press, 1st edition,2010.

CO-PO MAPPING:

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1			3	2		1
CO2			3	2		
CO3			3	2		
CO4	3				1	
CO5	3	3	3			
Avg	3	3	3	2	1	1

Attested

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MD3004 **NEURAL NETWORKS AND DEEP LEARNING** **L T P C**

3 0 0 3

UNIT I INTRODUCTION TO ARTIFICIAL NEURAL SYSTEMS 9

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, Generalized Delta Rule, BPN Application, Associative Memory Definition, BAM, Hopfield Memory, Simulated Annealing-Boltzmann Machine

UNIT III COMPETITIVE NETWORKS AND KERNEL FUNCTIONS 9

Unsupervised Learning Network- Introduction, Fixed Weight Competitive Nets, Maxnet, Hamming Network, Kohonen Self-Organizing Feature Maps, Learning Vector Quantization, Counter Propagation Networks, Adaptive Resonance Theory Networks. SVM, RBF, Simulation of BPN and SVM for classification of MRI brain tumor images.

UNIT IV INTRODUCTION TO DEEP LERANING 9

Introduction to Deep Learning, Historical Trends in Deep learning, Deep Feed - forward networks, Gradient-Based learning, Hidden Units, Architecture Design, Back-Propagation and Other Differentiation Algorithms.

UNIT V REGULARISATION AND OPTIMIZATION OF DEEP LEARING MODELS 9

Regularization for Deep Learning: Parameter norm Penalties, Norm Penalties as Constrained Optimization, Regularization and Under-Constrained Problems, Dataset Augmentation, Noise Robustness, Semi-Supervised learning, multi-task learning, Early Stopping, Parameter Typing and Parameter Sharing, Sparse Representations, Bagging and other Ensemble Methods, Dropout, Adversarial Training, Tangent Distance, tangent Prop and Manifold, Tangent Classifier.

Case study: Simulation of Deep CNN for classification of bio signals and medical images.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Know the Architecture of neural networks and its learning rules
CO2 Ability to understand the concepts of Neural Networks
CO3 Ability to simulate the Learning Networks in modeling real world systems
CO4 Ability to use an efficient algorithm for Deep Models
CO5 Ability to apply and simulate the optimization strategies for large scale applications.

REFERENCES:

1. Michael Nielsen, “Neural Networks and Deep Learning”, Springer, I edition, 2018.
2. Ian Goodfellow and Yoshua Bengio and Aaron Courville, “Deep Learning”, MIT Press, 2016.
3. Laurene V. Fausett, “Fundamentals of neural networks”, Pearson, 1st Edition, 2004.
4. Philip D. Wasermann, “ Advanced Methods in neural Computing”, Van NostrandReinhold, New York 1993.
5. Simon Haykins, “Neural Networks”, Prentice Hall International lnc, 1999.
6. James A Freeman and David M. Skapura, “Neural Networks”, Addison - Wesley, India1999.
7. Francois Chollet, “Google AI researcher and creator of the popular Keras deeplearning library”, published his book, Deep Learning with Python in October 2017.

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CO-PO MAPPING:

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1			3	3		
CO2	3	3	3	3		
CO3	3	3	3	3	3	
CO4	3	3	3	3	3	
CO5	3	3	3	3	3	1
Avg	3	3	3	3	3	1

MD3005 ADVANCES IN ELECTRONICS APPLIED TO HOSPITAL ENGINEERING L T P C
3 0 0 3

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 polarization, 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 AND AUGMENTED 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, Applications of Virtual Reality in Medicine. Introduction to AR– System Structure of Augmented Reality – Key Technology in AR – 3D Vision -Approaches to Augmented Reality – Alternative Interface Paradigms – Spatial AR – Input Devices, Navigation and Manipulation Interfaces.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this 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 Analyse 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 Apply the knowledge of optic sensor in physiological measurement

REFERENCES:

1. Syed Amin Tabish, " Hospital and Health Services Administration Principles andPractices", 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, "Fiber 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.

CO-PO MAPPING:

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1			3		
CO2				3	2	
CO3	1			3	2	
CO4				2	2	
CO5	1			3	2	
Avg	1			3	2	

MD3052 BRAIN CONTROL INTERFACE L T P C

3 0 0 3

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.

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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-LinearFeatures. Case study on feature extraction for various BCI Applications.

UNIT IV FEATURE TRANSLATION METHODS 9

Linear Discriminant Analysis – K Nearest neighbour method, Support Vector Machines – Regression – Learning Vector Quantization – Gaussian Mixture Modeling – Hidden Markov Modeling –Neural Networks.

UNIT V APPLICATIONS OF BCI 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Acquire the brain signal from different regions of brain cortex for specific BCI Application
CO2 Apply suitable preprocessing technique to brain signal
CO3 Analyze the event related potentials
CO4 Extract discriminant features from brain signals
CO5 Classify and derive the control signals for BCI applications
CO6 Design a BCI system for various applications

REFERENCES:

1. Jonathan Wolpaw, Elizabeth Winter Wolpaw, “Brain Computer Interfaces: Principles and practice”, Edition 1, Oxford University Press, USA, January 2012.
2. Bernhard Graimann, Brendan Allison, Gert Pfurtscheller, “Brain-Computer Interfaces: Revolutionizing Human – Computer Interaction", Springer, 2010
3. Arnon Kohen, “Biomedical Signal Processing Vol 2: Compression and automatic recognition” CRC Press Inc., 2021.
4. Bishop C.M “Neural networks for Pattern Recognition”, Clarendon Press,1995.
5. Andrew Webb “Statistical Pattern Recognition”, Wiley International, Second Edition, 2002.
6. Wolpaw J. R, N. Birbaumeretal “Brain control interface for Communication and control”,Clinical Neurophysiology, 2002.
7. 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, 2004.

CO-PO MAPPING:

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1			3	3		
CO2			3	3		
CO3	3		3	3		
CO4	3	3	3	3		
CO5	3		3	3	3	
CO6	3	3	3	3	3	
Avg	3	3	3	3	3	

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MD3057 MEDICAL DEVICE REGULAIONS AND STANDARDS L T P C

3 0 0 3

UNIT I MEDICAL DATA STANDARDS 9

Evolution of Medical Standards - HL7 – DICOM – IRMA - LOINC – HIPPA - Medical Vocabulary standards – Diagnosis Related Group (DRG) – ICD10 – MeSH – SNOMED – UMLS.

UNIT II MEDICAL DEVICE QUALITY MANAGEMENT SYSTEM 9

Key aspects of Indian Certification of Medical Devises Plus (ICMED) 13485 Plus – Implementation - Quality Management Systems - Management Responsibility - Resource Management - Product Realization - Measurement, Analysis and Improvement – A case study on the process of applying for ICMED 13485 plus.

UNIT III MEDICAL EQUIPMENT SAFETY STANDARDS 9

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

UNIT IV MEDICAL DEVICE TESTING AND CALIBRATION STANDARDS 9

ISO/IEC 17025:2017 standard – General requirements for the competence of Testing and Calibration laboratories – Management, Structural, Resource and process Requirements – A case study on the process of applying for NABL accreditation.

UNIT V HOSPITAL ACCREDITATION AND BASIC SAFETY STANDARDS 9

Quality Planning of Hospital Support System, Quality Assurance to Patients, National Accreditation Board for Hospitals (NABH) – Patient centred and Healthcare Organization Management standards - Electrical Safety Solution in Hospitals according to" IEC 60364-7-710" & NEC_SP30_2023_Medical. 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 - AERB Compliance – Radiation protection AE(RP)R-2004, Safety Code AE/RF-MED/SC-3. - Managing Hazardous Material and Biomedical Waste. A case study on the process of applying for NABH accreditation.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Discuss the general regulations of medical devices.
CO2 Examine the quality management systems for medical device manufacture.
CO3 Compare the approval process for new medical devices in different jurisdictions.
CO4 Interpret risk assessment management, safety and clinical testing approaches for new medical devices.
CO5 Evaluate the product development methodologies for medical devices.
CO6 Medical device and testing, personnel involved, quality assurance, quality management system.

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. https://www.bis.gov.in
4. https://www.qcin.org/public/uploads/ckdocs/1668347882.7%20ICMED_%20Section%204B_Certification%20Process%20for%20ICMED%20%2013485%20Plus.pdf
5. https://www.iso.org/ISO-IEC-17025-testing-and-calibration-laboratories.html
6. https://www.services.bis.gov.in/php/BIS_2.0/bisconnect/standard_review/Standard_review/Isdetails?ID=MjQ5OTA%3D
7. https://www.services.bis.gov.in/php/BIS_2.0/bisconnect/knowyourstandards/Indian_standards/isdetails/MjgwODc.

CO-PO MAPPING:

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1			2			
CO2	3	3	2	3		3
CO3	3	3		3		
CO4					3	3
CO5				3	3	3
CO6	3	3		3	3	3
Avg	3	3	2	3	3	3

MD3062 ULTRASOUND PRINCIPLES AND APPLICATIONS IN MEDICINE L T P C
3 0 0 3

UNIT I PRINCIPLES OF ULTRASONICS 9

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

UNIT II TISSUE-ULTRASOUND INTERACTION 9

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

UNIT III ULTRASOUND SCANNERS 9

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

UNIT IV 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.

UNIT V 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). Therapeutic applications-lithotripsy, ultrasound diathermy, ultrasound in tumour control, physiotherapy, Image guided surgery. Ultrasonic cleaners-cavitation process Case study on recent applications of ultrasound.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Better understanding of the characteristics of ultrasound with the living system
CO2 Knowledge on ultrasound transducer design and analysis
CO3 In-depth knowledge about the Ultrasound imaging systems
CO4 Ability to specify method of ultrasonic scanning for different organs
CO5 Understanding of various diagnostic and therapeutic applications of ultrasound and its recent advancements.

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.
5. Khandpur R.S, “Hand Book of Biomedical Instrumentation”, Tata Mc Graw Hill publication, New Delhi 2nd Edition, 2003.
6. M.A. Flower, Webb‘s, “Physics of Medical Imaging”, 2nd Edition, CRC Press ,Boca Raton, FL, 2012.
7. Thomas L. Szabo, “Diagnostic ultrasound imaging Inside out”, Elsevier Academic Press, London, 2013.

CO-PO MAPPING

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1			3			
CO2			3	2		
CO3			3	2		
CO4			3			

CO5		2	3			
Avg		2	3	2		

MD3056 MEDICAL DEVICE DESIGN AND DEVELOPMENT L T P C

3 0 0 3

UNIT I PRODUCT DESIGN 9

Definition, History and Modern Practice – Designs; Design and Product Life Cycle; Design Process; 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. Case studies on design and development of medical devices.

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), ServedAvailable 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. Case Studies on product economics.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Formulate and analyze a problem for the product design.

CO2 Analyze the various stages of product development and regulatory requirements.

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

CO4 Understand the Innovation & Product Development process in the Business Context.

CO5 Analyze the economics in product development and business strategies for turn Over from commercialization.

CO6 Design and develop medical devices for commercialization.

REFERENCES:

1. Jones, J.C. "Design Methods", John Wiley, 2nd Edition, 1992.
2. Cross N "Engineering Design Methods", John Wiley, 4th Edition, 2008.
3. Michael E. McGrath, "Product Strategy for High-Technology Companies", 2nd Edition, McGrawHill, 2000
4. Ulrich, K.T., and Eppinger, S.D., "Product Design and Development", McGraw Hill, 7th Edition,2020
5. Paul H king, Richard C. Fries, Arthur T. Johnson, "Design of Biomedical Devices and Systems", 3rd Edition, CRC Press, 2014
6. Peter J. Ogrodnik, "Medical Device Design: Innovation from Concept to Market", AcademicPress Inc, 1st Edition, 2012.
7. Stefanos Zenios, Josh Makower, Paul Yock, Todd J. Brinton, Uday N. Kumar, Lyn Denend, Thomas M. Krummel, "Bio design: The Process of Innovating Medical Technologies", Cambridge University press, 2nd Edition, 2015.

CO-PO MAPPING:

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1			3	3		
CO2		3	3	3		
CO3			3	3		
CO4	1	3	3	3		
CO5		3	3	3		1
CO6		3	3	3	3	
Avg	1	3	3	3	3	1

MD3053 IoMT ARCHITECTURE AND APPLICATIONS L T P C

3 0 0 3

UNIT I OVERVIEW 9

IoT - Historical overview - An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations. M2M and IoT Technology Fundamentals- Devices and gateways, Local and wide area networking, Data

management, Business processes in IoT, Everything as a Service (XaaS), M2M and IoT Analytics, Knowledge Management

UNIT II IOT SYSTEM ARCHITECTURE, DESIGN AND PROGRAMMING 9

Introduction, IoMT Devices-On-Body Devices, In Home Devices, Community Devices, In-Clinic Devices, In Hospital Devices, IoMT System Architecture - Data Collection Layer, Data Management Layer, Medical Server Layer; Design Methodology - Embedded computing logic - Microcontroller, System on Chips – IoT system building blocks - Arduino - Board details, IDE programming - Raspberry Pi – Interfaces and Raspberry Pi with Python Programming.

UNIT III ENABLING IoMT TECHNOLOGY 9

E-Health Industrial applications in IoMT - Body centric IoMT - Skin disorder IoMT detection - Layer management in IoMT - Sensor management - Network management - Internet management - Service management; Data acquisition in IoMT -Enabling biosensors - Cancer cell detection - Smart beds - Human activity detection - Skin care wearable - Smart pillbox; Software defined IoMT - Augmented reality for IoMT; Wearable sensor network; E-health cloud for medical of things - Explainable AI for IoMT; A case study on open challenges in the implementation of IoMT Technology.

UNIT IV INTERNET OF MEDICAL THINGS SECURITY THREATS AND CHALLENGES 9

Secured architecture for IoT enabled Personalized Healthcare Systems; IoMT Attack Types, Challenges in IoMT Security Schemes, Current Security Plans for IoMT, Potential Solutions for Security Vulnerabilities. A case study on the application of Block Chain concepts on Securing IoMT.

UNIT V APPLICATIONS OF IoT IN MEDICINE 9

Healthcare Application Development in Mobile and Cloud Environments; IoT Model for Neuro sensors, Prediction of retinal disorders, Diagnosis of chest diseases, System to diagnose Brain Disorders, Voice Apps on IoT device; Healthcare Application Approach to predict Diabetic Retinopathy through data analytics, Diagnosis of chest diseases using artificial neural networks. A study on IoT based chronic disease management.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Comprehend the essentials of IoT.
CO2 Analyze various IoMT layer Protocols with relevant field applications.
CO3 Execute Embedded programming with IoT devices
CO4 Design IoT-based systems for real-world problems and Biomedical Applications.
CO5 Secure the elements of an IoT device
CO6 Design an IoT device to work with a Cloud Computing infrastructure and transfer IoT data to the cloud and in between cloud providers

REFERENCES:

1. Deloitte, “MedTech and the Internet of Medical Things -How connected medical devices are transforming health care,” Centre for Health Solutions, 2018
2. Andy Brown, “IoMT at the heart of Digital Healthcare”, OMDIA, Silicon labs, 2022
3. Dr. Yogesh Shelke, Arpit Sharma, “IoMT, Thematic Report”, Technology Intelligence & IP Research. 2016
4. Ruby Dwivedi, Divya Mehrotra, and Shaleen Chandra, “Potential of Internet of Medical Things (IoMT) applications in building a smart healthcare system: A systematic review”, 2022 Mar-Apr; 12(2): 302–318.

5. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, “Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence”, 1st Edition, Academic Press, 2014.
6. Daniel Minoli, “Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications”, ISBN: 978-1-118-47347-4, Willy Publications.
7. Vijay Madisetti and Arshdeep Bahga, “Internet of Things (A Hands-on Approach)”, 1st Edition, VPT, 2014.

CO-PO MAPPING:

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1			3			
CO2				3		
CO3			3	3		
CO4	3	3			2	
CO5	3	3	3			
CO6	3	3		3		
Avg	3	3	3	3	2	

MD3054 MACHINE LEARNING TECHNIQUES L T P C
3 0 0 3

UNIT I SUPERVISED LEARNING 9

Overview of pattern recognition- Introduction, Supervised learning - Discriminant functions, Bayesian parameter estimation, Problems with Bayes Approach. Parametric Estimation- Maximum Likelihood estimation, Pattern classification by distance functions -minimum distance Patten classifier.

UNIT II UNSUPERVISED CLASSIFICATION AND DIMENSIONALITY REDUCTION 9

Clustering for unsupervised learning and classification, clustering concepts- k- means algorithm - Validity of clustering solutions. Dimensionality reduction- Principal Component Analysis, Independent Component Analysis, Regression-Linear, Non-linear and Logistic.

UNIT III NEURAL NETWORKS AND FUZZY LOGIC 9

Biological Neuron, Artificial Neural Network, Activation function, - Perceptron Algorithm, Back propagation Algorithm, Support Vector Machine, Fuzzy Logic -Fuzzy sets and fuzzy reasoning- fuzzy matrices-fuzzy functions-decomposition –Fuzzy inference systems - Mamdani and Sugeno model, Fuzzy clustering- fuzzy c- means algorithm

UNIT IV DEEP NEURAL NETWORKS 9

Introduction to deep neural networks- Introduction to Convolutional neural network architecture- convolution, pooling layers, regularization, dropout, Introduction to transfer learning- pretrained network architectures - AlexNet, GoogleNet, VGGNet, ResNet, Applications, LSTM, Encoder/Decoder Architectures, Case studies on the deep neural network for medical images and bio signals.

UNIT V APPLICATIONS IN HEALTH CARE 9

Breast cancer detection in Mammogram images, ECG Signal Analysis for Abnormality Detection, Epileptic Seizure detection, Brain tumor classification in MR Images, Microscopic image classification. Case studies on applications of machine learning technique in healthcare.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Apply statistical pattern classifiers for real world applications

CO2 Apply clustering algorithms for classification

CO3 Extract features and perform Dimensionality reduction

CO4 Apply Neural Networks and fuzzy logic for classification

CO5 Classify the real-world data using deep learning techniques

CO6 Design and implement various machine learning algorithms for Biomedical applications

REFERENCES:

1. Richard O. Duda, Peter Hart, David Stork, "Pattern Classification", John Wiley& Sons, 2012.
2. Laurene Fausett, "Fundamentals of Neural Networks, Architectures, Algorithms and Applications", Pearson Publications, 2004.
3. Ian Good Fellow, Yoshua Bengio, Aaron Courville, "Deep Learning – Adaptive computation and Machine learning series", MIT Press, 2016
4. Stephen Marsland, "Machine Learning – An Algorithmic Perspective", Chapman and Hall, Taylor and Francis, Second Edition, 2014.
5. Niranjan Dey , Surekha Borra , Amira S. Ashour , Fuqian Shi , "Machine Learning in bio-signal analysis and diagnostic imaging", AcademicPress, 2018.
6. Antonis Michalas , Meera Narvekar , Narendra Shekokar, "Design of Intelligent Applications using Machine learning and Deep learning Techniques", CRCPress, 2021.
7. S.Sridhar, Vijayalakshmi, "Machine Learning", Oxford University Press, 2021.

CO-PO MAPPING:

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		3	3		
CO2			3	3		
CO3			3	3		
CO4			3	3		
CO5	3	3	3	3		
CO6	3	3	3	3	1	
Avg	3	3	3	3	1	

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MD3051 **BIO MEMS AND ITS APPLICATIONS** **L T P C**

3 0 0 3

UNIT I MEMS MATERIALS AND FABRICATION 9

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

UNIT II 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, Introduction to simulation of microdevices.

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 micro conduits, in sub micrometer and nanoscale. Microscale fluid, expression for liquid flow in a channel, fluid actuation methods, Di electrophoresis, microfluid dispenser, microneedle, micropumps-continuous flow system, micromixers and its types, Microfluidic for Flow cytometry, cell sorting, cell trapping. Case study: Design of electrophoretic microcapillary network system.

UNIT V APPLICATIONS OF MEMS IN MEDICINE 9

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

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 modeling 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, 2011.

2. Tai Ran Hsu, “MEMS and Microsystems design and manufacture”, Tata McGraw Hill Publishing Company, New York, 1st edition, 2017.
3. Clement Kleinstreuer, "Microfluidics and Nanofluidics: Theory and Selected Applications", 1st ed., John Wiley & Sons, New Jersey, 2013.
4. Wanjun Wang, Stephen A.Soper, “Bio MEMS: Technologies and applications”, CRCPress, New York, 2007.
5. Albert Folch, “Introduction to Biomems”,1st Edition, CRC Press, Florida, 2016.
6. Francis E. H. Tay, “Microfluidics and BioMEMS application”, 1st Edition, Springer, Berlin, 2013.
7. Alok Pandya, Vijai Singh, “Micro/Nanofluidics and Lab-on-Chip Based Emerging Technologies for Biomedical and Translational Research Applications” - Part B, Academic Press, 2022.

CO-PO MAPPING:

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1			3			
CO2				3		1
CO3	3		3			
CO4	3			3		
CO5	3				3	1
Avg	3		3	3	3	1

MD3061 TELEHEALTH TECHNOLOGY L T P C

3 0 0 3

UNIT I TELEMEDICINE AND TELEHEALTH 9

History and Evolution of telemedicine, Purposes and its organization, Biomedical Telemetry, Teleconsultation, Tele health, Components, Delivery modes of Telemedicine, Global and Indian scenario- A study on Advances in Telemedicine, Benefits and Challenges.

UNIT II TELEMEDICAL TECHNOLOGY 9

Transmission of data, image, video, audio; Telemedicine Workstation and interfacing; Telecommunication Technologies.

UNIT III NETWORKING IN TELEMEDICINE 9

Network configuration, management, communication and implementation; Wireless Technologies – Types, Evolution, Transmission media, antenna and EMI; mHealth technologies, WBAN, WPAN and WSN using 5G: A case study on Chronic Disease Management.

UNIT IV TELEHOME CARE AND PERSONAL HEALTH MONITORS 9

Telehome care and telehealth – Categories, Telehome care technologies. Requirements and Management; Personal Health Monitors, Wearable Monitors. A feasibility study on the

implementation of Tele homecare in the Indian scenario.

UNIT V e-HEALTH AND LEGAL ISSUES 9

Internet, eHealth and cyber-Medicine; Videoconferencing – Components, categories, considerations; Videoconferencing standards and selection; Applications, PACKs, Telepathology, Tele dermatology, Teleradiology, Telecardiology, Teleophthalmology, Telesurgery; Ethical, privacy, Security and legal issues in Telemedicine. Assess the socioeconomic and medicolegal aspects of implementing e-Health services.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Solve healthcare delivery process

CO2 Evaluate how events in the technology space can impact the broader healthcare industry

CO3 Analyze and translate large datasets into actionable information for decision making

CO4 Propose strategies to improve access, quality or affordability through Technology

CO5 Apply advanced design principles when utilizing communication networks

CO6 Able to identify and address a range of sociotechnical factors that influence the success or failure of implementation projects and be able to apply principles and methods of evaluation to telehealth projects

REFERENCES:

1. Wootton R., Craig, J., Patterson, V. (Eds.), “Introduction to Telemedicine”. Royal Society of Medicine Press Ltd (ISBN 1853156779), 2006
2. D. Jude Hemanth, Valentina Emilia Balas, “Telemedicine Technologies**:** Big Data, Deep Learning, Robotics, Mobile and Remote Applications for Global Healthcare,” Academic Press, 2019
3. Kumar, S.N., Suresh, Sundara Varadhan, Vivekananth, Padmanabhan, Zafar, Sherin, “Advancement, Opportunities, and Practices in Telehealth Technology,” IGI Global, 2022.
4. David Dagan Feng, Biomedical Information Technology, Academic Press Series in Biomedical Engineering, Elsevier Inc, USA, 2008
5. Ilias G. Maglogiannis, Kostas Karpouzis and Manolis Wallace, Image and Signal Processing for Networked E-Health Applications, Morgan & Claypool Publishers’ series, USA, 2006.

CO-PO MAPPING:

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1		3	3	3		
CO2		3	3	3		
CO3	3			3	3	
CO4	3	3		3	3	
CO5			3		3	2
CO6	3	3				2
Avg	3	3	3	3	3	2

Attested

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MD3006 **WEARABLE BODY AREA NETWORKS** **L T P C**

3 0 0 3

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, case studies on optimal signal processing techniques for wearables.

UNIT V APPLICATIONS **9**

Monitoring patients with chronic disease, Hospital patients, Elderly patients, Cardiac arrhymia monitoring, Multi patient monitoring systems, Multichannel Neural recording, Gait analysis, Sports Medicine, Electronic pill. case studies on wearables for sports applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Understand the need for WBAN and the challenges involved in the design

CO2 Analyze the wireless Body Area Network and the hardware required for the implementation

CO3 Select the type of wearable sensor required for specific BAN application.

CO4 Implement the suitable signal processing technique for optimal power consumption.

CO5 Design wearable systems for wireless healthcare system applications

REFERENCES:

1. Annalisa Bonfiglio, Danilo De Rossi, "Wearable Monitoring Systems", Springer,2011.
2. Sandeep K. S. Gupta, Tridib Mukherjee, Krishna Kumar Venkata Subramanian, “Body Area Networks Safety, Security and Sustainability”, Cambridge University Press,2013.
3. Zhang, Yuan-Ting, “Wearable Medical Sensors and Systems”, Springer, 2021.
4. Guang - Zhong Yang, “Body Sensor Networks”, Springer, 2016.
5. Mehmet R. Yuce, Jamil Y. Khan, “Wireless Body Area Networks Technology, Implementation and Applications, Pan Stanford Publishing, 1st Edition, 2011
6. Jamil Khan , Mehmet R. Yuce, “Wireless Body Area Networks: Technology,Implementation

and Applications", Pan Stanford Publishing, 1st Edition, 2011.
7. Kasun Maduranga Silva Thotahewa , Jean-Michel Redouté, "Ultra-wideband Wireless Body Area Networks", Springer, 2016.

CO-PO MAPPING:

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1			3	3		
CO2			3	3		
CO3			3	3		
CO4	3	3	3	3		
CO5	3	3	3	3		
Avg	3	3	3	3		

MD3059 MICROFLUIDIC DEVICES FOR BIOMEDICAL APPLICATIONS L T P C
3 0 0 3

UNIT I INTRODUCTION TO MICROFLUIDICS 9

Microfluidics Versus Traditional Fluidics, properties of fluids, classification of fluids, pressure driven flow, continuity equation, momentum equation, equation of motion, laminar flow in circular conduits, fluid flow in micro conduits, in sub micrometer and nanoscale. Microscale fluid, expression for liquid flow in a channel - surface tension, contact angle and Electro Wetting, Navier Strokes equation. Electrokinetic phenomena- Electro-Osmosis, Di electrophoresis, Electric double layer, Debye length, capillary flow, flow through porous media, Diffusion.

UNIT II FABRICATION TECHNIQUES OF MICROFLUIDIC DEVICES 9

Materials, Clean room, Silicon crystallography, Miller indices. Silicon-Based Micromachining Techniques- Silicon Bulk Micromachining, Silicon Surface Micromachining, Polymer-Based Micromachining Techniques- Thick Resist Lithography, Polymeric Surface Micromachining, Soft Lithography, Micro stereo Lithography, Micro molding., Hot embossing, Fluid interconnections. Case Study: Fabrication of lab-on-a-paper - Lab-on-a-chip.

UNIT III COMPONENTS OF MICROFLUIDIC DEVICES 9

Design considerations and applications – Micromixers, Microvalves, Micropumps, Microchannels, Microflow sensors. Droplet generators - Microreactors, Liquid phase reactors, PCR reactors. Microparticle separator - Principles of separation and sorting of microparticles. Mathematical modeling of microfluidic devices and systems, Practical aspects of testing flow through microfluidic channels, Digital Microfluidics. Case study: Introduction to Simulation Tools to design Microfluidic device.

UNIT IV MICROFLUIDICS BIOCHIP 9

Microfluidic for Flow cytometry, cell sorting, cell trapping, Cell culture in microenvironment. Bioreactors on Microchips, Enzyme assay and inhibition, Chemical synthesis in microreactors, Sequential reaction and Parallel reaction in micro reactors, chemical separation, liquid

chromatography. Immunosensors - Nucleic acid sensors, DNA amplification platforms. Case Study: Experimental measurement of fluid velocity profiles through particle velocimetry.

UNIT V APPLICATIONS OF MICROFLUIDIC DEVICES IN HEALTHCARE 9

Diagnostic applications - In vitro diagnostics, Point - of - care diagnostics, Controlled drug delivery using microfluidic devices, Microneedles for drug delivery and monitoring, Microfluidic devices for cell manipulation, single-cell trapping, automated micro-robotic injection, Microfluidic devices for stem cell analysis and genetic analysis, Immunosensing, Microfluidic devices for radio chemical synthesis, paper-based microfluidic biomedical devices. Case study: Case studies - Microfluidic product development - Disease diagnosis – Prognosis.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Describe the fundamental principles and concepts of microfluidics.

CO2 Explain the different types of materials and fabrication techniques used in developing microfluidic devices.

CO3 Elaborate the design considerations of various microfluidic devices.

CO4 Illustrate the bioanalytical applications of microfluidic devices.

CO5 Elucidate the diagnostic and therapeutic applications of microfluidic devices.

REFERENCES:

1. Tabeling, P., “Introduction to microfluidics”, Oxford University Press Inc., 2005.
2. Oosterbroek and van den Berg, “Lab-on-a-chip: Miniaturized Systems for (Bio) Chemical Analysis and Synthesis”. Elsevier, 2003.
3. Gescheke et al, “Microsystems Engineering of Lab-on-a-Chip Devices”. Wiley, 2004.
4. Nguyen, N. T., Werely, S. T., “Fundamentals and Applications of Microfluidics”, Artech house Inc., 2002.
5. Madou, M. J., Manufacturing Techniques for Microfabrication and Nanotechnology (Vol. 2), CRC Press, Boca Raton, FL, 2011.
6. Kirby, B. J., Micro- and Nanoscale Fluid Mechanics: Transport in Microfluidic Devices, Cambridge University Press, 2010.
7. Chakraborty, S., Microfluidics and microfabrication, Springer, New York, NY, 2010.

CO-PO MAPPING:

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		2	3	2	1
CO2		3		3	2	1
CO3	3			3	2	
CO4			2	3	2	1
CO5	3	3	2	3	2	
Avg	3	3	2	3	2	1

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MD3055 **MEDICAL DATA ANALYTICS** **L T P C**

3 0 0 3

UNIT I PYTHON PROGRAMMING FOR DATA ANALYSIS 9

Python Functions and Packages – Data Frame Manipulation with numpy, Matlibplot and pandas – Exploration Data Analysis – Time Series Dataset – Clustering with Python – Dimensionality Reduction. Python integrated Development Environments (IDE) for Data Science.

UNIT II STATISTICAL ANALYSIS OF DATA 9

Importance of statistical analysis, Descriptive Statistics- Frequency Distribution, Measures of Central Tendency, Dispersion, Skewness, Univariate and Bivariate Statistics Inferential Statistics- ANOVA (Analysis of Variance), t-tests, regression analysis, Identifying and Normalizing Outliers, Missing value analysis and Data Visualization.

UNIT III MACHINE LEARNING TECHNIQUES 9

Supervised learning- Linear Regression, Multiple Variable Linear Regression, Logistic Regression, k-NN Classification, Support Vector Machines, Unsupervised Learning- K-means Clustering, Hierarchical Clustering, Ensemble Techniques- Decision Trees, Bagging and Random Forests.

UNIT IV DEEP NETWORKS 9

Multilayer Perceptrons, Activation and Loss functions, Regularization, Batch Normalization, CNN- • Convolution, Pooling, Padding & its Mechanisms, Forward Propagation and Backpropagation, AlexNet, VGGNet, GoogleNet and ResNet, Transfer Learning, Object Detection.

UNIT V R PROGRAMMING 9

R Programming- Functions, Vectors, list, Data manipulation and Visualization. Laboratory implementation: Classification of biosignals and medical images via Artificial intelligence and machine Learning algorithms. Case studies: Dementia Detection from MRI images, COVID-19 Infection Detection from Chest X-Ray Images.

TOTAL:45 PERIODS

COURSE OUTCOMES:

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

CO1 Perform data manipulation and analysis using Python

CO2 Perform the statistical analysis of data and better data visualization.

CO3 Describe and implement ML algorithms for medical data classification.

CO4 Design Deep Networks for various medical applications.

CO5 Implement R programs for medical data analysis.

REFERENCES:

1. Allen B. Downey, “Think Python: How to Think like a Computer Scientist”, 2nd Edition, O’Reilly Publishers, 2016.
2. Ian Goodfellow Yoshua Bengio Aaron Courville, Deep Learning, MIT Press, 2017
3. N D Lewis, Deep Learning Step by Step with Python, 2016.
4. Ethem Alpaydin, “Introduction to Machine Learning”, MIT Press, Fourth Edition, 2020.
5. Stephen Marsland, “Machine Learning: An Algorithmic Perspective, “Second Edition”, CRC Press, 2014.
6. Michael Freeman and Joel Ross, Programming Skills for Data Science: Start Writing Code to Wrangle, Analyze, and Visualize Data with R, Addison-Wesley, 2018.

Attested

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7. Benjamin S. Baumer, Daniel T. Kaplan and Nicholas J. Horton, Modern Data Science with R, Chapman and Hall/CRC, 2021.

CO-PO MAPPING:

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3			
CO2	3	3	3			
CO3	3	3	3	2		
CO4	3	3	3			
CO5	3		3	2	1	
Avg	3	3	3	2	1	

MD3060 PHYSIOLOGICAL SYSTEMS MODELING AND SIMULATION L T P C
3 0 0 3

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 Systemproperties, 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, TransferFunction and Concept of Impedance – Circuits into transfer function, Circuit Analog fromtransfer 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- using Open CV / MATLAB software, Simulation of Respiratory mechanics, Cardiovascular Control System, Skeletal muscle servo mechanism, Oculomotor System, Hodgkin Huxley Model, Glucose -Insulin Regulations. Introduction to finite element models - Finite Element Analysis to Study Percutaneous Heart Valves, Finite Element Modeling, and Simulation of Arteries.

Attested

TOTAL: 45 PERIODS

COURSE OUTCOME:

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 Describe the concepts of transfer function for first and second order system

CO3 Analyse various response characteristics of physiological system

CO4 Apprehend the feedback control system and its effects in real life.

CO5 Simulate 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, NewYork, 1969.
2. Manfreo Clynes and John H. Milsum, "Biomedical Engineering System", McGraw Hilland Co, New York, 1970.
3. Michael C.K. Khoo, " Physiological Control System - Analysis, Simulation andEstimation", Prentice Hall of India, New Delhi, 2001
4. Richard Skalak and Shu Chien, "Hand Book of Biomedical Engineering", McGraw Hilland Co, New York, 1987.
5. Vasilis Z. Marmarelis, "Nonlinear Dynamic Modelling of Physiological Systems", Wiley IEEE Press, 2004.
6. David T. Westwick, Robert E. Kearney, "Identification of Nonlinear Physiological Systems", Wiley-IEEE Press, 2003.
7. Minrui Fei, Shiwei Ma, Xin Li, Xin Sun, Li Jia and Zhou Su, "Advanced Computational Methods in Life System Modelling and Simulation," Springer,2017.

CO-PO MAPPING:

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2				
CO2				3	3	
CO3				3	3	
CO4				3	3	
CO5	3			3	3	
Avg	3	2		3	3	

MD3058 MEDICAL ROBOTICS AND AUTOMATION L T P C

3 0 0 3

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.

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UNIT II MANIPULATORS & BASIC KINEMATICS 9

Construction of Manipulators, Manipulator Dynamic and Force Control, Electronic and pneumatic manipulator, Forward Kinematic Problems, Inverse Kinematic Problems, Solutions of Inverse Kinematic problems. Navigation and Treatment Planning-Variable speed arrangements, Path determination – Machinery vision, Ranging – Laser –Acoustic, Magnetic, fiber optic and Tactile sensor.

UNIT III SURGICAL ROBOTS 9

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

UNIT IV REHABILITATION AND ASSITIVE ROBOTS 9

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

UNIT V WEARABLE ROBOTS 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Understand the concept, applications of robots and its component
CO2 Analyse the functions of manipulators and basic kinematics.
CO3 comprehend 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. Shane (S.Q.) Xie, Advanced Robotics for Medical Rehabilitation - Current State of the Art and Recent Advances, Springer, 2016.
4. Sashi S Kommu, Rehabilitation Robotics, I-Tech Education and Publishing, 2007.
5. Jacob Rosen, Blake Hannaford & Richard M Satava, “Surgical Robotics: System Applications & Visions”, Springer 2011.
6. ocelyn Troccaz, Medical Robotics, Wiley, 2012.
7. Achim Schweikard, Floris Ernst, Medical Robotics, Springer, 2015

CO-PO MAPPING:

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1			1	3		
CO2			1	3		
CO3	1	1	1	3	2	
CO4	1	1	1	3	2	2
CO5	1	1	1	3	2	2
Avg	1	1	1	3	2	2

BO3051 BIOMECHANICS AND ITS APPLICATIONS L T P C

3 0 0 3

UNIT I INTRODUCTION 9

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

UNIT II MECHANICS OF CIRCULATION 9

Flow properties of blood, viscosity, non-Newtonian viscosity, 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 - cortical and trabecular, 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. Physics of sports.

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 on muscle model.

UNIT V BIO MECHANICAL ASPECT OF ACCIDENT INVESTIGATION 9

Experimental and Analytical method of analysis, Head Injury tolerance, rotational injury, spine injury, Accident reconstruction, Analysis of impact, skid analysis – Damage analysis, Case study on accident investigation.

TOTAL:45 PERIODS

COURSE OUTCOMES:

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

CO1 Understand the concepts of mechanics and its application in medicine.

CO2 Analyse the properties of hard and soft tissues

CO3 Analyse the human locomotion for sports medicine

CO4 Understand the biomechanical aspects of accident investigation and injuries.

CO5 Conceptualize the control mechanics of physiological system

REFERENCES

1. Y.C. Fung, Biomechanics: Mechanical properties in living tissues, Springer Verlag, New York 2013.
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. David A. Winter, Biomechanics and Motor Control of Human Movement, Wiley Publisher, 4th Edition, 2009.
7. Margareta Nordin and Victor H. Frankel, "Basic Biomechanics of the Musculoskeletal System", Lippincott William &Wilkins, 4th Edition, 2012.

CO-PO MAPPING:

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1				3		
CO2				3		
CO3			2	3	1	1
CO4	1	1	2	3	1	1
CO5	1	1	2	3	1	1
Avg	1	1	2	3	1	1

BO3251 REHABILITATION ENGINEERING AND ASSISTIVE TECHNOLOGY **L T P C**
3 0 0 3

UNIT I INTRODUCTION **9**

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

UNIT II PROSTHETIC AND ORTHOTIC DEVICES **9**

Prosthetics and Orthotics in Rehabilitation- An Introduction, types of body powered and externally powered limb prosthetics, Lower limb, Upper limb orthotics, materials for prosthetic and orthotic devices, mobility aids. Functional Electrical Stimulation – restoration of upper limb and lower limb functions. Hybrid Assistive Systems (HAS). Gait analysis, Assessment of mobility rehabilitation, Bionic arm. Neuromodulation techniques-Introduction. Case study on neuromodulation related applications.

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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, Bionic eye, Braille Reader, Tactile devices for visually challenged, Text voice converter, screen readers. Low vision aids, Case study on sensory Substitution systems for visual impairment.

UNIT V REHABILITATION MEDICINE AND ADVOCACY 9

Physiological aspects of Function recovery, psychological aspects of Rehabilitation therapy, Legal rights of persons with disabilities- The PWD Act 2016, Provisions available in education, employment, and in day-to-day life. Architectural design features for motor and visual disability for day-to-day life-A Case study.

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 Analyse the design and working of prosthetic and orthotic devices.
CO3 Comprehend the design of sensory substitution systems for auditory and speech impairments.
CO4 Interpret the design of rehabilitation aids for the visually challenged.
CO5 Understand the stages of functional recovery and the provisions provided by the government for the differently abled people.
CO6 Apply the design concepts to develop a suitable assistive device for a particular case.

REFERENCES:

1. Rory A Cooper (Editor), Hisaichi Ohnabe (Editor), Douglas A. Hobson (Editor), “An Introduction to Rehabilitation Engineering (Series in Medical Physics and Biomedical Engineering” CRC Press, 2006.
2. Joseph D Bronzino, “The Biomedical Engineering Handbook”, Four Volume Set, 4th Edition, CRC Press, 2015.
3. Robinson C.J, “Rehabilitation Engineering,” CRC Press, 2006.
4. Sunder, “Textbooks of Rehabilitation,” Jaypee Brothers Medical Publishers Pvt. Ltd, New Delhi, 2nd Edition, Reprint 2007.
5. Albert M Cook and Webster J G, Therapeutic Medical Devices, Application and Design, Prentice Hall New York 1982
6. Reswick.J, “What is Rehabilitation Engineering, Annual review of Rehabilitation,” volume 2, Springer- Verlag, New York 1982
7. Warren E. Finn, Peter G. Lopressor, “Handbook of Neuroprosthetic Methods,” CRC, 2002.

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CO-PO MAPPING:

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1			3			
CO2	3	3	3	3		2
CO3			3	3		
CO4	3	3	3	3		
CO5	3	3	3			
CO6			3	3		2
Avg	3	3	3	3		2

BO3053 FINITE ELEMENT ANALYSIS FOR BIOMEDICAL ENGINEERING L T P C

3 0 0 3

UNIT I GENERAL INTRODUCTION 10

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

UNIT II BEAM ELEMENTS AND SCALAR PROBLEM IN 2D 9

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

UNIT III APPLICATIONS TO FIELD PROBLEMS 9

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

UNIT IV ISOPARAMETRIC FORMULATION ANDMISCELLANEOUS TOPICS 8

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

problems in fluid mechanics- numerical examples -plates and shells, Case study on design of blood vessels to understand haemodynamic.

UNIT V NON-LINEAR ANALYSIS 9

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

TOTAL :45 PERIODS

COURSE OUTCOMES:

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

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

REFERENCES:

1. Yang Z, “Finite Element analysis for Biomedical Engineering Applications”, CRC Press, 2019.
2. Seshu. P, “Textbook of Finite Element Analysis,” Prentice Hall of India, 2003.
3. J.N. Reddy, “Finite Element Method”, Tata McGraw Hill, 2003.
4. S.S. Rao, “The Finite Element Method in Engineering” Butter worth heinemann, 2001.
5. Reddy, J.N, “An Introduction to the Finite Element Method”, McGraw – Hill, 1985.
6. David V. Hutton, “Fundamentals of Finite Element Analysis”, McGraw-Hill, 1st Edition, 2003.

CO-PO MAPPING:

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1				3		
CO2				3		
CO3	1	1	1	3		1
CO4	1	1	1	3	1	
CO5	1	1	1	3		1
Avg	1	1	1	3	1	1

BO3054 PHOTONICS IN MEDICINE L T P C

3 0 0 3

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- water, melanin, bilirubin and their spectrum, optical characteristics of constituents of blood — RBC, plasma, hemoglobin properties - 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, photoacoustic tomography, laser induced breakdown spectroscopy (LIBS), hyperspectral imaging, bioimaging probes for clinical applications, 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, low level laser therapy (LLLT). Bio stimulation 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 Discuss the photonics instruments
CO2 Analyze the various optical properties of tissue
CO3 Describe diagnostic applications of lasers in medical field
CO4 Summarize therapeutic and surgical applications of lasers in medical fields
CO5 Describe the 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 Bio photonics", 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.
6. Gerd Keiser, "Bio photonics - Concepts to Applications", Springer, 2016.
7. Tuchin, Valery V., "Handbook of optical biomedical diagnostics", SPIE- The International Society for Optical Engineering, 2002.

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CO-PO MAPPING:

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1			2		
CO2	1					
CO3			3	2		
CO4	1		3			
CO5			3	2		
Avg	1		3	2		

BO3052 COGNITIVE FUNCTION ANALYSIS L T P C

3 0 0 3

UNIT I COGNITIVE FUNCTION ASSESSMENT 9

Brain lobes with their functions and areas, EEG Acquisition, Electrode placement, Preprocessing, Spectral analysis, Analysis of Event Related Potential, Quantitative Analysis – EEG, MEG, fMRI, Functional Near Infrared Spectroscopy (fNIRS), Cognitive Assessment tools.

UNIT II DETECTION OF COGNITIVE DISORDERS 9

Detection and Classification of Dementia, Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectral Disorder, Learning Disabilities, Sleep Studies and Stress Assessment, Case studies on ADHD.

UNIT III ANALYSIS OF COGNITIVE FUNCTION 9

EEG Analysis for Cognitive work load Assessment, Emotion detection, Performance Assessment and Enhancement of Sports, Effects of Yoga, Case studies on EEG Analysis of cognitive functions.

UNIT IV NEUROFEEDBACK 9

Neurofeedback System, Types of Neurofeedback, Neurofeedback protocols, Clinical Applications of Neurofeedback, Neurofeedback Training in the Treatment of Diseases and Disorders, Neurofeedback software, Case studies on Neurofeedback.

UNIT V BRAIN CONTROL INTERFACE 9

Structure of BCI system – Classification of BCI, Mu rhythm, Movement Related Potentials – Slow Cortical Potentials - P300 Event related potential - Visual Evoked Potential, Functional restoration using Neuroprosthesis - Functional Electrical Stimulation, Visual Feedback and control - External device controllers.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Analyze the brain signal and assess the cognitive function.

CO2 Detect and classify the various cognitive disorders.

CO3 Analyze the EEG signal for detecting the cognitive function

Attested

CO4 Design Neuro-feedback protocols for the treatment of various cognitive disorders

CO5 Design Brain control interface system for various applications

REFERENCES:

1. Juri Kroptov, “Quantitative EEG, Event Related Potentials and Neurotherapy”, Academic Press, 2008.
2. Jonathan Wolpaw, Elizabeth Winter Wolpaw, “Brain Computer Interfaces: Principles and practice”, Edition 1, Oxford University Press, USA, 2012.
3. Thomas H. Budzynski, Helen Kogan Budzynski, James R. Evans, Andrew Abarbanel, “Introduction to Quantitative EEG and Neurofeedback Advanced Theory and Applications”, Academic Press, 2nd Edition, 2008.
4. Guy A. Boy, “Cognitive Function Analysis: 2(Contemporary studies in cognitive science and Technology, 2)”, Praeger Publishers, 1998.
5. Neville A. Stanton , Paul M. Salmon , Guy H. Walker, “Cognitive Work Analysis : Applications, Extensions and Future directions”, CRC Press, 1st Edition, 2017.
6. Ann M. Bisantz , Catherine M. Burns, “Applications of Cognitive Work Analysis”, CRC Press, 1st Edition, 2008.
7. Amit Konar, “Artificial Intelligence and Soft Computing: Behavioral and cognitivemodeling of the Human Brain”, CRC Press, 1st Edition, 1999.

CO-PO MAPPING:

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1			3	3		
CO2	3	3	3	3		
CO3	3	3	3	3		
CO4	3	3	3	3		2
CO5	3		3	3		2
Avg	3	3	3	3		2

Attested

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