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

VISION OF THE DEPARTMENT

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 OF THE DEPARTMENT

- 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

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UNIVERSITY DEPARTMENTS
M.E. BIOMEDICAL ENGINEERING (R-2023)
REGULATIONS 2023
CHOICE BASED CREDIT SYSTEM

1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

I. Possess technical and intellectual skills to solve transdisciplinary problems in the fields of healthcare.
II. Exhibit competency in hospital and healthcare management.
III. Engage themselves in research and development activities in biomedical engineering and related fields.
IV. Exhibit leadership and entrepreneurship skills with ethical and social responsibilities.
V. Enhance their technical competence through lifelong learning.

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 specialization of the program. The mastery should be at a level higher than the requirements in the Biomedical Engineering bachelor program.
4.	**Engineering Design**	Apply fundamental principles of mathematical, biological, physical sciences and engineering to design and develop healthcare devices.
5.	**Development of Healthcare management Systems**	Demonstrate quality assurance and managerial skills in designing and implementing healthcare management system.
6.	**Environment and Society**	An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgements considering the impact of engineering solutions in global, economic, environmental and societal context.

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3. PEO/PO Mapping:

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

4. PROGRAM ARTICULATION MATRIX OF M.E. BIOMEDICAL ENGINEERING

		COURSE NAME	PO1	PO2	PO3	PO4	PO5	PO6
YEAR I	SEMESTER I	Advanced Applied Mathematics						
		Research Methodology and IPR						
		Human Biology	2		3			2
		Diagnostic and Therapeutic Equipment		1	3	3		
		Medical Imaging Systems		2	3	1		
		Signal and Image processing for Biological Systems	3	3	3	2		
		Clinical Instrumentation Laboratory	1	1	3	3	1	1
	SEMESTER II	Rehabilitation Engineering and Assistive Technology	3	3	3	3		2
		Hospital Administration and Equipment Management		3	3	3	1	2
		Health Informatics	3	3	3	3	1	1
		Professional Elective I						
		Professional Elective II						
		Advanced Biomedical Engineering Laboratory	2	3	3	3	2	1
		Mini Project	2	2	3	3	2	2
YEAR II	SEMESTER III	Professional Elective III						
		Professional Elective IV						
		Professional Elective V						
		Hospital Training	2	2	3	3	3	2
		Project Work I	2	2	3	3	2	2
	SEMESTER IV	Project Work II	2	2	3	3	2	2
		Average	2	2	3	3	2	2

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M.E. BIOMEDICAL ENGINEERING
REGULATIONS – 2023
CHOICE BASED CREDIT SYSTEM
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.	BO3101	Human Biology	PCC	3	0	0	3	3
4.	BO3102	Diagnostic and Therapeutic Equipment	PCC	3	0	0	3	3
5.	BO3103	Medical Imaging Systems	PCC	3	0	0	3	3
6.	BO3104	Signal and Image Processing for Biological Systems	PCC	3	0	4	7	5
PRACTICALS								
7.	BO3111	Clinical 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.	BO3251	Rehabilitation Engineering and Assistive Technology	PCC	3	0	0	3	3
2.	BO3201	Hospital Administration and Equipment Management	PCC	3	0	0	3	3
3.	BO3202	Health Informatics	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
PRACTICALS								
6.	BO3211	Advanced Biomedical Engineering Laboratory	PCC	0	0	4	4	2
7.	BO3212	Mini Project	EEC	0	0	4	4	2
			TOTAL	**15**	**0**	**8**	**23**	**19**

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SEMESTER III

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	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.	BO3311	Hospital Training (4 weeks)	EEC	0	0	0	0	2
5.	BO3312	Project Work I	EEC	0	0	12	12	6
			TOTAL	**9**	**0**	**12**	**21**	**17**

SEMESTER IV

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	BO3411	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	I
		TOTAL CREDITS				**4**	

PROFESSIONAL CORE COURSES (PCC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			L	T	P		
1.	BO3102	Diagnostic and Therapeutic Equipment Equipment	3	0	0	3	I
2.	BO3103	Medical Imaging Systems	3	0	0	3	I
3.	BO3104	Signal and Image Processing for Biological Systems	3	0	4	5	I
4.	BO3101	Human Biology	3	0	0	3	I
5.	BO3111	Clinical Instrumentation Laboratory	0	0	4	2	I
6.	BO3251	Rehabilitation Engineering and Assistive Technology	3	0	0	3	II

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7.	BO3201	Hospital Administration and Equipment Management	3	0	0	3	II
8.	BO3202	Health Informatics	3	0	0	3	II
9.	BO3211	Advanced Biomedical Engineering Laboratory	0	0	4	2	II
		TOTAL CREDITS				**27**	

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	I
		TOTAL CREDITS				**3**	

PROFESSIONAL ELECTIVES

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MD3051	Bio MEMS and Its Applications	PEC	3	0	0	3	3
2.	BO3001	Principles of Biostatistics	PEC	3	0	0	3	3
3.	BO3002	Biomaterials	PEC	3	0	0	3	3
4.	BO3003	Finance Management in Hospitals	PEC	3	0	0	3	3
5.	BO3004	Embedded System Design and Development	PEC	3	0	0	3	3
6.	BO3054	Photonics in Medicine	PEC	3	0	0	3	3
7.	BO3005	Physics in Medicine	PEC	3	0	0	3	3
8.	MD3060	Physiological Systems Modeling and Simulation	PEC	3	0	0	3	3
9.	BO3006	Principles of Genetic Analysis	PEC	3	0	0	3	3
10.	MD3061	Telehealth Technology	PEC	3	0	0	3	3
11.	BO3007	Tissue Engineering	PEC	3	0	0	3	3
12.	BO3051	Biomechanics and Its Applications	PEC	3	0	0	3	3
13.	MD3056	Medical Device Design and Development	PEC	3	0	0	3	3
14.	MD3052	Brain Control Interface	PEC	3	0	0	3	3
15.	BO3053	Finite Element Analysis for Biomedical Engineering	PEC	3	0	0	3	3
16.	BO3008	Hospital Planning, Organization and Management	PEC	3	0	0	3	3
17.	BO3009	Biomedical Waste Management and Control	PEC	3	0	0	3	3
18.	BO3010	Human Resources Management in Health Care	PEC	3	0	0	3	3

19.	MD3053	IoMT Architecture and Applications	PEC	3	0	0	3	3
20.	MD3055	Medical Data Analytics	PEC	3	0	0	3	3
21.	MD3057	Medical Device Regulations and Standards	PEC	3	0	0	3	3
22.	MD3058	Medical Robotics and Automation	PEC	3	0	0	3	3
23.	MD3059	Microfluidic Devices for Biomedical Applications	PEC	3	0	0	3	3
24.	BO3011	Nanomedicine Principles and Applications	PEC	3	0	0	3	3
25.	BO3012	Nanotoxicology	PEC	3	0	0	3	3
26.	BO3013	Neuroscience and Neural Engineering	PEC	3	0	0	3	3
27.	MD3054	Machine Learning Techniques	PEC	3	0	0	3	3
28.	BO3014	Quality Assurance and Safety in Hospitals	PEC	3	0	0	3	3
29.	MD3062	Ultrasound Principles and Applications in Medicine	PEC	3	0	0	3	3
30.	BO3052	Cognitive Function Analysis	PEC	3	0	0	3	3
31.	BO3015	Biomechanics of Human Movement and Wearable Robotic Systems	PEC	3	0	0	3	3

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			L	T	P		
1.	BO3212	Mini Project	0	0	4	2	II
2.	BO3311	Hospital training	0	0	0	2	III
3.	BO3312	Project Work I	0	0	12	6	III
4.	BO3411	Project Work II	0	0	24	12	IV
TOTAL CREDITS						**22**	

SUMMARY

	Name of the Programme: M.E. BIOMEDICAL ENGINEERING					
	SUBJECT AREA	CREDITS PER SEMESTER				CREDITS TOTAL
		I	II	III	IV	
1.	FC	4				**4**
2.	PCC	16	11			**27**
3.	PEC		6	9		**15**
4.	RMC	3				**3**
5.	EEC		2	8	12	**22**
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:

	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.

BO3101 HUMAN BIOLOGY L T P C

3 0 0 3

UNIT I FUNDAMENTALS OF CELL BIOLOGY 9

Cell-structure and functions of cellular organelles. Cell membrane transport-active and passive transport, carrier proteins, endocytosis and exocytosis, resting membrane potential, active potential and ionic basis of potentials. Cell Chemistry and its metabolic pathways, disorders related to carbohydrates, lipids and proteins.

UNIT II HOMEOSTASIS AND MUSCULOSKELETAL SYSTEM 9

Organization - tissues, body cavities, homeostasis-clotting factors and coagulation mechanism, anatomical planes and sections. Musculoskeletal System-structure of muscle, its types and functions, structure and functions of bone, axial and appendicular skeletal system, ligaments, tendons and joints, appendages.

UNIT III DIGESTIVE, RESPIRATPORY AND URINARY SYSTEM 9

Digestive system: organization of GI tract, digestion, absorption and elimination of food. Respiratory system structures involved in respiration and mechanism of breathing. Urinary system- organs of urinary system and mechanism of urine formation.

UNIT IV NERVOUS, CARDIOVASCULAR AND IMMUNE SYSTEM 9

Organization of nervous system-central nervous system, peripheral nervous system and autonomic nervous system. Cardiovascular system - circulatory blood vessels, anatomy and physiology of heart. Special senses: structure of eye and ear, immune system- innate immunity, acquired immunity and cells involved in defense mechanism.

UNIT V REGENERATIVE MEDICINE 9

Definition of stem cells and its types, culture of stem cells, protocol in the production of stem cells, medical applications of stem cells, ethical and legal issues in use of stem cells. Introduction to regeneration in different tissues, role of biomolecules in tissue regeneration, artificial organs. Engineered tissues, molecular therapy for regeneration and personalized therapies in regenerative medicine.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

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

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

CO3 Understand organization of different organs and its relationship with functions in human body.

CO4 Acquire the underlying knowledge in the molecular mechanism and to interpret the reason for dysfunction during diseased state.

CO5 Able to assess the societal and economic impact of public health on human population.

REFERENCES:

1. Donald Voet, Akif Uzman, Judith G. Voet, Charlotte W. Pratt, “Fundamentals of Biochemistry”, John Wiley and Sons, New York, 2008.
2. BD Ratner, AS Hoffmann, FJ Schoen, JE Lemmons, “An introduction to Materials in medicine”, Academic Press 1996.
3. Elaine.N. Marieb, “Essential of Human Anatomy and Physiology”, Eight edition, Pearson Education NewDelhi, 2007.
4. Gillian Pocock, Christopher D. Richards, "The Human Body An introduction for Biomedical and Health Sciences", 1st Edition, Oxford University Press, USA, 2009.
5. William F. Ganong, "Review of Medical Physiology”, 22nd edition, Mc Graw Hill New Delhi.
6. Eldra Pearl Solomon. "Introduction to Human Anatomy and Physiology", W.B.Saunders Company, 2003.
7. Arthur C. Guyton, "Text book of Medical Physiology", 11th Edition, Elsevier Saunders, 2006.
8. Gary A.Thibodeau, Kevin T.Patton, “Anatomy & Physiology”, 7th Edition, Mosby Publisher 2009.
9. Ranganathan T S, “Text Book of human Anatomy”, S. Chand and company New Delhi, 1994.
10. Stewart Sell, “Stem Cells Handbook”, Humana Press; Totowa NJ, USA; Oct. 2004.

CO-PO MAPPING:

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

BO3102 DIAGNOSTIC AND THERAPEUTIC EQUIPMENT L T P C

3 0 0 3

UNIT I BIO POTENTIAL RECORDING 9

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

UNIT II MEASUREMENT OF NON ELECTRICAL PARAMETER 9

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

UNIT III CARDIAC CARE UNITS 9

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

UNIT IV ASSIST DEVICES 9

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

UNIT V DIATHERMY, STIMULATOR AND PATIENT SAFETY 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Design and analyze the bioamplifiers.

CO2 Measure vital and non-electrical parameters.

CO3 Design and demonstrate the pacemaker and defibrillator.

CO4 Demonstrate the function of assist devices.

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

REFERENCES:

1. Joseph J. Carr and John M. Brown, “Introduction to Biomedical equipment technology”, Pearson Education, 4th Edition, 2014.
2. John G.Webster, “Medical Instrumentation Application and Design”, John Wiley and Sons, New York, 4th Edition, 2009.
3. Myer Kutz, “Biomedical Engineering & Design Handbook: Volume 2”, McGraw-Hill Publisher, 2nd Edition, 2009.
4. L.A Geddes and L.E.Baker, “Principles of Applied Biomedical Instrumentation”, John Wiley and Sons, 3rd Edition, Reprint 2008.
5. Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, “Biomedical Instrumentation and Measurements”, Pearson Education India; 2nd Edition, 2015.
6. Antony Y.K.Chan, "Biomedical Device technology, Principles and design”, Charles Thomas Publisher Ltd, Illinois, USA, 2008.

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CO-PO MAPPING:

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

BO3103 MEDICAL IMAGING SYSTEMS L T P C

3 0 0 3

UNIT I PRINCIPLES OF RADIOGRAPHIC EQUIPMENT 9

Physics of Radiography. X-Ray tubes, cooling systems, removal of scatters, mammography, digital radiography, dental X- ray, Fluoroscopy- construction of image Intensifier tubes, angiographic setup, DSA. Radiation Dosimetry- Exposure, Dose, Kerma, Absorbed, Equivalent and Effective dose

UNIT II COMPUTED TOMOGRAPHY 9

Need for sectional images, Principles of sectional scanning, Generation in CT, CT detectors, Methods of Reconstruction-Iterative, Back projection, convolution and Back-Projection and central slice theorem. Artifacts, Spiral CT, Ultra-fast CT Scanners, Principle of 3D imaging. Case study on recent development in CT technology.

UNIT III RADIO ISOTOPIC IMAGING 9

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

UNIT IV ULTRASOUND IMAGING SYSTEMS 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, Applications. Doppler Ultrasound, Ultrasound Image Quality and Artifacts. Case study on 3D&4D ultrasound imaging.

UNIT V MAGNETIC RESONANCE IMAGING 9

NMR, Principle of MRI, Relaxation processes and their measurements, Pulse sequencing and MR image acquisition, Imaging parameters- TE, TR and image contrast, Slice selection, frequency encoding and phase encoding, MRI Instrumentation, MR Artifacts, Magnetic Resonance Spectroscopy, Functional MRI. Case Study on recent advances in MRI.

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 Illustrate the principle and working of different types of radiation detectors.

CO5 Discuss the application and 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. D.N.Chesney and M.O.Chesney, “Radio graphic imaging”, CBS Publications, New Delhi, 1987.
3. Peggy, W., R.D.Ferimarch, “MRI for Technologists”, 2nd Edition, McGraw Hill Medical, 2000.
4. Steve Webb, “The Physics of Medical Imaging”, Taylor & Francis, New York.1988.
5. Donald W.McRobbice, Elizabeth A.Moore, Martin J.Grave and Martin R.Prince, “MRI from picture to proton”, 2nd Edition, Cambridge University press, New York 2006.
6. Jerry L.Prince and Jonathan M.Links, “Medical Imaging Signals and Systems”, Pearson Education Inc. 2014

CO-PO MAPPING:

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

BO3104 SIGNAL AND IMAGE PROCESSING FOR BIOLOGICAL SYSTEMS L T P C

3 0 4 5

UNIT I INTRODUCTION TO SIGNALS AND SYSTEM 9

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

UNIT II PROBABILITY AND RANDOM SIGNALS 9

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

UNIT III FILTERING FOR REMOVAL OF ARTIFACTS 9

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

applied to biological signals. Case study – Removal of noises and filtering applied to biological signals.

UNIT IV DIGITAL IMAGE FUNDAMENTALS 9

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

UNIT V IMAGE SEGMENTATION AND COMPRESSION 9

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

LIST OF EXPERIMENTS 60

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

TOTAL: 45L+60P=105 PERIODS

COURSE OUTCOMES:

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

CO1 Understand, analyze and implement signals in time series domain & estimate the spectrum

CO2 Analyze and apply filter techniques for random signals

CO3 Understand and validate Pre-processing techniques for removal of artifacts and enhancement of images

CO4 Understand, implement and validate the basic medical image processing algorithms

CO5 Implement image processing applications that incorporates different concepts of medical Image Processing

CO6 Develop and validate image processing algorithm using neural networks.

REFERENCES:

1. Arnon Cohen, “Bio-Medical Signal Processing Vol I and Vol II”, CRC Press Inc., Boca Rato, Florida 1999.
2. Rangaraj M. Rangayyan, “Biomedical Signal Analysis – A case study approach”, Wiley, 2nd Edition, 2009.

3. Willis J.Tompkins, “Biomedical Digital Signal Processing”, Prentice Hall of India, New Delhi, 2006.
4. Rafael C.Gonzalez and Richard E.Woods, “Digital Image Processing”, 4th Edition, Pearson Education, 2018.
5. Anil K Jain, “Fundamentals of Digital Image Processing”, 1st Edition, Pearson Education India, 2015.
6. Kavyan Najarian and Robert Splerstor, “Biomedical signals and Image processing”, 2nd Edition, CRC Press, 2012.
7. Geoff Dougherty, “Digital Image Processing for Medical Applications”, 1st Edition, Cambridge University Press, 2010.

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		
CO5	3		3	2		
CO6			3	3		
Avg	3	3	3	2		

BO3111 CLINICAL INSTRUMENTATION LABORATORY L T P C
0 0 4 2

LIST OF EXPERIMENTS

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

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1 Design and develop various bio signal amplifiers.

CO2 Understand the procedure to record and analyse various bio signals and physiological parameters.

CO3 Investigate the electrical safety of a medical equipment.

CO4 Analyze the Surgical diathermy unit.

CO5 Examine the functioning of human auditory and respiratory systems.

CO6 Gain knowledge on the working of instrumentations used for biosignals acquisition.

CO-PO MAPPING:

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

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.

Affiliated

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.

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

Attested

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BO3201 HOSPITAL ADMINISTRATION AND EQUIPMENT MANAGEMENT L T P C

3 0 0 3

UNIT I HEALTHCARE SYSTEM ORGANIZATION AND MANAGEMENT 9

Healthcare organizations of the country, the State, the Cities and the Region, Health Financing System, Health services, Functions of Hospitals, Types of Hospitals, Primary Health Care, Ambulatory care. Effective Hospital Management – Planning, Organizing, Directing and Leading, Controlling and Functional Management.

UNIT II HOSPITAL ADMINISTRATION AND PLANNING 9

Outpatient, Inpatient and Nursing services; Clinical support services – Radiology and Imaging, Laboratory services, Operation Theatre suite, Pharmacy, Central Sterile Supply department; Administrative services – Medical records, Hospital Infection, Hospital utilization statistics, Material Management, Marketing of Health services and Evaluation of Hospital services; Functional Hospital Organization – Hospital linen and laundry service, Disposal of Hospital Waste, Public relations, Ethical and legal aspects, Disaster Management, Quality assurance through Record review and Medical audit;

UNIT III REGULATORY REQUIREMENT AND HEALTH CARE CODES 9

FDA Regulation, Joint Commission Accreditation for Hospitals, National Fire Protection Association Standard, IRPQ; Function of Clinical Engineer, Role to be performed in Hospital, Manpower requirement for different types of hospitals, Professional Registration, Structure in Hospital.

UNIT IV EQUIPMENT MAINTENANCE POLICY AND PROCURES 9

Policy and Procedure Manual – Mission, Objectives, Life Cycle of the Medical Equipment, 5S tools; Maintenance Guidelines, Procurement and Organizational Structure; Organizing Maintenance Operations, Paperwork Control, Maintenance Job Planning, Maintenance Work Measurement and Standard, Training curriculum and skillset.

UNIT V EQUIPMENT GENERAL AND TECHNICAL MAINTENANCE 9

General Management of Medical Equipment – Types and Planned Maintenance, Management Manual; Biomedical Equipment and Maintenance Program - Technical Manual, Reporting Formats, Preventive Maintenance, Maintenance Budgeting and Forecasting, Contract Maintenance. Medical Equipment Trouble shooting – Flow charts and SoPs; Handling waste and Disposal.

TOTAL=45 PERIODS

COURSE OUTCOMES:

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

- **CO1** Demonstrate adequate knowledge and mastery of concepts and techniques relevant to hospital management
- **CO2** Develop awareness of the responsibilities of hospital management
- **CO3** Prepare to handle the management and development issues including structure and organization
- **CO4** Recognize how operational problems and situations are handled and best regulatory practices are adhered
- **CO5** Formulate ideas, develop SoPs and participate in equipment maintenance and policy procedures
- **CO6** Take a proactive and self-reflective role in working and to develop professional relationship

REFERENCES:

1. Syed Amin Tabish, "Hospital and Health Services Administration Principles and Practices", Oxford Press New Delhi 2001.
2. G D Kunders, "Hospitals, Facilities planning and Management", Tata McGraw Hill Education Private Ltd, New Delhi 2004.
3. BM Sakharkar, "Principles of Hospital Administration and Planning", Jaypee Brothers Medical Publishers (P) Ltd, Second Edition, 2009
4. "Biomedical equipment management and maintenance program: Technical guidance document for in-house support and monitoring of public private partnerships", Ministry of Health and Family Welfare, Government of India, New Delhi.
5. Justin Cooper and Alex Dahinten, "Medical Equipment Troubleshooting Flowchart Handbook", Engineering World Health, Version 6, 2013.
6. "Medical Equipment Maintenance Manual", Ministry of Health and Family Welfare, Government of India, New Delhi, 2010.

CO-PO MAPPING:

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

BO3202 HEALTH INFORMATICS L T P C

3 0 0 3

UNIT I INTRODUCTION TO HEALTH INFORMATICS 9

Historical highlights and Evolution of Health informatics, Hospital Information System – its characteristics and functional online and offline modules, Health Informatics, Bioinformatics, Medical Informatics, Clinical Informatics, imaging Informatics, Nursing Informatics, Public Health Informatics and Consumer Health Informatics.

UNIT II BIOINFORMATICS AND TECHNOLOGIES 9

Bio-information technologies, Semantic web and Bioinformatics, Genome projects - Education and Training - Nano technology in Healthcare - Nanomedicine, Nanopharma, CNT based Nano sensor, BioCom chip, Medical Nanorobo – Bioinformatics software tools.

UNIT III IMAGING INFORMATICS 9

Imaging Informatics Technology, Standard protocols in Imaging Informatics, key technologies – PACS, DICOM – Architectures - EHR with image distribution, Image aided detection and diagnosis, surgical simulation and interactive multimedia learning and HIPAA compliance; Big data and Deep learning in Imaging Informatics;

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UNIT IV NURSING AND CONSUMER INFORMATICS 9

Nursing Informatics – Definition – Components – Perspectives, Competencies, Applications - Roles and responsibilities, Data, Information and Knowledge – Support Decision making – Metastructures, Concepts and tools. Consumer Informatics – Bringing medical knowledge to consumers – EHR accessible to patients, Decision aids to support consumer choices, A status report on Nursing and Consumer Informatics in India.

UNIT V CLINICAL AND PUBLIC HEALTH INFORMATICS 9

History of Clinical and Public Health Informatics, Clinical information systems applications in health care, Outcomes relevant to the clinical goals and quality measures, Qualitative and quantitative methods for evaluating clinical information systems, Legal and regulatory issues, patient management systems, clinical image processing, clinical data mining. Public Health Informatics – Context, Science, key and Public Health Information Systems – Surveillance, Information Network, Geographic Information System (GIS), Challenges and Emerging solutions**.** A study on the current status, challenges and the way ahead for Public Health Informatics for India.

TOTAL=45 PERIODS

COURSE OUTCOMES:

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

CO1 Develop knowledge about problems and challenges that health informatics with its sub clauses addresses

CO2 Demonstrate basic skills and knowledge in health informatics for application in future health-related careers

CO3 Demonstrate ability to identify and understand Bioinformation Technologies and their applications

CO4 Analyze the key technologies that improved health care delivery and diversity issues in health informatics

CO5 Understand the various Standard Operating Protocols in the process of developing and implementing Health Informatics

CO6 Acquire a conceptual and theoretical framework of the design, development, and implementation of healthcare information systems

REFERENCES:

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

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CO-PO MAPPING:

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

BO3211 ADVANCED BIOMEDICAL ENGINEERING LABORATORY L T P C

0 0 4 2

LIST OF EXPERIMENTS

1. Modelling of lung mechanics
2. Modelling of cardiovascular system
3. Simulation and kinematic analysis of musculoskeletal model
4. LabVIEW based biosignal analysis
5. HTML programming
6. XHTML programming
7. XML programming
8. Java script programming
9. PHP/SQL Programming
10. Design and Development of interactive HIS

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1 Model various physiological systems using software tools

CO2 Demonstrate proficiency in simulating and analysis of musculoskeletal models.

CO3 Analyse the bio signals using software tools.

CO4 Demonstrate the basics of programming languages for Hospital information system (HIS) development.

CO5 Design and development of Hospital information system

CO6 Acquire knowledge about various software tools that can be deployed in healthcare field.

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		2	1
CO5	2	3	3	3	2	
CO6	2		3	3		1
Avg	2	3	3	3	2	1

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

BO3001 PRINCIPLES OF BIOSTATISTICS L T P C

3 0 0 3

UNIT I INTRODUCTION 9

Introduction to probability, likelihood & odds, distribution variability.

UNIT II STATISTICAL PARAMETERS 9

Statistical parameters p-values, computation and level chi square test and distribution. Hypothesis testing, tests of independence and tests of homogeneity.

UNIT III REGRESSION AND CORRELATION ANALYSIS 9

Regression, correction use of regression, multiple regression, Correlation model, Correlation coefficient.

UNIT IV INTERPRETING DATA 9

Interpreting life tables clinical trials, epidemical reading and interpreting of epidemical studies. An application in community health-Case Study

UNIT V META ANALYSIS 9

META analysis for research activities, purpose and reading of META analysis, kind of data used for META analysis. Case study on meta analysis for health care data.

Attested

TOTAL: 45 PERIODS

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COURSE OUTCOMES:

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

CO1 Demonstrate and understand the central concepts of modern statistical theory and their probabilistic foundation.

CO2 Compare the various parameters used in statistical significance.

CO3 Explain the techniques used in regression and correlation analyses.

CO4 Interpret results of the principal methods of statistical inference and design.

CO5 Use a statistical approach to combine the results from multiple studies.

REFERENCES:

1. Marcello Pagano and Kimberlea Gauvreu, "Principles of Biostatistics", Chapman and Hall/CRC, 2nd Edition, 2018.
2. Joseph A. Ingelfinger, Frederick Mosteller, Lawrence A. Thibodeau, James H, "Ware Biostatistics in Clinical Medicine", third edition, Singapore, 1994.
3. A.K Sharma, "Text Book of Biostatistics I", India: Discovery Publishing House Pvt. Limited, 2005.
4. A.K. Sharma, "Text Book of Correlations and Regression", Discovery Publishing House, India, 2005.
5. Walter T. Ambrosius, "Topics in Biostatistics", United Kingdom: Humana Press, 2007.
6. Malhotra,Rajeev Kumar, Indrayan, Abhaya, "Medical Biostatistics", United States: CRC Press, 2017.
7. Chan, Bertram K.C., "Biostatistics for Epidemiology and Public Health Using R", United States: Springer Publishing Company, 2015.

CO-PO MAPPING:

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

BO3002 **BIOMATERIALS** **L T P C**

3 0 0 3

UNIT I INTRODUCTION **9**

Definition of biomaterials, chemical properties, mechanical properties, surface chemistry of materials, DLVO theory, surface characterization and surface modification, biological response to materials, wound kinetics, biocompatibility.

UNIT II MATERIALS IN MEDICAL DEVICES **9**

Metals, ceramics, polymers- natural and synthetic polymers, biomimetic materials, composites.

Material synthesis, chemical composition, properties, uses in medicine and biosciences and failure mechanisms.

UNIT III STERILIZATION OF BIOMATERIALS 9

Definition for sterilization, disinfection and aspesis. Hospital acquired infections. Sterilization techniques: physical method- steam and radiation sterilization, process and mechanism of action of steam and rays, electron beam sterilization, chemical method of sterilization-ethylene oxide, chlorine dioxide and plasma gas sterilization. CSSD design and zoning, moral and ethical consideration. Work safety & standards to be followed in sterilization unit.

UNIT IV TESTING OF MATERIALS 9

Testing with tissue culture - in vitro and in vivo assessment of biocompatibility, testing with soft tissues and testing at non thrombogenic surface-blood compatibility and thromobogenicity. ISO standard for assessment of biocompatibility. Ethics, patents, regulatory bodies, policies and commercialization of medical device.

UNIT V HARD AND SOFT TISSUE REPLACEMENT 9

Cardiac implants-blood substitutes-orthopedic implants-ocular implants-neuromuscular implants-cochlear implants-trans cutaneous implants-artificial skin-artificial pancreas.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Understand the basic principles in material science and their contribution towards biomedical engineering.

CO2 Analyze different types of materials and implent in designing a device.

CO3 Understand to choose the best materials for tissue replacement.

CO4 Identify significant gap and to overcome the challenges for future developments.

CO5 Acquire the ability in applying engineering design to solve the problems with special consideration to public health and their safety for socio-economic wellbeing.

REFERENCES:

1. J.H.U.Brown (Ed), “Advances in Bio Medical Engineering”, Academic Press 1975.
2. Andrew F.Von Racum, “Hand Book of Bio Medical Evaluation”, Mc-Millan Publishers, 1980.
3. Jacob Cline, “Hand Book of Bio Medical Engineering”, Academic Press in Sandiego, 1988.
4. Jonathan Black, “Biological Performance of Materials- Fundamentals of bio compatibility”, 4th Edition, CRC Press 2005.
5. Larry L. Hench and Julian R.Jones, “Biomaterials, Artificial organs and Tissue Engineering”, 2005.
6. Buddy D.Ratner,Allan S .Hoffman, Frederick J. Schoen, Jack E. Lemons, “Biomaterial Science; An Introduction to Materials in Medicine”, 2nd Edition, Elsevier Academic Press,San Diego, 2004.
7. Jean Pierre Boutr, “Biocompatibility and performance of medical devices”, Springer publication, 2nd edition, 2019.

CO-PO MAPPING:

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

BO3003 FINANCE MANAGEMENT IN HOSPITALS L T P C

3 0 0 3

UNIT I INTRODUCTION 4

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

UNIT II ACCOUNTING TECHNIQUES 10

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

UNIT III COSTING IN HOSPITALS 10

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

UNIT IV MANAGEMENT ACCOUNTING 11

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

UNIT V FINANCING DECISIONS 10

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Understand the scope and applications of Financial Management.

CO2 Discuss the Accounting principles, Book keeping and Reporting concepts

CO3 Understand the techniques used in Costing and costing as a control Tool.

CO4 Explain the types and techniques of budgetary control.

CO5 Understand the types of financial decisions.

REFERENCES:

1. James C. Vanhorne, “Fundamentals of Financial Management”, Prentice Hall of India Pvt. Ltd., New Delhi, 8th Edition, 1993.
2. James C.Vanhorne, “Financial Management and Policy”, Prentice Hall of India Pvt. Ltd., New

Delhi, 9th Edition, 1995.
3. Prasannachandra, “Financial Management”, Tata McGraw Hill Publishing Co. Ltd., New Delhi, First Revised edition
4. IM Pandey, “Financial Management”, Vikas Publishing Co, 1999.

CO-PO MAPPING:

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

BO3004 EMBEDDED SYSTEM DESIGN AND DEVELOPMENT L T P C
3 0 0 3

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.

Attested

TOTAL: 45 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 using ARM processor.

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
Avg	3	2	3	3	3	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.

Attested

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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 Biophotonics", John Wiley and sons, Inc.Publications, 2003.
3. Tuan Vo Dinh, "Biomedical photonics – Handbook", CRC Press LLC, 2003.
4. Mark E. Brezinski, "Optical Coherence Tomography: Principles and Applications",Academic Press, 2006.
5. R. Splinter and B.A. Hooper, "An Introduction to Biomedical Optics", Taylor and Francis, 2007.
6. Gerd Keiser, "Biophotonics - 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		

BO3005 PHYSICS IN MEDICINE L T P C

3 0 0 3

UNIT I PRINCIPLES OF NUCLEAR PHYSICS 9

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

UNIT II PHYSICS OF INFRARED, MICROWAVE AND RADIO FREQUENCY 9

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

UNIT III LASER PHYSICS AND PHOTOMEDICINE 9

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

UNIT IV DIAGNOSTIC ULTRASOUND 9

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

UNIT V RADIOBIOLOGICAL EFFECT OF RADIATION 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Understand and appreciate the phenomena of nuclear physics
CO2 Discuss about the effects of IR, microwave and RF
CO3 Obtain the in-depth knowledge about the physical effects light and ultrasound
CO4 Understand the diagnostic and therapeutic applications of electromagnetic and ultrasound.
CO5 Specify the biological effects due to ionising radiation.

REFERENCES

1. Moselley, “Non ionizing Radiation, Non-ionising Radiation, Microwaves, Ultraviolet and Laser Radiation”, Taylor & Francis,1988
2. Glasserr.O, “Medical Physics”, Vol.1, 2,3-year Book Publisher Inc Chicago, 1980
3. Eric. J.Hall, and Amato J.Giaccia , “Radiobiology for radiologist”, Lippincott Williams and Wilkins, 2006
4. Sorenson James A, “Physics in Nuclear Medicine”, W.B. Saunder‘s Company, 1987.
5. Hylton B Meire and Pat Farrant, “Basic Ultrasound”, Wiley-Blackwell,2nd edition,2009.
6. Catherine Westbrrok ,John Talbot , “MRI in Practice”, Wiley-Blackwell,5th edition,2018
7. 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.
8. Steve Webb, “The Physics of Medical Imaging”, Taylor & Francis, New York.1988.

CO-PO MAPPING:

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

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.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Perceive knowledge about different types of physiological models for first order System
CO2 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.

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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	

BO3006 PRINCIPLES OF GENETIC ANALYSIS L T P C

3 0 0 3

UNIT I INTRODUCTION TO GENETICS 9

Overview of Genetics, DNA as genetic material, structure of DNA and RNA. Chromosome Structure & number, chromosome organization, eukaryotic genomes – repetitive and non repetitive sequence. DNA polymorphism.

UNIT II CENTRAL DOGMA 9

DNA replication, transcription and processing, translation and post translational modification, central dogma. Regulation of gene expression.

UNIT III LAW OF GENETIC INHERITANCE 9

Mitosis and meiosis, Mendel's Laws of Inheritance and probability and non Mendelian genetics. Genetic linkage and mapping-restriction cleavage, RFLP and SNPs, bacterial genetics, viral genetics & COVID-19. Genetic variation- population genetics, quantitative genetics, evolution genetics

UNIT IV GENETIC SEQUENCING 9

Mutations, CRISPR, Methods of gene transfer: blotting, polymerase chain reaction, genome sequencing, personalized genomics, genetics in medicine-cancer genetics, disease alleles and humans-detection and mapping. Human genome project-strategies and approaches, microsatellite markers, DNA microarray and medical benefits of HGP.

UNIT V ENGINEERING OF GENES 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Acquire a wide knowledge in gene arrangement, the mechanisms and regulation involved in gene amplification.

CO2 Acquire in depth knowledge in evolutionary analysis of genetic sequence

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

CO4 Able to interpret different forms of inheritance patterns and identify them in genetic data.

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

REFERENCES:

1. Watson. J. et al, "Molecular Biology of the Gene", 5th Edition, Pearson Publication, 2004.
2. Griffiths, Wesslers, Lewontin, Bart Gel, Suzuki, Miller, "Introduction to Genetics Analysis", W.H Freeman & company, New York 8th Edition - 2005.
3. Glick, B. R and J.J Pasternak, "Molecular Biotechnology, Principles and application of Recombinant DNA", 3rd Edition ASM Press, 2003.
4. Karp, Gerald, "Cell and Molecular Biology. Concepts and Experiments", 4th Edition, John Wiley Sons, 2005.
5. Weaver. R.F, "Molecular Biology", 3rd Edition, McGraw – Hill, 2005.
6. Tom Strachan, Andrew P Read, "Human molecular Genetics", 3rd Edition, Garland Publishing – 2004.
7. Robert J. Brooker, "Genetics: Analysis and Principles", 7th Edition, McGraw Hill, 2020.

CO-PO MAPPING:

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

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 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, Sundaravaradhan, 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

BO3007 **TISSUE ENGINEERING** **L T P C**

3 0 0 3

UNIT I INTRODUCTION TO TISSUE ENGINEERING 9

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

UNIT II BASIC COMPONENTS OF TISSUE ENGINEERING 9

CELLS: Cell adhesion, Cell migration and Cell aggregation – Cell growth and Cell cycle. Cellular Interactions: Cell – Cell and Cell – Matrix. Control of Cell migration in Tissue Engineering - Growth Factors –Cell delivery and Recirculation – Cell Culture in vitro – 3D culture in Tissue Engineering - In vitro Organogenesis - Cell transplantation. Case study on cell culture in tissue engineering.

UNIT III BIOMATERIALS IN TISSUE ENGINEERING 9

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

UNIT IV STEM CELLS IN TISSUE ENGINEERING 9

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

UNIT V APPLICATIONS OF TISSUE ENGINEERING 9

Bioreactors - 3D bioprinting of tissues and organs - Cartilage and Bone Tissue Engineering – Cartilage Tissue Engineering - Vascular Graft and Cardiac Tissue Engineering; Heart Valve Tissue Engineering; – Hepatic Tissue Engineering; Renal Tissue Engineering; Dental Tissue Engineering; Human Skin Substitute - Nerve Tissue Engineering.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Identify the importance of tissue engineering in the field of biomedical engineering

CO2 Explain the mechanisms involved in interaction of different materials with cells and tissues

CO3 Explain different methods involved in characterization and preparation of biomaterials in tissue engineering.

CO4 Analyse different types of stem cells and its application in tissue engineering

CO5 Apply the knowledge in creating new models in drug delivery systems using synthetic and natural scaffolds

REFERENCES:

1. W. Mark Saltzman, " Tissue Engineering – Engineering principles for design of replacement organs and tissue", Oxford University Press Inc. New York, 2004.
2. Clemens van Blitterswijk, "Tissue Engineering", Academic Press, 2008.

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3. Gray E Wnek, Gray L Browlin, "Encyclopaedia of Biomaterials and Biomedical Engineering", Marcel Dekker Inc. New York, 2004.
4. R.Lanza, J.Gearhart et.al,(Eds), "Essential of Stem cell Biology", Elsevier AcademicPress, 2006.
5. Sujata V.Bhatt, "Biomaterials", 2nd Edition, Narosa Publishing House, 2005.
6. Lanza, R., Langer, R., Vacanti, J. P., & Atala, A. (Eds.), "Principles of tissue engineering" Academic press, 2020.
7. Palsson, B., Hubbell, J. A., Plonsey, R., & Bronzino, J. D, "Principles and applications in engineering series. Tissue Engineering", CRC Press, Boca Raton, 2003.

CO-PO MAPPING:

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

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.

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TOTAL:45 PERIODS

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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
CO4	1	1	2	3		1
CO5	1	1	1	3		
Avg	1	1	2	3		1

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 turnover 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, McGraw Hill, 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", Academic Press 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

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.

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.

Attested

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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”, IEEETransactions 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	

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

BO3008 HOSPITAL PLANNING, ORGANIZATION AND MANAGEMENT L T P C

3 0 0 3

UNIT I FORMS OF ORGANISATION 9

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

UNIT II PRINCIPLE OF HOSPITAL MANAGEMENT 9

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

UNIT III STAFFING 9

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

UNIT IV MARKETING AND MANAGEMENT 9

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

UNIT V COMPUTER IN HOSPITAL 9

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

TOTAL :45 PERIODS

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COURSE OUTCOMES:

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

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

REFERENCES:

1. Goyal R.C, "Human Resource Management in Hospital", Prentice Hall of India Pvt. Ltd., New Delhi, 3rd Edition, 2003.
2. D.K.Sharma and R.C. Goyal, "Hospital Administration and Human Resource Management", PHI learning, 7th Edition, 2017.
3. Nauhria R.N. and Rajnish Prakash, "Management & systems", New Delhi Wheeler publishing, 1995.
4. Koontz, "Essentials of Management", McGraw Hill Education India Pvt. Ltd., 5th Edition, 2001.

CO-PO MAPPING:

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

BO3009 BIOMEDICAL WASTE MANAGEMENT AND CONTROL L T P C

3 0 0 3

UNIT I INTRODUCTION 9

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

UNIT II PRINCIPLES OF STERILIZATION 9

Disease and its mode of transmission - Disinfection methods- concept and mechanism –physical sterilization and chemical sterilization – Large scale autoclave , hydroclave - Microwave (Non-burn treatment technology, plasma arc). Thermal irradiation, dry heat techniques.

UNIT III DISPOSAL OF WASTE 9

Solid waste Disposal methods and Liquid waste Disposal methods – Incinerator and its types, crematories -hazardous waste, radioactive waste reduction and destruction methods – landfill and rules governing landfill, trans boundary movements.

UNIT IV CONTROLS APPLIED TO WASTE MANAGEMENT 9

Air pollution and emission control, rules governing pollution, EPA Act, instrumentation and monitoring, emission filters and its types, crematories- gas emission control device. Case studies related air pollution, HCF and CMBTF methods, BARC guidelines, biomedical waste regulation rules 2016.

UNIT V ENVIRONMENTAL SAFETY, RISKS & PUBLIC ISSUES 9

Risk management in hospitals - Environment issues in hospitals - Risk analysis, hazard identification, Risk quantification table, Litigation, Mitigation, NFPA.

TOTAL :45 PERIODS

COURSE OUTCOMES:

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

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

REFERENCES:

1. C.R. Brunner, “Medical Waste Disposable Handbook”, Incinerator Consultants Incorporated, Virginia, 2000.
2. Tarannum Dana, “Medical Waste Management”, July 2012.
3. Madhurisharma, “Hospital waste Management and its Monitoring”, Jaypee Brothers Medical publishers, second Edition February 2017.
4. D.B. Acharya, Meet singh, “The book of Hospital Management”, Minerva Press, 2007.
5. Dr. Shahnawaz Hamid, “A Handbook on Biomedical Waste: National and International Overview”, Notion Press; 1st edition, 2019.
6. Mohammad Mohsin, “Hospital waste management”, VDM Publishing, 2013.
7. Mohd. Faisal Khan, “Hospital waste Management : Principles and Guidelines”, Kanishka Publishers, 2010.

CO-PO MAPPING:

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

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BO3010 HUMAN RESOURCES MANAGEMENT IN HEALTH CARE L T P C

3 0 0 3

UNIT I PERSPECTIVES OF HUMAN RESOURCE MANAGEMENT 9

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

UNIT II THE CONCEPT OF BEST FIT EMPLOYEE 9

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

UNIT III TRAINING & EXECUTIVE DEVELOPMENT 9

Types of Training methods and their benefits - Executive development Programme - common practices - Benefits, self-development - knowledge Management. Case study on HRM practice in hospitals.

UNIT IV SUSTAINING EMPLOYEE INTEREST 9

Wage and Salary Administration – concept of incentives and its operational implications – Participative decision making – Concept of Collective Bargaining – Compensation plans – Rewards – Motivation – Theories of motivation - Grievances and redressal methods. Case study on HRM in health care environment for sustaining employee interest.

UNIT V PERFORMANCE APPRAISAL 9

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

TOTAL :45 PERIODS

COURSE OUTCOMES:

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

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

REFERENCES:

1. Goyal R.C, “Human Resource Management in Hospital”, Prentice Hall of India Pvt. Ltd., New Delhi, 3rd Edition, 2003.
2. D.K.Sharma and R.C. Goyal, “Hospital Administration and Human Resource Management”, PHI learning, 7th Edition, 2017.
3. Mamoria C.B. and Mamoria S. “Personnel Management”, Himalaya Publishing Company, 1997.
4. Decenzo and Robbins, “Human Resource Management”, Wiley & Sons, Singapore, 1999.

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CO-PO MAPPING:

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

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.

Attested

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, StamatisKarnouskos, 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	

Attested

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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	

MD3057 MEDICAL DEVICE REGULATIONS 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

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.

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. Jocelyn Troccaz, “Medical Robotics”, Wiley, 2012.
7. Achim Schweikard, Floris Ernst, “Medical Robotics”, Springer, 2015

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CO-PO MAPPING:

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

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.

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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

BO3011 NANOMEDICINE PRINCIPLES AND APPLICATIONS L T P C

3 0 0 3

UNIT I INTRODUCTION OF NANOPARTICLES 9

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

UNIT II NANOMATERIALS AND NANOENGINEERING 9

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

UNIT III NANOTECHNOLOGY IN DRUG DELIVERY 9

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

UNIT IV NANOTECHNOLOGY IN IMAGING, DIAGNOSTIC AND DETECTION 9

Nuclear imaging systems-SPECT and PET, advanced MR imaging, optical imaging and CT. Ultra sound imaging and therapy, nanoimaging systems, micro and nano fluidic diagnostics, biosensors and point-of-care diagnostics. Engineering molecular imaging contrast agents and emergence of cell-based tracking/imaging.

UNIT V APPLICATION IN CANCER THERAPY 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Gain knowledge in principles of nanomaterials and nanotechnology.

CO2 Understand latest scientific developments and discoveries in the field of Nanomedicine.

CO3 Understand the toxicological aspects of nano sized particles.

CO4 Acquire better understanding and conceptual thinking of present and future application of nanotechnology in healthcare.

CO5 Provides an understanding of scientific challenges and regulatory limitations in the implementation of nanomedicines.

REFERENCES:

1. CM, Niemeyer C.A. Mirkin., “Nanobiotechnology – Concepts, Applications and Perspectives”, Wiley – VCH, 2004.
2. Nicholas A. Kotov, “Nanoparticle Assemblies and Superstructures”, CRC, 2006.
3. T. Pradeep, “Nano: The Essentials”, McGraw – Hill education, 2007.

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4. Challa, S.S.R. Kumar, Josef Hormes, Carola Leuschaer, “Nanofabrication towards Biomedical Applications, Techniques, Tools, Applications and Impact”, Wiley –VCH, 2005.
5. Kewal K. Jain, “The Handbook of Nanomedicine”, Humana Press, 2008.
6. Zhang, “Nanomedicine, A Systems Engineering Approach”, 1st Ed., Pan Stanford Publishing, 2005.
7. Robert A. Freitas Jr., “Nanomedicine Volume IIA: Biocompatibility”, Landes Bioscience Publishers, 2003.
8. Harry. F. Tibbals, “Perspectives in Nanotechnology: Medical Nanotechnology and Nanomedicine”, CRC Press, Taylor & Francis Group, Ed 1, 2011.

CO-PO MAPPING:

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

BO3012 NANOTOXICOLOGY L T P C

3 0 0 3

UNIT I INTRODUCTION TO NANOMATERIALS 9

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

UNIT II ENVIRONMENTAL TOXICOLOGY 9

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

UNIT III TOXICOLOGICAL STUDIES 9

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

UNIT IV NANOREMEDIATION 9

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

UNIT V ETHICAL AND SAFETY ISSUES IN NANOTECHNOLOGY 9

Safety and pollution control techniques-handling, storage, packaging, transportation and disposal of pollutants. Public perceptions and education-communicating nanotechnological risks–understanding of nanotechnology's societal impact and ethical issues in nanoscience and nanotechnology. Regulation of engineered nanomaterials and green nanotechnology.Patenting nanomedicine and nanopharmaceuticals.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Understand the basic concepts of nanomaterials.

CO2 Understand the toxicology effects of nanoparticles in living organisms.

CO3 Acquire the underlying knowledge in developing toxic free nanoproducts.

CO4 Understand the remedial techniques and their relevance in the constructing risk-free environment.

CO5 Aware of ethical issues and regulations in order to develop nanoproducts with societal responsibilities.

REFERENCES:

1. Mark Wiesner, Jean-Yves Bottero, "Environmental Nanotechnology: Applications and Impacts of Nanomaterials", McGraw Hill Professional, 2007.
2. Challa S.S. R. Kumar, "Nanomaterials - Toxicity, Health and Environmental Issues", Wiley-VCH publisher, 2006.
3. Nancy A. Monteiro - Riviere, C. Lang Tran, "Nanotoxicology: Characterization, Dosing and Health Effects", Informa healthcare, 2007.
4. Drobne, "Nanotoxicology for safe and Sustainable Nanotechnology", Dominant publisher, 2007
5. M.Zafar Nyamadzi, "A Reference handbook of nanotoxicology", Dominant publisher, 2008.
6. Kenneth Klabunde, Gleb Sergeev, "Chemistry of Nanoparticle formation and interactions", 2nd edition, Springer, 2013.

CO-PO MAPPING:

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

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BO3013 NEUROSCIENCE AND NEURAL ENGINEERING L T P C

3 0 0 3

UNIT I INTRODUCTION TO NERVE AND NERVOUS SYSTEM 9

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

UNIT II BRAIN, BRAIN STEM AND SPINAL CORD 9

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

UNIT III NEURON TRACING 9

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

UNIT IV NERVE INJURY AND DISORDERS 9

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

UNIT V NEURAL ENGINEERING 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Understand basics of nervous system

CO2 Describe neural mechanisms, circuit formations and plexus.

CO3 Explain cortical areas and recording of cortical lobe.

CO4 Describe pharmacokinetics in neural system.

CO5 Understand the mechanism of neural regeneration

REFERENCES:

1. Mathews G.G., "Neurobiology: Molecules, Cells and Systems", 2nd Edition, Wiley-Blackwell Science, UK, 2000.
2. Malcom Carpenter, "Text book of Neuroanatomy", Lippincott Williams and Wilkins, 4th Edition, 1991.
3. Park, Joon B., "Biomaterials Science and Engineering", United States, Springer US, 2013.
4. W.Mark Saltzman, "Tissue Engineering—Engineering principles for design of replacement organs and tissue", Oxford University Press Inc., NewYork, 2004.

CO-PO MAPPING:

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1			3			
CO2			3			
CO3			3			
CO4			3			
CO5	3	2	3			2
Avg	3	2	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 – Adaptivecomputation 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, M.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	

BO3014 QUALITY ASSURANCE AND SAFETY IN HOSPITALS L T P C
3 0 0 3

UNIT I STANDARDIZATION OF QUALITY MEDICAL CARE IN HOSPITALS 9

Quality- Need for Standardization & Quality Management, TQM in Health care organization-Quality assurance methods, QA in Medical Imaging & Nuclear medicine, Diagnostic services – Classification of equipment

UNIT II REGULATORY REQUIREMENT FOR HEALTH CARE 9

FDA regulations, Accreditation for hospitals - JCI, NABH and NABL, Other regulatory Codes, Medical Device Calibration-Need for Calibration, analyzers for calibration, ISO/IEC 17025 Accreditation-Quality system manual, quality system procedure, Standard Operating Procedure, Uncertainty calculation, Traceability, Case study- calibration of patient monitoring system.

UNIT III HOSPITAL SAFETY 9

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

UNIT IV ELECTRICAL & FIRE SAFETY 9

Sources of shocks, macro & micro shocks -Hazards, monitoring and interrupting the Operation from leakage current-GFI units, Electrical safety-IEC-60601 standard-Electrical safety Analyzer, Fire safety measures- Causes of fire, Action to be taken in case of fire in a Hospital.

UNIT V ASSESSING QUALITY HEALTH CARE 9

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

TOTAL=45 PERIODS

COURSE OUTCOMES:

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

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

CO2 Discuss the system of regulatory measures, accreditation and calibration of medical devices.

CO3 Describe the significance of safety measures in hospitals and proper disposal of biomedical waste.

CO4 Understand the impacts of Electrical and Fire Safety Hazards mitigations.

CO5 Assess the quality practices using various tools.

REFERENCES:

1. Cesar A. Cacere & Albert Zana, "The Practice of Clinical Engg.", Academic press, New York,1977.
2. Webster J.G and Albert M.Cook, "Clinical Engg, Principles & Practices", Prentice Hall Inc., Engle wood Cliffs, New Jersy, 1979.
3. B.M.Sakharkar, "Principles of Hospital administration and Planning", JAYPEE Brothers, Medical Publishers (P) Ltd, 2004.
4. K.Shridhara Bhat, "Quality Management", Himalaya Publishing House, 2010.
5. Karen Parsley, Karen Parsley Philomena Corrigan, "Quality improvement in Healthcare", 2nd edition, Nelson Thrones Pub, 1999
6. Sharon Myers, "Patient Safety & Hospital Accreditation - A Model for Ensuring", Success Springer Publishers 2012
7. Joseph F Dyro, "Clinical Engineering Handbook", Elsevier Publishers, 2004

CO-PO MAPPING:

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

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.

Attested

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		

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.

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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

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 scienceand 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

BO3015 BIOMECHANICS OF HUMAN MOVEMENT AND WEARABLE ROBOTIC SYSTEMS **L T P C**

3 0 0 3

UNIT I FUNDAMENTALS OF HUMAN MOVEMENT 9

Biomechanics vs. Kinesiology, Anatomical Movement Descriptors, Mechanics of Musculoskeletal System – Tissue loads, Response of tissues to forces, Biomechanics of Muscle-Tendon Unit, Bone and Ligaments, Mechanical Characteristics of Muscles, Neuromuscular Control of Movement.

UNIT II BIOLOGICAL MODELS 9

Biomechatronic systems in close interaction with biological systems, Biologically Inspired Models – Neuromotor Control Structures and Mechanisms as Models, Muscular Physiology as a Model, Sensorimotor Mechanisms as a Model, Biomechanics of Human Limbs as a Model. Biomimetism and Bioimitation.

UNIT III WEARABLE ROBOTS 9

Kinematics and Dynamics of Wearable Robots – Robot Mechanics: Motion Equations, Leg Kinematics, Kinematic Models of Limbs, Dynamic Modelling of Human Limbs, Dual human–robot interaction in wearable robotics, Exoskeletons: an instance of wearable robots, Technologies involved in robotic exoskeletons, case studies on classification of wearable exoskeletons: application domains.

UNIT IV HUMAN ROBOT INTERACTION 9

Cognitive Interaction (cHRI) – cHRI using Electroencephalography (EEG) Monitoring, cHRI through Electromyography (EMG) Monitoring, cHRI through Biomechanical Monitoring. Physical Interaction – Kinematic Compatibility between Human limbs and Wearable Robots, Human Tolerance of Pressure, Transmission of forces through Soft Tissues. Control of Human-Robot Interaction – Closes Loop Behaviour, Stability Concepts. development of model of human robot interaction.

UNIT V LOWER LIMB WEARABLE ROBOTS – CASE STUDIES 9

Lower Limb Exoskeleton Control based on learned Gait Patterns, Identification and Tracking of Involuntary Human Motion based on Biomechanical Data, EEG based cHRI of a Robotic Wheelchair, Stance Stabilisation During Gait through Impedance Control, Ankle – Foot Orthosis Powered by Artificial Pneumatic muscles, GAIT – ESBiRRO, HAL (Hybrid Assistive Limb), BLEEX Exoskeleton. Development of simple control algorithm for exoskeleton.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Understand the Biomechanical aspects in Human Movement and analysis

CO2 Apply concepts in the design of Wearable Robot systems.

CO3 Analyse the different cognitive human robot interaction system.

CO4 Apply the knowledge to design and develop human robot interaction system.

CO5 Apply available research techniques and methods to solve new problems in movement related research.

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

REFERENCES

1. Jos´e L. Pons, “Wearable Robots: Bio mechatronic Exoskeletons”, John Wiley & Sons Ltd, 2008.
2. Duane Knudson, “Fundamentals of Biomechanics”, Second Edition, Springer Science+ Business Media, LLC, 2007.
3. Joseph Hamill and Kathleen M.Knutzen “Biomechanical Basis of Human Movement”, Third Edition, Lippincott Williams & Wilkins, 2015.
4. Myer Kutz, “Standard Handbook of Biomedical Engineering & Design”, The McGraw-Hill Companies, Inc., 2003.

CO-PO MAPPING:

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