NANDHA ENGINEERING COLLEGE
(Autonomous)
Affiliated to Anna University Chennai ✦ Approved by AICTE ✦ Accredited by NBA - New Delhi
Pitchandampalayam (P.O), Vaikkalmedu, Erode - Perundural Road, Erode - 638 052
Phone : 04294 - 225585, 223711, 223722, 226393 Mobile : 73737 23722 Fax : 04294 - 224787
Website : www.nandhaengg.org E.mail : info@nandhaengg.org

1.1.2 Details of Courses where syllabus revision was carried out

B.E. - Biomedical Engineering

R-22 Curriculum

Course Code	Course Name	% of Change
22BMC08	Microprocessors and Microcontrollers Interfacing	40
22BMC09	Radiology Equipment	100
22BMC10	Diagnostic and Therapeutic Equipment	5
22BMP05	Microprocessors and Microcontrollers Interfacing Laboratory	20
22BMC11	Fundamentals of Healthcare Analytics	100
22BMC12	Medical Image Processing	80
22BMP07	Medical Image Processing Laboratory	100
22BMX01	Cell Biology	100
22BMX02	Genetic Engineering	100
22BMX03	Genomics	100
22BMX04	Cancer Biology	100
22BMX05	Principles of Tissue Engineering	100
22BMX06	Neuroscience	100
22BMX07	Nuclear Medicine	100
22BMX08	Radiotherapy and Its Application	100
22BMX17	Medical Textiles	100
22BMX18	Virtual Reality	100
22BMX21	Soft Computing	100
22BMX22	Pattern Recognition Techniques and Its Applications	100
22BMX23	Machine Learning for Healthcare	100
22BMX24	Artificial Intelligence in Healthcare	100

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22BMX25	Deep Learning Techniques	100
22BMX26	Machine Vision	100
22BMX27	Biometric System	100
22BMX28	Brain Computer Interface and Applications	100
22BMX31	Biomechanics	100
22BMX32	Ergonomics	100
22BMX33	Finite Element Analysis	100
22BMX35	Cardiovascular Engineering	100
22BMX36	Rehabilitation Engineering	100
22BMX37	Prosthetic and Orthotic Devices	100
22BMX38	Haptics	100
22BMX47	Patient Safety and Standards	100
22BMX48	Medical Device Regulations	100
22BMX51	Bio-MEMS Technology	100
22BMX52	Nanotechnology in Medicine	100
22BMX53	Robotics in Healthcare	100
22BMX54	Advanced Healthcare System Design	100
22BMX55	Critical Care Equipment	100
22BMX56	Human Assist Devices	100
22BMX57	Ambulatory Services	100
22BMX58	Home Medicare Technology	100
	Average	**93.93**

HEAD
DEPARTMENT OF BME,
NANDHA ENGINEERING COLLEGE
(Autonomous),
ERODE- 52.

22BMC08 - MICROPROCESSORS AND MICROCONTROLLERS INTERFACING				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: 22BMC01				
Course Objectives:	• To make the students to Understand and demonstrate the principles, architectures, and functionalities of microprocessors, microcontrollers, and their associated peripherals. • To make the students to Develop and implement assembly and higher-level language programs to solve real-world problems, with an emphasis on debugging including those involving biosensors.			

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the knowledge of Microprocessor and Microcontrollers architectures and their instruction sets to develop assembly programs.	Ap	40%
CO2	Analyze the functioning of Microprocessor and Microcontroller systems, including interrupt handling and peripheral interfacing.	An	40%
CO3	Analyze the performance and efficiency of different Microcontroller.	An	15%
CO4	Develop skills to program Microcontrollers and debug using MPLAB X IDE.	An	5%
CO5	Apply knowledge to design and develop projects using biosensors.	C	Internal Assessment

UNIT I – 8085 MICROPROCESSOR	**(9)**
Introduction – Pin Configuration – Architecture of 8085 – Interrupts - Addressing Modes – Instruction Set Timing diagram of 8085.	
UNIT II – 8051 MICROCONTROLLER	**(9)**
Architecture of 8051 – Signals – Memory Organization - Interrupts – Counters and Timers - Serial communication.	
UNIT III – 8051 PROGRAMMING	**(9)**
8051 Addressing mode – Instruction Set – Timer Programming – Serial Port programming – Interrupt Programming.	
UNIT IV – PIC MICROCONTROLLER	**(9)**
PIC 16F877 Microcontroller Architecture - Memory organization - Interrupts - Timer/Counter - Compare/Capture/PWM modules (CCP) - Master Synchronous Serial Port module (MSSP) - MPLAB X IDE.	

UNIT V – PIC EXTERNAL INTERFACING	(9)
LCD & Keyboard Interfacing - ADC, DAC & LM35 Temperature Sensor Interfacing - External Memory Interface - Servo Motor Interfacing. Interfacing Protocols - SPI, I2C, Biosensors interfacing.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. Senthilkumar, Saravanan, Jeevanantham, Shan "Microprocessor & Interfacing", Oxford University Press, 2012.
2. John B Peatman, "Design with PIC Microcontrollers", 23rd Impression, Pearson Education Asia, 2013.

REFERENCES:

1. Ramesh S. Gaonkar, 'Microprocessor Architecture Programming and Application', 6th Edition, Penram International (P) Ltd., Mumbai, 2013.
2. Mohamed Ali Mazidi, Janice Gillispie Mazidi, Rolin McKinlay, "The 8051 Microcontroller and Embedded Systems: Using Assembly and C", 2nd Edition, Pearson Education, 2011.

WEB LINK:

1. https://onlinecourses.nptel.ac.in/noc20_ee42/preview

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2		3												
3				3										
4					3									3
5									3		2		3	
CO (W.A)	3	3		3	3				3		2		3	3

22BMC09 – RADIOLOGY EQUIPMENT				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE: NIL

Course Objectives:	• To understand the generation of X-ray and its uses in Medical imaging • To describe the principle of Computed Tomography. • To know the techniques used for visualizing various sections of the body. • To learn the principles of different radio diagnostic equipment in Imaging. • To discuss the radiation therapy techniques and radiation safety.

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the knowledge of the fundamental principles of various imaging techniques for efficient healthcare.	Ap	30%
CO2	Analyze the need for different medical imaging modalities.	An	30%
CO3	Correlate the most suitable diagnostic technique for a given clinical case.	An	20%
CO4	Assess the biological effects of medical imaging modalities related to human safety.	E	20%
CO5	Examine the published reports and observations from hospital visits for the chosen imaging modality, and record and share the information with the engineering community.	An	Internal Assessment

UNIT I – X RAYS	**(9)**
Nature of X-Rays- X-Ray Absorption – Tissue Contrast. X- Ray Equipment (Block Diagram) – X-Ray Tube, The Collimator, Bucky Grid, Power Supply, Digital Radiography - Discrete Digital Detectors, Storage Phosphor And Film Scanning, X-Ray Image Intensifier Tubes – Fluoroscopy – Digital Fluoroscopy. Angiography, Cine Angiography. Digital Subtraction Angiography. Mammography. X-Ray types.	
UNIT II - COMPUTED TOMOGRAPHY	**(9)**
Principles of Tomography, CT Generations, X- Ray Sources- Collimation- X- Ray Detectors – Viewing Systems – Spiral CT Scanning – Ultra Fast CT Scanners – CT Scan slices. Image Reconstruction Techniques – Back Projection And Iterative Method.	
UNIT III – MAGNETIC RESONANCE IMAGING	**(9)**
Fundamentals of Magnetic Resonance- Properties of Electromagnetic Waves : Speed , Amplitude, Phase, Orientation And Waves In Matter - Interaction of Nuclei With Static Magnetic Field And Radio Frequency Wave- Rotation And Precession – Induction of Magnetic Resonance Signals – Bulk Magnetization – Relaxation Processes T1 And T2. Block Diagram Approach of MRI System – System Magnet (Permanent, Electromagnet And Superconductors), Generations of Gradient Magnetic Fields, Radio Frequency Coils (Sending And Receiving), Shim Coils, Electronic Components, fMRI.	

UNIT IV – NUCLEAR IMAGING	(9)
Radioisotopes- Alpha, Beta, And Gamma Radiations. Radio Pharmaceuticals. Radiation Detectors – Gas Filled, Ionization Chambers, Proportional Counter, GM Counter And Scintillation Detectors, Gamma Camera – Principle of Operation, Collimator, Photomultiplier Tube, X-Y Positioning Circuit, Pulse Height Analyzer. Principles of SPECT and PET	
UNIT V – RADIATION THERAPY AND RADIATION SAFETY	**(9)**
Radiation Therapy – Linear Accelerator, Telegamma Machine. SRS – SRT – Recent Techniques In Radiation Therapy – 3D CRT – IMRT – IGRT and Cyber Knife – Radiation Measuring Instruments Dosimeter, Film Badges, Thermo Luminescent Dosimeters – Electronic Dosimeter – Radiation Protection In Medicine – Radiation Protection Principles	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

1. Isaac Bankman, I. N. Bankman, "Handbook of Medical Imaging: Processing and Analysis (Biomedical Engineering)", Academic Press, 2008.
2. Fitzpatrick J, Michael and Sonka, Milan, "Handbook of Medical Imaging, Volume 2. Medical Image Processing and Analysis", SPIE Press 2009.
3. Khin Wee Lai and Dyah Ekashanti Octorina Dewi, "Medical Imaging Technology: Reviews and Computational Applications", Springer Singapore, 2016.

REFERENCES:

1. Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw – Hill, New Delhi, 2014.
2. Dougherty, Geoff (Editor), "Medical Image Processing - Techniques and Applications", Springer-Verlag New York, 2011.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												2	
2		2	3										2	
3				3									2	
4			3					2						
5									3	3				
CO (W.A)	3	2	3	3				2	3	3			2	

22BMC10 - DIAGNOSTIC AND THERAPEUTIC EQUIPMENT				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: 22BMC04				
Course Objectives:	• To understand the devices for measurement of parameters related to cardiology. • To illustrate the recording and measurement of EEG. • To demonstrate EMG recording unit and its uses. • To explain diagnostic and therapeutic devices related to respiratory parameters. • To understand the various sensory measurements that hold clinical importance.			

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the principles and operational characteristics of various diagnostic equipment used in medical diagnostics.	Ap	40%
CO2	Analyze and interpret data obtained from biomedical equipment to diagnose and monitor medical conditions.	An	40%
CO3	Investigate complex problems related to biomedical equipment and propose effective solutions based on experimental data.	An	15%
CO4	Assess solutions for maintaining and troubleshooting biomedical equipment.	E	5%
CO5	Acquire hands-on experience with various biomedical instruments across different medical specialties and embracing lifelong learning.	E	Internal Assessment

UNIT I – CARDIAC EQUIPMENT	**(9)**
Electrocardiograph, Normal and Abnormal Waves, Heart Rate Monitor, Holter Monitor, Phonocardiography, ECG Machine Maintenance and Troubleshooting, Cardiac Pacemaker - Internal and External Pacemaker– Batteries, AC and DC Defibrillator- Internal and External, Defibrillator Protection Circuit, Cardiac Ablation Catheter.	
UNIT II – NEUROLOGICAL EQUIPMENT	**(9)**
Clinical Significance of EEG, Multi-Channel EEG Recording System, Epilepsy, Evoked Potential– Visual, Auditory And Somatosensory, MEG (Magneto Encephalo Graph). EEG Bio Feedback Instrumentation. EEG System Maintenance And Troubleshooting.	
UNIT III – MUSCULAR AND BIOMECHANICAL EQUIPMENT	**(9)**
Recording and Analysis of EMG Waveforms, Fatigue Characteristics, Muscle Stimulators, Nerve Stimulators, Nerve Conduction Velocity Measurement, EMG Bio Feedback Instrumentation. Static Measurement – Load Cell, Pedobarograph. Dynamic Measurement – Velocity, Acceleration, GAIT, Limb	

Position.

UNIT IV – RESPIRATORY MEASUREMENT AND ASSIST SYSTEM	(9)

Instrumentation for Measuring The Mechanics of Breathing – Spirometer - Lung Volume and Vital Capacity, Measurements Of Residual Volume, Pneumotachometer – Airway Resistance Measurement, Whole Body Plethysmograph, Intra-Alveolar and Thoracic Pressure Measurements, Apnoea Monitor. Types Of Ventilators – Pressure, Volume, and Time Controlled. Flow, Patient Cycle Ventilators, Humidifiers, Nebulizers, Inhalators.

UNIT V – SENSORY DIAGNOSTIC EQUIPMENT	(9)

Psychophysiological Measurements – Polygraph, Basal Skin Resistance (BSR), Galvanic Skin Resistance (GSR), Sensory Responses – Audiometer – Pure Tone, Speech, Eye Tonometer, Applanation Tonometer, Slit Lamp, Auto Refractometer.

TOTAL (L:45) = 45 PERIODS

TEXT BOOKS:

1. John G. Webster, "Medical Instrumentation: Application and Design", 5th Edition, Wiley India PvtLtd,New Delhi, 2021.
2. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", 4th Edition, Pearson Education, 2000.

REFERENCES:

1. L. A Geddes and L. E. Baker, "Principles of Applied Biomedical Instrumentation", 3rd Edition, 2008.
2. Khandpur. R.S., "Handbook of Biomedical Instrumentation". Second Edition. Tata McGrawHill Pub. Co.,Ltd. 2003.
3. Antony Y. K. Chan, "Biomedical Device Technology, Principles and Design", 3rd Edition, Charles Thomas Publisher Ltd., Illinois, USA, 2023.
4. Leslie Cromwell, "Biomedical Instrumentation and Measurement", 2nd Edition, Pearson Education, New Delhi, 2015.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												2	
2				2									2	
3		2		2									2	
4			2										2	
5						2						3		
CO (W.A)	3	2	2	2		2						3	2	

22BMP05 - MICROPROCESSORS AND MICROCONTROLLERS INTERFACING LABORATORY				
	L	**T**	**P**	**C**
	0	**0**	**4**	**3**
PRE-REQUISITE: NIL				
Course Objectives:	• To make the students to understand and apply the principles and techniques of coding, interfacing, and system design using various microcontrollers and development platforms to solve real-world problems. • To make the students to develop and enhance problem-solving, debugging, and collaboration skills to create efficient and effective solutions independently and as part of a team.			

Course Outcomes The Student will be able to		**Cognitive Level**
CO1	Examine the different interface modules using 8051 Microcontroller.	An
CO2	Develop and make a code to perform arithmetic and logical operations using 8085 and 8051/PIC.	C
CO3	Design and develop solutions for real time problems using Arduino/Raspberry pi.	C
CO4	Implement high-level language programs for peripheral interfacing and data processing using modern tools.	C
CO5	Develop an ability to work independently and collaboratively to provide valid solutions to real time problems.	An

LIST OF EXPERIMENTS

Assembly Language Programming:

1. Assembly language programming for 8/16 bit Arithmetic operators Using 8085.

2. Assembly language programming with control instructions Using 8085 (Increment / Decrement, Ascending / Descending order, Maximum / Minimum of numbers).

3. Assembly language programming for arithmetic and logical operations using 8051.

4. Interfacing and Programming of DC Motor Speed control using 8051.

5. Interfacing and Programming of Stepper Motor control using 8051.

High Level Language Programming:

The following programs have to be tested on 8051/PIC Development board or equivalent Embedded C Language on KEIL IDE or Equivalent.

6. Program to toggle all the bits of Port P1 continuously with delay.

7. Program to toggle P1.5 continuously with delay. Use Timer in mode 0, mode 1, mode 2 and mode 3 to create delay.

8. Program to interface 7 segment display to display a message on it .

9. Program to interface keypad. Whenever a key is pressed, it should be displayed on LCD.

10. Program to get analog input from Temperature sensor and display the temperature Value on LCD using ADC.
Sensor Interfacing:
11. To interface LED/Buzzer with platform/ Arduino /Raspberry Pi.
12. To interface Biosensors with platform/ Arduino /Raspberry Pi.
TOTAL (60 P) = 60 Periods

Mapping of COs with POs / PSOs														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1		3												
2	3													
3			3										3	
4					3									3
5									3					
CO (W.A)	**3**	**3**	**3**		**3**				**3**				**3**	**3**

22BMC11 – FUNDAMENTALS OF HEALTHCARE ANALYTICS				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: NIL				

Course Objectives:	• To understand the statistical methods for the design of biomedical research. • To comprehend the fundamental of mathematical and statistical theory in the application of Healthcare. • To apply the regression and correlation analyze in the healthcare data. • To understand the Meta analysis and variance analysis. • To interpret the results of the investigational methods.

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply fundamental statistical concepts and their application in biomedical data analysis.	Ap	30%
CO2	Analyze biomedical data and interpret findings using statistical software tools.	An	30%
CO3	Interpret statistical results to support or reject biomedical hypotheses.	An	20%
CO4	Employ regression and correlation analysis techniques to model relationships and patterns in biomedical datasets.	An	20%
CO5	Connect through expert talks on societal implications and ethical considerations of biomedical research and data analysis.	C	Internal Assessment

UNIT I – INTRODUCTION	**(9)**
Introduction, Computers and Bio Statistical Analysis, Introduction to Probability, Likelihood & Odds, Distribution Variability. Finding the Statistical Distribution using Appropriate Software Tool like R/ Python.	
UNIT II - STATISTICAL PARAMETERS	**(9)**
Statistical Parameters P-Values, Computation, Level Chi Square Test, Distribution and Hypothesis Testing -Single Population Proportion, Difference Between two Population Proportions, Single Population Variance, Tests of Homogeneity. Testing of Statistical Parameters using appropriate Software R / Python.	
UNIT III – REGRESSION AND CORRELATION ANALYSIS	**(9)**
Regression Model, Evaluating the Regression Equation, Correlation Model, Correlation Coefficient. Finding Regression, Correlation for the data using appropriate software like R / Python.	
UNIT IV – ANALYSIS OF VARIANCE	**(9)**
META analysis for research activities, purpose and reading of META analysis, kind of data used for META analysis, completely randomized design, randomized complete block design, repeated measures design,	

factorial experiment. Testing the variance using appropriate software tool like R / Python.	
UNIT V – CASE STUDIES	**(9)**
Epidemical reading and interpreting of epidemical studies, application in community health, Case study on Medical Imaging like MRI, CT. Case study on respiratory data, Case study on ECG data.	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

1. Wayne W. Daniel, "Biostatistics-A Foundation for Analysis in the Health Sciences", John Wiley & Sons Publication, 10th Edition, 2013.
2. Peter Armotage, Geoffrey Berry and J. N. S.Mathews, "Statistical methods in Medical Research", Wiley-Blackwell, 4th Edition, 2001.
3. Bernard Rosner, "Fundamentals of biostatistics", Nelson Education, 8th Edition 2015 ISBN: 978- 1-305-26892-0.

REFERENCES:

1. Marcello Pagano and Kimberlee Gauvreu, Principles of Biostatistics, Chapman and Hall/CRC, 2nd Edition, 2018.
2. Ronald N Forthofer and EunSul Lee, Introduction to Biostatistics, Academic Press, 1st Edition, 2014.
3. Animesh K. Dutta, Basic Biostatistics and its Applications, New Central Book Agency, 1st Edition, 2006.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													2
2		3												2
3				2										2
4					2									2
5						3		3				3		
CO (W.A)	3	3		2	2	3		3				3		2

22BMC12 – MEDICAL IMAGE PROCESSING				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: NIL				
Course Objectives:	• To learn the fundamental concepts of medical Image Processing techniques. • To understand the concepts of various image intensity transformation and filtering operations. • To be familiar in the techniques of segmentation and restoration of medical images. • To gain knowledge in medical image registration and visualization. • To be familiar with the application of medical image analysis.			

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply the basic concepts of digital image representation and the objectives of biomedical image analysis.	Ap	30%
CO2	Apply digital image processing algorithms for medical image enhancement, restoration and segmentation	Ap	30%
CO3	Apply various medical image compression standards and analyze CAD techniques.	Ap	20%
CO4	Analyze various registration and visualization techniques for medical images.	An	20%
CO5	Engage in self-study as an individual and a team-member to design and implement an open-ended experiment for medical image segmentation.	C	Internal Assessment

UNIT I – FUNDAMENTALS OF MEDICAL IMAGE PROCESSING AND TRANSFORMS	**(9)**
Overview of Image Processing system and human Visual system - Image representation – Pixel and Voxels, Gray scale and color models -Medical image file formats- DICOM- Discrete sampling model and Quantization- Relationship between the pixels, Arithmetic and logical operations- Image quality and Signal to Noise ratio- Image Transforms- 2D DFT, DCT, KLT.	
UNIT II - ENHANCEMENT TECHNIQUES	**(9)**
Gray level transformation - Log transformation, Power law transformation, Piecewise linear transformation. Histogram processing - Histogram equalization, Histogram Matching. Spatial domain Filtering-Smoothing filters, sharpening filters. Frequency domain filtering- Smoothing filters, Sharpening filters- Homomorphic filtering -Medical image enhancement using Hybrid filters- Performance measures for enhancement techniques.	
UNIT III – SEGMENTATION AND RESTORATION TECHNIQUES	**(9)**
ROI definition -Detection of discontinuities–Edge linking and boundary detection – Region based segmentation- Morphological processing, Active contour models. Image Restoration- Noise models–	

Restoration in the presence of Noise – spatial filtering, Periodic noise reduction by frequency domain filtering- linear position- Invariant degradation- Estimation of degradation function, Inverse filter, Weiner filtering.

UNIT IV – REGISTRATION AND VISUALISATION	**(9)**

Registration–Rigid body transformation, principal axes registration, and feature based. Visualisation- Orthogonal and perspective projection in medicine, Surface based rendering, Volume visualization in medical image. Explain the significance of registration of various imaging modalities

UNIT V – APPLICATIONS OF MEDICAL IMAGE ANALYSIS	**(9)**

Medical Image compression- DCT and Wavelet transform based image compression, Computer-aided diagnosis in mammography, Tumor imaging and treatment, Angiography, Bone strength and osteoporosis, Tortuosity, Applications: Contrast enhancement of mammograms - Detection of calcification by region growing,Feature Extraction - Shape and texture analysis of tumors.

TOTAL (L:45) : 45 PERIODS

TEXT BOOKS:

1. John G. Webster, "Medical Instrumentation Application and Design", 4th Edition, Wiley India Pvt. Ltd., New Delhi, 2015.
2. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", Pearson Education, 2012.

REFERENCES:

1. L. A Geddes and L. E. Baker, "Principles of Applied Biomedical Instrumentation", 3rd Edition, 2008.
2. Khandpur. R. S.,"Handbook of Biomedical Instrumentation". Second Edition. Tata Mc Graw Hill Pub. Co., Ltd. 2003.
3. Antony Y. K. Chan, "Biomedical Device Technology, Principles and design", Charles Thomas Publisher Ltd, Illinois, USA, 2008.
4. Leslie Cromwell, "Biomedical Instrumentation and Measurement", Pearson Education, New Delhi, 2007.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												2	
2		3	3										2	
3		3		3										2
4				3										2
5					3				3	2		2	2	
CO (W.A)	3	3	3	3	3				3	2		2	2	2

22BMP07 - MEDICAL IMAGE PROCESSING LABORATORY				
	L	T	P	C
	0	0	4	3

PRE-REQUISITE : NIL

Course Objectives:	• To learn the basics and fundamentals of image processing. • To analyze various applications of different transforms. • To demonstrate the different enhancement techniques. • To describe the applications of image segmentation process. • To illustrate the advancements and formatting in image processing.

The Student will be able to **Course Outcomes**		**Cognitive Level**
CO1	Apply different image enhancement algorithms in spatial and frequency domain filtering on the images.	Ap
CO2	Analyze the impact of image manipulation techniques.	An
CO3	Interpret images with various segmentation techniques.	An
CO4	Analyze various restoration techniques in the presence of noise and degradation.	An
CO5	Examine the various morphological operations on images.	An

LIST OF EXPERIMENTS

1. Basic operations on images.
2. Analysis of spatial and intensity resolution of images.
3. Analysis of images with different color models.
4. DFT analysis of images.
5. Histogram Processing.
6. Image Enhancement using Spatial and frequency domain filters.
7. Image segmentation using edge and region-based methods.
8. Translational and rotational operation of images.
9. Morphological operations on images.
10. Thresholding functions on images.
11. Image restoration in the presence of noise and degradation.
12. Extraction of shape and texture features from an image.

TOTAL (60 P) = 60 Periods

Mapping of COs with POs / PSOs														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3												2
2	3				3									2
3		3												2
4				3										2
5		3		3										2
CO (W.A)	**3**	**3**		**3**	**3**									**2**

22BMX01 - CELL BIOLOGY				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: NIL				
Course Objectives:	• To explore cell structure, functions and types. • To understand essential concepts like cellular processes and regulatory mechanisms. • To compare and contrast cellular processes and mechanisms across different cell types. • To investigate recent advancements in cell and molecular research. • To gain practical knowledge in cell culture techniques.			

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the knowledge of cell structures and their functions to explain biological processes.	Ap	30%
CO2	Analyze different methods of cellular transport and their roles in cell function.	An	30%
CO3	Evaluate the structure and function of key cell organelles.	E	20%
CO4	Critique cell signaling pathways and their components.	E	20%
CO5	Assess cutting-edge cell biology concepts effectively through interactive discussions and real-world observations during hospital visits.	E	Internal Assessment

UNIT I – CELL STRUCTURE	**(9)**
Cells - definition, Eukaryotic cell and prokaryotic cell -differences and key organelles, Relationship and evolution of Eukaryotic cell and prokaryotic cell, plant cells and animal cells - differences and general structure - Cellular environment, tissues, various types of cell, Extra cellular matrix, cytoskeletal proteins, Cell Cycle - Mitosis and meiosis.	
UNIT II – CELL ORGANELLES	**(9)**
Cell Organelles and function - Nucleus, Cytoplasm, Endoplasmic reticulum, Golgi complex, lysosomes, cell membranes, chloroplast, mitochondria - structure, importance and function.	
UNIT III – CELLULAR TRANSPORT	**(9)**
Transport across cell membranes - importance, classification - Active and passive, passive transport movement of water, small lipid across membrane. Active - Na+ K+ ATPase Pump, Lysosomal and Vacuolar pumps. Cotransport - Symport, antiport - examples, Endocytosis and Exocytosis transport across prokaryotic membrane, entry of viruses and toxins.	

UNIT IV – CELL SIGNALING AND SIGNAL TRANSDUCTION	(9)
Cell signaling - process importance, various kinds of Receptors and ligands - Examples, Different modes of action of ligands, Qualification and characterization of receptors, different modes of signal transduction and amplification with examples, signaling through G-Proteins (Monomeric and trimeric), signaling for growth factors, second messengers, protein kinases, Ca ions and cAMP molecule in signaling.	
UNIT V – CELL CULTURE	**(9)**
Definition, Media preparation, Propagation of eukaryotic and prokaryotic cell, cell lines, primary cultures, stock cell cultures, maintenance of cell lines in cell culture, explants cultures, differentiation and contamination.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. James E Darnell, Harvey F Lodish, David Baltimore, "Molecular Biology of the Cell", W.H. Freeman publishers, 2012.
2. Geoffrey Cooper, "The Cell: A molecular approach", OUP USA; 8th edition, 2019.
3. Verma and Aggarval, "Cytology", S. Chand Publications, 2003.

REFERENCES:

1. Bruce Alberts, Alexander Johnson, Julian Lewis and Martin Raff, "Molecular Biology of the Cell", fifth edition, Taylor and Francis group, 2012.
2. De Robertis, E.D.P and DeRobertis, E.M.F. (2010), "Cell and Molecular Biology", (8th edition) Lippincott Williams and Wilkins, Philadelphia.
3. Gerald Karp," Cell and Molecular Biology", John Wiley and sons Inc, 2013.

WEB LINK:

1. https://onlinecourses.nptel.ac.in/noc20_ee42/preview

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2		3												
3				3										
4					3									3
5									3		2		3	
CO (W.A)	3	3		3	3				3		2		3	3

22BMX02 - GENETIC ENGINEERING				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE: NIL

Course Objectives:	• To understand the concepts of Genetics. • To introduce the practice of recombinant DNA technologies. • To solve genetic engineering problems. • To design target gene expression with advanced genetic engineering techniques. • To explore with genetic engineering techniques for cloning target gene or protein expression.

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply basic genetic concepts and the roles of biomolecules in genetic processes.	Ap	40%
CO2	Illustrate techniques to perform gene cloning and create gene libraries.	An	40%
CO3	Analyze methods in disease diagnosis, forensic science and genetic research.	An	15%
CO4	Assess the impact and ethical implications of recent advancements in genetic engineering.	E	5%
CO5	Evaluate the societal, ethical and professional consequences of genetic engineering through interactive discussions.	E	Internal Assessment

UNIT I – BASICS OF GENETICS	**(9)**
Biomolecules: Carbohydrates, Proteins, Lipid, Amino Acid and Nucleic Acids. Nucleic Acids: Introduction, History, DNA and RNA - Genetic Material, Types, Mutation. Chromosome, Gene, Expression of Genetic Information, Regulation of mRNA Stability.	
UNIT II – RECOMBINANT DNA TECHNOLOGY	**(9)**
Gene Cloning - Concept and Basic Steps; Restriction Modification Enzymes used in Recombinant DNA Technology, Endonucleases, Ligases and Other Enzymes useful in Gene Cloning; Vectors: Plasmid, Bacteriophage and Other Viral Vectors, Cosmids, Artificial Chromosomes, Ti Plasmid, Shuttle Vectors, Expression Vectors; DNA Delivery Methods; Construction of Genomic and cDNA Libraries; Techniques for Selection, Screening and Characterization of Transformants.	
UNIT III – ROLE OF POLYMERASE CHAIN REACTION	**(9)**
Concept of PCR; DNA Polymerases; Primer Designing, Linkers, Adapters, Setting up PCR Reactions; Various types of PCR; Applications of PCR in Disease Diagnostics, Forensic Sciences and Genetic Engineering.	
UNIT IV – ADVANCED APPROACHES IN GENETIC ENGINEERING	**(9)**
Gene Expression in Prokaryotes & Eukaryotes, Tissue Specific Promoter, Wound Inducible Promoters, Strong and Regulatable Promoters, Promoter Analysis (EMSA and DNA Foot Printing), Gene Expression Profiling (Real Time PCR, SAGE, Differential Display, Microarray); DNA Sequencing Methods; Molecular Markers: RAPD, RFLP, AFLP, SNP; Site Directed Mutagenesis, Gene Silencing Techniques.	

UNIT V – APPLICATIONS OF GENETIC ENGINEERING	(9)
Genetic Engineering and Biotechnology; Creation of Recombinant Microorganisms, Transgenic Plants and Animals; Cloning of Sheep (Dolly) & Other Mammals; Applications in Conservation; Therapeutic Vs. Reproductive Cloning; Ethical Issues and the Prospects for Human Cloning; Gene Therapy; DNA Drugs and Vaccines.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. Old RW and Primrose SB, "Principles of Gene Manipulation, An Introduction to Genetic Engineering", Blackwell Science Publications, 1993.
2. B. Primrose and R. M. Twyman "Principles of Genome Analysis and Genomics", 3rd Edition, Blackwell Publishing, 2022.

REFERENCES:

1. Patrick Faraday, "Genetic Engineering: Emerging Concepts and Technologies", Syrawood Publishers, 2018.
2. "The Biotech Primer: An Insider"s Guide to the Science Driving the Biopharma Industry", The Biotech Primer for Non-Scientists Series, November 15, 2019.
3. Sandhya Mitra, "Genetic Engineering", 2nd Edition, Mcgraw Hill, 2017.
4. Desmond S. T. Nicholl, "An Introduction to Genetic Engineering", Cambridge University Press, 2023.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												2	
2		3											2	
3				3										2
4	3					3		3					2	
5									3	2		3	2	
CO (W.A)	3	3		3		3		3	3	2		3	2	2

22BMX03 - GENOMICS				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE: NIL

Course Objectives:	• To describe modern sequencing technologies • To apply principles of structural genomics to construct chromosome maps • To evaluate the ethical implications of genome sequencing projects. • To apply functional genomics techniques to study gene interactions. • To assess the role of genomics in predicting disease in pre-symptomatic individuals.

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply genomic sequencing technologies and tools to analyze and interpret genomic data.	Ap	40%
CO2	Analyze the importance and necessities to map chromosomes and organize genomic data.	An	40%
CO3	Evaluate major genome sequencing projects and their impact.	E	15%
CO4	Assess methods for genomic screening and personalized medicine to help treat genetic disorders.	E	5%
CO5	Explain advancements and ethical considerations in genomics through seminars and discussions.	U	Internal Assessment

UNIT I – INTRODUCTION	**(9)**
Introduction, Genomics, Sequencing Technologies: Polymerase Chain Reaction (PCR), Sanger Sequencing, High-Throughput Sequencing Technologies, Illumina, Ion Torrent, PacBio, Nanopore.	
UNIT II – STRUCTURAL GENOMICS	**(9)**
Eukaryotic Organelle Genomes (human and other organisms); Assigning Loci to Specific Chromosome; High Resolution Chromosome Mapping; Markers for Mapping (RFLP, Single Nucleotide Polymorphism, Microsatellite Markers, Copy Number Variation, Methods for Detection of Markers), Physical Mapping of Genome; Linkage Mapping; Using Genome Maps for Genetic Analysis - Organizational Principles of Human Genes: Application of Comparative Genomics to Understand the Molecular Mechanism.	
UNIT III – GENOME SEQUENCING	**(9)**
Whole Genome Shotgun Sequencing; Introduction to Various Databases, Genome Browsers & Associated Tools: ENSEMBL, Genecards, UCSC Genome Browser, Galaxy and their Application; Overview of Various Genome Scale Projects: Human Genome Project, Hapmap Project, 1000 Genome Projects, Expressed Sequence Tag (EST) Project; Ethical, Legal and Social Implications Addressed by The Human Genome Project; Concept of Epigenomics, Microrna, Long Non-Coding RNA; Concept of Three Dimensional Genome.	
UNIT IV – FUNCTIONAL GENOMICS	**(9)**
SAGE, Characterize The Proteome by ORF Analysis, Study of Gene Interactions by Yeast Two-Hybrid System, Study of Developmental Regulation by Using DNA Chips, Biomedical Genomics: Introduction to NGS-Based Targeted Re-Sequencing; Single Cell Sequencing; Experimental Design: WES, Transcriptome,	

WGBS, Chip-Seq; Concept of Metabolomics; Molecular Basis of Genetic Variations Leading to Medical Disorders: Types of Genetic Variations; Identification of Human Biomarkers using Genomics; Concept of Genome-Wide Association Studies (GWAS), Related Databases and its Limitations.
UNIT V – IMPACTS OF GENOMICS IN HEALTHCARE **(9)**
Screening for Genomic Disorders: Newborn Screening, Preconception Carrier Screening; Genomics of Cardiovascular Disease and Cancer; Concept of Pharmacogenomics; Concept of Genetic Counseling; Predicting Disease in Healthy (Pre-Symptomatic) People and its Ethical Concern.
TOTAL (L:45) = 45 PERIODS
TEXT BOOKS:
1. Primrose SB and R. Twyman "Principles Of Gene Manipulation &Geneomics Blackwell Science Publications, 2006. 2. Principles of Genome Analysis and Genomics by S.B.Primrose and R.M.Twyman, Third Edition (Blackwell Publishing), 2003.
REFERENCES:
1. Ansubel FM, Brent R, Kingston RE, Moore DD, "Current Protocols In Molecular Biology", Greene Publishing Associates, NY, 1988. 2. Berger SI, Kimmer AR, "Methods In Enzymology", Vol 152, Academic Press, 1987. 3. Genomes 3 by T. A. Brown, Third Edition (Garland Science Publishing), 2007.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2		3												
3				3										
4			2	3									2	
5									3	3		3		
CO (W.A)	3	3	2	3					3	3		3	2	

22BMX04 - CANCER BIOLOGY				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: NIL				
Course Objectives:	• To import knowledge on Cancer Biology fundamentals and principles of carcinogenesis. • To discuss about molecular cancer cell biology and metastasis. • To introduce various therapeutic procedures for treating carcinoma. • To emphasize knowledge of the historical background for the development of the tumor microenvironment. • To understand cell signaling processes including receptors, ligands, signal transduction, and the roles of G-Proteins, second messengers, protein kinases, Ca ions and cAMP.			

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Analyze the fundamentals of Cancer Biology and the principles of carcinogenesis.	Ap	40%
CO2	Apply therapeutic procedures for treating carcinoma.	Ap	40%
CO3	Evaluate molecular cancer cell biology and metastasis mechanisms.	E	15%
CO4	Assess the historical development of the tumor microenvironment.	E	5%
CO5	Relate theoretical knowledge to real-world scenarios and gain practical insights into cancer biology, clinical practices by assigning case studies.	An	Internal Assessment

UNIT I – FUNDAMENTALS OF CANCER BIOLOGY	**(9)**
Regulation of cell cycle, Mutations that cause changes in signal molecules, Cancer genes – Tumour suppressor genes, oncogenes and their mutations, Modulation of cell cycle in cancer, Different forms of cancers, Clinical examination, Radiological examination, Biopsy and its type, Prediction of aggressiveness of cancer, tumour markers, Molecular tools for early diagnosis.	
UNIT II – PRINCIPLES OF CARCINOGENESIS	**(9)**
Theory of carcinogenesis, Chemical carcinogenesis, Metabolism of carcinogemnesis, Principles of physical carcinogenesis, X-ray radiation, Mechanisms of radiation carcinogenesis, Diet and cancer.	
UNIT III – CELLULAR TRANSPORT	**(9)**
Transport across cell membranes - importance, classification - Active and passive, passive transport - movement of water, small lipid across membrane. Active - Na+ K+ ATPase Pump, Lysosomal and Vacuolar pumps. Cotransport - Symport, antiport - examples, Endocytosis and Exocytosis transport across prokaryotic membrane, entry of viruses and toxins.	
UNIT IV – CELL SIGNALING AND SIGNAL TRANSDUCTION	**(9)**

Cell signaling - process importance, various kinds of Receptors and ligands - Examples, Different modes of action of ligands, Qualification and characterization of receptors, different modes of signal transduction and amplification with examples, signaling through G-Proteins (Monomeric and trimeric), signaling for growth factors, second messengers, protein kinases, Ca ions and cAMP molecule in signaling.
UNIT V – CELL CULTURE **(9)**
Definition, Media preparation, Propagation of eukaryotic and prokaryotic cell, cell lines, primary cultures, stock cell cultures, maintenance of cell lines in cell culture, explants cultures, differentiation and contamination.
TOTAL (L:45) = 45 PERIODS
TEXT BOOKS:
1. James E Darnell, Harvey F Lodish, David Baltimore, "Molecular Biology of the Cell", W.H. Freeman Publishers, 2012 2. Geoffrey Cooper, "The Cell: A molecular approach", OUP USA; 8th Edition, 2019. 3. Vermaand Aggarval," Cytology", S. Chand Publications, 2003.
REFERENCES:
1. Bruce Alberts, Alexander Johnson, Julian Lewis and Martin Raff, "Molecular Biology of the Cell", 5th Edition, Taylor and Francis group, 2012. 2. De Robertis, E.D.P and DeRobertis, E.M.F. (2010), "Cell and Molecular Biology", 8th Edition Lippincott Williams and Wilkins, Philadelphia. 3. Gerald Karp," Cell and Molecular Biology", John Wiley and sons Inc, 2013.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2			3											
3		3		3										
4				3		3							2	
5							3		3			3		
CO (W.A)	3	3	3	3		3	3		3			3	2	

22BMX05 - PRINCIPLES OF TISSUE ENGINEERING				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: NIL				
Course Objectives:	• To study the cell types and differentiation. • To infer knowledge on the basic concepts of tissue engineering. • To study basics about stem cells and its applications. • To understand the methods and design involved in tissue engineering. • To study the clinical application on tissue repair/ engineering.			

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply Cell Biology and Tissue Engineering Principles.	Ap	40%
CO2	Analyze Stem Cell Applications and Engineering Methods in regenerative medicine and personalized healthcare solutions.	An	40%
CO3	Investigate Techniques in Tissue Engineering and Stem Cell Research of novel treatments for disease and injuries.	An	15%
CO4	Explain the engineering approaches and design methodologies in tissue engineering.	An	5%
CO5	Enhance their knowledge of complex scientific concepts in cell biology and tissue engineering by preparing and delivering seminars.	Ap	Internal Assessment

UNIT I – INTRODUCTION TO CELL BIOLOGY	**(9)**
Cell Types - Progenitor Cells - Cell Growth and Differentiation - Cell Culture: Expansion - Transfer - Storage and Characterization - Cell Signalling Molecules - Growth Factors - Cell Attachment: Differential Cell Adhesion, Receptor - Ligand Binding - Cell Surface Markers.	
UNIT II – FUNDAMENTALS OF TISSUE ENGINEERING	**(9)**
History and Scope of Tissue Engineering - Tissue Organization - Tissue Types: Epithelial, Connective - Vascularity and Angiogenesis - Wound Healing - Extra Cellular Matrix: Matrix Molecules and their Ligands - Tissue Culture – Materials in Tissue Engineering.	
UNIT III – STEM CELLS	**(9)**
Definition of Stem Cells – Types of Stem Cells – Differentiation, Dedifferentiation Maturation, Proliferation, Pleuripotency and Immortalization - Sources of Stem Cells: Haematopoetic – Fetal – Cord Blood – Placenta - Bone Marrow - Primordial Germ Cells - Cancer Stem Cells - Induced Pleuripotent Stem Cells.	
UNIT IV – ENGINEERING METHODS AND DESIGN	**(9)**
Soft Lithography - Self-assembled Monolayer, Micro Contact Printing, Micro Fluidic Patterning – Laminar Flow Patterning - Cell Interaction with Polymer Scaffolds and Gels - Polymer Scaffolds Fabrications: Electro Spinning - Solvent Casting and Particulate Leaching - Micro Fabrication of Cell Seeded Scaffolds.	
UNIT V – APPLICATION OF TISSUE ENGINEERING	**(9)**

Replacement Engineering: Bone, Cartilage, Skin, Blood, Pancreas, Kidney, Heart Valve and Liver - Regenerative Engineering: Peripheral Nerve Regeneration, Cardiac Tissue Regeneration, Muscle Regeneration – Regulation, Commercialization and Patenting.
TOTAL (L:45) = 45 PERIODS
TEXT BOOKS:
1. Robert P Lanza, Robert Langer and Joseph Vacanti, "Principles of Tissue Engineering", Academic Press, United States, 2020. 2. Donglu Shi and Qing Liu, "Tissue Engineering and Nanotheranostics", World Scientific Publications, Singapore, 2018.
REFERENCES:
1. Gary E. Wnek, Gary L Browlin, "Encyclopedia of Biomaterials and Biomedical Engineering", Marcel Dekker Inc, New York, 2008. 2. R. Lanza, Anthony Atala (Eds), "Essential of Stem Cell Biology", Academic Press, USA, 2013. 3. R. Lanza, Anthony Atala,"Handbook of Stem Cells", Academic Press, USA, 2012.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2		3												
3				3										
4					2								2	
5									3	3		3		
CO (W.A)	3	3		3	2				3	3		3	2	

22BMX06 - NEUROSCIENCE				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: NIL				
Course Objectives:	• To understand the basics of nervous systems and their functions • To characterize neuronal cells. • To identify the effects of neuronal functions and neural disorders. • To select suitable testing methods for analyzing neural behavior. • To apply theoretical knowledge to real-world scenarios.			

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the knowledge of the structure and function of the central and peripheral nervous systems, including signaling molecules and neurotransmitters.	Ap	40%
CO2	Analyze neuronal structures, synaptic functions and the effects of neurotransmitters and hormones.	An	40%
CO3	Identify the causes and features of common neurological and psychiatric disorders.	An	15%
CO4	Assess the basic research tools and techniques to study neuroscience.	E	5%
CO5	Apply theoretical knowledge of the nervous system, neuroanatomy and neurophysiology to analyze and solve real-world case studies related to neurological disorders.	An	Internal Assessment

UNIT I – INTRODUCTION TO NERVOUS SYSTEM	**(9)**
Nervous system: Introduction, Central and peripheral nervous system, Signalling molecules, First growth factor, First Neuro transmitters in brain, functional organization, Synaptic potentials and Receptor potentials.	
UNIT II – NEURO ANATOMY	**(9)**
Structures and functions of neurons, Synapse: function, signals produced by neurons, Sensors function, Glial cells, molecular and cellular organization of neuronal differentiation, characterization of neuronal cells.	
UNIT III – NEUROPHYSIOLOGY AND NEUROPHARMACOLOGY	**(9)**
Resting and action potentials; Mechanism of action potential conduction; Voltage dependent channels; nodes of Ranvier; Chemical and electrical synaptic transmission. Synaptic transmission, neurotransmitters and their release; fast and slow neurotransmission; characteristics of neurites; hormones and their effect on neuronal function.	
UNIT IV – NEUROLOGICAL DISORDERS	**(9)**
Pathogenesis, Genetic basis of neurological disorders, Psychiatric Disorders: Psychiatric epidemiology, Unipolar depression, Bipolar depression, Seasonal affective disorder, Panic disorder, Autism, Stroke, Huntington disease.	
UNIT V – BEHAVIOUR SCIENCE	**(9)**

Neuronal mechanism of behaviour, Animal behaviour, Behaviour in various environments, Behavioural and cognitive neuroscience, Behavioural studies using animal model, Testing motor functions, Grip Strength Test, Testing Cognitive Functions, Learning and memory related test.
TOTAL (L:45) = 45 PERIODS

TEXT BOOKS:

1. Georg Goldenberg, Bruce L. Miller, "Neuropsychology and Behavioral Neurology" Handbook of Clinical Neurology, Elsevier - libgen.lc., 2008.
2. Michael J. Aminoff, Handbook of Clinical Neurology, Elsevier, London, 2012.

REFERENCES:

1. Mason P., Medical Neurobiology, Oxford University Press, 2011.
2. Mathews G.G. Neurobiology, 2nd edition, Blackwell Science, UK, 2000.
3. Gordon M. Shepherd G.M, and Shepherd Neurobiology, 3rd Edition Oxford University Press, USA, 1994.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2		3												
3				3										
4					2									2
5						3	3					3		
CO (W.A)	3	3		3	2	3	3					3		2

22BMX07 - NUCLEAR MEDICINE				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: NIL				
Course Objectives:	• To understand the concepts of physics used in nuclear medicine. • To understand the construction and principle of operation of various nuclear medicine instruments. • To study the diagnostic applications of nuclear medicine. • To study the therapeutic applications of nuclear medicine. • To analyze radiation safety procedures and regulations.			

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply diagnostic and therapeutic techniques using radionuclides to diagnose and treat medical conditions.	Ap	40%
CO2	Illustrate the principles and mechanisms of radioactivity and radiation interaction in nuclear medicine.	An	40%
CO3	Interpret nuclear medicine instrumentation effectively, including gamma cameras, radiation detectors and electronic systems.	An	15%
CO4	Evaluate and implement radiation safety protocols and ethical standards in the use of radioactive materials in healthcare environments.	E	5%
CO5	Analyze information, identify key issues and propose effective solutions in complex biomedical contexts engaging with case studies.	An	Internal Assessment

UNIT I – BASICS OF NUCLEAR MEDICINE	**(9)**
Radioactivity and Interaction of Radiation; Alpha, Beta and Gamma Emission, Laws of Radioactive Decay, Mechanisms of Radioactive Delay, Radiation Intensity and Exposure, Decay Schemes and Energy Levels, Compton Scattering, Pair Productions, Particle Interactions.	
UNIT II - NUCLEAR MEDICINE INSTRUMENTATION	**(9)**
Construction and Principle Operation of Gamma Camera, Rectilinear Scanner, Basic Principles of Pulse Height Analyzer, Radiation Detectors-Ionization Chamber, Geiger Muller Counter, Semiconductor Detectors, Scintillation Detectors, Electronic Instrumentation for Radiation Detection System.	
UNIT III – DIAGNOSTIC APPLICATIONS OF RADIONUCLIDE	**(9)**
PET-CT, Single Photon Emission Computed Tomography (SPECT), Radio Iodine Therapy for Thyrotoxicosis, Differentiated Thyroid Cancers, Palliative Treatment for Bone Metastasis - 32P and 89 Strontium Dosage	

UNIT IV – THERAPEUTIC APPLICATIONS OF RADIONUCLIDE	(9)
Intravascular Particulate Radio Nuclide Therapy, Receptor Targeted Therapy, 1311- MIBG Therapy, Targeted Internal Radiation in HCC: 90 Y, Radio - Synovectomy using Yttrium	
UNIT V – RADIATION SAFETY	**(9)**
Radiation Protection in Different Nuclear Isotope Therapy Procedures, Management of Radiation Accidents, Radiation Effect on Pregnancy and Fertility, Diagnosis, Evaluation and Treatment of Radiation Overexposure, Instruments used in Radiation Survey & Monitoring, Handling of Radioactive Patients, Role of National and International Bodies in Radiation Safety, ICRP Recommendations, BARC Regulations Regarding Limits of Radiation Exposure.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. Simon Cherry, James Sorenson and Michael Phelps. "Physics in Nuclear Medicine", 4th Edition, Elsevier Saunders, 2012.
2. Essential Nuclear Medicine Physics, Rachel A Powsner and Edward R Powsner, 2nd Edition, Blackwell publishing, 2006.

REFERENCES:

1. Max. H. Lombardi, "Radiation Safety in Nuclear Medicine", 2nd Edition, CRC Press, Florida, USA, 1999.
2. Fred A Mettler and Milton J Guiberteau, "Essentials of Nuclear Medicine and Molecular Imaging", 7th Edition, Elsevier, 2018.
3. Harvey Ziessman, Janis O Malley and James Thrall, "Nuclear Medicine", 4th Edition, Elsevier, 2013.
4. Pete Shackett, "Nuclear Medicine Technology", 2nd Edition, Lipkott William Wilkkins, USA, 2008.
5. Jennifer Prekeges, "Nuclear Medicine Instrumentation", 2nd Revised Edition, John and Barelett Publishers, Inc USA, 2012.
6. Christian, Paul E., and Kristen M. Waterstram-Rich. Nuclear Medicine and PET/CT-E-Book: Nuclear Medicine and PET/CT-E-Book. Elsevier Health Sciences, 2013.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3			2										
2	3	2												
3			2	2									2	
4		2			2			3						
5						3	2			2				
CO (W.A)	3	2	2	2	2	3	2	3		2			2	

22BMX08 - RADIOTHERAPY BASICS & APPLICATION				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: NIL				
Course Objectives:	• To provide a knowledge on the interaction of Non-Ionizing radiation. • To infer knowledge on the principles and applications of optical radiations, lasers, and laser-tissue interactions. • To analyze the various techniques and instruments used in radiation dosimetry for medical applications. • To have a better understanding about radiation monitoring instruments. • To understand dosimetric concepts and factors influencing dose distribution in radiation therapy.			

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the knowledge of sources, properties and applications of non-ionizing radiation in medical contexts.	Ap	40%
CO2	Analyze Interactions Between Radiation and Biological Tissues.	An	40%
CO3	Evaluate and utilize various radiation detection and dosimetry techniques for accurate measurement and safety in medical practices.	An	15%
CO4	Assess the effective radiation monitoring techniques and understand key parameters for radiation treatment planning in clinical settings.	E	5%
CO5	Deduce insights from expert talks to enhance their understanding and problem-solving skills in medical radiation applications.	An	Internal Assessment

UNIT I – REVIEW OF NONIONISING RADIATION PHYSICS IN MEDICINE	**(9)**
Different Sources of Non Ionising Radiation -Their Physical; Properties - First Law of Photochemistry - Law of Reciprocity - Electrical Impedance and Biological Impedance - Principle and Theory of Thermography – Applications.	
UNIT II – TISSUE OPTICS	**(9)**
Various Types of Optical Radiations - UV, Visible and IR Sources - Lasers: Theory and Mechanism - Laser Surgical Systems - Measurement of Fluence from Optical Sources - Optical Properties of Tissues – Theory and Experimental Techniques - Interaction of Laser Radiation with Tissues – Photothermal - Photochemical – Photoablation – Electromechanical Effect.	
UNIT III – PRINCIPLES OF RADIATION DETECTION AND DOSIMETERS	**(9)**
Principles of Radiation Detection – Properties of Dosimeters - Theory of Gas Filled Detectors – Ion Chamber Dosimetry Systems - Free Air Ion Chamber – Parallel Plate Chamber - Ionization Chamber – Proportional Chamber - GM Counter – Condenser Type Chambers and Thimble Chambers Working and Different Applications – Film Dosimetery Luminescence Dosimetry – Semiconductor Dosimetry – Gel Dosimetry – Radiographic and Radiochromic Films – Scintillation Detections.	
UNIT IV – RADIATION MONITORING INSTRUMENTS	**(9)**

Introduction – Operational Quantities for Radiation Monitoring – Area Survey Meters – Ionization Chambers – Proportional Counters – Neutron Area Survey Meters – GM Survey Meters – Scintillation Detectors – Personal Monitoring – Film Badge – TLD – Properties of Personal Monitors – Radio photo Luminescent Glass Dosimetry System – OSLD.

UNIT V – RADIATION TREATMENT PLANNING PARAMETERS	**(9)**

Build-up, Central Axis Depth Doses for Different Energies and their Determination - Tissue Air Ratio, Tissue Maximum Ratio and Tissue Phantom Ratio - their Relationship - Back Scatter Factor – Phantom Scatter Factor – Collimator Scatter Factor - Source to Surface Distance – Dependence of SSD.

TOTAL (L:45) = 45 PERIODS

TEXT BOOKS:

1. F M Khan, "Physics of Radiation Therapy", 3rd Edition, Liippincott Williams & Wilkins, USA, 2003.
2. W. R. Hendee, "Medical Radiation Physics", Year Book Medical Publishers Inc., London, 2003.

REFERENCES:

1. E. B. Podgorsak, "Radiation Oncology Physics: A Handbook for teachers and students", IAEA publications 2005.
2. F. M. Khan, "The Physics of Radiation Therapy", 3rd Edition, Lippincott Williams and Wilkins, U.S.A., 2003.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2				3										
3			3											
4		3	3										3	
5						3	3					3		1
CO (W.A)	3	3	3	3		3	3					3	3	1

22BMX17 - MEDICAL TEXTILES				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: NIL				
Course Objectives:	• Provide students with a foundational understanding of medical textiles, including their properties, classifications, and various applications in healthcare. • Equip students with the knowledge to explore advanced materials, smart textiles, and their innovative uses in medical treatments, while considering relevant legal and ethical aspects.			

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Explain textile-based systems for various medical applications, including bandages, compression garments, sutures, implantables, extracorporeal materials and drug delivery textiles.	Ap	40%
CO2	Analyze the properties, applications, and testing methods of medical textiles, including antimicrobial fibers, nano fibrous materials and super absorbent polymers.	An	40%
CO3	Investigate the use of textile sensors and electronics in medical textiles, and address the legal and ethical issues involved.	An	15%
CO4	Assess the properties, applications and role of biopolymers in tissue engineering.	E	5%
CO5	Document and present the comparative study of various smart textiles.	E	Internal Assessment

UNIT I – INTRODUCTION	**(9)**
Medical textiles , classification, current market scenario in international and national level , government initiatives; antimicrobial fibres and finishes; nano fibrous materials and films; super absorbent polymers; operating room garments; personal health care and hygiene products and their testing methods; applications of non, wovens in medicine; textiles in infection prevention control.	
UNIT II – BIOPOLYMERS	**(9)**
Biopolymers: classification and their properties, requirements, and applications, testing methods; In vitro tests , direct contact, agar diffusion & elution methods , in vivo assessment of tissue compatibility. Tissue engineering: properties and materials of scaffolds, relationship between textile architecture and cell behavior , applications of textile scaffolds in tissue engineering.	
UNIT III – IMPLANTABLES, NON - IMPLANTABLES AND DRUG DELIVERY	**(9)**
Bandages, types, properties and applications; compression garments, types, properties and applications; sutures: types and properties; implantable textiles: hernia mesh , vascular prostheses , stents; Extra corporeal materials: Cartilage nerves , liver ligaments, kidney, tendons, cornea; Drug delivery textiles: Classification, mechanism various fabrication methods, characterization , applications.	
UNIT IV – WOUND CARE AND REUSABLE MEDICAL TEXTILES	**(9)**

Wound: types and healing mechanism, textile materials for wound dressing , bio active dressing , anti microbial textiles dressing , composite dressing , , testing of wound care materials; Wound 97 compression textiles; Reusable medical textiles: types, advantages, physical properties and performance, reusable processing methods.
UNIT V – SMART MEDICAL TEXTILES AND LEGAL ISSUES **(9)**
Smart textiles , types, characteristics , smart textiles in wound care; applications of phase change and shape memory materials , monitoring pregnancy, children and cardio patients , mobile health monitoring; electronics in medical textiles; Smart textiles in rehabilitation and applications; textile sensors for healthcare; legal and ethical values involved in the medical textile materials.
TOTAL (L:45) = 45 PERIODS
TEXT BOOKS:
1. Joon B. Park., and Joseph D. Bronzino., Biomaterials , Principles and Applications , CRCPress, Boca Raton London, New York, Washington, D.C. 2002. 2. Anand S.C., Kennedy J.F.,Miraftab M., and Rajendran S., Medical Textiles and Biomaterials for Health Care , Wood head Publishing Ltd., 2006. 3. Horrocks A R, Anand S C , Handbook of Technical Textiles, Woodhead Publishing and Textile Institute, USA, 2000.
REFERENCES:
1. Adanur S., Wellington Sears Handbook of Industrial Textiles , Technomic Publishing Co. Inc., Lancaster Pennylvania, 1995, ISBN 1, 56676, 340, 14. 2. Michael Szycher and Steven James Lee, Modern Wound Dressing: A Systematic Approach to Wound Healing , Journal of Biomaterials Applications, 1992.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1			3	3										
2	3	3												
3				3									2	
4		3		3										
5									3	2		2		
CO (W.A)	**3**	**3**	**3**	**3**					**3**	**2**		**2**	**2**	

22BMX18 - VIRTUAL REALITY				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: NIL				

Course Objectives:	• To learn the key components and commercial technologies of virtual reality, including input and output devices. • To understand the different types of modeling in VR, including geometric, kinematic, physical, behavior modeling, and model management. • To assess the impact of VR on users, including performance, health and safety issues, usability, and side effects like cyber sickness. • To develop practical skills in VR programming with Java 3D, including loading models, creating shapes, and designing animated 3D sprites and particle systems. • To explore various applications of VR technology in fields such as medicine, robotics, real-time tracking, gaming, movies, simulations, and therapy.

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the knowledge of the components and technologies of Virtual Reality (VR) systems including input and output devices.	Ap	40%
CO2	Implement VR programming concepts and techniques using Java 3D and other tools.	Ap	40%
CO3	Analyze modeling techniques in VR, including geometric, kinematics, physical, and behavior modeling.	An	15%
CO4	Assess human factors in VR systems, including user performance, health and safety issues, and usability.	E	5%
CO5	Function effectively to communicate as an individual to present the outcome of the implemented work in a team.	C	Internal Assessment

UNIT I – INTRODUCTION	**(9)**
The Three I's of Virtual Reality - Commercial VR Technology and the Five Classic Components of a VR System – Input. Devices :(Trackers, Navigation, and Gesture Interfaces): Three-Dimensional Position Trackers, Navigation and Manipulation-Interfaces and Gesture Interfaces-Output Devices: Graphics Displays-Sound Displays & Haptic Feedback	
UNIT II – MODELING	**(9)**
Geometric Modelling - Kinematics Modelling- Physical Modelling - Behavior Modelling - Model Management.	
UNIT III – HUMAN FACTORS	**(9)**
Methodology and Terminology - User Performance Studies - VR Health and Safety Issues - Usability of Virtual Reality System - Cyber Sickness - Side Effects of Exposures to Virtual Reality Environment.	
UNIT IV – VR PROGRAMMING	**(9)**

Introducing Java 3D - Loading and Manipulating External Models - Using a Lathe to make Shapes. 3D Sprites - Animated 3D Sprites - Particle Systems.	
UNIT V – APPLICATIONS	**(9)**
Medical Applications - Robotics Applications - Advanced Real Time Tracking - Other Applications - Games, Movies, Simulations, Therapy.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

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

REFERENCES:

1. John Vince, "Introduction to Virtual Reality", Springer-Verlag Ltd., 2004.
2. William R.Sherman and Alan B.Craig, "Understanding Virtual Reality – Interface, Application, Design", The Morgan Kaufmann Series, 2003.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2					3									3
3		3												
4			3			3								
5					3				3	3		3		
CO (W.A)	3	3	3		3	3			3	3		3		3

22BMX21 - SOFT COMPUTING				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: NIL				

Course Objectives:	• To understand the basics of artificial neural networks (ANNs) and their learning methods • To learn how to design and use different types of neural networks for practical biomedical problems. • To introduce the concepts of fuzzy logic and how it can help in making decisions with uncertain data.. • To understand genetic algorithms and how they can optimize solutions for biomedical problems • To explore hybrid computing techniques combining neural networks, fuzzy logic, and genetic algorithms.

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply artificial neural networks and learning methods to solve biomedical problems.	Ap	40%
CO2	Analyze the effectiveness of various neural network architectures, fuzzy logic systems and genetic algorithms in real-world biomedical applications.	An	40%
CO3	Assess hybrid computational systems combining neural networks, fuzzy logic and genetic algorithms for optimized biomedical solutions.	E	15%
CO4	Evaluate the performance and potential improvements of computational models in biomedical engineering.	E	5%
CO5	Assess ethical considerations and societal impacts of advanced computational techniques through seminars and discussions.	E	Internal Assessment

UNIT I – INTRODUCTION TO ARTIFICIAL NEURAL NETWORKS	**(9)**
Characteristics - Learning Methods – Taxonomy – Evolution of Neural Networks – Mcculloch - Pitts Neuron - Linear Separability - Hebb Network - Supervised Learning Network: Perceptron Networks - Adaptive Linear Neuron, Multiple Adaptive Linear Neuron.	
UNIT II – TYPES OF NEURAL NETWORKS	**(9)**
BPN, RBF, TDNN - Associative Memory Network: Auto-Associative Memory Network, Hetero-Associative Memory Network, BAM, Hopfield Networks, Iterative Autoassociative Memory Network & Iterative Associative Memory Network – Unsupervised Learning Networks: Kohonen Self Organizing Feature Maps, LVQ – CP Networks, ART Network. Case Studies On Biomedical Applications.	
UNIT III – FUZZY LOGIC	**(9)**
Membership Functions: Features, Fuzzification, Methods of Membership Value Assignments - Defuzzification: Lambda Cuts - Methods - Fuzzy Arithmetic and Fuzzy Measures: Fuzzy Arithmetic - Extension Principle - Fuzzy Measures - Formation of Rules-Decomposition of Rules, Fuzzy Inference Systems - Overview of Fuzzy Expert System - Fuzzy Decision Making. Case Studies on Biomedical	

Applications.	
UNIT IV – GENETIC ALGORITHM	**(9)**
Genetic Algorithm and Search Space - General Genetic Algorithm, Operators - Generational Cycle, Stopping Condition, Constraints. Classification, Genetic Programming, Multilevel Optimization, Real Life Problem, Advances In GA. Case Studies on Biomedical Applications.	
UNIT V – HYBRID SOFT COMPUTING TECHNIQUES	**(9)**
Neuro-fuzzy Hybrid Systems - Genetic Neuro Hybrid Systems - Genetic Fuzzy Hybrid and Fuzzy Genetic Hybrid Systems - Simplified Fuzzy ARTMAP. Case Studies on Biomedical Applications.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. Laurene V. Fausett, "Fundamentals of Neural Networks: Architectures, Algorithms and Applications" Pearson Education, 2010.
2. S. N. Sivanandam and S.N.Deepa, "Principles of Soft Computing", Wiley India Pvt. Ltd, 2011.
3. J. S. R. Jang, C.T. Sun and E.Mizutani, "Neuro-Fuzzy and Soft Computing", Pearson Education 2004.

REFERENCES:

1. S. Rajasekaran and G. A .Vijayalakshmi Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis & Applications", Prentice-Hall of India Pvt. Ltd., 2006.
2. George J. Klir, Ute St. Clair, Bo Yuan, "Fuzzy Set Theory: Foundations and Applications", Prentice Hall, New Delhi. 1997.
3. Simon Haykin, "Neural Networks Comprehensive Foundation", 2nd Edition, Pearson Education, 2005.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	3												
2				3	3									
3			3			3								
4				3			2						2	
5									3	2		2		
CO (W.A)	3	3	3	3	3	3	2		3	3		3	2	

22BMX22 - PATTERN RECOGNITION TECHNIQUES AND ITS APPLICATIONS				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: NIL				
Course Objectives:	• To understand pattern recognition and classification techniques. • To introduce clustering methods for unsupervised learning and classification. • To study about feature extraction and structural pattern recognition. • To equip students with knowledge of Hidden Markov Models (HMM) and Support Vector Machines (SVM). • To explore recent advances and practical applications of pattern recognition.			

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply Advanced Pattern Recognition Techniques.	Ap	40%
CO2	Analyze and Solve Complex Problems Using Clustering and Machine Learning Algorithms.	An	40%
CO3	Assess Biomedical Applications of Pattern Recognition.	E	15%
CO4	Design and Develop Pattern Classification Systems.	C	5%
CO5	Interpret modern pattern recognition tools and techniques in practical scenarios through assignments.	C	Internal Assessment

UNIT I – PATTERN CLASSIFIER	**(9)**
Overview of Pattern recognition – Discriminant functions – Supervised learning – Parametric estimation – Maximum Likelihood Estimation – Bayesian parameter Estimation – Problems with Bayes approach– Pattern classification by distance functions – Minimum distance pattern classifier.	
UNIT II – CLUSTERING	**(9)**
Clustering for unsupervised learning and classification – Clustering concept –Hierarchial clustering, Partitional clustering- k-means algorithm – Validity of Clusters.	
UNIT III – FEATURE EXTRACTION AND STRUCTURAL PATTERN RECOGNITION	**(9)**
KL Transforms – Feature selection through functional approximation – Binary selection -Elements of formal grammars - Syntactic description - Stochastic grammars - Structural representation.	
UNIT IV – HIDDEN MARKOV MODELS AND SUPPORT VECTOR MACHINE	**(9)**
State Machines – Hidden Markov Models – Training – Classification – Support vector Machine – Feature Selection.	
UNIT V – RECENT ADVANCES AND APPLICATIONS	**(9)**

Fuzzy logic – Fuzzy Pattern Classifiers – Case Study Using Fuzzy Pattern Classifiers CAD system in breast cancer detection, ECG signal classification, Fingerprint recognition, cell cytology classification.
TOTAL (L:45) = 45 PERIODS

TEXT BOOKS:
1. Andrew Webb, —Stastical Pattern Recognition, Arnold publishers, London,2002. 2. C.M.Bishop, —Pattern Recognition and Machine Learning, Springer, 2006. 3. Earl Gose, Richard Johnsonbaugh Steve Jost, —Pattern Recognition and Image Analysis, Prentice Hall of India Pvt Ltd., New Delhi, 1996.
REFERENCES:
1. M. Narasimha Murthy and V. Susheela Devi, —Pattern Recognition, Springer 2011. 2. Robert J.Schalkoff, —Pattern Recognition Statistical, Structural and Neural Approaches, John Wiley & Sons Inc., New York, 1992. 3. R.O.Duda, P.E.Hart and D.G.Stork, —Pattern Classification, John Wiley, 2001. 4. S.Theodoridis and K.Koutroumbas, —Pattern Recognition, 4th Ed., Academic Press, 2008.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2				3										
3		3					3						3	
4			3											
5					3				3			2		3
CO (W.A)	**3**	**3**	**3**	**3**	**3**		**3**		**3**			**2**	**3**	**3**

22BMX23 - MACHINE LEARNING FOR HEALTHCARE					
		L	T	P	C
		3	0	0	3
PRE-REQUISITE: NIL					
Course Objectives:	• To provide a comprehensive understanding of supervised learning techniques. • To introduce unsupervised learning methods • To equip with the skills to evaluate machine learning algorithms and model selection techniques • To delve into advanced topics in machine learning. • To explore scalable machine learning approaches.				

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply diverse machine learning techniques for data analysis and pattern recognition.	Ap	40%
CO2	Illustrate scalable machine learning solutions.	Ap	40%
CO3	Analyze applications in healthcare for improved diagnostics and treatment strategies.	An	15%
CO4	Assess model performance, conduct model selection and validation for effective decision-making.	E	5%
CO5	Determine practical application of machine learning concepts through assignments, fostering hands-on proficiency in algorithm implementation, model evaluation and real-world problem-solving.	Ap	Internal Assessment

UNIT I – SUPERVISED LEARNING	**(9)**
Basic Methods: Distance-Based Methods, Nearest-Neighbours, Decision Trees, Naive Bayes Linear Models: Linear Regression, Logistic Regression, Generalized Linear Models Support Vector Machines, Nonlinearity and Kernel Methods-Beyond Binary Classification: Multi-Class/Structured Outputs, Ranking.	
UNIT II – UNSUPERVISED LEARNING	**(9)**
Clustering: K-means/Kernel K-means, Dimensionality Reduction: PCA and kernel PCA, Matrix Factorization and Matrix Completion, Generative Models (Mixture Models and Latent Factor Models)	
UNIT III – EVALUATING ALGORITHMS	**(9)**
Machine Learning Algorithms and Model Selection, Introduction to Statistical Learning Theory, Ensemble Methods, Boosting, Bagging, Random Forests.	
UNIT IV – SPARSE MODELING AND ESTIMATION	**(9)**
Modeling Sequence/Time-Series Data, Deep Learning and Feature Representation Learning. Medical applications case study.	

UNIT V – SCALABLE MACHINE LEARNING	(9)
Online and Distributed Learning, A Selection from Some Other Advanced Topics, e.g., Semi-Supervised Learning, Active Learning, Reinforcement Learning, Inference in Graphical Models, Introduction to Bayesian Learning and Inference, Healthcare Applications Case Study.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. Kevin Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012.
2. Trevor Hastie, Robert Tibshirani, Jerome Friedman, "The Elements of Statistical Learning", Springer 2009.

REFERENCES:

1. Christopher Bishop, "Pattern Recognition and Machine Learning", Springer, 2007.
2. Arvin Agah, "Medical Applications of Artificial Intelligence", CRC Press, 2017.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	3												
2			3		3									
3			3	3										
4			3	3									2	
5									3			2		2
CO (W.A)	3	3	3	3	3				3			2	2	2

22BMX24 - ARTIFICIAL INTELLIGENCE IN HEALTHCARE				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: NIL				

Course Objectives:	• To understand AI fundamentals, its future and intelligent agents, focusing on problem-solving in healthcare. • To explore various search strategies and optimization problems, including constraint satisfaction and case studies. • To infer knowledge on learning methods, rule-based systems, decision tree learning and AI applications in medical diagnosis. • To discuss first-order predicate logic, Prolog programming and reasoning systems, with relevant case studies. • To study intelligent agent architecture, communication, negotiation and biomedical applications of multi-agent systems.

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the knowledge of ethical considerations and regulatory compliance requirements related to AI applications in healthcare.	Ap	40%
CO2	Apply AI algorithms to enhance diagnostic accuracy and personalize treatment plans in healthcare settings.	Ap	40%
CO3	Analyze robotic systems and automated processes using AI techniques to assist in surgery, rehabilitation and patient care, ensuring precision and safety in medical procedures.	An	15%
CO4	Assess AI-driven Systems for Medical Imaging and Signal Processing.	E	5%
CO5	Evaluate cutting-edge AI techniques and their use in biomedical engineering through expert's perspective.	E	Internal Assessment

UNIT I – EXPLORATION OF ARTIFICIAL INTELLIGENCE	**(9)**
Overview of Artificial intelligence - Definition - Future of Artificial Intelligence - Behavioral Characteristics of Intelligent Agents - Typical Intelligent Agents - Problem Solving Approach to healthcare problems.	
UNIT II – PROBLEM SOLVING METHODS	**(9)**
Problem solving Methods - Search Strategies- Uninformed - Informed - Heuristics - Local Search Algorithms and Optimization Problems - Searching with Partial Observations - Constraint Satisfaction Problems - Constraint Propagation - Backtracking Search. Case studies.	
UNIT III – AI DECISION TREE	**(9)**
Learning methods, Rule-based systems- Decision tree learning- Reinforcement learning. AI in Medical diagnosis.	
UNIT IV – KNOWLEDGE REPRESENTATION	**(9)**

First Order Predicate Logic - Prolog Programming - Unification - Forward Chaining-Backward Chaining - Resolution - Knowledge Representation - Ontological Engineering-Categories and Objects - Events - Mental Events and Mental Objects - Reasoning Systems for Categories - Reasoning with Default Information. Case Studies.
UNIT V – SOFTWARE AGENTS **(9)**
Architecture for Intelligent Agents - Agent communication - Negotiation and Bargaining - Argumentation among Agents - Trust and Reputation in Multi-agent systems. Biomedical applications.
TOTAL (L:45) = 45 PERIODS

TEXT BOOKS:

1. M. Tim Jones, "Artificial Intelligence: A Systems Approach", Jones and Bartlett Publishers, Inc.; First Edition, 2015 Reprint. ISBN-13: 978-9380298139.
2. Nils J. Nilsson, "The Quest for Artificial Intelligence", Cambridge University Press, 2009. ISBN-13: 978-0521122931.

REFERENCES:

1. William F. Clocksin and Christopher S. Mellish, "Programming in Prolog: Using the ISO Standard", 5th Edition, Springer, 2012 Reprint. ISBN 978-3-642-55481-0, DOI 10.1007/978- 3-642-5548.
2. Ian Millington, John Funge, "Artificial intelligence for Games", 2nd Edition, Morgan Kaufmann Publishers, CRC Press, 2012, ISBN: 978-0-12-374731-0.
3. S. Russell and P. Norvig, "Artificial Intelligence: A Modern Approach", 3rd Edition, Prentice Hall, 2016. ISBN-1537600311, 97-81537600314.
4. David L. Poole and Alan K. Mackworth, "Artificial Intelligence: Foundations of Computational Agents", Cambridge University Press, 2010. ISBN-13: 978-0521519007.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3		3					3						
2	3	3												
3			3	3		3							3	
4		3												
5							3							3
CO (W.A)	3	3	3	3		3	3	3					3	3

22BMX25 - DEEP LEARNING TECHNIQUES				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: NIL				
Course Objectives:	• To Apply Machine Learning Algorithms to Solve Diverse Real-World Problems. • To Implement Deep Learning Architectures for Effective Data Classification. • To Analyze and Optimize Convolutional Neural Networks for Complex Tasks • To Develop Efficient Recurrent Neural Networks and Recursive Nets for Sequential Data. • To Design and Implement Autoencoders and Generative Models for Data Synthesis.			

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply Basic Machine Learning Algorithms.	Ap	40%
CO2	Apply the knowledge of Deep Learning Models for Data Analysis.	Ap	40%
CO3	Interpret Techniques for Sequential Data Analysis.	An	15%
CO4	Assess Neural Network Performance.	E	5%
CO5	Analyze complex problems through structured assignments, applying sequential data analysis techniques such as RNNs and LSTM networks.	An	Internal Assessment

UNIT I – MACHINE LEARNING BASICS	**(9)**
Learning algorithms, Maximum likelihood estimation, Building machine learning algorithm, Basic Machine Learning Algorithms: Naive Bayes, Support Vector Machine, Decision Tree, Random Forest, Neural Networks - Multilayer Perceptron, Back-propagation algorithm and its variants stochastic gradient decent, Curse of Dimensionality.	
UNIT II – DEEP LEARNING ARCHITECTURES	**(9)**
Machine Learning and Deep Learning, Representation Learning, Width and Depth of Neural Networks,Activation Functions: RELU, LRELU, ERELU, Unsupervised Training of Neural Networks, Restricted Boltzmann Machines, Auto Encoders, Deep Learning Applications.	
UNIT III – CONVOLUTIONAL NEURAL NETWORKS AND TRANSFER LEARNING	**(9)**
Architectural Overview, Motivation, Layers, Filters, Parameter sharing, Regularization, Popular CNN Architectures ResNet, AlexNet , Applications Transfer learning Techniques, Variants of CNN DenseNet, PixelNet.	
UNIT IV – SEQUENCE MODELING RECURRENT AND RECURSIVE NETS	**(9)**

Recurrent Neural Networks, Bidirectional RNNs, Encoder decoder sequence to sequence architectures BPTT for training RNN, Long Short Term Memory Networks, Neural style transfer in Keras.	
UNIT V – AUTOENCODERS AND DEEP GENERATIVE MODELS	**(9)**
Under complete Auto encoder, Regularized Autoencoder, stochastic Encoders and Decoders, Contractive. Encoders - Deep Belief networks, Boltzmann Machines, Deep Boltzmann Machine, Generative Adversarial Networks.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. Ian Good fellow, Yoshua Bengio and Aaron Courville, Deep Learning, MIT Press, 2017.
2. Josh Patterson, Adam Gibson Deep Learning: A Practitioner's Approach, O'Reilly Media, 2017.
3. Umberto Michelucci Applied Deep Learning. A Case-based Approach to Understanding Deep Neural Networks press, 2018.

REFERENCES:

1. Kevin P. Murphy Machine Learning: A Probabilistic Perspective, The MIT Press, 2012.
2. Ethem Alpaydin, Introduction to Machine Learning, MIT Press, Prentice Hall of India, Third Edition 2014.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2		3												
3				3										3
4	3			3										
5									3			2		
CO (W.A)	3	3		3					3			2		3

22BMX26 - MACHINE VISION				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE: NIL

Course Objectives:	• To understand the basics and applications of machine vision. • To apply image filtering techniques to improve image quality. • To assess the performance of various edge detection methods. • To study dynamic vision processes like motion detection and tracking. • To analyze methods for recognizing objects based on features and patterns.

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply foundational concepts of machine vision to analyze and interpret visual data effectively.	Ap	40%
CO2	Analyze comprehensive solutions for dynamic vision tasks, including motion detection, object tracking and shape reconstruction from visual data.	An	40%
CO3	Assess the performance of edge detection algorithms in various contexts, employing metrics and benchmarks to measure accuracy and robustness.	E	15%
CO4	Evaluate and select appropriate techniques for image processing and filtering to optimize image quality and enhance feature extraction.	E	5%
CO5	Develop the practical skills needed to apply the knowledge of machine vision concepts in real-world scenarios through assignments.	C	Internal Assessment

UNIT I – MACHINE VISION FUNDAMENTALS	**(9)**
Machine Vision- Relationships to Other Fields-Role of Knowledge-Image Geometry-Perspective Projection-Coordinate Systems-Levels of Computation - Thresholding, Geometric Properties, Size, Position, Orientation, Projections, Run-Length Encoding, Binary Algorithms, Morphological Operators, Optical Character Recognition.	
UNIT II – REGION AND FILTERING BASED PROCESSING	**(9)**
Regions and Edges - Region Segmentation - Region Representation - Split and Merge - Region Growing - Image Filtering - Histogram Modification - Linear Systems - Linear Filters - Median Filter – Gaussian Smoothing	
UNIT III – EDGE DETECTION	**(9)**
Gradient - Steps in Edge Detection - Comparison- Second Derivative Operators: Laplacian Operator, Second Directional Derivative, Laplacian of Gaussian, Image Approximation - Gaussian Edge Detection, Canny Edge Detector - Subpixel Location Estimation - Edge Detector Performance - Methods for Evaluating Performance - Figure of Merit - Sequential Methods - Line Detection.	
UNIT IV – DYNAMIC VISION	**(9)**
Change Detection - Change Detection - Segmentation using Motion - Motion Correspondence – Image flow - Segmentation using a Moving Camera - Tracking - Shape from Motion	

UNIT V – OBJECT RECOGNITION	(9)
System Components - Complexity of Object Recognition - Object Representation: Observer-Centered Representations, Object-Centered Representations - Feature Detection - Recognition Strategies: Classification, Matching, Feature Indexing - Verification: Template Matching, Morphological Approach, Symbolic, Analogical Methods.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. Ramesh Jain, Ramesh C Jain, Machine Vision, pp., McGraw Hill, 1995.
2. Fabio Solari, Manuela Chessa, Silvio P. Sabatini, Machine vision Applications and Systems, BoD Books on Demand, 2012.
3. J. Shi and C. Tomasi, Good Features to Track. In IEEE Conference on Computer Vision and Pattern Recognition, 1994.

REFERENCES:

1. D. G. Lowe, Distinctive Image Features from Scale-Invariant Keypoints. In International Journal of Computer Vision, 2004.
2. D. Comaniciu and P.Meer, Robust analysis of feature spaces: Color image segmentation. IEEE.
3. Conference on Computer Vision and Pattern Recognition, June 1997, 750-755.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2			3		3								2	
3		3		3										2
4			3											2
5									3			2	2	
CO (W.A)	3	3	3	3	3				3			2	2	2

22BMX27 - BIOMETRIC SYSTEM				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: NIL				

Course Objectives:	• To understand the general principles of design of biometric systems and the underlying trade-offs. • To study the technologies of fingerprint. • To study the technologies of face recognition and hand geometry. • To study the technologies of iris. • To study the technologies of speech recognition and evaluation of biometrics systems.

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Explain Various Biometric Technologies and their Applications.	Ap	40%
CO2	Apply biometric recognition techniques to recognize and classify biometric features.	An	40%
CO3	Analyze biometric system performance.	An	15%
CO4	Infer integration strategies and security considerations in combining biometric modalities for enhanced authentication.	An	5%
CO5	Articulate emerging trends in biometrics, including multimodal systems and security implications, through guest lectures.	C	Internal Assessment

UNIT I – INTRODUCTION TO BIOMETRICS	**(9)**
Introduction and back ground – biometric technologies – passive biometrics – active biometrics – Biometric characteristics, Biometric applications – Biometric Authentication systems- Taxonomy of Application Environment, Accuracy in Biometric Systems- False match rate- False non match rate- Failure to enroll rate- Derived metrics-Biometrics and Privacy.	
UNIT II – FINGERPRINT TECHNOLOGY	**(9)**
History of fingerprint pattern recognition - General description of fingerprints- fingerprint sensors, fingerprint enhancement, Feature Extraction- Ridge orientation, ridge frequency, fingerprint matching techniques- correlation based, Minutiae based, Ridge feature based, fingerprint classification, Applications of fingerprints, Finger scan- strengths and weaknesses, Evaluation of fingerprint verification algorithms.	
UNIT III – FACE RECOGNITION AND HAND GEOMETRY	**(9)**
Introduction to face recognition, face recognition using PCA, LDA, face recognition using shape and texture, face detection in color images, 3D model based face recognition in video images, Neural networks for face recognition, Hand geometry – scanning – Feature Extraction – classification.	
UNIT IV – IRIS RECOGNITION	**(9)**
Introduction, Anatomical and Physiological underpinnings, Iris sensor, Iris representation and localization-Daugman and Wilde's approach, Iris matching, Iris scan strengths and Weaknesses, System performance, future directions.	

UNIT V – VOICE SCAN AND MULTIMODAL BIOMETRICS	(9)
Voice scan, speaker features, short term spectral feature extraction, Mel frequency cepstral coefficients, speaker matching, Gaussian mixture model, NIST speaker Recognition Evaluation Program, Introduction to multimodal biometric system – Integration strategies – Architecture – level of fusion – combination strategy, examples of multimodal biometric systems, Securing and trusting a biometric transaction – matching location – local host - authentication server – match on card (MOC).	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. James Wayman& Anil Jain, "Biometric Systems- Technology Design and Performance Evaluation", SPRINGER (SIE), 1st Edition, 2011.
2. Paul Reid, "Biometrics for Network Security", Pearson Education, 2004.
3. S.Y. Kung, S.H. Lin, M.W., "Biometric Authentication: A Machine Learning Approach", Prentice Hall, 2004.

REFERENCES:

1. Nalini K Ratha, Ruud Bolle, "Automatic fingerprint recognition system", Springer, 2003.
2. L C Jain, I Hayashi, S B Lee, U Halici, "Intelligent Biometric Techniques in Fingerprint and Face Recognition", CRC Press, 1st Edition, 1999.
3. John Chirillo, Scott Blaul, "Implementing Biometric Security", John Wiley & Sons, 2003.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2		3												
3				3										
4						3								
5					3							2		3
CO (W.A)	3	3		3	3	3						2		3

22BMX28 - BRAIN COMPUTER INTERFACE AND APPLICATIONS				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: NIL				

Course Objectives:	• To understand the basics of BCI systems, including their structure, types, and EEG signal processing. • To gain knowledge on various brain signals and neural activities relevant to BCIs. • To analyze different techniques for extracting features from brain signals for BCI applications. • To apply various methods for translating brain signal features into control commands. • To explore practical applications of BCIs in neuroprosthetics, device control and specific case studies.

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the fundamental principles, structures and classification of BCI systems.	Ap	40%
CO2	Analyze and preprocess EEG signals effectively, including artifact removal and signal enhancement techniques.	An	40%
CO3	Interpret BCI applications for external device control and functional restoration.	An	15%
CO4	Assess advanced feature extraction and translation methods such as wavelets, PCA and neural networks for BCI data analysis.	E	5%
CO5	Report real-world applications of BCI technology, including neuroprosthetics and mobile robot control, through case studies to evaluate the implementation challenges and successes of BCI systems.	E	Internal Assessment

UNIT I – INTRODUCTION TO BCI	**(9)**
Fundamentals of BCI – Structure of BCI system – Classification of BCI – Invasive, Non-invasive and Partially invasive BCI – EEG signal acquisition - Signal Preprocessing – Artifacts removal.	
UNIT II - ELECTROPHYSIOLOGICAL SOURCES	**(9)**
Sensorimotor activity – Mu rhythm, Movement Related Potentials – Slow Cortical Potentials-P300 - Visual Evoked Potential - Activity of Neural Cells - Multiple Neuromechanisms.	
UNIT III – FEATURE EXTRACTION METHODS	**(9)**
Time/Space Methods – Fourier Transform, PSD – Wavelets – Parametric Methods – AR, MA, ARMA models – PCA – Linear and Non-Linear Features.	
UNIT IV – FEATURE TRANSLATION METHODS	**(9)**

Linear Discriminant Analysis – Support Vector Machines - Regression – Vector Quantization– Gaussian Mixture Modeling – Hidden Markov Modeling – Neural Networks.	
UNIT V – APPLICATIONS OF BCI	**(9)**
Functional restoration using Neuroprosthesis - Functional Electrical Stimulation, Visual Feedback and control - External device control, Case study: Brain actuated control of mobile Robot.	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

1. Bernhard Graimann, Brendan Allison and Gert Pfurtscheller, "Brain-Computer Interfaces: Revolutionizing Human-Computer Interaction", Springer, 2010.

REFERENCES:

1. R. Spehlmann, "EEG Primer", Elsevier Biomedical Press, 1981.
2. Fred A Mettler, Milton J Guiberteau, "Essentials of Nuclear Medicine and Molecular Imaging" 7th Edition, Elseiver, 2018.
3. Arnon Kohen, "Biomedical Signal Processing", Vol I and II, CRC Press Inc, Boca Rato, Florida, 1986.
4. Bishop C.M., "Neural Networks for Pattern Recognition", Oxford, Clarendon Press, 1995.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2			3	3										
3		3												
4					3									3
5						3		3				2		
CO (W.A)	3	3	3	3	3	3		3				2		3

22BMX31 - BIOMECHANICS				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: NIL				

Course Objectives:	• To understand the fundamentals of fluid properties and classification, stress, and strain in fluids and non-fluids. • To analyze different types of fluid flows and measure viscosity in various flow conditions. • To explore the development and behavior of the boundary layer and the nature of turbulence. • To evaluate friction loss, velocity distribution, and blood flow dynamics in the human circulatory system. • To apply control theory and mechanical analysis to circulatory systems, focusing on myocardial mechanics and fluid dynamics of heart valves.

Course Outcomes The student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the knowledge of the mechanical properties and behaviors of biological materials such as bones, muscles and soft tissues.	Ap	30%
CO2	Analyze human motion dynamics and kinematics using biomechanical principles.	An	30%
CO3	Interpret biomechanical analysis techniques in practical applications.	An	20%
CO4	Assess joint mechanics and their implications for human movement.	E	20%
CO5	Apply biomechanical principles through detailed case studies, analyzing real-world scenarios to deepen understanding and problem-solving skills.	Ap	Internal Assessment

UNIT I – INTRODUCTION	**(9)**
Definition and perspective of biomechanics, Kinematic concept for analysing human motion, Kinetic concepts for analyzing human motion, Linear kinetics of human movement, Equilibrium, Angular kinetics of human movement, Anthropometry.	
UNIT II – BIOMECHANICS OF SOLIDS AND FLUIDS	**(9)**
Constitutive Equation, Stress, strain, viscoelasticity, models of viscoelasticity, Flow properties of blood, dynamics of fluid flow in cardiovascular system, Rheology of blood in micro vessels, Bio viscoelastic solids, Lubrication of joints.	
UNIT III – BIOMECHANICS OF HARD AND SOFT TISSUES	**(9)**
Bone: structure, composition, mechanical properties, anisotropy, fracture mechanisms – pseudo elasticity, Structure, function, mechanical properties of: skin, ligaments, skeletal muscles and tendons, Constitutive equations for soft tissues.	
UNIT IV – BIOMECHANICS OF JOINTS	**(9)**

Kinetics and kinematics of joints, Skeletal joints, mechanics of the elbow, mechanics of shoulder, mechanics of spinal column, mechanics of hip, mechanics of knee, mechanics of ankle.	
UNIT V – ORTHOPAEDIC APPLICATIONS	**(9)**
Gait analysis, Qualitative biomechanical analysis to: improve technique, understand injury development, Amputations and prosthetics, prosthetic components, Introduction to 3D printing, Introduction to accelerometer.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. Y.C.Fung, Bio-Mechanics, Mechanical Properties of Tissues, Springer-Verilog, 1993.
2. C. Ross Ether and Craig A. Simmons, Introductory Biomechanics from cells to organisms, Cambridge University Press, New Delhi, 2007.
3. Susan J Hall, Basics of Biomechanics, McGraw Hill Publishing.co. New York, 8th Edition, 2019.

REFERENCES:

1. Dhanjoo N. Ghista, Orthopaedic Mechanics, Academic Press, 1990.
2. Joseph D.Bronzino, Biomedical Engineering Fundamentals, Taylor& Francis, Fourth edition, 2015.
3. John Enderle, Susanblanchard, Joseph Bronzino, Introduction to Biomedical Engineering, Elsevier, Third edition, 2011.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	3						3						
2	3													
3				3										
4			3											
5							3					2		2
CO (W.A)	3	3	3	3			3	3				2		2

22BMX32 - ERGONOMICS				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE: NIL

Course Objectives:	• To get exposed to principles of visual capabilities. • To learn the mechanics of muscle physiology and significance of rest cycle. • To learn spatial compatibility and the relation between control orders and control response. • To know about the measurements and proportions of the human body. • To be familiar with the mathematical models, analysis and design of biomedical devices using case studies.

Course Outcomes The student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply ergonomic principles to optimize workplace environments and interfaces.	Ap	40%
CO2	Analyze physiological responses and ergonomic factors influencing workplace efficiency.	An	40%
CO3	Evaluate the impact of ergonomic design on human performance and safety.	E	15%
CO4	Assess ergonomic solutions integrating human factors and ergonomic principles.	E	5%
CO5	Discover interdisciplinary perspectives on ergonomic principles and their applications through group discussions, enhancing their understanding and application in real-world contexts.	C	Internal Assessment

UNIT I - VISUAL AND AUDITORY ERGONOMICS	**(9)**
Process of seeing – visual capabilities – factors affecting visual acuity and contrast sensitivity – human factor aspects of hard copy text and computer screen text, factors in selecting graphic representations symbols, qualitative visual display – process of hearing – principles of auditory display. Measures for monitoring control & mitigation.	
UNIT II - MUSCLE PHYSIOLOGY	**(9)**
Muscle physiology – muscle metabolism – respiratory response – joint motion study – measure of physiological in-efficiency and energy consumption – work rest cycles – aspects of manual and posture study, material handling (MMH) Bio-mechanical recommended limits of MMH.	
UNIT III - CONTROLS AND DISPLAYS	**(9)**
Spatial compatibility and physical arrangement of displays and controls - Design of displays and controls – movement capability – rotary controls and rotor displays movement of displays orientation of the operator and movement relationships control orders and control responses – human limitations in tracking task.	
UNIT IV - ANTHROPOMETRY	**(9)**
Anthropometry – anthropometric design principles – Physical work load and energy expenditure - work space envelope – factors in design of work space surfaces – principles of seat design – principles of control panel. ergonomic implications. Organization classification of human errors theories of accident causation-reducing accidents by altering behavior.	

UNIT V - CASE STUDIES	(9)
Biomedical Application, Design optimization of Medical Equipment, Ergonomic Keyboard Design for Carpal Tunnel Syndrome, Standing Desk Implementation for Workplace Ergonomics.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. Pascale Carayon, "Handbook of Human Factors and Engineering", 2nd Edition, CRC Press, 2011.
2. Martin Helander, "Guide to Human Factors and Ergonomics", 2nd Edition, CRC Press,2005
3. Benjamin W.Niebel, "Motion and Time Study", Richard, D. Irwin Inc., 7th Edition, 2002.

REFERENCES:

1. Shrawan Kumar, "Biomechanics in Ergonomics", 2nd Edition, CRC Press2007.
2. George Kanawaty, "Introduction to work study", ILO, 3rd Edition, Oxford & IBH Publishing, 2001
3. Stephen Pheasant, Christine M. Haslegrave, Bodyspace: Anthropometry, Ergonomics and the Design of Work, CRC Press, 2005.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	3												
2				3										
3			3			2		2						
4			3										2	
5									3	3				
CO (W.A)	3	3	3	3		2		2	3	3			2	

22BMX33 - FINITE ELEMENT ANALYSIS				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: NIL				

Course Objectives:	• To analyze and model engineering field problems using finite element methods. • To formulate and solve beam and 2D scalar problems using finite element methods. • To develop and apply higher-order and isoparametric elements to plane stress problems. • To evaluate elasticity equations and implement finite element solutions for plane stress, plane strain, and fluid mechanics. • To solve non-linear finite element problems in biomechanical research applications.

Course Outcomes The student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply mathematical models to analyze how engineering structures behave.	Ap	30%
CO2	Analyze and enhance biomechanical systems using computer models.	An	30%
CO3	Analyze the effects of different conditions on structures and check the accuracy of simulations.	An	20%
CO4	Assess models for engineering applications to enhance product design.	E	20%
CO5	Develop communication skills and critically analyze finite element analysis concepts through researching and presenting seminar topics.	An	Internal Assessment

UNIT I - INTRODUCTION TO MODELLING	**(9)**
Historical Background, Mathematical Modelling of field problems in Engineering, Governing Equations, 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.	
UNIT II - BEAM ELEMENTS AND SCALAR PROBLEM IN TWO DIMENSION	**(9)**
Fourth Order Beam Equation Transverse deflections, Natural frequencies of beams and longitudinal vibration. Second Order 2D Equations involving Scalar Variable Variation 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 Iso parametric elements Shape functions for isoparametric elements One, two and three dimensions Serendipity elements Numerical integration and application to plane stress problems transformation in coordinates- Jacobian of transformation order of convergence- numerical integration example problems- shape functions in natural coordinates rectangular elements- Lagrange family.	

UNIT IV - NON-LINEAR ANALYSIS	(9)
Introduction to Nonlinear problems, some solution methods, computational procedure, simple material nonlinearity, stress stiffening, contact interfaces, problems of gaps and contact, geometric nonlinearity, modelling considerations.	
UNIT V - IMPACT ANALYSIS	**(9)**
Mechanical properties of biological and commonly used biomedical engineering materials, Critical reviews of finite element analysis in biomechanical research. Modelling and force analysis of musculoskeletal systems, Stress calculations.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. King-Hay Yang, Basic Finite Element Method as Applied to Injury Biomechanics, Elsevier Academic Press. 2017.
2. Connie McGuire, Finite Element Analysis: Biomedical Aspects, NY Research press, 2015.
3. Moratal D., Finite Element Analysis from Biomedical Applications to Industrial Developments, InTech Publisher, 2014.

REFERENCES:

1. J N Reddy, Finite element methods, Tata Mc Graw Hill, 2003.
2. Seshu, Text Book of finite element analysis, Prentice Hall, New Delhi, 2003.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2		3												
3				3										
4			3										3	
5									2	3		2		
CO (W.A)	3	3	3	3					2	3		2	3	

22BMX35 - CARDIOVASCULAR ENGINEERING				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE: NIL

Course Objectives:	• To Understand Cardiovascular Functions. • To Analyze Cardiac Events and Cycles. • To infer knowledge on Cardiac Excitation and Regulation. • To Assess Cardiac Output Methods. • To Evaluate Hemodynamics Principles.

Course Outcomes The student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply knowledge of cardiac physiology and hemodynamics to assess and monitor patients' cardiovascular health, aiding in the diagnosis and treatment of cardiac conditions.	Ap	40%
CO2	Compare new treatments and interventions using cardiovascular physiology principles.	An	40%
CO3	Interpret clinical data and use it to inform medical decisions.	An	15%
CO4	Assess medical devices by using principles of cardiac excitation, contraction and hemodynamics.	E	5%
CO5	Articulate a research-based report, analyzing medical device testing to comprehend the causes of heart diseases and their connection to suitable treatments.	An	Internal Assessment

UNIT I – OVERVIEW OF THE CARDIOVASCULAR SYSTEM	**(9)**
Functions of the cardiovascular system, Circulation of blood, Central control of the cardiovascular system.	
UNIT II – CARDIAC CYCLE	**(9)**
Mechanical events, Arterial cycle and central venous pressure cycle, Clinical aspects of human cardiac cycle.	
UNIT III – CARDIAC EXCITATION AND CONTRACTION	**(9)**
Mechanism of contraction, Sinoatrial node function, cardiac conduction system, Atrioventricular node function, Autonomic regulation of the heart rate.	
UNIT IV – ASSESSMENT OF CARDIAC OUTPUT	**(9)**
Fick principle, Thermodilution and indicator dilution methods, Pulse Doppler methods, miscellaneous methods.	
UNIT V – HEMODYNAMICS	**(9)**

Relationship between pressure, flow and resistance, Frank-Starling law, Preload, after load and contractility, Control of stroke volume and cardiac output
TOTAL(L:45) = 45 PERIODS

TEXT BOOKS:
1. Susan J Hall, Basics of Biomechanics, McGraw Hill Publishing.co. New York, 8th Edition, 2018. 2. Dhanjoo N.Ghista, Orthopaedic Mechanics, Academic Press, 2014.
REFERENCES:
1. Joseph D.Bronzino, Biomedical Engineering Fundamentals, Taylor& Francis, 2006. 2. John Enderle, Susanblanchard, Joseph Bronzino, Introduction to Biomedical Engineering, Elsevier, 2005.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	3				2								
2			3					2					2	
3				3										
4				3										
5				3			3					2		
CO (W.A)	3	3	3	3		2	3	2				2	2	

22BMX36 - REHABILITATION ENGINEERING				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: NIL				
Course Objectives:	• To explain the need for medical aids. • To understand the sensory rehabilitation systems. • To learn the use of orthopedic prosthetics and orthotics in rehabilitation. • To understand virtual reality in rehabilitation. • To have an understanding of rehabilitation medicine and advocacy.			

Course Outcomes The student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the knowledge of roles and functions of the rehabilitation team and the principles of community-based rehabilitation to enhance proper delivery of care.	Ap	40%
CO2	Analyze engineering concepts in sensory augmentation and substitution, including visual, auditory and tactual systems to develop effective sensory aids.	An	40%
CO3	Analyze modern tools such as virtual reality and robotics to develop innovative rehabilitation systems and enhance mobility recovery.	An	15%
CO4	Assess orthopedic prosthetics, orthotics and functional electrical stimulation systems for motor rehabilitation using engineering principles.	E	5%
CO5	Develop insights into rehabilitation engineering advancements by engaging with industry experts, integrating academic knowledge with real-world practices.	C	Internal Assessment

UNIT I - INTRODUCTION TO REHABILITATION	**(9)**
Definition - Impairments, disabilities and handicaps, Primary and secondary disabilities, Activities of daily living, Appropriate Technology, Residual function. Rehabilitation. Rehabilitation team – members and their functions. Rehabilitation care –Need for proper delivery of rehabilitation care, Community based rehabilitation and its aspects.	
UNIT II - ENGINEERING CONCEPTS IN SENSORY AUGMENTATION AND SUBSTITUTION	**(9)**
Sensory augmentation and substitution- Visual system: Visual augmentation, Tactual vision substitution, and Auditory vision substitution. Auditory system- Auditory augmentation, Hearing aids, cochlear implants, visual auditory substitution, tactual auditory substitution. Tactual system - Tactual augmentation, Tactual substitution.	
UNIT III - ORTHOPEDIC PROSTHETICS AND ORTHOTICS	**(9)**
Engineering concepts in motor rehabilitation, Artificial limbs- body powered, externally powered and controlled orthotics and prosthetics, Myoelectric hand and arm prosthetics. Functional Electrical Stimulation Systems-Restoration of hand function, restoration of standing and walking, Hybrid Assistive Systems (HAS).	
UNIT IV - VIRTUAL REALITY	**(9)**

Introduction to virtual reality, Virtual reality-based rehabilitation, Hand motor recovery systems with Phantom haptics, Robotics and Virtual Reality Applications in Mobility Rehabilitation.	
UNIT V - REHABILITATION MEDICINE AND ADVOCACY	**(9)**
Physiological aspects of Function recovery, psychological aspects of Rehabilitation therapy, Legal aspect available in choosing the device and provision available in education, job and in day-to-day life.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. Joseph D Bronzino, "The Biomedical Engineering Handbook". 2nd edition, CRC Press, 2000.
2. Robinson C.J, "Rehabilitation Engineering", CRC Press, 2006.

REFERENCES:

1. Sashi S Kommu, "Rehabilitation Robotics", 1st edition, CRC Press, 2007.
2. Sunder, "Textbooks of Rehabilitation", Jaypee Brothers Medical Publishers Pvt. Ltd, New Delhi, 2nd Edition, Reprint 2007.
3. Horia- Nocholai Teodorecu, L.C.Jain, "Intelligent systems and technologies in rehabilitation Engineering", CRC; December 2000.
4. Etienne Grandjean, Harold Oldroyd, "Fitting the task to the man", Taylor & Francis, 1988.
5. Keswick. J., "What is Rehabilitation Engineering, Annual Reviews of Rehabilitation", Springer Verlag, New York, 1982.
6. Warren E. Finn, Peter G. Lopressor, "Handbook of Neuroprosthetic Methods",CRC, 2002.
7. Roy A Cooper (Editor), Hisaichi Ohnabe (Editor), Douglas A. Hobson (Editor), "An Introduction to Rehabilitation Engineering (Series in Medical Physics and Biomedical Engineering" CRC Press, 2000.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2		3												
3			3	3										
4					3									3
5							3					3		
CO (W.A)	3	3	3	3	3		3					3		3

22BMX37 - PROSTHETIC AND ORTHOTIC DEVICES				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: NIL				
Course Objectives:	• To apply suitable assistive technology (AT) for human mobility. • To analyze sensory impairment of vision and hearing and suggest suitable aiding devices. • To explore recent advancements in assistive technology for vital organs. • To evaluate an assistive device for a given organ impairment. • To assess the performance of an implant design based on its performance parameters.			

Course Outcomes The student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the knowledge of the advanced control systems and virtual reality applications in the context of assistive technologies and healthcare innovations.	Ap	40%
CO2	Apply the knowledge on advanced assistive devices to enhance healthcare outcomes and patient quality of life.	An	40%
CO3	Analyze clinical challenges through the integration of innovative assistive technologies and effective implant solutions.	An	15%
CO4	Assess proficient implant design principles and methodologies to address complex healthcare needs.	E	5%
CO5	Correlate industry insights, analyze diverse perspectives and enhance communication skills to evaluate societal, health, safety, legal, and cultural issues in professional engineering practice.	E	Internal Assessment

UNIT I – ASSISTIVE TECHNOLOGY FOR MOBILITY	**(9)**
Basic assessment and evaluation for mobility, Control systems, navigation in virtual space by wheelchairs, Wheel chair seating and pressure ulcers, Fuzzy logic expert system for automatic tuning of myoelectric prostheses, Intelligent prosthesis.	
UNIT II – ASSISTIVE TECHNOLOGY AND SENSORY IMPAIRMENTS	**(9)**
Visual and auditory impairment, assessment methods, Libraille, GRAB, mathematical Braille, Augmentative and alternative methods for hearing impairment, Use of multimedia technology to help hard of hearing children, Haptic as a substitute for vision.	
UNIT III – ASSIST DEVICES FOR VITAL ORGANS AND ADVANCEMENTS IN TECHNOLOGY	**(9)**
Cardiac assist devices, Intra-Aortic Balloon Pump (IABP), auxiliary ventricles, Dialysis for kidneys, Intermittent positive pressure breathing (IPPB) type assistance for lungs, Latest use of assistive technology for chronic heart diseases and healthcare, Information technology, telecommunications, new media in assisting healthcare, Future trends in assistive technology, virtual reality based training system for disabled children.	
UNIT IV – PRINCIPLES OF IMPLANT DESIGN	**(9)**

Principles of implant design, cardiac implants, Clinical problems requiring implants for solution, Permanent versus absorbable devices, the missing organ and its replacement, Tissue engineering, scaffolds, cells and regulators criteria for materials selection, Case study of organ regeneration.	
UNIT V – IMPLANT DESIGN PARAMETERS AND ITS SOLUTION	**(9)**
Biocompatibility, local and systemic effects of implants, Design specifications for tissue bonding and modulus matching, Degradation of devices, natural and synthetic polymers, corrosion, wear and tear, Implants for Bone, Devices for nerve regeneration, dental and otologic implants.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. Yadin David, Wolf W. von Maltzahn, Michael R. Neuman, Joseph.D, Bronzino, Clinical Engineering, CRC Press, 1st edition, 2010.
2. Kenneth J. Turner, Advances in Home Care Technologies: Results of the match Project, Springer, 1st edition, 2012.

REFERENCES:

1. Gerr, M. Craddock, Assistive Technology-Shaping the future, IOS Press, 1st edition, 2003.
2. Marion. A. Hersh, Michael A. Johnson, Assistive Technology for visually impaired and blind, Springer Science & Business Media, 1st edition, 2010.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2				3									2	
3		3		3										
4			3			3								
5						3	3	3						
CO (W.A)	3	3	3	3		3	3	3					2	

22BMX38 - HAPTICS				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE: NIL

Course Objectives:	• To comprehend the fundamentals of human haptics including the somatosensory system, motor system, and muscle physiology. • To design and evaluate haptic devices with a focus on human factors. • To understand and assess haptic sensors and actuators, addressing ergonomic barriers. • To implement and analyze computational haptics for various applications, focusing on rendering and stability. • 5. To explore and apply haptic technology in medical applications such as telemedicine, rehabilitation, and educational simulations.

Course Outcomes The student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the knowledge on the fundamentals of human haptic perception and its application in interface design.	Ap	40%
CO2	Analyze haptic systems using various sensor and actuator technologies.	An	40%
CO3	Assess advanced haptic rendering techniques and control methodologies in virtual environments.	E	15%
CO4	Evaluate applications of haptics in medical simulation, rehabilitation, virtual reality and other emerging fields.	E	5%
CO5	Articulate seminars effectively on haptics, demonstrating deep understanding and critical analysis of current advancements and applications.	E	Internal Assessment

UNIT I - INTRODUCTION	**(9)**
Touch, Sense of Touch, Perception of world through touch, Haptics, Tactile system, Tactile receptors, Sensory and Motor specialization of Hand, Haptic perception, Haptic Illusion, Tactile and Haptic Displays, Haptic exploration, Concepts and terminologies.	
UNIT II - HUMAN HAPTIC PERCEPTION	**(9)**
Introduction, Touch and cognition, Human Haptic system: Mechanical structure of Arm, Hand haptics system, Human sensory system, The motor system, Haptic cognition, Haptic exploration, Concept of Illusion, Human perceptual parameters for Haptics: Interface development, Perception Thresholds.	
UNIT III - MACHINE HAPTICS	**(9)**
Introduction, Haptic Interfaces: Robotic perspective, Haptic interface system, HAVE sensor: Electromechanic sensors, Optical sensors, Capacitive sensor, Resistive sensor, Force sensors, strain gauge sensors, Magnetic sensor, HAVE actuators: Magnetic Levitation Devices, Nonholonomic devices, Magnetic sensors and parallel mechanisms, performance specifications: physical attributes, special attributes and temporal attributes.	

UNIT IV - COMPUTER HAPTICS	(9)
Introduction, Haptic rendering subsystems, Polygon, based representation and scene graph, collision detection techniques and bounding volumes, control methods for Haptic systems: Impedance control architecture, Feed, forward impedance control architecture, positive feedback Impedance control architecture, Hybrid compensation Impedance control architecture, Admittance control architecture.	
UNIT V - HAPTICS APPLICATIONS	**(9)**
Introduction, Haptics for Medical Applications: Surgical simulation, stoke based rehabilitation, support of the visually impaired, Tele, surgery, Media: Haptic broadcasting. E, commerce, Video games, other application: Mobile Haptics, Haptics and VR, Introduction to Wearable Haptic devices.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. Lynette Jones, Haptics, The MIT Press, 2018.
2. Abdulmotaleb El Saddik, Mauricio Orozco, Mohamad Eid, Jongeun Cha, Haptics Technologies: Bringing Touch to Multimedia, Springer Science & Business Media, 2011.
3. Tom Bruno, Wearable Technology: Smart Watches to Google Glass for Libraries, Rowman & Littlefield Publishers, Lanham, Maryland, 2015.

REFERENCES:

1. Hiroyuki Kajimoto, Masashi Konyo, Shoichi Hasegawa, Takuya Nojima, Ki-Uk Kyung, Haptic Interaction: Science, Engineering and Design. (2017). Switzerland: Springer Nature Singapore.
2. Abdulmotaleb El Saddik, Mauricio Orozco, Mohamad Eid, Jongeun Cha, Haptics. Technologies Bringing Touch to Multimedia, Springer, 2011.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2		3												
3				3										
4					3									3
5									3	2				
CO (W.A)	3	3		3	3				3	2				3

22BMX47 - PATIENT SAFETY AND STANDARDS				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: NIL				

Course Objectives:	• To apply safety procedures in healthcare organizations. • To apply safety norms in different departments in healthcare sector according to their working environments.. • To analyze the Health care organization structure and the responsibilities of different levels to implement safety. • To analyze the regulatory standards for medical device maintenance. • To outline the accreditation protocols for a hospital and its safety standards.

Course Outcomes The student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Illustrate preparedness and response strategies for managing healthcare crises.	Ap	40%
CO2	Interpret complexity science principles to manage healthcare workflows effectively, improving quality and safety in clinical settings.	An	40%
CO3	Assess patient safety protocols across diverse healthcare departments.	E	15%
CO4	Evaluate and adhere to international regulatory standards for medical device maintenance and safety, ensuring compliance with ISO and national health directives.	E	5%
CO5	Analyze case study findings to evaluate and enhance healthcare practices and policies.	An	Internal Assessment

UNIT I – INTRODUCTION	**(9)**
Guidelines and safety practices for improving patient safety, Human error and patient safety, safer care, patients for patient safety, Human factors, patient safety from the perspective of medical residents, patient safety in the world, Infection prevention and control, Adverse event investigation and Risk assessment.	
UNIT II – PATIENT SAFETY IN DIFFERENT HEALTHCARE DEPARTMENTS	**(9)**
Patient safety in Intensive care and Anaesthesiology, Safe surgery, Emergency department clinical risk, obstetric safety patient, patient safety in internal medicine, risks in oncology and radiation therapy, patient safety in orthopaedics and Traumatology, patient safety in paediatrics, patient safety in paediatrics and ophthalmology.	
UNIT III – HEALTH ORGANIZATION	**(9)**
Community and Primary Care, Complexity Science as a Frame for Understanding the Management and Delivery of High Quality and Safer Care, Measuring Clinical Workflow to Improve Quality and Safety, shift work Organization, Non-technical Skills in Healthcare, Medication Safety, Digital Technology and Usability, Coping with the COVID-19 Pandemic: Roles and Responsibilities for Preparedness.	

UNIT IV – REGULATORY STANDARDS FOR MEDICAL DEVICE MAINTENANCE	(9)
International Standards, Medical Device Directive 93/42/EEC, Medical Electrical Equipment ISO 60601, Safety Testing of Medical Devices ISO 62353, Medical Device Inspection ISO17020. Indian Standards, National Health Mission, Biomedical Equipment Management and Maintenance Program (BMMP), ISO 9001-2008, AERB Compliance, Radiation protection.AE(RP)R-2004, Safety Code AE/RF-MED/SC-3.	
UNIT V – HOSPITAL ACCREDITATION AND SAFETY STANDARDS	**(9)**
Accreditation, JCI Accreditation & its Policies. Life Safety Standards- Protecting Occupants, Protecting the Hospital and Individuals from Fire, Smoke, and Heat. Managing Hazardous Medical Material and Waste, Laboratory and Radiation safety, Health and safety hazards of shift work. Patient Safety, Human factors, Reliability, Evidence based Medicine, Root cause Analysis.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. Donaldson L, Ricciardi W, Sheridan S, Tartaglia R, editors. Textbook of Patient Safety and Clinical Risk Management [Internet].
2. Cham (CH): Springer; 2021. PMID: 36315660.

REFERENCES:

1. William Charney, Handbook of Modern Hospital Safety, CRC Press, 2nd Edition, 2009.
2. Almira Badnjevic, Mario Cifrek, Ratko Magjarevic, Zijad Dzemic, Inspection of Medical Devices: For Regulatory Purposes, Springer Nature, 2018.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1		3						3						
2				3		3								
3	3					3								
4		3		3			3							
5									3			3		2
CO (W.A)	3	3		3		3	3	3	3			3		2

22BMX48 - MEDICAL DEVICE REGULATIONS				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE: NIL

Course Objectives:	• To understand the basic concepts of medical device regulations. • To apply the global policies on medical device regulations. • To analyze implications of the regulations. • To analyze the Standards and Regulations used for medical devices. • To analyze the software and Quality system regulation.

Course Outcomes The student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply principles of reliability engineering to enhance the performance of medical devices.	Ap	40%
CO2	Explain regulatory frameworks and compliance requirements in global medical device manufacturing.	An	40%
CO3	Illustrate quality management systems for medical device manufacturing adhering to international standards.	An	15%
CO4	Assess the impact of software regulations on medical device development and compliance.	E	5%
CO5	Correlate expert insights to enhance comprehension and application of global medical device regulations and standards.	An	Internal Assessment

UNIT I – INTRODUCTION	**(9)**
Defining the device, Overview of quality function deployment, Business proposal Reliability: Definition, Quality Vs Reliability Vs Unreliability, Types of Reliability, Optimizing reliability, Reliability's effects on medical devices. Concept of Failure: Causes of Failure, Practical aspects of failure, Failure rates, Hardware failure, Software Failure. Safety and Risk Management: Medical device safety and risk management, Effectiveness/performance of medical devices, Phases in the life span of a medical device.	
UNIT II – DRUG MANUFACTURING PRACTICES	**(9)**
Global Harmonization Task Force (GHTF): Objectives, Scope of the four GHTF study groups, Benefits of the GHTF, Global Medical Device Nomenclature (GMDN) The Food and Drug Administration: Device classification, Registration and listing, The 510 (k) Process, Declaration of conformity, The PMA application, Investigational Device Exemptions (IDEs), Good Manufacturing Practices (GMPs).	
UNIT III – MEDICAL DEVICE DIRECTIVES	**(9)**
The European Union: European Directives, European Standardization Bodies, European Standards Development Process, Other European Standards Considerations, Conformity Assessment and Testing, European Organization for Testing and Certification. The Medical Devices Directives: Process, Choosing the appropriate directive, Identifying the applicable essential requirements.	
UNIT IV – STANDARDS AND REGULATIONS	**(9)**
Standards and Regulation: Voluntary and mandatory standards, Standards development process, Conformity assessment with standards, National and international standards systems, Identification of standards, Current trends in the use of standards in medical device regulations. The ISO 9000 Series of	

Standards.	
UNIT V – SOFTWARES AND QUALITY SYSTEM REGULATIONS	**(9)**
Software and Quality system regulation: Software as a Technology, Domestic and International Software Regulations and Standards. Design controls, Document controls, Purchasing controls, Identification and traceability, Production and process controls, Acceptance activities, Non-conforming product, Corrective and preventive action.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. Michael Cheng, Medical Device Regulations Global Overview and Guiding Principles, World Health Organization, 2003.
2. Des O'Brien, Medical Device Regulations Roadmap A Beginners Guide, Create Space Independent Publishing Platform, 2017.
3. Aakash Deep, Medical Device Regulations A Complete Guide, Elsevier Science, 2022.

REFERENCES:

1. Jack Wong, Raymond Tong, Jenny Stanford Publishing Handbook of Medical Device Regulatory Affairs in Asia, Second Edition, 2018.
2. G.R Higson, Medical Device Safety, The Regulation of Medical Devices for Public Health and Safety, 2001.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2		3												
3				3		3								
4		3			3									2
5												3		
CO (W.A)	3	3		3	3	3						3		2

22BMX51 - BIO-MEMS TECHNOLOGY				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE: NIL

Course Objectives:	• To explore the principles and applications of MEMS and Microsystems in the healthcare industry. • To understand the fundamental principles of Micro-Opto Electromechanical Systems (MOEMS) and their applications. • To analyze the properties and applications of microfluidic systems. • To investigate BioMEMS technologies for clinical monitoring, lab-on-a-chip applications, and emerging technologies. • To comprehend the micromachining processes and technologies involved in microsystem fabrication.

Course Outcomes The student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply advanced microsystem technologies to solve healthcare challenges effectively.	Ap	40%
CO2	Explain the micromachining techniques to fabricate and enhance microsystems tailored for healthcare needs.	An	40%
CO3	Assess microfluidic systems and BioMEMS devices for clinical use.	E	15%
CO4	Evaluate and select appropriate MEMS/Microsystems for biomedical applications.	E	5%
CO5	Report their understanding and application among participants by fostering interactive discussions.	Ap	Internal Assessment

UNIT I – MEMS IN HEALTHCARE	**(9)**
MEMS and Microsystems- Introduction - Typical MEMS and Microsystem Products - Application of Micro-System in Healthcare Industry – Working Principles of Microsystems Micro-Sensors – Micro-Actuation - MEMS with Micro Actuation– Micro Accelerators.	
UNIT II – FUNDAMENTALS OF MOEMS	**(9)**
Micro-Opto Electromechanical Systems: Fundamental Principle of MOEMS Technology, Advantages - Light Modulators, Beam Splitter – Micro-Lens, Micro-Mirrors - Digital Micro-Mirror Device, Grating Light Valve, Optical Switch, Waveguide and Tuning.	
UNIT III – MICROFLUIDIC SYSTEMS	**(9)**
Microfluidics- Introduction and Fluid Properties, Applications of MFS- Fluid Actuation Methods- Electrophoresis, Dielectrophoresis, Electrowetting, Optoelectrowetting, Electroosmosis Flow, Electrothermal Flow, Thermocapillary Effect- Microfluidic Channel- Microdispenser- Microneedle-	

Microfilter
UNIT IV – BioMEMS **(9)**
Introduction to Biomems, Biomems for Clinical Monitoring, Lab on A Chip, DNA Sensors, E-Nose, E-Tongue. Microsystem Approaches to PCR, MEMS Based Implantable Drug Delivery System, Emerging Biomems Technology.
UNIT V – MICROMACHINING **(9)**
Micro System Technology-Photolithography-X-Ray Lithography-Etching-Deposition-Material Properties-Thin Film Process-Clean Room-Laser Deposition-Thin Film Diode-Transistor- FET-ISFET. Software Tools for Design, Analysis and Testing.
TOTAL(L:45) = 45 PERIODS

TEXT BOOKS:

1. Tai-Ran Hsu, "MEMS & Microsystems- Design, Manufacture and Nanoscale Engineering", 2nd Edition John Wiley & Sons, 2008.
2. Nitaigour Premchand Mahalik, "MEMS", 2 nd Reprint Tata McGraw Hill, 2008.

REFERENCES:

1. Albert Folch, "Introduction to Bio mems", 1st Edition, CRC Press, 2012.
2. N.P.Mahalik, "Micro Manufacturing & Nanotechnology", Springer, 2006.
3. Sergey Edward Lysherski, "Nano and Micro-electromechanical systems". CRCPress.2005.
4. Wanjun Wang, Steven A. Soper, "BioMEMS Technologies and Applications", CRC Press. 2006.
5. Abraham P. Lee, James L. Lee, "BioMEMS and Biomedical Nano technology", Vol.I, Springer, 2006.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												2	
2			2											
3		3		3										2
4			3	3										
5							2					3		
CO (W.A)	3	3	2.5	3			2					3	2	2

22BMX52 - NANOTECHNOLOGY IN MEDICINE				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE: NIL

Course Objectives:	• To introduce fundamental principles and characterization methods of nanotechnology. • To explore the intersection between biology and nanotechnology. • To familiarize with emerging areas in biotechnology and nanomedicine. • To infer knowledge in diagnostic characteristics of nanoparticles. • To apply nanotechnology appropriately in medical applications.

Course Outcomes The student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the knowledge of fundamental principles and techniques involved in nanotechnology.	Ap	40%
CO2	Analyze nanotechnology based solutions for biomedical applications, focusing on drug delivery, imaging and surgical interventions.	An	40%
CO3	Deduce the effectiveness of nanotechnology in cancer therapy, including drug delivery mechanisms and diagnostic techniques.	An	15%
CO4	Assess the safety, toxicity and environmental impact of nanomaterials to develop strategies for their safe and effective use.	E	5%
CO5	Connect through expert talks' perspective on the societal and environmental impacts of nanotechnology.	U	Internal Assessment

UNIT I – NANOSTRUCTURES	**(9)**
Preparation, Properties and Characterization - Self-Assembling Nanostructure - Vesicular and Micellar Polymerization-Nanofilms - Metal Nanoparticles - Lipid Nanoparticles - Nanoemulsion - Molecular Nanomaterials: Dendrimers.	
UNIT II – NANOTECHNOLOGY IN BIOMEDICAL INDUSTRY	**(9)**
Reconstructive Intervention and Surgery- Nanomaterials in Bone Substitutes and Dentistry – Implants and Prosthesis -in Vivo Imaging- Genetic Defects and Other Disease States — Nanorobotics in Surgery – Nanocarriers: Sustained, Controlled, Targeted Drug Delivery Systems.	
UNIT III – NANOTECHNOLOGY IN CANCER THERAPY	**(9)**
Cancer Cell Targeting and Detection- Polymeric Nanoparticles for Cancer Treatment – Mechanism of Drug Delivery to Tumors -Advantages and Limitations - Multifunctional Agents - Cancer Imaging – Magnetic Resonance Imaging- Cancer Immunotherapy.	
UNIT IV – NANOTECHNOLOGY IN COSMETICS	**(9)**
Polymers in Cosmetics: Film Formers – Thickeners – Hair Colouring – Conditioning Polymers: Conditioning, Cleansing – Silicons – Emulsions – Stimuli Responsive Polymeric Systems - Formulation of Nano Gels, Shampoos, Hair-Conditioners -Micellar Self-Assembly Sun-Screen Dispersions for UV Protection – Color Cosmetics.	

UNIT V – NANOTOXICITY	(9)
Nanotoxicology- Introduction, Dose Relationship- Hazard Classification-Risk Assessment and Management - Factors Affecting Nano Toxicity- Dermal Effects of Nanomaterials, Pulmonary, Neuro and Cardiovascular Effects of Nanoparticles - Gene–Cellular and Molecular Interactions of Nanomaterials.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. Springer Handbook of Nanotechnology- Ed. by, Springer-Verlag 2004.
2. Nanobiotechnology: Concepts, Applications and Perspectives, CM. Niemeyer C A. Mirkin, (Eds), Wiley, 2004.
3. Jo Anne Shatkin, "Nanotechnology: Health and Environmental Risks", 2nd Edition, CRC Press, 2013.
4. Sarah E. Morgan, Kathleen O. Havelka, Robert Y. Lochhead "Cosmetic Nanotechnology: Polymers and Colloids in Cosmetics", American Chemical Society, 2006.

REFERENCES:

1. Tuan VoDinh , "Nanotechnology in Biology and Medicine: Methods, Devices and Applications", CRC Press, 2007.
2. C.N.R. Rao, A. Muller, A. K. Cheetham (Eds), "The Chemistry of Nanomaterials: Synthesis, Properties and Applications", Wiley-VCH Verlag 2004.
3. Matthew Hull and Diana Bowman, "Nanotechnology: Environmental Health and safety, Risks, Regulation and Management", Elsevier, 2010.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2			3											
3				3									2	
4		3				3								
5							3					3		
CO (W.A)	3	3	3	3		3	3					3	2	

22BMX53 - ROBOTICS IN HEALTHCARE				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: NIL				
Course Objectives:	• To understand the foundational principles, programming modes, and kinematic analysis of robots for determining positions. • To explore the mechanics of parallel robots, apply Jacobian matrices for differential motions, and analyze forces in multi-degree-of-freedom (DOF) robots. • To design trajectory plans in joint and Cartesian spaces, implement motion control systems using controllers. • To analyze sensor characteristics, apply image processing techniques. • To examine applications in biomedical engineering.			

Course Outcomes The student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the knowledge of robotic technologies, including design, control, and kinematics, to address engineering problems.	Ap	40%
CO2	Analyze the role and functioning of sensors, actuators and vision systems in robotic applications.	An	40%
CO3	Explain the robotic solutions for biomedical engineering challenges, such as rehabilitation and surgical applications.	An	15%
CO4	Compare findings on robotic applications in biomedical engineering.	An	5%
CO5	Report on comprehensive understanding and application of robotic systems, incorporating principles of design, control, and practical applications.	Ap	Internal Assessment

UNIT I – BASIC CONCEPTS	**(9)**
Brief history - Types of Robot–Technology-Robot classifications and specifications- Design and Control issues- Various manipulators – Sensors - work cell - Programming languages.	
UNIT II – DIRECT AND INVERSE KINEMATICS	**(9)**
Mathematical representation of Robots - Position and orientation – Homogeneous transformation - Various joints - Representation using the Denavit Hattenberg parameters - Degrees of Freedom - Direct kinematics - Inverse kinematics - SCARA robots- Solvability – Solution methods - Closed form solution.	
UNIT III – PATH PLANNING, MANIPULATOR DIFFERENTIAL MOTION AND STATICS	**(9)**
Definition-Joint space technique of p-degree polynomial-Cubic polynomial-Cartesian space technique - Parametric descriptions - Straight line and circular paths - Position and orientation planning - Linear and angular velocities-Manipulator Jacobian-Prismatic and rotary joints–Inverse -Wrist and arm singularity - Static analysis - Force and moment Balance.	

UNIT IV – SENSORS, IMAGE PROCESSING AND ANALYSIS WITH VISION SYSTEMS	(9)
Sensor Characteristics, Position, Velocity, Acceleration, Force, Pressure and Torque, Microswitches, Visible and IR, Touch, Proximity, Range Finders, Sniff, Vision, Transforms – Fourier, Hough, Resolution, Quantization, Sampling, Image Processing, Segmentation, Region Growing and Splitting, Operations, Object Recognition, Depth, Specialized Lighting, Compression, Colour Images, Heuristics.	
UNIT V – APPLICATIONS	**(9)**
Applications in Biomedical Engineering – Bio Engineering Biologically Inspired Robots, Neural Engineering, Application in Rehabilitation – Interactive Therapy, Bionic Arm, Clinical and Surgical – Gynaecology, Orthopaedics, Neurosurgery.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. S. B. Niku, "Introduction to Robotics, Analysis, Control, Applications", Pearson Education, 2020
2. Robert Schilling, "Fundamentals of Robotics-Analysis and control", Prentice Hall of India, 2003.
3. Fu Gonzales and Lee, "Robotics", McGraw Hill, 1987.
4. J Craig, "Introduction to Robotics", Pearson Education, 2005.

REFERENCES:

1. Grover, Wiess, Nagel and Oderey, "Industrial Robotics", McGraw Hill, 2012.
2. Klafter, Chmielewski and Negin, "Robot Engineering", Prentice Hall Of India, 1989.
3. Mittal, Nagrath, "Robotics and Control, Tata McGraw Hill publications, 2003.
4. Bijay K. Ghosh, Ning Xi, T.J. Tarn, "Control in Robotics and Automation Sensor – Based integration", Academic Press, 1999.
5. Mikell P. Groover, Mitchell Weiss, "Industrial robotics, technology, Programming and Applications", McGraw Hill International Editions, 1986.
6. Richard D. Klafter, Thomas A. Chmielewski and Michael Negin, "Robotic engineering - An Integrated Approach", Prentice Hall Inc, Englewoods Cliffs, NJ, USA, 1989.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2		3											2	
3			3											
4				3										
5							3					3		
CO (W.A)	3	3	3	3			3					3	2	

22BMX54 - ADVANCED HEALTHCARE SYSTEM DESIGN				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: NIL				
Course Objectives:	• To analyze wearable devices and mobile health care technologies. • To evaluate digital radiology systems and medical image management. • To investigate health care networking and tele-consultation in medicine. • To critique the requirements, regulations, and ethical issues in digital health. • To assess standards and interoperability in e-health projects, emphasizing security and privacy.			

Course Outcomes The student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply digital health technologies for effective healthcare solutions.	Ap	40%
CO2	Explain the integration of mobile health and digital radiology for enhanced patient care.	An	40%
CO3	Analyze e-health networking and interoperability standards' impact on healthcare delivery.	An	15%
CO4	Assess the strategies for overcoming barriers to digital health innovation and ensuring security and privacy.	E	5%
CO5	Report on digital health technologies, emphasizing integration, standards, ethical considerations and innovation strategies in healthcare through seminars.	E	Internal Assessment

UNIT I – WEARABLE DEVICES AND M-HEALTH CARE	**(9)**
Introduction to Mobile Health Care-Devices-Economy-Average Length of Stay in Hospital, Outpatient Care, Health Care Costs, Mobile Phones, 4G, Smart Devices, Wearable Devices, Uptake of E-Health and M-Health Technologies. Standards, System Design and Case Study.	
UNIT II – DIGITAL RADIOLOGY	**(9)**
Digital Radiology for Digital Hospital, Picture Archiving and Communication, System Integration, Digital History of Radiology, Medical Image Archives, Storage and Networks.	
UNIT III – E-HEALTH	**(9)**
Health Care Networking, Medical Reporting using Speech Recognition, Physiological Tests and Functional Diagnosis with Digital Methods, Tele-Consultation in Medicine and Radiology.	
UNIT IV – DIGITAL HEALTH	**(9)**
Requirements and Best Practices, Laws and Regulations in Digital Health, Ethical Issues, Barriers and Strategies for Innovation.	

UNIT V – STANDARDS FOR INTER OPERABILITY	(9)
Selection and Implementation in E-Health Project, Design of Medical Equipments Based on User Needs. Security and Privacy in Digital Health Care.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. Wlater Hruby, "Digital Revolution in Radiology – Bridging the future of health care", 2nd Edition, Springer, New York. 2006.
2. Christoph Thuemmler, Chunxue Bai, "Health 4.0: How Virtualization and Big Data are Revolutionizing Healthcare", 1st Edition, Springer, 2017.
3. Samuel A. Fricker, Christoph Thümmler , Anastasius Gavras, "Requirements Engineering For Digital Health", Springer, 2015.

REFERENCES:

1. Rick Krohn (Editor), David Metcalf, Patricia Salber, "Health-e Everything: Wearables and The Internet of Things for Health, ebook. 2013.
2. Khandpur.R.S., "Handbook of Biomedical Instrumentation ", 2nd Edition, Tata Mc Graw Hill Pub. Co., Ltd. 2003
3. John, G. Webster. Medical Instrumentation: Application and Design. Second Edition. Wiley Publisher, New Delhi. 2013.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2	3													
3				3										3
4			3											
5									3	3		2		
CO (W.A)	3		3	3					3	3		2		3

22BMX55 - CRITICAL CARE EQUIPMENT				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE: NIL

Course Objectives:	• To gain a comprehensive understanding of various intensive care unit (ICU) equipment. • To explore the necessity and functionality of operation theatre equipment. • To study assistive critical care equipment. • To evaluate centralized systems essential for critical care environments. • To analyze patient safety considerations associated with electrical hazards, grounding inspections, and safety protocols in intensive care and operation rooms.

Course Outcomes The student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Demonstrate the functionality and efficiency of hospital departments, equipment and patient care systems.	Ap	40%
CO2	Analyze how healthcare professionals interact with patients and manage medical emergencies in a hospital setting.	An	40%
CO3	Devise strategies for installing and maintaining centralized systems for healthcare facilities to ensure operational efficiency and patient comfort.	An	15%
CO4	Assess and enforce patient safety protocols.	E	5%
CO5	Evaluate hospital operations, analyze healthcare delivery systems, assess management practices and appraise patient care quality after completing hospital visit.	E	Internal Assessment

UNIT I – INTENSIVE CARE UNIT EQUIPMENT	**(9)**
Suction apparatus, Different types; Sterilizers, Chemical, Radiation, Steam for small and large units. ICU ventilators. Automated drug delivery systems, Infusion pumps, components of drug infusion system, closed loop control infusion system, implantable infusion system. BMD Measurements – SXA - DXA - Quantitative ultrasound bone densitometer.	
UNIT II – OPERATION THEATRE EQUIPMENT	**(9)**
Craniotomy, Electrosurgical Machines (ESU), electrosurgical analysers, surgical aspirator, Instruments for operation. Anaesthesia Machine, Humidification, Sterilization aspects, Boyles apparatus. Endoscopy - Laparoscopy - Cryogenic Equipment - Anaesthesia gas, Anaesthesia gas monitor – surgical Microscope.	
UNIT III – ASSISTIVE CRITICAL CARE EQUIPMENT	**(9)**
Defibrillators, Haemodialysis Machine, Different types of Dialyzers, Membranes, Machine controls and measurements. Heart Lung Machine, different types of oxygenators, peristaltic pumps, Incubators.	
UNIT IV – CENTRALISED SYSTEMS	**(9)**

Centralized Oxygen, Nitrogen, Air supply & Suction. Centralized Air Conditioning, Operation Theatre table & Lighting. C Arm.
UNIT V – PATIENT SAFETY **(9)**
Patient electrical safety, Types of hazards, Natural protective mechanisms against electricity, Leakage current, Inspection of grounding and patient isolation, Hazards in operation rooms, ICCU and IMCUs, Opto couplers and Pulse transformers.
TOTAL(L:45) = 45 PERIODS

TEXT BOOKS:

1. John G. Webster, " Medical Instrumentation Application and Design", 4th edition, Wiley India Pvt. Ltd, New Delhi, 2015
2. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", Pearson education, 2012.
3. Khandpur. R.S.,"Handbook of Biomedical Instrumentation", 2nd Edition. Tata McGrawHill Pub. Co., Ltd., 2003

REFERENCES:

1. L. A Geddes and L. E. Baker, "Principles of Applied Biomedical Instrumentation", 3rd Edition, 2008.
2. Antony Y.K. Chan, "Biomedical Device Technology, Principles and Design", Charles Thomas Publisher Ltd, Illinois, USA, 2008.
3. Leslie Cromwell, "Biomedical Instrumentation and Measurement", Pearson Education, New Delhi, 2007.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2		3												
3			3										2	
4						3		3						
5							3					3		
CO (W.A)	3	3	3			3	3	3				3	2	

22BMX56 - HUMAN ASSIST DEVICES				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: NIL				
Course Objectives:	• To study the role and importance of machines that takes over the functions of the heart and lungs. • To study various mechanical techniques that helps a non-functioning heart. • To learn the functioning of the unit that does the clearance of urea from the blood. • To understand the tests to assess the hearing loss and development of electronic devices to compensate for the loss. • To study about recent techniques used in modern clinical applications.			

Course Outcomes The student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply safety standards and protocols in the operation and maintenance of critical care equipment with regulatory guidelines.	Ap	40%
CO2	Analyze the functionality and operational requirements of diverse medical devices.	An	40%
CO3	Evaluate recent advancements in medical technology to enhance diagnostic accuracy and patient management strategies.	E	15%
CO4	Assess the efficacy of medical interventions to optimize patient care.	E	5%
CO5	Interpret real-world case studies to evaluate the application, efficacy and safety of various medical devices in clinical settings.	E	Internal Assessment

UNIT I – HEART LUNG MACHINE AND ARTIFICIAL HEART	**(9)**
Condition to be satisfied by the H/L System. Different types of Oxygenators, Pumps, Pulsatile and Continuous Types, Monitoring Process, Shunting, The Indication for Cardiac Transplant, Driving Mechanism, Blood Handling System, Functioning and different types of Artificial Heart, Schematic for temporary bypass of left ventricle.	
UNIT II – CARDIAC ASSIST DEVICES	**(9)**
Assisted through Respiration, Right and left Ventricular Bypass Pump, Auxiliary ventricle, Open Chest and Closed Chest type, Intra Aortic Balloon Pumping, Prosthetic Cardiac valves, Principle of External Counter pulsation techniques.	
UNIT III – ARTIFICIAL KIDNEY	**(9)**
Indication and Principle of Haemodialysis, Membrane, Dialysate, types of filter and membranes, Different types of hemodialyzers, Monitoring Systems, Wearable Artificial Kidney, Implanting Type.	
UNIT IV – RESPIRATORY AND HEARING AIDS	**(9)**

Ventilator and its types-Intermittent positive pressure, Breathing Apparatus Operating Sequence, Electronic IPPB unit with monitoring for all respiratory parameters. Types of Deafness, Hearing Aids, SISI, masking techniques, wearable devices for hearing correction.	
UNIT V – RECENT TRENDS	**(9)**
Transcutaneous electrical nerve stimulator, bio-feedback, Diagnostic and point-of-care platforms.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. Gray E Wnek, Gray L Browlin, "Encyclopedia of Biomaterials and Biomedical Engineering", Marcel Dekker Inc New York, 2004.
2. John. G. Webster, "Bioinstrumentation" John Wiley & Sons (Asia) Pvt. Ltd., 2004.
3. Joseph D. Bronzino, "The Biomedical Engineering Handbook" 3rd Edition: Three Volume Set, CRC Press, 2006.

REFERENCES:

1. Andreas. F. Von racum, "Hand Book of Bio Material Evaluation", Mc-Millan Publishers, 1980.
2. Gray E Wnek, Gray L Browlin, "Encyclopedia of Biomaterials and Biomedical Engineering" Marcel Dekker Inc New York 2004.
3. D.S. Sunder, "Rehabilitation Medicine", 3rd Edition, Jaypee Medical Publication, 2010.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	3				3								
2	3	3												
3			3											
4				3									2	
5							3					3		
CO (W.A)	3	3	3	3		3	3					3	2	

22BMX57 - AMBULATORY SERVICES				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: NIL				

Course Objectives:	• To analyze artifacts and apply denoising techniques in patient monitoring systems • To design ambulance vehicles and comply with regulations for patient transportation. • To design efficient lift mechanisms for patient transport in ambulances. • To assess the design and regulatory aspects of mobile diagnostic equipment in ambulances. • To evaluate smart safety systems and automated alert systems in accident care.

Course Outcomes The student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Demonstrate advanced medical devices and systems for patient monitoring, diagnosis, and emergency care.	Ap	40%
CO2	Apply principles of biomedical engineering to create innovative solutions for patient transportation and care.	Ap	40%
CO3	Analyze safety and regulatory standards for medical devices and healthcare systems.	An	15%
CO4	Evaluate the efficiency and effectiveness of healthcare equipment and technology in clinical settings.	E	5%
CO5	Deduce insights from seminar presentations to improve the design and functionality of patient monitoring and emergency care systems.	An	Internal Assessment

UNIT I – PATIENT MONITORING SYSTEMS	**(9)**
Artifacts - Denoising techniques - Advancements in Wireless patient Monitoring system - Case study.	
UNIT II – DESIGN OF AMBULANCE	**(9)**
Vehicle Design - Ambulance Train - Disaster Relief Squad - Regulation for Patient Transportation - Case Study.	
UNIT III – LIFT MECHANISM	**(9)**
Design of Lift Mechanism for Patient - Design of Lift in Ambulance - Computer Based Systems - Case Study.	
UNIT IV – DESIGN OF MOBILE DIAGNOSTIC EQUIPMENT	**(9)**
Devices with Battery Backup - Mobile X-Ray Unit - Nursing - Medical Gas Handling – Regulations - GPS In Ambulance Networked Services - Case Study.	

UNIT V – ACCIDENT CARE SYSTEMS	(9)
Automated Alert System - Smart Safety Systems - Fire Protection - Maintenance And Regulation - Accreditation for Ambulance Services - Case Study.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. David Tse and Pramod Viswanath, "Fundamentals of Wireless Communication", Cambridge University Press, 2005.
2. Andreas F. Molisch, "Wireless Communications", 2nd Edition, John Wiley & sons, USA, 2010.

REFERENCES:

1. Jochen Schiller, "Mobile Communications", Addison Wesley Publishers, 2000.
2. Yi-Bing Lin and Imrich Chlamtac, "Wireless and Mobile Network Architecture", 2nd Edition, John Wiley and Sons, New Delhi, 2001.
3. Feher K., "Wireless Digital Communications", Prentice Hall of India, New Delhi, 1995.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												2	
2			3										2	
3				3										2
4		3		3										2
5									3	3		2		
CO (W.A)	3	3	3	3					3	3		2	2	2

22BMX58 - HOME MEDICARE TECHNOLOGY				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: NIL				
Course Objectives:	• To analyze the historical development and ethical issues in home health care • To apply homecare strategies tailored to diverse client needs. • To demonstrate proficiency in operating and managing medical devices commonly used in home healthcare settings.. • To identify and discuss recent advancements in medical health technologies relevant to home care. • To infer the impact and utilization of wireless technology in improving healthcare delivery at home.			

Course Outcomes The student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply effective strategies for infection control, patient education, and home care management.	Ap	40%
CO2	Analyze the advancements in health care technologies to enhance patient care, emergency response and remote monitoring capabilities.	An	40%
CO3	Deduce personalized care plans for elderly, children and mobility-impaired patients, including mobility transfers and comfort measures.	An	15%
CO4	Assess the functionality and impact of various medical devices and recommend suitable devices based on patient needs.	E	5%
CO5	Develop critical thinking and problem-solving skills in addressing complex issues related to home health care systems, patient management, medical device utilization and advancements in healthcare technology through case studies.	C	Internal Assessment

UNIT I – INTRODUCTION TO HOME HEALTH NURSING	**(9)**
Home Health Care – Purpose - Organization of Homecare System - Historical Development of Home Care - Environmental Influences of Home Care -Home Care Organization - Legal and Ethical Issues in Home Care - Case Management and Leadership Strategies - Organisation of Home Care System - Role of Home Care Nurse and Orientation Strategies - Environmental Influences on Home Care - Infection Control in Home - Patient Education in Home.	
UNIT II – WORKING WITH CLIENTS	**(9)**
Basic Human Needs - Communication and Interpersonal Skills - Caregiver Observation - Recording and Reporting, Confidentiality. Working with Elderly – Aging and Body Systems. Working with Children - Need for Home Care - Mobility Transfers and Ambulation - Range of Motion Exercises - Skin Care and Comfort Measures.	

UNIT III – MEDICAL DEVICES AT HOME	(9)
Medical Devices at Home - ECG Monitors - Smart Watch - Wireless Infant Monitoring System - PCG Monitors, Medical Alert Services. Activity Monitors - Automatic Wireless Healthcare Monitoring System - The Ventilator Dependent Patient - Device For Patient with Congestive Heart Failure - Device for Patient with Chronic Obstructive Pulmonary Disease - Device for Patient with Diabetic.	
UNIT IV – ADVANCEMENT IN MEDICAL TECHNOLOGIES	**(9)**
Advances and Trends in Health Care Technologies - Driver Impacting the Growth of Medical Technologies - Impact of Moore's Law of Medical Imaging - E-Health and Personal Healthcare - Defining the Future of Health Technology - Inventing the Future -Tools for Self-Health - Future of Nano Fabrication Molecular Scale Devices - Future of Telemedicine - Future of Medical Computing.	
UNIT V – WIRELESS TECHNOLOGY	**(9)**
Wireless Communication Basics - Types of Wireless Network - Body Area Network - Emergency Rescue - Remote Recovery - Personalized Ambient Monitoring - Future Trends in Healthcare Technology. Multi Model Interaction and Technologies for Care at Home - Cost of Home Healthcare - Direction for Emerging Technology.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. Robyn Rice, "Home care nursing practice: Concepts and Application", 4th Edition, Elsevier, 2006.
2. LodewijkBos, "Handbook of Digital Homecare: Successes and Failures", Springer, 2011.

REFERENCES:

1. Yadin David, Wolf W. von Maltzahn, Michael R. Neuman, Joseph. D. Bronzino, "Clinical Engineering", CRC Press, 2010.
2. Kenneth J. Turner, "Advances in Home Care Technologies: Results of the match Project", Springer, 2011.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2			3	3									2	
3		3												
4				3		3								2
5									3			3		2
CO (W.A)	3	3	3	3		3			3			3	2	2