M.E. Degree

in

MEDICAL ELECTRONICS

CURRICULUM & SYLLABUS (CBCS)

(For students admitted from the Academic Year 2022-2023)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

St. XAVIER'S CATHOLIC COLLEGE OF ENGINEERING

CHUNKANKADAI, NAGERCOIL – 629 003.

KANYAKUMARI DISTRICT, TAMIL NADU, INDIA

St. XAVIER'S CATHOLIC COLLEGE OF ENGINEERING

CHUNKANKADAI, NAGERCOIL – 629 003.

AUTONOMOUS COLLEGE AFFILIATED TO ANNA UNIVERSITY

ACADEMIC REGULATIONS 2022

M.E. MEDICAL ELECTRONICS CURRICULUM

CHOICE BASED CREDIT SYSTEM

Inconsonance to the vision of our College,

An engineering graduate we form would be a person with optimal human development, i.e. physical, mental, emotional, social and spiritual spheres of personality.

He/she would be also a person mature in relationships, especially knowing how to treat everyone with respect, including persons of complementary gender with equality and gender sensitivity guided by clear and pro-social values.

He would be patriotic and would hold the Indian Constitution and all the precepts it outlays close to his heart and would have a secular spirit committed to safeguard and cherish the multi-cultural, multi- religious and multi-linguistic ethos of Indian Society.

Academically, he/she would be a graduate with a strong engineering foundation with proficient technical knowledge and skills. He would have enough exposure and experience into the ethos of relevant industry and be industry ready to construct a successful career for himself and for the benefit of the society.

He would have been well trained in research methodology and would have established himself as a researcher having taken up many research projects, with sound ethical standards and social relevance. He would be a person with a passion for technical innovations committed to lifelong learning and research.

He would be well prepared and confident to develop ingenuous solutions to the problems people faceas an individual and as a team and work for the emancipation of our society with leadership and courage.

M.E Medical Electronics is a specialized course that integrates medical science with engineering to create innovative solutions for healthcare. It is a 2 year course with 4 semesters. The course offers an in-depth knowledge about medical field and the relationship between technology and biology. The curriculum offers advanced concepts of biomedical Engineering, signal and imaging modalities and their processing techniques. It provides in-depth knowledge about human assist devices and the development of biomedical devices. The curriculum also includes the usage of modern skill development tools like data science, machine learning and mixed reality for medical problems. This

course helps the postgraduates to lead a successful career in the healthcare industry and in research to develop devices and procedures that solve medical and health-related problems.

I.   PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

I	To enhance the skills of graduates in hardware and software to pursue Research or lead a successful career in the academic field of medical electronics.
II	To enable the graduates to acquire technical knowledge for Medical Electronics Manufacturing and skills for Industrial and Hospital requirement.
III	To enable the graduates to identify, analyze sustainable solutions and to develop ethical practicing ability to collaborate with team members for building medical electronics systems with cutting-edge technology.
IV	To facilitate the graduates to exhibit leadership skills, make decisions with societal and ethical responsibilities and communicate effectively in multidisciplinary settings.
V	To enable the graduates to recognize the need for lifelong learning, enhance their technical competencies throughout their career and become successful Entrepreneurs.

II.   PROGRAMME OUTCOMES (POs)

PO	Programme Outcomes
1	Independently carry out research/investigation and development work to solve practical problems
2	Write and present substantial technical report/document
3	Demonstrate a degree of mastery over the area as per the specialization of the program at a level higher than the requirements in the appropriate bachelor program
4	Identify and solve Biomedical Engineering problems related to human anatomy that address contemporary issues within a global and societal context for the development of low cost indigenous biomedical devices
5	Ability to design the techniques and tools of Medical Electronics Engineering to address the needs of technology in healthcare domain and understand the relevant technical, professional, and ethical issues
6	Understand and develop the competence for continuous learning in the area of design, biosignal processing, Medical Imaging , Radio Therapy and related equipment.

PEO's – PO's MAPPING:

PROGRAMME EDUCATIONAL OBJECTIVES	PROGRAMME OUTCOMES					
	1	**2**	**3**	**4**	**5**	**6**
I	3	3	2	2	-	-
II	3	-	3	2	-	3
III	2	-	-	2	3	3
IV	-	-	2	-	-	3
V	3	-	3	2	3	-

PROGRAM ARTICULATION MATRIX

Year	Semester	Course Name	PO					
			1	2	3	4	5	6
I	I	Applied Mathematics for Medical Engineers	1	-	-	-	2	2
		Bio Signal Processing	1	-	2	2.25	2	2
		Biomedical Instrumentation and Equipment	1	1	1	2.2	1.8	1.4
		Biomedical Instrumentation Laboratory	1.2	0.8	1.4	2.2	1.8	1.4
I	II	Medical Image Processing	2	2	1	2	1	1.4
		Embedded Systems and Internet of Things for Medical Application	2	2	1	1	2	2
		Machine Learning Techniques	1	-	2	2	2	2
		Human Anatomy and Physiology	1	1	1	2	1	1
		Data Acquisition and Design Laboratory	1.5	2	1.4	2.2	1.8	1.4

M.E. MEDICAL ELECTRONICS CURRICULUM

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY COURSES								
1.	MA22105	Applied Mathematics for Medical Engineers	FC	3	1	0	4	4
2.	MX22102	Biomedical Instrumentation and Equipment	PCC	3	0	0	3	3
3.		Professional Elective I	PEC	3	0	0	3	3
THEORY COURSES WITH PRACTICAL COMPONENT								
4.	MX22101	Bio Signal Processing	PCC	3	0	2	5	4

		PRACTICAL COURSES						
5.	MX22103	Biomedical Instrumentation Laboratory	PCC	0	0	4	4	2
EMPLOYABILITY ENHANCEMENT COURSES								
6.	MX22104	Technical Seminar	EEC	0	0	2	2	1
7.	RM22101	Research Methodology	RMC	2	0	0	2	2
MANDATORY COURSES								
8.		Audit Course I	AC	2	0	0	2	0
TOTAL				**16**	**1**	**8**	**25**	**19**

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY COURSES								
1.	MX22204	Human Anatomy and Physiology	PCC	3	0	0	3	3
2.		Professional Elective II	PEC	3	0	0	3	3
3.		Professional Elective III	PEC	3	0	0	3	3
THEORY COURSES WITH PRACTICAL COMPONENT								
4.	MX22201	Medical Image Processing	PCC	3	0	2	5	4
5.	MX22202	Embedded Systems and Internet of Things for Medical Application	PCC	3	0	2	5	4
6.	MX22203	Machine Learning Techniques	PCC	3	0	2	5	4
PRACTICAL COURSES								
7.	MX22205	Data Acquisition and Design Laboratory	PCC	0	0	4	4	2
EMPLOYABILITY ENHANCEMENT COURSES								
8.	RM22201	Research Tools Laboratory	RMC	0	0	4	4	2
MANDATORY COURSES								
9.		Audit Course II	AC	2	0	0	2	0
TOTAL				**20**	**0**	**14**	**34**	**25**

SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY COURSES								
1.		Professional Elective V	PEC	3	0	0	3	3
2.		Open Elective	OEC	3	0	0	3	3
THEORY COURSES WITH PRACTICAL COMPONENT								
3.		Professional Elective IV	PEC	3	0	2	5	4
EMPLOYABILITY ENHANCEMENT COURSES								
4.	MX22301	Inplant / Industrial / Practical Training (4 weeks during summer vacation)	EEC	0	0	4	4	2
5.	MX22302	Project Work I	EEC	0	0	6	6	3
		TOTAL		**9**	**0**	**12**	**21**	**15**

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
EMPLOYABILITY ENHANCEMENT COURSES								
1.	MX22401	Project Work II	EEC	0	0	24	24	12
		TOTAL		**0**	**0**	**24**	**24**	**12**

TOTAL CREDITS: 71

PROFESSIONAL ELECTIVES

SEMESTER I, PROFESSIONAL ELECTIVE – I

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MX22111	Biomechanics	PEC	3	0	0	3	3
2.	MX22112	Biometrics	PEC	3	0	0	3	3

3.	MX22113	Biomaterials	PEC	3	0	0	3	3
4.	MX22114	Medical Optics	PEC	3	0	0	3	3
5.	MX22115	Medical Equipment	PEC	3	0	0	3	3

SEMESTER II, PROFESSIONAL ELECTIVE – II

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MX22211	Wearable Technologies	PEC	3	0	0	3	3
2.	MX22212	Brain Computer Interface	PEC	3	0	0	3	3
3.	MX22213	Genetic Algorithms and Fuzzy Logics	PEC	3	0	0	3	3
4.	MX22214	Medical Robotics	PEC	3	0	0	3	3
5.	MX22215	Big Data Mining and Analytics	PEC	3	0	0	3	3
6.	MX22216	Tele Health Technology	PEC	3	0	0	3	3

SEMESTER II, PROFESSIONAL ELECTIVE – III

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MX22221	Health Care, Hospital and Equipment Management	PEC	3	0	0	3	3
2.	MX22222	Ultra Sound in Medicines	PEC	3	0	0	3	3
3.	MX22223	Bio Ethics and Standards	PEC	3	0	0	3	3
4.	MX22224	Medical Device Standards and Regulation	PEC	3	0	0	3	3
5.	MX22225	Tissue Engineering and Immuno Engineering	PEC	3	0	0	3	3
6.	MX22226	Medical Electronics Device Design	PEC	3	0	0	3	3

SEMESTER III, PROFESSIONAL ELECTIVE - IV

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MX22311	Biomems and Artificial Organs	PEC	3	0	2	5	4
2.	MX22312	Physiological Modeling	PEC	3	0	2	5	4
3.	MX22313	Deep Learning	PEC	3	0	2	5	4
4.	MX22314	Mixed Reality	PEC	3	0	2	5	4
5.	MX22315	3D Printing in Medical Applications	PEC	3	0	2	5	4

SEMESTER III, PROFESSIONAL ELECTIVE - V

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MX22321	Human Assist Devices	PEC	3	0	0	3	3
2.	MX22322	Medical Imaging Systems and Radio Therapy	PEC	3	0	0	3	3
3.	MX22323	Rehabilitation Engineering	PEC	3	0	0	3	3
4.	MX22324	Nanotechnology and Its applications	PEC	3	0	0	3	3
5.	MX22325	Pattern Recognition Techniques and Applications	PEC	3	0	0	3	3

AUDIT COURSES (AC)

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	AC22101	English for Research Paper Writing	AC	2	0	0	2	0
2.	AC22102	Constitution of India	AC	2	0	0	2	0
3.	AC22201	Disaster Management	AC	2	0	0	2	0
4.	AC22202	நற்றமிழ் இலக்கியம	AC	2	0	0	2	0

SUMMARY

S. No	Subject Area	Credits per Semester				Total Credits
		I	II	III	IV	
1	FC	4	-	-	-	4
2	PCC	9	17	-	-	26
3	PEC	3	6	7	-	16
4	OEC	-	-	4	-	3
5	EEC	1	2	5	12	20
6	RMC	2	-	-	-	2
7	Non-Credit AC	0	0	-	-	0
	Total	**19**	**25**	**16**	**12**	**71**

Table caption: **M.E. Medical Electronics**

SEMESTER I

MA22105	APPLIED MATHEMATICS FOR MEDICAL ENGINEERS	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

- To encourage students to develop a working knowledge of the central ideas of Linear Algebra
- To enable students to understand the concepts of Probability and Random Variables
- To make students understand the notion of a Markov chain, and how simple ideas of conditional probability and matrices can be used to give a thorough and effective account of discrete-time Markov chains
- To introduce the Fourier Transform as an extension of Fourier techniques on periodic functions and to solve partial differential equations

UNIT I	LINEAR ALGEBRA	12

Norms – Inner products – Gram-Schmidth orthogonolization process – QR factorization – Cholesky decomposition - Generalized eigenvectors – Singular value decomposition and applications – Pseudo inverse – Least square approximations

UNIT II	PROBABILITY AND THEORETICAL DISTRIBUTIONS	12

Probability - Axioms of probability - Conditional probability - Baye's theorem- Discrete random variable – Probability mass function– Continuous random variable – Probability density function – Properties - mean, variance – Special distributions: Binomial, Poisson and Normal distributions (Derivations not included).

UNIT III	TWO DIMENSIONAL RANDOM VARIABLES	12

Two dimensional Random variables-Discrete and continuous Joint distributions –Discrete and continuous Marginal distributions - conditional distributions - Central limit theorem(excluding proof)

–Covariance - Correlation –Karl Pearson correlation coefficient- Regression- Regression lines-Regression coefficient.

UNIT IV	RANDOM PROCESSES	12

Classification – Stationary random process - Strict sense stationary process – Wide sense stationary process – Markov process – Markov chain – Poisson process - Discrete parameter Markov chain - Chapman Kolmogorov equations (Statement only) - Limiting distributions – Auto correlation – Cross correlation.

UNIT V	FOURIER TRANSFORM FOR PARTIAL DIFFERENTIAL EQUATIONS	12

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

	TOTAL : 60 PERIODS

COURSE OUTCOMES:

Upon Completion of the course, the students will be able to:

CO1:	Define norms, inner products, random variables, random processes and Fourier transforms
CO2:	Demonstrate the concepts of singular values, distributions, correlation and regression in Engineering Field
CO3:	Discuss, Poisson processes and Fourier transforms of elementary functions
CO4:	Apply the concept of probability, random process and correlation in Engineering discipline
CO5:	Solve matrices, linear system of equations and functions of Fourier transform in Engineering Field

REFERENCES:

1.	Bronson, R.," Matrix Operation", Schaum's outline series, Tata McGrawHill, New York, 2011.
2.	Andrews, L. C. and Philips. R.L., "Mathematical Techniques for engineering and scientists", Prentice Hall of India, New Delhi,2006.
3.	Devore. J.L., Probability and Statistics for Engineering and the Sciences", Cengage Learning, 9 th Edition, Boston, 2017.
4.	Spiegel. M.R., Schiller. J. and Srinivasan. R.A., Schaum's Outlines on Probability and Statistics, Tata McGraw Hill, 4 th Edition, 2012.
5.	Sankara Rao,K., " Introduction to partial differential equations" Prentice Hall of India Pvt.Ltd., 3 rd Edition, New Delhi,2013

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	-	-	2	2
CO2	1	-	-	-	2	2
CO3	1	-	-	-	2	2
CO4	1	-	-	-	2	2
CO5	1	-	-	--	2	2
CO	**1**	**-**	**-**	**-**	**2**	**2**

Table of Specification for End Semester Question Paper

Unit No.	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: LINEAR ALGEBRA	2	1either or	1(2)-CO1	1(2)-CO1 1either or (16)-CO1	-	-
Unit-II: PROBABILITY AND THEORETICAL DISTRIBUTIONS	2	1either or	1(2)-CO2	1(2)-CO2 1either or (16)-CO2	-	-
Unit-III: TWO DIMENSIONAL RANDOM VARIABLES	2	1either or	1(2)-CO3	1(2)-CO3 1either or (16)-CO3	-	-
Unit-IV: RANDOM PROCESSES	2	1either or	1(2)-CO4	1(2)-CO4	1either or (16)-CO4	-
Unit-V: FOURIER TRANSFORM FOR PARTIAL DIFFERENTIAL EQUATIONS	2	1either or	1(2)-CO5	1(2)-CO5	1either or (16)-CO5	-
Total Qns. Title	10	5either or	5(2)	5(2) 3 either or (16)	2 either or (16)	-
Total Marks	20	80	10	58	32	-
Weightage	20%	80%	10%	58%	32%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

MX22102	BIOMEDICAL INSTRUMENTATION AND EQUIPMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:
- Study about the different bio potential and electrodes for its measurement.
- Understand the biosignal characteristics and the electrode placement for recording.
- Familiarize the different signal conditioning circuits.
- Learn the different measurement techniques for non-electrical parameters.

	• Familiarize the different biochemical measurements	
UNIT I	**BIO POTENTIAL ELECTRODES**	**9**

Origin of bio potential and its propagation. Recording Electrodes- Electrode-electrolyte interface, electrode–skin interface, half-cell potential, impedance, polarization effects of electrode – non polarizable electrodes. Types of electrodes - surface, needle and micro electrodes and their equivalent circuits. Biochemical-and Transcutaneous- electrodes: pH, pO_2, pCO_2.

UNIT II	**ELECTRODE CONFIGURATIONS**	**9**

Biosignals characteristics – frequency and amplitude ranges. ECG – Einthoven's triangle, standard 12 lead system. EEG – 10-20 electrode system, unipolar, bipolar and average mode. EMG– unipolar and bipolar mode. Recording of PCG, ERG, EOG and EGG.

UNIT III	**BIOAMPLIFIERS**	**9**

Need for bio-amplifier - single ended bio-amplifier, differential bio-amplifier, Impedance matching circuit, isolation amplifiers – transformer and optical isolation - isolated DC amplifier and AC carrier amplifier., Power line interference, Right leg driven ECG amplifier, Band pass filtering.

UNIT IV	**MEASUREMENT OF NON-ELECTRICAL PARAMETERS**	**9**

Temperature, respiration rate and pulse rate measurements. Blood Pressure: indirect methods - Auscultatory method, oscillometric method, direct methods: electronic manometer, Pressure amplifiers, Systolic, diastolic, mean detector circuit. Blood flow and cardiac output measurement: Indicator dilution, thermal dilution and dye dilution method, Electromagnetic and ultrasound blood flow measurement

UNIT V	**BIO-CHEMICAL MEASUREMENT**	**9**

Ion selective Field effect Transistor (ISFET), Immunologically sensitive FET (IMFET), Blood glucose sensors, Blood gas analyzers - colorimeter, Sodium Potassium Analyser, spectrophotometer, blood cell counter, auto analyzer (simplified schematic description) – Bio Sensors – Principles – Amperometric and Voltometric techniques

SUGGESTED ACTIVITIES
1. Demonstration on various electrodes and study of its characteristics
2. Demonstration about ECG, EEG, ERG, EOG & EGG
3. Design of amplifiers for ECG, EMG, EEG, EGG & EOG
4. Conduct experiments to measure BP, SpO2, Heart Rate, Body temperature
5. Conduct experiments to measure Blood Glucose, Blood cell counts

TOTAL: 45 PERIODS

COURSE OUTCOMES:	
At the end of the course, the students will be able to:	
CO1:	Illustrate the origin of bio potentials, need for bio-amplifiers and bio sensors
CO2:	Classify electrical, non- electrical and biochemical measurement techniques
CO3:	Identify the electrodes, amplifiers and the electrode placement for various physiological recording
CO4:	Select Indirect and direct methods for non- electrical parameters
CO5:	Design of various preamplifiers

REFERENCES:	
1.	John G. Webster, Amit J. Nimunkar, Medical Instrumentation application and design – 5th Edition, (An Indian Adaptation), Wiley India, 2021.

2.	Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", edition, 2015. Pearson education, 2012.
3.	Leslie Cromwell, —Biomedical Instrumentation and measurement, Prentice hall of India, New Delhi, 2nd edition, 2015.
4.	Myer Kutz, "Standard Handbook of Biomedical Engineering & Design", McGraw Hill, 2003.
5.	KhandpurR.S, Handbook of Biomedical Instrumentation, Tata McGraw Hill, New Delhi, 3rd edition, 2014

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	1	2	2
CO2	1	-	1	1	2	1
CO3	-	-	1	1	1	1
CO4	1	1	1	2	2	2
CO5	1	-	1	1	2	1
CO	1	1	1	1.2	1.8	1.4

Table of Specification for End Semester Question Paper

Unit No.	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: BIO POTENTIAL ELECTRODES	2	1either or	1(2)-CO1	1(2)-CO1	-	-
				1either or (16)-CO1		
Unit-II: ELECTRODE CONFIGURATIONS	2	1either or	1(2)-CO2	1(2)-CO2	-	-
				1either or (16)-CO2		
Unit-III: BIOAMPLIFIERS	2	1either or	1(2)-CO3	1(2)-CO3	-	-
				1either or (16)-CO3		
Unit-IV: MEASUREMENT OF NON-ELECTRICAL PARAMETERS	2	1either or	1(2)-CO4	1(2)-CO4	1either or (16)-CO4	-
Unit-V: BIO-CHEMICAL MEASUREMENT	2	1either or	1(2)-CO5	1(2)-CO5	1either or (16)-CO5	-
Total Qns. Title	10	5either or	5(2)	5(2) 3 either or (16)	2 either or (16)	-

Total Marks	20	80	10	58	32	-
Weightage	20%	80%	10%	58%	32%	-

<div align="center">Weightage for COs</div>

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

MX22101	BIO SIGNAL PROCESSING	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To introduce the characteristics of different biosignals
- To discuss linear and non-linear filtering techniques to extract desired information
- To demonstrate the significance of event detection applied in biosignal processing
- To extract the features from the biosignal
- To introduce techniques for automated classification and decision making to aid diagnosis

UNIT I	SIGNAL, SYSTEM AND SPECTRUM	9

Introduction to Biomedical Signals- Characteristics of some dynamic biomedical signals, Noises-random, structured and physiological noises. Filters- IIR and FIR filters. Spectrum – power spectral density function, cross-spectral density and coherence function, cepstrum and homomorphic filtering. Frequency Domain Filtering, Optimal Filtering: The Weiner Filter.

UNIT II	TIME SERIES ANALYSIS AND SPECTRAL ESTIMATION	9

Time series analysis – linear prediction models, Sequential estimation of poles and zeros, non-stationary process, fixed segmentation, adaptive segmentation, application in EEG, PCG and HRV signals, Spectral estimation – Blackman Tukey method, periodogram and model-based estimation. Measures derived from PSD, Application in Heart rate variability, PCG signals..

UNIT III	ADAPTIVE FILTERING AND EVENT DETECTION	9

Filtering – LMS adaptive filter, adaptive noise cancelling in ECG, improved adaptive filtering in FECG, EEG and other applications in Bio signals, Event detection in ECG – Derivative based approaches, Pan Tompkins Algorithm, Dicrotic Notch Detection, Correlation analysis of EEG signals, matched filtering.

UNIT IV	ANALYSIS OF BIOSIGNAL	9

Average of Signals-PCG, ECG and EMG. Signal length, Envelop Extraction, Amplitude demodulation, The Envelogram, Analysis of activity, Root Mean Square value, Zero-crossing rate, Turns Count, Form factor.

UNIT V	BIOSIGNAL CLASSIFICATION AND RECOGNITION	9

Statistical signal classification, linear discriminate function, direct feature selection and ordering, Back propagation neural network-based classification. Case study: 1. Various methods used to extract features from EEG signal Case Study 2: Diagnosis and monitoring of sleep apnea.

TOTAL: 45 PERIODS

PRACTICAL EXERCISES   **30 PERIODS**

1.Removal of noise and artifact using filtering

2. Noise cancellation using Adaptive filters	
3. QRS detection using Pan-Tompkin's algorithm	
4. Event detection in EEG signals	
5. Cepstral analysis of speech signals	
6. Adaptive segmentation of EEG signals	
7. Feature reduction using PCA	
8. Disease classification of biosignals	
	TOTAL: 75 PERIODS

COURSE OUTCOMES:

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

CO1:	Characterize different types of signals & systems
CO2:	Design filters for the analysis of random signals
CO3:	Analyze signals in time series domain & estimate the spectrum
CO4:	Analyze the significance of event detection and feature extraction from biosignal
CO5:	Analyze various classification methods for biosignals

REFERENCES:

1.	P.Ramesh Babu, ―Digital Signal Processing, 7th Edition, Scitech publications, Chennai, 2021.
2.	Raghuveer M. Rao and AjithS.Bopardikar, Wavelets transform – Introduction to theory and its applications, Pearson Education, India 2000
3.	Rangaraj M. Rangayyan, 2nd edition "Biomedical Signal Analysis-A case study approach", Wiley- Interscience /IEEE Press, 2015.
4.	Emmanuel C. Ifeachor, Barrie W.Jervis, second edition, "Digital Signal processing- A Practical Approach" Pearson education Ltd., 2002.
5.	Willis J.Tompkins, Biomedical Digital Signal Processing, Prentice Hall of India, New Delhi, 2006

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	-	-	2	2
CO2	1	-	2	2	2	2
CO3	1	-	2	2	2	2
CO4	1	-	2	2	2	2
CO5	1	-	2	3	2	2
CO	**1**	**-**	**2**	**2.25**	**2**	**2**

Table of Specification for End Semester Question Paper

Unit No.	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I:	2	1either	1(2)-CO1	1(2)-CO1	-	-

SIGNAL, SYSTEM AND SPECTRUM		or		1either or (16)-CO1		
Unit-II: TIME SERIES ANALYSIS AND SPECTRAL ESTIMATION	2	1either or	1(2)-CO2	1(2)-CO2 1either or (16)-CO2	-	-
Unit-III: ADAPTIVE FILTERING AND EVENT DETECTION	2	1either or	1(2)-CO3	1(2)-CO3 1either or (16)-CO3	-	-
Unit-IV: ANALYSIS OF BIOSIGNAL	2	1either or	1(2)-CO4	1(2)-CO4	1either or (16)-CO4	-
Unit-V: BIOSIGNAL CLASSIFICATION AND RECOGNITION	2	1either or	1(2)-CO5	1(2)-CO5	1either or (16)-CO5	-
Total Qns. Title	10	5either or	5(2)	5(2) 3 either or (16)	2 either or (16)	-
Total Marks	20	80	10	58	32	-
Weightage	20%	80%	10%	58%	32%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

MX22103	**BIOMEDICAL INSTRUMENTATION LABORATORY**	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:
- Familiarize the preamplifiers and signal conditioning circuits for ECG acquisition.
- Understand the designing of amplifiers for acquiring bio signals like EEG, EOG, EMG
- Study the concept of designing an isolation amplifier.
- Learn the different measurement techniques for non-electrical parameters.
- Design the PCB layout for any bio amplifier

LIST OF EXPERIMENTS:
1. Design of pre amplifiers to acquire bio signals along with impedance matching circuit using suitable IC's.
2. Design of ECG Amplifiers with appropriate filter to remove power line and other artefacts.
3. Design of EMG amplifier.
4. Design of frontal EEG amplifier.
5. Design a Pulse Oximeter and Measure O2 Saturation and HR

6.	Design and study the characteristics of optical Isolation amplifier.
7.	Plotting of human auditory response using Audiometry
8.	Measurement of respiratory parameters using Spyrometer
9.	Measurement of pulse-rate using Photo transducer.
10.	Measurement of pH and conductivity.
11.	Measurement of blood pressure using sphygmomanometer.
12.	Measurement and recording of peripheral blood flow.
13.	Design a PCB layout for any bio amplifier using suitable software tool.

TOTAL : 60 PERIODS

COURSE OUTCOMES:

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

CO1:	Design preamplifiers and signal conditioning circuits for ECG signal acquisition
CO2:	Design amplifiers for different bio signals like EEG, EOG, EMG
CO3:	Design an optical isolation amplifier
CO4:	Acquire various non-electrical parameters using suitable sensors/transducers.
CO5:	Implement PCB layout for any bio amplifier

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	2	2	3	2	2
CO2	1	-	1	2	2	1
CO3	-	-	1	1	1	1
CO4	2	2	2	3	2	2
CO5	1	-	1	2	2	1
CO	**1.2**	**0.8**	**1.4**	**2.2**	**1.8**	**1.4**

MX22104	TECHNICAL SEMINAR	L	T	P	C
		0	0	2	1

In this course, students will develop their scientific , technical reading and writing skills that they need to understand and construct research articles. A term paper requires a student to obtain information from a variety of sources (i.e., Journals, dictionaries, reference books) and then place it in logically developed ideas. The work involves the following steps**:**

1.	Selecting a subject, narrowing the subject into a topic
2.	Stating an objective.
3.	Collecting the relevant bibliography (atleast 15 journal papers)
4.	Preparing a working outline.
5.	Studying the papers and understanding the authors contributions and critically analyzing each paper.
6.	Preparing a working outline
7.	Linking the papers and preparing a draft of the paper.

8. Preparing conclusions based on the reading of all the papers.			
9. Writing the Final Paper and giving final Presentation			
Note : (Please keep a file where the work carried out by you is maintained. Activities to be carried out.)			
			TOTAL: 30 PERIODS

Activity	Instructions	Submission week	Evaluation
Selection of area of interest and Topic Stating an Objective	You are requested to select an area of interest, topic and state an objective	2nd week	**3 %** Based on clarity of thought, current relevance and clarity in writing
Collecting Information about your area & topic	1. List 1 Special Interest Groups or professional society 2. List 2 journals 3. List 2 conferences, symposia or workshops 4. List 1 thesis title 5. List 3 web presences (mailing lists, forums, news sites) 6. List 3 authors who publish regularly in your area 7. Attach a call for papers (CFP) from your area.	3rd week	**3%** (the selected information must be area specific and of international and national standard)
Collection of Journal papers in the topic in the context of the objective – collect 20 & then filter	• You have to provide a complete list of references you will be using-Based on your objective -Search various digital libraries and Google Scholar • When picking papers to read - try to: • Pick papers that are related to each other in some ways and/or that are in the same field so that you can write a meaningful survey out of them, • Favour papers from well-known journals and conferences, • Favour "first" or "foundational" papers in the field (as indicated in other people's survey paper), • Favour more recent papers, • Pick a recent survey of the field so you can quickly gain an overview,	4th week	**6%** (the list of standard papers and reason for selection)

	Find relationships with respect to each other and to your topic area (classification scheme/categorization) • Mark in the hard copy of papers whether complete work or section/sections of the paper are being considered		
Reading and notes for first 5 papers	Reading Paper Process • For each paper form a Table answering the following questions: • What is the main topic of the article? • What was/were the main issue(s) the author said they want to discuss? • Why did the author claim it was important? • How does the work build on other's work, in the author's opinion? • What simplifying assumptions does the author claim to be making? • What did the author do? • How did the author claim they were going to evaluate their work and compare it to others? • What did the author say were the limitations of their research? • What did the author say were the important directions for future research? Conclude with limitations/issues not addressed by the paper (from the perspective of your survey)	5th week	**8%** (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)
Reading and notes for next5 papers	Repeat Reading Paper Process	6th week	**8%** (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)
Reading and notes for final 5 papers	Repeat Reading Paper Process	7th week	**8%** (the table given should indicate your understanding of the

			paper and the evaluation is based on your conclusions about each paper)
Draft outline 1 and Linking papers	Prepare a draft Outline, your survey goals, along with a classification / categorization diagram	8th week	**8%** (this component will be evaluated based on the linking and classification among the papers)
Abstract	Prepare a draft abstract and give a presentation	9th week	**6%** (Clarity, purpose and conclusion) **6%** Presentation & Viva Voce
Introduction Background	Write an introduction and background sections	10th week	**5%** (clarity)
Sections of the paper	Write the sections of your paper based on the classification / categorization diagram in keeping with the goals of your survey	11thweek	**10%** (this component will be evaluated based on the linking and classification among the papers)
Your conclusions	Write your conclusions and future work	12th week	**5%** (conclusions – clarity and your ideas
Final Draft	Complete the final draft of your paper	13th week	**10%** (formatting, English, Clarity and linking) **4%** Plagiarism Check Report
Seminar	A brief 15 slides on your paper	14th & 15th week	**10%** (based on presentation and Viva voce)

RM22101	RESEARCH METHODOLOGY	L	T	P	C
		2	0	0	2
UNIT I	**RESEARCH DESIGN**				6
Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys					
UNIT II	**DATA COLLECTION AND SOURCES**				6
Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods. Data - Preparing, Exploring, examining and displaying					
UNIT III	**DATA ANALYSIS AND REPORTING**				6
Overview of Multivariate analysis, Hypotheses testing and Measures of Association Presenting Insights and findings using written reports and oral presentation.					

UNIT IV	INTELLECTUAL PROPERTY RIGHTS	6
Intellectual Property – The concept of IPR, Evolution and development of concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Bio diversity, Role of WIPO and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance..		
UNIT V	PATENTS	6
Patents – objectives and benefits of patent, Concept, features of patent, Inventive step, Specification, Types of patent application, process E-filling, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licences, Licensing of related patents, patent agents, Registration of patent agents.		
	TOTAL: 30 PERIODS	

REFERENCES:

1.	Cooper Donald R, Schindler Pamela S and Sharma JK, "Business Research Methods",Tata McGraw Hill Education, 11e (2012).
2.	Kothari C R, Gaurav Garg, "Research Methodology- Methods and Techniques" New Age International Publishers, 2019
3.	Catherine J. Holland, "Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets", Entrepreneur Press, 2007.
4.	David Hunt, Long Nguyen, Matthew Rodgers, "Patent searching: tools & techniques", Wiley,2007.
5.	The Institute of Company Secretaries of India, Statutory body under an Act of parliament,"Professional Programme Intellectual Property Rights, Law and practice", September 2013.

Table of specification for End semester question paper

Unit No. and Title	Total 2 Marks Qns.	Total 16 Marks Qns.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse (An) Evaluate (Ev)
			No. of Qns. (marks) and CO			
Unit-I: Research Design	2	1 either or	2(2) – CO1	1 either or (16) – CO1	-	-
Unit-II: Data Collection And Sources	2	1 either or	2(2) - CO2		1 either or (16) — CO2	-
Unit-III: Data Analysis And Reporting	2	1 either or	1(2) — CO3	1(2) — CO3		1 either or (16) — CO3
Unit-IV: Intellectual Property Rights	2	1 either or	2(2) - CO4		1 either or (16) — CO4	-
Unit-V: Patents	2	1 either or	1(2) – CO5	1(2) — CO5 1 either or (16) — CO5	-	

Total Qns. RESEARCH METHODOLOGY	10	5 either or	8(2)	2(2) 2 either or (16)	2 either or (16)	-
Total Marks	20	80	16	36	32	16
Weightage	20%	80%	16%	36%	32%	16%
Weightage for COs						
	CO1	CO2	CO3	CO4		CO5
Total Marks	20	20	20	20		20
Weightage	20%	20%	20%	20%		20%

SEMESTER II

MX22204	HUMAN ANATOMY AND PHYSIOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:
- To identify all the organelles of an animal cell and their function.
- To understand the structure and functions of the different types of systems of the human body.
- To understand about sensory organs and accessory organs of human being
- To demonstrate their knowledge of importance of anatomical features and physiology of human systems
- Gain knowledge in regulatory mechanism of human body

UNIT I	ORGANIZATION OF THE HUMAN BODY	8

Organization of the human body: from atoms to the entire organism. Anatomical directions and planes. Cell structures and functions – Plasma membrane and sub-organelles. Cell membrane transport. Cell to cell signaling, Cell cycle and regulations. Action potential, Homeostasis, Types of specialized tissues.

UNIT II	INTEGUMENTARY, SKELETAL, MUSCULAR AND RESPIRATORY SYSTEMS	9

Skin: Structure of skin and their parts, Skeletal: Types of Bone and function – Physiology of Bone formation – Division of Skeleton – Types of joints and function – Types of cartilage and function. Muscular: Parts of Muscle – Movements. Respiratory: Parts of Respiratory Systems – Types of respiration - Mechanisms of Breathing – Regulation of Respiration.

UNIT III	CARDIOVASCULAR, LYMPHATIC AND ENDOCRINE SYSTEMS	10

Cardiovascular: Structure of Heart, Conducting System of Heart – Properties of Cardiac Muscle -

Cardiac Cycle – Heart Beat – Types of Blood vessel – Regulation of Heart rate and Blood pressure, Lymphatic: Types of Lymphatic organs and vessels – Functions. Endocrine: Pituitary and Thyroid glands.

UNIT IV	NERVOUS, SENSE ORGANS AND REPRODUCTIVE SYSTEMS	10

Nervous: Structure, types and properties of Neuron, Mechanism of Nerve impulse. Brain: Structure and parts of brain – central and peripheral nervous system – Reflex mechanism. Sense: Structure and functions of eye and ear. Reproductive: Anatomy of testis and ovary

UNIT V	DIGESTIVE AND URINARY SYSTEMS	8

Digestive: Organs of Digestive system – Digestion and Absorption. Urinary: Structure of Kidney and Nephron – Mechanisms of Urine formation – Regulation of Blood pressure by Urinary System – Urinary reflex.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon Completion of the course, the students will be able to:

CO1:	Explain the general terminology, cell structure and function, histology, gross anatomy, and physiology related to the various human systems.
CO2:	Illustrate various anatomical parts of the human systems
CO3:	Identify interconnectedness of anatomy and physiology of various systems
CO4:	Identify human organ systems interrelation and apply a holistic approach to human health.
CO5:	Apply concept and knowledge of human systems to novel technical and/or clinical scenarios.

REFERENCES:

1.	Frederic H. Martini, Judi L. Nath, Edwin F. Bartholomew, Fundamentals of Anatomy and Physiology. 11th Edition, Pearson Publishers, 2014.
2.	Gillian Pocock, Christopher D. Richards, The human Body – An introduction for Biomedical and Health Sciences, Fifth Edition , Oxford University Press, USA, 2017.
3.	William F.Ganong, "Review of Medical Physiology", 22nd Edition, Mc Graw Hill, New Delhi, 2010.
4.	Eldra Pearl Solomon, "Introduction to Human Anatomy and Physiology", - 4th Edition, W.B. Saunders Company, 2015.
5.	Guyton & Hall, "Medical Physiology", 13th Edition - Elsevier Saunders, 2015.
6.	Elaine.N.Marieb, "Essential of Human Anatomy and Physiology", Eleventh Edition, Pearson Education, New Delhi, 2015.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	2	1	1
CO2	1	1	1	2	1	1

CO3	1	1	1	2	1	1
CO4	1	1	1	2	1	1
CO5	1	1	1	2	1	1
CO	**1**	**1**	**1**	**2**	**1**	**1**

Table of specifications for End Semester Question Paper

Unit No.	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: ORGANIZATION OF THE HUMAN BODY	2	1either or	1(2)-CO1	1(2)-CO1 1either or (16)-CO1	-	-
Unit-II: INTEGUMENTARY, SKELETAL, MUSCULAR AND RESPIRATORY SYSTEMS	2	1either or	1(2)-CO2	1(2)-CO2 1either or (16)-CO2	-	-
Unit-III: CARDIOVASCULAR, LYMPHATIC AND ENDOCRINE SYSTEMS	2	1either or	1(2)-CO3	1(2)-CO3 1either or (16)-CO3	-	-
Unit-IV: NERVOUS, SENSE ORGANS AND REPRODUCTIVE SYSTEMS	2	1either or	1(2)-CO4	1(2)-CO4	1either or (16)-CO4	-
Unit-V: DIGESTIVE AND URINARY SYSTEMS	2	1either or	1(2)-CO5	1(2)-CO5	1either or (16)-CO5	-
Total Qns. Title	10	5either or	5(2)	5(2) 3 either or (16)	2 either or (16)	-
Total Marks	20	80	10	58	32	-
Weightage	20%	80%	10%	58%	32%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20

Weightage	20%	20%	20%	20%	20%

MX22201	MEDICAL IMAGE PROCESSING	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To understand the fundamentals of medical image processing techniques.
- To understand the basic concepts of image enhancement, image restoration, morphological image processing, image segmentation, feature recognition in medical images
- To provide information about various medical imaging modalities
- To provide information about classification and image visualization in medical image processing projects.
- To familiarize the student with the image processing facilities in Matlab, Python and open CV.

UNIT I	FUNDAMENTALS OF IMAGE PROCESSING	9

Image perception, Image fidelity criteria, Image model, Image sampling and quantization, basic relationship between pixels, Image quantization, Optimum mean square quantizer, Image transforms - 2D-DFT and other transforms. DFT, DCT, KLT, SVD, wavelet transform.

UNIT II	MEDICAL IMAGE ENHANCEMENT AND RESTORATION	9

Image Enhancement operation- intensity transformation, histogram processing, Noise distributions, spatial filtering –smoothing filter, sharpening filter, Median, Geometric mean, Harmonic mean, Contra harmonic mean filters, Homomorphic filtering, Color image enhancement. Image Restoration - degradation model, Unconstrained and constrained restoration, Inverse filtering- Wiener filtering

UNIT III	MEDICAL IMAGE REPRESENTATION	9

Pixels and voxels – algebraic image operations - gray scale and color representation- depth- color and look up tables - image file formats- DICOM- other formats- Analyze 7.5, NifTI and Interfile, Image quality and the signal to noise ratio.

UNIT IV	MEDICAL IMAGE ANALYSIS AND CLASSIFICATION	9

Image segmentation- pixel based, edge based, region based segmentation. Image representation and analysis, Feature extraction and representation, Statistical, Shape, Texture, feature and image classification – Statistical, Rule based, Neural Network approaches.

UNIT V	IMAGE REGISTRATIONS AND VISUALIZATION	9

Image Registration: Rigid body transformation – Affine transformation, Principal axes registration, Iterative principal axes registration, Feature based registration, Elastic deformation based registration, Registration of Images from Different modalities.
Image visualization: 2D display methods, 3D display methods, surface and volume based 3D display methods – Surface Visualization and Volume visualization, 3D Echocardiography, 3D+time Echocardiography, virtual endoscopy, virtual reality based interactive visualization

	45 PERIODS
PRACTICAL EXERCISES:	**30 PERIODS**

The following experiments should be performed in OpenCV / Python / Scilab / Matlab Octave /

other Open source software	
1. Preprocessing of medical images	
2. Filtering of medical images.	
3. Edge detection using Python	
4. Segmentation of ROI in medical images.	
5. Feature extraction in medical images	
6. Neural network based classification	
7. Medical image fusion.	
8. Steganography using OpenCV.	
	TOTAL : 75 PERIODS

COURSE OUTCOMES:	
At the end of the course, the students will be able to:	
CO1:	Explain the basic concepts of medical image processing algorithms
CO2:	Enumerate the image pre-processing applications that incorporate different concepts of filters for medical image processing and reconstruction of an image
CO3:	Identify the image representation model in real time applications
CO4:	Use image segmentation, feature extraction and image classification processes in medical applications
CO5:	Develop knowledge in image registration and visualization and possibility of applying image processing concepts in medical imaging applications

REFERENCES:	
1	Atam P.Dhawan, Medical Image Analysis, 2nd Edition, John Wiley & Sons, Inc.,Hoboken, New Jersey, 2011.
2	Anil K Jain, Fundamentals of Digital Image Processing, 1st Edition, Pearson Education India, 2015.
3	Rafael C.Gonzalez and Richard E.Woods, Digital Image Processing, 4th Edition,Pearson Education, 2018.
4	Wolfgang Birkfellner, ―Applied Medical Image Processing – A Basic course, 2nd Edition, CRC Press, 2014.
5	Geoff Dougherty, Digital Image Processing for Medical Applications, 1st Edition, Cambridge University Press, 2010.
6	John L.Semmlow, ―Biosignal and Biomedical Image Processing Matlab Based applications, Marcel Dekker Inc.,New York,2004
7	Kavyan Najarian and Robert Splerstor, ―Biomedical signals and Image processing, CRC – Taylor and Francis,New York,2006
8	Milan Sonka et aI, ―Image Processing, Analysis and Machine Vision‖, Brookes/Cole, Vikas Publishing House, 2nd edition, 1999.
9	Ravikanth Malladi, Geometric Methods in Biomedical Image Processing (Mathematics and Visualization), 1st Edition, Springer-Verlag Berlin Heidelberg 2002.
10	Joseph V. Ha nal, Derek L.G. Hill and David J. Hawkes, Medical Image Registration, CR Press.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	2	1	2	1	2
CO2	2	2	1	2	1	1
CO3	2	2	1	2	1	1
CO4	2	2	1	2	1	1
CO5	2	2	1	2	1	2
CO	**2**	**2**	**1**	**2**	**1**	**1.4**

Table of Specification for End Semester Question Paper

Unit No.	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: FUNDAMENTALS OF IMAGE PROCESSING	2	1either or	1(2)-CO1	1(2)-CO1 1either or (16)-CO1	-	-
Unit-II: MEDICAL IMAGE ENHANCEMENT AND RESTORATION	2	1either or	1(2)-CO2	1(2)-CO2 1either or (16)-CO2	-	-
Unit-III: MEDICAL IMAGE REPRESENTATION	2	1either or	1(2)-CO3	1(2)-CO3 1either or (16)-CO3	-	-
Unit-IV: MEDICAL IMAGE ANALYSIS AND CLASSIFICATION	2	1either or	1(2)-CO4	1(2)-CO4	1either or (16)-CO4	-
Unit-V: IMAGE REGISTRATIONS AND VISUALIZATION	2	1either or	1(2)-CO5	1(2)-CO5	1either or (16)-CO5	-
Total Qns. Title	10	5either or	5(2)	5(2) 3 either or (16)	2 either or (16)	-
Total Marks	20	80	10	58	32	-
Weightage	20%	80%	10%	58%	32%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

MX22202	EMBEDDED SYSTEMS AND INTERNET OF THINGS FOR MEDICAL APPLICATION	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To understand hardware and software for ARM processor.
- To understand ARM processor and Building Blocks of Embedded Systems
- To provide information about sensor interfacing with microcontroller boards
- To provide information about various protocols for IoT
- To familiarize the student with the various applications in healthcare using IoT.

UNIT I	HARDWARE AND SOFTWARE OF ARM PROCESSOR	9

ARM processor fundamentals, architecture, Instruction set, Memory system, Exception/ Interrupt handling. Cortex-M Processors, Embedded Software Development- Introduction to C language and C preprocessor.

UNIT II	DATA ACQUISITION SYSTEMS	10

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

UNIT III	SENSOR INTERFACING WITH MICROCONTROLLER BOARDS	8

Basics of hardware design, functions of passive components-sensors and actuators, Introduction to Arduino Due; Arduino integrated development environment and programming

UNIT IV	IOT: AN INTRODUCTION	9

Networked Embedded System types and overview, Introduction to IOT , Application of IOT in health-care - Patient Monitoring & diagnostics, Home healthcare & Personal care & Fitness.

UNIT V	EMBEDDED WEB-SERVER & IOT CLOUD SERVICES APPLICATION & CASE STUDY	9

Embedded web server: Basic introduction and its application in IOT. Case Study1: Wireless Patient Monitor system, Case Study2: Wearable Fitness & Activity Monitor - Application Design: Design of IOT based pulse oximeter, block diagram, concepts of analog front end, signal process and Wi-Fi integration, Design of single channel and multi-channel ECG and EMG amplifier systems incorporating analog, digital communication..

	45 PERIODS

PRACTICAL EXERCISES:	**30 PERIODS**

LIST OF EXPERIMENTS

1.	Interfacing with Pressure sensor, Light sensor, IR sensor.
2.	Temperature sensor Interfacing using ARM processor
3.	Experiments with Atmega -Digital: - Button, Digital Input Pullup, Blink Without Delay
4.	Introduction to ARM7- Cortex processor Instruction set
5.	EPROM Interfacing using ARM processor.
6.	Study of basic image processing algorithm using Single board computers such as Raspberry Pi, Beagle Bone black etc.

COURSE OUTCOMES:

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

CO1:	Explain ARM processor and Building Blocks of Embedded Systems.
CO2:	Enumerate the data acquisition system.
CO3:	Outline sensor interfacing with Arduino.
CO4:	Make use of various IoT protocols in healthcare.
CO5:	Build various applications in healthcare using IOT based approach

TOTAL: 75 PERIODS

REFERENCES:

1.	Andrew Sloss, Dominic Symes, Chris Wright, ARM system developer's guide: designing and optimizing system software, Morgan Kaufmann, 2004.
2.	Getting Started with Internet of Things- CunoPfister, 2011
3.	S. Salivahanan, S. Arivazhagam, "Digital circuits and Design", 4th Edition, Vikas Publishing House, 2012.
4.	Interconnecting Smart Objects with IP- J. P Vasseur, Adam Dunkels, 2010 24 Course.
5.	R. S. Khandpur, "Printed Circuit Boards Design - Fabrication, Assembly and Testing", 1st Edition, McGraw Hill Education, 2017.
6.	Brian W. Kernighan, Dennis M. Ritchie, "The C programming language", 2nd Edition, Prentice Hall, Englewood Cliffs, New Jersey, 1988.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	2	1	1	2	2
CO2	2	2	1	1	2	2
CO3	2	2	1	1	2	2
CO4	2	2	1	1	2	2
CO5	2	2	1	1	2	2
CO	**2**	**2**	**1**	**1**	**2**	**2**

Table of Specification for End Semester Question Paper

Unit No.	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: Hardware And Software Of Arm Processor	2	1either or	1(2)-CO1	1(2)-CO1 1either or (16)-CO1	-	-
Unit-II: Data Acquisition Systems	2	1either or	1(2)-CO2	1(2)-CO2 1either or (16)-CO2	-	-
Unit-III: Sensor Interfacing With Microcontroller Boards	2	1either or	1(2)-CO3	1(2)-CO3 1either or (16)-CO3	-	-

Unit-IV: IOT An Introduction	2	1either or	1(2)-CO4	1(2)-CO4	1either or (16)-CO4	-
Unit-V: Embedded Web-Server & IOT Cloud Services Application & Case Study	2	1either or	1(2)-CO5	1(2)-CO5	1either or (16)-CO5	-
Total Qns. Title	10	5either or	5(2)	5(2) 3 either or (16)	2 either or (16)	-
Total Marks	20	80	10	58	32	-
Weightage	20%	80%	10%	58%	32%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

MX22203	MACHINE LEARNING TECHNIQUES	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To understand the concepts and mathematical foundations of machine learning and types of problems tackled by machine learning
- To explore the different supervised learning techniques including ensemble methods
- To learn different aspects of unsupervised learning and reinforcement learning
- To learn the role of probabilistic methods for machine learning
- To understand the basic concepts of neural networks and deep learning

UNIT I	MATHEMATICAL BACKROUND	9

Machine Learning–Types of Machine Learning –Machine Learning process, Mathematical Foundations – Linear Algebra – Arithmetic of matrices, Norms, Eigen decomposition, Singular value decomposition. Probability theory – probability distribution, decision theory.

UNIT II	SUPERVISED LEARNING	9

Introduction-Discriminative and Generative Models -Linear Regression - Least Squares -Under-fitting / Overfitting -Cross-Validation – Lasso Regression- Classification - Logistic Regression- Gradient Linear Models -Support Vector Machines –Kernel Methods -Instance based Methods - K-Nearest Neighbors - Tree based Methods –Decision Trees –CART - Ensemble Methods – Random Forest.

UNIT III	UNSUPERVISED LEARNING	9

Introduction - Clustering Algorithms -K – Means – Hierarchical Clustering - spectral clustering-Cluster Validity - Dimensionality Reduction –Principal Component Analysis, Independent Components Analysis.

UNIT IV	BAYESIAN LEARNING	9

Introduction -Naïve Bayes Algorithm -Maximum Likelihood -Maximum Apriori -Bayesian Belief Networks -Probabilistic Modelling of Problems - Bayesian Linear Regression.		
UNIT V	**NEURAL NETWORKS AND DEEP LEARNING**	**9**

Artifitial Neural Networks –- Perceptron – Multi-layer Perceptron — Back Propagation – Activation function and Loss Functions- Introduction to Deep Learning– Convolution Neural Networks – Recurrent Neural Networks – case study.

	45 PERIODS
PRACTICAL EXERCISES:	**30 PERIODS**
LIST OF EXPERIMENTS	

1. Implement a Linear Regression model and tune the model's hyperparameters.
2. Implement a binary classification model determine the model's effectiveness with different classification metrics.
3. Classify the normal and abnormal bio signals with Nearest Neighbor classifier.
4. Analyze the training and validation results of the classifier. Detect and fix a common training problem.
5. Implement the k-means algorithm using https://archive.ics.uci.edu/ml/datasets/Codon+usage dataset
6. Implement the Naïve Bayes Classifier using https://archive.ics.uci.edu/ml/ datasets/ Gait+ Classification dataset
7. Implement the convolutional neural network for feature extraction and classification of medical images.

	TOTAL : 75 PERIODS
COURSE OUTCOMES:	
At the end of the course, the students will be able to:	
CO1:	Explain the mathematical and statistical prospective of machine learning algorithms
CO2:	Design supervised learning models appropriate to specific applications.
CO3:	Apply unsupervised learning algorithms to real problems
CO4:	Develop probability models based on Bayesian learning.
CO5:	Analyze the performance of neural network model , deep learning model and CNN.

REFERENCES:	
1	Stephen Marsland, "Machine Learning: An Algorithmic Perspective", Chapman & Hall/CRC, 2nd Edition, 2014.
2	Ethem Alpaydin, "Introduction to Machine Learning", Third Edition, Adaptive Computation and Machine Learning Series, MIT Press, 2014..
3	Tom M Mitchell, "Machine Learning", McGraw Hill Education, 2013.
4	Shai Shalev-Shwartz and Shai Ben-David, "Understanding Machine Learning: From Theory to Algorithms", Cambridge University Press, 2015.
5	Christopher Bishop, "Pattern Recognition and Machine Learning", Springer, 2007.
6	Hal Daumé III, "A Course in Machine Learning", 2017 (freely available online).
7	Trevor Hastie, Robert Tibshirani, Jerome Friedman, "The Elements of Statistical Learning", Springer, 2009 (freely available online).

8	Aurélien Géron , Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems 2nd Edition, o'reilly, (2017).
9	Kevin P Murphy, Machine Learning: A Probabilistic Perspective,2nd Edition, MIT Press, 2022.
10	Csaba Szepesvari, Algorithms for Reinforcement Learning (Synthesis Lectures on Artificial Intelligence & Machine Learning), Morgan & Claypool Publishers, 2010

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	-	-	2	2
CO2	1	-	2	2	2	2
CO3	1	-	2	2	2	2
CO4	1	-	2	2	2	2
CO5	1	-	2	2	2	2
CO	**1**	**-**	**2**	**2**	**2**	**2**

Table of Specification for End Semester Question Paper

Unit No.	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: MATHEMATICAL BACKROUND	2	1either or	1(2)-CO1	1(2)-CO1 1either or (16)-CO1	-	-
Unit-II: SUPERVISED LEARNING	2	1either or	1(2)-CO2	1(2)-CO2 1either or (16)-CO2	-	-
Unit-III: UNSUPERVISED LEARNING	2	1either or	1(2)-CO3	1(2)-CO3 1either or (16)-CO3	-	-
Unit-IV: BAYESIAN LEARNING	2	1either or	1(2)-CO4	1(2)-CO4	1either or (16)-CO4	-
Unit-V: NEURAL NETWORKS AND DEEP LEARNING	2	1either or	1(2)-CO5	1(2)-CO5	1either or (16)-CO5	-
Total Qns. Title	10	5either or	5(2)	5(2) 3 either or (16)	2 either or (16)	-
Total Marks	20	80	10	58	32	-
Weightage	20%	80%	10%	58%	32%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

MX22205	DATA ACQUISITION AND DESIGN LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

- To understand the production of x-rays and its application to different medical Imaging.
- To explore the different types of Radio diagnostic techniques.
- To understand the special imaging techniques for visualizing the cross sections of the body.
- To understand the production of Magnetic resonance images for various pulse sequences.
- To realize the importance of image quality assessments for medical imaging systems

LIST OF EXPERIMENTS:

1. Acquisition and analysis of medical images.
2. Development of software for medical image compression.
3. Development of neural network for signal classification.
4. Development of algorithm for medical data security.
5. Simulation of instrumentation amplifier.
6. Multichannel data acquisition for EEG recording.
7. Modeling and simulation of internal noise cancellation circuit.
8. Study of DICOM standards.
9. Study of lung and cardiovascular model.
10. Measurement of Galvanic skin resistance.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

Upon completion of this course the students will be able to

CO1:	Explain the functionalities and applications of X ray in medicine.
CO2:	Demonstrate the images acquisition procedures using CT.
CO3:	Explain the suitable projection methods for anatomy and biology specific.
CO4:	Demonstrate the applications of standards and models in the field of medicine.
CO5:	Explain the assessment method to quantify the presence of noise in the image.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	3	2	2

CO2	1	-	1	2	2	1
CO3	-	-	1	1	1	1
CO4	2	2	2	3	2	2
CO5	1	-	1	2	2	1
CO	**1.5**	**2**	**1.4**	**2.2**	**1.8**	**1.4**

RM22201	**RESEARCH TOOLS LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**

COURSE OBJECTIVES:

- To familiarize the fundamental concepts/techniques for Project Management
- To familiarize the journal paper formatting using suitable Software
- To familiarize the software for literature review and Bibliography
- To find the plagiarism percentage of article contents
- To prepare a quality research report and the presentation

LIST OF EXPERIMENTS:

1	Use of tools / Techniques for Research - Project management -Microsoft Project / Microsoft OneNote / Asana.
2	Hands on Training related to Software for Paper Formatting like LaTeX / MS Office
3	Design a Layout of a Research Paper - Guidelines for Submitting the Research Paper - Review Process -Addressing Reviewer Comments.
4	Introduction to Data Analysis Software - Origin SPSS, ANOVA etc.,
5	Introduction to Software for detection of Plagiarism – Urkund, Turniton
6	Preparing Bibliography / Different Reference Formats. – EndNote, Mently
7	Format of Project Report - Use of Quotations - Method of Transcription- Elements: Title Page - Abstract - Table of Contents - Headings and Sub-Headings - Footnotes - Tables and Figures
8	Introduction to Microsoft Excel –for Research Analysis
9	Presentation using PPTs.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

Upon completion of this course the students will be able to

CO1:	List the various stages in research and develop systematic planning of project stages.
CO2:	Write a journal paper and formulate as per the standard journal format
CO3:	Develop a literature review and relevant references for a research problem using suitable software.
CO4:	Determine the plagiarism of the article / report content by using the Software
CO5:	Compile a research report and the presentation

34

SEMESTER III

MX22301	INPLANT / INDUSTRIAL / PRACTICAL TRAINING	L	T	P	C
		0	0	4	2

COURSE OBJECTIVE:

- To train the students in the field work so as to have first-hand knowledge of practical problems in carrying out engineering tasks.

SYLLABUS:

The students individually undertake training in reputed companies /organization during the summer vacation for a specified duration of four weeks. At the end of training, a detailed report on the work done should be submitted within ten days from the commencement of the semester. The students will be evaluated through a viva-voce examination by a team of internal staff.

TOTAL: 120 PERIODS

MX22302	PROJECT WORK I	L	T	P	C
		0	0	6	3

COURSE OBJECTIVES:

- To identify a specific problem for the current need of the society and collecting information related to the same through detailed review of literature.
- To develop the methodology to solve the identified problem.
- To train the students in preparing project reports and to face reviews and viva-voce examination.

SYLLABUS:

The student individually works on a specific topic approved by faculty member who is familiar in this area of interest. The student can select any topic which is relevant to his/her specialization of the programme. The topic may be experimental or analytical or case studies. At the end of the semester, a detailed report on the work done should be submitted which contains clear definition of the identified problem, detailed literature review related to the area of work and methodology for carrying out the work. The students will be evaluated through a viva-voce examination by a panel of examiners including one external examiner.

TOTAL: 90 PERIODS

COURSE OUTCOME:

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

CO1:	Discover potential research areas.
CO2:	Apply the knowledge gained from theoretical and practical courses to be creative, well-planned, organized and coordinated
CO3:	Represent data acquired in graphical and reader-friendly formats
CO4:	Derive detailed conclusions from work carried out
CO5:	Report and present the findings of the work conducted

MX22401	PROJECT WORK II	L	T	P	C
		0	0	24	12

COURSE OBJECTIVES:

- To solve the identified problem based on the formulated methodology.
- To develop skills to analyze and discuss the test results, and make conclusions

SYLLABUS

The student should continue the phase I work on the selected topic as per the formulated methodology / Undergo internship. At the end of the semester, after completing the work to the satisfaction of the supervisor and review committee, a detailed report should be prepared and submitted to the head of the department. The students will be evaluated based on the report and the viva-voce examination by a panel of examiners including one external examiner.

TOTAL : 360 PERIODS

COURSE OUTCOMES:

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

CO1	Discover potential research areas.
CO2	Apply the knowledge gained from theoretical and practical courses to be creative, well-planned, organized and coordinated
CO3	Represent data acquired in graphical and reader-friendly formats
CO4	Derive detailed conclusions from work carried out
CO5	Report and present the findings of the work conducted

SEMESTER I, PROFESSIONAL ELECTIVES – I

MX22111	BIOMECHANICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

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

UNIT I	INTRODUCTION	9

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

UNIT II	MECHANICS OF CIRCULATION	9

Flow properties of blood, effect of shear rate, hematocrit, temperature and protein Content of blood, rheology of blood and microvessels, dynamics of circulatory system, turbulence flow around prosthetic heart valves. .	
UNIT III **MECHANICS APPLIED TO ORTHOPEDICS**	**9**
Orthopedic biomechanics, mechanical properties of bones, stress-induced bone growth, kinematics and kinetics of joints, lubrication of joints, gait analysis, spatio-temporal parameters of gait. Analysis of force in orthopedic implants.	
UNIT IV **MECHANISM OF BIOLOGICAL SYSTEMS**	**9**
Biomechanics of Joints Classification of Motion - Classification of joints - Factors influencing motion at a joint, Skeletal muscles servo mechanism, Cardiovascular control mechanism, respiratory control mechanism, Finite element analysis in Biomechanics - case study.	
UNIT V **BIOMECHANICAL ASPECT OF ACCIDENT INVESTIGATION**	**9**
Experimental and Analytical method of analysis, Clinical evaluation, Head Injury tolerance, rotational injury, spine injury – Accident reconstruction, Analysis of impact, skid analysis – Damage analysis.	
	TOTAL: 45 PERIODS

COURSE OUTCOMES:	
Upon Completion of the course, the students will be able to:	
CO1:	Demonstrate the application of mechanics in medicine.
CO2:	Explain the properties of blood, bone and soft tissues like articular cartilage tendons and ligaments
CO3:	Demonstrate a conceptual and theoretical framework of the development, and implementation of orthopedic implants
CO4:	Apply the knowledge of evaluating the force in implants
CO5:	Analyze different injuries from accident investigation

REFERENCES:	
1	Y.C.Fung, Biomechanics: Mechanical properties in living tissues, Springer Verlag, New York 1993.
2	Susan J.Hall, Basics BioMechanics, 6th Edition, McGraw-Hill Publishing Co, 2016.
3	Subrata pal, Text book of Biomechanics, Viva education private limited, 2017.
4	C.R Ethier and C.A.Simmons , Biomechanics from cells to organisms.
5	D.Dawson and Right, Introduction to Biomechanics of joints and joint replacement, Mechanical Engineering, publications Ltd. 1991.
6	Jacob Kline, Head book of BioMedical Engineering, Academic Press.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	2	1	2	1
CO2	2	2	2	1	2	1
CO3	2	2	2	2	2	1
CO4	2	2	2	1	2	2
CO5	2	2	2	1	2	2
CO	2	1.8	2	1.2	2	1.4

Table of Specification for End Semester Question Paper

Unit No.	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: INTRODUCTION	2	1either or	1(2)-CO1	1(2)-CO1 1either or (16)-CO1	-	-
Unit-II: MECHANICS OF CIRCULATION	2	1either or	1(2)-CO2	1(2)-CO2 1either or (16)-CO2	-	-
Unit-III: MECHANICS APPLIED TO ORTHOPEDICS	2	1either or	1(2)-CO3	1(2)-CO3 1either or (16)-CO3	-	-
Unit-IV: MECHANISM OF BIOLOGICAL SYSTEMS	2	1either or	1(2)-CO4	1(2)-CO4	1either or (16)-CO4	-
Unit-V: BIOMECHANICAL ASPECT OF ACCIDENT INVESTIGATION	2	1either or	1(2)-CO5	1(2)-CO5	1either or (16)-CO5	-
Total Qns. Title	10	5either or	5(2)	5(2) 3 either or (16)	2 either or (16)	-
Total Marks	20	80	10	58	32	-
Weightage	20%	80%	10%	58%	32%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

MX22112	BIOMETRICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the basics of Biometrics and its functionalities
- To learn the role of physiological traits in biometrics
- To identify the concept of behavioral traits
- To expose the user interface in context of Biometric Applications
- To learn to develop applications with biometric security

UNIT I	INTRODUCTION	9

Biometrics versus traditional techniques, Characteristics, Processes, Performance measures, Assessing the privacy risks of biometrics - Designing privacy sympathetic biometric systems, Biometric standards, Applications and properties, Biometrics in medicine

UNIT II	PHYSIOLOGICAL TRAITS	9

Face, Ear, Retina, Iris, Finger, Automated fingerprint identification system, Palm print, Hand vascular geometry analysis, , Dental, Cognitive Biometrics: ECG, EEG

UNIT III	BEHAVIORAL TRAITS	9

Signature, Keystroke, Voice, Gait, Gesture recognition, Video face, Mapping the body technology, Case Study.

UNIT IV	USER INTERFACE	9

Biometric interfaces: Human machine interface - Iris image interface - Hand geometry and fingerprint sensor, - Securing Biometric templates - Cancellable biometrics.

UNIT V	APPLICATION AREAS	9

Surveillance applications- personal applications –design and deployment -user system interaction-operational processes – architecture –application development –design validation disaster recovery plan-maintenance-privacy concerns, RFID biometrics ,   DNA Biometrics – Comparative study of various biometrics techniques. .

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon Completion of the course, the students will be able to:

CO1:	Explain the general principles of design of biometric systems and the underlying trade-offs.
CO2:	Identify fingerprint, iris, face and speech recognition technologies
CO3:	Demonstrate the various behavioral traits in biometrics
CO4:	Interpret the user interfaces
CO5:	Illustrate personal privacy and security implications of biometrics based identification technology and the issues involved.

REFERENCES:

1.	Paul Reid, "Biometrics for Network Security", Pearson Education, New Delhi, 2013.
2.	Samir Nanavati, Michael Thieme and Raj Nanavati, "Biometrics – Identity Verification in a Networked World", John Wiley and Sons, New Delhi, 2012.
3.	Anil K Jain, Patrick Flynn and Arun A Ross, "Handbook of Biometrics", Springer, USA, 2010.
4	John D Woodward, Nicholas M Orlans and Peter T Higgins, "Biometrics: The Ultimate Reference", Dream Tech, New Delhi, 2009.

5.	N. V. Boulgouris, Konstantinos N. Plataniotis, Evangelia Micheli-Tzanakou, 'Biometrics: Theory, Methods, and Applications', John Wiley & Sons, 2009.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	-	1	1	1
CO2	2	1	-	2	1	1
CO3	2	1	-	2	1	1
CO4	1	1	-	2	1	1
CO5	2	1	-	1	1	1
CO	1.6	1	-	1.6	1	1

Table of Specification for End Semester Question Paper

Unit No.	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: INTRODUCTION	2	1either or	1(2)-CO1	1(2)-CO1	-	-
				1either or (16)-CO1		
Unit-II: PHYSIOLOGICAL TRAITS	2	1either or	1(2)-CO2	1(2)-CO2	-	-
				1either or (16)-CO2		
Unit-III: BEHAVIORAL TRAITS	2	1either or	1(2)-CO3	1(2)-CO3	-	-
				1either or (16)-CO3		
Unit-IV: USER INTERFACE	2	1either or	1(2)-CO4	1(2)-CO4	1either or (16)-CO4	-
Unit-V: APPLICATION AREAS	2	1either or	1(2)-CO5	1(2)-CO5	1either or (16)-CO5	-
Total Qns. Title	10	5either or	5(2)	5(2) 3 either or (16)	2 either or (16)	-
Total Marks	20	80	10	58	32	-
Weightage	20%	80%	10%	58%	32%	-

Weightage for COs					
	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

MX22113	BIOMATERIALS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

UNIT I	INTRODUCTION	10

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

UNIT II	MATERIALS IN MEDICAL DEVICES	10

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

UNIT III	STERILIZATION OF BIOMATERIALS	7

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

UNIT IV	TESTING OF MATERIALS	9

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

UNIT V	HARD AND SOFT REPLACEMENT	9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon Completion of the course, the students will be able to:

CO1:	Explain the basic principles in material science and their contribution towards Biomedical engineering
CO2:	Identify different types of materials and apply them in designing a device
CO3:	Select the materials for designing an implant in tissue replacement
CO4:	Analyse significant gaps required to overcome challenges and further developments
CO5:	Examine the compatibility and functioning of artificial organs inside the living system.

REFERENCES:

1	J.H.U.Brown (Ed), Advances in BioMedical Engineering, Academic Press 1975.
2	Andrew F.Von Racum, HandBook of Bio Medical Evaluation, Mc-Millan Publishers, 1980.
3	Jacob Cline, HandBook of BioMedical Engineering, Academic Press in Sandiego, 1988.
4	Jonathan Black, Biological Performance of Materials- Fundamentals of biocompatibility, 4th Edition, CRC Press 2005.
5	Larry L. Hench and Julian R.Jones, Biomaterials, Artificial organs and Tissue Engineering, 2005.

6	Buddy D.Ratner, Allan S .Hoffman, Frederick J. Schoen, Jack E. Lemons, Biomaterial Science; An Introduction to Materials in Medicine,2nd Edition, Elsevier Academic Press, San Diego, 2004.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	2	2	2
CO2	1	1	1	2	2	2
CO3	1	1	1	2	2	2
CO4	1	1	1	2	2	2
CO5	1	1	1	2	2	2
CO	**1**	**1**	**1**	**2**	**2**	**2**

Table of Specification for End Semester Question Paper

Unit No.	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: INTRODUCTION	2	1either or	1(2)-CO1	1(2)-CO1	-	-
				1either or (16)-CO1		
Unit-II: MATERIALS IN MEDICAL DEVICES	2	1either or	1(2)-CO2	1(2)-CO2	-	-
				1either or (16)-CO2		
Unit-III: STERILIZATION OF BIOMATERIALS	2	1either or	1(2)-CO3	1(2)-CO3	-	-
				1either or (16)-CO3		
Unit-IV: TESTING OF MATERIALS	2	1either or	1(2)-CO4	1(2)-CO4	1either or (16)-CO4	-
Unit-V: HARD AND SOFT REPLACEMENT	2	1either or	1(2)-CO5	1(2)-CO5	1either or (16)-CO5	-
Total Qns. Title	10	5either or	5(2)	5(2) 3 either or (16)	2 either or (16)	-
Total Marks	20	80	10	58	32	-
Weightage	20%	80%	10%	58%	32%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

MX22114	MEDICAL OPTICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand various optical properties of tissue
- To gain the knowledge of photonics instruments
- To know the engineering and practical applications of optics related to diagnostics applications
- To acquire knowledge about therapeutic and surgical applications of lasers in medical fields
- To gain the knowledge of fiber optic sensors used In medical application.

UNIT I	OPTICAL PROPERTIES OF THE TISSUES	9

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

UNIT II	INSTRUMENTATION IN PHOTONICS	9

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

UNIT III	DIAGNOSTIC APPLICATIONS	9

Wood's lamp, Imaging techniques - Optical coherence tomography, Elastography, Fluorescence Imaging, Raman Imaging, FLIM, FRAP, NIRS-Application, X-Ray Diagnostic Techniques, Speckle Correlometry, Near-Field Imaging in Biological and Biomedical Applications.

UNIT IV	THERAPEUTIC AND SURGICAL APPLICATIONS OF LIGHT	9

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

UNIT V	FIBER OPTIC SENSORS AND APPLICATIONS	9

Patents – objectives and benefits of patent, Concept, features of patent, Inventive step, Specification, Types of patent application, process E-filling, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licences, Licensing of related patents, patent agents, Registration of patent agents.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon Completion of the course, the students will be able to:

CO1:	Understand various optical properties of tissue
CO2:	Describe the photonics instruments
CO3:	Know the diagnostic applications of lasers in medical fields
CO4:	Analyze the therapeutic and surgical applications of lasers in medical fields
CO5:	Examine the types of fiber optic sensors used in medical application

REFERENCES:

1	Mark E. Brezinski, "Optical Coherence Tomography: Principles and Applications",Academic Press, 2006.

2	Markolf H.Niemz, "Laser-Tissue Interaction Fundamentals and Applications", Springer, 2007.
3	Paras N. Prasad, "Introduction to Biophotonics, A. John Wiley and sons", Inc. Publications,2003.
4	R. Splinter and B.A. Hooper, "An Introduction to BioMedical Optics", Taylor and Francis, 2007.
5	Tuan Vo Dinh, "Biomedical photonics – Handbook", CRC Press LLC, 2003.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	2	2	2
CO2	1	1	1	2	2	2
CO3	1	1	1	2	2	2
CO4	1	1	1	2	2	2
CO5	1	1	1	2	2	2
CO	**1**	**1**	**1**	**2**	**2**	**2**

Table of Specification for End Semester Question Paper

Unit No.	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: OPTICAL PROPERTIES OF THE TISSUES	2	1either or	1(2)-CO1	1(2)-CO1 1either or (16)-CO1	-	-
Unit-II: INSTRUMENTATION IN PHOTONICS	2	1either or	1(2)-CO2	1(2)-CO2 1either or (16)-CO2	-	-
Unit-III: DIAGNOSTIC APPLICATIONS	2	1either or	1(2)-CO3	1(2)-CO3 1either or (16)-CO3	-	-
Unit-IV: THERAPEUTIC AND SURGICAL APPLICATIONS OF LIGHT	2	1either or	1(2)-CO4	1(2)-CO4	1either or (16)-CO4	-
Unit-V: FIBER OPTIC SENSORS AND APPLICATIONS	2	1either or	1(2)-CO5	1(2)-CO5	1either or (16)-CO5	-
Total Qns. Title	10	5either or	5(2)	5(2) 3 either or	2 either or (16)	-

				(16)		
Total Marks	20	80	10	58	32	-
Weightage	20%	80%	10%	58%	32%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

MX22115	MEDICAL EQUIPMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To learn about cardiac care unit, pulmonary analyzers and aid equipments and their functions.
- To understand the principle involved in physiotherapy and electrotherapy equipments.
- To gain knowledge about instruments used to kidney and bones measurements
- To study about the instruments used for sensory measurements and be able to design sensors
- To provide latest knowledge of special medical assistive and therapeutic equipments

UNIT I	CARDIAC CARE UNIT AND PULMONARY ANALYSERS	9

Pacemakers – Need different types, electrode types and placement, batteries for pacemakers. Defibrillators - AC and DC defibrillators. Regulation of Breathing - Pulmonary gas flow measurements - Pulmonary volume measurements - Respiratory gas analyzers – Nitrogen Gas Analyzer, Oxygen Analyzer - Humidifier, Nebulizer – Ventilators - Anesthesia machine.

UNIT II	PHYSIOTHERAPY AND ELECTROTHERAPY EQUIPMENTS	9

Tissue response -Short wave diathermy - Microwave diathermy - Ultrasonic therapy Unit - Electrotherapy - FES, TENS - Bladder stimulator - Lithotripter system - Extra corporeal Shock wave therapy- Electrical safety-IEC-60601 standard, Physiological effects of current, GFI units, Earthing Scheme, Electrical safety Analyzer.

UNIT III	INSTRUMENTS DEALING WITH KIDNEY AND BONES	9

Regulation of Water and Electrolyte Balance – Artificial Kidney – Hemodialysis - Grafts for dialysis - Peritoneal dialysis - Dialyzers – different types, Thermograph BMD Measurements–SXA – DXA - Quantitative ultrasound bone densitometer..

UNIT IV	SENSORY INSTRUMENTATION	9

Basic Audiometer, Pure tone audiometer, Audiometer system Bekesy – Hearing Aids - Ophthalmoscope – Tonometer - Measurement of Basal Skin response and Galvanic skin response - Instruments for testing Motor responses - Biofeedback Instrumentation.

UNIT V	SPECIAL EQUIPMENTS AND RECENT TRENDS	9

Endoscopy – Laparoscopy - Cryogenic Equipment - Automated drug delivery system – Components of drug infusion system – Implantable infusion systems. Biotelemetry and Multipatient telemetry, Applications of IoT in Healthcare.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon Completion of the course, the students will be able to:	
CO1:	Illustrate the special therapeutic equipment, aid equipment and their functions
CO2:	Outline the working of the Physiotheraphy Equipment, Automated drug delivery, Sensory Equipment and their functions
CO3:	Choose different Safety, special Equipment and Feedback mechanism in instruments.
CO4:	Identify instruments used in Gas Analyzer, kidney, bones, Sensory and instruments in testing motor nerves
CO5:	Construct measurement systems using IoT for any applications

REFERENCES:	
1	Geddes LA and Baker L.E Principles of Applied Biomedical Instrumentation, 3rd Edition, John Wiley and sons, New york, August 2008.
2	Joseph J Carr and John Brown – Introduction to Biomedical equipment Technology- Pearson Education 4th edition New Delhi 2001.
3	Khandpur R.S HandBook of Biomedical Instrumentation – Tata Mc Graw Hill publication, New Delhi 3rd edition 2014.
4	Khandpur R.S HandBook of Biomedical Instrumentation – Tata Mc Graw Hill publication, New Delhi 2nd edition 2003.
5	R. Anand Natarajan - Biomedical Instrumentation and Measurements- PHI Learning, New Delhi, 2nd edition, 2015.
6	Webster J.G Medical Instrumentation application and design – John Wiley and sons New York, 5th edition 2020.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	3	2	2
CO2	1	-	1	2	2	1
CO3	-	-	1	1	1	1
CO4	1	1	1	3	2	2
CO5	1	-	1	2	2	1
CO	1	1	1	2.2	1.8	1.4

Table of Specification for End Semester Question Paper

Unit No.	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: CARDIAC CARE UNIT AND PULMONARY ANALYSERS	2	1either or	1(2)-CO1	1(2)-CO1 1either or (16)-CO1	-	-

Unit-II: PHYSIOTHERAPY AND ELECTROTHERAPY EQUIPMENTS	2	1either or	1(2)-CO2	1(2)-CO2 1either or (16)-CO2	-	-
Unit-III: INSTRUMENTS DEALING WITH KIDNEY AND BONES	2	1either or	1(2)-CO3	1(2)-CO3 1either or (16)-CO3	-	-
Unit-IV: SENSORY INSTRUMENTATION	2	1either or	1(2)-CO4	1(2)-CO4	1either or (16)-CO4	-
Unit-V: SPECIAL EQUIPMENTS AND RECENT TRENDS	2	1either or	1(2)-CO5	1(2)-CO5	1either or (16)-CO5	-
Total Qns. Title	10	5either or	5(2)	5(2) 3 either or (16)	2 either or (16)	-
Total Marks	20	80	10	58	32	-
Weightage	20%	80%	10%	58%	32%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

SEMESTER II, PROFESSIONAL ELECTIVE – II

MX22211	**WEARABLE TECHNOLOGIES**	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To identify the motivation, guiding principles, and challenges of Wearable Computing.
- To develop skills pertaining to the design of a holistic interactive wearable system comprising of the physical, digital, and the human aspects.
- To provide the basic understanding of measurement and instrumentation systems and the insight of the resistive sensors and its applications in real life.
- To introduce the concept of the reactive sensors and self-generating sensors and its applications in real life
- To impart the importance of smart sensors, sensor interface standards for wearable device applications and to provide a brief overview of the wearable technology and its impact on social life.

UNIT I	**INTRODUCTION**	9

Attributes of wearables, Meta-wearable, Challenges and opportunities, Future of wearables - Social

aspects of wearability and interaction: Social interpretation of Aesthetics - Case study: Google glass - Wearable haptics: Need for wearable haptic devices - Categories of wearable haptic and tactile display – Wearable sensorimotor enhancer.

UNIT II	WEARABLE SENSORS	9

Chemical and Biochemical sensors, System design, Challenges in chemical, Bio-chemical sensing, Application areas - Inertia sensors, Parameters from inertia sensors - Applications for wearable motion sensors - Measurement of energy expenditure by body worn heat flow sensors, Point-of-Care Sensors- Application areas- challenges in the clinical environment..

UNIT III	FLEXIBLE ELECTRONICS	9

Introduction, Thin-film transistors: Materials and Technologies, Review of Semi-conductors in flexible electronics - Low-power Integrated Circuit Design for Bio-potential sensing: Analog circuit design techniques - Low- power design for ADCs - Digital circuit design techniques - Architectural design for low-power bio-potential acquisition, Practical considerations.

UNIT IV	ENERGY HARVESTING SYSTEMS	9

Energy harvesting from human body: Temperature gradient, Foot motion - Wireless energy transmission - Energy harvesting from light and RF energy - Energy and power consumption issues, Future considerations.

UNIT V	MONITORING PHYSICAL AND PHYSIOLOGICAL PARAMETERS	9

Wearable sensors for physiological signal measurement - Physical measurement: Cardiovascular diseases, food intake detection and characterization, Neurological diseases, Gastrointestinal diseases - Wearable and non- invasive assistive technologies: Assistive devices for individuals with severe paralysis, Wearable tongue drive system, Sensor signal-processing algorithm, Dual-mode tongue drive system, IoT-Based Intelligent Capsule Endoscopy.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1:	Summarize the existing wearable technology, with a futuristic vision along with socio-economic impact and issues.
CO2:	Explain the sensor and signal processing requirement of wearable systems.
CO3:	Recognize the materials used in the field of flexible electronics technology and its power constraints
CO4:	Summarize the techniques and issues associated with energy harvesting from human body
CO5:	Elucidate the applications of wearable technology in health care

REFERENCES:

1.	Edward Sazonov, Michael R Neuman, "Wearable Sensors: Fundamentals, Implementation and Applications", Academic Press, London, 2021.
2.	Tom Bruno, "Wearable Technology: Smart Watches to Google Glass for Libraries", Rowman & Littlefield Publishers, Lanham, Maryland, 2015.
3.	Raymond Tong, "Wearable Technology in Medicine and Health Care", Academic Press, USA, 2018.
4.	Haider Read, "The Wearable Technology Handbook", United Scholars Publication, USA, 2017.
5.	Hamilton Ortiz, 'Wearable technologies', Intech Open, 2018.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	-	-	-	-
CO2	-	-	-	-	1	-
CO3	2	1	-	-	-	2
CO4	-	-	2	-	-	-
CO5	2	-	1	-	1	-
CO	2	1	1.5	-	1	2

Table of Specification for End Semester Question Paper

Unit No.	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I INTRODUCTION	2	1either or	1(2)-CO1	1(2)-CO1	-	-
				1either or (16)-CO1		
Unit-II: WEARABLE SENSORS	2	1either or	1(2)-CO2	1(2)-CO2	-	-
				1either or (16)-CO2		
Unit-III: FLEXIBLE ELECTRONICS	2	1either or	1(2)-CO3	1(2)-CO3	-	-
				1either or (16)-CO3		
Unit-IV: ENERGY HARVESTING SYSTEMS	2	1either or	1(2)-CO4	1(2)-CO4	1either or (16)-CO4	-
Unit-V: MONITORING PHYSICAL AND PHYSIOLOGICAL PARAMETERS	2	1either or	1(2)-CO5	1(2)-CO5	1either or (16)-CO5	-
Total Qns. Title	10	5either or	5(2)	5(2) 3 either or (16)	2 either or (16)	-
Total Marks	20	80	10	58	32	-
Weightage	20%	80%	10%	58%	32%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

MX22212	BRAIN COMPUTER INTERFACE	L	T	P	C
		3	0	0	4

COURSE OBJECTIVES:

- To know the basic concepts of brain computer interface.
- To study various signal acquisition methods.
- To understand the signal processing methods used in BCI.
- To acquire knowledge of various machine learning methods of BCI.
- To explore various applications of BCI.

UNIT I	INTRODUCTION TO BCI	9

Introduction - Brain structure and function, Brain Computer Interface Types - Synchronous and Asynchronous -Invasive BCI -Partially Invasive BCI - Non-Invasive BCI, Structure of BCI System, BCI Monitoring Hardware, EEG, MEG, fMRI.

UNIT II	BRAIN ACTIVATION	9

Brain activation patterns - Oscillatory potential and ERD, Slow cortical potentials, Movement related potentials-Mu rhythms, motor imagery, Stimulus related potentials – Visual Evoked Potentials – P300 and Auditory Evoked Potentials.

UNIT III	FEATURE EXTRACTION METHODS	9

Data Processing – Spike sorting, Frequency domain analysis, Wavelet analysis, Time domain analysis, Spatial filtering -Principal Component Analysis (PCA), Independent Component Analysis (ICA), Artefacts reduction, Feature Extraction - Phase synchronization

UNIT IV	MACHINE LEARNING METHODS FOR BCI	9

Classification techniques –Binary classification, Multiclass Classification, Evaluation of classification performance, Regression - Linear, Polynomial, RBF's, Support vector machine, Graph theoretical unctional connectivity analysis.

UNIT V	APPLICATIONS OF BCI	9

Case Studies - Invasive BCIs: decoding and tracking arm (hand) position, controlling prosthetic devices such as orthotic hands, Cursor and robotic control using multi electrode array implant, Cortical control of muscles via functional electrical stimulation. Ethics of Brain Computer Interfacing.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On the successful completion of the course, students will be able to.

CO1:	Explore the concept of BCI.
CO2:	Describe the different brain activation signals.
CO3:	Select appropriate feature extraction methods.
CO4:	Apply machine learning algorithms for translation.
CO5:	Develop high-fidelity BCI prototypes

REFERENCES:

1	Rajesh P.N. Rao, Brain-Computer Interfacing: An Introduction, Cambridge University Press, 1st Edition, 2013.
2	Ella Hassianien A and Azar A.T Ed, Brain-Computer Interfaces Current Trends an Applications, Springer, 2015.
3	Jonathan Wolpaw and Elizabeth Winter Wolpaw, Brain Computer Interfaces: Principles and practice, Oxford University Press, USA, 1stEdition, 2012.

4	Bernhard Graimann, Brendan Allison and Gert Pfurtscheller, Brain-Computer Interfaces: Revolutionizing Human-Computer Interaction, Springer, 2010.
5	Ali Bashashati, Mehrdad Fatourechi, Rabab K Ward and Gary E Birch, A survey of signal Processing algorithms in brain–computer interfaces based on electrical brain signals, Journal of Neural Engineering, Vol.4, 2007, pp.32-57
6	Arnon Kohen, Biomedical Signal Processing, Vol I and II, CRC Press Inc, Boca Rato Florida
7	Bishop C.M., Neural networks for Pattern Recognition, Oxford, Clarendon Press, 2005
8	Andrew Webb, Statistical Pattern Recognition, Wiley International, 2nd Edition, 2002

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	-	-	-	-
CO2	1	-	2	-	-	-
CO3	1	-	2	2	1	-
CO4	1	-	2	2	-	2
CO5	1	-	2	2	1	2
CO	1	-	2	2	1	2

Table of Specification for End Semester Question Paper

Unit No.	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: INTRODUCTION TO BCI	2	1either or	1(2)-CO1	1(2)-CO1	-	-
				1either or (16)-CO1		
Unit-II: BRAIN ACTIVATION	2	1either or	1(2)-CO2	1(2)-CO2	-	-
				1either or (16)-CO2		
Unit-III: FEATURE EXTRACTION METHODS	2	1either or	1(2)-CO3	1(2)-CO3	-	-
				1either or (16)-CO3		
Unit-IV: MACHINE LEARNING METHODS FOR BCI	2	1either or	1(2)-CO4	1(2)-CO4	1either or (16)-CO4	-
Unit-V: APPLICATIONS OF BCI	2	1either or	1(2)-CO5	1(2)-CO5	1either or (16)-CO5	-
Total Qns. Title	10	5either or	5(2)	5(2) 3 either or (16)	2 either or (16)	-

Total Marks	20	80	10	58	32	-
Weightage	20%	80%	10%	58%	32%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

MX22213	GENETIC ALGORITHMS AND FUZZY LOGICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To provide basic knowledge about the fundamentals of genetic algorithm
- To familiarize with the ant colony and particle swam optimization techniques
- To learn the basics of fuzzy logic
- To enrich the students' knowledge with fuzzy systems and its applications
- To lean the neuro fuzzy system and fuzzy logic controller

UNIT I	GENETIC ALGORITHMS	9

Introduction, Building block hypothesis, working principle, Basic operators and Terminologies like individual, gene, encoding, fitness function and reproduction, Genetic modeling:, Significance of Genetic operators, Inheritance operator, cross over, inversion & deletion, mutation operator, Bitwise operator, GA optimization problems, Applications of GA.

UNIT II	OTHER OPTIMIZATION TECHNIQUES	9

Ant Colony Optimization: Introduction – From real to artificial ants- Theoretical considerations – Particle Swarm Optimization-:Introduction – Principles of bird flocking and fish schooling – Evolution of PSO – Operating principles – PSO Algorithm.

UNIT III	FUZZY LOGIC	9

Introduction to Fuzzy Logic, Classical and Fuzzy Sets, Membership Function, Operations on Fuzzy Sets, Fuzzy Arithmetic, Compliment, Intersections, Unions, Fuzzy Relation

UNIT IV	FUZZY RULE BASED SYSTEM	9

Linguistic Hedges. Rule based system, Fuzzification and Defuzzification, Fuzzy inference systems - Mamdani and Sugeno model, Fuzzy clustering- fuzzy c- means algorithm- fuzzy control method-fuzzy decision making.

UNIT V	ADVANCES AND APPLICATIONS	9

Case studies: Fuzzy logic control of Blood pressure during Anaesthesia, Fuzzy logic application to Biosignals and medical Image processing, Adaptive fuzzy system. Introduction to Neuro-fuzzy logic.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:	Perceive the knowledge in fuzzy logic and Neuro-fuzzy logic
CO2:	Apply genetic algorithm for practical applications
CO3:	Apply suitable optimization algorithm for real time problems
CO4:	Develop decision making and expert system using fuzzy rules and reasoning.
CO5:	Apply the various hybrid soft computing techniques in real time problems

REFERENCES:

1	Marco Dorigo and Thomas Stutzle, "Ant Colony optimization", Prentice Hall of India, New Delhi, 2004
2	David E. Goldberg, "Genetic Algorithms in search, Optimization & Machine Learning", Pearson Education, 2006
3	Kenneth A DeJong,"Evolutionary Computation A Unified Approach", Prentice Hall of India, New Delhi, 2006.
4	H.-J. Zimmermann, "Fuzzy Set Theory and its Applications", Springer Science+Business Media New York, 4th edition, 2001
5	Timothy Ross, "Fuzzy Logic with Engineering Applications", Wiley, 2016
6	EthemAlpaydin, "Introduction to Machine Learning (Adaptive Computation and Machine Learning Series)", MIT Press, 2004

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	-	-	2	2
CO2	1	-	2	2	2	2
CO3	1	-	2	2	2	2
CO4	1	-	2	2	2	2
CO5	1	-	2	2	2	2
CO	1	-	2	2	2	2

Table of Specification for End Semester Question Paper

Unit No.	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: GENETIC ALGORITHMS	2	1either or	1(2)-CO1	1(2)-CO1	-	-
				1either or (16)-CO1		
Unit-II: OTHER OPTIMIZATION TECHNIQUES	2	1either or	1(2)-CO2	1(2)-CO2	-	-
				1either or (16)-CO2		
Unit-III: FUZZY LOGIC	2	1either or	1(2)-CO3	1(2)-CO3	-	-
				1either or (16)-CO3		
Unit-IV: FUZZY RULE BASED	2	1either or	1(2)-CO4	1(2)-CO4	1either or (16)-CO4	-

SYSTEM						
Unit-V: ADVANCES AND APPLICATIONS	2	1either or	1(2)-CO5	1(2)-CO5	1either or (16)-CO5	-
Total Qns. Title	10	5either or	5(2)	5(2) 3 either or (16)	2 either or (16)	-
Total Marks	20	80	10	58	32	-
Weightage	20%	80%	10%	58%	32%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

MX22214	MEDICAL ROBOTICS	L	T	P	C
		3	0	0	3

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

UNIT I	INTRODUCTION TO ROBOTICS	9

Introduction to Robotics, Overview of robot subsystems, Degrees of freedom, configurations and concept of workspace, Dynamic Stabilization. Sensors and Actuators: Sensors and controllers, Internal and external sensors, position, velocity and acceleration sensors, Proximity sensors, force sensors Pneumatic and hydraulic actuators, Stepper motor control circuits, End effectors, Various types of Grippers, PD and PID feedback actuator models.

UNIT II	MANIPULATORS & BASIC KINEMATICS	9

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

UNIT III	SURGICAL ROBOTS	9

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

UNIT IV	REHABILITATION AND ASSISTIVE ROBOTS	9

Pediatric Rehabilitation, Robotic Therapy for the Upper Extremity and Walking, Clinical-

Based Gait Rehabilitation Robots, Motion Correlation and Tracking, Motion Prediction, Motion Replication. Portable Robot for Tele rehabilitation, Robotic Exoskeletons – Design considerations, Hybrid assistive limb. Case Study, Application in Rehabilitation - Interactive Therapy, Bionic Arm

UNIT V	WEARABLE ROBOTS	9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

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

REFERENCES:

1.	Nagrath and Mittal, "Robotics and Control", Tata McGraw Hill, First edition, 2003
2.	Spong and Vidhyasagar, "Robot Dynamics and Control", John Wiley and Sons, First edition, 2008..
3.	Fu.K.S, Gonzalez. R.C., Lee, C.S.G, "Robotics, control", sensing, Vision and Intelligence, Tata McGraw Hill International, First edition, 2008.
4.	Bruno Siciliano, Oussama Khatib, Springer Handbook of Robotics, 1st Edition, Springer, 2008.
5.	Shane (S.Q.) Xie, Advanced Robotics for Medical Rehabilitation - Current State of the Art and Recent Advances, Springer, 2016.
6.	Sashi S Kommu, Rehabilitation Robotics, I-Tech Education and Publishing, 2007.
7.	Jose L. Pons, Wearable Robots: Biomechatronic Exoskeletons, John Wiley & Sons Ltd, England, 2008.
8.	Howie Choset, Kevin Lynch, Seth Hutchinson, "Principles of Robot Motion: Theory, Algorithms, and Implementations", Prentice Hall of India, First edition, 2005.
9.	Philippe Coiffet, Michel Chirouze, "An Introduction to Robot Technology", Tata McGraw Hill, First Edition, 1983
10.	Jacob Rosen, Blake Hannaford & Richard M Satava, "Surgical Robotics: System Applications & Visions", Springer 2011
11.	Jocelyn Troccaz, Medical Robotics, Wiley, 2012
12.	Achim Schweikard, Floris Ernst, Medical Robotics, Springer, 2015

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	-	1	1	1
CO2	1	1	-	1	1	1
CO3	1	1	-	2	1	1
CO4	2	1	-	2	2	1
CO5	2	1	-	1	2	1
CO	1.4	1	-	1.4	1.4	1

Table of Specification for End Semester Question Paper

Unit No.	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: INTRODUCTION TO ROBOTICS	2	1either or	1(2)-CO1	1(2)-CO1	-	-
				1either or (16)-CO1		
Unit-II: MANIPULATORS & BASIC KINEMATICS	2	1either or	1(2)-CO2	1(2)-CO2	-	-
				1either or (16)-CO2		
Unit-III: SURGICAL ROBOTS	2	1either or	1(2)-CO3	1(2)-CO3	-	-
				1either or (16)-CO3		
Unit-IV: REHABILITATION AND ASSISTIVE ROBOTS	2	1either or	1(2)-CO4	1(2)-CO4	1either or (16)-CO4	-
Unit-V: WEARABLE ROBOTS	2	1either or	1(2)-CO5	1(2)-CO5	1either or (16)-CO5	-
Total Qns. Title	10	5either or	5(2)	5(2) 3 either or (16)	2 either or (16)	-
Total Marks	20	80	10	58	32	-
Weightage	20%	80%	10%	58%	32%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

MX22215	BIG DATA MINING AND ANALYTICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the computational approaches to Modeling, Feature Extraction
- To understand the need and application of Map Reduce
- To understand the various search algorithms applicable to Big Data
- To analyze and interpret streaming data
- To learn how to handle large data sets in main memory and learn the various clustering techniques applicable to Big Data.

UNIT I	DATA MINING AND LARGE SCALE FILES	9

Introduction to Statistical modeling – Machine Learning – Computational approaches to modeling – Summarization – Feature Extraction – Statistical Limits on Data Mining - Distributed File Systems – Map-reduce – Algorithms using Map Reduce – Efficiency of Cluster Computing Techniques.

UNIT II	SIMILAR ITEMS	9

Nearest Neighbor Search – Shingling of Documents – Similarity preserving summaries – Locality sensitive hashing for documents – Distance Measures – Theory of Locality Sensitive Functions – LSH Families – Methods for High Degree of Similarities

UNIT III	MINING DATA STREAMS	9

Stream Data Model – Sampling Data in the Stream – Filtering Streams – Counting Distance Elements in a Stream – Estimating Moments – Counting Ones in Window – Decaying Windows .

UNIT IV	LINK ANALYSIS AND FREQUENT ITEMSETS	9

Page Rank –Efficient Computation - Topic Sensitive Page Rank – Link Spam – Market Basket Model – A-priori algorithm – Handling Larger Datasets in Main Memory – Limited Pass Algorithm – Counting Frequent Item sets

UNIT V	CLUSTERING	9

Introduction to Clustering Techniques – Hierarchical Clustering –Algorithms – K-Means – CURE – Clustering in Non -– Euclidean Spaces – Streams and Parallelism – Case Study: Advertising on the Web – Recommendation Systems.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:	Explain the concept Map Reduce technique, Nearest neighbor search and clustering Techniques for solving Big Data problems.
CO2:	Solve Data Intensive Problems using Map Reduce Paradigm and Nearest neighbor search.
CO3:	Interpret data streaming models and processing the data stream.
CO4:	Explain the computations and algorithms associated with link and frequent item set.
CO5:	Design solutions for problems in Big Data by suggesting appropriate clustering techniques

REFERENCES:

1	Jure Leskovec, AnandRajaraman, Jeffrey David Ullman, "Mining of Massive Datasets", Cambridge University Press, 3rd Edition, 2020.

2	Jiawei Han, MichelineKamber, Jian Pei, "Data Mining Concepts and Techniques", Morgan Kaufman Publications, Third Edition, 2012.
3	Ian H.Witten, Eibe Frank "Data Mining – Practical Machine Learning Tools and Techniques", Morgan Kaufman Publications, Third Edition, 2011.
4	David Hand, HeikkiMannila and Padhraic Smyth, "Principles of Data Mining", MIT PRESS, 2001.
5	https://swayam.gov.in/nd2_arp19_ap60/preview.
6	https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/106104189/lec1.Pdf
7	https://examupdates.in/big-data-analytics/.
8	https://www.tutorialspoint.com/big_data_analytics/index.htm
9	https://www.tutorialspoint.com/data_mining/index.htm.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	-	2	2	1
CO2	-	1	2	-	1	-
CO3	1	-	-	-	-	1
CO4	2	1	1	-	-	2
CO5	-	1	2	-	-	-
CO	1.6	1	1.6	2	1.5	2

Table of Specification for End Semester Question Paper

Unit No.	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: DATA MINING AND LARGE SCALE FILES	2	1either or	1(2)-CO1	1(2)-CO1 1either or (16)-CO1	-	-
Unit-II: SIMILAR ITEMS	2	1either or	1(2)-CO2	1(2)-CO2 1either or (16)-CO2	-	-
Unit-III: MINING DATA STREAMS	2	1either or	1(2)-CO3	1(2)-CO3 1either or (16)-CO3	-	-
Unit-IV: LINK ANALYSIS AND FREQUENT ITEMSETS	2	1either or	1(2)-CO4	1(2)-CO4	1either or (16)-CO4	-
Unit-V: CLUSTERING	2	1either or	1(2)-CO5	1(2)-CO5	1either or (16)-CO5	-

Total Qns. Title	10	5either or	5(2)	5(2) 3 either or (16)	2 either or (16)	-
Total Marks	20	80	10	58	32	-
Weightage	20%	80%	10%	58%	32%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

MX22216	TELEHEALTH TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the key principles for telemedicine and health.
- To understand telemedical technology.
- To introduce the knowledge of telemedicine standards.
- To understand m-Health platforms for telemedicine applications.
- To make student understand the applications of health care sectors.

UNIT I	TELEMEDICINE AND HEALTH	9

History and Evolution of telemedicine, Functional diagram of telemedicine system, Telemedicine, Tele health, Tele care, Organs of telemedicine, Global and Indian scenario, International regulations in e-health and telemedicine, Ethical and legal aspects of Telemedicine-Confidentiality, Social and legal issues, Safety and regulatory issues, Advances in Telemedicine.

UNIT II	TELEMEDICAL TECHNOLOGY	9

Principles of Multimedia - Text, Audio, Video, data, Data communications and networks, PSTN, POTS, ANT, ISDN, Internet, Air/ wireless communications: GSM satellite, and Micro wave, Modulation techniques, Types of Antenna, Integration and operational issues, Communication infrastructure for telemedicine – LAN and WAN technology. Satellite communication. Mobile hand held devices and mobile communication. Internet technology and telemedicine using world wide web (www). Video and audio conferencing. Clinical data –local and centralized

UNIT III	TELEMEDICAL STANDARDS SECURITY AND LEGAL ISSUES	9

Data Security and Standards: Encryption, Cryptography, Mechanisms of encryption, phases of Encryption. Protocols: TCP/IP, ISO-OSI, Standards to followed DICOM, HL7, H. 320 series (Video phone based ISBN) T. 120, H.324 (Video phone based PSTN), Video Conferencing, Realtime Telemedicine integrating doctors / Hospitals, Clinical laboratory data, Radiological data, and other clinically significant biomedical data, Administration of centralized medical data, security and confidentially of medical records and access control, Cyber laws related to telemedicine..

UNIT IV	m-HEALTH AND TELEMEDICINE	9

Mobile Devices : Smart phones, Tablet PCs, iPads, PDAs, Wearable computers – m-Health

technology and communication infrastructure - Healthcare Apps – m-Health applications: Education and awareness, Remote data collection, Remote monitoring, Communication and training for healthcare workers, Disease and epidemic outbreak tracking, Diagnostic and treatment support – m-Health and the Transformation of Clinical Trials - Harnessing data, advanced analytics, and the Internet of Things to optimize digitized clinical trials, Challenges of m Health.

UNIT V	TELEMEDICAL APPLICATIONS	9

Telemedicine access to health care services – health education and self-care. • Introduction to robotics surgery, telesurgery. Telecardiology, Teleoncology, Telemedicine in neurosciences, Electronic Documentation, e-health services security and interoperability., Telemedicine access to health care services– health education and self-care, Business aspects - Project planning and costing, Usage of telemedicine. Telemedicine and in loco assistance of patients, Interactive videoconferencing consults, Store and forward consults, Remote monitoring and home care.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:	Describe the key principles of telemedicine and e-health.
CO2:	Understand telemedical technology
CO3:	Demonstrate telemedical standards and legal issues
CO4:	Design and develop m-Health platforms for telemedical applications
CO5:	Acquire knowledge of telemedicine applications to health care sectors

REFERENCES:

1	Wootton, R., Craig, J., Patterson, V. (Eds.), Introduction to Telemedicine. Royal Society of Medicine Press Ltd (ISBN 1853156779), 2006.
2	Teresa L. Thompson, Roxanne Parrott, Jon F. Nussbaum, TheRoutledge Handbook of Health Communication, Routledge, 2011.
3	David Dagan Feng, Biomedical Information Technology, Academic Press Series in Biomedical Engineering, Elsevier Inc, USA, 2008.
4	Ilias G. Maglogiannis, Kostas Karpouzis and Manolis Wallace, Image and Signal Processing for Networked E-Health Applications, Morgan & Claypool Publishers' series, USA, 2006.
5	Bernard Fong, A.C.M. Fong, C.K. Li, Telemedicine Technologies: Information Technologies in Medicine and Telehealth, Wiley, 2011.
6	Bemmel, J.H. van, Musen, M.A. (Eds.) (1997). Handbook of Medical Informatics. Heidelberg, Germany: Springer. (ISBN 3-540-63351-0).
7	Ferrer-Roca, O., Sosa-Iudicissa, M. (editors), Handbook of Telemedicine. IOS Press (Studies in Health Technology and Informatics, Volume 54). (ISBN 90-5199-413-3), 2002.
8	Magnuson, J.A., Fu, Jr., Paul C. (Eds.), Public Health Informatics and Information systems, ISBN 978-1-4471-4237-9, Springer, 2014.
9	Simpson, W. 2006. Video over IP. A practical guide to technology and applications. Focal Press (Elsevier). ISBN-10: 0-240-80557-7.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	-	1	1	1
CO2	1	1	-	1	1	1
CO3	1	1	-	1	1	1
CO4	1	1	-	2	2	1
CO5	2	1	-	2	2	1
CO	1.2	1	-	1.4	1.4	1

Table of Specification for End Semester Question Paper

Unit No.	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: TELEMEDICINE AND HEALTH	2	1either or	1(2)-CO1	1(2)-CO1 1either or (16)-CO1	-	-
Unit-II: TELEMEDICAL TECHNOLOGY	2	1either or	1(2)-CO2	1(2)-CO2 1either or (16)-CO2	-	-
Unit-III: TELEMEDICAL STANDARDS SECURITY AND LEGAL ISSUES	2	1either or	1(2)-CO3	1(2)-CO3 1either or (16)-CO3	-	-
Unit-IV: m-HEALTH AND TELEMEDICINE	2	1either or	1(2)-CO4	1(2)-CO4	1either or (16)-CO4	-
Unit-V: TELEMEDICAL APPLICATIONS	2	1either or	1(2)-CO5	1(2)-CO5	1either or (16)-CO5	-
Total Qns. Title	10	5either or	5(2)	5(2) 3 either or (16)	2 either or (16)	-
Total Marks	20	80	10	58	32	-
Weightage	20%	80%	10%	58%	32%	-

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

SEMESTER II, PROFESSIONAL ELECTIVE – III

MX22221	HEALTH CARE, HOSPITAL AND EQUIPMENT MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To develop an understanding of the various setups of hospital, health care codes and equipment management
- To enable the student to work in the hospital environment

UNIT I	HEALTH SYSTEM	9

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

UNIT II	HOSPITAL ORGANIZATION AND MANAGEMENT	9

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

UNIT III	REGULATORY REQUIREMENT AND HEALTH CARE CODES	12

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

UNIT IV	TRAINED TECHNICAL PERSONNEL	9

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

UNIT V	EQUIPMENT MAINTENANCE MANAGEMENT	9

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

TOTAL 45 PERIODS

COURSE OUTCOMES:

Upon Completion of the course, the students will be able to:

CO1:	Explain the basics about Health system and their services
CO2:	Illustrate the organization structure in hospitals
CO3:	Explain the regulation of health care codes
CO4:	Plan the duties of technical personnel
CO5:	Establish Health system and hospital organization.
CO6:	Analyze the standards and the training required for technical work for equipment Management.

REFERENCES:

1.	R.C. Goyal, Human Resource Management in Hospital, Prentice Hall of India, 7th Edition, 2017.
2.	Cesar A. Caceres and Albert Zara, The Practice of Clinical Engineering, Academic Press, New York, 1977.
3.	Webster. J. G. and Albert M. Cook, Clinical Engineering Principles and Practices Prentice Hall Inc., Englewood Cliffs, New Jersey, 1979.
4.	Hans Pfeiff, Vera Dammann (Ed.), Hospital Engineering in Developing Countries, Z Report, Eschbom, 1986.
5.	Jacob Kline, Handbook of Bio Medical Engineering, Academic Press Inc. San Deigo 1988.
6.	Syed Amin Tabish, Hospital and Health Services Administration Principles and Practices Oxford Press New Delhi 2001.
7.	G D Kunders, Hospitals, Facilities planning and Management, Tata McGraw Hill Education Private Ltd, New Delhi 2004.
8.	Joseph F. Dyro, "Clinical Engineering Handbook", Elsevier Academic Press, 2004
9.	B.M.Sakharkar,"Principles of Hospital Administration", Jaypee Brothers Medical Publishers, 2nd Edition, 2014.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	-	2	1	-
CO2	1	-	-	1	1	-
CO3	1	-	-	1	2	1
CO4	1	-	-	1	2	1
CO5	1	-	-	1	1	1
CO6	1	-	2	2	2	2
CO	**1**	**-**	**0.33**	**1.33**	**1.5**	**0.83**

Table of Specification for End Semester Question Paper

Unit No.	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: HEALTH SYSTEM	2	1either or	1(2)-CO1	1(2)-CO1 1either or (16)-CO1	-	-
Unit-II: HOSPITAL ORGANIZATION AND MANAGEMENT	2	1either or	1(2)-CO2	1(2)-CO2 1either or (16)-CO2	-	-

Unit-III: REGULATORY REQUIREMENT AND HEALTH CARE CODES	2	1either or	1(2)-CO3	1(2)-CO3 1either or (16)-CO3	-	-
Unit-IV: TRAINED TECHNICAL PERSONNEL	2	1either or	1(2)-CO4	1(2)-CO4	1either or (16)-CO4	-
Unit-V: EQUIPMENT MAINTENANCE MANAGEMENT	2	1either or	1(2)-CO5	1(2)-CO5	1either or (16)-CO5	-
Total Qns. Title	10	5either or	5(2)	5(2) 3 either or (16)	2 either or (16)	-
Total Marks	20	80	10	58	32	-
Weightage	20%	80%	10%	58%	32%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

MX22222	ULTRA SOUND IN MEDICINES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand ultrasound principles and explain the basic physical properties of ultrasound.
- To describe the indications of ultrasound, particularly in the evaluation of disease.
- To describe the advantages and limitations of Ultrasound compared to other imaging modalities.
- To describe various types of ultrasound-guided diagnostic and therapeutic procedures.
- To describe the normal ultrasound anatomy of various organs and recognize the ultrasound characteristics of various pathologic conditions

UNIT I	INTRODUCTION	9

History - Role of Ultrasound in Medical Imaging - Stress And Strain Relationships – Acoustic Wave Equation - Acoustic Properties of Biological Tissues - Doppler Effect - Continuous mode and pulsed mode. Measurement of ultrasonic energy, Manipulation of ultrasonic beam – Beam profile and intensity distribution in different axes.

UNIT II	ULTRASOUND TRANSDUCERS	9

Piezoelectric Effect - Properties of Important Piezoelectric Materials – Ultrasonic Transducers - Acoustic Properties of Transducer Materials - Transducer Beam Characteristics.

UNIT III	GRAY-SCALE ULTRASONIC IMAGING	9

A (Amplitude)-Mode - B (Brightness)-Mode Imaging - Beam Forming -Speckle - Image Quality - M-Mode - C-Mode - Ultrasound Computed Tomography.Scan converters, Signal processing, signal controls- TGC, Flares and acoustic shadows, artefact..

UNIT IV	DOPPLER FLOW MEASUREMENTS	9

Non-directional CW Flow Meters - Directional Doppler Flow Meters – Pulsed Doppler Flow Meters - Techniques for direction detection – Envelope Fluctuation Methods, Phase Tracking Methods - Clinical Applications And Doppler Indices - fetal heart rate detection, blood flow detection using Doppler signal and imaging technique. Color Doppler Flow Imaging - Elasticity Imaging.

UNIT V	BIOLOGICAL EFFECTS AND APPLICATIONS	9

Acoustic Phenomena at High-Intensity Levels – Ultrasound Bioeffects: Mechanical Effects and Index - Ultrasound Therapy - Hyperthermia - High-Intensity Focused Ultrasound - - Lithotripsy -Diagnostic Ultrasound Imaging. Ultrasonic diagnosis in Abdomen, Breast, Thyroid, Heart, Chest, Eye, Kidney, Skull, Pregnant and Non Pregnant uterus, 3-Dimensional Ultrasonic Imaging of the Fetus, Advantages and Limitations of 3-Dimensional Ultrasound, Machine Learning–Assisted ultrasound Diagnostic System for Thyroid Nodules, Detection of Pancreatic Cancer in Endoscopic Ultrasonography.

TOTAL 45 PERIODS

COURSE OUTCOMES:

Upon Completion of the course, the students will be able to:

CO1:	Identify and use appropriate transducers based on their characteristics
CO2:	Explain the basic principle of Ultrasound for biomedical engineering
CO3:	Demonstrate bio effects of ultrasound waves
CO4:	Explore the principles of gray scale imaging and doppler flow Measurements
CO5:	Apply the principle of ultrasound in flow measurements and gray scale Imaging

REFERENCES:

1	Brain M Dale, Mark A. Brown, Richard C. Semelka , "MRI Basic Principles and Applications" , John Wiley & Sons, Oxford, Fifth Edition, 2015.
2	Vincent Perrin, "MRI Techniques", John Wiley & Sons, USA, 2013.
3	Catherine Westbrook, "Handbook of MRI Technique", John Wiley & Sons, Oxford, 2013.
4	Govind B Chavhan , "MRI made easy (for Beginners)", Jaypee, New Delhi, 2013.
5	M.A.Flower, Webb's Physics of Medical Imaging, 2nd Edition, CRC Press ,Boca Raton, FL, 2012

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	-	2	2	1
CO2	-	1	2	-	1	-
CO3	1	-	2	2	-	1
CO4	2	1	1	-	-	2
CO5	-	1	2	-	-	-
CO	1.6	1	1.8	2	1.5	2

Table of Specification for End Semester Question Paper

Unit No.	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: INTRODUCTION	2	1either or	1(2)-CO1	1(2)-CO1	-	-
				1either or (16)-CO1		
Unit-II: ULTRASOUND TRANSDUCERS	2	1either or	1(2)-CO2	1(2)-CO2	-	-
				1either or (16)-CO2		
Unit-III: GRAY-SCALE ULTRASONIC IMAGING	2	1either or	1(2)-CO3	1(2)-CO3	-	-
				1either or (16)-CO3		
Unit-IV: DOPPLER FLOW MEASUREMENTS	2	1either or	1(2)-CO4	1(2)-CO4	1either or (16)-CO4	-
Unit-V: BIOLOGICAL EFFECTS AND APPLICATIONS	2	1either or	1(2)-CO5	1(2)-CO5	1either or (16)-CO5	-
Total Qns. Title	10	5either or	5(2)	5(2) 3 either or (16)	2 either or (16)	-
Total Marks	20	80	10	58	32	-
Weightage	20%	80%	10%	58%	32%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

MX22223	BIO ETHICS AND STANDARDS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

UNIT I	INTRODUCTION TO MEDICAL ETHICS	8

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

UNIT II	ETHICAL THEORIES & MORAL PRINCIPLES	9

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

UNIT III	HOSPITAL ACCREDITATION STANDARDS	9

Accreditation- JCI Accreditation & its Policies. Patient Organization management standards

UNIT IV	HOSPITAL SAFETY STANDARDS	10

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

UNIT V	MEDICAL EQUIPMENT SAFETY STANDARDS	9

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

TOTAL 45 PERIODS

COURSE OUTCOMES:

Upon Completion of the course, the students will be able to:

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

REFERENCES:

1	Domiel A Vallero, Biomedical Ethics for Engineers, Elsevier Pub.1st edition, 2007.
2	Johnna Fisher, Biomedical Ethics: A Canadian Focus., Oxford University Press Canada, 2009.
3	Robert M Veatch, The Basics of Bio Ethics, 4th Edition. Routledge, 2019.
4	Physical Environment Online: A Guide to The Joint Commission's Safety Standards is published by HCPro, Inc. 2010.
5	Joint Commission Accreditation Standards for Hospitals, 7th Edition 2020.
6	Ben Mepham, Bioethics-An Introduction for the biosciences, 2nd Edition, Oxford University Press, 2013.
7	Nils Hoppe and Jose Miola - Medical law and Medical Ethics - Cambridge University Press- 2014.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	1	2	1	2	1
CO2	2	2	1	1	1	1
CO3	2	1	2	1	2	2
CO4	1	1	2	2	2	1
CO5	1	1	2	2	2	1
CO	1.6	1.2	1.8	1.4	1.8	1.2

Table of Specification for End Semester Question Paper

Unit No.	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: Introduction To Medical Ethics	2	1either or	1(2)-CO1	1(2)-CO1	-	-
				1either or (16)-CO1		
Unit-II: Ethical Theories & Moral Principles	2	1either or	1(2)-CO2	1(2)-CO2	-	-
				1either or (16)-CO2		
Unit-III: Hospital Accreditation Standards	2	1either or	1(2)-CO3	1(2)-CO3	-	-
				1either or (16)-CO3		
Unit-IV: Hospital Safety Standards	2	1either or	1(2)-CO4	1(2)-CO4	1either or (16)-CO4	-
Unit-V: Medical Equipment Safety Standards	2	1either or	1(2)-CO5	1(2)-CO5	1either or (16)-CO5	-
Total Qns. Title	10	5either or	5(2)	5(2) 3 either or (16)	2 either or (16)	-
Total Marks	20	80	10	58	32	-
Weightage	20%	80%	10%	58%	32%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

MX22224	MEDICAL DEVICE STANDARDS AND REGULATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- Explain standards and safety aspects of medical devices.
- Illustrate the hospital safety standards and maintenance.
- Develop the medical equipment safety standards.
- Prepare medical device regulations.
- Establish medical device risk assessment and regulatory requirements

UNIT I	STANDRADS AND SAFETY	9

Quality management system for medical devices (ISO 9001 and ISO13485), safety and standardization for risk management (ISO 14971), European standard conformity (CE marking), FDA guidelines for medical devices approval and classification based on risk assessment.

UNIT II	HOSPITAL SAFETY STANDARDS	9

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

UNIT III	MEDICAL EQUIPMENT ESSENTIAL REQUIREMENTS	9

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

UNIT IV	MEDICAL DEVICE REGULATION	9

Medical device and in vitro diagnostics: Introduction & types of devices including combination devices. Medical Device Rules, 2017: Implications on medical devices. Classification of medical

UNIT V	MEDICAL DEVICE RISK ASSESSMENT	9

Inspection of medical device and IVD establishments. ISO 14971 (Medical devices: Application of risk management to medical devices). Regulatory requirements of biocompatibility of medical devices and ISO 10993. Clinical investigation of medical devices, regulation of investigational medical devices. Medical device regulation: International practices.

TOTAL 45 PERIODS

COURSE OUTCOMES:

Upon Completion of the course, the students will be able to:

CO1:	Explain the key point in standard and safety of medical devices
CO2:	Familiarize the process and procedures of hospital safety and standards.
CO3:	Apply the knowledge of hospital safety and standards in medical equipment
CO4:	Analyze the device regulation and its types.
CO5:	Survey medical device risk assessment

REFERENCES:

1	Seeram Ramakrishna, Lingling Tian, Charlene Wang, Susan Liao, Wee Eong Teo, Medical Devices Regulations, Standards and Practice, Wood head Publishing, 1st Edition, 2015.

2	Joint Commission International Accreditation Standards for Hospitals, Joint Commission International, 7th Edition, 2021.
3	Joseph D. Nally (ed.), Good Manufacturing Practices for Pharmaceuticals, CRC Press sixth edition, 2007.
4	https://nptel.ac.in/courses/127106136.
5	MDR17, Regulation of Medical Devices.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	1	1	1	2
CO2	1	2	1	2	1	2
CO3	1	2	1	1	1	2
CO4	1	2	1	1	1	2
CO5	1	2	1	1	1	2
CO	**1**	**2**	**1**	**1.8**	**1**	**2**

Table of Specification for End Semester Question Paper

Unit No.	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: STANDRADS AND SAFETY	2	1either or	1(2)-CO1	1(2)-CO1	-	-
				1either or (16)-CO1		
Unit-II: HOSPITAL SAFETY STANDARDS	2	1either or	1(2)-CO2	1(2)-CO2	-	-
				1either or (16)-CO2		
Unit-III: MEDICAL EQUIPMENT ESSENTIAL REQUIREMENTS	2	1either or	1(2)-CO3	1(2)-CO3	-	-
				1either or (16)-CO3		
Unit-IV: MEDICAL DEVICE REGULATION	2	1either or	1(2)-CO4	1(2)-CO4	1either or (16)-CO4	-
Unit-V: MEDICAL DEVICE RISK ASSESSMENT	2	1either or	1(2)-CO5	1(2)-CO5	1either or (16)-CO5	-
Total Qns. Title	10	5either or	5(2)	5(2) 3 either or (16)	2 either or (16)	-
Total Marks	20	80	10	58	32	-

| Weightage | 20% | 80% | 10% | 58% | 32% | - |

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

MX22225	TISSUE ENGINEERING AND IMMUNO ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand basics of tissue engineering
- To learn basics of cell mechanics in tissue engineering
- To know the importance of biomaterials in tissue engineering
- To understand basics of Immunology
- To understand the importance of applied immunology for therapy

UNIT I	INTRODUCTION TO TISSUE ENGINEERING	9

History and scope of tissue engineering – Scientific and Social Challenges - Structure and organization of Tissues – Development of Tissue – Cell and Extracellular matrix interaction – Morphogenesis and Tissue Engineering – Cell Determination and Differentiation..

UNIT II	FUNDAMENTALS OF CELL MECHANISMS	9

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

UNIT III	BIOMATERIALS IN TISSUE ENGINEERING	9

Data Security and Standards: Encryption, Cryptography, Mechanisms of encryption, phases Biological vs Nonbiological materials – Extra Cellular Matrix – Collagen, Chitin & Degradable and Nondegradable materials – Polymer, Ceramics and Metals – Cell interaction with different materials –- Scaffolds - Control releaser agents in Tissue Engineering – Cell interaction with suspension and gels – Tissue response to implants.

UNIT IV	INTRODUCTION TO IMMUNOLOGY	9

Introduction of Immunology – Antigen; Antibody; Cytokine; Heparin; Histamine; Innate and Adaptive Immunity. Immune Recognition – Immune Effectors function – Immune Regulation – Immune memory. Introduction of Stem cells - Induced Pluripotent Stem cells- Stem cell identification - Surface markers & FACS analysis..

UNIT V	APPLIED IMMUNOLOGY	9

Introduction – Inflammation – microorganisms survival strategies – Vaccines – Newer approaches to vaccine development – Immunization against cancer – Immune Responses– Pathogens, Cancer and Biomaterials. Immunotherapy

	TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:	Define the statement of tissue engineering in healthcare
CO2:	Explain the invitro organization of tissue culture

CO3:	Explain different methods involved in characterization and preparation of biomaterials in tissue engineering
CO4:	Explain different types of stem cells and its application in tissue engineering
CO5:	Explain the basics of immunology in human being

REFERENCES:	
1	R.Lanza, J.Gearhart et.al,(Eds), Essential of Stem cell Biology, Elsevier Academic Press, 2nd edition 2009.
2	Robert P. Lanza, Robert Langer and Joseph Vacanti., Principles of Tissue Engineering, 2nd Edition, Academic press, Elsevier 2013.
3	Gary E Wnek, Gary L Browlin – Encyclopedia of Biomaterials and Biomedical Engineering – Marcel Dekker Inc New York, 2nd edition, 2008..
4	SujataV.Bhatt, Biomaterials (2nd Edition), Narosa Publishing House, 2005.
5	W. Mark Saltzman Tissue Engineering – Engineering Principles for Design of Replacement Organs and Tissue, Oxford University Press Inc. New York, 2004.
6	Peter J Delves, Seamus J Martin, Dennis R Burtn and Ivan M Roitt., Roitts Essential Immunology, 13th Edition, Wiley –Blackwell, 2016.
7	Judith a Owen, Jenni Punt and Sharon A Stranford, Kuby Immunology, Macmillan Internation, 7th Edition, 2012.
8	Ananthanarayan and Paniker. Textbook of Microbiology, Eleventh Edition. Himayatnagar, Hyderabad : Orient Longman.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	2	2	2
CO2	1	1	1	2	2	2
CO3	1	1	1	2	2	2
CO4	1	1	1	2	2	2
CO5	1	1	1	2	2	2
CO	1	1	1	2	2	2

Table of Specification for End Semester Question Paper

Unit No.	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: INTRODUCTION TO TISSUE ENGINEERING	2	1either or	1(2)-CO1	1(2)-CO1 1either or (16)-CO1	-	-
Unit-II: FUNDAMENTALS OF CELL MECHANISMS	2	1either or	1(2)-CO2	1(2)-CO2 1either or (16)-CO2	-	-

Unit-III: BIOMATERIALS IN TISSUE ENGINEERING	2	1either or	1(2)-CO3	1(2)-CO3 1either or (16)-CO3	-	-
Unit-IV: INTRODUCTION TO IMMUNOLOGY	2	1either or	1(2)-CO4	1(2)-CO4	1either or (16)-CO4	-
Unit-V: APPLIED IMMUNOLOGY	2	1either or	1(2)-CO5	1(2)-CO5	1either or (16)-CO5	-
Total Qns. Title	10	5either or	5(2)	5(2) 3 either or (16)	2 either or (16)	-
Total Marks	20	80	10	58	32	-
Weightage	20%	80%	10%	58%	32%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

MX22226	**MEDICAL ELECTRONICS DEVICE DESIGN**	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To explore the concepts in designing power systems for medical electronics.
- To interpret the essential circuitry needed for sensor design.
- To develop an understanding of data acquisition system design.
- To provide knowledge about noise cancellation system
- To gain necessary knowledge about the hardware implementation of DSP

UNIT I	**DESIGN OF POWER SUBSYSTEMS IN MEDICAL ELECTRONICS**	9

Transient voltage protections- Electromagnetic interference- Inrush current control- Overvoltage protection- Under voltage protection- Overload protection- Output filtering- Power failure warning- Flightback switch back power supplies- Half-bridge Flyback converters.

UNIT II	**SENSOR DESIGN FUNDAMENTALS**	9

Sensor parameters- Sensor Interfacing- Signal conditioning amplifiers- Instrumentation amplifiers- Isolation amplifiers- Charge-coupled device sensors- Position and motion sensors- Accelerometers- Temperature sensors- Fiber optics based medical sensors, Applications.

UNIT III	**DATA ACQUISITION SYSTEMS**	9

Sample and hold conversion- Multichannel acquisition- High speed sampling in ADC- Selection of drive amplifier for ADC performance- Driving ADCs with switched capacitor inputs- ADC input protection- External protection of amplifiers- High speed ADC architectures

UNIT IV	**NOISE AND INTERFERENCE ISSUES IN ANALOG CIRCUITS**	9

Noise calculations in Op-Amp- Internal noise in Op-Amps- Proper power supply decoupling-

Bypass capacitors and resonances- Designing power bus rails in power-ground planes for noise control- ASIC.

UNIT V	HARDWARE APPROACH TO DIGITAL SIGNAL PROCESSING	9

DSP hardware- Arithmetic logic unit- Multiplier-accumulator- Shifter- Data address generators- Program sequencer- Serial ports- Interfacing ADCs and DACs to digital signal processors- Parallel ADCs o DSP interface- Parallel DAC to DSP interface- Serial interfacing to DSP processors.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1:	Explain the power systems used in the design of medical electronics devices
CO2:	Classify the biosensors design according the type of device
CO3:	Interpret the data acquired from the sensors.
CO4:	Infer the concept noise and interference issues in the devices.
CO5:	Analyze signal processing of the medical electronic device using hardware implementation of DSP.

REFERENCES:

1	Kunal Pal, Heinz-Bernhard Kraatz, Anwesha Khasnobish, Bioelectronic and medical devices, Elsevier, 2019.
2	Rüdiger Kramme, Klaus-Peter Hoffmann, Robert Steven Pozos, Springer handbook of medical technology, Springer, 2011.
3	Reinaldo Perez, Design of medical electronic devices, Academic press, 2002.
4	David prutchi, Michael Norris, Design and Development of Medical electronic instrumentation, Wiley interscience, 2005.
5	Dennis Fitzpatrick, Implantable electronic medical devices, Elsevier, 2015.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	2	1	2	2	1
CO2	2	2	2	1	2	1
CO3	2	2	2	1	1	1
CO4	2	2	1	1	2	2
CO5	2	2	2	2	2	2
CO	**2**	**2**	**1.6**	**1.4**	**1.8**	**1.4**

Table of Specification for End Semester Question Paper

Unit No.	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: DESIGN	2	1either	1(2)-CO1	1(2)-CO1	-	-

OF POWER SUBSYSTEMS IN MEDICAL ELECTRONICS		or		1either or (16)-CO1		
Unit-II: SENSOR DESIGN FUNDAMENTALS	2	1either or	1(2)-CO2	1(2)-CO2 1either or (16)-CO2	-	-
Unit-III: DATA ACQUISITION SYSTEMS	2	1either or	1(2)-CO3	1(2)-CO3 1either or (16)-CO3	-	-
Unit-IV: NOISE AND INTERFERENCE ISSUES IN ANALOG CIRCUITS	2	1either or	1(2)-CO4	1(2)-CO4	1either or (16)-CO4	-
Unit-V: HARDWARE APPROACH TO DIGITAL SIGNAL PROCESSING	2	1either or	1(2)-CO5	1(2)-CO5	1either or (16)-CO5	-
Total Qns. Title	10	5either or	5(2)	5(2) 3 either or (16)	2 either or (16)	-
Total Marks	20	80	10	58	32	-
Weightage	20%	80%	10%	58%	32%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

SEMESTER III, PROFESSIONAL ELECTIVES – IV

MX22311	BIOMEMS AND ARTIFICIAL ORGANS	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To understand the basics with current advancement and challenges associated with operations.
- To understand the uses of bio instrumentation, processes for micro electro mechanical systems and their applications in the biomedical areas.
- To give a basic idea of the artificial organs that can aid a human to live a normal life.
- To comprehend the processes and challenges involved in implants and prosthesis using alloys.
- To determine and selection of right materials for its bio applications.

UNIT I	INTRODUCTION	9

Historical perspective, Development of MEMS Technology, MEMS Technology: Present, Future and Challenges, MEMS Applications, Comparison of MEMS and Microelectronics.

UNIT II	SENSORS AND ACTUATORS	9

MEMS Actuators, MEMS Sensing, Electron Tunneling, Sensor Noise, MEMS Physical Sensors, MEMS Chemical Sensors, Classification of Physical Sensors, Integrated, Intelligent or Smart sensors, Bio Sensing Principles and Sensing Methods, Biosensors Arrays and Implantable devices.

UNIT III	ARTIFICIAL ORGANS / IMPLANTS	9

Artificial Heart, Prosthetic Cardiac Valves, Artificial lung (oxygenator), Artificial Kidney (Dialyser membrane) – Wearable artificial kidney, Dental Implants. Artificial Organs design and simulation – Case study – Design of artificial pancreas.

UNIT IV	REPLACEMENT DEVICES FOR RESPIRATORY AND DIGESTIVE SYSTEM	9

Artificial lung versus natural lung – Lung replacement devices - Tracheal replacement devices - Laryngeal replacement devices - Artificial esophagus - Liver functions: Hepatic failure, Liver support systems, General replacement of liver functions – Endocrine pancreas and insulin secretion - Diabetes - Insulin therapy - Insulin administration systems.

UNIT V	TISSUE REPLACEMENT IMPLANTS	9

Soft-tissue replacements, sutures, surgical tapes, adhesive, and Dental implants - Fracture plates - Joint and Spinal replacement - Artificial skin: Current treatment for skin loss, Design principles for skin replacement - Ear and Eye implants.

	45 PERIODS
PRACTICAL EXERCISES:	**30 PERIODS**

1. Simulation of structures for MEMS sensors.
2. Designing of MEMS based accelerometer.
3. Modeling and simulation of MEMS biosensor.
4. Designing of micro cantilever for medical application.
5. Modeling and simulation of chemical sensor.
6. Modeling and simulation of prosthetic heart valves.
7. Modeling and simulation of dialyzer membrane for hemodialysis.
8. Modeling and stress analysis of dental implants.
9. Modeling and simulation of artificial joints.
10. Designing of bone plates and comparison of its mechanical properties with selected biocompatible materials

	TOTAL :75 PERIODS

COURSE OUTCOMES:

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

CO1:	Explain the basics of MEMs technology with current advancement and challenges associated with operations.
CO2:	Illustrate the characteristics of MEMs Physical and chemical sensor.
CO3:	Explain the artificial organs that can aid a human to live a normal life.
CO4:	Show the processes and challenges involved in replacement devices for respiratory and digestive system.
CO5:	Interpret the biomaterials for implants, soft and hard tissue replacements.

REFERENCES:

1.	BioMEMS and Biomedical Nanotechnology, volume III Tejaldesai, sangetha Bhatia.
2.	Gerald Miller, "Artificial Organs", Morgan and Claypool Publisher, Narosa Publishing

	HouseWilliston, 2006.
3.	Wanjun Wang, Stephen A.Soper, BioMEMS: Technologies and Applications, CRC Press, New York, 2007.
4.	Joseph D, Bronzino, Donald R. Peterson, "The biomedical engineering handbook", CRC Press Taylor and Francis, 2015.
5.	Subrata Pal,''Design of Artificial human joints and Organs'',2014.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	ProgrammeOutcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	1	2	2	1
CO2	1	1	-	1	2	1
CO3	2	2	2	1	2	1
CO4	1	2	2	2	2	1
CO5	1	1	2	2	2	1
CO	1	1.6	1.4	1.6	2	1

Table of Specification for End Semester Question Paper

Unit No.	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: INTRODUCTION	2	1either or	2(2)-CO1	1either or (16)-CO1	-	-
Unit-II: SENSORS AND ACTUATORS	2	1either or	2(2)-CO2	1either or (16)-CO2	-	-
Unit-III: ARTIFICIAL ORGANS / IMPLANTS	2	1either or	1(2)-CO3	1(2)-CO3 1either or (16)-CO3	-	-
Unit-IV: REPLACEMENT DEVICES FOR RESPIRATORY AND DIGESTIVE SYSTEM	2	1either or	1(2)-CO3	1(2)-CO3 1either or (16)-CO4	1either or (16)-CO4	-
Unit-V: TISSUE REPLACEMENT IMPLANTS	2	1either or	1(2)-CO3	1(2)-CO5 1either or (16)-CO5		-
Total Qns.	10	5either or	7(2)	3(2) 4 either or (16)	1 either or (16)	-
Total Marks	20	80	14	70	16	-
Weightage	20%	80%	14%	70%	16%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

MX22312	PHYSIOLOGICAL MODELING	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To identify the general principles for modeling and simulating a system.
- To apply these principles when designing mathematical models for a number of realistic systems.
- To model the dynamic systems.
- To analyze models for cardio, pulmonary and respiration activities.
- To implement and use computer based modeling and simulation for studying physiological systems.

UNIT I	INTRODUCTION	9

Introduction to physiological system and mathematical modeling of physiological system, classification of model – gray box & black box, parametric & non parametric, lumped & distributed models, linear & non-linear, characteristics of models. Purpose of physiological modelling and signal analysis, linearization of nonlinear models. Engineering system and physiological system, System variables & properties- Resistance, Compliance & their analogy.

UNIT II	DYNAMIC PHYSIOLOGICAL SYSTEM	9

Dynamic systems and their control, modeling and block diagrams, Types of Eye movement, Eye movement system and Wetheimer's saccadic eye model. Robinson's Model, Oculomotor muscle model, Linear Reciprocal Innervations Oculomotor Model. Open &close loop systems instability, automatic aperture control.

UNIT III	NON LINEAR MODELS	9

Nonparametric Modeling-Volterra Models. Wiener Models. Efficient Volterra Kernel Estimation. Parametric Modeling- Basic Parametric Model Forms and Estimation Procedures- Volterra Kernels of Nonlinear Differential Equations. Discrete-Time Volterra Kernels of NARMAX Model.

UNIT IV	CARDIO, PULMONARY AND RESPIRATORY MODELING	9

Cardiovascular system and pulmonary mechanics modeling and simulation, Model of Cardiovascular Variability, Model of Circadian Rhythms. Respiratory mechanics & muscle mechanics. Voltage clamp experiment - Hodgkin and Huxley's model of action potential, model for strength-duration curve, model of the whole neuron.

UNIT V	SIMULATION OF PHYSIOLOGICAL SYSTEMS	9

Simulation of physiological systems using OpenCV / MATLAB software. Biological receptors: - Introduction, receptor characteristics, transfer function models of receptors.

	45 PERIODS
PRACTICAL EXERCISES	**30 PERIODS**
LIST OF EXPERIMENTS	

1. Design Lumped and Distributed SIMULINK model for simple lung mechanism.

2.	Design a SIMULINK model for steady-state analysis of muscle stretch reflex.
3.	Design a SIMULINK model for steady-state respiratory control.
4.	Design a SIMULINK model of neuromuscular reflex models
5.	Design a SIMULINK model to compute frequency response of linearized lung mechanics model.
6.	Design a SIMULINK model to compute frequency response of glucose-insulin regulation (Stolwijk and Hardy model).
7.	Design a SIMULINK model for respiratory sinus arrhythmia (Saul model).
8.	Design a SIMULINK model of simplified and linearized version of Hodgkin-Huxley model.
9.	Design a SIMULINK model for cardiovascular variability. (stroke volume constant)
10.	Design a SIMULINK model for cardiovascular variability. (stroke volume variable)

TOTAL :75 PERIODS

COURSE OUTCOMES:

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

CO1:	Explain the basics of physiology to develop a more in-depth level that will enable engineering analysis of selected physiological systems
CO2:	Enumerate the dynamic models, simulate and visualize, dynamic responses of physiological models using software
CO3:	Illustrate nonlinear models of physiological system
CO4:	Analyze the physiological function into an engineering model for cardio, and respiratory system
CO5:	Survey the physiological models using Simulation systems.

REFERENCES:

1.	Michel C Khoo, Physiological Control Systems -Analysis, simulation and estimation, Prentice Hall of India, 2010.
2.	Marmarelis, "Nonlinear Dynamic Modeling of Physiological Systems", Wiley-IEEE Press, 2004.
3.	Joseph D. Bronzino, The Biomedical Engineering Hand Book, 3rd Edition, CRC Press, 2006.
4.	John D. Enderle, "Model of Horizontal eye movements: Early models of saccades and smooth pursuit", Morgan & Claypool Publishers, 2010.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	1	2	2	1
CO2	2	2	2	2	1	2
CO3	2	2	2	2	2	1
CO4	2	2	2	1	2	2
CO5	2	3	2	1	2	2
CO	2	2.2	1.8	1.8	1.8	1.8

Table of Specification for End Semester Question Paper

Unit No.	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: INTRODUCTION	2	1either or	2(2)-CO1	1either or (16)-CO1	-	-
Unit-II: DYNAMIC PHYSIOLOGICAL SYSTEM	2	1either or	2(2)-CO2	1either or (16)-CO2	-	-
Unit-III: NON LINEAR MODELS	2	1either or	1(2)-CO3	1(2)-CO3 1either or (16)-CO3	-	-
Unit-IV: CARDIO, PULMONARY AND RESPIRATORY MODELING	2	1either or	1(2)-CO4	1(2)-CO4	1either or (16)-CO4	-
Unit-V: SIMULATION OF PHYSIOLOGICAL SYSTEMS	2	1either or	1(2)-CO5	1(2)-CO5	1either or (16)-CO5	-
Total Qns.	10	5either or	7(2)	3(2) 3 either or (16)	2 either or (16)	-
Total Marks	20	80	14	54	32	-
Weightage	20%	80%	14%	54%	32%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

MX22313	DEEP LEARNING	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:
- To develop and Train Deep Neural Networks.
- To develop a CNN for object detection and recognition.
- To build and train RNNs, to solve real-world problems.
- To study the structure of LSTM and GRU and the differences between them
- To design Auto Encoders for Image Processing.

UNIT I	INTRODUCTION TO DEEP LEARNING	9

Review of Neural Networks- Building Blocks of Neural Network. Multilayer Perceptron, Back-

propagation algorithm and its variants Stochastic gradient decent, Optimizers. Activation Functions. Loss Functions, Data Pre-processing for neural networks, Overfitting and Underfitting. Hyperparameters, Deep networks

UNIT II	CONVOLUTIONAL NEURAL NETWORK	9

CNN. Architecture- Input Layers, Convolution Layers. Pooling Layers. Dense Layers, Filters and Feature Maps, Dropout Layers and Regularization, Batch Normalization. Various Activation Functions. Various Optimizers. Popular CNN Architectures: LeNet, AlexNet, VGG16, ResNet, UNet

UNIT III	TRANSFER LEARNING & SEQUENCE MODELLING	9

Transfer Learning with Image Data. RCNN, Fast R-CNN, Faster R-CNN, Mask-RCNN, YOLO. Recurrent Neural Networks, Bidirectional RNNs (BRNN). Long Short-Term Memory (LSTM). Bi-directional LSTM. Sequence-to-Sequence Models (Seq2Seq). Gated recurrent unit GRU.

UNIT IV	DEEP REINFORCEMENT & UNSUPERVISED LEARNING	9

About Deep Reinforcement Learning. Q-Learning. Deep Q-Network (DQN). Policy Gradient Methods. Actor-Critic Algorithm. About Autoencoding. Convolutional Auto Encoding. Variational Auto Encoding. Generative Adversarial Networks.

UNIT V	APPLICATIONS OF DEEP LEARNING	9

Autoencoders for Feature Extraction. Auto Encoders for Classification. Denoising Autoencoders. Sparse Autoencoders. Case studies-Deep Neural network for Medical image segmentation

	45 PERIODS
PRACTICAL EXERCISES:	**30 PERIODS**

LIST OF EXPERIMENTS

1. Implement a perceptron in TensorFlow/Keras Environment.
2. Implement a Feed-Forward Network in TensorFlow/Keras. for signal / Image data.
3. Implement an Image Classifier using CNN in TensorFlow/Keras for abnormal detection.
4. Implement a Transfer Learning concept for medical Image Classification.
5. Implement an Autoencoder in TensorFlow/Keras and improve the deep learning model by tuning hyper parameters
6. Implement a Simple LSTM using TensorFlow/Keras
7. Implement a classifier in Recurrent Neural network.

	TOTAL:75 PERIODS

COURSE OUTCOMES:

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

CO1:	Realize neural network for data preprocessing and feature extraction.
CO2:	Understand CNN architecture for object detection.
CO3	Understand transfer learning and recurrent networks
CO4:	Analyze the Deep Reinforcement & Unsupervised Learning networks
CO5:	Apply deep learning network for Feature Extraction and Classification..

REFERENCES:

1.	Deep Learning A Practitioner's Approach Josh Patterson and Adam Gibson O'Reilly Media, Inc.2017.
2.	Learn Keras for Deep Neural Networks, Jojo Moolayil, Apress,2018.
3.	Deep Learning Projects Using TensorFlow 2, Vinita Silaparasetty, Apress, 2020.
4.	Deep Learning with Python, François Chollet, Manning Shelter Island,2017.
5.	Pro Deep Learning with TensorFlow, Santanu Pattanayak, Apress,2017.

6.	Ian Goodfellow, YoshuaBengio and Aaron Courville, " Deep Learning", MIT Press, 2017.
7.	Umberto Michelucci "Applied Deep Learning. A Case-based Approach to Understanding Deep Neural Networks" Apress, 2018.
8.	https://nptel.ac.in/courses/106106184

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	-	-	2	1
CO2	1	-	-	1	2	1
CO3	1	-	-	1	2	1
CO4	1	-	-	2	2	1
CO5	1	-	-	2	2	1
CO	1	-	-	1.5	2	1

Table of Specification for End Semester Question Paper

Unit No.	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: INTRODUCTION TO DEEP LEARNING	2	1either or	2(2)-CO1	1either or (16)-CO1	-	-
Unit-II: CONVOLUTIONAL NEURAL NETWORK	2	1either or	2(2)-CO2	1either or (16)-CO2	-	-
Unit-III: TRANSFER LEARNING & SEQUENCE MODELLING	2	1either or	1(2)-CO3	1(2)-CO3 1either or (16)-CO3	-	-
Unit-IV: DEEP REINFORCEMENT & UNSUPERVISED LEARNING	2	1either or	1(2)-CO4	1(2)-CO4	-	1either or (16)-CO4
Unit-V: APPLICATIONS OF DEEP LEARNING	2	1either or	1(2)-CO5	1(2)-CO5	1either or (16)-CO5	-
Total Qns.	10	5either or	7(2)	3(2) 3 either or (16)	1 either or (16)	1 either or (16)
Total Marks	20	80	14	54	16	16
Weightage	20%	80%	14%	54%	16%	16%

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

MX22314	**MIXED REALITY**	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To study about fundamental concept and components of Virtual Reality.
- To study about interactive techniques in Virtual Reality.
- To study about visual computation in Virtual Reality.
- To study about augmented and mixed reality and its applications.
- To know about I/O interfaces and its functions.

UNIT I	**INTRODUCTION TO VIRTUAL REALITY**	9

Introduction, Fundamental Concept and Components of Virtual Reality. Primary Features and Present Development on Virtual Reality. Computer graphics, Real time computer graphics, Flight Simulation, Virtual environment requirement, benefits of virtual reality, Historical development of VR, Scientific Landmark 3D Computer Graphics: Introduction, The Virtual world space, positioning the virtual observer, the perspective projection, human vision, stereo perspective projection, 3D clipping, Colour theory, Simple 3D modelling, Illumination models, Reflection models, Shading algorithms, Radiosity, Hidden Surface Removal, Realism Stereographic image.

Suggested Activities:
- Flipped classroom on uses of MR applications.
- Videos – Experience the virtual reality effect.
- Assignment on comparison of VR with traditional multimedia applications.

Suggested Evaluation Methods:
- Tutorial – Applications of MR.
- Quizzes on the displayed video and the special effects.

UNIT II	**INTERACTIVE TECHNIQUES IN VIRTUAL REALITY**	9

Introduction, from 2D to 3D, 3D spaces curves, 3D boundary representation Geometrical Transformations: Introduction, Frames of reference, Modeling transformations, Instances, Picking, Flying, Scaling the VE, Collision detection Generic VR system: Introduction, Virtual environment, Computer environment, VR technology, Model of interaction, VR Systems.

Suggested Activities:
- Flipped classroom on modeling three dimensional objects.
- External learning – Collision detection algorithms.
- Practical – Creating three dimensional models.

Suggested Evaluation Methods:
- Tutorial – Three dimensional modeling techniques.
- Brainstorming session on collision detection algorithms.
- Demonstration of three-dimensional scene creation.

UNIT III	**VISUAL COMPUTATION IN VIRTUAL REALITY**	9

Animating the Virtual Environment: Introduction, The dynamics of numbers, Linear and Nonlinear interpolation, the animation of objects, linear and non-linear translation, shape & object inbetweening, free from deformation, particle system. Physical Simulation: Introduction, Objects falling in a gravitational field, Rotating wheels, Elastic collisions, projectiles, simple pendulum, springs, Flight dynamics of an aircraft.

Suggested Activities:
- External learning – Different types of programming toolkits and learn different types of available VR applications.
- Practical – Create VR scenes using any toolkit and develop applications.

Suggested Evaluation Methods:
- Tutorial – VR tool comparison.
- Brainstorming session on tools and technologies used in VR.
- Demonstration of the created VR applications.

UNIT IV	AUGMENTED AND MIXED REALITY	9

Taxonomy, technology and features of augmented reality, difference between AR and VR, Challenges with AR, AR systems and functionality, Augmented reality methods, visualization techniques for augmented reality, wireless displays in educational augmented reality applications, mobile projection interfaces, marker-less tracking for augmented reality, enhancing interactivity in AR environments, evaluating AR systems.

Suggested Activities:
- External learning - AR Systems

Suggested Evaluation Methods:
- Brainstorming session different AR systems and environments.

UNIT V	I/O INTERFACE IN VR & APPLICATION OF VR	9

Human factors: Introduction, the eye, the ear, the somatic senses. VR Hardware: Introduction, sensor hardware, Head-coupled displays, Acoustic hardware, Integrated VR systems. VR Software: Introduction, Modeling virtual world, Physical simulation, VR toolkits, Introduction to VRML, Input -- Tracker, Sensor, Digital globe, Video-based Input, 3D Menus & 3DScanner etc. Output -- Visual /Auditory / Haptic Devices. VR Technology in Film & TV Production. VR Technology in Physical Exercises and Games. Demonstration of Digital Entertainment by VR.

Suggested Activities:
- External learning – Different types of sensing and tracking devices for creating mixed reality environments.
- Practical – Create MR scenes using any toolkit and develop applications.

Suggested Evaluation Methods:
- Tutorial – Mobile Interface Design.
- Brainstorming session on wearable computing devices and games design.
- Demonstration and evaluation of the developed MR application.

	45 PERIODS
PRACTICAL EXERCISES:	**30 PERIODS**

LIST OF EXPERIMENTS

1. Study of tools like Unity, Maya, 3DS MAX, AR toolkit, Vuforia and Blender.
2. Use the primitive objects and apply various projection methods by handling the camera
3. Download objects from asset stores and apply various lighting and shading effects.
4. Model three dimensional objects using various modeling techniques and apply textures over

	them.
5.	Create three dimensional realistic scenes and develop simple virtual reality enabled mobile applications which have limited interactivity.
6.	Add audio and text special effects to the developed application.
7.	Develop VR enabled applications using motion trackers and sensors incorporating full haptic interactivity.
8.	Develop AR enabled applications with interactivity like E learning environment, Virtual walkthroughs and visualization of historic places.
9.	Develop MR enabled simple applications like human anatomy visualization, DNA/RNA structure visualization and surgery simulation.
10.	Develop simple MR enabled gaming applications
	TOTAL :75 PERIODS

COURSE OUTCOMES:

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

CO1:	Explain the fundamental concept and components of Virtual Reality.
CO2:	Infer I/O Interfaces and its functions in real time applications.
CO3:	Apply the concepts of visual computation in Virtual Reality.
CO4:	Compute enumerate the interactive techniques in Virtual Reality.
CO5:	Apply the concepts of augmented and mixed reality and its applications.

REFERENCES:

1	Burdea, G. C. and P. Coffet. Virtual Reality Technology, Second Edition. Wiley- IEEE Press, 2003/2006.
2	Alan B. Craig, Understanding Augmented Reality, Concepts and Applications, Morgan Kaufmann, First Edition 2013.
3	Alan Craig, William Sherman and Jeffrey Will, Developing Virtual Reality Applications, Foundations of Effective Design, Morgan Kaufmann, 2009.
4	John Vince, "Virtual Reality Systems ", Pearson Education Asia, 2007.
5	Adams, "Visualizations of Virtual Reality", Tata McGraw Hill, 2000.
6	Grigore C. Burdea, Philippe Coiffet , "Virtual Reality Technology", Wiley Inter Science, 2nd Edition, 2006.
7	William R. Sherman, Alan B. Craig, "Understanding Virtual Reality: Interface, Aplication and Design", Morgan Kaufmann, 2008.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	1	-	-	1	2
CO2	2	1	-	-	1	2
CO3	2	1	-	-	1	2
CO4	2	1	1	-	1	2
CO5	2	1	1	-	1	2
CO	2	1	1	-	1	2

Table of Specification for End Semester Question Paper

Unit No.	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: Introduction To Virtual Reality	2	1either or	2(2)-CO1	1either or (16)-CO1	-	-
Unit-II: Interactive Techniques In Virtual Reality	2	1either or	2(2)-CO2	1either or (16)-CO2	-	-
Unit-III: Visual Computation In Virtual Reality	2	1either or	1(2)-CO3	1(2)-CO3 1either or (16)-CO3	-	-
Unit-IV: Augmented And Mixed Reality	2	1either or	1(2)-CO4	1(2)-CO4	1either or (16)-CO4	-
Unit-V: I/O Interface In VR & Application Of VR	2	1either or	1(2)-CO5	1(2)-CO5	1either or (16)-CO5	-
Total Qns.	10	5either or	7(2)	3(2) 3 either or (16)	2 either or (16)	-
Total Marks	20	80	14	54	32	-
Weightage	20%	80%	14%	54%	32%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

MX22315	3D PRINTING IN MEDICAL APPLICATIONS	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To apply the concepts of medical imaging, 3D scanning and digitizing for accurate 3D model construction.
- To identify the errors during processing of medical image data and minimize them.
- To select the suitable material for the given medical application.
- To analyze and select an additive manufacturing technology for a given medical application.
- To analyze and design the virtual models of the patient for planning the surgery

UNIT I	DESIGN OF POWER SUBSYSTEMS IN MEDICAL ELECTRONICS	9

Overview, Workshop on Medical Applications for Reverse Engineering and Rapid prototyping, Background on Rapid Prototyping, Stereolithography and Other Resin-type Systems, Fused Deposition Modelling and Selective Laser Sintering, Droplet/Binder Systems, Related Technology:

Microsystems and Direct Metal Systems, File Preparation, Relationship with Other Technologies, Disadvantages with RP for Medical Applications.		
UNIT II	**BIOMODELLING**	**9**
Introduction, Surgical Applications of Real Virtuality - Cranio-maxillofacial bio modeling, Use of real virtuality in customized cranio-maxillofacial prosthetics, Bio-model-guided stereotaxy, Vascular bio-modelling, Skull-base tumors surgery, Spinal surgery, Orthopedic bio modeling.		
UNIT III	**MEDICAL DATA TRANSFER**	**9**
Introduction, Medical Imaging: from Medical Scanner to 3D Model, Computer Approach in Dental Implantology. Bio Build Paradigm - Importing a dataset, Volume reduction, Anatomical orientation confirmation, Volume editing, Image processing, Build orientation optimization, 3D visualization, RP file generation, Future Enhancements		
UNIT IV	**ORTHOPEDIC IMPLANTS**	**9**
Introduction to orthopedic implants, Electron Beam Melting Technology, Direct Fabrication of Titanium Orthopedic Implants - EBM fabrication of custom knee implants, EBM fabrication of custom bone implants, Direct fabrication of bone ingrowth surfaces.		
UNIT V	**SCAFFOLD BASED TISSUE ENGINEERING**	**9**
Introduction, Medical Imaging: from Medical Scanner to 3D Model, Computer Approach in Dental Implantology. Bio Build Paradigm - Importing a dataset, Volume reduction, Anatomical orientation confirmation, Volume editing, Image processing, Build orientation optimization, 3D visualization, RP file generation, Future Enhancements.		
		45 PERIODS
PRACTICAL EXERCISES		**30 PERIODS**
LIST OF EXPERIMENTS		
1. Review of CAD Modeling Techniques and Introduction to Rapid Prototyping		
2. Forming Groups & Assigning Creative Idea		
3. Generating STL files from the CAD Models & Working on STL files		
4. Modeling Creative Designs in CAD Software		
5. Assembling Creative Designs in CAD Software		
6. Processing the CAD data in Catalyst software (Selection of Orientation, Supports generation, Slicing, Tool path generation)		
7. Simulation in Catalyst Software		
8. Fabricating the physical part on FDM RP machine		
9. Removing the supports & post processing (cleaning the surfaces)		
10. Demonstrating Creative Working Mode		
		TOTAL:75 PERIODS
COURSE OUTCOMES:		
At the end of the course, the students will be able to:		
CO1:	Explain the concepts of medical imaging, 3D scanning and digitizing for accurate 3D model construction	
CO2:	Outline the errors during processing of medical image data and minimize them	
CO3:	Interpret the data acquisition and data transfer mechanisms.	
CO4:	Identify an additive manufacturing technology for orthopedic implants	
CO5:	Choose models suitable for scaffold-based tissue engineering	

	REFERENCES:	
1	Ian Gibson, Advanced Manufacturing Technology for Medical Applications, John Wiley, 2005.	
2	Paulo Bartolo and Bopaya Bidanda, Bio-materials and Prototyping Applications in Medicine, Springer, 2008.	
3	Joseph D. Bronzino, The Biomedical Engineering Hand Book, 3rd Edition, CRC Press, 2006.	
4	Dennis Fitzpatrick, Implantable electronic medical devices, Elsevier, 2015.	
5	Johannes Wild. 3D Printing 101: The Ultimate Beginners Guide (3D Printing/Introduction, Troubleshooting and Ideas) 2019.	

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	-	-	-	-
CO2	-	-	-	-	1	-
CO3	1	1	-	-	-	2
CO4	-	-	2	-	-	-
CO5	1	-	1	-	1	-
CO	1	1	1.5	-	1	2

Table of Specification for End Semester Question Paper

Unit No.	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: Design Of Power Subsystems In Medical Electronics	2	1either or	1(2)-CO1	1(2)CO1 1either or (16)-CO1		-
Unit-II: Biomodelling	2	1either or	1(2)-CO2	1(2)-CO2 1either or (16)-CO2		-
Unit-III: Medical Data Transfer	2	1either or	1(2)-CO3	1(2)-CO3 1either or (16)-CO3		-
Unit-IV: Orthopedic Implants	2	1either or	1(2)-CO4	1(2)-CO4	1either or (16)-CO4	-
Unit-V: Scaffold Based Tissue Engineering	2	1either or	1(2)-CO5	1(2)-CO5	1either or (16)-CO5	-

Total Qns. Title	10	5either or	5(2)	5(2) 3 either or (16)	2 either or (16)	-
Total Marks	20	80	10	58	32	-
Weightage	20%	80%	10%	58%	32%	-

Weightage for COs					
	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

SEMESTER III, PROFESSIONAL ELECTIVES – V

MX22321	HUMAN ASSIST DEVICES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To identify the motivation, guiding principles, and challenges of Wearable Computing.
- To develop skills pertaining to the design of a holistic interactive wearable system comprising of the physical, digital, and the human aspects.
- To provide the basic understanding of measurement and instrumentation systems and the insight of the resistive sensors and its applications in real life.
- To introduce the concept of the reactive sensors and self-generating sensors and its applications in real life
- To impart the importance of smart sensors, sensor interface standards for wearable device applications and to provide a brief overview of the wearable technology and its impact on social life**.**

UNIT I	HEART LUNG MACHINE AND ARTIFICIAL HEART	9

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

UNIT II	CARDIAC ASSIST DEVICES	9

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

UNIT III	ARTIFICIAL KIDNEY	9

Indication and Principle of Haemodialysis, Membrane, Dialysate, Different types of hemodialyzers, Monitoring Systems, Wearable Artificial Kidney, Implanting Type

UNIT IV	PROSTHETIC AND ORTHOTIC DEVICES	9

Spinal orthotics and Prosthesis, Splint – Static and Dynamic. Hand and Arm Replacement - Different Types of Models Externally Powered Limb Prosthesis, Intelligent prosthesis, Lower Limb and Upper

limb orthotic devices, Feedback in Orthodic System, Functional Electrical Stimulation, Ultrasonic and laser canes, Intra ocular lens, Braille Reader, Tactile devices for visually Challenged, Text to voice converter, Screen readers Sensory Assist Devices, Materials for Prosthetic and orthotic devices, Haptic Devices, Transcutaneous electrical nerve stimulator.

UNIT V	RESPIRATORY AND HEARING AIDS	9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1:	Explain the importance of Heart lung machine and artificial heart
CO2:	Describe the importance of different types of cardiac assist devices
CO3:	Describe about the implantation of artificial kidney and related issues.
CO4:	Explore the different types of models for Prosthetic and orthotic purpose.
CO5:	Perceive the knowledge in different types of respiratory and hearing aids

REFERENCES:

1	Andreas.F.Von racum, Handbook of biomaterial evaluation, Mc-Millan publishers, 1986.
2	Albert M.Cook and Webster J.G., Therapeutic Medical Devices, Prentice Hall Inc.,New Jersey,1982.
3	Gray E Wnek, Gray L Browlin – Encyclopedia of Biomaterials and Biomedical Engineering –Marcel Dekker Inc New York 2008.
4	John. G. Webster – Bioinstrumentation - John Wiley & Sons (Asia) Pvt Ltd – 2008.
5	Kolff W.J., Artificial Organs, John Wiley and Sons, New York, 1979.
6	Gerr . M. Craddock "Assistive Technology-Shaping the future", IOS Press, 1st edition, 2003.
7	Michelle M. Lusardi, Milagros Jorge, Caroline Nielsen "Orthotics & Prosthetics in Rehabilitation", Elsevier, Third Edition, 2013,

Mapping of Course Outcomes to Programme Outcomes

Course Outcome	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	-	3	2	1
CO2	-	1	2	-	1	-
CO3	1	-	2	3	-	1
CO4	2	1	1	-	-	2
CO5	-	1	2	-	-	-
CO	1.6	1	1.8	3	1.5	2

Table of Specification for End Semester Question Paper

Unit No.	Total 2	Total 16	Cognitive Level

	Marks Qus.	Marks Qus.	Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: Heart Lung Machine And Artificial Heart	2	1either or	2(2)-CO1	1either or (16)-CO1	-	-
Unit-II: Cardiac Assist Devices	2	1either or	2(2)-CO2	1either or (16)-CO2	-	-
Unit-III: Artificial Kidney	2	1either or	1(2)-CO3	1(2)-CO3 1either or (16)-CO3	-	-
Unit-IV: Prosthetic And Orthotic Devices	2	1either or	1(2)-CO4	1(2)-CO4	1either or (16)-CO4	-
Unit-V: Respiratory And Hearing Aids	2	1either or	1(2)-CO5	1(2)-CO5	1either or (16)-CO5	-
Total Qns.	10	5either or	7(2)	3(2) 3 either or (16)	2 either or (16)	-
Total Marks	20	80	14	54	32	-
Weightage	20%	80%	14%	54%	32%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

MX22322	MEDICAL IMAGING SYSTEMS AND RADIO THERAPY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:
- To describe the production of x-rays and its application to different medical Imaging
- To interpret the different types of Radio diagnostic techniques.
- To illustrate the special imaging techniques for visualizing the cross sections of the body.
- To develop the production of Magnetic resonance images for various pulse sequences.
- To discover the importance of image quality assessments for medical imaging systems.

UNIT I	X – RAYS	9

Principle and production of soft X – Rays, X- ray machine and digital radiography, principles of Angiography and Fluoroscopic Techniques, digital subtraction angiography, mammography. Hazardous Effects of Radiation.

UNIT II	CT AND ULTRASOUND IMAGING	9

CT principle- Multi section Radiography, Computerized Axial Tomography, Type of Detection, image reconstruction, Spiral CT, Transverse Tomography,3D Imaging. Ultrasonic frequency for medical application, different modes of Display A, B and M, ultrasonic probes, Real time echo and 2D scanner.

UNIT III	COMPUTER AIDED TOMOGRAPHY	9

Need for sectional images, Principles of sectional scanning, Method of convolution and Back

Propagation, Methods of reconstruction, Multislice CT, artifacts.		
UNIT IV	**MAGNETIC RESONANCE IMAGING AND EMISSION COMPUTED TOMOGRAPHY IMAGING**	**9**

Principle of MRI, MRI instrumentation, Imaging Different Sections of the Body, Tissue Characterization, MR Spectroscopy, Functional MRI. Alpha, Beta, Gamma Emission, different types of Radiation Detectors, Functions of Gamma Camera, PET, SPECT, PET/CT, PET/MRI.

UNIT V	**MONITORING PHYSICAL AND PHYSIOLOGICAL PARAMETERS**	**9**

Global parameter assessment, spatial – frequency assessment, Image – processing assessment, Observer assessment, Image discrimination models, figure of merit, Comparing model to human performance.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1:	Explain the functionalities and applications of X ray in medicine.
CO2:	Enumerate images acquisition procedures using CT.
CO3:	Apply the special imaging techniques for visualizing the cross sections of the body using Computer aided tomography.
CO4:	Identify the applications of magnetic fields in the field of medicine.
CO5:	Analyze the assessment method to quantify the presence of noise in the image.

REFERENCES:

1.	Richard L. Van Metter, Jacob Beutel, Harold L. Kundel, Handbook of Medical Imaging, Volume 1. Physics and Psychophysics, SPIE, 2000.
2.	Chesney D. N., Chesney M. O. Radio graphic imaging, CBS Publications, New Delhi, 1987.
3.	Donald W. McRobbice, Elizabeth A. Moore, Martin J. Grave and Martin R. Prince MRI from Picture to proton, Cambridge University press, second edition, New York 2007.
4.	Frederick W Kremkau, Diagnostic Ultrasound Principles & Instruments, Saunders Elsevier, 2005.
5.	Jerry L. Prince, Jonathan M. Links, Medical Imaging Signals and Systems- Pearson Education Inc. 2014.
6.	Peggy, W., Roger D. Ferimarch, MRI for Technologists, McGraw Hill, New York, second edition, 2000.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	2	1	2	1	2
CO2	2	2	1	2	2	1
CO3	2	2	2	2	1	1
CO4	2	2	1	2	2	1
CO5	2	2	2	2	2	2
CO	**1.8**	**2**	**1.4**	**2**	**1.6**	**1.4**

Table of Specification for End Semester Question Paper

Unit No.	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: X – Rays	2	1either or	2(2)-CO1	1either or (16)-CO1	-	-
Unit-II: CT And Ultrasound Imaging	2	1either or	2(2)-CO2	1either or (16)-CO2	-	-
Unit-III: Computer Aided Tomography	2	1either or	1(2)-CO3	1(2)-CO3 / 1either or (16)-CO3	-	-
Unit-IV: Magnetic Resonance Imaging And Emission Computed Tomography Imaging	2	1either or	1(2)-CO4	1(2)-CO4	1either or (16)-CO4	-
Unit-V: Monitoring Physical And Physiological Parameters	2	1either or	1(2)-CO5	1(2)-CO5	1either or (16)-CO5	-
Total Qns.	10	5either or	7(2)	3(2) 3 either or (16)	2 either or (16)	-
Total Marks	20	80	14	54	32	-
Weightage	20%	80%	14%	54%	32%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

MX22323	REHABILITATION ENGINEERING	L	T	P	C
		3	0	0	3

COURSEOBJECTIVES:

- To learn the basics of rehabilitation engineering.
- To study about principle of rehabilitation engineering.
- To understand different types of Therapeutic Exercise Technique.
- To understand the tests to assess the hearing loss and development techniques of electronic devices for visually and auditory impaired.
- To study about various orthopaedic devices and prosthetic devices.

UNIT I	INTRODUCTION TO REHABILITATION	9
Rehabilitation: Epidemiology of Rehabilitation, Health, Levels of Prevention, Preventive Rehabilitation, Diagnosis of Disability, Functional Diagnosis, Importance of Psychiatry in Functional diagnosis, Impairment disability handicap, Primary & secondary Disabilities, Rehabilitation team Classification of members, The Role of Psychiatrist, Occupational therapist, Physical therapist, Recreation therapist, Prosthetist - Orthotist, Speech pathologist, Rehabilitation nurse, Social worker, Corrective therapist, Psychologist, Music therapist, Dance therapist & Biomedical engineer		
UNIT II	PRINCIPLE OF REHABILITATION	9
Introduction, The Human Component, Principles of Assistive Technology Assessment, Principles of Rehabilitation Engineering- Key Engineering Principles, Key Ergonomic Principles.		
UNIT III	THERAPEUTIC EXERCISE TECHNIQUE	9
Co-ordination exercises, Frenkels exercises, Gait analyses-Pathological Gaits, Gait Training, Relaxation exercises-Methods for training Relaxation, Strengthening exercises-Strength training, Types of Contraction, Mobilisation exercises, Endurance exercises.		
UNIT IV	MANAGEMENT OF COMMUNICATION & VIRTUAL REALITY	9
Impairment-introduction to communication, Aphasia, Types of aphasia, Treatment of aphasic patient, Augmentative communication-general form of communication, types of visual aids, Hearing aids, Types of conventional hearing aid, Writing aids. 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	ORTHOTIC, PROSTHETIC DEVICES & RESTORATION TECHNIQUES	9
General orthotics, Classification of orthotics-functional & regional, General principles of Orthosis, Calipers- FO, AFO, KAFO, HKAFO. Prosthetic devices: Hand and arm replacement, Body powered prosthetics, Myoelectric controlled prosthetics and Externally powered limb prosthetics. Functional Electrical Stimulation Systems-Restoration of hand function, restoration of standing and walking, Hybrid Assistive Systems (HAS).		
		TOTAL : 45 PERIODS
COURSE OUTCOMES:		
At the end of the course, the students will be able to:		
CO1:	Explain the basics of rehabilitation Engineering.	
CO2:	Explain the key engineering principles of rehabilitation and assistive technology.	
CO3:	Illustrate the types of therapeutic exercises to benefit the society.	
CO4:	Apply different types hearing aids, visual aids and their application in biomedical field and explain engineering concepts in virtual reality.	
CO5:	Develop prosthetic and orthotic devices for restoration of limb function.	
REFERENCES:		
1	Rory A Cooper, An Introduction to Rehabilitation Engineering, Taylor & Francis, CRC press, 2006.	
2	Susan B O'Sullivan, Thomas J Schmitz, Physical Rehabilitation. 5th Edition, Davis publications, 2019.	
3	Joseph D.Bronzino,The Biomedical Engineering Handbook,Third Edition: Three Volume Set,CRC Press,2006.	
4	MacLachlan M. and Gallagher P. Enabling Technologies – Body Image and Body Function, Churchill Livingstone, 2004.	

5	Mann W.C. (ed). Smart Technology for Aging, Disability, and Independence – The State of The Science, Wiley, New Jersey, 2005.
6	Muzumdar A. Powered Upper Limb Prostheses – Control, Implementation and Clinical Application. Springer, 2004.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	1	2	1
CO2	2	2	2	1	2	1
CO3	2	2	3	1	2	1
CO4	2	2	3	1	2	2
CO5	2	2	3	1	2	2
CO	**2**	**2**	**2**	**1**	**2**	**1.4**

Table of Specification for End Semester Question Paper

Unit No.	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: Introduction To Rehabilitation	2	1either or	2(2)-CO1	1either or (16)-CO1	-	-
Unit-II: Principle Of Rehabilitation	2	1either or	2(2)-CO2	1either or (16)-CO2	-	-
Unit-III: Therapeutic Exercise Technique	2	1either or	1(2)-CO3	1(2)-CO3	-	-
				1either or (16)-CO3		
Unit-IV: Management Of Communication & Virtual Reality	2	1either or	1(2)-CO4	1(2)-CO4	1eitheror (16)-CO4	-
Unit-V: Orthotic, Prosthetic Devices & Restoration Techniques	2	1either or	1(2)-CO5	1(2)-CO5	1either or (16)-CO5	-
Total Qns.	10	5either or	7(2)	3(2) 3 either or (16)	2 either or (16)	-
Total Marks	20	80	14	54	32	-
Weightage	20%	80%	14%	54%	32%	-

Weightage for COs					
	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

MX22324	NANOTECHNOLOGY AND ITS APPLICATIONS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

UNIT I	INTRODUCTION OF NANOPARTICLES	9

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

UNIT II	NANOMATERIALS AND NANOENGINEERING	9

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

UNIT III	NANOTECHNOLOGY IN DRUG DELIVERY	9

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

UNIT IV	NANOTECHNOLOGY IN IMAGING, DIAGNOSTIC ANDDETECTION	9

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

UNIT V	APPLICATION IN CANCER THERAPY	9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1:	Illustrate basic stem cell biology, requirement for tissue engineering and discoveries in the field of Nanomedicine
CO2:	Relate the latest scientific developments and toxicological aspects of Nano sized particles.
CO3:	Recognize the materials used in the field of flexible electronics technology and its power constraints
CO4:	Identify the drug delivery and diagnostic process using nanotechnology.
CO5:	Apply the new approaches used in synthesis of Nano-materials and applications.

REFERENCES:

1	CM, Niemeyer C.A. Mirkin., Nanobiotechnology – Concepts, Applications and Perspectives – 2004, Wiley – VCH.
2	Nicholas A. Kotov, Nanoparticle Assemblies and Superstructures. 2006 -CRC.
3	Nano: The Essentials: T. Pradeep. McGraw – Hill education – 2007.
4	Challa, S.S.R. Kumar, Josef Hormes, Carola Leuschner, Nanofabrication towards Biomedical Applications, Techniques, Tools, Applications and Impact.2005, Wiley – VCH.
5	Kewal K. Jain, The Handbook of Nanomedicine. Humana Press, (2008).
6	Zhang, Nanomedicine, A Systems Engineering Approach 1st Ed., Pan Stanford Publishing, (2005).
7	Robert A. Freitas Jr., Nanomedicine Volume IIA: Biocompatibility, Landes Bioscience Publishers, (2003).
8	Ahmad Tarig Jameel and Abu Zahrim Yaser, Advances in Nanotechnology and its Applications.Springer,2020

Mapping of Course Outcomes to Programme Outcomes

Course Outcome	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	2	1	1
CO2	1	-	1	1	11	1
CO3	-	-	1	1	1	1
CO4	1	1	1	2	1	1
CO5	1	-	1	1	1	1
CO	**1**	**1**	**1**	**1.4**	**1**	**1**

Table of Specification for End Semester Question Paper

Unit No.	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: INTRODUCTION OF NANOPARTICLES	2	1either or	1(2)-CO1	1(2)CO1 1either or (16)-CO1		-
Unit-II: NANOMATERIALS AND NANOENGINEERING	2	1either or	1(2)-CO2	1(2)-CO2 1either or (16)-CO2		-
Unit-III: NANOTECHNOLOGY IN DRUG DELIVERY	2	1either or	1(2)-CO3	1(2)-CO3	1either or (16)-CO3	-

Unit-IV: NANOTECHNOLOGY IN IMAGING, DIAGNOSTIC ANDDETECTION	2	1either or	1(2)-CO4	1(2)-CO4	1either or (16)-CO4	-
Unit-V: APPLICATION IN CANCER THERAPY	2	1either or	1(2)-CO5	1(2)-CO5	1either or (16)-CO5	-
Total Qns.	10	5either or	5(2)	5(2) 3 either or (16)	2 either or (16)	-
Total Marks	20	80	10	42	48	-
Weightage	20%	80%	10%	42%	48%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

MX22325	PATTERN RECOGNITION TECHNIQUES AND APPLICATIONS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the fundamentals of Pattern recognition.
- To impart knowledge on various clustering techniques.
- To study about feature extraction and selection.
- To explore different classification models.
- To understand Fuzzy pattern classifiers and applications.

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– Non Parametric techniques, Perceptron Algorithm-LMSE Algorithm- Pattern classification by distance functions – Minimum distance pattern classifier.

UNIT II	CLUSTERING	9

Clustering Concept – Hierarchical Clustering Procedures – Partitional Clustering, Quick partitions-Mixture models - Sum-of-squares methods -k-nearest-neighbour method – Properties and Algorithms-Example application study -Clustering of Large Data Sets – EM Algorithm – Grid Based Clustering– Density Based Clustering.

UNIT III	FEATURE EXTRACTION AND SELECTION	9

Entropy Minimization – KL Transforms – Regression-Linear, Non-linear and Logistic, Prediction, Feature Selection through Functions Approximation – Binary Feature Selection Feature selection criteria -Search algorithms for feature selection- Suboptimal search algorithms- Example application

study.		
UNIT IV	**HIDDEN MARKOV MODELS AND SUPPORT VECTOR MACHINE**	**9**
State Machines – Hidden Markov Models: Forward- Backward Algorithm, Sum and Product Algorithm for the HMM, Extensions of the Hidden Markov Model – Support Vector Machines: Maximum Margin Classifiers, Relevance Vector Machines- Sparse Kernel Machines.		
UNIT V	**APPLICATIONS**	**9**
Elementary Neural Network for Pattern Recognition, Application of PR in image segmentation, CAD system in breast cancer detection, ECG signal classification, Fingerprint recognition, cell cytology classification.		

SUGGESTED ACTIVITIES

1. Implementation of image classification using perceptron model in Matlab /python.
2. Implementation of feature extraction using KL transform in Matlab / Open CV/ python.
3. Implementation of partitional clustering in Matlab/OpenCV/python.
4. Implementation of density-based clustering in Matlab/OpenCV/ python
5. Implementation of Bayes classifier in Matlab/OpenCV/python.
6. Implementation of classification using neural networks in Matlab / OpenCV /python.
7. Implementation of image segmentation in Matlab/OpenCV/python.

TOTAL: 45 PERIODS

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

CO1:	Illustrate basic pattern classifier using Bayes approach and distance classifier.
CO2:	Identify the the clustering algorithms for pattern recognition.
CO3:	Identify various feature extraction and feature selection methods.
CO4:	Apply HMM and SVM for real time applications.
CO5:	Apply the pattern recognition techniques for bio signal and medical image applications.

REFERENCES:

1.	Andrew Webb, "Statistical Pattern Recognition", Arnold publishers, London, 2011.
2.	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.
4.	M. Narasimha Murthy and V. Susheela Devi, "Pattern Recognition", Springer 2011.
5.	R.O.Duda, P.E.Hart and D.G.Stork, "Pattern Classification", John Wiley, 2001.
6.	Robert J.Schalkoff, "Pattern Recognition Statistical, Structural and Neural Approaches", John Wiley & Sons Inc., New York, 1992.
7.	S.Theodoridis and K.Koutroumbas, "Pattern Recognition", 4th Edition, Academic Press, 2008.
8.	Christopher Bishop, Pattern Recognition and Machine Learning "Publisher Springer-Verlag New York Inc.2011.
9.	https://archive.nptel.ac.in/courses/117/105/117105101/

Mapping of Course Outcomes to Programme Outcomes

COURSE OUTCOME	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	1	1	1	2
CO2	1	2	1	1	1	2
CO3	1	2	1	1	1	2
CO4	1	2	1	1	1	2
CO5	1	2	1	1	1	2
CO	**1**	**2**	**1**	**1**	**1**	**2**

Table of Specification for End Semester Question Paper

Unit No.	Total 2 Marks Qus.	Total 16 Marks Qus.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse(An) Evaluate(Ev)
Unit-I: PATTERN CLASSIFIER	2	1either or	2(2)-CO1	1either or (16)-CO1	-	-
Unit-II: CLUSTERING	2	1either or	2(2)-CO2	1either or (16)-CO2	-	-
Unit-III: FEATURE EXTRACTION AND SELECTION	2	1either or	1(2)-CO3	1(2)-CO3 / 1either or (16)-CO3	-	-
Unit-IV: HIDDEN MARKOV MODELS AND SUPPORT VECTOR MACHINE	2	1either or	1(2)-CO4	1(2)-CO4	1either or (16)-CO4	-
Unit-V: APPLICATIONS	2	1either or	1(2)-CO5	1(2)-CO5	1either or (16)-CO5	-
Total Qns. Title	10	5either or	7(2)	3(2) 3 either or (16)	2 either or (16)	-
Total Marks	20	80	14	54	32	-
Weightage	20%	80%	14%	54%	36%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

AUDIT COURSES

AC22101	ENGLISH FOR RESEARCH PAPER WRITING	L	T	P	C
		2	0	0	0

COURSE OBJECTIVES:

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

UNIT I	INTRODUCTION TO RESEARCH PAPER WRITING	6

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

UNIT II	PRESENTATION SKILLS	6

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

UNIT III	TITLE WRITING SKILLS	6

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

UNIT IV	RESULT WRITING SKILLS	6

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

UNIT V	VERIFICATION SKILLS	6

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

TOTAL: 30 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will.../ will be able to...

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

REFERENCES:

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

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	2	-	1	-	-
CO2	-	2	-	1	-	-
CO3	-	2	-	1	-	-
CO4	-	2	-	1	-	-
CO5	-	2	-	1	-	-
CO	-	2	-	1	-	-

AC22102	CONSTITUTION OF INDIA	L	T	P	C
		2	0	0	0

COURSE OBJECTIVES:

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

UNIT I	HISTORY OF MAKING OF THE INDIAN CONSTITUTION	5

History, Drafting Committee, (Composition & Working).

UNIT II	PHILOSOPHY OF THE INDIAN CONSTITUTION	5

Preamble, Salient Features

UNIT III	CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES	5

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

UNIT IV	ORGANS OF GOVERNANCE	5

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

UNIT V	LOCAL ADMINISTRATION	5

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

UNIT VI	ELECTION COMMISSION	5

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

		TOTAL: 30 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will.../ will be able to...

CO1:	Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics
CO2:	Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India
CO3:	Discuss the circumstances surrounding the foundation of the Congress Socialist Party[CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution
CO4:	Discuss the passage of the Hindu Code Bill of 1956.

REFERENCES:

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

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	-	2	1	-	-	-
CO2	-	2	1	-	-	-
CO3	-	2	1	-	-	-
CO4	-	2	1	-	-	-
CO5	-	2	1	-	-	-
CO	-	2	1	-	-	-

AC22201	**DISASTER MANAGEMENT**	**L**	**T**	**P**	**C**
		2	**0**	**0**	**0**

COURSE OBJECTIVES:

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

UNIT I	**INTRODUCTION**	**6**

Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.		
UNIT II	**REPERCUSSIONS OF DISASTERS AND HAZARDS**	**6**
Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.		
UNIT III	**DISASTER PRONE AREAS IN INDIA**	**6**
Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics.		
UNIT IV	**DISASTER PREPAREDNESS AND MANAGEMENT**	**6**
Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.		
UNIT V	**RISK ASSESSMENT**	**6**
Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will.../ will be able to...

CO1:	Summarize basics of disaster
CO2:	Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response
CO3:	Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives
CO4:	Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations
CO5:	Develop the strengths and weaknesses of disaster management approaches

REFERENCES:

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

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	-	-	1	2
CO2	1	-	-	-	1	2
CO3	1	-	-	-	1	2
CO4	1	-	-	-	1	2
CO5	1	-	-	-	1	2
CO	1	-	-	-	1	2

AC22202	நற்றமிழ் இலக்கியம்	L	T	P	C
		2	0	0	0

UNIT I	சங்க இலக்கியம்	6

1. தமிழின் துவக்க நூல் தொல்காப்பியம் – எழுத்து, சொல், பொருள்
2. அகநானூறு (82) - இயற்கை இன்னிசை அரங்கம்
3. குறிஞ்சிப் பாட்டின் மலர்க்காட்சி
4. புறநானூறு (95,195) - போரை நிறுத்திய ஒளவையார்

UNIT II	அறநெறித் தமிழ்	6

1. அறநெறி வகுத்த திருவள்ளுவர்
   - அறம் வலியுறுத்தல், அன்புடைமை, ஒப்புரவறிதல், ஈகை, புகழ்
2. பிற அறநூல்கள் - இலக்கிய மருந்து – ஏலாதி, சிறுபஞ்சமூலம், திரிகடுகம், ஆசாரக்கோவை   (தூய்மையை வலியுறுத்தும் நூல்)

UNIT III	இரட்டைக் காப்பியங்கள்	6

1. கண்ணகியின் புரட்சி - சிலப்பதிகார வழக்குரை காதை
2. சமூகசேவை இலக்கியம் மணிமேகலை - சிறைக்கோட்டம் அறக்கோட்டமாகிய காதை

UNIT IV	அருள்நெறித் தமிழ்	6

1. சிறுபாணாற்றுப்படை
          - பாரி முல்லைக்குத் தேர் கொடுத்தது,   பேகன் மயிலுக்குப் போர்வை கொடுத்தது, அதியமான் ஒளவைக்கு நெல்லிக்கனி கொடுத்தது, அரசர் பண்புகள்
2. நற்றிணை - அன்னைக்குரிய புன்னை சிறப்பு
3. திருமந்திரம் (617, 618) - இயமம் நியமம் விதிகள்
4. தர்மச்சாலையை நிறுவிய வள்ளலார்
5. புறநானூறு - சிறுவனே வள்ளலானான்
6. அகநானூறு (4)   - வண்டு
   நற்றிணை (11)   - நண்டு
   கலித்தொகை (11)   - யானை, புறா
   ஐந்திணை 50 (27)   - மான் ஆகியவை பற்றிய செய்திகள்

UNIT V	நவீன தமிழ் இலக்கியம்	6

1.உரைநடைத் தமிழ்,
   - தமிழின் முதல் புதினம்,
   - தமிழின் முதல் சிறுகதை,
   - கட்டுரை இலக்கியம்,
   - பயண இலக்கியம்,   - நாடகம்,
2.நாட்டு விடுதலை போராட்டமும் தமிழ் இலக்கியமும்,
3. சமுதாய விடுதலையும் தமிழ் இலக்கியமும்,
4.பெண் விடுதலையும் விளிம்பு நிலையினரின் மேம்பாட்டில்
  தமிழ் இலக்கியமும்,
5.அறிவியல் தமிழ்,
6.இணையத்தில் தமிழ்,
7.சுற்றுச்சூழல் மேம்பாட்டில் தமிழ் இலக்கியம்.	

	TOTAL: 30 PERIODS

	REFERENCES:
1	தமிழ் இணைய கல்விக்கழகம் (Tamil Virtual University)
2	தமிழ் விக்கிப்பீடியா (Tamil Wikipedia)
3	தர்மபுர ஆதீன வெளியீடு
4	வாழ்வியல் களஞ்சியம்
5	தமிழ்கலைக் களஞ்சியம் - தமிழ் வளர்ச்சித் துறை (thamilvalarchithurai.com)
6	அறிவியல் களஞ்சியம் - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்