M.E. Degree

in

MEDICAL ELECTRONICS

CURRICULUM & SYLLABUS (CBCS)

(Innovation and Product Development for sustainability)

(For students admitted from the Academic Year 2026-2027)

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 2026
M.E. MEDICAL ELECTRONICS CURRICULUM
CHOICE BASED CREDIT SYSTEM

VISION OF THE INSTITUTION

To be a centre of excellence in engineering education and research for a technically empowered humane society.

MISSION OF THE INSTITUTION

M1: Foster a vibrant academic environment for learning fundamental concepts, emerging technologies, and research-oriented practices.
M2: Cultivate personal maturity and professional skills through stimulating coaching and practical training.
M3: Provide inspiring high calibre faculty to mentor students from diverse backgrounds, especially the underprivileged.
M4: Create ample opportunities to transform rural youth into top class professionals and technocrats, capable of serving at the local and global levels with ethical integrity.

VISION OF THE PROGRAMME

Developing technically competent Electronics and Communication Engineers with academic excellence, innovative research, ethical standards and international outlook to serve the society

MISSION OF THE PROGRAMME

M1. To provide quality teaching in order to produce graduates with academic excellence, technical competence and ethical values.
M2. To develop advanced professionalism and exceptional career growth through inspiring faculty members and excellent infrastructure.
M3. To create awareness on state of the art technologies through research and industry-institute collaboration.
M4. To inculcate a sense of innovation and commitment among the students to apply knowledge and technologies for the benefit of the society.

PROGRAMME EDUCATIONAL OBJECTIVES

I	To enable the graduates to pursue Clinical Research or lead a successful career in the academic field of medical electronics.
II	To enable the graduates to acquire all the required Medical Electronics Manufacturing skills for Industrial Application or for Hospital Requirement
III	To enable the graduates to critically analyse, acquire essential skills, innovate medical

	products and to become successful Entrepreneurs in the field of medical electronics.
IV	To facilitate the graduates to exhibit leadership skills, make decisions with societal and ethical responsibilities, function and communicate effectively in multidisciplinary settings.
V	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.

PROGRAMME OUTCOMES

1	An ability to independently carry out research/investigation and development work to solve practical problems
2	An ability to write and present a substantial technical report/document.
3	Ability to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.
4	Ability to acquire and understand, synthesize and generate hypotheses using knowledge of mathematics and electronics
5	Model, design and realize devices and systems using the techniques and tools of Medical Electronics Engineering in healthcare domain
6	Optimize, maintain and Provide sustainable solutions for health care devices / systems and its allied fields by imbibing managerial and techno-social values

KNOWLEDGE AND ATTITUDE PROFILE (WK)

WK1: A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.

WK2: Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.

WK3: A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.

WK4: Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.

WK5: Knowledge, including efficient resource use, environmental impacts, whole-life cost, re use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.

WK6: Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.

WK7: Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.

WK8: Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.
WK9: Ethics, inclusive behavior and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.

PEOs – POs MAPPING

Programme Educational Objectives	Programme Outcomes					
	1	**2**	**3**	**4**	**5**	**6**
I	3	3	3	3	2	1
II	2	1	2	2	3	3
III	3	2	2	3	3	2
IV	1	3	2	1	2	3
V	2	1	1	2	3	3

PROGRAMME ARTICULATION MATRIX

Year	Semester	Course Name	Programme Outcomes					
			1	**2**	**3**	**4**	**5**	**6**
I	I	Induction Programme	2	2	2	-	-	-
		Mathematical Modelling and Computational Techniques in Engineering	2	1	2	3	1	1
		Biomedical Sensors and Instrumentation	2	1	2	2	2	2
		Bio Signal Processing	3	1	3	3	2	2
		Human Anatomy and Physiology	2	1	3	2	2	2
		Biomedical Instrumentation Laboratory	2	1	3	2	3	1
		Research Methodology and Intellectual Property Rights	3	3	2	2	2	2
		Research Tools Laboratory	2	2	2	3	3	2
		Technical Seminar*	3	2	3	2	2	3
I	II	Hospital Planning Organization and Management	2	2	2	2	2	2
		Medical Image Processing	3	2	2	2	2	2
		Machine Learning Techniques	2	1	3	2	2	2
		Data Acquisition and Design Laboratory	3	2	2	2	2	2

SUSTAINABLE DEVELOPMENT GOALS

GOAL 1: No Poverty
End poverty in all its forms everywhere (eradicate extreme poverty currently measured as people living on less than $1.25 a day.)

GOAL 2: Zero Hunger
End hunger, achieve food security and improved nutrition and promote sustainable agriculture

GOAL 3: Good Health and Well-being
Ensure healthy lives and promote well-being for all at all ages

GOAL 4: Quality Education
Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

GOAL 5: Gender Equality
Achieve gender equality and empower all women and girls

GOAL 6: Clean Water and Sanitation
Ensure availability and sustainable management of water and sanitation for all

GOAL 7: Affordable and Clean Energy
Ensure access to affordable, reliable, sustainable and modern energy for all

GOAL 8: Decent Work and Economic Growth
Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

GOAL 9: Industry, Innovation and Infrastructure
Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

GOAL 10: Reduced Inequality
Reduce inequality within and among countries

GOAL 11: Sustainable Cities and Communities
Make cities and human settlements inclusive, safe, resilient and sustainable

GOAL 12: Responsible Consumption and Production
Ensure sustainable consumption and production patterns

GOAL 13: Climate Action
Take urgent action to combat climate change and its impacts

GOAL 14: Life Below Water
Conserve and sustainably use the oceans, seas and marine resources for sustainable development

GOAL 15: Life on Land
Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

GOAL 16: Peace and Justice Strong Institutions
Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels

GOAL 17: Partnerships to achieve the Goal
Strengthen the means of implementation and revitalize the global partnership for sustainable development.

SEMESTER: I

Number of Courses : **8**
Total Credits : **23**

Course Code	Course Title	Course Type	Classroom Instruction(CI) (in Hours per Semesters)		Lab Instruction (LI) (in Hours per Semesters)	Term Work(TW) and Self Learning(SL) (in Hours per Semesters)	Total Number of Hours (in Hours per Semesters)	Total Credits (C)=(Total Hours/30)	SDG Goal Mapped	Category
			L	T	P					
IP26C07	Induction Programme *	TC	24	0	0	6	30	0	4,8,9, 16,17	IP
MA26C06	Mathematical Modelling and Computational Techniques in Engineering	TC	45	15	0	60	120	4	4,8,9, 12	BSC
MX26101	Biomedical Sensors and Instrumentation	TC	45	0	0	45	90	3	3,4, 9, 10,17	PCC
MX26102	Bio Signal Processing	TCP	45	0	30	45	120	4	3,4, 9, 10,17	PCC
MX26103	Human Anatomy and Physiology	TC	45	0	0	45	90	3	3,4,9, 10,11, 17	PCC
MX26104	Biomedical Instrumentation Laboratory	PC	0	0	60	0	60	2	3,4, 9, 10,17	PCC
RM26C01	Research Methodology and Intellectual Property Rights	TC	45	15	0	60	120	4	1,2,3, 7	FC
RM26C02	Research Tools Laboratory	PC	0	0	60	0	60	2	4,9,16 ,17	FC
MX26106	Technical Seminar**	-	0	0	30	0	30	1	3,4,9	EEC
Total			**225**	**30**	**180**			**23**		

* - Refer clause 21 in regulation 2026. The evaluation procedure is detailed in the syllabus.
** - Internally Evaluated Course. The evaluation procedure is detailed in the syllabus.
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SEMESTER: II

Number of Courses : **8**
Total Credits : **17**

Course Code	Course Title	Course Type	Classroom Instruction(CI) (in Hours per Semesters)		Lab Instruction(LI) (in Hours per Semesters)	Term Work(TW) and Self Learning(SL) (in Hours per Semesters)	Total Number of Hours (in Hours per Semesters)	Total Credits (C)=(Total Hours/30)	SDG Goal Mapped	Category
			L	T	P					
MX26201	Hospital Planning Organization and Management	TC	45	0	0	45	90	3	3,4,8,9,10,11,12,17	PCC
MX26202	Medical Image Processing	TC	45	0	0	45	90	3	3,4,9	PCC
MX26203	Machine Learning Techniques	TCP	45	0	30	45	120	4	3,4,9	PCC
MX26204	Data Acquisition and Design Laboratory	PC	0	0	60	0	60	2	3,9,16	PCC
	Professional Elective I	TC	45	0	0	45	90	3		PEC
	Open Elective I	TC	45	0	0	45	90	3		OEC
MX26S01	Industry Collaborated Course I*	-	15	0	15	0	30	1		ICC
MX26S02	Self-Learning Course*	-	0	0	0	30	30	1		SLC
Total			**195**	**0**	**105**			**17**		

* - Evaluation and certification by course offering body.

SEMESTER II, OPEN ELECTIVE I

Course Code	Course Title	Course Type	Classroom Instruction(CI) (in Hours per Semesters)		Lab Instruction(LI) (in Hours per Semesters)	Term Work(TW) and Self Learning(SL) (in Hours per Semesters)	Total Number of Hours (in Hours per Semesters)	Total Credits (C)=(Total Hours/30)	SDG Goal Mapped	Category
			L	T	P					
MX26021	Tele Health Technology	TC	45	0	0	45	90	3	3,9,10,16	PEC
MX26022	Diagnostic and Therapeutic Equipment	TC	45	0	0	45	90	3	3,4,8,9,12	PEC

SEMESTER II, PROFESSIONAL ELECTIVES – I

Course Code	Course Title	Course Type	Classroom Instruction(CI) (in Hours per Semesters)		Lab Instruction(LI) (in Hours per Semesters)	Term Work(TW) and Self Learning(SL) (in Hours per Semesters)	Total Number of Hours (in Hours per Semesters)	Total Credits (C)=(Total Hours/30)	SDG Goal Mapped	Category
			L	T	P					
MX26001	Tissue Engineering	TC	45	0	0	45	90	3	3,8,9,12,16,17	PEC
MX26002	Biomaterials and Biomechanics	TC	45	0	0	45	90	3	3,4,9,10	PEC
MX26003	Micro and Nano Fluids	TC	45	0	0	45	90	3	6,7,9,12,13	PEC
MX26004	Mixed Reality	TCP	45	0	30	45	120	4	3,4,8,9,12	PEC
MX26005	Wearable Technologies	TC	45	0	0	45	90	3	3,7,9,10	PEC

SEMESTER I

IP26C07	Induction Programme	L	T	P	TW/SL	Total	C	SDG
		24	0	0	6	30	0	4,8,9, 16,17

COURSE OBJECTIVES:

- To familiarize students with institutional policies, academic regulations, and programme structure.
- To introduce research methodology, ethical practices, and emerging engineering trends.
- To develop communication, technical writing, and presentation skills.
- To create awareness about career opportunities, higher education, and industry expectations.
- To inculcate professional ethics, teamwork, and leadership qualities.

COURSE CONTENT:

Unit 1	Institutional Orientation	4	0	0	1	5		4

Vision, Mission, and Quality Policy – Organizational structure – Campus facilities – Library, laboratory, and IT infrastructure – Student support systems – Interaction with faculty and peers.

Activities:

1. Campus Resource Mapping and Group Presentation.

Unit 2	Academic Regulations & Programme Structure	4	0	0	1	5		4,9

Choice Based Credit System (CBCS) – Curriculum framework – Credit requirements – Evaluation and assessment procedures – Attendance norms – Examination system – Academic integrity guidelines.

Activities:

1. Preparation of Individual Academic Plan.

Unit 3	Research Methodology & Emerging Technologies	8	0	0	2	10		4

Research process – Problem identification – Literature review – Research ethics and plagiarism – Overview of emerging technologies (AI, Data Science, IoT, etc.) – Interdisciplinary research opportunities.

Activities:

1. Mini Research Problem Identification and Presentation.

Unit 4	Skill Development & Career Planning	4	0	0	1	5		8

Communication skills – Technical writing – Presentation skills – Resume preparation – Career opportunities – Higher studies – Competitive exams – Internship and placement readiness.

Activities:

1. Resume Preparation and Elevator Pitch Presentation.

Unit 5	**Professional Development & Well-Being**	**4**	**0**	**0**	**1**	**5**		**16,17**

Engineering ethics – Professional values – Teamwork and leadership – Innovation and entrepreneurship – Startup ecosystem – Time management – Stress management – Counseling and mentoring support.

Activities:

1. Case Study Analysis on Ethics and Teamwork.

COURSE OUTCOMES:

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

CO1: Apply institutional policies and academic regulations to manage postgraduate studies effectively.
CO2: Apply research methodologies and ethical principles to identify research problems.
CO3: Demonstrate communication, technical writing, and presentation skills.
CO4: Analyze career opportunities and industry expectations for informed decision-making.
CO5:Apply professional ethics and teamwork skills in academic and organizational environments.

Weightage: Continuous Assessment: 100%

Assessment Methodology: Active Participation (40%), Assignments (30%), Quiz (30%)

REFERENCES:

1.	Johri, A., "International Handbook of Engineering Education Research", Taylor & Francis, 2023.
2.	Murthy, D. N. P., & Page, N. W.," Education and Research for the Future", Springer, 2023.
3.	Oliveira, T. A., & Hebebci, M. T. (Eds.), Current Academic Studies in Technology and Education 2024, ISRES Publishing, 2024.
4.	Kannan, R., Thirumalai, P., & Geetha, T. V, "Proceedings of the International Conference on Technology for Education (T4E 2024)", Springer, 2024.
5.	Rajesh, S., Raghu Prasad, B. K., & Praveen, K. V., "Recent Advances in Sustainable Construction Technology", Geotechnics and Structural Engineering, Springer, 2026.

E resources/E materials:

1.	https://alison.com/course/essentials-of-research-methodology
2.	https://www.coursera.org/learn/research-methodologies

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	PO1 (Research Capability)	PO2 (Technical Communication)	PO3 (Domain Mastery)
CO1	2	1	2
CO2	3	2	2
CO3	1	3	1
CO4	2	2	2
CO5	1	2	1
CO	2	2	2

MA26C06	Mathematical Modelling and Computational Techniques in Engineering	L	T	P	TW/SL	Total	C	SDG
		45	15	0	60	120	4	4,8,9,12

COURSE OBJECTIVES:

- To familiarize the students with the formulation and construction of mathematical models for a linear programming problem in real-life situations.
- To develop students' ability to formulate and solve real-world optimization problems using transportation and assignment models.
- To understand advanced matrix concepts such as norms, inner products, and various matrix decompositions to solve engineering and optimization problems.
- To provide a foundation in probability theory and random variables for analyzing uncertainty and solving real-world problems.
- To develop an understanding of non-Markovian queueing models and analyze their performance using the Pollaczek - Khinchin formula.

COURSE CONTENT:

Unit 1	Linear Programming	9	3	0	12	24		4,8,9,12

Formulation of linear programming problems – Graphical solution method – Canonical and standard form of linear programming problem – Simplex method – Artificial variables: Big-M method.

Activity:

1. Formulate a linear programming model to maximize system efficiency or minimize operating cost and solve it using Big-M method**.**

Unit 2	Transportation and Assignment Models	9	3	0	12	24		4,8,9,12

Definition of the transportation model – Mathematical formulation of transportation models – Basic feasible solution: Vogel's approximation method – Optimal solution by modified distribution (MODI) method – Definition of the assignment model – Mathematical formulation of assignment models – Hungarian method for solving assignment problems.

Activity:

1. Model the distribution of medical devices from multiple warehouses to hospitals using Vogel's Approximation Method to minimize cost and time.

Unit 3	**Matrix Theory**	**9**	**3**	**0**	**12**	**24**		**4,9, 12**

Definitions: Norms and inner products – Definitions: Band matrices and Toeplitz matrices – Matrix decomposition: Cholesky decomposition – QR factorization – Least square approximations using QR factorization.

Activity:

1. Use signal data from communication or biomedical systems to form system matrices and apply QR decompositions to estimate system parameters.

Unit 4	**Probability and Random Variables**	**9**	**3**	**0**	**12**	**24**		**4,9, 12**

Probability - Axioms of probability – Conditional probability – Independence of events – Baye's theorem (statement and problems) – Discrete random variables – Probability mass function – Continuous random variable – Probability density function – Probability distribution – Cumulative distribution function – Mean – Variance – Special distributions: Binomial and Poisson distributions.

Activity:

1. Perform probability analysis on a medical screening dataset involving prevalence of disease and diagnostic test outcomes and model the number of data packets arriving at a communication node over fixed intervals using Poisson distribution and interpret network performance.

Unit 5	**Queueing Models**	**9**	**3**	**0**	**12**	**24**		**4,8,9 ,12**

Introduction to queueing theory – Structure and characteristics of queueing systems – Queue disciplines – Kendall's notation – Markovian models: M/M/1/∞ and M/M/c/∞ queues – Steady-state probabilities – Mean system size, average waiting time and utilization factor – Little's formula – Non-Markovian models: M/G/1 queue – Pollaczek-Khinchin formula.

Activity:

1. Examine network traffic or hospital service systems by representing them through non Markovian and evaluate performance metrics using Pollaczek–Khinchin formula.

COURSE OUTCOMES:

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

CO1: Apply graphical, simplex and the Big-M method to solve linear programming problems.

CO2: Solve transportation problems using modified distribution method and assignment problems using Hungarian Method to obtain optimal allocation results.

CO3: Utilize matrix factorization techniques including Cholesky and QR decompositions to resolve engineering-focused matrices.

CO4: Apply probability and discrete distributions in engineering field.

CO5: Choose suitable Markovian and non-Markovian queueing models to evaluate the performance of queueing systems.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%	
Assessment Methodology: Activity (30%) and Internal Assessment test (70%)	
REFERENCES:	
1.	Taha. H.A., "Operation Research: An Introduction", Eleventh edition, Pearson Education, New Delhi, Reprint 2023.
2.	Kanti Swarup, P. K. Gupta and Man Mohan , "Operation Research", Twentieth edition, Sultan Chand & sons, 2022.
3.	Richard Bronson & Gabriel B. Costa., "Schaum's Outline of Differential Equations", Fifth edition, McGraw Hill, 2022.
4.	Ronald E. Walpole and Raymond H. Myers "Probability and Statistics for Engineers & Scientists", Pearson Publications, Nineth edition, 2024.
5.	Sheldon M. Ross, "Introduction to Probability Models", Academic Press, Thirteenth edition, Reprint 2024.
E resources/E materials:	
1.	https://allen.in/jee/maths/graphical-method-linear-programming
2.	https://www.acsce.edu.in/acsce/wp-content/uploads/2020/03/1585041316993_Module-4.pdf
3.	https://ocw.mit.edu/courses/6-241j-dynamic-systems-and-control-spring-2011/04fddfbcb1eb933ecca85dab8bfbb171_MIT6_241JS11_chap04.pdf

Mapping of Course Outcomes to Programme Outcomes

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

MX26101	Biomedical Sensors and Instrumentation	L	T	P	TW/SL	Total	C	SDG
		45	0	0	45	90	3	3,4,9,10, 17

COURSE OBJECTIVES

- To understand the working principles and biomedical applications of sensors and transducers used for physiological measurements.
- To study the origin of biopotentials and the characteristics of electrode–tissue interfaces for accurate biosignal acquisition
- To learn methods for measuring key physiological parameters such as pulse, respiration, temperature, blood pressure, and blood flow.
- To acquire the ability to record, analyze, and interpret biosignals including ECG, EEG, EMG, and PCG.
- To develop skills in designing bioamplifiers and signal-conditioning circuits with proper safety, isolation, and noise reduction for medical instrumentation.

COURSE CONTENT:

Unit 1	Biomedical Sensors & Transducers	``` `9	0	0	9	18		3,4,9,10, 17

Resistive transducers (strain gauge – gauge factor, configuration, displacement & pressure sensing, biomedical applications), RTDs, thermistors, temperature sensors, capacitive and inductive transducers, LVDT, thermocouples.

Activities:

1. Case study on strain gauge applications in biomedical measurement.
2. Demonstration/assignment on temperature sensors in medical devices.

Unit 2	Biopotential and its Measurements	9	0	0	9	18		3,4,9,10

Origin and propagation of biopotentials, electrode– electrolyte and electrode–skin interface, half-cell potential, polarization, surface/needle/micro electrodes & equivalent circuits, non-polarizable electrodes.

Activities:

1. Simulation/lab: Measuring skin–electrode impedance.
2. Comparative study of electrode types and their biomedical uses

Unit 3	Measurement of Non-Electrical Parameter	9	0	0	9	18		3,4,9,10

Measurements of Respiration Rate, Temperature, Pulse rate, Blood pressure Measurements- Direct, Indirect. Blood flow Measurements – In vitro, In vivo, Gas flow measurements. Blood cell counter.

Activities:

1. Practical measurement of pulse rate and respiration using available sensors.
2. Assignment on methods of blood pressure measurement and comparison.

Unit 4	**Biosignals & Measurement Systems**	**9**	**0**	**0**	**9**	**18**		**3,4,10,11**

Characteristics of biosignals (frequency, amplitude), ECG (Einthoven's triangle, 12-lead system), EEG (10–20 system, recording modes), EMG (recording modes), PCG, ERG, EOG, EGG – recording methods, waveform analysis, abnormal signals, evoked responses.

Activities:

1. Lab experiment: ECG or EEG signal recording and waveform analysis.
2. Case study on clinical use of EMG or PCG signals.

Unit 5	**Bioamplifiers & Signal Conditioning**	**9**	**0**	**0**	**9**	**18**		**3,4,10, 11,17**

Need for bioamplifiers, single-ended & differential bioamplifiers, impedance matching, isolation amplifiers (transformer & optical isolation), isolated DC & AC carrier amplifiers, power-line interference removal, right-leg driven ECG amplifier, band-pass filtering, recording systems.

Activities:

1. Design exercise: Differential bioamplifier for ECG.
2. Simulation of noise removal techniques (band-pass filtering, right-leg drive).

COURSE OUTCOMES:

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

CO1: Implement the principles, characteristics, and biomedical applications of transducers.
CO2: Practice the generation of bio-potentials used in clinical signal acquisition.
CO3: Demonstrate the measurement of physiological parameters using biomedical instruments.
CO4: Employ ECG, EEG, and EMG signal recording and waveform interpretation to detect abnormalities
CO5: Utilize bio-signal conditioning techniques to enhance signal quality during medical measurements.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Internal Assessment Test (70%), Activities (30%)

REFERENCES:

1.	Olfa Kanoun and Nabil Derbel, "Advanced Systems for Biomedical Applications", Springer, 2021.
2.	Webster, J. G**.,** "Medical Instrumentation: Application and Design. John Wiley & Sons**",** Fifth Edition, Indian Adaptation 2020.
3.	Khandpur, R. S.," Handbook of Biomedical Instrumentation", McGraw Hill Education, Third Edition, 2024.
4.	Leslie Cromwell, Fred J Weibell., "Biomedical Instrumentation & Measurement" Second Edition, The power of Knowledge,2025
5.	P.V.Kumar,"Biomedical Instrumentation - A Textbook on Basic Concepts and Instruments Used in Biomedical Instrumentation", White Falcon Publishing, 2024.

E resources/E materials:	
1.	https://onlinecourses.nptel.ac.in/noc25_bt49/preview

Mapping of Course Outcomes to Programme Outcomes

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

MX26102	Bio Signal Processing	L	T	P	TW/SL	Total	C	SDG
		45	0	30	45	120	4	3,4,9,10, 17

COURSE OBJECTIVES:

- To discuss of biomedical signals, noise sources, filtering techniques and spectrum analysis
- To perform Time series modelling and extract features from bio-signals
- To design Adaptive filters to eliminate noise and artifacts from Bio-signals
- To analysis the Biosignal for various applications
- To classify the bio-signals using optimal features

COURSE CONTENT:

Unit 1	Signal, System and Spectrum	9	0	6	9	24		3,4,9

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

Practical :

1. Implementation of FIR & IIR filters for ECG noise removal.
2. Power Spectral Density (PSD) estimation of EEG signals using Welch's method.

Activities:

1. Assignment on design of FIR & IIR filters.

Unit 2	Time Series Analysis and Spectral Estimation	9	0	6	9	24		3,4,9,10

Time series analysis – linear prediction models, Sequential estimation of poles and zeros, nonstationary process, fixed segmentation, adaptive segmentation, application in EEG, PCG and HRV signals, Spectral estimation – Blackman Tukey method, periodogram and model-based estimation

Practical :

1. Time series modeling of ECG signals using linear prediction (AR model).
2. Spectral estimation using Periodogram & Blackman-Tukey methods on HRV

Activities:

1. Case study on adaptive segmentation in EEG signals.

Unit 3	**Adaptive Filtering and Event Detection.**	**9**	**0**	**6**	**9**	**24**		**3,4,9,10, 17**

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

Practical :

1. Implementation of LMS adaptive filter for ECG denoising.
2. QRS detection using Pan Tompkins method

Activities:

1. Group project: Noise artifact removal from EMG recordings.

Unit 4	**Analysis of Biosignal**	**9**	**0**	**6**	**9**	**24**		**3,9**

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

Practical :

1. Analysis of ECG signal using time-domain features
2. Analysis of PCG signal using envelope extraction method.

Activities:

1. Mini-project:-Biosignal analysis in virtual instrumentation platform.

Unit 5	**Biosignal Classification**	**9**	**0**	**6**	**9**	**24**		**3,4,9,10**

Statistical signal classification, linear discriminate function, Back propagation neural network-biosignal classification using CNN & LSTM

Practical :

1. ECG classification using CNN/LSTM

Activities:

1. Simulation of statistical classification for EMG/EEG signals.

COURSE OUTCOMES:

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

CO1: Identify techniques to remove noises in biomedical signals and perform spectrum analysis.
CO2: Analyze biomedical signals using time-series and spectral estimation techniques.
CO3: Design adaptive filtering and event-detection methods to remove noise and analyze the

biosignals. CO4: Examine biosignals using envelope extraction and time-domain features. CO5: Apply statistical and deep learning models for biosignal classification.	
Weightage: Continuous Assessment: 50%, End Semester Examinations: 50%	
Assessment Methodology: Internal Assessment Test (30%), Activities (10%), Practical (10%)	
REFERENCES:	
1.	P.Ramesh Babu, "Digital Signal Processing", Seventh Edition, Scitech publications, Chennai, 2021.
2.	Paul S. Addison , "The Wavelet Transform Handbook: Introductory Theory and Applications in Science, Engineering, Medicine and Finance", Second Edition, CRC Press,2020.
3.	Hugo Humberto Plcido Da Silva, Hugo Filipe Silveira Gamboa, "Biosignal Acquisition and Processing: A Project-based Learning Approach", Springer Nature, 2024.
4.	Ariful Islam, "Digital Signal Processing with Python: A Practical Approach: Hands -on tutorials on Python for DSP", Kindle Edition, 2023.
5.	Paunwala C., "Biomedical Signal and Image Processing With Artificial Intelligence", Springer, 2023.
E resources/E materials:	
1.	https://nptel.ac.in/courses/108105101
2.	https://vlab.amrita.edu/?sub=3&brch=310&sim=1843&cnt=4
3.	https://bmsp-coep.vlabs.ac.in/List%20of%20experiments.html

Mapping of Course Outcomes to Programme Outcomes

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

MX26103	Human Anatomy and Physiology	L	T	P	TW/SL	Total	C	SDG
		45	0	0	45	90	3	3,4, 9,10, 11,17

COURSE OBJECTIVES:

- To understand the structural organization of the human body, including cells, tissues, and major organ systems essential for biomedical applications.
- To explain the physiological mechanisms that regulates body functions and maintains homeostasis under normal and altered conditions.
- To provide foundational knowledge of major organ systems such as cardiovascular, respiratory, nervous, digestive, endocrine, musculoskeletal, and urinary systems.
- To develop practical skills through laboratory activities, demonstrations, and case studies for better interpretation of anatomical structures and physiological processes.
- To relate anatomical and physiological concepts to biomedical engineering, enabling students to connect human physiology with diagnostic, therapeutic, and monitoring technologies.

COURSE CONTENT:

Unit 1	Human Body and Cellular Organization	9	0	0	9	18		3,4,9

Overview of human body organization: anatomical terms and body planes, Cell structure and functions of cell organelles, Transport mechanisms across cell membrane, Tissues – epithelial, connective, muscular, and nervous, Homeostasis and feedback mechanisms.

Activities:

1. Microscopy lab – identification of cell structures and tissues.
2. Case study on disorders related to cell cycle regulation.

Unit 2	Musculoskeletal and Nervous Systems Integumentary, Skeletal, Muscular and Respiratory Systems	9	0	0	9	18		3,4,9,10

Skeletal system – types of bones, joints, and movements, Skin (structure & functions), bones (types, formation, joints, cartilage), muscular system (parts, movement), respiratory system (structure, types, breathing, regulation).

Activities:

1.Skeleton model demonstration – identification of major bones & joints.

2.Spirometry experiment – measurement of lung volumes & capacities

Unit 3	Cardiovascular, Lymphatic and Endocrine Systems	9	0	0	9	18		3,4,9

Heart structure & conduction system, cardiac cycle, cardiac muscle properties, heart rate regulation, blood vessels, blood composition, Blood pressure regulation and circulation pathways, blood groups. Lymphatic organs, functions. Endocrine glands (pituitary, thyroid).

Activities:

1. ECG recording and analysis of heart rate.
2. Blood group determination practical.

Unit 4	**Nervous, Sense Organs and Reproductive Systems**	**9**	**0**	**0**	**9**	**18**		**3,4,10,11**

Neuron structure, properties, nerve impulse, CNS & PNS, brain parts, reflex mechanism. Sensory systems (eye, ear). Male and female reproductive organs and physiology, Menstrual cycle, pregnancy, and parturition (instead of Reproductive system (male & female anatomy).

Activities:

1. Reflex activity demonstration (e.g., knee-jerk reflex).
2. Model/diagram study of brain, eye, and ear structures.

Unit 5	**Digestive and Urinary Systems**	**9**	**0**	**0**	**9**	**18**		**3,4,10,17**

Digestive organs, digestion & absorption, kidney & nephron structure, urine formation, urinary reflex, blood pressure regulation by urinary system.

Activities:

1. Urine analysis (physical and chemical tests).
2. Chart/animation-based activity on digestive processes.

COURSE OUTCOMES:

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

CO1: Apply the principles of structural organization, cellular functions, and homeostatic mechanisms to explain normal human body functioning and physiological responses.

CO2: Inspect the anatomy and physiology of the integumentary, skeletal, muscular and respiratory systems and evaluate their functional interrelationships in maintaining body function and health.

CO3: Identify the functional organization of cardiovascular, lymphatic, and endocrine systems and analyze their regulatory mechanisms.

CO4: Analyze the functional aspects of the nervous, sensory, and reproductive systems using experimental and model-based observations.

CO5: Examine the physiological processes of digestion, excretion, and their role in homeostatic control mechanisms.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Internal Assessment Test (70%), Activities (30%)

REFERENCES:

1.	Guyton A.C. & Hall J.E., “Textbook of Medical Physiology”, Elsevier, Fourteenth Edition, 2021.
2.	Marieb E.N. & Hoehn K., “Human Anatomy & Physiology”, Pearson Education, Twelveth Edition, 2023.
3.	Tortora G.J. & Derrickson B., “Principles of Anatomy and Physiology”, Wiley, Sixteenth Edition, 2022.

4.	Ross & Wilson, "Anatomy and Physiology in Health and Illness", Elsevier, Fourteenth Edition, 2021.
5.	Sherwood L., "Human Physiology: From Cells to Systems", Cengage Learning, Tenth Edition, 2020.
E resources/E materials:	
1.	https://nptel.ac.in/courses/112/106/112106225
2.	https://nptel.ac.in/courses/121/105/121105024
3.	https://onlinecourses.nptel.ac.in/noc24_md19

Mapping of Course Outcomes to Programme Outcomes

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

MX26104	**Biomedical Instrumentation Laboratory**	**L**	**T**	**P**	**TW/SL**	**TOTAL**	**C**	**SDG**
		0	**0**	**60**	**0**	**60**	**2**	**3,4,9, 10,17**

Course Objectives: To provide hands-on experience in designing, recording, analysing, and evaluating biomedical signals, sensors, and medical devices, enabling students to understand instrumentation principles, safety standards, and real-time clinical applications.

- To design bio-signal acquisition and amplification circuits for ECG, EMG, and EEG signals.
- To measure key physiological parameters using biomedical sensors and instruments.
- To study isolation techniques for safe and reliable biomedical signal measurement.
- To record and analyze physiological responses such as auditory and optical signals.
- To design PCB layouts for biomedical amplifier circuits using suitable software.

LIST OF ACTIVITIES:

1. Design of pre amplifiers to acquire bio signals along with impedance matching circuit using suitable ICs.
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 heart Rate
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.

COURSE OUTCOMES:

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

CO1: Construct basic amplifiers and filter circuits for acquiring bio-signals.

CO2: Operate biomedical sensors and transducers to measure physiological parameters.

CO3: Implement signal conditioning and isolation techniques for accurate measurements.

CO4: Analyze recorded bio-signals to extract meaningful information.

CO5: Develop simple PCB layouts for biomedical instrumentation circuits.

Weightage: Continuous Assessment: 60%, End Semester Examinations: 40%

Assessment Methodology: Evaluation of Student's work, Observation, Record, Activities etc.(75%), Model Practical Exam (25%)

REFERENCES:

1.	Olfa Kanoun and Nabil Derbel, "Advanced Systems for Biomedical Applications", Springer, 2021.
2.	Webster, J. G**.,**" Medical Instrumentation: Application and Design", Fifth Edition, John Wiley & Sons, Indian Adaptation, 2020.
3.	Khandpur, R. S.," Handbook of Biomedical Instrumentation", Third Edition, McGraw Hill Education, 2024.
4.	Leslie Cromwell, Fred J Weibell, "Biomedical Instrumentation & Measurement", Second Edition, The power of Knowledge, 2025.
5.	P. V. Kumar,"Biomedical Instrumentation - A Textbook on Basic Concepts and Instruments Used in Biomedical Instrumentation", White Falcon Publishing, 2024.

E resources/E materials:

1.	NeuroKit2 — Open-Source Python ToolboxLink: https://github.com/neuropsychology/NeuroKit
2.	Biomedical Sensors Lecture (Scribd)Link: Biomedical Sensors Lecture Notes (PDF)
3.	OpenBCI Platform (EEG/EMG/EKG acquisition hardware + software) Link: https://openbci.com

Mapping of Course Outcomes to Programme Outcomes

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

RM26C01	**Research Methodology and Intellectual Property Rights**	**L**	**T**	**P**	**TW/SL**	**Total**	**C**	**SDG**
		45	**15**	**0**	**60**	**120**	**4**	**1,2,3,7**
COURSE OBJECTIVES:								
● To understand modern research processes, ethics, and data-driven decision making. ● To familiarize students with research design, data collection, and analysis methods. ● To develop skills in technical writing, publication, and presentation. ● To create awareness on Intellectual Property Rights and patent systems. ● To introduce contemporary research tools and innovation protection mechanisms.								
COURSE CONTENT:								
Unit 1	**Research Design and Modern Research Approaches**	**9**	**3**	**0**	**12**	**24**		**1**
Research ecosystem and lifecycle, types of research, problem identification, literature gap analysis, research questions and hypotheses, AI-assisted literature review tools, research design frameworks, qualitative and quantitative research, experimental and survey methods, research ethics and plagiarism awareness. **Activities:** Literature gap identification, ethics discussion.								
Unit 2	**Data Collection, Sources and Preparation**	**9**	**3**	**0**	**12**	**24**		**3**

Primary and secondary data sources, digital and open datasets, measurement scales, questionnaire design, sampling techniques, sample size estimation, data preprocessing, cleaning, transformation, and basic data visualization. **Activities:** Questionnaire design, data visualization exercise.								
Unit 3	**Data Analysis, Interpretation and Scientific Communication**	**9**	**3**	**0**	**12**	**24**		**2**
Descriptive and inferential statistics, hypothesis testing, correlation and regression basics, introduction to multivariate analysis, use of analytical tools (Excel/SPSS/Python – overview), interpretation of results, technical report writing, journal and conference paper formats (IEEE/IET), presentation techniques. **Activities:** Data analysis demo, paper formatting.								
Unit 4	**Intellectual Property Rights and Innovation Ecosystem**	**9**	**3**	**0**	**12**	**24**		**7**
Concept, meaning, and significance of Intellectual Property Rights (IPR); types of IPR including patents, copyrights, trademarks, industrial designs, and geographical indications; role of IPR in innovation, research, and economic development; overview of national IPR framework with reference to Indian Patent Office and international agreements under World Intellectual Property Organization; importance of IPR in academia, industry, and technology-driven entrepreneurship. **Activities:** IPR case study.								
Unit 5	**Patents and Technology Protection**	**9**	**3**	**0**	**12**	**24**		**2,7**
Patent concepts and objectives, patentability criteria, novelty and inventive step, patent specifications, prior art search, types of patent applications, patent filing process, examination and grant, licensing and technology valuation, career opportunities in patent and innovation management. **Activities:** Patent search exercise.								
COURSE OUTCOMES:								
At the end of the course, the students will be able to: CO1: Apply suitable research methodologies to formulate research problems. CO2: Design data collection instruments and choose appropriate sampling methods. CO3: Analyze and interpret research data using basic analytical tools. CO4: Apply appropriate IP strategies for safeguarding innovations and research outputs. CO5: Apply principles of IPR, patents, and ethical research practices in research and innovation activities.								
Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%								
Assessment Methodology: Internal Assessment Test (70%), Activities (30%)								
TEXT BOOKS:								
1.	John W. Creswell, J. David Creswell, “Research Design: Qualitative, Quantitative, and Mixed Methods Approaches”, Fifth Edition, Sage Publications, 2023.							

2.	Deborah E. Bouchoux, “Intellectual Property: Patents, Trademarks, Copyrights and Trade Secrets”, Fifth Edition, Cengage Learning, 2021.
REFERENCES:	
1.	Pamela S. Schindler, “Business Research Methods”, Fourteenth Edition, McGraw Hill, 2025.
2.	Deborah E. Bouchoux, “Intellectual Property: Patents, Trademarks, Copyrights and Trade Secrets”, Fifth Edition, Cengage Learning, 2021.
3.	David Hitchcock , “Patent Searching Made Easy”, Second Edition, Routledge, 2020.
4.	Wayne C. Booth, Gregory G. Colomb, Joseph M. Williams, Joseph Bizup, William T. FitzGerald ,” The Craft of Research”, Fifth Edition, University of Chicago Press, 2024.
5.	V.K. Ahuja,” Intellectual Property Rights: Law and Practice”, Third Edition, LexisNexis, 2022.
E resources/E materials:	
1.	WIPO IP Portal – Online learning modules on Intellectual Property Rights and patents.(https://www.wipo.int/academy)
2.	Google Scholar – Scholarly literature search and citation tracking platform. (https://scholar.google.com)
3.	Indian Patent Office (IPO) Website – Patent search, filing procedures, and legal guidelines. (https://ipindia.gov.in)

Mapping of Course Outcomes to Programme Outcomes

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

RM26C02	Research Tools Laboratory	L	T	P	TW/SL	Total	C	SDG
		0	0	60	0	60	2	4,9,16,17

COURSE OBJECTIVES:

- To provide hands-on training in modern research and project management tools.
- To develop skills in literature review, reference management, and plagiarism checking.
- To train students in research paper formatting, writing, and publication workflow.
- To introduce data analysis and visualization tools for research applications.
- To enable preparation of professional research reports and technical presentations.

LIST OF ACTIVITIES:

1. Research Planning and Project Management
1.1 Research lifecycle, milestones, and project planning
1.2 Gantt chart preparation using MS Project / Notion / OneNote

2. Literature Review and Reference Management
2.1 Advanced literature search using Google Scholar / Scopus
2.2 Reference management using Mendeley / Zotero

3. Research Problem Identification
3.1 Literature gap analysis, AI-assisted literature gap analysis
3.2 Research problem, objectives, and hypothesis formulation

4. Research Paper Formatting
4.1 IEEE / IET journal and conference templates
4.2 Professional writing using Overleaf , Grammarly

5. Publication Workflow
5.1 Journal selection using Elsevier Journal Finder
5.2 Peer review process and reviewer response simulation

6. Data Analysis – Basic Tools
6.1 Data entry, cleaning, and preprocessing
6.2 Descriptive statistics and graphical visualization

7. Data Analysis – Advanced Tools
7.1 Introduction to SPSS / MATLAB for research analysis
7.2 Interpretation of results and inference

8. Plagiarism Detection and Research Ethics
8.1 Plagiarism checking using Turnitin / Urkund
8.2 Ethical paraphrasing and citation practices

9. Referencing and Citation Standards
9.1 IEEE, APA referencing styles

9.2 Automated citation generation and consistency check

10. AI in Research and Automation
10.1 AI tools for research assistance, ChatGPT ,Perplexity AI -Automated summarization, idea generation
10.2 Ethical use of AI in research

COURSE OUTCOMES:

At the end of the course, the students will be able to:
CO1: Plan and manage research activities using modern research tools.
CO2: Conduct systematic literature review and manage references effectively.
CO3: Analyze and interpret research data using suitable software tools.
CO4: Prepare plagiarism-free research papers and technical reports.
CO5: Present research findings professionally through reports and presentations.

Weightage: Continuous Assessment: 60%, End Semester Examinations: 40%

Assessment Methodology: Evaluation of Student's work, Observation, Record, Activities etc.(75%), Model Practical Exam (25%)

REFERENCES:

1.	Wayne C. Booth, Gregory G. Colomb, Joseph M. Williams, Joseph Bizup, William T. FitzGerald , "The Craft of Research", Fifth Edition, University of Chicago Press, 2024.
2.	John W. Creswell, J. David Creswell, "Research Design: Qualitative, Quantitative, and Mixed Methods Approaches", Fifth Edition, SAGE Publications, 2023.
3.	Mark N. K. Saunders, Philip Lewis, Adrian Thornhill , "Research Methods for Business Students" , Ninth Edition, Pearson Education, 2023.
4.	Herman Aguinis," Research Methodology: Best Practices for Rigorous, Credible, and Impactful Research", SAGE Publications, 2025.
5.	Jiawei Han, Micheline Kamber, Jian Pei," Data Mining: Concepts and Techniques", Third Edition, Morgan Kaufmann / Elsevier 2025.

E resources/E materials:

1.	Reference organization, citation generation, PDF management https://www.mendeley.com
2.	Collaborative LaTeX writing for research papers https://www.overleaf.com.
3.	Plagiarism detection and originality reports https://www.turnitin.com.

Mapping of Course Outcomes to Programme Outcomes

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

MX26106	Technical Seminar	L	T	P	TW/SL	Total	C	SDG
		0	0	30	0	30	1	3,4,9

COURSE OBJECTIVES:

- In this course, students will develop their scientific and 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.

LIST OF ACTIVITIES:

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 analysing 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

Method of Evaluation:

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	3rd week	3% (the selected information must be area specific and of international and

	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 regularlyin your area 7. Attach a call for papers (CFP) from your area.		national standard)
Collection of Journal papers in the topic in the context of the objective – collect20 & 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,	4^{th} 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? 5 th week 8% (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper) • What simplifying assumptions does the author claim to be making? • What did the author	5^{th} week	8% (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)

	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)		
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 willbe evaluated based on the linking and classification amongthe papers)
Abstract	Prepare a draft abstract and give a presentation	9th week	6% (Clarity, purpose andconclusion) 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 /	11th week	10% (this component willbe evaluated based on the linking and

	categorization diagram in keeping with the goals of your survey		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 andlinking) 4% Plagiarism Check Report
Seminar	A brief 15 slides on your paper	14th week & 15th week	10% (based on presentation and Viva-voce)

COURSE OUTCOMES:

At the end of the course, the students will be able to:
CO1: Identify latest developments in the field of Medical Electronics.
CO2: Develop technical writing abilities for seminars, conferences and journal publications.
CO3: Make use of modern tools to present the technical details.

Weightage: Review 1: 25%, Review 2: 25% , Review 3: 50%

Assessment Methodology: Review:50%, Report: 30%, Viva-voce Examination: 20%

Mapping of Course Outcomes to Programme Outcomes

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

SEMESTER II

MX26201	Hospital Planning Organization and Management	L	T	P	TW/SL	Total	C	SDG
		45	0	0	45	90	3	3,4,8,9,10, 11,12,17

COURSE OBJECTIVES:

- To implement principles of hospital planning and infrastructure design
- To execute hospital organizational and administrative frameworks
- To demonstrate management practices in healthcare systems
- To utilize quality assurance and patient safety standards
- To operate modern healthcare technologies and digital systems

COURSE CONTENT:

Unit 1	Principles Of Management and Healthcare Systems	9	0	0	9	18		3,8,10

Forms of organization: Sole proprietorship, Partnership, Public and Private companies -Evolution of management and principles of management -Functions of management: Planning, Organizing, Staffing, Directing, Controlling- Healthcare delivery systems in India and global context - Public vs private healthcare systems - Levels of care: Primary, Secondary, Tertiary.

Activities:

1. Case Study Analysis: Analyze a real hospital (public vs private) and identify: Type of organization, Management structure, Level of healthcare delivery
2. Concept Map: Create a diagram showing: Evolution of management & Functions of management in a hospital.

Unit 2	Hospital Planning and Administration	9	0	0	9	18		3,9,11

Hospital administration and management concepts - Challenges in hospital administration -Hospital planning concepts and strategic planning - Design and layout of hospitals - Equipment planning and biomedical equipment management - Facility planning in hospitals -Legal aspects of hospital administration.

Activities:

1. Quiz: Hospital Planning, Design and Administration.

Unit 3	Human Resource Management in Hospitals	9	0	0	9	18		3,4,8

Staffing patterns in hospitals -Recruitment and selection process -Training and development of hospital staff - Organizational structures in hospitals -Career development and performance management.

Activities:

1. Role Play: Simulate a recruitment process- Interview panel, Candidate evaluation & Selection decision.

Unit 4	**Marketing and Healthcare Management**	**9**	**0**	**0**	**9**	**18**		**3,12,17**

Basic concepts of marketing -Principles of social marketing - Social marketing in healthcare sector - Consumer behavior in healthcare -Market research in health services -Advertising in healthcare sector -E-marketing of healthcare services

Activities:

1. Case study: Designing a Marketing Plan for a Healthcare Facility.
2. Report writing: Consumer Behaviour Study in Hospital Selection.

Unit 5	**Hospital Technical Support and Information Systems**	**9**	**0**	**0**	**9**	**18**		**3,4,9**

Hospital Information System (HIS) and technical support - Management decision systems and information requirements -Administrative information systems- Support service technical information systems- Medical transcription and medical records department -Network and IT infrastructure support -Biomedical equipment and medical device support systems - Importance of technical support services in hospitals.

Activities:

1**.** Flow diagram: Draw a Hospital Information System (HIS) flow diagram: Patient registration → Diagnosis → Billing → Record

2. Journal Reference: Hospital Information Systems (HIS) & Digital Health

COURSE OUTCOMES:

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

CO1: Identify management principles and organizational structures in healthcare systems for effective service delivery.

CO2: Develop hospital planning, design, and administrative strategies for effective healthcare facility management.

CO3: Analyze human resource management practices including staffing, recruitment, and training processes in hospital settings.

CO4: Apply marketing strategies and consumer behavior concepts in promoting healthcare services.

CO5: Examine hospital information systems and technical support services including IT infrastructure and biomedical equipment in healthcare operations.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Internal Assessment Test (70%), Activities (30%)

REFERENCES:

1.	B. M. Sakharkar, “A Guide to Hospital Administration and Planning”, Springer Nature Singapore, 2023.
2.	Ajay Garg, “Monitoring Tools for Setting up the Hospital Project: Initial Planning, Building and Equipment”, Springer Nature, 2023.

3.	D. C. Joshi and Mamta Joshi, "Hospital Administration", Second Edition, Jaypee Brothers Medical Publishers, 2022.
4.	Ajay Garg and Anil Dewan, "Manual of Hospital Planning and Designing: For Medical Administrators, Architects and Planners", Springer Nature Singapore, 2022.
5.	Syed Amin Tabish, "Hospital Management and Administration: Principles and Practice", Second Edition, Oxford University Press, 2021.
E resources/E materials:	
1.	NPTEL – Healthcare Management, Hospital Administration, Biomedical Systems https://nptel.ac.in/courses (Search: Healthcare Management / Hospital Administration / Biomedical Systems courses)
2.	MIT Open Courseware – Systems Engineering and Healthcare Systems https://ocw.mit.edu (Relevant areas: systems engineering, healthcare systems, operations research in healthcare)
3.	Ministry of Health and Family Welfare (Government of India) https://mohfw.gov.in (Policies, healthcare guidelines, national health programs, and hospital standards)

Mapping of Course Outcomes with Programme Outcomes

Course Outcomes	Programme Outcomes					
	1	**2**	**3**	**4**	**5**	**6**
CO1	2	1	2	2	1	2
CO2	3	2	3	2	2	2
CO3	2	2	2	2	1	3
CO4	2	2	2	3	1	2
CO5	3	2	3	2	3	2
CO	2	2	2	2	2	2

MX26202	**Medical Image Processing**	**L**	**T**	**P**	**TW/SL**	**Total**	**C**	**SDG**
		45	**0**	**0**	**45**	**90**	**3**	**3,4,9**

COURSE OBJECTIVES:

- To understand the fundamentals of medical image processing techniques and understand the basic concepts of image enhancement, image restoration, image segmentation, feature recognition in medical images.
- To provide information about various medical imaging modalities and provide information about classification and image visualization in medical image processing.

- To familiarize the student with the image processing facilities in MATLAB.

COURSE CONTENT:

Unit 1	**Concepts of Image Processing**	**9**	**0**	**0**	**9**	**18**		**4,9**

Image perception, Image fidelity criteria, Image model, Image sampling and quantization, Basic relationship between pixels, Image transforms-DFT, DCT, KLT, SVD and wavelet transform.

Activities:

1. Write a MATLAB program to reduce the resolution (sampling) of an image and display the result.

Unit 2	**Medical Image Enhancement and Restoration**	**9**	**0**	**0**	**9**	**18**		**3,9**

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

Activities:

1. Implement different filtering techniques using MATLAB/Python to remove noise from a medical image and compare the results.

Unit 3	**Medical Image Representation**	**9**	**0**	**0**	**9**	**18**		**3,4,9**

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

Activities: (Assignment)

1. Compare DICOM vs NIfTI vs Interfile vs Analyze 7.5.

Unit 4	**Medical Image Analysis and Classification**	**9**	**0**	**0**	**9**	**18**		**3,9**

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

Activities: (Case Study)

1. Tumor detection using medical images.

Unit 5	**Image Registrations and Visualization**	**9**	**0**	**0**	**9**	**18**		**3,9**

Image Registration: Rigid body transformation-Affine transformation, Principal axes registration, Iterative principal axes registration, Feature based registration, Image visualization: 2-D display methods, 3-D display methods, surface and volume based 3-D display methods.Surface Visualization and Volume visualization, 3-D Echocardiography, 3D+time Echocardiography, virtual reality based interactive visualization.

Activities: (Flipped Class)

1. Image registration techniques.
2. 3D visualization in medical imaging.

COURSE OUTCOMES:

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

CO1: Identify image processing concepts and image transforms.
CO2: Use image enhancement and restoration techniques to improve image quality.
CO3: Apply image representation methods and image file formats.
CO4: Analyze segmentation and feature extraction techniques for image classification.
CO5: Examine image registration and visualization techniques for 2D and 3D images.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Internal Assessment Test (70%), Activities (30%)

REFERENCES:

1.	Wolfgang Birkfellner, "Applied Medical Image Processing -A Basic course", 3rd Edition CRC Press, 2024.
2.	Wilhelm Burger, Mark J. Burge, "Digital Image Processing An Algorithmic Introduction", Springer, 2022.
3.	Jiri Jan," Medical Image Processing, Reconstruction and Analysis: Concepts and Methods", Second Edition, CRC Press, 2020.
4.	Elizabeth Berry, "A Practical Approach to Medical Image Processing", CRC Press, 2020.
5.	Majumder Dwijesh Kumar Dutta, Ray Dipankar, "Fundamentals of Medical Image Processing Using Matlab", PHI Learning, June 2022.
6.	Oleg S. Pianykh," Digital Imaging and Communications in Medicine DICOM A Practical Introduction and Survival Guide", Third Edition, Springer,2021.
7.	Alejandro Frangi, Jerry Prince & Milan Sonka," Medical Image Analysis", Elsevier, 2023.

E resources/E materials:

1.	https://in.mathworks.com/products/image-processing.html
2.	https://in.mathworks.com/products/image.html
3.	https://scikit-image.org/
4.	https://www.nih.gov/

Mapping of Course Outcomes with Programme Outcomes

Course Outcomes	Programme Outcomes					
	1	**2**	**3**	**4**	**5**	**6**
CO1	2	1	2	1	1	2
CO2	3	2	2	2	3	2
CO3	2	2	2	1	2	2
CO4	3	2	3	2	3	2
CO5	3	2	3	3	3	3
CO	3	2	2	2	2	2

MX26203	**Machine Learning Techniques**	**L**	**T**	**P**	**TW/SL**	**Total**	**C**	**SDG**
		45	**0**	**30**	**45**	**120**	**4**	**3,4,9**

COURSE OBJECTIVES:

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

COURSE CONTENT:

Unit 1	**Mathematical Background**	**9**	**0**	**6**	**9**	**24**		**4,9**

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.

Activities:

1. Study of Python Basic Libraries such as Statistics, Math, Numpy , Pandas and Matplotlib
2. Experiments that refresh Python, programming frameworks used for the course.

Practical Experiments:

1. Write a python program to compute Central Tendency Measures: Mean, Median, Mode, Measure of Dispersion: Variance, Standard Deviation.
2. Experiments that allow students to appreciate mathematics and data manipulation; (a) Features, Representation of the data/real-world phenomena (b) mathematical operations that manipulate the data (c) plot/visualise the data distributions (say in 2D) (d) eigen values, eigen vectors, rank of matrices.

Unit 2	**Supervised Learning**	**9**	**0**	**6**	**9**	**24**		**4,9**

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.

Activities:

1. Write a Python program to implement Simple Linear Regression
2. Experiment related to Nearest neighbour classifier, (a) visualize the decision boundaries (b) appreciate the role of hyperparameter K.

Practical Experiments:

1. Implement a binary classification model determine the model's effectiveness with different classification metrics.
2. Write a program to implement k-Nearest Neighbour Algorithm to classify the iris data set.

Unit 3	**Unsupervised Learning**	**9**	**0**	**6**	**9**	**24**		**4,9**

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

Activities:

1. Experiments related to K-Means, by varying in "K", "initialization". How the "analysis of the algorithm" can be seen in the lab (e.g. change of objective across iterations). Try multiple datasets.
2. Decision Tree as a classifier and see the overfitting with "deep" trees. How the overfitting can be controlled by seeing validation performance during the training

Practical Experiments:

1. Implement the k-means algorithm using https://archive.ics.uci.edu/ml/datasets/Codon+usage dataset
2. Dimensionality Reduction using PCA and its applications in (a) removing irrelevant features (b) compression /compaction

Unit 4	**Bayesian Learning**	**9**	**0**	**6**	**9**	**24**		**3,9**

Naïve Bayes Algorithm -Maximum Likelihood -Maximum Apriori -Bayesian Belief Networks - Probabilistic Modelling of Problems - Bayesian Linear Regression.

Activities:

1. An experiment that makes students appreciate the utility of naive Bayes classifier in practice (say designing a text classifier).
2. For a Simple linear dataset implement implement Bayesian Linear Regression and compare it with linear regression.

Practical Experiments:

1. Construct a Bayesian network to diagnose CORONA infection using standard WHO Data Set.
2. Implement the Naïve Bayes Classifier using https://archive.ics.uci.edu/ml/ datasets/ Gait+ 28 Classification dataset

Unit 5	**Neural Networks and Deep Learning**	**9**	**0**	**6**	**9**	**24**		**3,4,9**

Artificial 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

Activity:

1. Experiment that exposes the GD and BP in simple neural networks. Show the learning process (graphs) and performances.
2. See how (i) initialization (ii) momentum (iii) update rules have helped in getting better

solution

Practical Experiments:

1. Implement the convolutional neural network for feature extraction and classification of medical images
2. Experiment that use a modern library and implementation of a deep neural network, expose
3. computational graphs, expose the generalized way of appreciating BP as a learning algorithm in Deep Neural Networks

COURSE OUTCOMES:

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

CO1: Identify the concept of linear algebra and statistics to 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 Neural network and deep learning model for the given application.

Weightage: Continuous Assessment: 50%, End Semester Examinations: 50%

Assessment Methodology: Internal Assessment Test (30%), Activities (10%), Practical (10%)

REFERENCES:

1.	Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong," Mathematics for Machine Learning", Cambridge University Press ,2020
2.	Kevin P Murphy, "Probabilistic Machine Learning: An Introduction, MIT Press",2022.
3.	Ethem Alpaydın, "Introduction to Machine Learning", Fourth Edition, MIT Press, 2020.
4.	Aurélien Géron, "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow", Third Edition, O'Reilly Media, 2022.
5.	K. T. V. Reddy, N. D. Gopal, B. Eswara Reddy, "Concepts and Real-Time Applications of Deep Learning", Springer, 2022.

E resources/E materials:

1.	https://ocw.mit.edu/
2.	https://online.stanford.edu/

Mapping of Course Outcomes with Programme Outcomes

Course outcomes	Programme Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	1	2	3	1	-
CO2	2	1	3	2	3	1
CO3	2	1	3	2	3	1

CO4	2	1	3	3	2	-
CO5	3	2	3	2	3	2
CO	2	1	3	2	2	1

MX26204	**Data Acquisition and Design Laboratory**	**L**	**T**	**P**	**TW/SL**	**Total**	**C**	**SDG**
		0	**0**	**60**	**0**	**60**	**2**	**3,9,16**

COURSE OBJECTIVES:

- To understand the principles of X-ray generation and its applications in medical imaging systems
- To analyze various radio diagnostic techniques used in clinical practice
- To study advanced imaging modalities for cross-sectional visualization of the human body
- To comprehend the principles of Magnetic Resonance Imaging (MRI) and pulse sequence design
- To evaluate image quality and noise characteristics in medical imaging systems

LIST OF ACTIVITIES:

1. Acquisition and analysis of medical images using software tools
2. Development of algorithms for medical image compression
3. Design and implementation of neural networks for biomedical signal classification
4. Development of algorithms for medical data security and encryption
5. Simulation and analysis of instrumentation amplifier circuits
6. Multichannel data acquisition and analysis for EEG signals
7. Modeling and simulation of internal noise cancellation circuits
8. Study and implementation of DICOM standards for medical imaging
9. Study and simulation of lung and cardiovascular system models
10. Measurement and analysis of Galvanic Skin Resistance (GSR)

LAB REQUIREMENTS

Personal computers / Workstations with high processing capability /Data Acquisition (DAQ) systems /Biomedical sensors (EEG electrodes, GSR sensors, etc.) / Instrumentation amplifier kits. / MATLAB / Simulink (for signal & image processing) / LabVIEW (for data acquisition and visualization) /Python (with libraries like NumPy, OpenCV, TensorFlow) Medical image processing tools (ImageJ / ITK-SNAP).

COURSE OUTCOMES:

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

CO1: Interpret the principles and applications of X-ray imaging in medical diagnostics.
CO2: Perform medical image acquisition procedures using CT imaging techniques.
CO3: Apply appropriate projection and imaging methods for anatomical and biological analysis.
CO4: Implement medical imaging standards and physiological models in healthcare applications.
CO5**:** Analyze image quality and quantify noise in medical imaging systems.

Weightage: Continuous Assessment: 60%, End Semester Examinations: 40%	
Assessment Methodology: Evaluation of Student's work, Observation, Record, Activities etc.(75%), Model Practical Exam (25%)	
REFERENCES:	
1.	Gogoi, A., & Mazumder, N., "Biomedical Imaging: Advances in Artificial Intelligence and Machine Learning", Springer, 2024.
2.	Alper, C. M.," Recent Advances in Biomedical Imaging". MDPI, 2024.
3.	Paunwala, C., Paunwala, M., Kher, R., Thakkar, F., Kher, H., Atiquzzaman, M., & Noor, N. M., "Biomedical Signal and Image Processing with Artificial Intelligence", Springer, 2023.
E resources/E materials:	
1.	National Electrical Manufacturers Association – DICOM standard documentation for medical imaging
2.	MATLAB, Python, ImageJ – Image processing, signal analysis, and AI applications
3.	NPTEL – Online courses on biomedical instrumentation and signal processing

Mapping of Course Outcomes with Programme Outcomes

Course Outcomes	Programme Outcomes					
	1	**2**	**3**	**4**	**5**	**6**
CO1	3	2	2	2	2	2
CO2	3	2	3	2	3	2
CO3	2	2	3	2	3	2
CO4	3	2	2	3	2	2
CO5	2	2	2	2	2	3
CO	3	2	2	2	2	2

PROFESSIONAL ELECTIVE –I

MX26001	Tissue Engineering	L	T	P	TW/SL	Total	C	SDG
		45	0	0	45	90	3	3,8,9,12, 16,17

COURSE OBJECTIVES:

- To understand the basics of tissue engineering, cell mechanics and importance of biomaterials in tissue engineering.
- To understand the importance of stem cell in tissue engineering and tissue culture applications in human healthcare

COURSE CONTENT:

Unit 1	Concepts Of Tissue Engineering	9	0	0	9	18		3,9,12

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.

Activities:

1. Analyze a real-world tissue engineering application (e.g., skin or cartilage regeneration) and develop a concept map linking: tissue structure → cell–extracellular matrix interaction → development → morphogenesis → differentiation.

Unit 2	Cell Mechanisms	9	0	0	9	18		3,8,9

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

Activities:

1. Create a flowchart linking: cell adhesion → migration → aggregation → growth → differentiation

Unit 3	Biomaterials in Tissue Engineering	9	0	0	9	18		3,9,16

Biological vs Non biological materials – Extra Cellular Matrix – Collagen, Chitin & Degradable and Non degradable 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.

Activities:

1. Compare biological vs non-biological materials used in tissue engineering.

Unit 4	Stem Cells in Tissue Engineering	9	0	0	9	18		3,8,12,17

Hemopoetic Stem cells - Embryonic Stem cells - Adult stem cells – Cancer Stem cells – Cord Blood cells – Induced Pluripotent Stem cells - Stem cell identification - Surface markers & FACS analysis – Differentiation, Dedifferentiation and Immortalization – Application of stem cells in tissue Engineering.

Activities:

1. Seminar- Application of stem cells in tissue Engineering

Unit 5	**Tissue Engineering Applications**	**9**	**0**	**0**	**9**	**18**		**3,8,9,17**

Synthetic components – Artificial organs – Joints and dental prostheses - Connective Tissue Engineering – Cardiovascular Tissue Engineering – Neural Tissue Engineering - Cell and Drug Delivery systems.

Activities:

1. Analyze and compare different tissue engineering applications and propose a conceptual design for a suitable tissue engineering or drug delivery solution for a specific medical condition.

COURSE OUTCOMES:

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

CO1: Identify the fundamentals of tissue engineering, tissue structure, cell organization, and morphogenesis.

CO2: Analyze cell mechanisms including adhesion, migration, growth, interactions and in vitro culture techniques for tissue engineering.

CO3: Apply knowledge of biomaterials, scaffolds, and cell–material interactions in tissue engineering applications.

CO4: Evaluate the role of stem cells and tissue engineering applications in regenerative medicine, artificial organs, and drug/cell delivery systems.

CO5: Examine the design principles, material characteristics and functional performance of synthetic components used in artificial organs.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Internal Assessment Test (70%), Activities (30%)

REFERENCES:

1.	Robert P. Lanza, Robert Langer and Joseph Vacanti.,"Principles of tissue engineering", Academic Press, 2020,
2.	Beate Brand-Saberi," Essential Current Concepts in Stem Cell Biology", First Edition, Springer Nature, 2020,
3.	Pedro Granja, Diego Mantovani, Hakan Engqvist, "Handbook of Biomaterials", Wiley, 2025.
3.	Shane Hector,"Materials for Tissue Engineering: Building a Better Tomorrow", 2023.
4.	Rajesh K. Kesharwani , Raj K. Keservani , Anil K. Sharma, " Tissue Engineering: Applications and Advancements", Apple Academic Pr Inc, 2022
5.	Robert Lanza, Anthony Atala," Essentials of Stem Cell Biology", Fourth Edition, Academic Press, 2026,
6.	Joseph D. Bronzino Joon B. Park., "Biomaterials", Taylor & Francis, 2024.

E resources/E materials:	
1.	NPTEL NOC: Tissue Engineering
2.	PMC - NIH: Biomaterials and Stem Cells for Tissue Engineering
3.	BioTecNika: Tissue Engineering Certification Course
4.	Springer Nature: Tissue Engineering Book Series

Mapping of Course Outcomes with Programme Outcomes

Course Outcomes	Programme Outcomes					
	1	**2**	**3**	**4**	**5**	**6**
CO1	2	1	2	2	1	1
CO2	3	2	2	3	2	1
CO3	3	2	3	2	3	2
CO4	2	2	3	2	3	2
CO5	3	3	3	2	3	3
CO	3	2	3	2	2	2

MX26002	**Biomaterials and Biomechanics**	**L**	**T**	**P**	**TW/SL**	**Total**	**C**	**SDG**
		45	**0**	**0**	**45**	**90**	**3**	**3,4,9,10**

COURSE OBJECTIVES:

- To introduce the fundamental concepts and classifications of biomaterials including metals, ceramics, polymers, composites, and biomimetic materials.
- To understand the mechanical, chemical, and surface properties of biomaterials and their interaction with biological systems.
- To provide knowledge on sterilization techniques and standard testing methods for evaluating biocompatibility.
- To study the biomechanics of tissues and fluids, including bone, soft tissues, and blood flow behavior.
- To analyze movement biomechanics and the design principles of implants and prosthetic devices.
- To understand the mechanics of cardiovascular and respiratory systems and their biomedical applications.

COURSE CONTENT:

Unit 1	**Biomaterials**	**9**	**0**	**0**	**9**	**18**		**3,9**

Definition of biomaterials, Metals, Ceramics, Polymers and Biomimetic Materials, Composites. mechanical properties, surface chemistry of materials, surface modification, Tissue Reaction, Wound

Kinetics, Bio Compatibility, Material preparation, Properties, uses in medicine and biosciences and failure mechanisms.

Activities:

1. Case study: Failure Analysis of a Titanium Hip Implant
2. Quiz : Biomaterials

Unit 2	**Sterilization and Testing of Biomaterials**	**9**	**0**	**0**	**9**	**18**		**3**

Sterilization techniques. ETO, gamma radiation, autoclaving. Effects of sterilization on material properties. 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.

Activities:

1. Case study: Sterilization-Induced Failure of a Polymer-Based Medical Device
2. Think pair share : Selection of Sterilization Technique and Biocompatibility Testing

Unit 3	**Tissue and Fluid Biomechanics**	**9**	**0**	**0**	**9**	**18**		**3,4**

Mechanical properties of bone, cortical and cancellous bones, viscoelastic properties, Maxwell & Voight models. Electrical properties of bone, type of fractures. Soft Tissues: Cartilage, Tendon, Ligament, and Muscle; Structure and functions - Material Properties, Modeling. Newton's law, stress, strain, elasticity, Hooke's law, viscosity, Newtonian fluid, non-Newtonian fluid, viscoelastic fluids, Velocity and pressure profile of blood flow, Resistance against flow.

Activities:

1. Case study: Biomechanical Analysis of Bone Fracture and Blood Flow Complications
2. Concept map activity : Integrated Biomechanics of Tissues and Fluids

Unit 4	**Movement Biomechanics and Implants**	**9**	**0**	**0**	**9**	**18**		**3,10**

Gait analysis, Analysis of Joints forces in Elbow, knee and shoulder. General concepts of Implants, classification of implants, soft tissue and Hard tissue replacement, Design of orthopedic implant, specifications for a prosthetic joint, fixation of implants.

Activities:

1. Case study: Design and Performance Analysis of a Knee Prosthetic Implant
2. Research paper writing: Recent Advances in Orthopedic Implants and Biomechanics

Unit 5	**Cardiac & Respiratory Mechanics**	**9**	**0**	**0**	**9**	**18**		**3,9**

Cardiovascular system, Mechanical properties of blood vessels: arteries, arterioles, capillaries, and veins. Function of native heart valves, artificial heart valves, biological and mechanical valves development, testing of valves. Alveoli mechanics, Interaction of blood and lung, P-V curve of lung, Breathing mechanism, Airway resistance, Physics of lung diseases.

Activities:

1. Case study: Failure Analysis of an Artificial Heart Valve and Respiratory Complication

2. Research paper writing: Advances in Cardiovascular and Respiratory Biomechanics

COURSE OUTCOMES:

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

CO1: Identify the classification, properties, preparation methods, and applications of biomaterials used in medical and bioscience fields.

CO2: Examine the interaction of biomaterials with biological systems, including tissue reactions, wound healing, biocompatibility, and failure mechanisms.

CO3: Evaluate sterilization techniques (ETO, gamma radiation, autoclaving) and standard testing methods (in vitro, in vivo, ISO standards) for assessing biomaterials.

CO4: Apply principles of biomechanics to study mechanical and viscoelastic properties of bone, soft tissues, and fluid mechanics of blood flow.

CO5: Analyze movement biomechanics, implant design, and the mechanics of cardiovascular and respiratory systems for biomedical applications.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Internal Assessment Test (70%), Activities (30%)

REFERENCES:

1.	Roger Narayan, "Biomedical Materials", Second Edition, Springer, 2021.
2.	Rishabha Malviya and Sonali Sundram, "Engineered Biomaterials: Synthesis and Applications", Springer, 2023.
3.	Vivek Sheel Rajput and Jasdeep Bhinder, "Advanced Materials for Biomedical Applications: Development and Processing", Springer, 2024.
4.	Deepa Suhag, "Handbook of Biomaterials for Medical Applications", Springer, 2024.
5.	Anurag Dixit, Anil Kumar and D. K. Pathak," Additive Manufacturing for Biomedical Applications: Recent Trends and Challenges", Springer, 2024.
6.	Arnab Chanda, Sarabjeet Singh Sidhu and Gurpreet Singh, "Materials for Biomedical Simulation: Design, Development and Characterization", Springer, 2023.
7.	Arnab Chanda and Gurpreet Singh, "Soft Tissue Simulants", Springer, 2024.
8.	Ajit Behera, Debasis Nayak and Biswajit K. Swain, "Surface Engineering of Biomaterials: Synthesis and Processing Techniques", CRC Press, 2024.

E resources/E materials:

1.	https://archive.nptel.ac.in/noc/courses/noc21/SEM1/noc21-bt08/
2.	https://www.youtube.com/watch?v=Cb3PdAlb9EU

3.	https://www.youtube.com/watch?v=ulunrSz5H0o

Mapping of Course Outcomes with Programme Outcomes

Course Outcomes	Programme Outcomes					
	1	**2**	**3**	**4**	**5**	**6**
CO1	2	1	3	2	2	1
CO2	3	2	3	2	2	1
CO3	2	2	3	1	2	3
CO4	2	1	3	3	3	1
CO5	3	2	3	3	3	2
CO	2	2	3	2	2	2

MX26003	**Micro and Nano Fluids**	**L**	**T**	**P**	**TW/SL**	**Total**	**C**	**SDG**
		45	**0**	**0**	**45**	**90**	**3**	**6, 7, 9, 12, 13**

COURSE OBJECTIVES:

- To explain the fundamental principles governing microscale and nanoscale fluid flows.
- To interpret interfacial phenomena and their influence in micro/nanofluidic systems.
- To examine advanced fabrication techniques used in micro- and nanofluidic devices.
- To investigate lab-on-chip systems and fluid manipulation mechanisms for biomedical applications.
- To assess the role of micro/nanofluidics in energy and environmental applications.

COURSE CONTENT:

Unit 1	**Microscale and Nanoscale Flows**	**9**	**0**	**0**	**9**	**18**		**6,7**

Definition of a fluid, Pressure-driven flows, Low Reynolds number flows, Electrokinetic phenomena, The electric double layer, Debye length, Electrokinetic phenomena: revisited, Coupling species transport and fluid mechanics, Numerical simulations and advanced modeling methods.

Activities:

1. Self-study task: Explore real-world examples of low Reynolds number flows (e.g., blood flow in capillaries) and write a short note.
2. Concept mapping: Create a visual map linking Reynolds number, electrokinetics, and transport phenomena.
3. Numerical practice: Solve problems on pressure-driven and electroosmotic flows.
4. Mini research: Summarize one journal paper on electrokinetic flow in microchannels.

Unit 2	**Interfaces in Microfluidic and Nanofluidic Systems**	**9**	**0**	**0**	**9**	**18**		**9,12**

Surfaces, Surface charge, Surface energy, Thermodynamics of surfaces, Surface characterization methods with relevance to microfluidics and nanofluidics, Surface tension-driven flows, Device interfaces.

Activities:

1. Case exploration: Identify how surface properties affect a real microfluidic device (e.g., lab-on-chip).
2. Poster Presentation: Draw and label electric double layer and surface energy profiles.
3. Reflection note: Write a brief explanation of how surface chemistry impacts device performance.

Unit 3	**Fabrication Methods and Techniques**	**9**	**0**	**0**	**9**	**18**		**9,13**

Micro- and nano fabrication, Advanced patterning techniques, Materials in micro- and nano fluidics, Fabrication case study.

Activities:

1. Video-based learning: Watch tutorials on photolithography and soft lithography and summarize steps.
2. Design task: Sketch a microfluidic chip with labeled fabrication layers.
3. Material study: Compare properties of PDMS, silicon, and glass in a tabular form.
4. Self-assessment quiz: Prepare MCQs based on fabrication techniques.

Unit 4	**Lab-On-A-Chip and Fluid Manipulation Applications**	**9**	**0**	**0**	**9**	**18**		**9**

Fluid manipulation, Microvalves and nanovalves, Micropumps and nanopumps, On-chip separations and combinations, Transport and analysis systems for DNA, Biosensors, Nanomedicine and nano biotechnology, Instrumentation and platforms at the microscale and nanoscale.

Activities:

1. Application review: Study one lab-on-chip system used in diagnostics and write its working principle.
2. Component analysis: Compare micropumps vs microvalves in terms of function and efficiency.
3. Innovation task: Propose a simple biosensor-based microfluidic application.
4. Presentation : Create slides explaining DNA analysis using microfluidics.

Unit 5	**Energy and Environmental Applications**	**9**	**0**	**0**	**9**	**18**		**7, 6, 9, 13**

Combustion-based devices, Microfuel cells, Electrokinetic energy conversion, Sensors for water contamination, Energy-efficient water purification, Asymmetry-driven ion pumps.

Activities:

1. Literature survey: Review recent applications of microfluidics in water purification or fuel cells.
2. Case study write-up: Analyze a microfuel cell system and its advantages.

3. Critical thinking: List benefits of electrokinetic energy conversion over conventional methods.
4. Sustainability note: Explain how microfluidics contributes to environmental protection.

COURSE OUTCOMES:

At the end of the course, the students will be able to:
CO1: Demonstrate microscale flow behavior and electrokinetic effects.
CO2: Implement interfacial phenomena in micro/nanofluidic systems.
CO3: Analyse fabrication methods and material selection for micro/nanodevices.
CO4: Examine lab-on-chip systems and fluid manipulation techniques in bio-applications.
CO5: Assess micro/nanofluidic technologies for energy conversion and environmental sustainability.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Internal Assessment Test (70%), Activities (30%)

REFERENCES:

1.	Tabeling, P., "Introduction to Microfluidics", Second Edition, Oxford University Press, 2023.
2.	Murshed, Sohel, S.M, "Advances in Microfluidics and Nanofluids", London Intech Open, 2021.
3.	Bastian E. Rapp, "Microfluidics: Modeling, Mechanics and Mathematics" Elsevier Science Ltd, 2022.
4.	A. K. Pandey, H. Upreti , O. D. Makinde , A. J. Chamkha, "Applications of Hybrid Nanofluids in Science and Engineering", CRC Press, 2025.
5.	Mohammad Mehdi Rashidi, "Nanofluids: Preparation, Applications and Simulation Methods (Micro and Nano Technologies)", Elsevier Science Ltd, 2024.

E resources/E materials:

1.	NPTEL Course: Microfluidics and Nanofluidics, https://onlinecourses.nptel.ac.in/noc23_me134/preview
2.	NPTEL Course: Biomicrofluidics, https://onlinecourses.nptel.ac.in/noc19_bt27/preview

Mapping of Course Outcomes with Programme Outcomes

Course Outcomes	Programme Outcomes					
	1	**2**	**3**	**4**	**5**	**6**
CO1	2	1	3	1	2	1
CO2	2	1	3	2	2	1
CO3	3	2	3	1	3	2
CO4	2	2	3	3	3	2
CO5	3	2	3	3	2	3
CO	2	2	3	2	2	2

MX26004	Mixed Reality	L	T	P	TW/SL	Total	C	SDG
		45	0	30	45	120	4	3,4,8,9,12

COURSE OBJECTIVES:

- Apply VR, AR, and MR concepts with 3D graphics to build basic virtual environments.
- Apply 3D interaction techniques and transformations to model and manipulate virtual objects.
- Analyse animation, simulation, and rendering techniques to enhance VR system performance.
- Develop AR/MR applications using tools such as Unity, Unreal Engine, and Vuforia.
- Design and evaluate VR/MR applications based on usability and real-world requirements.

COURSE CONTENT:

Unit 1	Virtual Reality	9	0	6	9	24		4,9,12

Overview of Mixed Reality: Definitions and differences between VR, AR, and MR. Core VR Concepts: Virtual environment requirements, benefits, and historical context. 3D Computer Graphics: Virtual world space, perspective projection, stereographic imaging, basic 3D modeling, illumination models (Phong, Gouraud), shading algorithms, hidden surface remova

Activities:

1.VR/AR/MR concept comparison

2. Study of evolution and applications of VR systems

3. Exploration of basic 3D graphics concepts and visualization techniques

Practical Experiments:

1. VR Scene Development: Create a VR scene in Unity with 3D objects, lighting, shading, and collision detection.

Unit 2	Interactive Techniques in Virtual Reality	9	0	6	9	24		4,8,9

3D Interaction: Transition from 2D to 3D, 3D space curves, boundary representation. Geometrical Transformations: Frames of reference, modelling transformations, scaling, collision detection

Activities:

1. VR/AR/MR concept mapping
2. Study of virtual environments and historical evolution of VR
3. Basic 3D object modelling and visualization exercises

Practical Experiments:

1**.** VR Scene Development: Create a VR scene in Unity with 3D objects, lighting, shading, and collision detection.

2. Basic 3D Modelling: Design simple 3D objects and apply transformations, lighting, and shading techniques**.**

Unit 3	VR Systems and Visual Computation in Virtual Reality	9	0	6	9	24		4,9

Components (virtual environment, computer environment, VR technology), interaction models, introduction to Unity/Unreal Engine for VR development. Animation in VR: Linear/non-linear interpolation, object animation, shape in-betweening. Physical Simulation: Gravity, elastic collisions, projectiles, basic physics in VR using Unity/Unreal Engine physics engines. Real-Time Rendering: Optimization techniques for VR performance

Activities:

1. Study of VR system components and interaction models
2. Exploration of animation techniques in virtual environments
3. Analysis of physical simulation and real-time rendering concepts

Practical Experiments:

1. Physics-Based VR Application: Build a VR application in Unity with animated objects and physics interactions (gravity, projectiles).
2. Animation Experiment: Create object animations using interpolation techniques in Unity.

Unit 4	**Augmented and Mixed Reality**	**9**	**0**	**6**	**9**	**24**		**4,9**

AR/MR Fundamentals: Taxonomy, technology, differences between AR and VR, challenges. AR Techniques: Marker-based and marker-less tracking, visualization methods, ARKit/ARCore integration. Applications: AR in education, mobile interfaces, interactive environments.

Activities:

1. Study and comparison of AR, VR, and MR technologies
2. Exploration of AR tracking techniques (marker-based and marker-less)
3. Analysis of real-world AR applications in education and mobile systems

Practical Experiments:

1. AR/MR Application: Develop an AR/MR application using Unity and Vuforia for an educational or gaming use case (interactive visualization or simple AR game).
2. Marker-Based AR Experiment: Create an AR application using image markers for object visualization.

Unit 5	**I/O Interfaces and Applications of VR/MR**	**9**	**0**	**6**	**9**	**24**		**3,4,9**

Human Factors: Eye, ear, haptic feedback in VR/MR. Hardware: Sensors, head-mounted displays (HMDs), motion trackers, haptic devices. Software: VR/MR toolkits (Unity, Unreal Engine, Vuforia), VRML basics, application development. Industry Applications: VR/MR in gaming, film, education, medical visualization (e.g., surgery simulation)

Activity:

1. Analyze how visual perception (eye) works in VR (depth, stereoscopy)
2. Study audio perception (ear) including spatial sound
3. Explore haptic feedback and its importance in immersion

Practical Experiments:

1. Create a simple VR environment using Unity

Tasks:

- Add 3D objects and environment
- Implement basic navigation (walk/look around)
- Integrate simple interaction (object selection)

COURSE OUTCOMES:

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

CO1: Apply fundamental concepts of Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR) along with 3D graphics techniques to develop basic virtual environments.

CO2: Apply 3D interaction techniques and geometrical transformations to model, manipulate, and visualize objects in virtual environments.

CO3: Analyse animation, physical simulation, and real-time rendering techniques to design efficient and interactive VR systems.

CO4: Develop Augmented and Mixed Reality applications using tools such as Unity and Vuforia by implementing tracking and visualization techniques.

CO5: Evaluate VR/MR systems by integrating hardware components, human factors, and application requirements for real-world use cases.

Weightage: Continuous Assessment: 50%, End Semester Examinations: 50%

Assessment Methodology: Internal Assessment Test (30%), Activities (10%), Practical(10%)

REFERENCES:

1.	Ralf Doerner, Wolfgang Broll, Paul Grimm and Bernhard Jung, "Virtual and Augmented Reality: Foundations and Methods of Extended Realities (XR)", Springer, 2022.
2.	Jitendra Kumar Verma and Sudip Paul, *"*Advances in Augmented Reality and Virtual Reality", Springer, 2022.
3.	Karupppasamy Subburaj, Sunpreet Singh, Saša Ćuković, Kamalpreet Sandhu, Gerrit Meixner and Radu Emanuil Petruse, "Smart VR/AR/MR Systems for Professionals*"*, CRC Press, 2024
4.	Sumit Badotra, Sarvesh Tanwar, Ajay Rana, Nidhi Sindhwani and Ramani Kannan, "Handbook of Augmented and Virtual Reality", De Gruyter, 2023
5.	Mamata Rath and Tusharkanta Samal, "Modern Development and Challenges in Virtual Reality", IntechOpen, 2023.

E resources/E materials:

1.	NPTEL, "Foundation Course on Virtual Reality and Augmented Reality", IIT Madras, 2022.Available at: https://elearn.nptel.ac.in
2.	National Institute of Electronics & Information Technology, AR/VR Training Resources, Government of India.
3.	NPTEL, "Foundation for Virtual and Augmented Reality Systems", IIT Guwahati, 2026.Available at: https://onlinecourses.nptel.ac.in/noc26_cs03/preview

Mapping of Course Outcomes with Programme Outcomes

Course Outcomes	Programme Outcomes					
	1	**2**	**3**	**4**	**5**	**6**
CO1	2	1	3	3	2	1
CO2	2	1	3	3	3	1
CO3	3	1	3	3	2	2
CO4	3	2	3	2	3	2
CO5	3	2	3	2	3	3
CO	3	1	3	3	3	2

MX26005	**Wearable Technologies**	**L**	**T**	**P**	**TW/SL**	**Total**	**C**	**SDG**
		45	**0**	**0**	**45**	**90**	**3**	**3,7,9,10**

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.

COURSE CONTENT:

Unit 1	**Concept of Wearables**	**9**	**0**	**0**	**9**	**18**		**3,9**

Attributes of wearables, Meta-wearable, Challenges and opportunities, Future of wearables - Social aspects of wearability and interaction: Social interpretation of Aesthetics – Adoption of Innovation and Aesthetic Change, On-Body Interaction: Social Acceptance of Gesture. Wearable haptics: Need for wearable haptic devices - Categories of wearable haptic and tactile display – Wearable sensorimotor enhancer.

Activities:

1. Case study: Google glass
2. Think-Pair-Share: "Why do some wearables succeed socially while others fail?"

Unit 2	**Wearable Sensors**	**9**	**0**	**0**	**9**	**18**		**3,9**

Wearable bio and chemical sensors- System design, Challenges in chemical Bio-chemical sensing, Application areas. Wearable Inertial Sensors -Wearable Inertia sensors, Parameters from inertia sensors - Applications for wearable motion sensors. Measurement of energy expenditure by body worn heat flow sensors-Energy expenditure background, Examples of body worn devices.

Activities:

1. Group Seminar: Accelerometers vs Gyroscopes in Wearables
2. Skill-Based Activity: Design a wearable system for Health monitoring / environmental

sensing.

Unit 3	**Flexible Electronics**	**9**	**0**	**0**	**9**	**18**		**7,9**

Thin-film transistors: Materials and Technologies, Review of Semi-conductors in flexible electronics - Thin-FilmTransistors Based on a-IGZO, Further Improvements and Limitations, Plastic Electronics for SmartTextiles. Low-power Integrated Circuit Design for Bio-potential sensing: Low- power design for ADCs – Low power Digital circuit design techniques - Architectural design for low-power bio-potential acquisition, Practical considerations.

Activities:

1. Think-Pair-Share: Can flexible electronics replace conventional silicon electronics completely?"
2. Quiz: Low-power design basics

Unit 4	**Energy Harvesting Systems**	**9**	**0**	**0**	**9**	**18**		**7,9**

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.

Activities:

1. Concept Mapping: Human energy sources (heat, motion)
2. Case study: Smartwatch energy management

Unit 5	**Monitoring Physical and Physiological Parameters**	**9**	**0**	**0**	**9**	**18**		**3,10**

Wearable sensors for the early detection of diseases: Cardiovascular diseases, 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

Activities:

1. Case study: Future directions of wearable assistive technology.
2. Presentation: Why use the tongue for wearable Technology?

COURSE OUTCOMES:

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

CO1: Apply and analyze wearable technologies to evaluate future trends and socio-economic impacts.

CO2: Apply sensor selection and signal processing techniques and analyze system requirements in wearable systems. CO3: Apply knowledge of flexible electronic materials and analyze power constraints and performance trade-offs.

CO4: Apply energy harvesting techniques from the human body and analyze efficiency issues and design challenges.

CO5: Apply wearable technologies in healthcare and analyze their effectiveness and limitations.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Internal Assessment Test (70%), Activities (30%)

REFERENCES:

1.	Edward Sazonov, Michael R. Neuman," Wearable Sensors: Fundamentals, Implementation and Applications", Academic Press, 2021.
2.	Ram K. Gupta, Inamuddin, Ali Mohammad," Flexible and Wearable Sensors: Materials, Technologies and Challenges", Springer, 2020.
3.	Subhas Chandra Mukhopadhyay, "Flexible Bioelectronics for Power Autonomous Sensing and Data Analytics ", Springer, 2022.
4.	Haider Butt, Muhammad M. Qasim," Flexible and Wearable Electronics for Smart Clothing", Wiley, 2021.
5.	Garima Srivastava, Manju Khari ,"Bioelectronics and Medical Devices Applications and Technology", CRC Press,2024.
E resources/E materials:	
1.	WEARABLE TECH - YouTube
2.	Wearable Technologies: Innovation platform & professional networking solutions - YouTube
3.	Wearable Devices - YouTube
4.	https://pmc.ncbi.nlm.nih.gov/articles/PMC11265384
5.	Wearable Technologies | Videos

Mapping of Course Outcomes with Programme Outcomes

Course Outcomes	Programme Outcomes					
	1	**2**	**3**	**4**	**5**	**6**
CO1	2	3	1	2	2	1
CO2	3	3	2	2	2	1
CO3	3	2	3	1	2	1
CO4	2	3	2	2	2	1
CO5	2	3	2	3	3	2
CO	2	3	2	2	2	1

OPEN ELECTIVE COURCES (OEC)

MX26901	Tele Health Technology	L	T	P	TW/SL	Total	C	SDG
		45	0	0	45	90	3	3,9,10,16

COURSE OBJECTIVES:

- To understand the concepts, evolution, and applications of telemedicine in healthcare services.
- To apply multimedia, networking, and communication technologies in telemedicine systems.
- To familiarize telemedicine standards, security mechanisms, and legal aspects related to healthcare data.
- To explore mHealth technologies, and healthcare applications for remote monitoring and communication.
- To examine the impact of telemedicine applications in advanced healthcare services.

COURSE CONTENT:

Unit 1	Telemedicine and Health	9	0	0	9	18		3,10,16

History and Evolution of telemedicine, Organs of telemedicine, Global and Indian scenario, Ethical and legal aspects of Telemedicine – Confidentiality, Social and legal issues, Safety and regulatory issues, Advances in Telemedicine.

Activities:

1. Case Study: Telemedicine for Rural Healthcare.
2. Quiz: Basics of Telemedicine Technologies.

Unit 2	Telemedical Technology	9	0	0	9	18		3,9

Principles of Multimedia – Text, Audio, Video, data, Data communications and networks, PSTN, POTS, ANT, ISDN, Internet, Air/ wireless communications Communication infrastructure for telemedicine – LAN and WAN technology. Satellite communication, Mobile communication.

Activities:

1. Case Study: Multimedia Components in Telemedicine
2. Think Pair Share: Limitations of Wireless Communication in Telemedicine

Unit 3	Telemedical Standards Security and Legal Issues	9	0	0	9	18		3,9,16

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 Conferencing, Security and confidentiality of medical records, Cyber laws related to telemedicine.

Activities:

1. Case study: Evaluate how DICOM standards enable secure medical image sharing between hospitals.
2. Flowchart: Phases of encryption in secure telemedicine communication.

Unit 4	m-Health and Telemedicine	9	0	0	9	18		3,9,10

Mobile Devices: Smart phones, Tablet PCs, iPads, PDAs, Wearable computers – mHealth technology and communication infrastructure - Healthcare Apps – m-Health applications: Education and awareness, Remote data collection, Remote monitoring, Communication and training for healthcare workers.

Activities:

1. Case study: Analyze the role of smartphones in remote patient monitoring during emergency healthcare situations.
2. Research paper writing: Applications of wearable computers in improving chronic disease management.

Unit 5	**Telemedical Applications**	**9**	**0**	**0**	**9**	**18**		**3,9,10**

Telemedicine access to health care services – health education and self-care. Introduction to robotics surgery, telesurgery. Telecardiology, Teleoncology, Telemedicine in neurosciences, Telemedicine access to health care services.

Activities:

1. Case study activity: Evaluate the effectiveness of telecardiology in emergency cardiac care.
2. Research paper writing: Applications of robotic surgery in modern healthcare systems.

COURSE OUTCOMES:

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

CO1: Analyze telemedicine concepts and healthcare services.

CO2: Utilize multimedia and communication technologies and differentiate networking infrastructure used in telemedicine.

CO3: Identify security protocols and telemedicine standards and investigate data security and cyber laws.

CO4: Evaluate healthcare applications for remote monitoring and communication.

CO5: Investigate telemedicine applications in specialized healthcare services.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Internal Assessment Test (70%), Activities (30%)

REFERENCES:

1.	Tanupriya Choudhury, Avita Katal, Jung-Sup Um, Ajay Rana, and Marwan Al-Akaidi, “Telemedicine: The Computer Transformation of Healthcare”, Springer, 2023.
2.	Sinjini Mitra, “Advances in Mobile Health Technology: A Research Perspective”, CRC Press, 2022.
3.	Kota Kodama, and Shintaro Sengoku, " Mobile Health (mHealth): Rethinking Innovation Management to Harmonize AI and Social Design ", Springer, 2022.
4.	Mamta Mittal, and Gopi Battineni, “Information and Communication Technology (ICT) Frameworks in Telehealth”, Springer, 2023.

5.	Hossam Mahmoud, Hady Naal, and Emile Whaibeh, "Essentials of Telebehavioral Health: A Practical Guide", Springer, 2022.
E resources/E materials:	
1.	https://www.physio-pedia.com/Fundamentals_of_Telehealth_Technology
2.	https://www.youtube.com/watch?v=U5xsX2ersHQ
3.	https://www.youtube.com/watch?v=mfePdDh9t6Q

Mapping of Course Outcomes with Programme Outcomes

Course Outcomes	Programme Outcomes					
	1	**2**	**3**	**4**	**5**	**6**
CO1	2	1	3	1	2	2
CO2	2	1	3	3	3	2
CO3	2	2	3	2	2	3
CO4	2	2	3	2	3	3
CO5	3	2	3	2	3	3
CO	2	2	3	2	3	3

MX26902	**Diagnostic and Therapeutic Equipment**	**L**	**T**	**P**	**TW/SL**	**TOTAL**	**C**	**SDG**
		45	**0**	**0**	**45**	**90**	**3**	**3,4,8,9, 12**

COURSE OBJECTIVES:

- Understand the devices for measurement of parameters related to cardiology.
- To learn how EEG, MEG, and evoked potential systems record and interpret brain activity.
- To study EMG and nerve stimulation techniques used to assess muscle and nerve functions.
- To gain knowledge on design principles of respiratory devices
- To gain knowledge on design of diathermy unit and essential electrical safety practices

COURSE CONTENT:

Unit 1	**Cardiac Care Units**	**9**	**0**	**0**	**9**	**18**		**3,9**

Pacemakers, DC defibrillators (asynchronous & synchronous), patient monitoring systems, principles of bio-telemetry, Echocardiography- Modes - Doppler Echocardiography- Advanced Techniques.

Activities:

1. Virtual demonstration on pacemaker design and battery longevity.
2. Simulation of patient monitoring and telemetry systems

Unit 2	**Neurological Equipment**	**9**	**0**	**0**	**9**	**18**		**3,4**

Multi-channel EEG recording, clinical EEG (sleep patterns, epilepsy), evoked potentials (visual, auditory, somatosensory), EEG biofeedback, psychophysiological measurements, MEG principles.

Activities:

1. EEG waveform analysis for epilepsy and sleep stages.
2. Virtual demonstration on MEG applications in neurology

Unit 3	**Muscular Equipment**	**9**	**0**	**0**	**9**	**18**		**3,9**

EMG (recording, waveform analysis, fatigue characteristics), muscle and nerve stimulators, nerve conduction velocity, EMG biofeedback, EGG (Electro-gastrograph), MMG (Magneto-myograph), SQUID and fluxgate magnetometers.

Activities:

1**.** Lab experiment: EMG recording during muscle activity.
2. Case discussion on clinical use of nerve conduction studies

Unit 4	**Respiratory Measurement and Assist Systems**	**9**	**0**	**0**	**9**	**18**		**3,9**

Lung Volume and vital capacity, Spirometer, measurements of residual volume. pneumotachometer – Airway resistance measurement, Whole body plethysmography. Intra-Alveolar and Thoracic pressure measurements, Apnea Monitor. Types of Ventilators – Pressure, Volume, and Time controlled. Flow, Patient Cycle Ventilators, Humidifiers, Nebulizers, Inhalators.

Activities:

1. Spirometry practical: measurement of lung capacity.
2. Design-based assignment on ventilator control systems.

Unit 5	**Diathermy, Stimulator and Patient Safety**	**9**	**0**	**0**	**9**	**18**		**3,8,12**

Diathermy-Physiological effects of high frequency radiation, Depth of Penetration, short wave, Ultrasonic and microwave diathermy, Surgical diathermy, Hazards and safety procedures.

Activities:

1. Demonstration of diathermy equipment with safety considerations.
2. Simulation/Case study on electrical safety hazards in hospitals

COURSE OUTCOMES:

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

CO1: Design basic functional blocks of cardiac care systems.
CO2: Identify the principles EEG and MEG techniques to study and analyze neurological signals.
CO3: Apply EMG measurement techniques to evaluate muscular activity and nerve conduction
CO4: Design respiratory monitoring instruments and ventilator control systems for patient breathing support.
CO5: Examine diathermy systems incorporating electrical safety and protection standards.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Internal Assessment Test (70%), Activities (30%)

REFERENCES:	
1.	Enderle, J., & Bronzino, J., “Introduction to Biomedical Engineering”, Fourth Edition, Academic Press, 2021.
2.	John G. Webster, Amit J. Nimunkar,” Medical Instrumentation: Application and Design”, Fifth Edition, John Wiley & Sons, 2020.
3.	Iadanza, E., “Clinical Engineering Handbook”, Second Edition, Academic Press, 2020.
4.	Molimard, J., “Biomedical Devices and Sensors”, Wiley-ISTE, 2024.
5.	Mishra, S., Das, S., & Balamurugan, S., “Smart Wearables for Digital Medicine”, Wiley-Scrivener, 2026.
E resources/E materials:	
1.	https://onlinecourses.swayam2.ac.in/nou23_bt05
2.	https://onlinecourses.nptel.ac.in/noc25_bt49

Mapping of Course Outcomes to Programme Outcomes

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