



First Year Curriculum

Admission Year 2026-27

First Year Curriculum for the Admission Year 2026-27 Batch

M.Tech. in Biomedical Engineering

Faculty of Engineering & Technology

Parul University

Vadodara, Gujarat, India

SEMESTER 1

- a. **Course Name:** Biostatistics
- b. **Course Code:** 03023101PC01
- c. **Prerequisite:** Basic Knowledge of Calculus, Linear algebra, Probability theory is must.
- d. **Rationale:** To explain various statistics techniques for design of biological experiments, especially in medicine, pharmacy; the collection, summarization, and analysis of data from those experiments; and the interpretation of, and inference from, the results.
- e. **Course Learning Objective:**

CLOBJ 1	Understand the fundamental concepts, principles, and applications of biostatistics in biomedical, healthcare, and research fields.
CLOBJ 2	Develop knowledge of data collection methods, measurement scales, sampling techniques, and experimental design.
CLOBJ 3	Apply descriptive statistical methods to organize, summarize, and interpret biological and medical data.
CLOBJ 4	Understand probability concepts and probability distributions used in statistical analysis and decision-making.
CLOBJ 5	Develop analytical skills for estimation, hypothesis testing, and interpretation of statistical results.
CLOBJ 6	Apply regression and correlation methods for analyzing relationships among variables in biomedical and scientific studies.

- f. **Course Learning Outcomes:**

CLO 1	Understand the foundational concepts of biostatistics including measurement scales, sampling, statistical inference, and design of experiments, and demonstrate their relevance in biological and health sciences.
CLO 2	Apply descriptive statistical tools to summarize, organize, and interpret data using measures of central tendency and dispersion.
CLO 3	Analyze probabilistic events and distributions (discrete and continuous) including standard normal distribution to solve real-life biological problems.
CLO 4	Estimate population parameters using different estimation techniques and interpret the outcomes in the context of biological data.
CLO 5	Perform hypothesis testing and regression analysis, and interpret the statistical significance and relationships among variables using appropriate tests and models.

g. Teaching & Examination Scheme:

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Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	-	-	3	20	20	-	60	-	100

Lectures; T- Tutorial; P-Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continues Evaluation, ESE- End Semester Examination

h. Course Content:

Sr. No.	Topics	W (%)	T
1	Introduction to Biostatistics Introduction, Some basic concepts, Measurement and Measurement Scales, Sampling and Statistical Inference, The Scientific Method and the Design of Experiments, Computers and Biostatistical Analysis.	15%	6
2	Descriptive Statistics Introduction, The Ordered Array, Grouped Data: The Frequency Distribution, Descriptive Statistics: Measures of Central Tendency, Descriptive Statistics: Measures of Dispersion	20%	9
3	Probability Definition of Probability, Law of Probability, Conditional Probability, Discrete Probability Distributions, Random Variables, Continuous Probability Distributions, Standard Normal Distribution, Case Study.	25%	12
4	Estimation Overview of Estimation, Estimation of the Mean of a Distribution, Variance of a Distribution, Binomial Distribution, Poisson Distribution, Case Study.	20%	9
5	Hypothesis Testing & Regression Methods Hypothesis Testing: A Single Population Mean, Difference between Two Population Means, A Single Population Proportion, Difference Between Two Population Proportions, A Single Population Variance, The Ratio of Two Population Variances, The Type II Error and the Power of a Test. Overview of Regression and Correlation Methods, Fitting Regression Lines:- The Method of Least Squares, F-Test for Simple Linear Regression, t-Test for Simple Linear Regression, Partial and Multiple Correlation.	20%	9
Total:		100%	60

i. Text Book and Reference Book:

1. Introduction to Statistics for Biomedical Engineers By Kristina M. Ropella
2. A foundation for analysis in the health sciences By Wayne S. Daniel, Biostatistics | John Wiley & Sons
3. Primer of biostatistics By Stanton A. Glantz | Mc Graw Hill
4. Fundamentals of Biostatistics By Bernard Rosner | 6th edition

a. Course Name: Advanced Biomedical Signal Processing

- b. **Course Code:** 03023101PC03
- c. **Prerequisite:** Fundamental Knowledge of signal processing is must.
- d. **Rationale:** The course aims at providing the students with the knowledge and methodology for extracting useful information, implement the advanced signal processing and pattern classification techniques on different biomedical signals like ECG, EEG, and EMG and from that interpret the results and validate the descriptors obtained in the light of knowledge of the biological system involved.
- e. **Course Learning Objective:**

CLOBJ 1	Understand the principles of biomedical signal conversion, sampling techniques, and signal acquisition systems.
CLOBJ 2	Develop knowledge of digital signal processing concepts including Z-transform, digital filters, and transfer functions.
CLOBJ 3	Analyze and design finite impulse response (FIR) and infinite impulse response (IIR) filters for biomedical signal processing applications.
CLOBJ 4	Understand the concepts and applications of integer filters, adaptive filters, and signal averaging techniques in noise reduction and signal enhancement.
CLOBJ 5	Develop knowledge of biomedical data reduction techniques for efficient signal storage and processing.
CLOBJ 6	Apply digital signal processing techniques for ECG analysis, QRS detection, arrhythmia monitoring, and interpretation of biomedical signals.

f. **Course Learning Outcomes:**

CLO 1	Understand the fundamental concepts of signal conversion and sampling techniques essential for biomedical signal processing.
CLO 2	Apply the basics of digital filtering including Z-transform and pole-zero plots to analyze and design biomedical digital filters.
CLO 3	Design and implement Finite and Infinite Impulse Response (FIR & IIR) filters for smoothing, notch filtering, and ECG signal analysis.
CLO 4	Analyze the structure and function of integer and adaptive filters and evaluate their applications in biomedical noise cancellation.
CLO 5	Apply signal averaging and data reduction algorithms such as AXEC, Huffman, and CORTES to extract meaningful biomedical data.
CLO 6	Evaluate ECG signals using QRS detection, ST segment analysis, and arrhythmia monitoring systems for diagnostic purposes.

g. **Teaching & Examination Scheme:**

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				T	CE	P	Theory	P	
3	-	0	3	20	20	-	60	-	100

L: Lectures; T- Tutorial; P-Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continues Evaluation, ESE- End Semester Examination

h. Course Content:

Sr. No.	Topics	W (%)	T
1	Signal Conversion Sampling basics, simple signal conversion system, conversion requirements for biomedical signals, signal conversion circuits.	10%	5
2	Basics of Digital Filtering Digital filters, Z transform, Elements of digital filters, types of digital filters, Transfer function of a differential equation, Z-plane pole zero plots, The rubber membrane concept.	15%	6
3	Finite & Infinite Impulse Response Filters Filters Characteristics, Smoothing Filters, Notch Filters, Derivatives, window design, Frequency sampling, minimax design. Infinite Impulse Response filters: Generic equation of IIR filters, simple one-pole example, Integrator, Design method of two-pole filters, IIR Digital filter for ECG Analysis	25%	11
4	Integer & Adaptive Filters Basic Design Concept, LP, HP BP and Band reject filters, The effects of filter cascades, Adaptive filters: Principle of noise canceler model, 60 Hz adaptive canceling using a sine wave model, other applications of adaptive filtering.	20%	8
5	Signal Averaging Basics of Signal Averaging, Signal averaging as a digital filter, a typical averager, software for signal averaging, limitations of signal averaging.	10%	5
6	Data Reduction Techniques Turning point algorithm, AZTEC algorithm, CORTES, Fan algorithm, Huffman algorithm.	10%	5
7	ECG QRS Detection and Analysis System Bandpass filtering Techniques, Differentiation techniques, Template matching techniques, QRS detection algorithm. ECG interpretation, ST segment analyser, portable arrhythmia Monitor	10%	5
Total:		100%	45

i. Text Book and Reference Book:

1. Biomedical Signal processing By J. A. Tompkins and J. A. White | PHI
2. Biomedical Signal Analysis, A Case Study Approach By Rangaraj M. Rangayyan
3. Digital Signal Processing: Principles, Algorithms and Applications By John G. Proakis Dimitris K Manolakis | PHI | 3
4. Discrete-Time Signal Processing By Alan V. Oppenheim | PHI | 2

-	-	2	1	-	-	20	-	30	50
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L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE Continuous Evaluation , ESE- End Semester Examination

h. Course Content:

Sr. No.	List of Experiments
1.	Write a program in MATLAB to generate the standard signals.
2.	To verify sampling theorem and check the effect of aliasing in MATLAB.
3.	To perform Z-transform from zeros and poles of a given system function.
4.	To Perform the Rubber Membrane Concept.
5.	Design and Implementation of filters using FDA tool in MATLAB.
6.	Write a MATLAB Code for design of filter using transfer function.
7.	To study about the Smoothing Filter using Hanning Filter and Least Square technique.
8.	To study about the Smoothing Filter using Moving Average Filter.
9.	To study about IIR Filter.
10.	To study about FIR Filter.

- a. **Course Name:** Healthcare Management
- b. **Course Code:** 03023101PC05
- c. **Prerequisite:** Basic understanding of healthcare systems, management principles, and statistics is recommended.
- d. **Rationale:** The course aims at introduction to general management principles and basic healthcare application, to explore on International and national healthcare problems and issues, to discuss Planning, budgeting and uses of computers and information technology, to Explore International standards and protocol for hospital management
- e. **Course Learning Objective:**

CLOBJ 1	Understand the fundamental principles of management and their applications in healthcare and hospital environments.
CLOBJ 2	Develop knowledge of healthcare service providers, hospital systems, organizational hierarchy, and leadership in healthcare management.
CLOBJ 3	Understand the structure, functions, and services of hospitals including outpatient, inpatient, emergency, nursing, dietary, and support services.
CLOBJ 4	Analyze hospital planning requirements including budgeting, communication systems, power supply, sanitation, safety, and infrastructure management.
CLOBJ 5	Develop knowledge of computer applications and information management systems used in hospital administration and patient care.
CLOBJ 6	Understand hospital standards, biomedical equipment management, maintenance procedures, and the role of biomedical engineers in healthcare services.

f. Course Learning Outcomes:

CLO 1	Analyze the healthcare system, including its structure, financing, and delivery.
CLO 2	Understand the roles and responsibilities of healthcare managers and leaders.
CLO 3	Apply management principles to healthcare organizations, including planning, organizing, and controlling.
CLO 4	Evaluate healthcare policies and programs, including their impact on healthcare outcomes.
CLO 5	Develop strategic plans to improve healthcare quality, safety, and efficiency.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	-	-	3	20	20	-	60	-	100

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h. Course Content:

Sr. No.	Content	Weightage(%)	Teaching Hours
1	Introduction Principles of Management – Origin of principles of Management, Henry Fayol’s 14 principles of Management, elements of management, organizational hierarchy, Introduction to principles of management in Healthcare environment, health ergonomics.	10%	5
2	Healthcare Service Providers Role of the healthcare service providers Conventional hospital setup, types of leadership in healthcare environment, Private clinics, Corporate hospitals.	20%	10
3	Classification of Hospital Systems General Hospital –Specialist Hospital –Teaching – Research, Primary Health Centre –Their role, Functions. Role of Biomedical Engineers, Aspects of Hospital Services- Outpatient- Inpatient supportive emergency, drug and medical supply, Nursing Services, Dietary services, Transport services.	15%	5
4	Hospital Planning Orientation, Budgeting, Communication within the hospital and outside the hospitals - Electric power supply for various theatres and rooms, Diesel generator, Standby power supply- Air conditioning of important theatres and equipment housings - Water supply requirements & management, Lifts and firefighting equipment’s - Sanitation within the hospitals, Laundry services	20%	10
5	Computer and Information Management in Hospital Computer aided hospital management- Application, Administration/Discharge records of patients, Patient billing, Maintenance of patient records and their history -	20%	10

	Maintenance of inventory of medicines and drugs – Purchase.		
6	Hospital Standards and Maintenance Introduction to ISO - WHO standards, FDA standards, Indian standards for biomedical equipment services, Their purchase, Servicing and maintenance- Keeping intact and throwing the condemned equipment, Training personal for medical equipment, Preventive and periodical maintenance procedures.	15%	5
Total:		100 %	45

i. Text books:

1. Management Principles for Health Professionals By Joan Gratto Liebler, Charles R. McConnell | Jones and Bartlett Learning, Massachusetts | 6
2. Introduction to Health Care Management By Sharon Bell Buchbinder, Nancy H. Shanks | Jones and Bartlett Learning, Massachusetts | 1
3. Healthcare Management By Walshe, Kieran, Smith, Judith | McGraw Hill, New York | 2011

- a. **Course Name:** Advance Biomaterials
- b. **Course Code:** 03023101PE01
- c. **Prerequisite:** Fundamental Knowledge of Material science is required.
- d. **Rationale:** The course aims at providing the students with the knowledge of biomaterials, classification (metals, polymers, and ceramics, bio-resorbable and biodegradable materials), different properties on materials used in medicine.
- e. **Course Learning Objective:**

CLOBJ 1	Understand the history, classification, and fundamental concepts of biomaterials used in medical and biomedical applications.
CLOBJ 2	Develop knowledge of the mechanical, bulk, and surface properties of biomaterials and their characterization techniques.
CLOBJ 3	Understand the structure, properties, and biomedical applications of metallic, ceramic, polymeric, biodegradable, and bioresorbable biomaterials.
CLOBJ 4	Analyze the biocompatibility, stability, degradation, and host response associated with biomaterials in biological environments.
CLOBJ 5	Develop knowledge of testing methods for evaluating tissue compatibility, blood-material interactions, and performance of biomaterials.
CLOBJ 6	Understand international and Indian standards, specifications, and contemporary issues related to biomaterials and medical implants.

f. Course Learning Outcomes:

CLO 1	Understand the history, classification, and general properties of biomaterials used in medicine.
CLO 2	Analyze the bulk and surface properties of materials and evaluate their mechanical characteristics for biomedical applications.
CLO 3	Classify and compare various metallic and ceramic biomaterials, and assess their suitability in cardiovascular, dental, and orthopedic applications.
CLO 4	Evaluate different types of polymeric biomaterials and their sterilization, stability, and biocompatibility with human tissue systems.
CLO 5	Perform and interpret in-vitro and in-vivo testing of biomaterials, analyzing the interaction of materials with biological environments.
CLO 6	Examine host responses, toxicity, and regulatory standards for biomaterials, and interpret issues related to foreign body reactions and implant-related complications.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	-	-	3	20	20	-	60	-	100

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h. Course Content:

Sr. No.	Content	Weightage(%)	Teaching Hours
1	Introduction Define medical care and a hospital, Role of hospital in health care: Changing role of hospitals, Environmental health services, Health and medical care, Hospital Planning and design: Classification of Hospitals, Different guiding principles in hospital planning, Various factors influencing hospital utilization.	10%	5
2	Out/In patient & Nursing Services Out/In patient: Introduction of outpatient services: Outpatient, Emergency outpatient, referred outpatient, general outpatient, outpatient visit, unit of service & service time. Flowchart of an outpatient department, Common problems in outpatient services. Nursing Services: Various functions and roles of nursing services, Factors influencing the number of nurses.	15%	7
3	Intensive Care Unit and Central Sterile Supply Department Intensive Care Unit: Introduction, Role and functions of an ICU, Types of ICU, Layout of an ICU. Central Sterile Supply Department: Introduction of CSSD, Functions of CSSD, Flowchart of CSSD.	25%	10
4	Effective hospital management Introduction, Principles of hospital management, Various managerial activities of a hospital. Roles and functions of hospital administration, Skills of Effective Managers, Characteristics of Effective Managers.	20%	8
5	Administrative services Introduction, Various functions of medical records, Flowchart of an inpatient record, Material Management: Operative goals of materials management, material management process.	10%	5
6	Disposal of Hospital Waste	10%	5

	Define waste, types of waste, characteristics of a good waste disposal system, General classification of waste, Colour coding of containers, Transportation of waste: On-site and Off-site waste, Symbols of Hospital Hazards.		
7	Disposal of Hospital Waste Define waste, types of waste, characteristics of a good waste disposal system, General classification of waste, Colour coding of containers, Transportation of waste: On-site and Off-site waste, Symbols of Hospital Hazards.	10%	5
Total:		100 %	45

i. Text books:

1. Materials: engineering, science, processing and design By Michael F. Ashby, Hugh Shercliff, David Cebon | Elsevier Ltd, Cambridge | 3
2. Biomaterials Science By Ratner, Hoffman, Schoen, Lemons | Academic Pres | 1
3. PEEK Biomaterials Handbook By Steven M. Kurtz | Elsevier, Atlanta | 1

- a. **Course Name:** Networking and Information System in Medicine
- b. **Course Code:** 03023101PE03
- c. **Prerequisite:** Basics of Computer Networks and Medical Terminology is required.
- d. **Rationale:** This subject introduces students to the design, implementation, and application of healthcare IT systems, including Hospital Information Systems (HIS), Picture Archiving and Communication Systems (PACS), Electronic Health Records (EHR), and telemedicine platforms. Students will also learn about networking standards, security protocols, data interoperability, and the role of IoT and cloud technologies in modern healthcare delivery systems.
- e. **Course Learning Objective:**

CLOBJ 1	Understand the fundamental concepts of networking, communication systems, and security principles in healthcare environments.
CLOBJ 2	Develop knowledge of communication networks, data transmission methods, internet technologies, and wireless communication systems used in healthcare applications.
CLOBJ 3	Understand standards and protocols for medical data exchange, telemedicine, and video conferencing systems.
CLOBJ 4	Analyze the structure, functions, and modules of Hospital Management Information Systems (HMIS) and Hospital Information Systems (HIS).
CLOBJ 5	Develop knowledge of computerized patient records (CPR), healthcare data management, and healthcare information system development tools.
CLOBJ 6	Understand Picture Archival and Communication Systems (PACS), DICOM standards, medical image storage, retrieval, compression, and computeraided diagnosis systems.

f. Course Learning Outcomes:

CLO 1	Understand the basic concepts of computer networking, network components, services, system security, and network management in healthcare systems.
CLO 2	Analyze various communication types, including PSTN, POTS, ATN, ISDN, and wireless systems, and their applications in medical information exchange.
CLO 3	Explain the standards for real-time telemedicine and data exchange protocols such as H.320, H.324, and T.120 for video and text communication in clinical settings.
CLO 4	Evaluate the structure, development, and functional areas of Hospital Management Information Systems (HMIS) including specialized modules like blood bank, pharmacy, and diet planning.
CLO 5	Design and interpret features and functionalities of Hospital Information Systems with emphasis on CPR (Computer-based Patient Record) and HMIS development tools.
CLO 6	Apply knowledge of PACS systems, including DICOM standards, image compression, storage, retrieval, and CAD tools, in the management of diagnostic

	imaging data.
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g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	-	-	3	20	20	-	60	-	100

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h. Course Content:

Sr. No.	Content	Weightage(%)	Teaching Hours
1	Introduction of Microprocessor Introduction, System Components, Networked Communities, Host Management, User Management- Application Level Services, Network Level Services, and Principles of Security, Security Implications, and Analytical System Administration.	10%	5
2	Communication Network and Services Types of information: Audio, Video, Still Images, Text and data, and Fax - Types of Communication and Network: PSTN, POTS, ATN, and ISDN - Basic concepts of Communication and Network: Internet, and Wireless communications.	25%	11
3	Standards for Data Exchange Real-time Telemedicine. Data Exchange: Network Configuration, circuit and packet switching, H.320 series (Video phone based ISBN) T.120, H.324 (Video phone based PSTN). Video Conferencing	10%	5
4	Hospital Management Need for HMIS, Capabilities & Development of HMIS, functional area, modules forming HMIS, (like Pathology Lab, Blood bank, Pharmacy, Diet planning).	25%	11
5	Hospital Information System Maintenance and development of HMIS-Ideal Features and functionality of CPR, Development tools for CPR.	20%	8
6	Picture Archival Communication Systems (PACS) Types of image formats, DICOM standard, PACS system: Block diagram, Storing & retrieving images, Algorithm for retrieving images, Compressions and its significance, Lossless data Storage and in-house communication, Computer aided diagnosis (CAD), Centralized Database.	10%	5
Total:		100 %	45

i. Text books:

1. Computer Networks By Andrew S. Tanenbaum | Fifth edition
2. Medical Informatics: An Executive primer By Kenneth R. Ong | HIMSS Publishing | 1st 2015
3. Telemedicine Technologies: Information Technologies in Medicine and Telehealth By Bernard Fong, A.C.M. Fong and C.K. Li, | Wiley- Blackwell, New Jersey | 1
4. Web-based Application in Healthcare and Biomedicine By Lazakidu | Springer, New York. | 1

- a. **Course Name:** MEMS & NEMS For Biomedical Applications
- b. **Course Code:** 03023101PE05
- c. **Prerequisite:** Students should have prior knowledge in signal conditioning and measurement systems, Familiarity with physiological systems and biomedical instrumentation.
- d. **Rationale:** This Course is offered to Introduce and discuss the historical background of evolution of MEMS and Microsystems, Comprehend various modern micromachining techniques and discuss scaling effects in miniaturizing devices, To discuss and compare various tools and techniques to create microfluidic devices for various BioMEMS and Microfluidic applications.
- e. **Course Learning Objective:**

CLOBJ 1	Understand the fundamental concepts, history, materials, and technologies involved in Micro Electro Mechanical Systems (MEMS) and biomedical nanotechnology.
CLOBJ 2	Develop knowledge of microfabrication and micromachining techniques including lithography, etching, ion implantation, wafer bonding, and LIGA processes.
CLOBJ 3	Analyze scaling laws and their significance in MEMS design related to mechanics, electrostatics, fluid mechanics, and heat transfer.
CLOBJ 4	Understand the principles and operation of microfluidic systems, microsensors, actuators, micropumps, and intelligent materials used in biomedical applications.
CLOBJ 5	Develop knowledge of BioMEMS applications in healthcare including drug delivery systems, biosensors, biochips, microneedles, neural prostheses, and catheter-based sensors.
CLOBJ 5	Understand nanotechnology applications in biomedicine, nanofabrication techniques, diagnostic systems, and the effects and toxicity of nanomaterials in the human body.

f. Course Learning Outcomes:

CLO 1	Describe the fundamental principles of Micro-Electro-Mechanical Systems (MEMS) and Nano-Electro-Mechanical Systems (NEMS).
CLO 2	Explain the design, fabrication, and characterization of MEMS and NEMS devices for biomedical applications.
CLO 3	Analyze the applications of MEMS and NEMS in biomedical fields, including diagnostics, therapeutics, and tissue engineering.
CLO 4	Design and develop MEMS and NEMS-based biomedical devices, such as biosensors, lab-on-a-chip, and implantable devices.
CLO 5	Evaluate the performance and limitations of MEMS and NEMS-based biomedical devices.
CLO 6	Apply microfabrication and nanofabrication techniques to create MEMS and NEMS devices.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	-	-	3	20	20	-	60	-	100

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE Continuous Evaluation, ESE- End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage(%)	Teaching Hours
1	Introduction to MEMS MEMS Introduction, Historical Background- Smart materials and structures-Microsystems and their advantages Materials used- Technology involved in MEMS	10%	5
2	Micro Machining Technology Lithography, etching, Ion implantation, Wafer bonding, Integrated processing- Bulk micro machining, Surface micro machining, Coating technology and CVD, LIGA process	20%	8
3	Scaling Scaling in Geometry-Scaling in Rigid, Body Dynamics, Scaling in Electrostatic Forces, Scaling in Electromagnetic Forces-Scaling in Electricity, Scaling in Fluid Mechanics, Scaling in Heat Transfer	10%	5
4	Microfluidic System General principles, Micro sensors, Pressure sensors, Actuators, Electrostatic forces, Piezoelectric crystals, Intelligent materials and structures - Important consideration on microscale fluid, Properties of fluid, Fluid actuation methods, Micro-pumps, Typical Micro-fluidic channel, Micro fluid dispenser	20%	9
5	MEMS Application in Medicine (BioMEMS) Special features/requirements for medical applications. Current scenario of MEMS for health care. Drug delivery systems and MEMS. Application models – Blood pressure sensors – Biochip –Micro needles-Microelectrodes. Neural prosthesis and catheter end sensors	20%	8
6	Biomedical Nanotechnology Nanotechnology and biomedicine- Medical applications of Nanotechnology- Drug synthesis and delivery- Nanobiomedicine and diagnostic	10%	5
7	Nanofabrication Techniques Nanofabrication methods – Nano materials in human body-	10%	5

	Toxicity in nano-materials		
	Total:	100 %	45

i. Text books:

1. Introduction to Biomems By Albert Folch | CRC Press | 1
2. Microfluidics and Biomems application By Francis E. H. Tay | Springer, Berlin | 1
3. MEMS & Microsystem, Design and manufacture By Tai-Ran Hsu | McGraw Hill, New York | 1

- a. **Course Name:** Ergonomics
- b. **Course Code:** 03023101PE07
- c. **Prerequisite:** Basic knowledge of human anatomy, physiology and biomechanics is required.
- d. **Rationale:** This course will provides students with a comprehensive understanding of the principles and practices of designing and optimizing systems, products, and environments to reduce stress, discomfort, and injury, thereby promoting safety, efficiency, and well-being.
- e. **Course Learning Objective:**

CLOBJ 1	Understand the fundamental concepts of ergonomics and human factors engineering in healthcare systems.
CLOBJ 2	Develop knowledge of human-machine interaction, human reliability, and control mechanisms in biomedical and healthcare environments.
CLOBJ 3	Analyze workplace design principles, anthropometric factors, and environmental conditions affecting healthcare workers and patient safety.
CLOBJ 4	Understand physiological stress and fatigue assessment techniques using biomedical signals such as EMG and EEG.
CLOBJ 5	Develop knowledge of ergonomic methodologies including workflow analysis, risk management, simulation-based training, and healthcare system evaluation.
CLOBJ 6	Apply ergonomic principles and patient safety strategies in hospitals, intensive care units, emergency departments, and other healthcare settings.

f. Course Learning Outcomes:

CLO 1	Understand the fundamentals of ergonomics and human factors in healthcare, and analyze their impact on patient safety, work design, and healthcare worker performance.
CLO 2	Explain the principles of human-machine interaction and evaluate manual, automated, and technological systems involved in healthcare environments.
CLO 3	Design workplace layouts using anthropometry and ergonomic principles for healthcare settings, including environmental considerations and digital workspace ergonomics.
CLO 4	Apply measurement tools and evaluation methods for assessing physical stress, fatigue, and musculoskeletal disorders using EMG and EEG data.
CLO 5	Implement ergonomic methodologies such as cognitive work analysis, workflow simulations, and technology design to improve patient safety and healthcare delivery.
CLO 6	Evaluate ergonomic interventions in various hospital departments (ICU, emergency, primary care, anesthesia, etc.) for improving system performance and safety through

	real-life case studies.
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g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	-	-	3	20	20	-	60	-	100

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE Continuous Evaluation, ESE- End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage(%)	Teaching Hours
1	Carbohydrates Classification, structure, properties and functions of carbohydrates: Monosaccharides, Disaccharides, Oligosaccharides-examples; Polysaccharide classes- homo and hetero polysaccharides, conjugated carbohydrates, glycolysis, gluconeogenesis, TCA cycle, Pentose Phosphate Pathway, glycogenesis, Glycogen Storage Disease, Respiratory chain and ATP synthesis.	15%	6
2	Fatty Acids and Lipids Fatty acids- basic structure, types, properties, functions and essential fatty acids; ketone bodies, Classes, structure, properties and functions of lipids: Simple lipid-fat and wax, Compound lipid-Phospholipid, sphingolipid, ether lipid and glycolipid, Derived lipid cholesterol biosynthesis, fatty acid biosynthesis and degradation, Inborn errors of lipid metabolism.	15%	6
3	Amino Acids, Peptides and Proteins Amino acids- classification, properties; Essential amino acids; Peptide bond, significant natural and artificial peptides examples; Proteins- structure / conformation levels-primary, secondary, tertiary and quaternary, Ramachandran plot, classification, Biosynthesis of aromatic amino acids 20% 9 tyr, trp, phe, biodegradation of proteins and urea cycle, Review on amino acid metabolic disorders.	20%	10
4	Nucleotides and Nucleic Acids Nucleotides- composition, structure, properties and functions; Nucleic acids- types (RNA, DNA), DNA Structure- Chargaff's rules on DNA base composition, Unusual forms of	20%	11

	DNA, RNA types, structure and functions, biosynthesis of purines and pyrimidines and its degradation, Inborn errors of nucleic acid metabolism - Review.		
5	Vitamins Vitamins: classification (A, D, E, K, and B-complex members), basic structure, source, daily requirement, functions and deficiency symptoms.	10%	4
6	Minerals- Functions and Disorders Minerals: classification- macro elements and microelements, specific function and deficiency disorders, review on vitamins and mineral supplementations.	10%	5
Total:		100 %	45

i. Text books:

1. Harper's Biochemistry
By Murray R.K, Granner B.K, Mayes P.A, Rodwell | Prentice Hall International, 2008.
2. Biochemistry
By FJain and Jain | Chand Publication, 2008.
3. Biochemistry
By Voet and Voet | John Wiley & Sons Inc., 2nd Edition, 2013.
4. Biochemistry
By Jain and Jain | Chand Publication, 2008.

- a. **Course Name:** Biochemistry Lab
- b. **Course Code:** 03062403PE06
- c. **Prerequisite:** Basic Knowledge of chemical reactions, solutions, and concentrations.
- d. **Rationale:** The Biochemistry Lab provides hands-on experience in analyzing biomolecules and understanding biochemical processes essential for life. It reinforces theoretical concepts through practical experiments involving carbohydrates, proteins, enzymes, lipids, and clinical biochemistry parameters. The laboratory develops skills in sample handling, use of biochemical instruments, data analysis, and interpretation, forming a strong foundation for biomedical, clinical, and research applications.

e. Course Learning Objective:

CLOBJ 1	Perform systematic biochemical tests to classify and identify essential biomolecules like carbohydrates and proteins.
CLOBJ 2	Analyze the structural properties and biological significance of monosaccharides, disaccharides, and polysaccharides.
CLOBJ 3	Examine key carbohydrate and lipid metabolic pathways alongside their respective inborn metabolic errors.
CLOBJ 4	Evaluate the functional properties and structural hierarchy of proteins using tools like the Ramachandran plot.
CLOBJ 5	Investigate the structure of nucleic acids, applying Chargaff's rules to understand DNA base composition.
CLOBJ 6	Correlate the specific biological functions of vitamins and minerals to their respective clinical deficiency disorders.

f. Course Learning Outcomes:

CLO 1	Identify and classify carbohydrates, lipids, proteins, nucleic acids, vitamins, and minerals.
CLO 2	Explain the structure, properties, and biological functions of major biomolecules.
CLO 3	Perform and interpret biochemical tests for carbohydrates, lipids, proteins, and nucleic acids.
CLO 4	Analyze metabolic pathways and related inborn errors using experimental data.
CLO 5	Evaluate the role of biomolecules and metabolism in normal physiology and disease.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
-	-	2	1	-	-	50	-	-	50

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE Continuous Evaluation, ESE- End Semester Examination

h. Course Content:

Sr. No.	List of Experiments
1.	Study of classification, structure, properties and functions of carbohydrates.
2.	Study of monosaccharides, disaccharides and polysaccharides with examples and biological significance.
3.	Study of carbohydrate metabolism pathways (Glycolysis, Glycogenesis, Glycogenolysis, Gluconeogenesis, TCA cycle, Pentose Phosphate Pathway).
4.	Study of fatty acids: structure, types, properties, essential fatty acids and functions.
5.	Study of lipids: classification, structure and functions of simple, compound and derived lipids.
6.	Study of lipid metabolism and inborn errors of lipid metabolism.
7.	Study of amino acids: classification, essential amino acids and properties.
8.	Study of proteins: levels of structure, Ramachandran plot and biological functions.
9.	Study of nucleotides and nucleic acids (DNA & RNA): structure, types and functions.
10.	Study of DNA structure, Chargaff's rule, unusual forms of DNA and RNA types.

11.	Study of biosynthesis and degradation of purines and pyrimidines and inborn errors.
12.	Study of vitamins and minerals: classification, sources, functions and deficiency disorders.

SEMESTER 4

- a. **Course Name:** Medical Imaging Techniques
- b. **Course Code:** 03062404PC01
- c. **Prerequisite:** Basic knowledge of human anatomy and physiology, physics of radiation and waves, mathematics, and fundamental electronics.
- d. **Rationale:** The course will provide fundamental knowledge of the principles, instrumentation, and clinical applications of medical imaging techniques, enabling students to understand image formation, non-invasive diagnosis, patient safety, and the role of imaging in modern healthcare systems.
- e. **Course Learning Objective:**

CLOBJ 1	Explain the fundamental physics of electromagnetic radiation and X-ray generation.
CLOBJ 2	Describe the components, image intensifiers, and receptors of conventional diagnostic X-ray equipment.
CLOBJ 3	Identify the instrumentation and specific procedures associated with Catheterization laboratories (CATH-LAB).
CLOBJ 4	Analyze the basic principles, operational generations, and artifacts of Computed Tomography (CT).
CLOBJ 5	Outline the generation, detection, and magnetic parameters of signals in Magnetic Resonance Imaging (MRI).
CLOBJ 6	Evaluate the properties of ultrasound waves and various diagnostic modes (A, B, M, and Doppler).

- f. **Course Learning Outcomes:**

CLO 1	Understand the fundamental principles and physics behind medical imaging modalities.
CLO 2	Explain the instrumentation, image formation, and acquisition methods used in clinical imaging.
CLO 3	Analyze and interpret images from various diagnostic techniques for clinical applications.

CLO 4	Apply knowledge of image processing and enhancement to improve diagnostic accuracy.
CLO 5	Develop problem-solving, critical thinking, and decision-making skills relevant to medical imaging applications.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
4	0	0	4	20	20	-	60	-	100

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE Continuous Evaluation, ESE- End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage (%)	Teaching Hours
1.	Fundamentals of X-ray Equipment Electromagnetic radiation, Properties of X-rays, Interactions between X-rays and matter: coherent scattering, photoelectric effect, Compton scattering, Pair production and Photodisintegration. X-ray Generation: White and characteristic radiation, X-ray Generators: Line focus principle, Factors affecting X-ray emission spectrum. Construction of Xrays: Filters, Beam restrictors, Grids, Intensifying screen (Fluorescent screen), Image intensifier, Xray Receptors: X-ray Film and Radiation Detectors, Construction of stationary anode X-ray tube, X-RAY machine: Block diagram.	25%	14
2.	Diagnostic methods of X-ray Conventional X-ray radiography with its basic components, Fluoroscopy, Angiography, and Mammography: Mammographic Equipment, Attenuation of imaging techniques, Biological effects of ionizing radiation: Threshold, Exposure time, Exposure area, variations in species and	15%	10

	individual sensitivity, variations in cells sensitivity, Short term and Long term effects.		
3.	CATH-LAB Introduction of CATH-LAB, Typical instrumentation layout in a Catheterization laboratory, Instruments used in CATH-LAB: Stent catheter, C-Arm machine, Guide wire, Angioplasty balloon, cutting balloon, IATV- Black Panel Detector etc., Pressure waveforms associated with catheterization procedure.	10%	8
4.	Computed Tomography & Magnetic Resonance Imaging Techniques Computed tomography: Basic Principle of CT, CT number, Generations of CT- Scanner, CT Artefacts. Magnetic Resonance Imaging: Principle of NMR and Blockdiagram of MRI Machine, Generation and detection of NMR signal, Parameters: Angular momentum, Magnetic dipole moment, magnetization, Larmor frequency, free induction decay, Relaxation time.	25%	14
5.	Ultrasound Imaging Introduction of USG, Properties of ultrasound, Generation and Detection of Ultrasound: Piezoelectric effect, Construction of Ultrasonic transducer, Pulse-echo technique: Block-diagram of Pulse echo system, Ultrasound imaging methods: - A-scan, B-scan, C-scan, M-scan, Doppler method: Continuous wave Doppler method and Pulsed wave Doppler method.	25%	14
Total:		100%	60

i. Text Book and Reference Book:

1. Hand Book of Biomedical Instrumentation. Tata McGraw Hill
By R.S. Khandpur
2. Medical Instrumentation. Application and Design
By John Webster | John Wiley and Sons. Inc
3. Fundamentals of medical imaging
By Paul Suetens | Cambridge university press

- a. **Course Name:** Medical Imaging Techniques Lab
- b. **Course Code:** 03062404PC02
- c. **Prerequisite:** Basic knowledge of physics, human anatomy, imaging equipment, radiation safety, digital imaging, and professional conduct.
- d. **Rationale:** This laboratory is designed to provide hands-on experience with medical imaging equipment, teach image acquisition and processing techniques, enable interpretation of diagnostic images, and ensure practice of patient safety and professional protocols in clinical imaging.

e. Course Learning Objective:

CLOBJ 1	Operate the front panel controls and familiarize with the components of an X-ray machine.
CLOBJ 2	Analyze the effects of varying mAs and kVp parameters on X-ray image display and intensifiers.
CLOBJ 3	Examine the hardware components and operational generations of clinical CT-Scan machines.
CLOBJ 4	Identify various functional areas and specific procedures (Angiography/Angioplasty) within a Cath-Lab.
CLOBJ 5	Demonstrate familiarity with the physical setup of Magnetic Resonance Imaging systems in diagnostic centers.
CLOBJ 6	Evaluate different modes of Ultrasound imaging and assess their potential biological effects.

f. Course Learning Outcomes:

CLO 1	Explain the methods of image acquisition, formation, and reconstruction used in different imaging modalities.
CLO 2	Operate imaging instruments, perform imaging procedures, and acquire diagnosticquality images safely.

CLO 3	Analyze acquired images to identify anatomical structures, common artifacts, and abnormalities.
CLO 4	Assess image quality, evaluate the effectiveness of imaging techniques, and suggest improvements for better diagnostic outcomes.
CLO 5	Design and optimize imaging protocols integrating safety, equipment capabilities, and clinical requirements.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
-	-	2	1	-	-	50	-	-	50

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE Continuous Evaluation, ESE- End Semester Examination

h. Course Content:

Sr. No.	List of Experiments
1.	To study about the Front Panel of X-ray machine.
2.	To study about the Image intensifier & its effect of varying the MAS, and KVP values on display film in X ray.
3.	To study about Computed Tomography (CT-Scan) Machine.
4.	To study about the Generations of CT-Scan Machine.
5.	To Study about the identification of various areas of Cath-Lab in Hospital.
6.	To study about various procedures done in Cath lab (Angiography and Angioplasty).

7.	To Study about Magnetic Resonance Imaging (MRI) in Hospital Diagnostic Centre.
8.	To Study about the Ultrasound Imaging.
9.	To Study about the different modes of Ultrasound.
10.	To Study about the Biological effects of Ultrasound.

- a. **Course Name:** Biomedical Instrumentation - I
- b. **Course Code:** 03062404PC03
- c. **Prerequisite:** Basic understanding of human anatomy and physiology, as well as fundamental electronic circuits like operational amplifiers and sensors.
- d. **Rationale:** Biomedical Instrumentation - I introduces students to the fundamental principles of acquiring, processing, and displaying physiological signals from the human body. By studying the block diagrams and working mechanisms of diagnostic tools—ranging from ECG machines to pulse oximeters—students develop the technical competence required to operate, calibrate, and maintain essential patient-care equipment.
- e. **Course Learning Objective:**

CLOBJ 1	Classify medical instruments based on diagnostic, therapeutic, and physiological applications.
CLOBJ 2	Describe the physiological origins and measurement techniques for bioelectric signals like ECG, EEG, and EMG.
CLOBJ 3	Explain the principles and electronic techniques used for continuous heart rate and pulse rate monitoring.
CLOBJ 4	Analyze direct and indirect measurement methods for blood pressure and oxygen saturation (SpO ₂).
CLOBJ 5	Assess respiratory parameters utilizing spirometers and apnea monitoring techniques.

CLOBJ 6	Differentiate between types of audiometers and hearing aids based on air and bone conduction properties.
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f. Course Learning Outcomes:

CLO 1	Remember the various sources of bio-signals and the diverse classifications of medical instruments to identify the correct device based on diagnostic or therapeutic needs.
CLO 2	Understand the physiological origins and measurement protocols for ECG, EEG, and EMG, including the 12-lead configuration and the 10-20 electrode placement system.
CLO 3	Analyze various patient monitoring techniques for heart rate, blood pressure, and oxygen saturation to interpret the accuracy of vital sign measurements in clinical environments.
CLO 4	Apply the principles of spirometry to measure lung volumes and capacities, facilitating the assessment of pulmonary function through spirograms.
CLO 5	Evaluate the different types of audiometers and hearing aids by comparing air and bone conduction mechanisms to address specific auditory impairments.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	0	0	3	20	20	-	60	-	100

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE Continuous Evaluation, ESE- End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage (%)	Teaching Hours
1.	Introduction to Medical Instruments Introduction to medical instrumentation, Various Sources of biomedical Signals, Basic block diagram of medical instrumentation. Classification of medical	15%	7

	instruments based on various principles, such as based on diagnostic application, based on therapeutic application, based on Imaging application, based on analytical application, based on physiological parameter and bio-potential, based on Biological system, and based on different departments in the hospital.		
2.	Biomedical Signals Introduction to Biomedical signals, Introduction to Electrocardiograph, Block diagram of ECG machine, working principle of ECG, 12-lead ECG measurement. Phonocardiography: Introduction of PCG, Origin of sound. Introduction to Electroencephalograph, 10-20 electrode placement system, Block diagram of EEG machine. Introduction to Electromyography, Block diagram of EMG machine.	25%	11
3.	Patient Monitoring Devices Heart rate measurement Techniques: Average calculation, Beat-to-Beat calculation and combination of both. BlockDiagram of Average heart rate meter, Block-Diagram of Instantaneous heart rate meter. Pulse rate Measurement Techniques: Electrical, Mechanical and Optical Methods, Concept of Oxygen Saturation measurement (Oximetry), Types of Oximeter: Finger tip pulse oximeter and Ear oximeter. Blood Pressure measurement Techniques: Direct method, Indirect method. Introduction to Respiration rate, Measurement of respiration rate Techniques: Displacement method, Thermistor Method, Impedance pneumography method. Introduction of Apnoea, Block-Diagram of Apnoea Monitor.	30%	13
4.	Pulmonary Function Test Analyzer Introduction to Pulmonary function test, Spirogram, various Lung volumes and capacities; Spirometry: Types of Spirometer such as Basic Spirometer & Wedge Spirometer.	15%	7
5.	Audiometers and Hearing Aids Air & bone conduction, Hearing transducers, Types of audiometers, Hearing aid: Conventional and Digital.	15%	7
Total:		100%	45

i. Text Book and Reference Book:

1. Hand Book of Biomedical Instrumentation. Tata McGraw Hill
By R.S. Khandpur
2. Biomedical Instrumentation and Measurement
By Carr Joseph J. and Brown John M | Pearson
3. Medical Instrumentation Application & Design
By John G. Webster | Houghton Mifflin, Co. Boston. USA
4. Biomedical Instrumentation and Measurements
By Leslie Cromwell, Fred J. Weibell and Erich A. Pfeiffer

- a. **Course Name:** Biomedical Instrumentation - I Lab
- b. **Course Code:** 03062404PC04
- c. **Prerequisite:** Basic knowledge of physics, human anatomy, imaging equipment, radiation safety, digital imaging, and professional conduct.
- d. **Rationale:** This laboratory is designed to provide hands-on experience with medical imaging equipment, teach image acquisition and processing techniques, enable interpretation of diagnostic images, and ensure practice of patient safety and professional protocols in clinical imaging.
- e. **Course Learning Objective:**

CLOBJ 1	Perform and analyze ECG recordings using various standard lead configurations.
CLOBJ 2	Evaluate the functional performance and waveform outputs of biopotential recorders like EEG and EMG machines.
CLOBJ 3	Measure human blood pressure accurately using a clinical sphygmomanometer and stethoscope.
CLOBJ 4	Determine oxygen saturation levels (SpO ₂) utilizing non-invasive pulse oximeters.
CLOBJ 5	Assess auditory functions and lung capacities utilizing an audiometer and spirometer respectively.

CLOBJ 6	Record and interpret body temperature and heart sounds using digital thermometers and Phonocardiographs (PCG).
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f. Course Learning Outcomes:

CLO 1	Remember the specific functions of various ECG lead systems and electrode placement protocols to ensure accurate and repeatable diagnostic recordings.
CLO 2	Understand the operational workflow and control settings of biopotential recorders (EEG and EMG) to distinguish between physiological signals and artifacts.
CLO 3	Analyze various measurement techniques for vital signs, such as the auscultatory method for blood pressure and the spectroscopic method for SpO ₂ .
CLO 4	Apply standardized testing procedures to assess the performance of specialized equipment like audiometers and spirometers.
CLO 5	Evaluate the functional integrity of digital thermometers and Phonocardiographs (PCG).

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
-	-	2	1	-	-	50	-	-	50

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE Continuous Evaluation, ESE- End Semester Examination

h. Course Content:

Sr. No.	List of Experiments
1.	To study about the performance of ECG machine.

2.	To study about the different types of leads used in ECG machine.
3.	To study about the performance of the EEG machine.
4.	To study about the performance of the EMG machine.
5.	To study about the measurement of blood pressure using sphygmomanometer and stethoscope.
6.	To study about the measurement of SpO2 using pulse oximeter.
7.	To study about the performance of audiometer.
8.	To study about the measurement of body temperature using digital thermometer.
9.	To study about the measurement of heart sound using PCG.
10.	To study about the performance of spirometer.

- a. **Course Name:** Orthotics and Prosthetics
- b. **Course Code:** 03062404PC05
- c. **Prerequisite:** Basic Understanding of Human Anatomy & Physiology and Material Science.
- d. **Rationale:** This course provides an understanding of the principles, design, fabrication, and clinical application of orthotic and prosthetic devices, enabling students to analyze human movement impairments and select or design appropriate assistive devices to restore function, improve mobility, and enhance the quality of life of individuals with physical disabilities.
- e. **Course Learning Objective:**

CLOBJ 1	Define standard terminology and classify biomaterials used in orthotic and prosthetic fabrication.
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CLOBJ 2	Understand the biomechanical principles governing pressure distribution, force systems, and lever arms.
CLOBJ 3	Distinguish the design and application of upper/lower limb orthoses, and spinal braces.
CLOBJ 4	Analyze stump preparation, socket designs, and joint mechanisms in lower limb prosthetics.
CLOBJ 5	Evaluate terminal devices and myoelectric signal control systems utilized in upper limb prosthetics.
CLOBJ 6	Assess the role of CAD/CAM, 3D printing, and mobility aids in advanced rehabilitation engineering.

f. Course Learning Outcomes:

CLO 1	Remember the standard terminology, classification systems, and material properties used in the fabrication of orthotic and prosthetic devices.
CLO 2	Understand the biomechanical functions of various orthoses and how they correct deformities or support weakened musculoskeletal structures.
CLO 3	Analyze the design features of lower and upper limb prostheses, including socket interfaces and suspension mechanisms, relative to the level of amputation.
CLO 4	Apply mechanical principles to select appropriate components (joints, feet, terminal devices) based on patient functionality and clinical needs.
CLO 5	Evaluate the role of modern technologies, such as CAD/CAM and myoelectric systems, in improving patient rehabilitation outcomes.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	

4	0	0	4	20	20	-	60	-	100
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L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE Continuous Evaluation, ESE- End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage (%)	Teaching Hours
1.	Introduction to Orthotics and Prosthetics Historical development of Orthotics and Prosthetics; Definitions and terminology; Classification of devices; Biomaterials in Orthotics and Prosthetics: Metals, polymers, composites, and leather; Biomechanical principles applied to orthotic and prosthetic design: Pressure distribution, threepoint force systems, and lever arms.	17%	10
2.	Orthotics-Upper and Lower Limb Lower Limb: Foot Orthoses (FO), Ankle-Foot Orthoses (AFO), Knee-Ankle-Foot Orthoses (KAFO); Types of ankle joints and knee joints; Pathological gait correction. Upper Limb: Static vs. Dynamic splints; Wrist-Hand Orthoses (WHO), Elbow splints, Shoulder abduction splints. Spinal Orthotics: Cervical collars (soft/hard), TLSO, Milwaukee brace.	25%	15
3.	Prosthetics-Lower Limb Levels of amputation (Transtibial, Transfemoral, Syme's); Stump preparation and healing; Socket designs (PTB, TSB, Ischial Containment); Suspension systems; Prosthetic feet (SACH, Single Axis, Dynamic Response); Knee mechanisms (Constant friction, Polycentric, Hydraulic/Pneumatic); Alignment principles (Bench, Static, Dynamic).	25%	15
4.	Prosthetics-Upper Limb Levels of upper limb amputation; Body-powered vs. Externally powered systems; Harnessing and control cables; Terminal Devices: Passive hands, Voluntary opening/closing hooks, Cosmetic hands; Introduction to Myoelectric control systems: Electrodes and signal processing basics.	17%	10
5.	Advanced Rehabilitation Engineering CAD/CAM in Orthotics and Prosthetics: Scanning, modification, and carving; 3D printing applications in assistive devices; Mobility Aids: Wheelchairs (manual and powered), Crutches, and Walkers; Psychological aspects of amputation and device acceptance; Maintenance and care of devices.	16%	10
Total:		100%	60

i. Text Book and Reference Book:

1. Atlas of Orthoses and Assistive Devices
By Hsu, Michael, and Fisk | Elsevier | 4th edition, Pub. Year 2008
2. Prosthetics and Orthotics: Lower Limb and Spine
By Bella J. May | F.A. Davis Company | 2nd edition, Pub. Year 2002
3. Introduction to Prosthetics and Orthotics
By Ron Seymour | Slack Incorporated | 2nd edition, Pub. Year 2002
4. Biomedical Engineering Handbook (Rehabilitation Engineering Section)
By Joseph D. Bronzino | CRC Press | 3rd edition, Pub. Year 2006

- a. **Course Name:** Telemedical Instrumentation
- b. **Course Code:** 03062404PE01
- c. **Prerequisite:** Basic knowledge of Electronics, Biomedical Instrumentation, and Communication Systems is required.
- d. **Rationale:** The course will provide an understanding of telemedical instrumentation, including biomedical data acquisition, communication technologies, and remote monitoring systems used in modern healthcare applications.
- e. **Course Learning Objective:**

CLOBJ 1	Outline the fundamental concepts, components, benefits, and applications of telemedicine systems.
CLOBJ 2	Differentiate between various communication networks like PSTN, ISDN, and GSM used in healthcare data transfer.
CLOBJ 3	Explain data exchange techniques, differentiating between circuit switching and packet switching networks.
CLOBJ 4	Understand data security measures, encryption mechanisms, and communication protocols like TCP/IP and OSI.
CLOBJ 5	Identify the ethical and legal frameworks concerning patient confidentiality and medical records access.
CLOBJ 6	Evaluate the clinical implementation of tele-radiology, tele-cardiology, tele-surgery, and Mobile Health (M-Health).

f. Course Learning Outcomes:

CLO 1	Understand the principles and components of telemedical instrumentation systems.
CLO 2	Explain biomedical data acquisition and transmission techniques used in telemedicine.
CLO 3	Analyze communication networks and protocols applied in telemedical applications.
CLO 4	Identify telemedical devices and systems used for remote diagnosis and patient monitoring.
CLO 5	Evaluate challenges related to data security, reliability, and ethical issues in telemedicine.

g. Teaching & Examination Scheme:

Teaching Scheme	Evaluation Scheme
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L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
4	0	0	4	20	20	-	60	-	100

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE Continuous Evaluation, ESE- End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage (%)	Teaching Hours
1.	Fundamentals of Telemedicine Concept of telemedicine, Block diagram of telemedicine system, Future Scopes of telemedicine, benefits and limitations of telemedicine, Applications of Telemedicine.	10%	8
2.	Types of Communication and Networking Types of information: Audio, Video, Images, Text and Data, Fax, Types of communication, Types of Networking: PSTN, ISDN, Internet, Difference between Internet and Intranet. Wireless communications: Wave propagation, types of Wave propagation, GSM network (Global system for mobile communication), Satellite and micro wave, Real time telemedicine.	25%	14
3.	Data Exchanges Data exchanges: Network configuration: Circuit switching, Packet switching, Difference between circuit switching network and packet switching network, Video conferencing: Block diagram of video conferencing, Applications.	15%	10
4.	Data Security and Standards Cryptography, Data security and standards: Encryption, Blockdiagram of Encryption, Mechanisms of encryption, Phases of encryption, Block-diagram of Decryption, Mechanisms of Decryption, Phases of Decryption. Protocols: Block-Diagram of TCP/IP model, Block-Diagram of OSI model, Ethical and legal aspects of Telemedicine: Confidentiality and Law, Patient rights and consent, Access to medical records.	25%	14
5.	Applications of Telemedicine in Medical Field Tele radiology system, Block-Diagram of Tele radiology system, Tele pathology system, Tele-cardiology, Block Diagram of Tele cardiology system, Tele-surgery, Applications of Mobile Health (M-Health) in telemedicine.	25%	14
Total:		100%	60

i. Text Book and Reference Book:

1. Computer networks
By Andrew S Tanenbaum | PHI Learning, New Delhi, 2010
2. Data Communications and Networking
By B. A. Forouzan | Tata McGraw Hill | 4th Edition
3. Electronic Communications
By Dennis Roddy & John Coolen | PHI

- c. **Prerequisite:** Basic Understanding of human anatomy and physiology, fluid mechanics, and the fundamental properties of materials.
- d. **Rationale:** This course provides a comprehensive understanding of the engineering principles required to design life-sustaining artificial organs and prosthetic devices. By studying blood rheology, mass transfer in dialyzers, and the gas exchange mechanics of oxygenators, students learn to develop biocompatible solutions that mimic complex physiological functions, preparing them for roles in high-acuity clinical support and medical device R&D.
- e. **Course Learning Objective:**

CLOBJ 1	Analyze the rheological properties of blood and the physiological issues associated with extracorporeal flow.
CLOBJ 2	Describe the mass transfer principles and membrane configurations used in artificial kidneys and hemodialyzers.
CLOBJ 3	Differentiate the gas exchange mechanics utilized in bubble, film, and membrane oxygenators.
CLOBJ 4	Understand the functional engineering concepts behind liver support systems and the artificial pancreas.
CLOBJ 5	Explain the principles of specific sensory and assistive medical devices like hearing aids and ophthalmoscopes.
CLOBJ 6	Evaluate the biocompatibility of advanced ceramics and composites used for artificial hearts and joint replacements.

f. Course Learning Outcomes:

CLO 1	Remember the fundamental properties of biomaterials and the rheological characteristics of blood to predict how fluids behave in extracorporeal circuits.
CLO 2	Understand the mechanisms of artificial waste removal and the structural differences between flat plate, coil, and hollow fiber hemodialyzers.
CLO 3	Analyze various gas exchange techniques used in bubble and membrane oxygenators to ensure safe respiratory support during cardiopulmonary bypass procedures.
CLO 4	Apply the principles of sensory and circulatory assistance to patient care scenarios.
CLO 5	Evaluate the performance and biocompatibility of advanced materials in the context of joint replacements and Ventricular Assist Devices (VAD).

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
4	0	0	4	20	20	-	60	-	100

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE Continuous Evaluation, ESE- End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage (%)	Teaching Hours
1.	Introduction Biomaterials used in artificial organs and prostheses, inflammation, rejection, correction. Rheological properties of blood, blood viscosity variation: effect of shear rate, hematocrit, temperature and protein contents. Casson equation, flow properties of blood through the blood vessels, problems associated with extracorporeal blood flow.	15%	9
2.	Artificial Kidney Brief of kidney filtration, basic methods of artificial waste removal, hemodialysis, and equation for artificial kidney and middle molecule hypothesis. Hemodialysers: flat plate type, coil type and hollow fiber. Analysis of mass transfer in dialyers (cross current & cocurrent flow), regeneration of dialysate, membrane configuration, wearable artificial kidney machine, separation of antigens from blood in ESRD patients.	25%	15
3.	Artificial Heart Lung Machine Brief of lungs gaseous exchange/transport, artificial heart-lung devices. Oxygenators: bubble, film oxygenators and membrane oxygenators. Gas flow rate and area for membrane oxygenators. Liver support system, artificial pancreas, blood and skin.	20%	12
4.	Applications Air conduction, bone conduction, masking, functional diagram of an audiometer. Hearing aids: different types, receiver amplifiers. Ophthalmoscope, retinoscope, I.A.B.P principle and application.	15%	9

5.	Advanced Biomaterials New ceramics for joint replacement surgery, Composites for joint replacement surgery, New biomaterials for improving the blood and tissue compatibility of total artificial hearts (TAH), Ventricular assist devices (VAD), Recent advancement and future directions.	25%	15
Total:		100%	60

i. Text Book and Reference Book:

1. Hand Book of Biomedical Instrumentation.
By R.S. Khandpur | Tata McGraw Hill
2. Biomedical Engineering and Instrumentation
By Joseph Bronzino | PWS Engineering, Boston
3. Artificial Organs
By Gerald E. Miller | Morgan & Claypool Publishers, Pub. Year 2006
4. Rehabilitation Engineering
By Robinson C.J | CRC press, Pub. Year 1995

- a. **Course Name:** Pharmaceutical Instrumentation
- b. **Course Code:** 03062404PE05
- c. **Prerequisite:** Basic Understanding of organic chemistry functional groups, the behavior of light within the electromagnetic spectrum, and fundamental electrical concepts like signal-to-noise ratio.
- d. **Rationale:** This course provides an in-depth study of the sophisticated analytical instruments used to characterize chemical compounds and biological molecules in the pharmaceutical industry. By mastering techniques ranging from spectroscopy to high-performance chromatography, students develop the technical expertise necessary to operate and maintain the complex equipment that ensures the efficacy and safety of modern medicine.
- e. **Course Learning Objective:**

CLOBJ 1	Explain the theory, instrumentation design, and qualitative applications of UV-Visible Spectroscopy.
CLOBJ 2	Understand the structural factors affecting fluorescence and the clinical applications of Spectrofluorimetry.
CLOBJ 3	Analyze vibrational frequencies and interpret chemical structures using Infrared (IR) and FT-IR spectrophotometry.
CLOBJ 4	Describe the fundamental principles, chemical shifts, and structural interpretations of NMR and ESR spectroscopy.
CLOBJ 5	Evaluate fragmentation processes and various ionization techniques utilized in mass spectrometry.
CLOBJ 6	Classify and apply various chromatographic and electrophoretic techniques for biological drug separation.

f. Course Learning Outcomes:

CLO 1	Remember the fundamental properties of biomaterials and the rheological characteristics of blood to predict how fluids behave in extracorporeal circuits.
CLO 2	Understand the mechanisms of artificial waste removal and the structural differences between flat plate, coil, and hollow fiber hemodialyzers.
CLO 3	Analyze various gas exchange techniques used in bubble and membrane oxygenators to ensure safe respiratory support during cardiopulmonary bypass procedures.
CLO 4	Apply the principles of sensory and circulatory assistance to patient care scenarios.
CLO 5	Evaluate the performance and biocompatibility of advanced materials in the context

of joint replacements and Ventricular Assist Devices (VAD).

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
4	0	0	4	20	20	-	60	-	100

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE Continuous Evaluation, ESE- End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage (%)	Teaching Hours
1.	UV-Visible Spectroscopy Brief review of electromagnetic spectrum and absorption of radiations. The Chromophore Concept, Absorption Law and limitations. Theory of Electronic Spectroscopy, Absorption by Organic Molecules, choice of solvent and solvent effects, modern instrumentation - design and working principle. Applications of UV-Visible Spectroscopy (qualitative and Quantitative Analyses), Woodward-Fischer rules for calculating absorption maximum, Photometric titrations and its applications.	13%	8
2.	Spectrofluorimetry Theory, instrumentation, advantages, relationship of chemical structure to fluorescence spectra, solvent effect, effect of acids and bases on fluorescence spectra, concentration effects, factors affecting fluorescence intensity, comparison of fluorescence and UV-Visible absorption methods, applications in Pharmacy.	7%	4
3.	Infrared Spectrophotometry Introduction, basic principles, vibrational frequency and factors influencing vibrational frequency, instrumentation and sampling techniques, interpretation of spectra, applications in Pharmacy, FT-IR: Theory and applications, Attenuated total	10%	6

	Reflectance (ATR).		
4.	<p>Nuclear Magnetic Resonance Spectroscopy Fundamental principles and theory, Instrumentation, solvents, chemical shift, and factors affecting chemical shift, spin-spin coupling, coupling constant, and factors influencing the value of coupling constant, spin-spin decoupling, proton exchange reactions, FT-NMR, 2D-NMR, NMDR, NOE, NOESY, COSY and applications in Pharmacy, interpretation of spectra, C-13 NMR: Introduction, Natural Abundance, C-13 NMR spectra and its structural applications.</p>	17%	10
5.	<p>Electron Spin Resonance Spectroscopy Theory and Principle, Limitations of ESR, choice of solvent, G-values, Hyperfine splitting, Instrumentation, Difference between ESR & NMR, applications.</p>	7%	4
6.	<p>Mass Spectroscopy Basic principles and instrumentation, ion formation and types, fragmentation processes and fragmentation pattern, Chemical Ionization Mass Spectroscopy (CIMS), Field Ionization Mass Spectroscopy (FIMS), Fast Atom Bombardment MS (FABMS), Matrix-Assisted Laser Desorption/Ionization MS (MALDI-MS), GC-MS, interpretation of spectra and applications in Pharmacy.</p>	13%	8
7.	<p>X-Ray Diffraction Methods Introduction, Generation of X-Rays, X-Ray Diffraction, Bragg's Law, X-Ray Powder Diffraction, interpretation of diffraction patterns and applications.</p>	7%	4
8.	<p>Chromatographic Techniques Classification of chromatographic methods based on mechanism of separation: paper chromatography, thin-layer chromatography, ion exchange chromatography, column chromatography and affinity chromatography - techniques and applications. Gas Chromatography: Theory and principle, column operation, instrumentation, derivatisation methods and applications. High Performance Liquid Chromatography: Principle, instrumentation, solvents used, elution techniques, RP-HPLC, LC-MS and its applications. HPTLC and Super Critical Fluid Chromatography (SFC): Theory and principle, instrumentation, elution techniques and pharmaceutical applications.</p>	17%	10

9.	Electrophoresis Theory and principles, classifications, instrumentation, moving boundary electrophoresis, Zone electrophoresis (ZE), Isoelectric focusing (IEF) and applications.	9%	6
Total:		100%	60

i. Text Book and Reference Book:

1. Analytical Instrumentation
By R.S. Khandpur
2. Principles of Instrumental Analysis
By Douglas A. Skoog, F. James Holler, and Stanley R. Crouch. | Cengage Learning
3. Instrumental Methods of Chemical Analysis
By G.R. Chatwal and S.K. Anand. | Himalaya Publishing House
4. Pharmaceutical Analysis: A Textbook for Pharmacy Students and Pharmaceutical Chemists
By David G. Watson. | Elsevier Health Sciences

- a. **Course Name:** Biomechanics
- b. **Course Code:** 03062404PE07
- c. **Prerequisite:** Basic Understanding of engineering physics (statics and dynamics), introductory human anatomy, and fundamental calculus.
- d. **Rationale:** Biomechanics applies the rigorous principles of classical mechanics to the complex structures of the human body to understand how forces interact with living tissues. By analyzing the structural integrity of bones, the viscoelasticity of soft tissues, and the fluid dynamics of blood, students gain the predictive power necessary to innovate in the fields of orthopedic implants, injury prevention, and gait rehabilitation.
- e. **Course Learning Objective:**

CLOBJ 1	Apply the fundamental principles of vector mechanics and Newton's laws of motion to biological systems.
CLOBJ 2	Describe the structural composition, mechanical, and viscoelastic properties of cortical and cancellous bone.
CLOBJ 3	Understand the material properties and modeling of soft tissues including cartilage, tendons, ligaments, and muscles.
CLOBJ 4	Construct free-body diagrams to analyze internal forces and equilibrium stresses across skeletal joints.
CLOBJ 5	Explain the rheological properties of blood flow using bio-fluid mechanics principles like the Hagen-Poiseuille equation.
CLOBJ 6	Assess human locomotion and physical energetics through applied engineering approaches to gait analysis.

f. Course Learning Outcomes:

CLO 1	Remember the fundamental laws of motion, vector mechanics, and properties of inertia to establish a mathematical foundation for analyzing bodily movements and equilibrium.
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CLO 2	Understand the structural composition and viscoelastic nature of hard and soft tissues to describe the active and passive behaviors of musculoskeletal units.
CLO 3	Analyze various skeletal joints by constructing free-body diagrams to calculate the internal forces and stresses acting on the hip, knee, and spinal column.
CLO 4	Apply the principles of bio-fluid mechanics to model blood flow and understand the rheological variations within the vascular system.
CLO 5	Evaluate human locomotion through gait analysis and clinical energetics to optimize engineering approaches.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
4	0	0	4	20	20	-	60	-	100

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE Continuous Evaluation, ESE- End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage (%)	Teaching Hours
1.	Introduction of Mechanics Review of the principles of mechanics, Vector mechanics- Resultant forces of Coplaner & Noncoplaner and Concurrent & non-concurrent forces, parallel force in space, Equilibrium of coplanar forces, Newton's laws of motion, Work and energy, Moment of inertia.	17%	10
2.	Mechanics of Hard tissue Structure and functions of Hard Tissues: Bone structure & composition of bone, mechanical properties of bone, cortical and cancellous bones, Viscoelastic properties.	17%	10

3.	Mechanics of Soft tissue Structure and functions of Soft Tissues: Cartilage, Tendon, Ligament, and Muscle; Material Properties: Cartilage, Tendon, Ligament, and Muscle; Modeling of soft tissues: Cartilage, Tendon, Ligament, and Muscle, Hills's muscle model.	20%	12
4.	Biomechanics of Joints Skeletal joints, forces and stresses in human joints, Analysis of rigid bodies in equilibrium, free body diagrams, types of joint, biomechanical analysis of elbow, shoulder, spinal column, hip knee and ankle.	25%	15
5.	Bio-fluid Mechanics & Applied Biomechanics New ceramics for joint replacement surgery, Composites for joint replacement surgery, New biomaterials for improving the blood and tissue compatibility of total artificial hearts (TAH), Ventricular assist devices (VAD), Recent advancement and future directions.	21%	13
Total:		100%	60

i. Text Book and Reference Book:

1. Hand Book of Biomedical Instrumentation.
By R.S. Khandpur | Tata McGraw Hill
2. Fundamentals of Biomechanics-Equilibrium, Motion and Deformation
By N. Ozkaya and M. Nordin | springer-verlag | 2nd edition, Pub. Year 1999
3. The Biomedical Engineering Handbook
By Joseph D, Bronzino | CRC Press | 3rd edition, Pub. Year 2006
4. Biomechanics- Principles and Applications
By D. J. Schneck and J. D. Bronzino | CRC Press | 2nd edition, Pub. Year 2000

- a. **Course Name:** Ophthalmic Instrumentation
- b. **Course Code:** 03062404PE09
- c. **Prerequisite:** Basic knowledge of human anatomy and physiology, elementary physics (light and optics), and introductory concepts of health care and medical terminology.
- d. **Rationale:** This course provides fundamental knowledge of the structure and function of the human eye, principles of ophthalmic and physiological optics, and commonly used diagnostic procedures and instruments. It prepares students to understand eye diseases, perform basic ophthalmic assessments, and assist in primary eye care and vision screening. The course is essential for developing competency in eye health management, prevention of blindness, and support in ophthalmic clinical practice.
- e. **Course Learning Objective:**

CLOBJ 1	Describe the gross anatomy of the human eye and explain the physiological mechanisms of vision.
CLOBJ 2	Understand the principles of physiological optics and identify the causes of various refractive anomalies.
CLOBJ 3	Explain the operational principles of ophthalmic diagnostic tools like the retinoscope, lensometer, and slit lamp.
CLOBJ 4	Recognize common ocular diseases, eye emergencies, and the principles of primary eye care.
CLOBJ 5	Outline the role of ophthalmic assistants in the clinical prevention of blindness and visual impairment.
CLOBJ 6	Identify and utilize fundamental ophthalmic measurement instruments including tonometers, keratometers, and focimeters.

f. Course Learning Outcomes:

CLO 1	Describe the gross anatomy and physiology of the eye and explain the mechanism of vision.
CLO 2	Explain principles of ophthalmic, geometrical, and physiological optics related to the human eye.
CLO 3	Identify refractive errors, optical aberrations, and their causes using basic optical concepts.
CLO 4	Recognize ophthalmic diagnostic instruments and outline their clinical applications.
CLO 5	Identify common ocular diseases and apply principles of primary eye care and prevention of blindness.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
4	0	0	4	20	20	-	60	-	100

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE Continuous Evaluation, ESE- End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage (%)	Teaching Hours
1.	Anatomy & Physiology of Eye Gross, anatomy of coats of eye ball cornea, sclera, Urea, Retina, Lens and vitreous. Physiology of eye ball, physiology of vision, color vision, ocular Movements.	20%	12
2.	Ophthalmic & Geometrical, Physiological Optics Nature of light, Laws of Refraction, Optical aberrations of ophthalmic glasses. Optics of the human Eye & refractive error. Photometry, fiber optics, colour theory. Refractive anomalies & their cause.	20%	12

3.	Ophthalmic Diagnostic Procedures Refractive Instruments, Retinoscope, Optometers, Lensometer, slit lamp. Tonometer, fundus camera, keritometer, orthoptism instruments, colour vision. Direct & Indirect ophthalmoscopy.	20%	12
4.	Ocular eye Disease & Primary Eye Care Common Eye Diseases, types of conjunctivitis including trachoma, corneal ulcer & opacities, Iritis, cataract, lids and lacrimal sac eye emergencies, Eye injuries, first aid and treatment, Glaucoma, Squint, Systemic disorders, screening and prevention of blindness & visual impairment. Role of Ophthalmic Assistant, Ophthalmic in primary eye care. Blindness in adult, children and primary care.	25%	15
5.	Ophthalmic Instruments Trial set, slit lamp, Focimeter, Lensometer, Retinoscopy, Optometers, Ophthalmoscope. Tonometer, Keritometer, Refractometer, Innovation in Ophthalmic equipment.	15%	9
Total:		100%	60

i. Text Book and Reference Book:

1. Human Anatomy and Physiology,
By Ross and Wilson | Churchill Livingstone (Elsevier)
2. Introduction to Visual Optics,
By Alan H. Tunnacliffe | Butterworth-Heinemann
3. Clinical Optics (2nd Edition),
By A. R. Elkington & H. J. Frank | Blackwell Scientific Publications
4. Optics and Refraction,
By L. P. Agarwal | CBS Publishers & Distributors
5. Principles and Practice of Refraction,
By Duke-Elder | Butterworth-Heinemann
6. Ophthalmic Optics and Refraction (System of Ophthalmology, Vol. 5),
By Duke-Elder | Henry Kimpton Publishers.

- a. **Course Name:** Dental Medical Equipments
- b. **Course Code:** 03062404PE11
- c. **Prerequisite:** Basic knowledge of human anatomy, oral structures, and fundamental concepts of biomedical instruments is required to understand dental instruments and their clinical applications.
- d. **Rationale:** The course provides essential knowledge of the principles, construction, operation, and maintenance of commonly used dental instruments and devices. It enables students to understand the role of dental equipment in diagnosis, treatment, and patient safety. The course prepares learners to handle, troubleshoot, and manage dental medical equipment effectively, supporting quality dental care and biomedical engineering applications in clinical environments.
- e. **Course Learning Objective:**

CLOBJ 1	Identify the components and standard instrument setups for basic oral examinations and local anesthesia.
CLOBJ 2	Describe the classification, usage, and maintenance of hand and motor-driven restorative dental instruments.
CLOBJ 3	Recognize specialized surgical instruments including forceps, elevators, and bone chisels used in oral surgeries.
CLOBJ 4	Understand the specific tools, setups, and procedures required for periodontic treatments.
CLOBJ 5	Explain the endodontic instrument setups necessary for conservative root canal therapies and apicoectomies.
CLOBJ 6	Apply appropriate care, sterilization, and safety precautions when handling diverse dental medical equipment.

f. Course Learning Outcomes:

CLO 1	Identify and describe basic dental examination and anesthetic instruments along with their functions.
CLO 2	Explain the classification, usage, and maintenance of restorative dental instruments used in cavity preparation and filling procedures.
CLO 3	Apply knowledge of surgical dental instruments in understanding extraction and minor oral surgical procedures.
CLO 4	Analyze the role of endodontic, orthodontic, and periodontal instruments in diagnosis and treatment of dental conditions.
CLO 5	Differentiate between various dental instruments used across specialties based on clinical application and procedure requirements.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
4	0	0	4	20	20	-	60	-	100

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE Continuous Evaluation, ESE- End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage (%)	Teaching Hours
1.	Introductions of the Basic Examination and Anesthetic Instruments Introduction: Parts of dental hand instruments, Black's classification of instruments, Maintenance of cutting instruments; The Basic Oral Examination: Importance of oral examination diagnosis service, Scope of oral diagnosis, Facilitating patient treatment, Instruments used in patient treatment, Basic dental examination setup; Standard Procedures: Oral examinations, Medical histories,	25%	14

	Radiographs (X-rays), Study casts; Anesthetic Instruments: General, Instruments for local anesthesia, Anesthetic instrument setup, Procedures.		
2.	Introduction of Restorative Instruments Introduction: General, Definitions, Classes of cavity preparations, Facilitating patient treatment; Instruments: Examination and diagnostic instruments, Local anesthetic instruments, Rubber dam, Saliva ejectors, Motor-driven rotary instruments used for cavity preparation, Hand instruments used for cavity preparation, Matrix retainers and bands, Instruments used in filling prepared cavities, Carving and finishing instruments.	25%	14
3.	Surgical Instruments Introduction: General, Asepsis and cleanliness, Dental specialist as an assistant in oral surgery; Instruments: General, Extraction forceps, Root elevators, Periosteal elevators, Curettes, Rongeur forceps, Bone files, Bone chisels, Surgical mallets, Surgical burs, Scissors, Surgical knives, Suture needles, Gingival retractors, Irrigating syringe, Dental aspirator, Dressing forceps, Sponge forceps, Instrument forceps, Hemostats, Needle holders, Towel clamp, Surgical instrument stand.	20%	12
4.	Periodontic Instruments Introduction, Instruments, Instrument setups and surgical procedures, common periodontal duties.	10%	8
5.	Endodontic Instruments General, Responsibility of the dental assistant, Instruments (dental chair), Instrument setups and procedures, Root canal treatment (conservative therapy), Apicoectomy surgical endodontic therapy, Care and cleaning of instruments, Safety precautions.	20%	12
Total:		100%	60

i. Text Book and Reference Book:

1. Dental Instruments: A Pocket Guide
By Linda Bartolomucci Boyd | Elsevier
2. Basic Guide to Dental Instruments
By Carmen Scheller-Sheridan | Wiley Blackwell
3. Handbook of Instruments in Dentistry
By Purushottam Singh Chauhan | CBS Publishers & Distributors Pvt. Ltd.
4. Dentist's Desk Reference: Materials, Instruments and Equipment
By American Dental Association

- a. **Course Name:** Workshop on PCB and electronics design
- b. **Course Code:** 03069102BS01
- c. **Prerequisite:** Basic knowledge of electrical and electronic components, circuit theory, and schematic reading.
- d. **Rationale:** This workshop provides hands-on exposure to PCB layout and electronics design, enabling students to translate circuits into practical hardware through schematic capture, PCB fabrication, component assembly, testing, and troubleshooting, thereby strengthening practical skills and design confidence in electronic systems.
- e. **Course Learning Objective:**

CLOBJ 1	Identify and interpret the specifications of general-purpose electronic components (resistors, capacitors, inductors).
CLOBJ 2	Classify and select appropriate cables, switches, and connectors based on their electrical carrying capacity.
CLOBJ 3	Understand the processes involved in schematic layout, component tracing, and fabrication of Printed Circuit Boards.
CLOBJ 4	Apply effective soldering and de-soldering theories for assembling both through-hole and surface-mount circuits.
CLOBJ 5	Distinguish between the classifications of primary, rechargeable, and reserve battery technologies.
CLOBJ 6	Evaluate battery capacities, IEC standards, and their specific applications in modern electronic systems.

- f. **Course Learning Outcomes:**

CLO 1	Identify and explain the characteristics, specifications, and applications of commonly used electronic components and devices.
CLO 2	Test and analyze electronic components and basic circuits using standard laboratory instruments and measurement techniques.
CLO 3	Use electronic workshop tools safely and effectively for circuit assembly, soldering, desoldering, and troubleshooting.
CLO 4	Select appropriate interconnection hardware such as cables, connectors, and switches based on functional and performance requirements.
CLO 5	Design and fabricate printed circuit boards using appropriate software tools and standard fabrication practices.
CLO 6	Understand the fundamentals of cells and batteries, their classifications, standards, and applications in modern electronic systems.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
1	0	0	1	20	20	-	60	-	100

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE Continuous Evaluation, ESE- End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage (%)	Teaching Hours
1.	<p>Identification and Testing of Electronic components</p> <p>Resistors: General-purpose resistors, Power resistors, Wirewound resistors, Thick film resistors, Surface-mount resistors, ceramic resistor, Axial resistors, Precision resistors, Variable resistors, Thermistor, resistor array, standard resistor values.</p> <p>Inductors: Iron core, Ferrite core, Toroidal core inductor, Variable with slug, Air core.</p> <p>Capacitors: cylindrical capacitor, disc capacitor, ceramic capacitor, capacitor array, electrolytic</p>	25%	5

	<p>capacitor, tantalum capacitors</p> <p>Transformer: 6-0-6, 12-0-12, 9V, 12V transformers.</p> <p>Electronic components: Relay, Diode, Zener diode, LED, Photo diode, BJT, Phototransistor, LDR, Solar cell, Photocell, Opto-coupler. Testing of Resistor, Capacitor, Diode and Transistor, Inductor using Multimeter.</p> <p>ICs: Monolithic IC, thick & thin film IC, Hybrid IC, Linear IC, Digital IC , IC packages-SIP, TO 5 ,Flat , DIP, Pin Identification, Device pattern Identification..</p> <p>Electronic Workshop Tools: Breadboard, Solder iron, solderstand, solder-wire, flux, Cutter, pliers, screwdriver set, wire stripper, de-solder pump, De-solder wick, drilling machine.</p>		
2.	<p>Cables, Connectors and Switches</p> <p>Cables: General specifications of cables-characteristic impedance, current carrying capacity, flexibility. Types of cables – SWG Single core, Multi core, Single strand, Multi strand and their types, Armoured cable, Shielded wires, Coaxial cables, Twisted pair, Flat ribbon cable, Teflon coated wires, Fiber cables , optical Fiber Cable</p> <p>Connectors: General specifications of connectors-contact resistance, breakdown voltage, insulation resistance, Constructional diagram, applications of BNC, D series, Audio, Video, printer, edge, FRC, RJ 45 connectors. Constructional diagram and applications of Phone Plug & Jacks</p> <p>Switches: Toggle switch- SPDT, DPDT, TPDT, Centre off, Without centre off, Rotary switch types depending on their poles and positions Rocker switch, Push button latch and non latch, Tactile switch, Micro switch, Limit switch, DIP switch, Thumb wheel switch- BCD, Decimal, Membrane switch</p>	25%	4
3.	<p>Printed Circuit Board (PCB)</p> <p>PCB layout, PCB design software, PCB layout - Component side and copper side, Tracing for PCB Fabrication, Soldering - types - selection of materials and soldering practice in connectors and general purpose PCB.</p>	25%	3
4.	<p>Cells and batteries</p> <p>Classification: Primary Cells, rechargeable batteries, Reserve Batteries, Fuel Cells, IEC standard of batteries, Battery capacity, Battery Technology used for EVs: Ni-MH, Pb-Pb02, Na-NiCl, Ni-cd, Zn-Br2, Li-Ion, Na-S.</p>	25%	3
Total:		100%	15

i. Open source software and website:

1. <https://www.electrical4u.com/types-of-resistor/> (for Resistor)
2. https://www.electronics-tutorials.ws/resistor/res_1.html (for Resistor)
3. <https://www.electrical4u.com/electrical-engineering-articles/batteries/> (for

Batteries)

4. <https://www.electronicshub.org/types-of-diodes/> (for Diodes)
5. <https://nptel.ac.in> (for online courses and video of all engineering branches)
6. www.electronicsforu.com (for basic electronic projects and technical videos)
7. <https://www.vlab.co.in> (Virtual Lab for all engineering branches)
8. Fritzing – PCB Designing Open Source Software.
9. KiCAD – PCB Designing Open Source Software.
10. www.freepcb.com/

- i. **Course Name:** Workshop on PCB and electronics design Lab
- j. **Course Code:** 03062404ES02
- k. **Prerequisite:** Basic knowledge of electronic components, circuit symbols, and elementary electrical measurements.
- l. **Rationale:** This laboratory provides hands-on experience in schematic capture, PCB layout, fabrication, soldering, testing, and troubleshooting of electronic circuits, enabling students to translate theoretical concepts into practical hardware designs while following safe and standard workshop practices.

m. Course Learning Objective:

CLOBJ 1	Perform functional testing on basic active and passive electronic components using a standard multimeter.
CLOBJ 2	Interpret component datasheets to ensure the proper application of diodes, transistors, and Integrated Circuits.
CLOBJ 3	Measure essential electrical parameters like voltage, current, and power utilizing a Cathode Ray Oscilloscope (CRO).
CLOBJ 4	Execute standard, safe soldering and desoldering techniques on a general-purpose Printed Circuit Board.
CLOBJ 5	Design, trace, and fabricate a customized PCB layout using both manual tracing and computer software (e.g., KiCAD).

CLOBJ 6	Classify, test, and compare various types of batteries and successfully construct a functional electronic mini-project.
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n. Course Learning Outcomes:

CLO 1	Identify, test, and analyze basic electronic components and devices using standard laboratory instruments.
CLO 2	Interpret electronic component datasheets and specifications for proper selection and application in circuits.
CLO 3	Measure electrical parameters such as voltage, current, power, and signal characteristics using multimeter and CRO.
CLO 4	Apply safe workshop practices and effectively use tools, cables, connectors, switches, and relays for circuit implementation.
CLO 5	Design, prepare, and fabricate printed circuit boards and implement simple electronic circuits and mini projects.

o. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
0	0	4	3	-	-	50	-	-	50

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE Continuous Evaluation, ESE- End Semester Examination

p. Course Content:

Sr. No.	List of Experiments
1.	Identification and Functional Testing of Basic Electronic Components. (Transformer, Diode, Zener Diode, Varactor Diode, LED, Photodiode, BJT, Phototransistor, FET, DIAC, TRIAC, LDR, Solar Cell, Photocell, Opto-coupler, Seven Segment Display, Relay)
2.	Study and Interpretation of Electronic Component Datasheets. (Diodes, Zener Diode, LED, Varactor Diode, Transistors, ICs, Voltage Regulators, and SMD Components)
3.	Demonstration of Workshop Tools, Materials, and Measuring Instruments.

4.	Measurement of Voltage and Current in Basic Electrical and Electronic Circuits Using Multimeter.
5.	Testing of Electronic Components Using CRO. (Component Test Mode)
6.	Measurement of Voltage, Current, and Power of 6-0-6 and 12-0-12 Transformers.
7.	Study of IC Packages and Soldering Techniques. (Through-Hole and Surface Mount Devices)
8.	Demonstration and Implementation of various cable and connectors for suitable application.
9.	Study and Application of Different Types of Relays for Basic Switching Circuits.
10.	Implementation of Simple Switch Circuits on Breadboard.
11.	Demonstrate precautionary steps to adopt Safe work practices.
12.	Soldering and Desoldering Techniques on General Purpose PCB.
13.	Preparation of PCB Layout Using Manual Method.
14.	Preparation of PCB Layout Using Computer Software.
15.	Tracing of Electronic Circuit from Given PCB Layout.
16.	Design and Fabrication of a Simple Electronic Mini Project Using PCB.
17.	Study and Classification of Different Types of Batteries with Specifications.
18.	Testing of Different Types of Batteries Using Multimeter.