17BMX14 – COMMUNICATION SYSTEMS				
	L	T	P	C
	3	0	0	3

PREREQUISITE : NIL

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To apply analog modulation techniques.	1.1	The students will be able to apply analog modulation techniques.	**a,b,j,l**
2.0	To gain knowledge on various receiver techniques.	2.1	The students will be able to learn various receiver techniques.	**a,b,d,g,j,l**
3.0	To infer knowledge on various types coding techniques.	3.1	The students will be able to infer knowledge on various types of coding techniques.	**a,c**
4.0	To know the various digital modulation techniques.	4.1	The students will be able to learn the digital modulation techniques.	**a,b,c,g,j,l**
5.0	To analyze various error control coding techniques.	5.1	The students will be able to analyze various error control coding techniques.	**a,b,d,g**

UNIT I – ANALOG MODULATION	**(9)**
Amplitude Modulation – AM, DSBSC, SSBSC, VSB – Angle Modulation – PM and FM – Modulators and Demodulators.	
UNIT II – RECEIVER CHARACTERISTICS	**(9)**
Noise Sources and Types – Noise Figure and Noise Temperature – Noise in Cascaded Systems – Single Tuned Receivers – Super Heterodyne Receivers.	
UNIT III – INFORMATION THEORY	**(9)**
Measure of Information – Entropy – Source Coding Theorem – Discrete Memoryless Channels – Lossless, Deterministic, Noiseless, BEC, BSC – Mutual Information – Channel Capacity – Shannon-Fano Coding, Huffman Coding, Run Length Coding, LZW Algorithm.	
UNIT IV – BANDPASS SIGNALING	**(9)**
Geometric Representation of Signals – Correlator and Matched Filter – ML Detection – Generation And Detection, PSD, BER of Coherent BPSK, BFSK, QPSK – Principles of QAM – Structure of non-coherent receivers – BFSK, DPSK.	

UNIT V – ERROR CONTROL CODING TECHNIQUES	(9)
Channel Coding Theorem – Linear Block Codes – Hamming Codes – Cyclic Codes (CRC) – Convolutional Codes – Viterbi Decoding (Soft/Hard Decision Decoding).	
TOTAL (L: 45) = 45 PERIODS	

TEXT BOOKS:

1. B.P.Lathi, "Modern Digital and Analog Communication Systems'', 3rd Edition, Oxford University Press, 2007.
2. H Taub, D L Schilling, G Saha, "Principles of Communication Systems", 3rd Edition, TMH, 2007.
3. S. Haykin, "Digital Communications", John Wiley, 2005.

REFERENCES:

1. H P Hsu, Schaum, "Outline Series, Analog and Digital Communications", TMH, 2006.
2. B.Sklar, "Digital Communications Fundamentals and Applications", 2nd Edition, Pearson Education, 2007.

17BMX15 – MEDICAL OPTICS				
	L	T	P	C
	3	0	0	3

PREREQUISITE : NIL

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To provide knowledge on the impact and properties of light.	1.1	The students will be able to acquire knowledge on the impact and properties of light.	a,g
2.0	To acquire knowledge of the fundamentals of optical properties of tissues.	2.1	The students will be able to demonstrate knowledge of the fundamentals of optical properties of tissues.	a,b,d,h,l
3.0	To describe surgical applications of laser.	3.1	The students will be able to describe surgical applications of laser.	a,b,d,h,l
4.0	To understand photonics and its therapeutic applications.	4.1	The students will be able to describe photonics and its therapeutic applications.	a,b,c,g,l
5.0	To learn the concepts of laser and light to understand the laser safety procedures.	5.1	The students will be able to apply the concepts of laser and light to understand the laser safety procedures.	a,b,f,g

UNIT I - INSTRUMENTATION IN PHOTONICS	**(9)**
Review of Basic Properties of Light – Reflection, Refraction, Scattering, Fluorescence and Phosphorescence. Instrumentation for Absorption, Scattering and Emission Measurements, Excitation Light Sources – High Pressure Arc Lamp, LEDs, Lasers. Optical Filters. Optical Detectors - Time Resolved and Phase Resolved Detectors, Optical Tweezers.	
UNIT II - OPTICAL PROPERTIES OF THE TISSUES	**(9)**
Light Transport Inside the Tissue, Optical Properties of Tissue. Laser Characteristics as applied to Medicine and Biology - Laser Tissue Interaction - Chemical, Thermal, and Electromechanical. Photo Ablative Processes.	
UNIT III - SURGICAL APPLICATIONS OF LASERS	**(9)**
Lasers in Ophthalmology - Dermatology – Dentistry – Urology – Otolaryngology - Tissue Welding.	
UNIT IV - NON-THERMAL DIAGNOSTIC APPLICATIONS	**(9)**
Optical Coherence Tomography, Elastography, Laser Induced Fluorescence (LIF)-Imaging, FLIM Raman Spectroscopy and Imaging, FLIM – Holographic and Speckle Application of Lasers in Biology and Medicine.	

UNIT V – THERAPEUTIC APPLICATIONS	(9)
Phototherapy, Photodynamic Therapy (PDT) - Principle and Mechanism - Oncological and Non-oncological Applications of PDT - Biostimulation Effect – Applications - Laser Safety Procedures.	
TOTAL (L: 45) = 45 PERIODS	

TEXT BOOKS:

1. Markolf H.Niemz, “Laser-Tissue Interaction Fundamentals and Applications”, Springer, 2007.
2. Paras N. Prasad, “Introduction to Bio photonics”, A. John Wiley and sons, Inc. Publications, 2003.

REFERENCES:

1. Helena Jelinkova, “Lasers for Medical Applications: Diagnostics, Therapy and Surgery’’, 1st Edition, Woodhead Publishing, 2013.
2. Mark E. Brezinski, “Optical Coherence Tomography: Principles and Applications”, Academic Press, 2006.
3. R. Splinter and B.A. Hooper, “An Introduction to Biomedical Optics”, Taylor and Francis, 2007.
4. Tuan Vo Dinh, “Biomedical photonics – Handbook”, CRC Press LLC, 2003.

17BMX16 – BODY AREA NETWORKS				
	L	T	P	C
	3	0	0	3
PREREQUISITE : NIL				
COURSE OBJECTIVES AND OUTCOMES:				

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To know about BAN network.	**1.1**	The students will be able to understand the importance and role of body area networks.	**a,f,g,l**
2.0	To know the hardware requirement of BAN.	**2.1**	The students will be able to design a BAN for appropriate application in medicine.	**a,b,c,d,f,g,h,j**
3.0	To understand the various communication standards.	**3.1**	The students will be able to analyze the various communication standards.	**a,f,g,j**
4.0	To understand the communication and security aspects in the BAN.	**4.1**	The students will be able to demonstrate the security aspects and the need for compliance with medical device regulations in different regions.	**a,b,d,f,g,h,**
5.0	To know the applications of BAN in the field of medicine.	**5.1**	The students will be able to match BAN concepts to medical applications.	**a,c,e,h**

UNIT I – INTRODUCTION BAN	**(9)**
Definition, BAN and Healthcare, Technical Challenges - Sensor Design, Biocompatibility, Energy Supply, Optimal Node Placement, Number of Nodes, System Security and Reliability, BAN Architecture – Introduction.	
UNIT II – HARDWARE FOR BAN	**(9)**
Processor - Low Power MCUs, Mobile Computing MCUs, Integrated Processor with Radio Transceiver, Memory, Antenna - PCB Antenna, Wire Antenna, Ceramic Antenna, External Antenna, Sensor Interface, Power Sources - Batteries and Fuel Cells for Sensor Nodes.	
UNIT III – WIRELESS COMMUNICATION AND NETWORK	**(9)**
RF Communication in Body, Antenna Design and Testing, Propagation, Base Station - Network topology – Stand-alone BAN, Wireless Personal Area Network Technologies - IEEE 802.15.1, IEEE P802.15.13, IEEE 802.15.14, Zigbee.	
UNIT IV – COEXISTENCE ISSUES WITH BAN	**(9)**
Interferences – Intrinsic - Extrinsic, Effect on Transmission, Counter Measures - on Physical Layer and Data Link Layer, Regulatory Issues - Medical Device Regulation in USA and Asia, Security and Self-protection - Bacterial Attacks, Virus Infection, Secured Protocols.	

UNIT V - APPLICATIONS OF BAN	(9)
Monitoring Patients with Chronic Disease, Hospital Patients, Elderly Patients, Cardiac Arrythmias Monitoring, Multi patient Monitoring Systems, Multichannel Neural Recording, Gait Analysis, Sports Medicine, Electronic Pill.	
TOTAL (L: 45) = 45 PERIODS	

TEXT BOOKS:

1. Annalisa Bonfiglio, Danilo De Rossi, "Wearable Monitoring Systems", Springer, 2011.
2. Sandeep K.S. Gupta,Tridib Mukherjee, Krishna Kumar Venkata Subramanian, “Body Area Networks Safety, Security, and Sustainability”, Cambridge University Press, 2013.

REFERENCES:

1. Zhang, Yuan-Ting, “Wearable Medical Sensors and Systems”, Springer, 2013.
2. Guang-ZhongYang, “Body Sensor Networks”, 2nd Edition, Springer, 2014.
3. Mehmet R. Yuce, Jamil Y.Khan, “Wireless Body Area Networks Technology, Implementation, and Applications”, Pan Stanford Publishing, Singapore, 2012.

17BMX17 – MEDICAL WEARABLE DEVICES							
				L	T	P	C
				3	0	0	3
PREREQUISITE : NIL							
COURSE OBJECTIVES AND OUTCOMES:							
Course Objectives		**Course Outcomes**		**Related Program outcomes**			
1.0	To understand about the various sensors used for physiological system measurements.	**1.1**	The students will be able to describe various sensors used for measurements in physiological systems.	**a,f,l**			
2.0	To gain knowledge about bio signal acquisition methods and signal processing methods for human systems.	**2.1**	The students will be able to understand the bio signal acquisition methods and signal processing methods for human systems.	**a,b.l**			
3.0	To know the energy harvesting from various sources.	**3.1**	The students will be able to analyze the usage of optimized energy techniques for wearable devices.	**a,c,f,h,l**			
4.0	To understand the affiliation of wireless communication and BAN in Tele health technology.	**4.1**	The students will be able to analyze the wireless communication and BAN in Tele health technology.	**a,c,d,f,g,h,j**			
5.0	To understand various applications of wearable devices in Tele health technology.	**5.1**	The students will be able to infer the various applications of wearable systems.	**a,g,h,l**			

UNIT I – SENSORS	**(9)**
Need for Wearable Systems, Sensors for Wearable Systems - Inertia Movement Sensors, Respiration Activity Sensor, Inductive Plethysmography, Impedance Plethysmography, Pneumography, Wearable Ground Reaction Force Sensor, GSR, Radiant Thermal Sensor, Wearable Motion Sensors, CMOS – Based Biosensors, E-Textiles, Bio compatibility.	
UNIT II – SIGNAL PROCESSING	**(9)**
Wearability Issues - Physical Shape and Placement of Sensor, Technical Challenges – Sensor Design, Signal Acquisition, Constraint on Sampling Frequency for Reduced Energy Consumption, Light Weight Signal Processing, Rejection of Irrelevant Information, Data Mining.	
UNIT III – ENERGY HARVESTING FOR WEARABLE DEVICES	**(9)**
Solar Cell, Vibration Based, Thermal Based, Human Body as a Heat Source for Power Generation, Hybrid Thermoelectric Photovoltaic Energy Harvests, Thermopiles.	

UNIT IV – WIRELESS HEALTH SYSTEMS	(9)
Need for Wireless Monitoring, Definition of Body Area Network, BAN and Healthcare, Technical Challenges - System Security and Reliability, BAN Architecture – Introduction, Wireless Communication Techniques.	
UNIT V – APPLICATIONS OF WEARABLE SYSTEMS	**(9)**
Medical Diagnostics, Medical Monitoring - Patients with Chronic Disease, Hospital Patients, Elderly Patients, Multi parameter Monitoring, Neural Recording, Gait Analysis, Sports Medicine, Smart Fabrics.	
TOTAL (L: 45) = 45 PERIODS	

TEXT BOOKS:

1. Edward Sazonov, Michael R Neuman, "Wearable Sensors: Fundamentals, Implementation and Applications", AcademicPress, USA, 2014.
2. Annalisa Bonfiglio, Danilo De Rossi, "Wearable Monitoring Systems", Springer, 2011.

REFERENCES:

1. Sandeep K.S. Gupta, Tridib Mukherjee, Krishna Kumar Venkatasubramanian, "Body Area Networks Safety, Security, and Sustainability," Cambridge University Press, 2013.
2. Andreas Lymberis, Danilo de Rossi, “Wearable eHealth Systems for Personalized Health Management - State of the Art and Future Challenges”, IOS press, The Netherlands, 2004.
3. Hang,Yuan-Ting, "Wearable Medical Sensors and Systems", Springer, 2013.
4. Mehmet R. Yuce, Jamil Y. Khan, "Wireless Body Area Networks Technology, Implementation and Applications", Pan Stanford Publishing Pvt. Ltd, Singapore, 2012.
5. Guang-ZhongYang, “Body Sensor Networks”, 2nd Edition, Springer, 2014.

17BMX18 – TELEMEDICINE AND MEDICAL IoT					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To learn the key principles for telemedicine and multimedia technologies in telemedicine.	**1.1**	The students will be able to understand the key principles for telemedicine and multimedia technologies in telemedicine.	**a,f,g,h,j**	
2.0	To know telemedical standards.	**2.1**	The students will be able to demonstrate telemedical standards.	**a,f,g,j**	
3.0	To understand telemedical technology and mobile telemedicine	**3.1**	The students will be able to discuss telemedical technology and mobile telemedicine.	**a,b,d,f,g,j,l**	
4.0	To understand aspects of IoT in telemedicine.	**4.1**	The students will be able to understand the various aspects of IoT in telemedicine.	**a,d,e,g,j**	
5.0	To gain knowledge on application of telehealth in healthcare.	**5.1**	The students will be able to analyze the applications of telehealth in healthcare.	**a,g,h,l**	

UNIT I – TELEMEDICAL TECHNOLOGY	**(9)**
Evolution of Telemedicine, Functional Diagram of Telemedicine System, Telemedicine, Telehealth, Tele care, Organs of Telemedicine, Principles of Multimedia, PSTN, POTS, ANT, ISDN, Internet, Air/ Wireless Communications, Types of Antenna, Integration and Operational Issues, Communication Infrastructure for Telemedicine. Mobile Hand Held Devices and Mobile Communication. Internet Technology and Telemedicine using World Wide Web (www). Clinical Data – Local and Centralized.	
UNIT II – TELEMEDICAL STANDARDS	**(9)**
Data Security and Standards - Mechanisms of Encryption, Phases Of Encryption. Protocols: TCP/IP, ISO-OSI, Standards to followed DICOM, HL7, H. 320 series (Video phone based ISBN) T. 120, H.324 (Video phone based PSTN), Video Conferencing, Real-time Telemedicine Integrating Doctors / Hospitals, Clinical Laboratory Data, Radiological Data, and Other Clinically Significant Biomedical Data, Administration of Centralized Medical Data, Security and Confidentially of Medical Records and Access Control, Cyber Laws related to Telemedicine.	
UNIT III – MOBILE TELEMEDICINE	**(9)**
Tele radiology: Definition, Basic parts, Tele pathology, Multimedia Databases, Color Images Of Sufficient Resolution, Dynamic Range, Spatial Resolution, Compression Methods, Interactive Control of Color, Medical Information Storage and Management for Telemedicine - Patient Information Medical History, Test Reports, Medical Images Diagnosis and Treatment. Hospital Information System - Doctors, Paramedics, Facilities Available. Pharmaceutical Information System.	

UNIT IV – INTRODUCTION TO IoT	(9)
Introduction to Internet of Things (IoT). Review of CC3200 Core and its Architecture, Introduction to Advanced ARM Cortex M4 Architecture, Peripherals Overview, User API, Power Challenges with IoT, CC3200 Simple Link Applications, Starting with Code Composer Studio V6. Various Wireless Protocols and its Applications: ZigBee, Bluetooth Low Energy, 6LowPAN, Wi-Fi.	
UNIT V – APPLICATIONS OF TELEHEALTH TECHNOLOGY	**(9)**
Telemedicine Access to Health Care Services – Health Education and Self-care - Introduction to Robotics Surgery, Telesurgery, Telecardiology, Teleoncology, Telemedicine in Neurosciences - Electronic Documentation - e-health Services - Security and Interoperability - Telemedicine Access to Health Care Services - Introduction to WLAN, WLAN Parameters, AP/STATION Modes and its Security Types, Socket Connection, WLAN AP and WLAN STATION Configuration Settings.	
TOTAL (L: 45) = 45 PERIODS	

TEXT BOOKS:

1. R.S.Khandpur, "Telemedicine Technology and Applications (mhealth, Telehealth and ehealth)", PHI Learning Pvt. Ltd., Delhi, 2017.
2. Wootton, R., Craig, J., Patterson, V., "Introduction to Telemedicine", Royal Society of Medicine Press Ltd., Taylor & Francis 2006.

REFERENCES:

1. Latifi, R, "Current Principles and Practices of Telemedicine and e-Health", IOHS Press, Washington DC, 2008.
2. Bashshur, R.L., Shannon G.W., "History of Telemedicine", New Rochelle NY: Mary Ann Liebert Publishers, 2009.
3. Victor Lyuboslavsky, "Telemedicine and Telehealth 2.0: A Practical Guide for Medical Providers and Patients", 1st Edition, CreateSpace Independent Publishing Platform, 2015.

17BMX19 – MEDICAL INFORMATICS					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To teach ICT applications in medicine with an introduction to health informatics.	**1.1**	The students will be able to discuss about health informatics and different ICT applications in medicine.	**a,c,e,g,l**	
2.0	To understand the theories and practices adopted in Hospital Information Systems in the light of medical standards.	**2.1**	The students will be able to appreciate and adopt medical standards.	**a,f,h**	
3.0	To know medical data formats and recent trends in Hospital Information systems for data acquisition and storage.	**3.1**	The students will be able to recognize medical data formats and recent trends in Hospital Information systems for data acquisition and storage.	**a,b,c,e,f,h,l**	
4.0	To introduce the basics of bioinformatics, resources in the field and to apply the standards in proper health care delivery.	**4.1**	The students will be able to understand the basics of bioinformatics, resources in the field and the standards in proper health care delivery.	**a,c,f,h**	
5.0	To understand the recent trends in medical informatics.	**5.1**	The students will be able to discuss the recent trends in medical informatics.	**a,b,c,e,g,h,l**	

UNIT I – MEDICAL INFORMATICS	**(9)**
Introduction - Medical Informatics – Bioinformatics – Health Informatics - Structure of Medical Informatics – Functional Capabilities of Hospital Information System - On-line Services and Off – Line Services - History taken by Computer, Dialogue with the Computer.	
UNIT II – MEDICAL STANDARDS	**(9)**
Evolution of Medical Standards – IEEE 11073 - HL7 – DICOM – IRMA - LOINC – HIPPA – Electronics Patient Records – Healthcare Standard Organizations – JCAHO (Join Commission on Accreditation of Healthcare Organization) – JCIA (Joint Commission International Accreditation) - Evidence Based Medicine - Bioethics.	
UNIT III – MEDICAL DATA ACQUISITION AND STORAGE	**(9)**
Plug-in Data Acquisition and Control Boards – Data Acquisition using Serial Interface - Medical Data Formats – Signal, Image and Video Formats – Medical Data bases - Automation in Clinical Laboratories - Intelligent Laboratory Information System - PACS , Data mining.	

UNIT IV - HEALTH INFORMATICS	(9)
Bioinformatics Databases, Bio-information Technologies, Semantic Web and Bioinformatics, Genome Projects, Clinical Informatics, Nursing Informatics, Public Health Informatics - Education and Training.	
UNIT V - RECENT TRENDS IN MEDICAL INFORMATICS	**(9)**
Medical Expert Systems, Virtual reality applications in medicine, Virtual Environment - Surgical simulation – Radiation therapy and planning – Telemedicine – virtual Hospitals - Smart Medical Homes – Personalized e-health services – Biometrics - GRID and Cloud Computing in Medicine.	
TOTAL (L: 45) = 45 PERIODS	

TEXT BOOK:

1. R. D. Lele, "Computers in Medicine: Progress in Medical Informatics", Tata McGraw Hill Publishing Computers Ltd., New Delhi, 2005.
2. Mohan Bansal, "Medical Informatics", Tata McGraw Hill Publishing Computers Ltd., New Delhi, 2003.

REFERENCES:

1. Mathivanan.N, "PC-Based Instrumentation", Prentice Hall of India Pvt. Ltd., New Delhi, 2007.
2. Yi – Ping Phoebe Chen, "Bioinformatics Technologies", Springer International Edition, New Delhi, 2007.
3. Orpita Bosu and Simminder Kaur Thukral, "Bioinformatics Databases, Tools and Algorithms", Oxford University Press, 2007.

17BMX20 – HOSPITAL PLANNING, ORGANIZATION AND MANAGEMENT				
	L	T	P	C
	3	0	0	3
PREREQUISITE : NIL				

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To learn about the sole proprietorship and partnership to the principles of management and evolution.	**1.1**	The students will be able to understand the sole proprietorship and partnership to the principles of management and evolution.	**f,h,i,k**
2.0	To know about the importance of hospital management and the process of forecasting techniques and decision-making process.	**2.1**	The students will be able to learn the importance of hospital management and the process of forecasting techniques and decision-making process.	**f,g,h,i,k**
3.0	To understand the pattern of staffing, selection and recruiting process to the training of organizational and career development.	**3.1**	The students will be able to discuss the pattern of staffing, selection and recruiting process to the training of organizational and career development.	**f,h,i,j,k**
4.0	To infer knowledge on the basic marketing in health sector with a principle to social marketing.	**4.1**	The students will be able to analyze the basic marketing in health sector with a principle to social marketing.	**b,d,h,i,j**
5.0	To know about system development of life cycle and main categories of information systems in hospital.	**5.1**	The students will be able to gain knowledge on the system development of life cycle and main categories of information systems in hospital.	**d,e,h**

UNIT I – FORMS OF ORGANISATION	**(9)**
Sole Proprietorship, Partnership, Company-public and Private Sector Enterprises, Principles of Management, Evolution of Management.	
UNIT II – PRINCIPLE OF HOSPITAL MANAGEMENT	**(9)**
Importance of Management and Hospital, Management Control Systems. Forecasting Techniques Decision-making Process.	
UNIT III – STAFFING	**(9)**
Staffing Pattern in Hospitals, Selection, Recruiting Process, Training of Staff, Organizational Structures, Career Development.	

UNIT IV – MARKETING AND MANAGEMENT	(9)
Basic Concepts Marketing, Principles of Social Marketing, Social Marketing in Health Sector, Consumer Behavior and Research Health, Advertising in Health Sector, Relevance of e-marketing of Health Care Services.	
UNIT V – COMPUTER IN HOSPITAL	**(9)**
System Development Life Cycle, Reasons to use Computers in Hospital, Main Categories of Information Systems in Hospitals.	
	TOTAL (L: 45) = 45 PERIODS

TEXT BOOKS:

1. G. D. Kunders, "Hospitals: Facilities Planning and Management", Tata Mc Graw Hill Education, New Delhi, 2004.
2. Goyal R.C., "Human Resource Management in Hospital", Prentice Hall of India Pvt. Ltd., New Delhi, 2000.

REFERENCES:

1. Nauhria R.N. and Rajnish Prakash, "Management & Systems", New Delhi Wheeler Publishing, 1995.
2. Syed Amin Tabish, "Hospitals & Nursing Homes: Planning, Organisations & Management", Jaypee Brothers Medical Publishers (P) Limited, 2003.

17BMX21 – FINANCE MANAGEMENT IN HOSPITALS				
	L	T	P	C
	3	0	0	3

PREREQUISITE : NIL

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To learn the scope and goal of financial management.	**1.1**	The students will be able to understand the scope and goal of financial management.	**b,d,f,h,k**
2.0	To infer knowledge on the basic principles and processes involved in the accounting.	**2.1**	The students will be able to discuss on the basic principles and processes involved in the accounting.	**b,d,f,h,k**
3.0	To develop skills in analyzing various technical and analytical tools for accounting.	**3.1**	The students will be able to interpret the skills used for analyzing various technical and analytical tools for accounting.	**a,b,c,e,h,k**
4.0	To understand the basic budgetary control in cost and volume with profit analysis.	**4.1**	The students will be able to analyze the basic budgetary control in cost and volume with profit analysis.	**b,d,h,k**
5.0	To enhance skills in decision-making in a hospital setting and practice the preparation of final accounts.	**5.1**	The students will be able to come up with ideas on decision-making in a hospital setting and practice the preparation of final accounts.	**c,f,h,k**

UNIT I – INTRODUCTION	**(9)**
Finance Function – Meaning – Definition - Scope of Finance Function- Executive Functions & Incidental Functions - Scope and Goal of Financial Management in Hospitals – Profit Maximization & Wealth Maximization.	
UNIT II – ACCOUNTING TECHNIQUES	**(9)**
Types of Accounting, Hospital Accounting - Financial Book Keeping, Book Keeping Obligations. Accounting Concepts & Conventions – Final Accounts: Trading – Profit & Loss Accounts - Balance Sheet.	
UNIT III – COSTING IN HOSPITALS	**(9)**
Nature & Scope of Cost Accounting – Cost Analysis & Classification - Cost Calculation, Significance of Internal Billing in Hospital - Necessary for Internal & External Controlling Cost, Cost Unit Calculation.	

UNIT IV – MANAGEMENT ACCOUNTING	(9)
Budgeting & Budgetary control – Cost – Volume – Profit Analysis.	
UNIT V – FINANCING DECISIONS	**(9)**
Cost of Capital & Capital Structure – Sources of Short Term Finance: Management of Working Capital – Sources of Long Term Finance: Share Capital, Debentures - Corporate Debit Capacity.	
TOTAL (L: 45) = 45 PERIODS	

TEXT BOOKS:

1. G R Kulkarni, P Satyashankar, Libert Anil Gomes, "Financial Management for Hospital", 2009.
2. I M Pandey Vikas, "Financial Management", Publishing Co., 1999.
3. Jaypee Brothers "Administration", Medical Publishers Pvt. Limited, 01-Jul-2009.

REFERENCES:

1. James C.Vanhorne, "Financial Management and Policy", 9th Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 1995.
2. Michael Nowicki, "The Financial Management of Hospitals and Healthcare Organizations", Health Administration Press, 2008.
3. Prasanna Chandra, "Financial Management", 1st Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi.

17BMX22 – HUMAN RESOURCES MANAGEMENT IN HOSPITAL					
			L	T	P	C
			3	0	0	3
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To know about the evolution of human resource management.	**1.1**	The students will be able to learn the evolution of human resource management.	**b,f,h**	
2.0	To infer knowledge on the organisational job design and the forecasting of human resource requirements.	**2.1**	The students will be able to recognize the organisational job design and the forecasting of human resource requirements.	**c,h,j**	
3.0	To be studious on the type of training method in the executive development programme.	**3.1**	The students will be able to discuss the training method in the executive development programme.	**f,h**	
4.0	To encompass the strategy of employee sustainability.	**4.1**	The students will be aware of the employee sustainability strategy.	**f,g,h**	
5.0	To acquaint various methods involved in performance appraisal.	**5.1**	The students will be able to narrate the various methods involved in performance appraisal.	**b,g,h**	

UNIT I – PERSPECTIVES OF HUMAN RESOURCE MANAGEMENT	**(9)**
Evolution of Human Resource Management - Importance of Human Factor, Objectives of Human Resource Management - Human Resource Policies - Need for HRD/HRM in Healthcare Organization - Computer Applications in Human Resource Management.	
UNIT II – THE CONCEPT OF BEST FIT EMPLOYEE	**(9)**
Organizational Job Design - Job Description - Job Analysis - Job Rotation-job Evaluation- Man-power Planning-Importance of Human Resource Planning, Forecasting of Human Resource Requirements - Selection Procedures - Test, Validation, Interviews, Recruitment, Medical Examination.	
UNIT III – TRAINING & EXECUTIVE DEVELOPMENT	**(9)**
Types of Training Methods and their Benefits - Executive Development Programme – Common Practices - Benefits, Self-development - Knowledge Management.	
UNIT IV – SUSTAINING EMPLOYEE INTEREST	**(9)**
Wage and Salary Administration – Concept of Incentives and its Operational Implications – Participative Decision making – Concept of Collective Bargaining – Compensation Plans – Rewards – Motivation – Theories of Motivation - Grievances and Redressal Methods.	

UNIT V - PERFORMANCE APPRAISAL	(9)
Importance of Performance Appraisal - Methods of Performance Evaluation - Traditional Methods – Modern Methods – Feedback – Promotion – Demotion – Transfer. Implications of Job Change. The Control Process, Methods and Requirements of Effective Control System.	
TOTAL (L: 45) = 45 PERIODS	

TEXT BOOKS:

1. D. K. Sharma, R. C. Goyal, "Hospital Administration and Human Resource Management", PHI Learning Pvt. Ltd., 2013.
2. Decenzo and Robbins, "Human Resource Management", Wiley & Sons, Singapore, 1999.

REFERENCES:

1. Mamoria C.B. and Mamoria S., "Personnel Management", Himalaya Publishing Company, 1997.
2. R.C.Goyal, "Human Resource Management in Hospitals", Prentice Hall of India, 2000.
3. Walter J. Flynn, Robert L. Mathis, John H. Jackson, "Healthcare Human Resource Management", 2006.

17BMX23 – HOSPITAL ARCHITECTURE					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To gain knowledge on various framework and structure of health care system.	**1.1**	The students will be able to analyze the various framework and structure of health care system.	**a,c,e,f,h**	
2.0	To know all the facets of hospital planning.	**2.1**	The students will be able to familiar with all the facets of hospital planning.	**a,c,d,g,h,i**	
3.0	To learn the newest findings in the area of hospital planning.	**3.1**	The students will be able to interpret the newest findings in the area of hospital planning.	**a,c,d,g,h,i,l**	
4.0	To implement the perspectives in constructing hospital standards.	**4.1**	The students will be able to discuss the perspectives in constructing hospital standards.	**a,c,g,h**	
5.0	To be studious in hospital planning activities covering every department.	**5.1**	The students will be enlightened in hospital planning activities covering every department.	**a,c,g,h,k**	

UNIT I – INTRODUCTION TO HEALTH CARE SYSTEM	**(9)**
International and National Level Policy Framework for Healthcare Facilities – Types of Healthcare Facilities based on Public and Private Ownership, Bed Size and Type of Health Care Services based on Outpatient, Inpatient and Diagnostic Care - Organizational, Function and Structure of the Hospital.	
UNIT II – HOSPITAL PLANNING	**(9)**
Principles of Planning, Regionalization, Hospital Planning Team, Planning Process, Size of the Hospital, Site Selection, Hospital Architect, Architect Report, Equipping a Hospital, Interiors & Graphics, Construction & Commissioning, Planning for Preventing Injuries, Electrical Safety.	
UNIT III – PLANNING & DESIGNING OF DIFFERENT SERVICES IN HOSPITALS	**(9)**
Planning and Designing of Administrative Services, Medical and Ancillary Services, Nursing Services, Supportive Services, Public Areas and Staff Services, Hospital Services of Training Methods and their Benefits - Executive Development Programme – Common Practices - Benefits, Self-development - Knowledge Management.	
UNIT IV – STANDARDS AND NORMS FOR HOSPITALS	**(9)**
Design and Construction Standards for the Hospitals namely BIS – India and JCAHO, AIA and NHS – General Guidelines and Standard for Out-patient Area, In-patient Area and Diagnostic Area in the Hospitals. Voluntary & Mandatory Standards, General Standards, Mechanical Standards, Electrical Standards, Standard for Centralized Medical Gas System, Standards for Biomedical Waste.	

UNIT V - FACILITIES FOR SUPPORTIVE SERVICES	(9)
Transport, Information System, Communication, Food Services, Mortuary, Heating Ventilation and Air Conditioning, Medical Gases, House Keeping, Laundry.	
TOTAL (L: 45) = 45 PERIODS	

TEXT BOOKS:

1. G.Kunders, "Hospitals - Facilities Planning & Management", Tata McGraw - Hill Education, 2004.
2. Purnima Sharma, Sangeet Sharma, Nerendra Malhotra, Jaideep Malhotra, "Step by Step Hospital Designing and Planning", 2nd Edition, Jaypee Brothers-Medical Publishers, New Delhi, 2010.

REFERENCES:

1. S.K.Gupta, S.kant, R.Chandrashekhar, S.Satpathy, "Modern trends in Planning and Designing of Hospitals: Principles and Practice", Jaypee Brothers-Medical publishers, New Delhi, 2007.
2. Sa Tabish, "Hospital and Nursing Homes Planning, Organisation and Management", Jaypee Brothers-Medical Publishers, New Delhi, 2003.

17BMX24 – HEALTH POLICY AND EQUIPMENT MANAGEMENT				
L	T	P	C	
3	0	0	3	

PREREQUISITE : NIL

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To learn about the various health care systems.	**1.1**	The students will be able to interpret on the various health care systems.	**e,f,h**
2.0	To infer knowledge on various health policies.	**2.1**	The students will be able to analyze various health policies.	**b,f,h**
3.0	To introduce the equipment maintenance management skills.	**3.1**	The students will be able to learn the equipment maintenance management skills.	**a,c,f,g,h**
4.0	To enlighten students on logistics support and reliability required for hospitals.	**4.1**	The students will be able to understand about the logistics support and reliability required for hospitals.	**f,h,k**
5.0	To protect equipment from electromagnetic interferences.	**5.1**	The students will be able to identify and restore equipment from electromagnetic interferences.	**a,b,c,g**

UNIT I – HEALTH SYSTEM	**(9)**
Health Organization of the Country, the State and Cities, Health Financial System, Teaching cum Research Hospitals, General Hospital, PHC Reference System, Ambulatory Care.	
UNIT II – NATIONAL HEALTH POLICY	**(9)**
Need for Evaluating a Health Policy, Need for providing Primary Health Care, Health Education, Health Insurance, Health Legislation, Inter Sectoral Co-operation.	
UNIT III – EQUIPMENT MAINTENANCE MANAGEMENT	**(9)**
Organizing the Maintenance Operation, Biomedical Equipment Procurement Procedure, Proper Selection, Compatibility, Testing and Installation, Purchase and Contract Procedure, Trained Medical Staff, Proper use of Equipment and Operating Instructions. Maintenance Job Planning, Preventive Maintenance, Maintenance Budgeting, Contract Maintenance.	
UNIT IV – LOGISTIC SUPPORT & RELIABILITY	**(9)**
Maintenance Equipment and Tools, Failure Analysis, Spare Parts and Maintenance Materials. Reliability Fundamentals.	

UNIT V – EMI IN HOSPITAL EQUIPMENTS	(9)
Principles of EMI, Computation of EMI, Method of Suppressing and Isolating the Unit from Interference.	
TOTAL (L: 45) = 45 PERIODS	

TEXT BOOKS:

1. Antony Kelly, "Maintenance Planning & Control", Butterworth, London 1984.
2. Binseng Wang, "Medical Equipment Maintenance: Management and Oversight", Morgan & Claypool Publishers, 2012.

REFERENCES:

1. Hans Pleiff Veradammann, "Hospital Engineering in Developing Countries", First edition, GTZ Report Eschborn, 1986.
2. Keith Willson, Keith Ison, Slavik Tabakov, "Medical Equipment Management", CRC Press, 2013.
3. R. C. Goyal, "Human Resource Management in Hospitals", Prentice Hall of India, New Delhi, 2000.

17BMX25 – HOSPITAL WASTE MANAGEMENT				
	L	T	P	C
	3	0	0	3

PREREQUISITE : NIL

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To infer knowledge on the importance of waste disposal.	**1.1**	The students will be able to understand the importance of waste disposal.	**a,b,g,h**
2.0	To understand the various sterilization methods.	**2.1**	The students will be able to recognize the various sterilization methods.	**a,d,g,h**
3.0	To discuss health care waste management.	**3.1**	The students will be able to implement health care waste management.	**a,d,g,h,k**
4.0	To understand the controls applied to waste management.	**4.1**	The students will be able to realize the controls applied to waste management.	**a,d,g,h,l**
5.0	To prevent environmental pollution and ensure safety.	**5.1**	The students will be able to analyze the causes of environmental pollution and ensure safety.	**a,b,c,d,g,h**

UNIT I – HOSPITAL WASTE	**(9)**
Definition. Classification, Categories, Sources. Routes. Associated Diseases, Risks, Control of Hazards, Associated Problems in India; Need, Objective and Importance of Bio Medical Waste Management Programme in Health Care Facilities; Steps in Management of BMW.	
UNIT II – CONTROL OF HOSPITAL ACQUIRED INFECTION	**(9)**
Types of Infection; Common Nosocomial Infection and their Causative Agents; Prevention of Hospital Acquired Infection; Role of Central Sterile Supply Department; Infection Control Committee; Monitoring and Control or Cross-Infection; Staff Health.	
UNIT III – BIOMEDICAL WASTE MANAGEMENT	**(9)**
Meaning, Categories of Biomedical Wastes; Disposal of Biomedical Waste Products; Incineration and its Importance; Standards for Waste Autoclaving, Micro Waving and Deep Burial; Segregation, Packaging, Transportation and Storage.	
UNIT IV – HUMAN WASTE DISPOSAL AND SEWAGE DISPOSAL	**(9)**
Diseases carried from Excreta; Sanitation Barrier; Methods of Excreta Disposal; Sewage Wastes: Meaning, Composition; Aims of Sewage Disposal; Decomposition of Organic Matter; Modern Sewage Treatment; Drawbacks of Improper Disposal of Wastes; Solid and Liquid Waste Disposal.	

UNIT V – SAFETY AND PROTECTIVE MEASURE	(9)
Principles of Safe Handling; Personal Protective Devices and other Protective Measures; Occupational Safety; Training for Doctors, Nurses, Nodal Officers and Waste Management Analyzers.	
TOTAL (L: 45) = 45 PERIODS	

TEXT BOOK:

1. Anantpreet Singh & Kaur Sukhjit, "Bio-medical waste disposal", Jaypee Brothers Medical Publishers Pvt. Ltd, 2012.

REFERENCES:

1. Bahera. P.K, "Sustainable Bio-medical Waste Management", Dominant Publishers & Distributors, 2009.
2. Sharma, "Holistic Approach to Hospital Waste Management", Department of Hospital Administration – AIIMS, New Delhi, 2006.

17BMM01 – INTRODUCTION TO BIOMEDICAL ENGINEERING				
L	T	P	C	
3	0	0	3	

PREREQUISITE : NIL

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To interpret the role of biomedical engineering in society.	**1.1**	Students will be able to interpret the role of biomedical engineering in society.	**a,f,i**
2.0	To demonstrate the principles of various diagnostic devices.	**2.1**	Students will be able to demonstrate the principles of various diagnostic devices.	**a,c,g**
3.0	To identify the various techniques used in diagnosis though imaging.	**3.1**	Students will be able to identify the various techniques used in diagnosis though imaging.	**a,b,c,g**
4.0	To describe the working principles of various therapeutic and assist devices.	**4.1**	Students will be able to describe the working principles of various therapeutic and assist devices.	**a,b,g,h**
5.0	To understand device specific safety goals and standards.	**5.1**	Students will be able to understand device specific safety goals and standards.	**a,b,g**

UNIT I – INTRODUCTION	**(9)**
Historical Perspective - Evolution of Modern Healthcare System - Modern Healthcare System - Role of Biomedical Engineers in various Domain - Recent Advances in Biomedical Engineering - Professional Status of Biomedical Engineering - Professional Societies for Biomedical Engineering.	
UNIT II – FUNDAMENTALS OF MEDICAL INSTRUMENTATION	**(9)**
Anatomy and Physiology – Sources of Biomedical Signals- Basic Medical Instrumentation System - Performance Requirements – Intelligent Medical Instrumentation Systems - PC based Medical Instruments - General Constraints in Design of Medical Instruments.	
UNIT III – DIAGNOSTIC IMAGING	**(9)**
X-rays, Nuclear Medical Imaging - Positron Emission Tomography - Magnetic Resonance Imaging Scanners - Diagnostic Ultrasound - Thermal Imaging Systems.	
UNIT IV – INTRODUCTION TO BIOMEDICAL EQUIPMENT	**(9)**
ECG - EEG - Cardiac Pacemakers - Cardiac Defibrillators – Haemodialysis Machines - Artificial Kidney – Dialyzers – Ventilators - Humidifiers, Nebulizers and Aspirators - Anaesthesia Machine.	

UNIT V – MEDICAL SAFETY STANDARDS	(9)
Medical Standards and Regulations – Institutional Review Boards – Good Laboratory Practices - Good Manufacturing Practices - Human Factors.	
TOTAL (L: 45) = 45 PERIODS	

TEXT BOOKS:

1. Enderle, John D, Bronzino, Joseph D, Blanchard, Susan M, "Introduction to Biomedical Engineering", 2nd Edition, Elsevier Inc, 2005.
2. R. S. Khandpur, "Handbook of Biomedical Instrumentation", 2nd Edition, McGraw-Hill Publishing Company Limited, 2003.
3. Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, "Biomedical Instrumentation and Measurement", 2nd Edition, Prentice Hall of India, New Delhi, 2002.

REFERENCES:

1. John G Webster, "Medical Instrumentation: Application and Design", 4th Edition, John Wiley and Sons, New York, 2010.
2. Daniel A Vallero, "Biomedical Ethics for Engineers", 1st Edition, Elsevier Publication, 2007
3. Joseph. J Carr, John M Brown, "Introduction to Biomedical Equipment Technology", 4th Edition, John Wiley & Sons, New York, 2008.
4. Norbert Leitgeb, "Safety of Electro-medical Devices - Risks Opportunities", Springer-Verlag/Wein, 2010.
5. Michael Domach "Introduction to Biomedical Engineering", Pearson, 2004.

17BMM02 – BIO PHYSICS				
	L	T	P	C
	3	0	0	3

PREREQUISITE : NIL

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To impart knowledge on the fundamentals of light.	**1.1**	Students will be able to be familiar with the fundamentals of light.	**a,g**
2.0	To assess the significance of sound in medicine.	**2.1**	Students will be able to learn the significance of sound in medicine.	**a,c,g**
3.0	To comprehend radioactive nuclides.	**3.1**	Students will be able to understand radioactive nuclides.	**a,g**
4.0	To outline the interaction of radiation with matter.	**4.1**	Students will be able to narrate the interaction of radiation with matter.	**a,f,g**
5.0	To understand the applications of light, sound and radiation in medicine.	**5.1**	Students will be able to interpret the applications of light, sound and radiation in medicine.	**a,f,g**

UNIT I – NON IONIZING RADIATION	**(9)**
Non-ionizing Electromagnetic Radiation: Overview of Non-ionizing Radiation Effects - Electromagnetic Spectrum - Low Frequency Effects - Higher Frequency Effects. Physics of Light, Measurement of Light and its Unit - Limits of Vision and Color Vision, Thermography – Fundamentals of Near Infrared Spectroscopy.	
UNIT II – SOUND IN MEDICINE	**(9)**
Physics of Sound, Normal Sound Levels – Ultrasound Fundamentals – Generation of Ultrasound (Ultrasound Transducer) - Interaction of Ultrasound with Matter; Cavitations, Reflection, Transmission - Scanning Systems – Artifacts – Ultrasound - Doppler Shift.	
UNIT III – PRINCIPLES OF RADIOACTIVE NUCLIDES	**(9)**
Radioactive Decay – Spontaneous Emission – Isometric Transition – Gamma Ray Emission, Alpha, Beta, Positron Decay, Electron Capture, Sources of Radioisotopes Natural and Artificial Radioactivity, Decay Series, Production of Radionuclides – Cyclotron produced Radionuclide - Reactor produced Radionuclide - Fission and Electron Capture Reaction, Radionuclide Generator -Technetium Generator.	
UNIT IV – INTERACTION OF RADIATION WITH MATTER	**(9)**
Interaction of Charged Particles with Matter – Specific Ionization, Linear Energy Transfer Range, Bremsstrahlung, Annihilation, Interaction of X and Gamma Radiation with Matter- Photoelectric Effect, Compton Scattering, Pair Production, Attenuation of Gamma Radiation ,Interaction of Neutron with Matter and their Clinical Significance.	

UNIT V – CLINICAL APPLICATIONS	(9)
Thermography Applications - Clinical Applications of Doppler – Applications of Gamma radiation in Medicine - Radionuclide used in Medicine and Technology.	
TOTAL (L: 45) = 45 PERIODS	

TEXT BOOKS:

1. John R Cameran, James G Skofronick, “Medical Physics”, John-Wiley & Sons Publications, 2002.
2. W.J. Meredith and J.B. Massey, “Fundamental Physics of Radiology”, Varghese Publishing House, 2011.

REFERENCES:

1. S. Webb, “The Physics of Medical Imaging”, Taylor and Francis, 2013.
2. J. P. Woodcock, “Ultrasonic Medical Physics Handbook Series”, Adam Hilger, Bristol, 2002.
3. Hylton B. Meire and Pat Farrant, “Basic Ultrasound”, John Wiley & Sons, 1994.

17BMM03 – BIOMEDICAL SENSORS				
	L	T	P	C
	3	0	0	3

PREREQUISITE : NIL

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To identify the calibration procedure for the basic instruments involved in physiological parameter measurement.	**1.1**	Students will be able to identify the calibration procedure for the basic instruments involved in physiological parameter measurement.	**a,b,h**
2.0	To develop medical sensors based on the basic transduction principles.	**2.1**	Students will be able to develop medical sensors based on the basic transduction principles.	**a,b,c,e,g**
3.0	To understand the various medical sensor for a particular application.	**3.1**	Students will be able to analyze the various medical sensors.	**a,b,c,g**
4.0	To comprehend the various bio chemical sensor for a particular application.	**4.1**	Students will be able to analyze the various bio chemical sensors.	**a,b,c,g**
5.0	To understand the various bio potential electrodes	**5.1**	Students will be able to analyze the working of various bio potential electrodes	**a,b,c,d**

UNIT I – SCIENCE OF MEASUREMENT	**(9)**
Generalized Instrumentation System, General Properties of Input Transducer. Static Characteristics: Accuracy, Precision, Resolution, Reproducibility, Sensitivity, Drift, Hysteresis, Linearity, Input Impedance and Output Impedance. Dynamic Characteristics: First Order and Second Order Characteristics, Time Delay, Transfer Function – First and Second Order Systems.	
UNIT II – DIFFERENT TRANSDUCTION PRINCIPLE	**(9)**
Temperature Transducers - Thermo Resistive Transducers, Thermoelectric, Displacement Transducers - Potentiometric, Resistive Strain Gauges, Inductive Displacement, and Capacitive Displacement Transducer. Pressure Transducer - Indirect Method - Measurement of Blood Pressure using Sphygmomanometer, Piezo-electric Type, Catheter Tip Transducers, Measurement of Intracranial Pressure, Catheter Tip - Implantable Type.	
UNIT III – BIO SENSORS	**(9)**
Electrolytic Sensors, Optical Sensor, Fiber Optic Sensors. Biosensors in Clinical Chemistry, Medicine and Health Care.	

UNIT IV – BIO CHEMICAL SENSORS	(9)
Introduction, Advantages and Limitations, Various Components of Biosensors, Biocatalysts based Biosensors, Bio-affinity based Biosensors & Microorganisms based Biosensors, Types of Membranes used in Biosensor Constructions.	
UNIT V – BIO POTENTIAL ELECTRODES	**(9)**
Electrodes Electrolyte Interface, Half Cell Potential, Polarization, Polarizable and Non Polarizable, Electrodes, Calomel Electrode, Electrode Circuit Model, Electrode Skin-Interface and Motion Artifact. Body Surface Electrodes. Ion Exchange Membrane Electrodes, Oxygen Electrodes, CO_2 Electrodes Enzyme Electrode, ISFET for Glucose, Urea.	
TOTAL (L: 45) = 45 PERIODS	

TEXT BOOKS:

1. John G. Webster, "Medical Instrumentation-Application and Design", 2013.
2. Richard S.C. Cobbold, "Transducers for Biomedical Measurements: Principles and Applications", John Wiley & Sons, 2004.

REFERENCES:

1. Nandini K. Jog, "Electronics in Medicine and Biomedical Instrumentation", 2nd Edition, PHI 2013.
2. Hermann K P. Neubert, "Instrument Transducer – An Introduction to their Performance and Design", 1975.

17BMM04 – ANALYTICAL INSTRUMENTATION				
	L	T	P	C
	3	0	0	3

PREREQUISITE : NIL

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To identify various techniques and methods of analysis which occur in the various regions of the spectrum.	**1.1**	Students will be able to analyze various techniques and methods in the various regions of the spectrum.	**a,b,d,g**
2.0	To learn the unique methods of separation of closely similar materials.	**2.1**	Students will be able to understand the chromatography methods of separation of closely similar materials.	**a,b,f**
3.0	To outline the important analytical methods of industrial gases.	**3.1**	Students will be able to interpret the important analytical methods of industrial gases.	**a,b,d,e,g**
4.0	To discuss the principle involved in pH and dissolved component analyzers.	**4.1**	Students will be able to understand the principle involved in pH and dissolved component analyzers.	**a,b,e,g**
5.0	To illustrate the various methods involving electromagnetic resonance.	**5.1**	Students will be able to discuss on the various methods involving electromagnetic resonance.	**a,b,d,g**

UNIT I – COLORIMETRY AND SPECTROPHOTOMETRY	**(9)**
Significance of Invitro Diagnostics - Special Methods of Analysis – Beer-Lambert Law – Colorimeters – UV-Visible Spectrophotometers – Single and Double Beam Instruments – Sources and Detectors – IR Spectrophotometers – Types – Attenuated Total Reflectance Flame Photometers – Atomic Absorption Spectrophotometers – Sources and Detectors – FTIR Spectrophotometers – Flame Emission Photometers – Fluorescence Spectrophotometer.	
UNIT II – CHROMATOGRAPHY	**(9)**
Different techniques – Gas chromatography – Detectors – Liquid chromatographs – Applications – High-pressure liquid chromatographs – Applications.	
UNIT III – GAS ANALYZERS	**(9)**
Types of Gas Analyzers – Oxygen, NO2 and H2S Types, IR Analyzers, Thermal Conductivity Analyzers, Analysis based on Ionization of Gases.	

UNIT IV – pH METERS AND DISSOLVED COMPONENT ANALYZERS	(9)
Principle of pH Measurement, Glass Electrodes, Hydrogen Electrodes, Reference Electrodes, Selective Ion Electrodes, Ammonia Electrodes, Cyclic Voltametry, Biosensors, Dissolved Oxygen Analyzer – Sodium Analyzer – Silicon Analyzer.	
UNIT V – ELECTRO MAGNETIC RESONANCE	**(9)**
NMR – Basic Principles – NMR Spectrometer - Applications. Electron Spin Resonance Spectroscopy – Basic Principles, Instrumentation and Applications.	
	TOTAL (L: 45) = 45 PERIODS

TEXT BOOK:

1. R.S. Khandpur, "Handbook of Analytical Instruments", Tata McGraw Hill publishing Co. Ltd., 2007.
2. Sivasankar, "Instrumental Methods of Analysis", Oxford University Press India, 2012.

REFERENCES:

1. Robert D. Braun, "Introduction to Instrumental Analysis", McGraw Hill, Singapore, 1987.
2. Liptak, B.G, "Process Measurement and Analysis", Chilton Book Company, 1995.
3. G.W. Ewing, "Instrumental Methods of Analysis", McGraw Hill, 1992.
4. R.K.Jain, "Mechanical and Industrial Measurements", Khanna Publishers, New Delhi, 1999.
5. H.H. Willard, L.L. Merritt, J.A. Dean, F.A. Settle, "Instrumental Methods of Analysis", CBS Publishing & Distribution, 1995.

17BMM05 – RADIATION AND NUCLEAR MEDICINE					
			L	T	P	C
			3	0	0	3
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To acquire knowledge about radiation activity in the living cells.	**1.1**	Students will be able to acquire knowledge about radiation activity in the living cells.	**a,b,d,g,h**	
2.0	To identify the key principles of nuclear medicine and radioactivity.	**2.1**	Students will be able to identify the key principles of nuclear medicine and radioactivity.	**a,b,c,f,g,h**	
3.0	To analyze the working principle of advanced nuclear medicine imaging systems.	**3.1**	Students will be able to analyze the working principle of advanced nuclear medicine imaging systems.	**a,b,c,e,f,g,h**	
4.0	To interpret the effects of ionizing and non-ionizing radiations.	**4.1**	Students will be able to interpret the effects of ionizing and non-ionizing radiations.	**a,b,d,g**	
5.0	To analyze the effect of microwave on human organs and systems.	**5.1**	Students will be able to analyze the effect of microwave on human organs and systems.	**a,b,c,f,g,h**	

UNIT I – ACTION OF RADIATION IN LIVING CELLS	**(9)**
Various Theories related to Radiation at Cellular Level - DNA and Chromosomal Damages - Somatic Application of Radiation - Radio Sensitivity Protocols of different Tissues of Human - Ld50/30 Effective Radiation on Skin, Bone Marrow, Eye, Endocrine Glands, and Basis of Radio Therapy.	
UNIT II – NUCLEAR MEDICINE	**(9)**
Basic Characteristic and Units of Radioactivity, Ionization Chamber, GM Tubes, Gas Filled Detectors, Scintillation Detectors, Semiconductor Detectors, Liquid Scintillation Counter, Statistical Aspects of Nuclear Medicine.	
UNIT III – NUCLEAR MEDICINE IMAGING SYSTEMS	**(9)**
Rectilinear Scanners, Scintillation Camera, Principle of Operation, Collimator, Photomultiplier Tube, Pulse Height Analyser, Computerized Multi Crystal Gamma Camera, Principles of PET and SPECT.	
UNIT IV – RADIATION THERAPY	**(9)**
Principles of Radiation Therapy, Radio Therapy Treatment Planning Dose in Radiotherapy, Mega Voltage Therapy, Intensity Modulated Radiation Therapy, Brachy-therapy, Radiotherapy using Radio Isotopes.	

UNIT V - RADIOBIOLOGY AND RADIOLOGICAL PROTECTION	(9)
Radiation Sensitivity of Biological Materials, Evidence on Radiobiological Damage from Cell Survival Curve, Radiation Effects on Humans, Maximum Permissible Dose Equivalent Limits, Hazard from Ingested Radioactivity substances, ICRP Regulations, Quality Factor and Sievert, Principles of Radiological Protection, Personnel Dosimetry.	
TOTAL (L: 45) = 45 PERIODS	

TEXT BOOKS:

1. Mary Alice S, Paula J Visconti, E Russell Ritenour, Kelli Haynes,"Radiation Protection In Medical Radiography", Elsevier Health Sciences, 2014.
2. Glasser O., "Medical Physics", Volume I, II, III, The Year Book Publishers Inc, Chicago, 1980.

REFERENCES:

1. Moselly H., "Non Ionizing Radiation", Adam-Hilgar, Bristol, 1988.
2. Khan,F.M, "Physics for Radiation Therapy", Williams & Wilkins, 2009.
3. Gopal B.Saha, "Physics and Radiation biology of Nuclear Medicine", 2006.

17BMM06 – RADIOLOGICAL IMAGING TECHNIQUES				
	L	T	P	C
	3	0	0	3

PREREQUISITE : NIL

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To gain knowledge on quality assurance test for radiography, method of recording sectional images.	**1.1**	Students will be able to gain knowledge on quality assurance test for radiography, method of recording sectional images.	**a,b,e,g**
2.0	To learn the functioning of radio isotopic imaging equipment.	**2.1**	Students will be able to learn the functioning of radio isotopic imaging equipment.	**a,c,g**
3.0	To interpret the image acquisition, reconstruction and imaging outputs of MRI.	**3.1**	Students will be able to interpret the image acquisition, reconstruction and imaging outputs of MRI.	**a,b,g**
4.0	To understand the ultrasound imaging techniques.	**4.1**	Students will be able to understand the ultrasound imaging techniques.	**a,b,g**
5.0	To identify the IR medical imaging techniques for specific pathology.	**5.1**	Students will be able to analyze the various aspects of Thermography in pathology.	**a,b,d,g**

UNIT I – X-RAY AND CT IMAGING	**(9)**
Principles and Production of Soft X-rays and Hard X-rays - Details of Radiographic and Fluoroscopic Images in X-Ray Systems - Screen-film and Image Intensifier Systems - Evolution of CT Machines - CT Image Formation- Conversion of X-ray Data into Scan Image, Mathematical details of various Algorithms - Spiral CT, Transverse Tomography - CT Angiography.	
UNIT II – PET AND SPECT IMAGING	**(9)**
Introduction to Emission Tomography, Basic Physics of Radioisotope Imaging Compton Cameras for Nuclear Imaging, PET Scanner Principles, SPECT, Computer Techniques in Fast Acquisition Analytic Image Reconstruction Techniques, Attenuation, Scatter Compensation in SPECT Spatial Compensation in SPECT.	
UNIT III – MAGNETIC RESONANCE IMAGING	**(9)**
Principles of MRI Pulse Sequence – Image Acquisition and Reconstruction Techniques – MRI Instrumentation Magnetic Gradient System RF Coils – Receiver System Functional MRI – MRI Artifacts- Various Types of Pulse Sequences for Fast Acquisition of Imaging, NMR Spectroscopy - Application of MRI.	

UNIT IV – ULTRASOUND IMAGING	(9)
Production of Ultrasound – Properties and Principles of Image Formation, Capture and Display – Principles of A-mode, B-mode and M-mode Display – Doppler Ultra Sound and Color Flow Mapping – Applications of Diagnostic Ultra Sound.	
UNIT V – INFRA-RED IMAGING	**(9)**
Physics of Thermography – Imaging Systems – Pyroelectric Videocon Camera Clinical Thermography – Liquid Crystal Thermography.	
TOTAL (L: 45) = 45 PERIODS	

TEXT BOOK:

1. John Ball and Tony Price Chesney's, "Radiographic Imaging", Blackwell Science Limited, U.K., 2006.
2. Farr, "The Physics of Medical Imaging", Adem Hilger, Bristol & Philadelphia, 2007.
3. S Webb, "The Physics of Medical Imaging", Adam Highler, Bristol Published by CRC Press, first edition 1988.

REFERENCES:

1. M. Analoui, J.D. Bronzino, D.R.Peterson, "Medical Imaging: Principles and Practices", CRC Press, 2012.
2. S. Webb, "Physics of Medical Imaging", Taylor & Francis, 2010.
3. T. Farncombe, K. Iniewski, "Medical Imaging: Technology & Applications", CRC Press, 2013.
4. J.S. Benseler, "The Radiology Handbook: A Pocket Guide to Medical Imaging", Ohio University Press, 2006.
5. R.R.Carlton, A.M.Adler, "Principles of Radiographic Imaging: An Art and a Science", 5th Edition, Delmar Cengage Learning; 2012.
6. N.B.Smith, A. Webb, "Introduction to Medical Imaging Physics, Engineering and Clinical Applications", CRC Press, 2010.

17BMM07 – ICU AND OPERATION THEATRE EQUIPMENT				
	L	T	P	C
	3	0	0	3

PREREQUISITE : NIL

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To offer clear understanding of various intensive care equipment and their working.	**1.1**	Students will be able to offer clear understanding of various intensive care equipment and their working.	**a,b,d,e,g,l**
2.0	To suggest suitable critical care equipments and operational devices.	**2.1**	Students will be able to suggest suitable critical care equipments and operational devices.	**a,b,d,e,g,l**
3.0	To understand the necessity of different operation theatre equipment.	**3.1**	Students will be able to understand the necessity of different operation theatre equipment.	**a,b,d,e,g,i,l**
4.0	To acquire knowledge on centralized systems.	**4.1**	Students will be able to acquire knowledge on centralized systems.	**a,b,d,g**
5.0	To analyze the quality of equipment and ensure patient safety.	**5.1**	Students will be able to analyze the quality of equipment and ensure patient safety.	**a,b,d,f,g,h**

UNIT I – ICU EQUIPMENT	**(9)**
Suction Apparatus, Different types; Sterilizers, Chemical, Radiation, Steam for Small and Larger Units. Automated Drug Delivery Systems, Infusion Pumps, Closed Loop Control Infusion System, Implantable Infusion System.	
UNIT II – CRITICAL CARE EQUIPMENT	**(9)**
Hemodialysis Machine, Different types of Dialyzers, Membranes, Machine Controls and Measurements. Heart Lung Machine, Different Types of Oxygenators, Peristaltic Pumps, Incubators.	
UNIT III – OPERATION THEATRE EQUIPMENT	**(9)**
Surgical Diathermy, Instruments for Operation. Anesthesia Equipment, Humidification, Sterilization Aspects, Boyles Apparatus.	
UNIT IV – CENTRALISED SYSTEMS	**(9)**
Centralized Oxygen, Nitrogen, Air Supply & Suction. Centralized Air Conditioning, Operation Theatre Table & Lighting.	

UNIT V – PATIENT SAFETY	(9)
Patient Electrical Safety, Types of Hazards, Natural Protective Mechanisms against Electricity, Leakage Current, Inspection of Grounding and Patient Isolation, Hazards in Operation Rooms, ICCU and IMCUs, Opto couplers and Pulse Transformers.	
TOTAL (L: 45) = 45 PERIODS	

TEXT BOOK:

1. Khandpur R. S, "Handbook of Biomedical Instrumentation", 2nd Edition, Tata Mc Graw Hill Pub. Co., Ltd. 2003.
2. John, G. Webster, "Medical Instrumentation, Application and Design", 2nd Edition, John Wiley & Sons, Inc., NewYork, 2008.

REFERENCES:

1. Joseph Dubovy, "Introduction to Biomedical", Mc Graw Hill Co, 1978.
2. Terry Bahil. A, "Biomedical and Clinical Engineering", Prentice Hall Inc., 1981.

17BMM08 – BIOMATERIALS AND ARTIFICIAL ORGANS				
	L	T	P	C
	3	0	0	3
PREREQUISITE : NIL				
COURSE OBJECTIVES AND OUTCOMES:				

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To study the characteristics and classification of biomaterials	**1.1**	The students will be able to understand the structure and mechanical properties of biomaterials	**a,b,c,d,e,f,g**
2.0	To learn about the metallic and Ceramic materials in tissue replacements	**2.1**	The students will be able to interpret various metallic and ceramic implant materials in medical field	**a,b,c,d,e,f,g, h,k,l**
3.0	To learn about the polymeric materials and composites in tissue replacements	**3.1**	The students will be able to implement various polymeric implant materials according to the need for treatment	**a,b,c,d,e,f,g, h,k,l**
4.0	To study the soft and hard tissue replacement in biomedical applications	**4.1**	The students will be able to analyze soft and hard tissue replacement implants in biomedical applications	**a,b,c,d,e,f,g, h,k,l**
5.0	To know the compatibility and functioning of artificial organs inside the living system	**5.1**	The students will be able to assess compatibility and functioning of artificial organs inside the living system	**a,b,c,d,e,f,g, h,k,l**

UNIT I – BIO-MATERIALS STRUCTURE AND BIO-COMPATIBILITY	**(9)**
Definition and Classification of Bio-materials, Mechanical Properties of Biomaterials, Structure Property Relationship of Biological and Biomaterials Viscoelasticity, Wound Healing Process, Body Response to Implants, Blood Compatibility, Carcinogenicity.	
UNIT II – IMPLANT MATERIALS I	**(9)**
Metallic Implant Materials: Stainless Steels, Cobased Alloys, Ti-Based Alloys, Dental Metals, Deterioration of Metallic Implant Materials. Ceramic Implant Materials: Structure–Property Relationship of Ceramics, Aluminum Oxides, Zirconia, Hydroxyapatite, Glass Ceramics, Carbons.	
UNIT III – IMPLANT MATERIALS II	**(9)**
Polymerization, Polyamides, Acryrilic Polymers, Rubbers, High Strength Thermoplastics, Deterioration of Polymers, Bio Polymers: Collagen and Elastin. Composites – Structure, Mechanics, Biocompatibility, Applications. Materials for Ophthalmology: Contact Lens, Intraocular Lens.	

UNIT IV – TISSUE REPLACEMENT IMPLANTS	(9)
Soft Tissue Replacements, Sutures, Surgical Tapes, Adhesive, Percutaneous and Skin Implants, Maxillofacial Augmentation, Vascular Grafts, Hard Tissue Replacement Implants, Internal Fracture Fixation Devices, Joint Replacements.	
UNIT V – ARTIFICIAL ORGANS	**(9)**
Blood Substitutes, Artificial Skin, Artificial Heart, Prosthetic Cardiac Valves, Artificial Lung (Oxygenator), Artificial Kidney (Dialyser Membrane), Artificial Pancreas, Dental Implants.	
TOTAL (L: 45) = 45 PERIODS	

TEXT BOOK:

1. Sujata V. Bhatt, "Biomaterials", 7th Edition, Narosa Publishing House, 2005.
2. Michael Lysaght, Thomas J Webster, "Biomaterials for Artificial Organs", Elsevier Science, 2018.

REFERENCES:

1. Park Joseph D.Bronzino, "Biomaterials-Principles and Applications", CRC Press, 2003.
2. J. Park, "Biomaterials: An Introduction", Springer Science & Business Media, 2012.
3. Myer Kutz, "Standard Handbook of Biomedical Engineering & Design", McGraw-Hill, 2003.

22BMC01 - ANALOG AND DIGITAL ELECTRONICS *(BIOMEDICAL ENGINEERING)*			
L	**T**	**P**	**C**
3	**0**	**0**	**3**

PREREQUISITE : 22ECC04 - ELECTRONIC DEVICES AND CIRCUITS (THEORY + LAB)

	Course Objectives		Course Outcomes
1.0	To study the circuit configuration and introduce practical applications of linear integrated circuits	**1.1**	The students will be able to design analog linear circuits
2.0	To introduce the concept of ADC and DAC in real time systems	**2.1**	The students will be able to apply the concept of ADC and DAC in real time systems
3.0	To study the various number systems and logic gates and their reduction techniques	**3.1**	The Students can apply the Boolean laws and theorems to minimize the Boolean expressions
4.0	To introduce the design of various combinational digital circuits using logic gates	**4.1**	The students will be able to design various combinational digital circuits using logic gates
5.0	To bring out the analysis and design procedures for synchronous and asynchronous sequential circuits	**5.1**	The students will be able to design synchronous and asynchronous sequential circuits

UNIT I – INTRODUCTION TO OPERATIONAL AMPLIFIERS AND ITS APPLICATIONS	**(9)**
Operational amplifier – Ideal Characteristics, Performance Parameters, Voltage Follower, Inverting Amplifier, Non-inverting Amplifiers, Differentiator, Integrator, Voltage to Current Converter, Current to Voltage Converter, Differential Amplifier, Instrumentation amplifier, Low pass, High pass and Band Pass Filters, Comparator.	
UNIT II – DIGITAL TO ANALOG AND ANALOG TO DIGITAL CONVERTERS	**(9)**
Analog Switches, High Speed Sample and Hold Circuit and IC's, Types of D/A converter - Weighted Resistor, R-2R ladder DAC, D/A Accuracy and Resolution. A/D converter - Flash, Dual Slope, Successive Approximation, A/D Accuracy and Resolution.	
UNIT III – NUMBER SYSTEMS, LOGIC GATES AND LOGIC FAMILES	**(9)**
Number Systems – Decimal, Binary, Octal, Hexadecimal, 1's and 2's complements, Codes – Binary, BCD, 8421, 2421, Excess 3, Biquinary, Gray, Alphanumeric codes, Boolean theorems, Logic gates, Universal gates, Sum of Products and Product of Sums, Minterms and Maxterms, Karnaugh map and Tabulation methods.	
UNIT IV – COMBINATIONAL LOGIC CIRCUITS	**(9)**
Problem Formulation and Design of Combinational Circuits - Code - Converters, Half and Full Adders, Half and Full Subtractors, Magnitude Comparator, Decoder, Encoder, Priority Encoder, Mux/Demux. Parity Generator and Checker.	

UNIT V – SEQUENTIAL LOGIC CIRCUITS	(9)
Flip Flops – SR, JK, T, D, Master/Slave FF, Analysis and Design of Clocked Sequential Circuits – State Minimization, State Assignment, Circuit Implementation. Counters – Ripple & Ring counter, Shift registers – SISO, SIPO, PISO, PIPO.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. D. Roy Choudhury and Shail B. Jain, "Linear Integrated Circuits", 4th Edition, New Age International Publishers, 2018.
2. M. Morris Mano and Michael D.Ciletti, "Digital Design", Pearson, 5th Edition, 2013.
3. John.F.Wakerly, "Digital design principles and practices", Pearson Education, 5th Edition, 2018.

REFERENCES:

1. Taub and Schilling, "Digital Integrated Electronics", Mc Graw Hill, 2017.
2. Sergio Franco, "Design with Operational Amplifiers and Analog Integrated Circuits", 3rd Edition, Mc Graw Hill Education, 2017.
3. Charles H.Roth, Jr, "Fundamentals of Logic Design", 7th Edition, Jaico Books, 2013.
4. S Salivahanan and V S Kanchana Bhaaskaran, Linear Integrated Circuits, 3rd Edition, McGraw Hill Education, 2018.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2	2	2	1						1	1	2	
2	3	2	2	2	1						1	1	2	
3	3	3	2	2	2						1	1	1	
4	3	3	3	2	2						1	2	2	
5	3	3	3	2	2						1	2	2	
CO (W.A)	3	2.6	2.4	2	1.6						1	1.4	1.8	

22BMC02 - ANATOMY AND HUMAN PHYSIOLOGY				
	L	T	P	C
	3	0	2	4
PRE REQUISITE : NIL				

Course Objectives		Course Outcomes	
1.0	To integrate the individual functions of all the cells and tissues and organs into functional whole, the human body.	1.1	Students will be able to identify and explain basic elements of human body
2.0	To understand functional anatomy of skeletal and muscular system	2.1	Students will be able to explain the functions of skeletal and muscular system
3.0	To emphasize on the cardiovascular, respiratory and their interrelatedness.	3.1	Students will be able to describe the structure, function of cardiovascular system and respiratory system
4.0	To understand the basic functioning of digestive and excretory system and the resultant unified organization.	4.1	Students will be able to describe the structure of digestive and excretory system.
5.0	To stimulate to understand the structure and functions of Nervous and sensory system	5.1	Students will be able to describe the physiological process of Nervous and sensory system

UNIT I - BASIC ELEMENTS OF HUMAN BODY	**(9)**
Cell – Cell Structure and organelles - Functions of each component in the cell. Cell membrane –Transport across membrane - Action potential (Nernst, Goldman equation), Homeostasis. Tissue: Types, Functions.	
UNIT II - SKELETAL AND MUSCULAR SYSTEM	**(9)**
Skeletal: Types of Bone and function – Physiology of Bone formation – Division of Skeleton -Types of joints and function – Types of cartilage and function. –Types of muscles – Structure and Properties of Skeletal Muscle- Changes during muscle contraction- Neuromuscular junction.	
UNIT III - CARDIOVASCULAR AND RESPIRATORY SYSTEM	**(9)**
Cardiovascular System: Structure – Conduction System of heart – Cardiac Cycle – Cardiac output. Blood: Composition – Functions - Haemostasis – Blood groups and typing. Blood Vessels – Structure and types - Blood pressure - Respiratory system: Parts of respiratory system – Respiratory physiology – Lung volumes and capacities – Gaseous exchange.	
UNIT IV - DIGESTIVE AND EXCRETORY SYSTEMS	**(9)**
Structure and functions of gastrointestinal system - secretory functions of the alimentary tract - digestion and absorption in the gastrointestinal tract - structure of nephron - mechanism of urine formation - skin and sweat gland - temperature regulation.	
UNIT V - NERVOUS AND SENSORY SYSTEM	**(9)**
Structure and function of nervous tissue – Brain and spinal cord – Functions of CNS – Nerve conduction and synapse – Reflex action – Somatic and Autonomic Nervous system. Physiology of Vision, Hearing, Integumentary, Olfactory systems. Taste buds.	
TOTAL (L:45) : 45 PERIODS	

LIST OF EXPERIMENTS

1. Identification of Blood Collection Tubes and Phlebotomy Equipments
2. Collection of Blood Samples
3. Identification of Blood Group
4. Determination of Bleeding and Clotting Time
5. Estimation of Haemoglobin
6. Total RBC Count
7. Total WBC Count
8. Differential Count of Different WBC
9. Visual Activity- Snellen's Chart and Jaeger's Chart
10. Hearing Test – Tuning Fork

TEXT BOOKS:

1. Guyton & Hall, "Text Book of Medical Physiology", 13th Edition, Saunders, 2015.
2. Elaine.N. Marieb, "Essential of Human Anatomy and Physiology", 9th Edition, Pearson Education, New Delhi, 2018.
3. Gopal B. Saha "Physics and Radiobiology of Nuclear Medicine", 3rd Edition, Springer, 2006. (Unit 2, 3, 4).

REFERENCES:

1. Ranganathan T S, "Text Book of Human Anatomy", S. Chand & Co. Ltd., New Delhi, 2012.
2. Sarada Subramanyam, K Madhavan Kutty, Singh H D, "Textbook of Human Physiology", S. Chand and Company Ltd, New Delhi, 2012.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2	1									2	2	
2	3	3	2	2			1					2	2	
3	3	3	2	2			1					2	2	
4	3	3	2	2			1					2	2	
5	3	3	2	2			1					2	2	
CO (W.A)	**3**	**2.8**	**1.8**	**2**			**1**					**2**	**2**	

22BMC03 - SENSORS AND MEASUREMENTS				
	L	T	P	C
	3	0	0	3

PRE REQUISITE : 22ECC02 – BASICS OF ELECTRICAL & INSTRUMENTATION ENGINEERING

Course Objectives		Course Outcomes	
1.0	To make students to know the principle of transduction and characteristics of photoelectric and piezo electric sensors.	1.1	The students will be able to narrate principle of operation and working of various photoelectric and piezo electric sensors.
2.0	To enable the student to know the principle and operation of different bio potential electrodes.	2.1	The students will be able to explicate the concepts, types, working and practical applications of various electrodes for acquiring and recording various physiological parameters.
3.0	To make the students to understand various types of biosensors.	3.1	The students will be able to demonstrate the concepts, types, working and applications of biosensors.
4.0	To make the students to learn about functionalities of signal conditioning circuits and different bridges for measurement.	4.1	The students will be able to demonstrate the various functional elements of signal conditioning circuits and employ AC and DC bridges for relevant parameter measurement.
5.0	To make the students to know the different display and recording devices.	5.1	The students will be able to employ multimeter, DSO and different types of recorders for appropriate display and recording.

UNIT I - PHOTOELECTRIC AND PIEZO ELECTRIC SENSORS	(9)

Phototube, Scintillation Counter, Photo Multiplier Tube (PMT), Photovoltaic, Photo Conductive Cells, Photo Diodes, Phototransistor, Comparison of Photoelectric Transducers. Optical Displacement Sensors and Optical Encoders. Piezoelectric Active Transducer – Equivalent Circuit and its Characteristics.

UNIT II - BIO POTENTIAL ELECTRODES	(9)

Electrodes Electrolyte Interface, Half-Cell Potential, Polarization, Polarizable and Non Polarizable Electrodes, Calomel Electrode, Electrode Circuit Model, Electrode Skin-Interface and Motion Artifact. Body Surface Electrodes. Ion Exchange Membrane Electrodes, Oxygen Electrodes, CO2 Electrodes, Enzyme Electrode, ISFET for Glucose, Urea.

UNIT III - BIOSENSORS	(9)

Biosensors: Introduction, Advantages and Limitations, Various Components of Biosensors, Biocatalysts based Biosensors, Bio-affinity based Biosensors & Microorganisms based Biosensors, Types of Membranes used in Biosensor Constructions, Electronic Nose.

UNIT IV - SIGNAL CONDITIONING CIRCUITS	(9)

Functions of Signal Conditioning Circuits, Preamplifiers, Concepts of Passive Filters, Impedance Matching Circuits, Isolation Amplifier. AC and DC Bridges – Wheat stone Bridge, Kelvin, Maxwell, Hay, Schering.

UNIT V - DISPLAY AND RECORDING DEVICES	(9)
Multimeter, DSO, LCD/LED displays, PMMC writing systems, servo recorders, photographic recorder, magnetic tape recorder.	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

1. Sawhney A K and Puneet Sawhney, "A Course in Electrical & Electronic Measurements & Instrumentation", Dhanpat Rai and Company, New Delhi, 2015.
2. John G. Webster, "Medical Instrumentation Application and Design", 4th Edition, Wiley India Pvt. Ltd., New Delhi, 2015.

REFERENCES:

1. Kalsi H S, "Electronic Instrumentation and Measurement", Tata McGraw Hill, 2011.
2. Nandini K. Jog, "Electronics in Medicine and Biomedical Instrumentation, 2nd Edition, PHI, 2013.
3. Harry N, Norton, "Biomedical Sensors: Fundamentals and Application", Noyes Publications, 2001.
4. Tatsuo Togawa, Toshiyo Tamma and P. Ake Ã–berg, "Biomedical Transducers and Instruments", CRC Press, 2018.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3		1			1	2					2	3	
2	3		1			1	2					3	3	
3	3	1	2			3	2					3	3	
4	3	1	1			2	2					2	3	
5	3	1	1			3	2					3	3	
CO (W.A)	3	1	1.2			2	2					2.6	3	

22BMP01 - ANALOG AND DIGITAL ELECTRONICS LABORATORY					
		L	T	P	C
		0	0	4	2
PRE-REQUISITE : NIL					
Course Objectives		**Course Outcomes**			
1.0	To understand the applications of operation amplifier.	1.1	The students will be able to design and implement arithmetic circuits for different applications using op-amp.		
2.0	To enable the students to learn about active filters.	2.1	The students will be able to Implement filter circuits using op-amp.		
3.0	To enable the student to design the combinational logic circuits.	3.1	The Students will be able to design the combinational circuits like adder, subtractor, code convertors, magnitude comparator, mux and demux.		
4.0	To understand the operation of flip-flops.	4.1	The students will be able to design and analyze Flip flops.		
5.0	To make the students to learn and practice with design of sequential logic circuits.	5.1	The students will be able to design Sequential Circuits using logic gates.		

LIST OF EXPERIMENTS

1. Inverting and Non-inverting amplifier
2. Integrator and Differentiator
3. Design and analysis of active filters using op-amp
4. Study of logic gates.
5. Design of Half adder and Full adder
6. Design of Code Converters
7. Design of Magnitude Comparator.
8. Multiplexer and Demultiplexer using Digital ICs
9. Design of Flip flops – SR, JK, T, D
10. Design of counters.

Total (60 P) = 60 periods

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

22BMP02 - SENSORS AND MEASUREMENTS LABORATORY					
		L	T	P	C
		0	0	4	2
PRE REQUISITE : NIL					
Course Objectives		**Course Outcomes**			
1.0	To make students understand about the different transducers	1.1	The students will be able to explain the working of different types of transducers and select a transducer for particular applications		
2.0	To enable students to learn about the characteristics of temperature sensors	2.1	The students will be able to choose the temperature sensors for an application based on their characteristics		
3.0	To impart knowledge about photodiodes, phototransistors and LDR	3.1	The students will be able to explain the working and applications of photodiodes, phototransistors and LDR		
4.0	To make students to understand the characteristics of bridge circuits	4.1	The students will be able to analyze the characteristic of various bridges and its responses		
5.0	To make students to understand about the various measurements methods using Hall effect transducer, Strain Gauge and Load Cell	5.1	The students will be able to demonstrate the various measurements methods Hall effect transducer, Strain Gauge and Load Cell		

LIST OF EXPERIMENTS

1. Characteristics of Potentiometric Transducer.
2. Characteristics of Thermistor.
3. Characteristics of Thermocouple.
4. Characteristics of LDR.
5. Characteristics of Photo Diode and Photo Transistors.
6. Characteristics of RTD.
7. Characteristics of LVDT.
8. Measurement of unknown Resistance using Kelvin Double Bridge and Wheatstone Bridge.
9. Measurement of unknown Capacitance using Schering Bridge.
10. Measurement of unknown Inductance using Anderson Bridge.
11. Characteristics of Hall effect Transducer.
12. Characteristics of strain gauge and Load cell.

Total (60 P) = 60 periods

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

22BMC04 - BIOMEDICAL INSTRUMENTATION				
	L	T	P	C
	3	0	0	3
PRE REQUISITE : 22BMC03 – SENSORS AND MEASUREMENTS				

Course Objectives		Course Outcomes	
1.0	To understand the basic theory of Bio potential Electrodes and Bio potential measurement	1.1	The Students will be able to describe the electrode behaviour and circuit models
2.0	To understand the fundamentals of Bio potential recording	2.1	The Students will be able to describe the fundamentals of Bio potential recording
3.0	To design Bio potential amplifiers for acquisition of bio signals	3.1	The Students will be able to design various bio amplifiers
4.0	To study the various non-electrical physiological parameter measurement	4.1	The Students will be able to measure various nonelectrical physiological parameters
5.0	To study the various biochemical measurements	5.1	The Students will be able to measure various biochemical parameters

UNIT I - BIOPOTENTIAL ELECTRODES	**(9)**
Origin of Bio potential and its Propagation: Nernst equation for Membrane Resting Potential, Generation and Propagation of Action Potential, Conduction through Nerve to Neuromuscular Junction. Bio Electrodes: Electrode-electrolyte Interface, Electrode–skin Interface, Half-cell Potential, Impedance, Polarization effects of Electrode – Non Polarizable Electrodes, Types of Electrodes - Surface, Needle and Micro electrodes and their equivalent circuits. Recording problems - Measurement with two electrodes.	
UNIT II - BIOPOTENTIAL MEASUREMENTS	**(9)**
Bio Signal Characteristics – Frequency and Amplitude ranges. ECG – Einthoven's Triangle, Standard 12 lead system, Block Diagram. Measurements of Heart Sounds - PCG. EEG – 10-20 electrode system, Unipolar, Bipolar and Average Mode, Functional Block Diagram. EMG – Unipolar and Bipolar mode, Block Diagram, EOG and ERG.	
UNIT III - BIOPOTENTIAL AMPLIFIER	**(9)**
Need for Bio-amplifier - Single ended Bio-amplifier, Instrumentation Amplifier, Differential Bio-amplifier, Right leg driven ECG amplifier. Bandpass Filtering, Isolation Amplifiers – Transformer, Optical Isolation, Isolated DC Amplifier and AC Carrier Amplifier, Artifacts and Removal.	
UNIT IV - NON-ELECTRICAL PHYSIOLOGICAL PARAMETER MEASUREMENT	**(9)**
Temperature, Respiration Rate and Pulse Rate Measurements, Plethysmography, Pulse Oximetry, Blood Pressure: Direct Methods - Pressure Amplifiers - Systolic, Diastolic, Mean Detector Circuit, Indirect Methods - Auscultatory Method, Oscillometric Method, Ultrasonic Method. Blood flow - Electromagnetic and Ultrasound Blood flow Measurement. Cardiac output Measurement- Indicator dilution, Dye dilution and Thermodilution method.	

UNIT V - BIOCHEMICAL MEASUREMENT	(9)
Biochemical Sensors - pH, pO2 and pCO2, Ion Selective Field Effect Transistor (ISFET), Immunologically sensitive FET (IMFET), Blood Glucose Sensors - Blood Gas Analyzers, Spectrophotometer, Blood Cell Counter, Auto analyzer.	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

1. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", 4th Edition, Pearson Education, 2014.
2. John G. Webster, "Medical Instrumentation Application and Design", 4th Edition, John Wiley and Sons, New York, 2009.

REFERENCES:

1. Khandpur R. S, "Handbook of Biomedical Instrumentation", 3rd Edition, Tata McGraw Hill, New Delhi, 2014.
2. L.A Geddes and L. E. Baker, "Principles of Applied Biomedical Instrumentation", 3rd Edition Reprint, John Wiley and Sons, 2008.
3. Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, "Biomedical Instrumentation and Measurements", 2nd Edition, Pearson Education India, 2015.
4. Myer Kutz, "Standard Handbook of Biomedical Engineering & Design", McGraw-Hill Publisher, 2003.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	1	2	1		1	1					1	3	
2	3	1	2	1		1	1					2	3	
3	3	1	2	1		1	1					2	3	
4	3	1	2	1		1	1					1	3	
5	3	1	2	1		1	1					1	3	
CO (W.A)	3	1	2	1		1	1					1.4	3	

22BMC05 - BIOSIGNAL PROCESSING					
		L	T	P	C
		3	0	0	3
PREREQUISITE : 22ECC05 – SIGNALS AND SYSTEMS					
Course Objectives		**Course Outcomes**			
1.0	To learn Discrete Fourier transforms and Fast Fourier Transform and its properties	**1.1**	The students will be able to apply DFT and FFT for the analysis of biomedical signals		
2.0	To understand the characteristics and design of IIR filters	**2.1**	The students will be able to design and implement digital IIR filters in biosignal analysis		
3.0	To know the characteristics and design of FIR filters	**3.1**	The students will be able to design and implement digital FIR filters in the field of biomedical signal analysis		
4.0	To acquire knowledge about various biomedical signals and difficulties in signal analysis	**4.1**	The students will be able to identify the biomedical signals and difficulties in signal analysis		
5.0	To illustrate the PCG and EEG signals using adaptive segmentation technique	**5.1**	The students will be able to analyze the PCG and EEG signals using adaptive segmentation technique		

UNIT I – DISCRETE AND FAST FOURIER TRANSFORM	**(9)**
Introduction to DFT – Efficient Computation of DFT – Properties of DFT – FFT Algorithms – Decimation in Time (DIT) and Decimation in Frequency (DIF) Algorithms – Linear and Circular Convolution – Overlap Save and Add Methods.	
UNIT II - IIR FILTER DESIGN	**(9)**
Analog Filter Design – Discrete time IIR filter from analog filter (Butterworth Filter, Chebyshev Filter) – IIR Filter Design: Impulse Invariance, Bilinear Transformation Technique – Realization using Direct form – Cascade and Parallel forms.	
UNIT III - FIR FILTER DESIGN	**(9)**
Linear phase FIR filters – Filter design: Windowing Techniques (Rectangular Window, Hamming Window, Hanning Window), Frequency Sampling Techniques – Realization of FIR filters Transversal – Linear phase.	
UNIT IV - INTRODUCTION TO BIOMEDICAL SIGNALS	**(9)**
Biosignal Characteristics of Electro Cardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Phonocardiogram (PCG), Electrogastrogram (EGG), Objectives of Biomedical Signal Analysis, Difficulties in Biomedical signal analysis.	
UNIT V - ANALYSIS OF NONSTATIONARY AND MULTICOMPONENT SIGNALS	**(9)**
Time-variant Systems - Fixed Segmentation - Adaptive Segmentation - Application of Adaptive Segmentation in EEG and PCG Signals - Introduction to Wavelets.	
TOTAL (L) = 45 PERIODS	

TEXT BOOKS:

1. John G. Proakis & Dimitris G Manolakis, "Digital Signal Processing – Principles, Algorithms & Applications", 4th Edition, Pearson Education / Prentice Hall, 2007.
2. Rangaraj M. Rangayyan, "Biomedical Signal Analysis - A Case Study Approach", Wiley, 2nd Edition, 2016.

REFERENCES:

1. Emmanuel C. Ifeachor, Barrie W. Jervis, "Digital Signal Processing - A Practical Approach", Pearson Education Ltd., 2004.
2. Arnon Cohen, "Bio-Medical Signal Processing Vol I and Vol II", CRC Press Inc., Boca Rato, Florida, 2019.
3. Willis J. Tompkins, "Biomedical Digital Signal Processing", Prentice Hall of India, New Delhi, 2003.
4. D C Reddy, "Biomedical Signal Processing – Principals and Techniques", Tata Mc Graw Hill Publications, 2007

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	3	3	2	3							2	3	1
2	3	2	3	3	2							2	3	1
3	3	2	2	3	3							2	3	1
4	3	3	3	3	3							2	3	1
5	2	3	3	3	3							2	3	1
CO (W.A)	2.8	2.6	2.8	2.8	2.8							2.0	3.0	1

22BMC06 - BIOCONTROL SYSTEM					
		L	T	P	C
		3	0	0	3
PRE REQUISITE : NIL					
Course Objectives		**Course Outcomes**			
1.0	To study the mathematical techniques for analysis of given system	**1.1**	The students will be able to develop mathematical model for a given system		
2.0	To study the given system in time domain analysis	**2.1**	The students will be able to determine and analyze the time domain specifications of different systems		
3.0	To study the stability analysis of the given system	**3.1**	The students will be able to perform stability analysis of the given system using various techniques		
4.0	To study the given system in frequency domain analysis	**4.1**	The students will be able to determine and analyze the frequency domain specifications of the different systems		
5.0	To study the concept of physiological control system	**5.1**	The students will be able to explain the concept and model of physiological control systems		

UNIT I - CONTROL SYSTEM MODELING	**(9)**
Terminology and Basic Structure of Control System, Example of a Closed Loop System, Transfer Function, Modeling of Electrical Systems, Translational and Rotational Mechanical Systems, Block Diagram and Signal Flow Graph Representation of Systems, Reduction of Block Diagram and Signal Flow Graph, Conversion of Block Diagram to Signal Flow Graph. Need for Modeling Physiological System.	
UNIT II - TIME RESPONSE AND STABILITY ANALYSIS	**(9)**
Step and Impulse Responses of First Order and Second Order Systems - Time Domain Specifications of First and Second Order Systems - Steady State Error Constants. Introduction to PI, PD and PID Controllers.	
UNIT III - STABILITY ANALYSIS	**(9)**
Definition of Stability, Routh - Hurwitz Criteria of Stability, Root Locus Technique - Construction of Root Locus and Study of Stability.	
UNIT IV - FREQUENCY RESPONSE ANALYSIS	**(9)**
Frequency Response, Nyquist Stability Criterion, Nyquist Plot and Determination of Closed Loop Stability, Definition of Gain Margin and Phase Margin, Bode plot, Determination of Gain Margin and Phase Margin using Bode plot, use of Nichol's chart to compute Frequency and Bandwidth.	
UNIT V - PHYSIOLOGICAL CONTROL SYSTEM	**(9)**
Example of Physiological Control System, Difference between Engineering and Physiological Control Systems, Generalized System Properties, Models with Combination of System Elements, Linear Models of Physiological Systems - Examples, Introduction to Simulation. Illustration with Real Time Applications.	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

1. J. Nagarath and M. Gopal, "Control Systems Engineering", New Age International Publishers, September, 2021.
2. Michael C K Khoo, "Physiological Control Systems", IEEE Press, Prentice Hall India, 2005.

REFERENCES:

1. Salivahanan S. Rengaraj R. and Venkatakrishnan G. R., "Control Systems Engineering", Pearson Education India, 2015.
2. Benjamin C. Kuo, "Automatic Control Systems", Prentice Hall of India, 1995.
3. Ogata, Katsuhiko and Yanjuan Yang, "Modern Control Engineering", Vol 4, Prentice-Hall, 2002.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2	2	2								1	2	1
2	3	2	2	2								1	2	1
3	3	2	2	2								1	2	1
4	3	2	2	2	1							1	2	1
5	3	2	2	2	1							2	2	1
CO (W.A)	3	2	2	2	1							1.2	2	1

22BMC07 - BIOMATERIALS AND ARTIFICIAL ORGANS					
		L	T	P	C
		3	0	0	3
PREREQUISITE : 22BMC02 – ANATOMY AND HUMAN PHYSIOLOGY					
Course Objectives		**Course Outcomes**			
1.0	To study the characteristics and classification of biomaterials	**1.1**	The students will be able to understand the structure and mechanical properties of biomaterials		
2.0	To understand the response of biomaterials in living system	**2.1**	The students will be able to interpret various metallic and ceramic implant materials in medical field		
3.0	To learn about the polymeric materials and composites in tissue replacements	**3.1**	The students will be able to implement various polymeric implant materials according to the need for treatment		
4.0	To study the soft and hard tissue replacement in biomedical applications	**4.1**	The students will be able to analyze soft and hard tissue replacement implants in biomedical applications		
5.0	To know the compatibility and functioning of artificial organs inside the living system	**5.1**	The students will be able to assess compatibility and functioning of artificial organs inside the living system		

UNIT I – BIO-MATERIALS STRUCTURE AND BIO-COMPATIBILITY	**(9)**
Definition and Classification of Bio-materials, Mechanical Properties of Biomaterials, Structure Property Relationship of Biological and Biomaterials Viscoelasticity, Wound Healing Process, Body Response to Implants, Blood Compatibility, Carcinogenicity.	
UNIT II – IMPLANT MATERIALS I	**(9)**
Metallic Implant Materials: Stainless Steels, Cobased Alloys, Ti-Based Alloys, Dental Metals, Deterioration of Metallic Implant Materials. Ceramic Implant Materials: Structure–Property Relationship of Ceramics, Aluminum Oxides, Zirconia, Hydroxyapatite, Glass Ceramics, Carbons. Bio Dissolvers.	
UNIT III – IMPLANT MATERIALS II	**(9)**
Polymerization, Polyamides, Acryrilic Polymers, Rubbers, High Strength Thermoplastics, Deterioration of Polymers, Bio Polymers: Collagen and Elastin. Composites – Structure, Mechanics, Biocompatibility, Applications. Materials for Ophthalmology: Contact Lens, Intraocular Lens.	
UNIT IV – TISSUE REPLACEMENT IMPLANTS	**(9)**
Soft Tissue Replacements, Sutures, Surgical Tapes, Adhesive, Percutaneous and Skin Implants, Maxillofacial Augmentation, Vascular Grafts, Hard Tissue Replacement Implants, Internal Fracture Fixation Devices, Joint Replacements.	
UNIT V – ARTIFICIAL ORGANS	**(9)**
Blood Substitutes, Artificial Skin, Artificial Heart, Prosthetic Cardiac Valves, Artificial Lung (Oxygenator), Artificial Kidney (Dialyser Membrane), Artificial Pancreas, Dental Implants.	
TOTAL (L) = 45 PERIODS	

TEXT BOOKS:

1. Sujata V. Bhatt, "Biomaterials", 7th Edition, Narosa Publishing House, 2005.
2. Michael Lysaght, Thomas J Webster, "Biomaterials for Artificial Organs", Elsevier Science, 2018.

REFERENCES:

1. Park Joseph D.Bronzino, "Biomaterials-Principles and Applications", CRC Press, 2003.
2. J. Park, "Biomaterials: An Introduction", Springer Science & Business Media, 2012.
3. Myer Kutz, "Standard Handbook of Biomedical Engineering & Design", McGraw-Hill, 2003.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	2	1	1	2		2	2					2	2	
2	3	2	2	2		2	1					1	2	
3	3	2	2	2		2	1					1	2	
4	3	3	2	3		2	2					2	3	
5	3	3	2	3		3	2					2	3	
CO (W.A)	2.8	2.2	1.8	2.4		2.2	1.6					1.6	2.4	

22BMP023 - BIOSIGNAL PROCESSING LABORATORY

	L	T	P	C
	0	0	4	2

PRE REQUISITE : NIL

Course Objectives		Course Outcomes	
1.0	To acquire knowledge of various biomedical signals and sampling techniques	**1.1**	The students will be able to identify the various biomedical signals and sampling techniques
2.0	To learn DFT and FFT for computation of biosignals	**2.1**	The students will be able to apply DFT and FFT for the analysis of biomedical signals
3.0	To understand the characteristics and design of IIR filters	**3.1**	The students will be able to design and simulate digital IIR filters for biosignals
4.0	To study the characteristics and design of FIR filters for biosignals	**4.1**	The students will be able to design and simulate digital FIR filters for biosignals
5.0	To analyze the ECG and EEG Signal Processing	**5.1**	The students will be able to associate ECG and EEG data acquisition and processing

LIST OF EXPERIMENTS

1. (a)Representation of Basic Signals (Sine, Cosine, Unit impulse, Unit Step, Square, Exponential, Sawtooth)

   (b) Introduction of various Biomedical Signals (ECG, EEG, EMG).
2. DFT and FFT computation of Biosignals.
3. Digital IIR Butterworth filter-LPF & HPF.
4. Digital IIR Chebyshev filter-LPF & HPF.
5. FIR Filter Design Using Windowing Technique.
6. Up sampling and down sampling.
7. Design of IIR filter for ECG signal.
8. Event Detection: QRS in ECG.
9. Event Detection: Alpha activity in EEG.
10. Separation of Mixtures of Signals using PCA and ICA.

TOTAL (P:60) : 60 PERIODS

Mapping of COs with POs / PSOs														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	2	1	2	2	3	1	1		1			1	1	2
2	2	1	2	2	3	1	1		1	1		1	1	2
3	2	1	2	2	3	1	1		1	1		1	1	2
4	2	2	2	2	3	1	1		1			1	1	2
5	2	2	2	2	3	1	1		2	1		1	1	2
CO (W.A)	**2**	**1.4**	**2**	**2**	**3**	**1**	**1**		**1.2**	**1**		**1**	**1**	**2**

22BMP04 - BIOMEDICAL INSTRUMENTATION LABORATORY

	L	T	P	C
	0	0	4	2

PRE REQUISITE : NIL

	Course Objectives		Course Outcomes
1.0	To design preamplifiers and amplifiers for various bio signal recordings	**1.1**	The students will able to design preamplifiers and amplifiers for various bio signal recordings
2.0	To learn measurement of physiological parameters	**2.1**	The students will able to measure physiological parameters
3.0	To understand the measurement of biochemical parameters	**3.1**	The students can analyze biochemical parameters
4.0	To impart knowledge on designing of bio signal acquisition system	**4.1**	The students can design PCB layout for any bio amplifier
5.0	To measure various non-electrical parameters using suitable sensors/transducers	**5.1**	The students can able to measure various non-electrical parameters using suitable sensors/transducers

LIST OF EXPERIMENTS

1. Design a suitable circuit to detect QRS complex and measure heart rate.
2. Design of pre amplifiers to acquire bio signals along with impedance matching circuit using suitable ICs.
3. Design of ECG amplifiers with appropriate filter to remove power line and other artifacts.
4. Design of EMG amplifier.
5. Design of frontal EEG amplifier.
6. Design and study the characteristics of optical isolation amplifier.
7. Measurement of blood pressure using sphygmomanometer.
8. Design a Multiplexer and Demultiplexer for any two bio signals.
9. Measurement of pulse rate using photo transducer.
10. Measurement of pH and Conductivity.
11. Measurement of SPO_2

TOTAL (P:60) : 60 PERIODS

Mapping of COs with POs / PSOs														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	2	1	2	2		1	1		2	1		1	2	1
2	2	1	2	2		1	1		2	1		1	2	1
3	2	1	2	2		1	1		2	1		1	2	1
4	2	2	2	2		1	1		2	1		1	2	1
5	2	2	2	2		1	1		2	1		1	2	1
CO (W.A)	**2**	**1.4**	**2**	**2**		**1**	**1**		**2**	**1**		**1**	**2**	**1**