MUTHAYAMMAL ENGINEERING COLLEGE

An Autonomous Institution

(Approved by AICTE | Accredited by NAAC | Affiliated to Anna University)
Rasipuram - 637 408, Namakkal Dist., Tamil Nadu.

Curriculum/Syllabus

Programme Code : BME

Programme Name : B.E-BIOMEDICAL ENGINEERING

Regulation : 2023

MUTHAYAMMAL ENGINEERING COLLEGE

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Rasipuram - 637 408, Namakkal Dist., Tamil Nadu.

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DESIGNING YOUR FUTURE
Estd. 2000

Institution Vision & Mission

Institution Vision

- To be a Centre of Excellence in Engineering, Technology and Management on par with International Standards.

Institution Mission

- To prepare the students with high professional skills and ethical values.
- To impart knowledge through best practices.
- To instill a spirit of innovation through Training, Research and Development.
- To undertake continuous assessment and remedial measures.
- To achieve academic excellence through intellectual, emotional and social stimulation.

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Department Vision & Mission

Department Vision

- To produce competent Biomedical Engineers for providing better healthcare to the society.

Department Mission

- To impart value-based education in Biomedical Engineering using medical equipments.
- To prepare the students for placements and entrepreneurship in Healthcare industries through Hospital Training.
- To provide solutions to healthcare industries and society through lifelong learning with ethical values

Program Educational Objectives

PEO1 : Graduate will be able to Apply Biomedical engineering concepts to handle modern medical equipments in diagnosis process.

PEO2 : Graduate will be able to Generate solutions that address real-time challenges in the healthcare sector.

PEO3 : Graduate will be able to Maintain and improve technical competence in Biomedical engineering through lifelong learning with ethical and moral values..

Program Specific Outcomes

PSO1 : Acquire the necessary knowledge and basic skills, along with a deep understanding of engineering and medical sciences.

PSO2 : Solve real time Biomedical Engineering problems using appropriate medical equipments to improve the quality of life.

PSO3 : Develop systems for measurement, analysis and interpretation of medical data for better healthcare in the society.

Program Outcomes

PO1 : **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2 : **Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and Engineering sciences.

PO3 : **Design/Development solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4 : **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 : **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6 : **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 : **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

PO8 : **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9 : **Individual and team work:** Function effectively as an individual and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10 : **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11 : **Project management and finance:** Demonstrate knowledge and understanding of the engineering management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12 : **Lifelong learning:** Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

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B.E.–Biomedical Engineering

Grouping of Courses

I. Humanities and Social Sciences Courses (HS)

Sl.No.	Course Code	Course Title	Category	Contact Hours	Instruction Hours/Week/ Credit			
					L	T	P	C
1.	23HSS01	Technical and Communicative English – I	HS	4	3	0	0	3
2.	23HSS02	Technical and Communicative English – II	HS	4	3	0	0	3
3.	23HSS03	Technical English For Engineers	HS	3	2	0	0	2
4.	23HSS04	Communicative English for Engineers	HS	3	2	0	0	2
5.	23HSS05	Commercial English	HS	3	2	0	0	2
6.	23HSS06	Basics of Japanese Language	HS	3	2	0	0	2
7.	23HSS07	Basics of French	HS	3	2	0	0	2
8.	23HSS08	Heritage of Tamils	HS	2	1	0	0	1
9.	23HSS09	Tamils and Technology	HS	2	1	0	0	1

II. Basic Sciences (BS)

1.	23BSS01	Engineering Physics	BS	4	3	0	0	3
2.	23BSS02	Physics Laboratory	BS	4	0	0	4	2
3.	23BSS03	Bio and Nanomaterial Sciences	BS	4	3	0	0	3
4.	23BSS04	Materials Science	BS	4	3	0	0	3
5.	23BSS05	Applied Physics	BS	4	3	0	0	3
6.	23BSS11	Engineering Chemistry	BS	4	3	0	0	3
7.	23BSS12	Chemistry Laboratory	BS	4	0	0	4	2
8.	23BSS13	Applied Chemistry	BS	4	3	0	0	3
9.	23BSS21	Algebra and Calculus	BS	5	3	1	0	4
10.	23BSS22	Advanced Calculus and Complex Analysis	BS	5	3	1	0	4
11.	23BSS23	Differential Equations and Vector Analysis	BS	5	3	1	0	4
12.	23BSS24	Transforms and Partial Differential Equations	BS	5	3	1	0	4
13.	23BSS25	Discrete Mathematics	BS	5	3	1	0	4
14.	23BSS26	Statistics and Queuing Model	BS	5	3	1	0	4
15.	23BSS27	Statistics and Numerical Methods	BS	5	3	1	0	4
16.	23BSS28	Numerical Methods	BS	5	3	1	0	4
17.	23BSS29	Probability and Random Processes	BS	5	3	1	0	4

III. General Engineering Science (GES)

1.	23GES01	Programming for Problem Solving Using C	GES	4	3	0	0	3
2.	23GES02	Programming in C Laboratory	GES	3	0	0	2	1
3.	23GES03	Python Programming	GES	4	3	0	0	3
4.	23GES04	Computer Peripherals and Programming Essentials	GES	4	3	0	0	3
5.	23GES05	Python Programming Laboratory	GES	3	0	0	2	1
6.	23GES06	Electrical and Electronics Sciences	GES	4	3	0	0	3
7.	23GES07	CAD Laboratory	GES	4	0	0	4	2
8.	23GES08	Electric Circuits	GES	4	3	0	0	3
9.	23GES09	Engineering Mechanics for Electrical Engineers	GES	4	3	0	0	3
10.	23GES10	Engineering Graphics	GES	4	3	0	0	3
11.	23GES11	Engineering Drawing	GES	4	3	0	0	3
12.	23GES12	Mechanical and Building Sciences	GES	4	3	0	0	3
13.	23GES13	Data Structures using Python	GES	4	3	0	0	3
14.	23GES14	Electronics Product Design	GES	4	3	0	0	3
15.	23GES15	Manufacturing Processes	GES	4	3	0	0	3
16.	23GES16	Fundamentals of Civil Engineering	GES	4	3	0	0	3
17.	23GES17	Bioorganic Chemistry	GES	4	3	0	0	3
18.	23GES18	Basics Electrical and Electronics Engineering	GES	4	3	0	0	3
19.	23GES19	Engineering Mechanics	GES	4	3	0	0	3
20.	23GES20	Basics of Human Anatomy	GES	4	3	0	0	3
21.	23GES21	Engineering Practices Laboratory	GES	4	0	0	4	2
22.	23GES22	Computer Aided Building Drawing Laboratory	GES	4	0	0	4	2
23.	23GES23	Bioorganic Chemistry Laboratory	GES	4	0	0	4	2
24.	23GES24	Electric Circuits Laboratory	GES	3	0	0	2	1
25.	23GES25	Data Structures using Python Laboratory	GES	3	0	0	2	1
26.	23GES28	Renewable Energy Resources	GES	3	3	0	0	3

IV. Professional Core (PC)

1.	23BMC01	Human Anatomy & Physiology	PC	3	3	0	0	3
2.	23BMC02	Biomedical Sensors & Instruments	PC	3	3	0	0	3
3.	23BMC03	Signals and Systems	PC	3	3	0	0	3
4.	23BMC04	Circuit Theory	PC	3	3	0	0	3
5.	23BMC05	Electronic Devices and Circuits	PC	3	3	0	0	3
6.	23BMC06	Biomaterials and Artificial Organs	PC	3	3	0	0	3
7.	23BMC07	Biomedical Instrumentation – I	PC	3	3	0	0	3
8.	23BMC08	Fundamentals of Biochemistry	PC	3	3	0	0	3
9.	23BMC09	Control System for Biomedical Engineering	PC	3	3	0	0	3

10.	23BMC10	Analog and Digital Integrated Circuits	PC	3	3	0	0	3
11.	23BMC11	Biomedical Instrumentation - II	PC	3	3	0	0	3
12.	23BMC12	Medical Signal Processing	PC	3	3	0	0	3
13.	23BMC13	Microprocessors and Microcontrollers in Medicine	PC	3	3	0	0	3
14.	23BMC14	Pathology and Microbiology	PC	3	3	0	0	3
15.	23BMC15	Embedded Systems and IoMT	PC	3	3	0	0	3
16.	23BMC16	Medical Imaging Techniques	PC	3	3	0	0	3
17.	23BMC17	Medical Image Processing	PC	3	3	0	0	3
18.	23BMC18	Analytical & Diagnostic Equipments	PC	3	3	0	0	3
19.	23BMC19	Biomechanics & Rehabilitation Engineering	PC	3	3	0	0	3
20.	23BMC20	Engineering Ethics and Human Values	PC	2	2	0	0	2
21.	23BMC21	Devices and Circuits Laboratory	PC	2	0	0	2	1
22.	23BMC22	Sensors and Measurements Laboratory	PC	2	0	0	2	1
23.	23BMC23	Analog and Digital Integrated Circuits laboratory	PC	2	0	0	2	1
24.	23BMC24	Biochemistry and Human Physiology Laboratory	PC	2	0	0	2	1
25.	23BMC25	Biomedical Instrumentation Laboratory	PC	2	0	0	2	1
26.	23BMC26	Medical Signal Processing Laboratory	PC	2	0	0	2	1
27.	23BMC27	Microprocessor and Microcontroller Laboratory	PC	2	0	0	2	1
28.	23BMC28	Medical Image Processing Laboratory	PC	2	0	0	2	1
29.	23BMC29	Embedded Systems Laboratory	PC	2	0	0	2	1

V. Professional Elective (PE)

1.	23BME01	Basic Clinical Sciences	PE	3	3	0	0	3
2.	23BME02	Biostatistics	PE	3	3	0	0	3
3.	23BME03	Medical Science	PE	3	3	0	0	3
4.	23BME04	Sports Physical Therapy	PE	3	3	0	0	3
5.	23BME05	Telemedicine	PE	3	3	0	0	3
6.	23BME06	Brain Computer Interface and Applications	PE	3	3	0	0	3
7.	23BME07	Medical Optics	PE	3	3	0	0	3
8.	23BME08	Medical Informatics	PE	3	3	0	0	3
9.	23BME09	Virtual Reality	PE	3	3	0	0	3
10.	23BME10	Wearable Systems	PE	3	3	0	0	3
11.	23BME11	Internet of Things in Medicine	PE	3	3	0	0	3
12.	23BME12	Hospital Waste Management	PE	3	3	0	0	3
13.	23BME13	Fiber optics and Lasers in Medicine	PE	3	3	0	0	3
14.	23BME14	Communication Engineering	PE	3	3	0	0	3
15.	23BME15	Medical Physics	PE	3	3	0	0	3
16.	23BME16	Electrical Safety and Quality assurance	PE	3	3	0	0	3

17.	23BME17	Robotics in medicine	PE	3	3	0	0	3
18.	23BME18	MEMS and its Biomedical Applications	PE	3	3	0	0	3
19.	23BME19	Neural Engineering	PE	3	3	0	0	3
20.	23BME20	Forensic science in healthcare	PE	3	3	0	0	3
21.	23BME21	Medical Ethics and Standards	PE	3	3	0	0	3
22.	23BME22	Biometric Systems	PE	3	3	0	0	3
23.	23BME23	Hospital Management	PE	3	3	0	0	3
24.	23BME24	Advanced Therapeutic equipments	PE	3	3	0	0	3
25.	23BME25	Patient safety, standards and ethics	PE	3	3	0	0	3

VI. Employability Enhancement Courses (EEC)

1.	23BMS01	Mini Project	EEC	2	0	0	2	1
2.	23BMS02	Industrial Training/ Hospital Training - II	EEC	10	0	0	6	3
3.	23BMS03	Project Work	EEC	18	0	0	24	12
4.	23BMS04	Presentation Skill and Technical Seminar	EEC	2	0	0	2	1
5.	23BMS05	Innovative Practices	EEC	2	0	0	0	1
6.	23BMS06	Internship –I / Hospital Training - I	EEC	0	0	0	0	1
7.	23BMS07	Internship –II / Hospital Training - III	EEC	0	0	0	0	1
8.	23BMS08	Professional Skills for Biomedical Engineers	EEC	2	0	0	2	1

VII. Mandatory Courses (MC)

1.	23BMM01	Organizational Behaviour	MC	3	3	0	0	0
2.	23BMM02	India Constitution (Common to All Branches)	MC	3	3	0	0	0
3.	23BMM03	Essence of Indian Traditional Knowledge	MC	3	3	0	0	0

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B.E.- Biomedical Engineering
Curriculum | UG - R2023
Semester -I

Sl.No.	Course Code	Course Title	Category	Contact Hours	Instruction Hours/Week/ Credit			
					L	T	P	C
Theory								
1.	23HSS01	Technical and Communicative English - I	HS	2	3	0	0	3
2.	23BSS21	Algebra and Calculus	BS	4	3	1	0	4
3.	23BSS11	Engineering Chemistry	BS	3	3	0	0	3
4.	23GES01	Programming for Problem Solving Using C	GS	3	3	0	0	3
5.	23GES10	Engineering Graphics	GS	3	3	0	0	3
6.	23HSS08	Heritage of Tamils	HS	1	1	0	0	1
Practical								
7.	23BSS12	Chemistry Laboratory	BS	2	0	0	4	2
8.	23GES02	Programming in C Laboratory	GS	2	0	0	2	1
							Total Credit	**20**

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Semester -II

Sl.No.	Course Code	Course Title	Category	Contact Hours	Instruction Hours/Week/ Credit			
					L	T	P	C
Theory								
1.	23HSS02	Technical and Communicative English II	HS	4	2	0	2	3
2.	23BSS23	Differential Equations and Vector Analysis	BS	4	3	1	0	4
3.	23BSS01	Engineering Physics	BS	3	3	0	0	3
4.	23GES13	Data Structures using Python	GS	3	3	0	0	3
5.	23GES14	Electronics Product Design	GS	3	3	0	0	3
6.	23HSS09	Tamils and Technology	HS	1	1	0	0	1
Practical								
7.	23GES05	Python Programming Laboratory	GS	2	0	0	2	1
8.	23BSS02	Physics Laboratory	BS	2	0	0	4	2
							Total Credit	**21**

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B.E.- Biomedical Engineering
Curriculum | UG - R2023
Semester -III

Sl.No.	Course Code	Course Title	Category	Contact Hours	Instruction Hours/Week/ Credit			
					L	T	P	C
Theory								
1.	23BSS29	Probability and Random Processes	BS	4	3	1	0	4
2.	23BMC01	Human Anatomy & Physiology	PC	3	3	0	0	3
3.	23BMC02	Biomedical Sensors & Measurements	PC	3	3	0	0	3
4.	23BMC03	Signals and Systems	PC	3	3	0	0	3
5.	23BMC04	Circuit Theory	PC	3	3	0	0	3
6.	23BMC05	Electronic Devices and Circuits	PC	3	3	0	0	3
Practical								
7.	23BMC21	Devices and Circuits Laboratory	PC	2	0	0	2	1
8.	23BMC22	Sensors and Measurements Laboratory	PC	2	0	0	2	1
9.	23BMS08	Professional Skills for Biomedical Engineers	EEC	2	0	0	2	1
							Total Credit	**22**

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Semester -IV

Sl.No.	Course Code	Course Title	Category	Contact Hours	Instruction Hours/Week/ Credit			
					L	T	P	C
Theory								
1.	23BMC06	Biomaterials and Artificial Organs	PC	3	3	0	0	3
2.	23BMC07	Biomedical Instrumentation - I	PC	3	3	0	0	3
3.	23BMC08	Fundamentals of Biochemistry	PC	3	3	0	0	3
4.	23BMC09	Control System for Biomedical Engineering	PC	3	3	0	0	3
5.	23BMC10	Analog and Digital Integrated Circuits	PC	3	3	0	0	3
6.	23BSS28	Numerical Methods	BS	4	3	1	0	4
Practical								
7.	23BMC23	Analog and Digital Integrated Circuits laboratory	PC	2	0	0	2	1
8.	23BMC24	Biochemistry and Human Physiology Laboratory	PC	2	0	0	2	1
9.	23BMS05	Innovative Practices	EEC	2	0	0	0	1
							Total Credit	**22**

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Semester -V

Sl.No.	Course Code	Course Title	Category	Contact Hours	Instruction Hours/Week/ Credit			
					L	T	P	C
Theory								
1.	23BMC11	Biomedical Instrumentation - II	PC	3	3	0	0	3
2.	23BMC12	Medical Signal Processing	PC	3	3	0	0	3
3.	23BMC13	Microprocessors and Microcontrollers in Medicine	PC	3	3	0	0	3
4.	23BMC14	Pathology and Microbiology	PC	3	3	0	0	3
5.	23BMC19	Biomechanics & Rehabilitation Engineering	PC	3	3	0	0	3
6.		Professional Elective I	PE	3	3	0	0	3
7.	23BMM01	Mandatory Course – I	MC	2	2	0	0	0
Practical								
8.	23BMC25	Biomedical Instrumentation Laboratory	PC	2	0	0	2	1
9.	23BMC26	Medical Signal Processing Laboratory	PC	2	0	0	2	1
10.	23BMC27	Microprocessor and Microcontroller Laboratory	PC	2	0	0	2	1
11.	23BMS06	Internship – I / Hospital Training - I	EEC	2	0	0	0	1
							Total Credit	**22**

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Semester -VI

Sl.No.	Course Code	Course Title	Category	Contact Hours	Instruction Hours/Week/ Credit			
					L	T	P	C
Theory								
1.	23BMC15	Embedded Systems and IoMT	PC	3	0	0	3	3
2.	23BMC16	Medical Imaging Techniques	PC	3	0	0	3	3
3.	23BMC17	Medical Image Processing	PC	3	0	0	3	3
4.		Professional Elective II	PE	3	0	0	3	3
5.		Professional Elective III	PE	3	0	0	3	3
6.		Open Elective I	OE	3	0	0	3	3
Practical								
7.	23BMS01	Mini Project	EEC	2	0	0	2	1
8.	23BMC28	Medical Image Processing Laboratory	PE	2	0	0	2	1
9.	23BMC29	Embedded Systems Laboratory	PE	2	0	0	2	1

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Semester -VII

Sl.No.	Course Code	Course Title	Category	Contact Hours	Instruction Hours/Week/ Credit			
					L	T	P	C
Theory								
1.	23BMC18	Analytical & Diagnostic Equipments	PC	3	3	0	0	3
2.	23BMC20	Engineering Ethics and Human Values	PC	2	2	0	0	2
3.		Professional Elective IV	PE	3	3	0	0	3
4.		Professional Elective V	PE	3	3	0	0	3
5.		Open Elective II	OE	3	3	0	0	3
6.		Open Elective III	OE	3	3	0	0	3
Practical								
7.	23BMS02	Project Work Phase – I	EEC	6	0	0	6	3
8.	23BMS04	Presentation Skill and Technical Seminar	EEC	2	0	0	0	1
							Total Credit	**21**

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Semester -VIII

Sl.No.	Course Code	Course Title	Category	Contact Hours	Instruction Hours/Week/ Credit			
					L	T	P	C
Practical								
1.	23BMS03	Project Work Phase –II	HS	24	0	0	24	12
2.	23BMS07	Internship – II / Hospital Training - II			0	0	0	1
							Total Credit	**13**

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B.E.- Biomedical Engineering
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Summary of Course Component

Sl.No.	Course Area	Semesters								Total Credits	% of Credits
		I	II	III	IV	V	VI	VII	VIII		
1.	HS	4	4	-	-	-	-	-	-	8	4.96
2.	BS	9	9	4	4	-	-	-	-	26	16.14
3.	GES	7	7	-	-	-	-	-	-	14	8.69
4.	PC	-	-	17	17	18	11	5	-	68	40.99
5.	PE	-	-	-	-	-	6	6	-	15	9.31
6.	OE	-	-	-	-	-	-	3	-	9	5.59
7.	EEC	-	-	1	1	1	1	4	13	21	13.04
8.	MC	-	-	-	-	-	-	-	-	-	-
9.	NPTEL	-	-	-	-	3	3	3	-	**9**	5.59
Total		20	20	22	22	22	21	21	13	**161**	**100.00**

Chairman
Board of Studies
Department of Biomedical Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram, Namakkal Dist. 637 408

23BMC01	HUMAN ANATOMY & PHYSIOLOGY	L	T	P	C
		3	0	0	3

Course Objective:

- Know basic structural and functional elements of human body.
- Learn organs and structures involving in system formation and functions.
- Understand circulatory system.
- Learn urinary and nervous system.
- Study about muscles and joints.

Course Outcomes:

23BMC01.CO1 Identify basic structural and functional elements of human body.

23BMC01.CO2 Explain the structure and functions of skeletal system.

23BMC01.CO3 Describe the functions of circulatory system.

23BMC01.CO4 Discuss the physiological process of urinary system and nervous system.

23BMC01.CO5 Identify various muscles and joints.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BMC01.CO1	X	X	X	-	-	X	-	-	-	X	-	X	X	-	-
23BMC01.CO2	X	X	X	-	-	X	-	-	-	X	-	X	X	-	-
23BMC01.CO3	X	X	X	-	-	X	-	-	-	X	-	X	X	-	-
23BMC01.CO4	X	X	X	-	-	X	-	-	-	X	-	X	X	-	-
23BMC01.CO5	X	X	X	-	-	X	-	-	-	X	-	X	X	-	-

Unit-I Basic Elements of Human Body **9**

Cell: Structure and organelles - Functions of each component in the cell. Cell membrane – transport across membrane – origin of cell membrane potential – Action potential Tissue: Types – Specialized tissues – functions, Types of glands.

Unit-II Skeletal System **9**

Bone, Types of bone, structure, bone cells, functions of bone. Axial skeleton- skull, sinuses, Fontanelles, vertebral column- characteristics of typical vertebra, different parts of vertebral column (parts only), features of vertebral column, movements and functions of vertebral column, sternum, ribs, shoulder girdle and upper limb, pelvic girdle and lower limb.

Unit-III Circulatory System **9**

Blood composition - functions of blood – functions of RBC. WBC types and their functions Blood groups – importance of blood groups – identification of blood groups. Blood vessels - Structure of heart – Properties of Cardiac muscle – Conducting system of heart – Cardiac cycle – ECG - Heart sound - Volume and pressure changes and regulation of heart rate –Coronary Circulation. Factors regulating Blood flow.

Unit-IV Urinary and Nervous System **9**

Urinary system: Structure of Kidney and Nephron. Mechanism of Urine formation and acid base regulation – Urinary reflex – Homeostasis and blood pressure regulation by urinary system. -Structure of a Neuron – Types of Neuron. Synapses and types. Conduction of action potential in neuron Brain – Divisions of brain lobes - Cortical localizations and functions - EEG. Spinal cord – Tracts of spinal cord - Reflex mechanism – Types of reflex. Autonomic nervous system and its functions.

Unit-V Muscles and Joints **9**

Muscle tissue: Skeletal muscle, Smooth muscle, Cardiac muscle, functions of muscle tissue, muscle tone and

fatigue. Types of joint- Fibrous, Cartilaginous, Synovial, characteristics of synovial joints, shoulder joint, elbow joint, radioulnar joint, wrist joint, joints of hands and fingers, Hip joint, Knee joint, ankle joint, joints of foot and toes.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Elaine.N. Marieb,	Essential of Human Anatomy and Physiology	Pearson Education NewDelhi.	8th edition, 2007
2.	Gillian Pocock, Christopher D. Richards	The Human Body An introduction for Biomedical and Health Sciences	Oxford University Press, USA	2009

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	William F. Ganong	Review of Medical Physiology	Mc Graw Hill New Delhi	22nd edition
2.	Eldra Pearl Solomon	Introduction to Human Anatomy and Physiology	W.B.Saunders Company	2003
3.	Arthur C. Guyton	Text book of Medical Physiology	11 th Edition, Elsevier Saunders	11th Edition, 2006
4.	Juergen Mai George Paxinos	The Human nervous System	Academic Press 3rd Edition	2011
5.	Midthun Joseph	The Digestive and Urinary Systems	World Book, Inc	2011

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23BMC02	BIOMEDICAL SENSORS & MEASUREMENTS	L	T	P	C
		3	0	0	3

Course Objective:

- To understand the purpose of measurement, the methods of measurements, errors associated with measurements.
- To know the principle of transduction, classifications and the characteristics of different transducers and study its biomedical applications.
- To understand the principle of Photoelectric and Piezoelectric Sensors
- To study signal conditioning & signal analysers.
- To know the different display and recording devices.

Course Outcomes:

23BMC02.CO1	Describe the purpose and methods of measurements
23BMC02.CO2	Apply the characteristics of various transducers in measurements
23BMC02.CO3	Apply the principle of Photoelectric and Piezoelectric Sensors
23BMC02.CO4	Apply signal conditioning & signal analyser
23BMC02.CO5	Demonstrate different display and recording devices.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BMC02.CO1	X	X	X	X	-	-	-	-	-	-	-	X	X	-	-
23BMC02.CO2	X	X	X	X	X	X	-	-	-	-	-	X	X	-	-
23BMC02.CO3	X	X	X	X	X	X	-	-	-	-	-	X	X	-	-
23BMC02.CO4	X	X	X	X	X	X	-	-	-	-	-	X	X	-	-
23BMC02.CO5	X	X	X	X	X	X	-	-	-	-	-	X	X	-	-

Unit-I Science of Measurement **7**

Measurement System– Instrumentation – Classification and Characteristics of Transducers – Static and Dynamic – Errors in Measurements – Calibration – Primary and secondary standards.

Unit-II Displacement, Pressure, Temperature Sensors **11**

Resistive Transducers: Strain Gauge: Gauge factor, sensing elements, configuration, biomedical applications; strain gauge as displacement & pressure transducers, RTD materials & range, Characteristics, thermistor characteristics, biomedical applications of Temperature sensors Capacitive transducer, Inductive transducer, LVDT, Active type: Thermocouple – characteristics

Unit-III Photoelectric and Piezoelectric Sensors **9**

Phototube, scintillation counter, Photo Multiplier Tube (PMT), photovoltaic, Photo conductive cells, photo diodes, phototransistor, comparison of photoelectric transducers, spectrophotometric applications of photo electric transducers. Piezoelectric active transducer and biomedical applications as pressure & Ultrasound transducer.

Unit-IV Signal Conditioning and Signal Analyzer **9**

AC and DC Bridges –wheat stone bridge, Kelvin, Maxwell, Hay, Schering – Concepts of filters, Pre-amplifier – impedance matching circuits – isolation amplifier. Spectrum analyzer.

Unit-V Display and Recording Devices **9**

Digital voltmeter – Multi meter – CRO – block diagram, CRT – vertical & horizontal deflection system, DSO, LCD monitor, PMMC writing systems, servo recorders, photographic recorder, magnetic tape recorder, Inkjet recorder, thermal recorder. Demonstration of the display and recording devices

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	L.A Geddes and L.E.Baker.	Principles of Applied Biomedical Instrumentation	John Wiley and sons	3rd Edition, Reprint 2008
2.	Albert D.Helfrick	Modern Electronic Instrumentation and Measurement Techniques	William D.Cooper. Prentice Hall of India,	2007

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	A.K.Sawhney	Electrical & Electronics Measurement and Instrumentation	Dhanpat Rai & Co, New Delhi	10th Edition, 2000
2.	Ernest O Doebelin and Dhanesh N Manik	Measuremet systems, Application and design	Mc Graw-Hill	5th Edition, 2007
3.	Khandpur R.S	Handbook of Biomedical Instrumentation	Tata McGraw Hill, New Delhi	3rd Edition, 2014
4.	Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer	Biomedical Instrumentation and Measurement	Prentice Hall India Pvt. Ltd. , New Delhi	2nd Edition, Reprint, 2013
5.	John G.Webster	'Medical Instrumentation Application and Design'	John Wiley and Sons, New York	4th edition, 2009

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23BMC03	SIGNALS AND SYSTEMS	L	T	P	C
		3	0	0	3

Course Objective:

- To understand the basic properties and types of signal & systems.
- To learn Continuous Time signals and its analysis using Laplace Transform & Fourier transforms.
- To learn Continuous Time LTI Systems and its analysis.
- To understand Z transform & DTFT and their properties.
- To characterize LTI systems in the Time domain and various Transform domains.

Course Outcomes:

23BMC03.CO1	Classify CT and DT signals and systems.
23BMC03.CO2	Apply Laplace transform, Fourier transform in CT signal analysis
23BMC03.CO3	Analyze continuous time LTI systems using Fourier and Laplace Transforms.
23BMC03.CO4	Apply Z Transform and DTFT in DT Signal Analysis.
23BMC03.CO5	Analyze discrete time LTI systems using Z transform and DTFT.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BMC03.CO1	x	x	x	x	x	-	-	-	-	-	-	x	x	x	x
23BMC03.CO2	x	x	x	x	x	-	-	-	-	-	-	x	x	x	x
23BMC03.CO3	x	x	x	x	x	-	-	-	-	-	-	x	x	x	x
23BMC03.CO4	x	x	x	x	x	-	-	-	-	-	-	x	x	x	x
23BMC03.CO5	x	x	x	x	x	-	-	-	-	-	-	x	x	x	x

Unit-I Signals & Systems **9**

Signals- Classification of signals- Continuous –time and Discrete time signals, Deterministic and random signal, even and odd signals, periodic and periodic signals, energy and power signals, Basic Continuous –time and Discrete time signals- Unit step, Unit impulse, Unit Ramp, Exponential, sinusoidal ,Exponentially damped sinusoidal signals, Pulse signals, Transformation of independent variables, Basic operations on signals- amplitude scaling ,addition, multiplication, differentiation and integration, Representation of signals in terms of impulses, Systems- Classification of systems - Static & Dynamic, Linear & Nonlinear, Time-variant & Time-invariant, Causal & Non causal, Stable & Unstable.

Unit-II Analysis Of Continuous Time Signals **9**

The Laplace Transform : The region of convergence for Laplace Transforms, The Inverse Laplace Transform, Properties of the Laplace Transform, Fourier series analysis-spectrum of Continuous -Time (CT) signals, Continuous- time Fourier Transform : Representation of A periodic signal , The Fourier transform for periodic signals, Properties of the continuous- time Fourier transform, The convolution property, The multiplication property, Application of Fourier Transform, the relationship between Laplace transform and Fourier transform

Unit-III Linear Time Invariant Systems **9**

Continuous –time LTI systems: Block diagram representation-impulse response, Convolution integrals, Properties of Linear Time Invariant Systems, Casual LTI systems Described by differential equations, Fourier and Laplace transforms in Analysis of CT systems

Unit-IV Analysis Of Discrete Time Signals **9**

DTFT– Properties of DTFT, Application of DTFT, Discrete Time Fourier series – Definition, properties ,Sampling theorem, Z Transform- The region of convergence for Z transform, The inverse Z transform, Properties of Z Transform, the unilateral Z transform , Geometric evaluation of the Fourier transform from the pole zero plot,

The relationship between Z transform and DTFT

Unit-V Linear Time Invariant-Discrete Time Systems 9

Casual LTI system described by difference equation, solving differential equation using Z transform, Block diagram representation-Impulse response - Convolution sum, Discrete Fourier and Z Transform Analysis of Recursive & Non-Recursive systems .

Total Periods: 45

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Rangaraj.M.Rangayyan	Biomedical signal processing	Wiley-IEEE press	2nd Edition, 2015
2.	P. Ramakrishna Rao	Signals and Systems	McGraw Hill	2nd Edition, 2013
3.	B P Lathi	Signals and Systems	B S Publisher	2001
4.	Nagrath ,Sharan	Signals and Systems	McGraw Hill	2009
5.	S.Salivahanan, N.Sureshkumar and A.Vallavaraj	Signals and Systems	Tata McGraw Hill	2011

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23BMC04	CIRCUIT THEORY	L	T	P	C
		3	0	0	3

Course Objective:

- To introduce the basic concepts of DC and AC circuits behavior
- To study the transient and steady state response of the circuits subjected to step and sinusoidal excitations.
- To introduce different methods of circuit analysis using Network theorems, duality and topology

Course Outcomes:

23BMC04.CO1 Comprehend and design ac/dc circuits.

23BMC04.CO2 Apply circuit theorems in real time.

23BMC04.CO3 Evaluate ac/dc circuits.

23BMC04.CO4 Analyze the electrical circuits.

23BMC04.CO5 Develop and understand ac/dc circuits.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BMC04.CO1	X	X	X	X	-	-	-	-	-	-	-	X	X	-	-
23BMC04.CO2	X	X	X	X	X	X	-	-	-	-	-	X	X	-	-
23BMC04.CO3	X	X	X	X	X	X	-	-	-	-	-	X	X	-	-
23BMC04.CO4	X	X	X	X	X	X	-	-	-	-	-	X	X	-	-
23BMC04.CO5	X	X	X	X	X	X	-	-	-	-	-	X	X	-	-

Unit-I BASIC CIRCUITS ANALYSIS 9

Basic Components of electric Circuits, Charge, current, Voltage and Power, Voltage and Current Sources, Ohms Law, Kirchoff's Laws, Mesh current and node voltage method of analysis for D.C and A.C. circuits. The single Node – Pair Circuit, series and Parallel Connected Independent Sources, Resistors in Series and Parallel, voltage and current division, Nodal analysis, Mesh analysis

Unit-II NETWORK THEOREM AND DUALITY 9

Useful Circuit Analysis techniques - Linearity and superposition, Thevenin and Norton Equivalent Circuits, Maximum Power Transfer, application of Network theorems. Network reduction: voltage and current division, source transformation, Delta-Wye Conversion. Duals, Dual circuits.

Unit-III SINUSOIDAL STEADY STATE ANALYSIS 9

Sinusoidal Steady – State analysis , Characteristics of Sinusoids, The Complex Forcing Function, The Phasor, Phasor relationship for R, L, and C, impedance and Admittance, Nodal and Mesh Analysis, Phasor Diagrams, AC Circuit Power Analysis, Instantaneous Power, Average Power, apparent Power and Power Factor, Complex Power.

Unit-IV TRANSIENTS AND RESONANCE IN RLC CIRCUITS 9

Basic RL and RC Circuits, The Source- Free RL Circuit, The Source-Free RC Circuit, The Unit- Step Function, Driven RL Circuits, Driven RC Circuits, RLC Circuits, Frequency Response, Parallel Resonance, Series Resonance, Quality Factor.

Unit-V COUPLED CIRCUITS AND TOPOLOGY 9

Magnetically Coupled Circuits, mutual Inductance, the Linear Transformer, the Ideal Transformer, Anintroduction to Network Topology, Trees and General Nodal analysis, Links and Loop analysis

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Hayt Jack Kemmerly, Steven Durbin	"Engineering Circuit Analysis"	Mc Graw Hill education	9th Edition, 2018
2.	Joseph Edminister and Mahmood Nahvi	"Electric Circuits" Schaum's Outline Series	Tata McGraw Hill Publishing Company, New Delhi	Fifth Edition Reprint 2016

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Robert.L. Boylestead	Introductory Circuit Analysis	Pearson Education India	12th Edition, 2014
2.	John O Mallay	Schaum's Outlines "Basic Circuit Analysis	.The Mc Graw Hill companies	2nd Edition, 2011.
3.	Charles.K.Alexander, Mathew N.O.Sadiku	Fundamentals of Electric Circuits	McGraw Hill	5th Edition, 2012.
4.	Allan H.Robbins, Wilhelm C.Miller	Circuit Analysis Theory and Practice	Cengage Learning	5th Edition, 1st Indian, Reprint, 2013

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23BMC05	ELECTRONIC DEVICES AND CIRCUITS	L	T	P	C
		3	0	0	3

Course Objective:

- Understand the theory of semiconductor diodes and their application.
- Gain a thorough understanding of operation and characteristics of TRIAC & DIAC, GTO.
- Know the basics of BJT operation, configuration and their application.
- Understand the concept of amplifiers and different types of feedback.
- Gain knowledge about the operation of oscillators and power supplies.

Course Outcomes:

23BMC05.CO1	Explain the structure and operation of the basic electronic devices.
23BMC05.CO2	Understand the different types of transistor structure and their operation.
23BMC05.CO3	Learn the different types of amplifiers and its small signal analysis.
23BMC05.CO4	Design the multistage and differential amplifier.
23BMC05.CO5	Know about the feedback amplifiers and oscillators.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BMC05.CO1	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X
23BMC05.CO2	X	X	X	X	-	-	-	-	-	-	X	-	X	X	X
23BMC05.CO3	X	X	X	X	-	-	-	-	X	-	X	X	X	X	X
23BMC05.CO4	X	X	X	X	-	-	-	-	X	-	X	X	X	X	X
23BMC05.CO5	X	X	X	X	-	-	-	-	X	-	X	X	X	X	X

Unit-I APPLICATIONS OF SEMICONDUCTOR DEVICES 9

Introduction to semiconductor diode, PN junction diode structure, operation and VI characteristics - Zener diode -. Display devices- LED, LCD, Rectifiers: Half Wave and Full Wave Rectifiers

Unit-II TRANSISTORS 9

UJT, BJT, JFET, MOSFET, IGBT Construction, operation and V-I characteristics – Thyristor construction, operation and V-I characteristics, Two transistor analogy.

Unit-III AMPLIFIERS 9

BJT small signal model – Analysis of CE, CB, CC amplifiers- Gain and frequency response – MOSFET small signal model– Analysis of CS and Source follower – Gain and frequency response

Unit-IV MULTISTAGE AMPLIFIERS AND DIFFERENTIAL AMPLIFIER 9

BICMOS cascade amplifier, Differential amplifier – Common mode and Difference mode analysis – Single tuned amplifiers – Gain and frequency response – Neutralization methods, power amplifiers –Types (Qualitative analysis).

Unit-V FEEDBACK AMPLIFIERS AND OSCILLATORS 9

Advantages of negative feedback – voltage / current, series, Shunt feedback –positive feedback – Condition for oscillations, RC phase shift, Wien bridge, Hartley, Colpitts and Crystal oscillators

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Jacob. Millman, Christos C.Halkias	Electronic Devices and Circuits	Tata McGraw Hill	2012
2.	Sedha.R.S	A Text Book of Applied Electronics	Sultan Chand Publishers	2010

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	David A.Bell	Electronic Devices and Circuits	Prentice Hall of India Private Limited	2013
2.	Gupta.J.B	Electron Devices and Circuits	S.K.Kataria & Sons	2012
3.	Mathur.S.P, Kulshreshtha.D.C and Chanda.P.R	Electronic Devices – Applications and Integrated circuits	Umesh Publications	2010
4.	Malvino	Electronic Principles	Tata McGraw Hill	2010
5.	Boylestad & Nashelsky	Electronic Devices & Circuit Theory	Prentice Hall Of India (P) Ltd	2009

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23BMC06	BIOMATERIALS AND ARTIFICIAL ORGANS	L	T	P	C
		3	0	0	3

Course Objective:

- To learn characteristics and classification of Biomaterials.
- To understand different metals and ceramics used as biomaterials.
- To learn polymeric materials and combinations.
- To study about tissue replacement implants.
- To know artificial organ developed using these materials.

Course Outcomes:

23BMC06.CO1 Identify types of Biomaterials and its properties.

23BMC06.CO2 Interpret different metals and ceramics used as implants.

23BMC06.CO3 Interpret the polymeric materials and combinations.

23BMC06.CO4 Recognize materials that could be used as tissue replacements.

23BMC06.CO5 ;cuss the artificial organ development.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BMC06.CO1	X	X	X	-	-	-	-	-	-	-	-	X	X	X	-
23BMC06.CO2	X	X	X	-	-	X	X	-	-	-	-	X	X	X	-
23BMC06.CO3	X	X	X	-	-	X	X	-	-	-	-	X	X	X	-
23BMC06.CO4	X	X	X	X	-	X	X	-	-	-	-	X	X	X	-
23BMC06.CO5	X	X	X	X	-	X	X	-	-	X	-	X	X	X	-

Unit-I STRUCTURE OF BIO-MATERIALS 9

Definition and classification of bio-materials, mechanical properties, visco-elasticity, wound healing process, body response to implants, blood compatibility

Unit-II IMPLANT MATERIALS 9

Metallic implant materials, stainless steels, co-based alloys, Ti-based alloys, ceramic implant materials, aluminum oxides, hydroxyl-apatite glass ceramics carbons, medical applications

Unit-III POLYMERIC MATERIALS 9

Polymerization, polyamides, Acryrilic polymers, rubbers, high strength thermoplastics, medical applications. Bio polymers: Collagen and Elastin

Unit-IV TISSUE REPLACEMENT MATERIALS 9

Soft-tissue replacements, sutures, surgical tapes, adhesive, Percutaneous and skin implants, maxillofacial augmentation, blood interfacing implants, hard tissue replacement implants, internal fracture fixation devices, joint replacements.

Unit-V ARTIFICIAL ORGANS 9

Artificial Heart, Prosthetic Cardiac Valves, Artificial lung (oxygenator), Artificial Kidney (Dialyser membrane), Dental Implants – Artificial limb & hand. Ethical, Environmental and Safety issues in the implantation of artificial organs.

Total Periods: 45

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Sujata V. Bhatt	Biomaterials Second Edition	Narosa Publishing House	2005
2.	JoonB.Park Joseph D. Bronzino	Biomaterials - Principles and Applications	CRC Press	2003
3.	Park J.B	Biomaterials Science and Engineering	Plenum Press	1984
4.	Myer Kutz	Standard Handbook of Biomedical Engineering & Design	McGraw-Hill	2003
5.	John Enderle, Joseph D. Bronzino, Susan M. Blanchard	Introduction to Biomedical Engineering	Elsevier	2005

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23BMC07	BIOMEDICAL INSTRUMENTATION - I	L	T	P	C
		3	0	0	3

Course Objective:

- To understand the importance of electrical safety and metrology of medical Equipment.
- To familiarize the operating principles of a wide range of biomedical equipments.
- To gain the knowledge and functionality of medical equipment used in Neonatology and drug delivery.
- To perceive the governing principles and functions of respiratory equipment and ventilators.
- To comprehend the principles of anaesthesia machine and sterilization equipment.

Course Outcomes:

23BMC07.CO1	Identify the electrical safety aspects and measurement errors in medical equipment.
23BMC07.CO2	Assess the need and operating principle of equipment used in surgery, physiotherapy and audiometry.
23BMC07.CO3	Demonstrate the functionality of medical equipment used in Neonatology and drug delivery.
23BMC07.CO4	Handle the respiratory equipment and ventilators.
23BMC07.CO5	Demonstrate the principles of anesthesia machine and sterilization equipment.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BMC07.CO1	X	-	-	X	X	X	X	X	-	-	-	X	X	X	-
23BMC07.CO2	X	-	-	X	X	X	X	X	-	-	-	X	X	X	-
23BMC07.CO3	X	-	-	X	X	X	X	X	-	-	-	X	X	X	-
23BMC07.CO4	X	-	-	X	X	X	X	X	-	-	-	X	X	X	-
23BMC07.CO5	X	-	-	X	X	X	X	X	-	-	-	X	X	X	-

Unit-I General Metrology **9**

Global metrology scenario, Measurement units, Measurement standards, Measurement traceability. Measurement Units: Base SI units, Derived SI units, SI multipliers and conversions, Fundamental constants, Common measurements. Electrical Safety: physiological effects of electricity, macro-shock and micro-shock hazards, electrical safety codes and standards, electrical safety analyzers, testing the electrical systems, Electrical safety analyzer.

Unit-II Electrosurgical Equipment **9**

ESU, principles of cutting and coagulation, spark gap, valve and solid state generators, safety features. Physiotherapy Equipment-Short Wave, Microwave and Ultrasound Diathermy, Audiometry: Common tests and procedures, audiometer

Unit-III Neonatal instrumentation **9**

Incubators, baby warmers, apnea monitor, calibration of warmers, and phototherapy devices. Drug delivery systems: Infusion pumps, components of drug infusion system, syringe pump, peristaltic pump, Implantable infusion system, closed loop control in infusion systems, examples of typical infusion pumps, Insulin pumps, Calibration of infusion systems

Unit-IV Respiratory measurements **9**

Principles and techniques of impedance Pneumography and pneumotachograph. Ventilators: Artificial

Ventilation, Types of ventilators, Modern Ventilators, High frequency Ventilators, Humidifiers, Nebulizers and Aspirators, calibration of a ventilator

Unit-V General anesthesia **9**

Medical gases and vacuum systems, Humidification, patient breathing circuit, ventilator & scavenging system, monitoring system, capnography, anesthesia equipment. Boyle's apparatus, Block diagram & principle of operation. Liquid medical –O2 systems, vaporizers, Theatre sterility practices, CSSD equipment.

Total Periods: 45

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	R.S.Khandpur	Hand Book of Bio-Medical instrumentation	Tata McGraw Hill Publishing Co Ltd	2004
2.	Leslie Cromwell, Fred J.Weibell, Erich A.Pfeiffer	Bio-Medical Instrumentation and Measurements	Pearson Education	2nd Edition, 2002
3.	M.Arumugam	Bio-Medical Instrumentation	Anuradha Agencies	2003
4.	L.A. Geddes and L.E.Baker	Principles of Applied Bio-Medical Instrumentation	John Wiley & Sons	1975
5.	J.Webster	Medical Instrumentation	John Wiley & Sons	1995

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23BMC08	FUNDAMENTALS OF BIOCHEMISTRY	L	T	P	C
		3	0	0	3

Course Objective:

- To introduce the relevance of this course to the existing technology through demonstrations, case studies, simulations, contributions of scientist, national/international policies with a futuristic vision along with socio-economic impact and issues
- To get a clear idea of biomolecules and their functions.
- To know the significance of biomolecules in biological systems.
- To understand the metabolic pathways in normal and pathological conditions.
- To introduce the relevance of this course to the existing technology through demonstrations, case studies, simulations, contributions of scientist, national/international policies with a futuristic vision along with socio-economic impact and issues

Course Outcomes:

23BMC08.CO1 Describe the surface properties involved in biological systems.

23BMC08.CO2 Explain about bio molecules such as Carbohydrates, Lipids, Nucleic Acid & Protein

23BMC08.CO3 Explain functions of bio molecules

23BMC08.CO4 Assess the significance of biomolecules in biological systems.

23BMC08.CO5 Analyze the etiology and biological parameters in metabolic diseases.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BMC08.CO1	X	X	X	-	X	-	X	-	-	X	-	X	X	-	-
23BMC08.CO2	X	X	X	X	X	-	X	-	-	X	-	X	X	-	-
23BMC08.CO3	X	X	X	X	X	-	X	-	-	X	-	X	X	-	-
23BMC08.CO4	X	X	X	X	X	-	X	-	-	-	-	X	X	-	-
23BMC08.CO5	X	X	X	X	X	-	X	-	-	-	-	X	X	-	-

Unit-I Introduction to Biochemistry **9**

Introduction to Biochemistry, water as a biological solvent, weak acid and bases, pH, buffers, Handerson – Hasselbalch equation, physiological buffers in living systems, Energy in living organism. Properties of water and their applications in biological systems. Introduction to Biomolecules, Biological membrane, Clinical application of Electrolytes and radioisotopes

Unit-II Carbohydrates **9**

Classification of carbohydrates – mono, di, oligo and polysaccharides. Structure, physical and chemical properties of carbohydrates Isomerism, racemisation and mutarotation. Digestion and absorption of carbohydrates. Metabolic pathways and bioenergetics – Glycolysis, glycogenesis, glycogenolysis and its hormonal regulation. TCA cycle and electron transport chain. Oxidative phosphorylation. Biochemical aspect of Diabetes mellitus and Glycogen storage Disease.

Unit-III Lipids **9**

Classification of lipids- simple, compound and derived lipids. Nomenclature of fatty acid, physical and chemical properties of fat..Metabolic pathways: synthesis and degradation of fatty acid (beta oxidation), hormonal regulation of fatty acid metabolism, ketogenesis, Biosynthesis of Cholesterol. Disorders of lipid metabolism.

Unit-IV Nucleic Acid & Protein **9**

Structure of purines and pyrimidines, nucleoside, nucleotide, DNA act as a genetic material, chargoffs rule. Watson and crick model of DNA. Structure of RNA and its type. Metabolism and Disorder of purines and pyrimidines nucleotide Classification, structure and properties of proteins, structural organization of proteins,

classification and properties of amino acids. Separation of protein, Inborn Metabolic error of amino acid metabolism.

Unit-V Enzyme and its Clinical Application 9

Classification of enzymes, apoenzyme, coenzyme, holoenzyme and cofactors. Kinetics of enzymes – Michaelis-Menten equation.Factors affecting enzymatic activity: temperature, pH, substrate concentration and enzyme concentration. Inhibitors of enzyme action: Competitive, non- competitive, irreversible. Enzyme: Mode of action, allosteric and covalent regulation. Clinical enzymology. Measurement of enzyme activity and interpretation of units.

Total Periods: 45

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Rafi MD	Text book of biochemistry for Medical Student	Second Edition, University Press	2014
2.	David.W.Martin, Peter.A.Mayes , Victor. W.Rodwell,.	Harper's Review of Biochemistry	LANGE Medical Publications	1981
3.	Keith Wilson & John Walke	Practical Biochemistry – Principles & Technique	Oxford University Press	2009
4.	Pamela.C.Champe & Richard.A.Harvey	Lippincott Biochemistry	Lippincott's Illustrated Reviews, Raven publishers	1994

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23BMC09	CONTROL SYSTEM FOR BIOMEDICAL ENGINEERING	L	T	P	C
		3	0	0	3

Course Objective:

- To analyze electromechanical systems using mathematical modeling.
- To determine transient and steady state behavior of systems using standard test signals.
- To discuss the linear systems for steady state errors, absolute stability and relative stability.
- To design a stable control system satisfying requirements of stability and reduced steady state error.
  - To elaborate the concepts of modern control theory using state-space approach

Course Outcomes:

23BMC09.CO1	Analyze electromechanical systems using mathematical modeling.
23BMC09.CO2	Determine Transient and Steady State behavior of systems using standard test signals.
23BMC09.CO3	Discuss the linear systems for steady state errors, absolute stability and relative stability.
23BMC09.CO4	Design a stable control system satisfying requirements of stability and reduced steady state error.
23BMC09.CO5	Elaborate the concepts of modern control theory using state-space approach.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BMC09.CO1	X	X	X	X	X	-	-	-	-	-	-	X	X	-	X
23BMC09.CO2	X	X	X	X	X	-	-	-	-	-	-	X	X	-	X
23BMC09.CO3	X	X	X	X	X	-	-	-	-	-	-	X	X	-	X
23BMC09.CO4	X	X	X	X	X	-	-	-	-	-	-	X	X	-	X
23BMC09.CO5	X	X	X	X	X	-	-	-	-	-	-	X	X	-	X

Unit-I CONTROL SYSTEM MODELING 9

Basic elements in control systems-Open and closed loop systems- Transfer function- Mechanical systems & Differential governing equation - Modeling of Electrical systems- Electrical analogy of mechanical systems & Thermal system - Block diagram reduction techniques-Signal flow graphs.

Unit-II TIME RESPONSE ANALYSIS 9

Introduction to time response analysis - First Order Systems - Impulse and Step Response analysis of second order systems- P, PI, PD and PID controllers - Steady state errors - P, PI, PD and PID Compensation - Analysis using MATLAB

Unit-III FREQUENCY RESPONSE ANALYSIS 9

Introduction to frequency response - Bode plot - Polar plot - Nyquist stability - Frequency Domain specifications from the plots - Constant M and N Circles - Nichols chart - Use of Nichol's Chart in Control System Analysis.

Unit-IV STABILITY ANALYSIS 9

Introduction to stability - Routh Hurwitz criterion. - Root Locus Technique - Construction of Root Locus & its Stability - Dominant Poles - Application of Root Locus Diagram - Nyquist stability criterion - Relative Stability - Analysis using MATLAB.

Unit-V STATE VARIABLE ANALYSIS AND BIOMEDICAL APPLICATIONS 9

State models for linear and time invariant Systems – State equations - Transfer function from State Variable Representation - Solutions of the state equations - Concepts of Controllability and Observability - Sampling Theorem - Sampler & Hold - Open loop & Closed loop sampled data systems - Lung mechanics model with proportional control

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	M. Gopal	Control Systems Principles and Design	Tata McGraw Hill, New Delhi	4th Edition, 2012
2.	K. Ogata	Modern Control Engineering	Prentice Hall of India	5th Edition 2012

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Arthur, G.O.Mutambara	Design and Analysis of Control Systems	CRC Press	2009
2.	Richard C. Dorf and Robert H. Bishop	Modern Control Systems	Pearson Prentice Hall	2012
3.	Benjamin C. Kuo	Automatic Control systems	Pearson Prentice Hall	2010
4.	Arthur, G.O.Mutambara	Design and Analysis of Control Systems	CRC Press	2009
5.	Richard C. Dorf and Robert H. Bishop	Modern Control Systems	Pearson Prentice Hall	2012

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23BMC10	ANALOG AND DIGITAL INTEGRATED CIRCUITS	L	T	P	C
		3	0	0	3

Course Objective:

- To study the characteristics of basic electronic devices and amplifier circuits.
- To study the characteristics of operational amplifiers and its applications.
- To understand the logic gates and combinational logic circuits.
- To understand the flipflops and sequential logic circuits
- To study the principle of data converters.

Course Outcomes:

23BMC10.CO1 Apply basic electronic devices and amplifier circuits.

23BMC10.CO2 Apply operational amplifiers.

23BMC10.CO3 Apply number systems and design combinational logic circuits.

23BMC10.CO4 Apply flipflops and design sequential logic circuits

23BMC10.CO5 Apply the principle of data converters.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BMC10.CO1	X	X	X	X	X	-	-	-	-	-	-	X	X	X	-
23BMC10.CO2	X	X	X	X	X	-	-	-	-	-	-	X	X	X	-
23BMC10.CO3	X	X	X	X	X	-	-	-	-	-	-	X	X	X	-
23BMC10.CO4	X	X	X	X	X	-	-	-	-	-	-	X	X	X	-
23BMC10.CO5	X	X	X	X	X	-	-	-	-	-	-	X	X	X	-

Unit-I Diode Circuits **9**

P-N junction diode, I-V characteristics of a diode; review of half-wave and full-wave rectifiers, clamping and clipping circuits. Input output characteristics of BJT in CB, CE, CC configurations, biasing circuits, Load line analysis, common-emitter, common-base and common collector amplifiers; Small signal equivalent circuits.

Unit-II Introduction to Operational amplifier and its Applications **9**

Operational amplifier -Ideal Characteristics, Performance Parameters, Linear and Nonlinear Circuits and Their Analysis- Voltage Follower, Inverting Amplifier, Noninverting Amplifiers, Differentiator, Integrator, Voltage To Current Converter, Instrumentation Amplifier, Low Pass, High Pass Filter and Band Pass Filters, Comparator, Multivibrator and Schmitt Trigger, Triangular Wave Generator

Unit-III The Basic Gates and Combinational Logic Circuits **9**

Number Systems – Decimal, Binary, Octal, Hexadecimal, 1″s and 2″s complements, Codes -Binary, BCD, Excess 3, Gray, Boolean theorems, Logic gates, Universal gates, Sum of products and product of sums, Minterms and Maxterms, Karnaugh map and Tabulation methods. Logic families- TTL, MOS, CMOS, BiCMOS -Comparison of Logic families.

Unit-IV Sequential Logic Circuits **9**

Flip flops – SR, JK, T, D, Master/Slave FF, Triggering of FF, Analysis and design of clocked sequential circuits – state minimization, state assignment, circuit implementation. Counters, Ripple Counters, Ring Counters. Types of Registers, Serial In – Serial Out, Serial In – Parallel out, Parallel In -Serial Out, Parallel In – Parallel Out, Universal Shift Register

Unit-V Data Converters **9**

Introduction, Basic DAC techniques, Different types of DACs-Weighted resistor DAC, R-2R ladder DAC, Different Types of ADCs - Parallel Comparator Type ADC, Counter Type ADC, Successive Approximation ADC and Dual Slope ADC.

Total Periods: 45

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Sergio Franco	Design with operational amplifiers and analog integrated circuits	3rd Edition, Tata McGraw-Hill	2007
2.	D.Roy Choudhry, Shail Jain	Linear Integrated Circuits	New Age International Pvt. Ltd	2000
3.	Ramakant A.Gayakwad	OP-AMP and Linear IC's	Prentice Hall of India	2002

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23BMC11	BIOMEDICAL INSTRUMENTATION - II	L	T	P	C
		3	0	0	3

Course Objective:

- To understand the need for several assist devices in the ICU.
- To understand the operating principles of a wide range of Biomedical Equipments.

Course Outcomes:

23BMC11.CO1 Demonstrate the cardiac assist devices and ICU layout.

23BMC11.CO2 Assess use of electrical stimulation principles to overcome cardiac rhythm disturbances.

23BMC11.CO3 Enumerate various defibrillators along with their working principles.

23BMC11.CO4 Perceive the governing principles of oxygenators and ophthalmic instruments.

23BMC11.CO5 Comprehend the principles of hemodialysis machine and lithotripter.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BMC11.CO1	X	X	X	X	-	X	-	-	-	X	-	X	X	X	X
23BMC11.CO2	X	X	X	X	-	X	-	-	-	X	-	X	X	X	X
23BMC11.CO3	X	X	X	X	-	X	-	-	-	X	-	X	X	X	X
23BMC11.CO4	X	X	X	X	-	X	-	-	-	X	-	X	X	X	X
23BMC11.CO5	X	X	X	X	-	X	-	-	-	X	-	X	X	X	X

Unit-I Critical physiological parameters **9**

Critical physiological parameters to be monitored. Intensive coronary care unit layout. Assist devices of the heart: Principles of external counter pulsation techniques. Intra-aortic Balloon pump.Prosthetic heart valves, Mechanical and tissue Valves. Types of mechanical valves: Ball and Cage, tilting disc and Bileaflet valves. Types of tissue valves: Homografts or Allografts (human cadaver) and Heterografts or Xenografts (Porcine or Bovine), Testing of prosthetic heart valves.

Unit-II Cardiac Pacemakers **9**

Need for a Pacemaker, Types-Asynchronous, Synchronous, External and implantable. Asynchronous pacemakers: Working principle, block diagram. Synchronous/Demand Pacemaker: Modes of triggering-ventricular triggered and atrio-ventricular synchronized pacemaker, Programmable pacemaker, Implantable Pacemaker: Technical and qualitative requirements of power supplies, lead wires and electrodes, packaging. Microprocessor based implantable pacemaker, Rate responsive pacemaker.

Unit-III Defibrillators **9**

Sinusoidal Steady – State analysis , Characteristics of Sinusoids, The Complex Forcing Function, The Phasor, Phasor relationship for R, L, and C, impedance and Admittance, Nodal and Mesh Analysis, Phasor Diagrams, AC Circuit Power Analysis, Instantaneous Power, Average Power, apparent Power and Power Factor, Complex Power.

Unit-IV Heart lung Machine **9**

Governing principles, Qualitative requirements, Functional details of Bubble, Thin Film and membrane-type of blood oxygenators. Ophthalmic Instruments - Intraocular Pressure Measurement, Contacting and Non-Contacting types, Refractometer, Ophthalmoscope, Retinoscope, Keratometer

Unit-V Haemodialyzer **9**

Artificial Kidney, Dialyzers, Membranes for Haemodialysis, Haemodialysis Machine, Monitoring circuits for hemodialysis machine, Portable Kidney Machines. Lithotriptors: Principles and Applications, Need for

Lithotriptor, First Lithotriptor Machine, Modern Lithotriptor Systems, Extra-corporeal shock-wave Therapy.

Total Periods: 45

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	R.S.Khandpur	Hand Book of Bio-Medical instrumentation	Tata McGraw Hill Publishing Co Ltd	2004
2.	Leslie Cromwell, Fred J.Weibell, Erich A.Pfeiffer	Bio-Medical Instrumentation and Measurements	Pearson Education	2nd Edition, 2002
3.	M.Arumugam	Bio-Medical Instrumentation	Anuradha Agencies	2003.
4.	L.A. Geddes and L.E.Baker	Principles of Applied Bio-Medical Instrumentation	John Wiley & Sons	1975
5.	J.Webster	Medical Instrumentation	John Wiley & Sons	1995

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23BMC12	MEDICAL SIGNAL PROCESSING	L	T	P	C
		3	0	0	3

Course Objective:

- To study about the adaptive filters and their analysis.
- To understand the Data Compression Techniques.
- To understand the Cardio-logical Signal Processing.
- To learn the Neurological signal processing.
- To study the sleeping modes of EEG.

Course Outcomes:

23BMC12.CO1 Identify filter for the ECG analysis.

23BMC12.CO2 Write the types of algorithm for data compression.

23BMC12.CO3 Analyze ECG signal and their parameters estimations.

23BMC12.CO4 Analyze EEG and estimate their parameters.

23BMC12.CO5 Analyze the sleeping modes of EEG.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BMC12.CO1	X	X	X	X	X	X	-	-	-	-	-	X	X	X	X
23BMC12.CO2	X	X	X	X	X	X	-	-	-	-	-	X	X	X	X
23BMC12.CO3	X	X	X	X	X	X	-	-	-	-	-	X	X	X	X
23BMC12.CO4	X	X	X	X	X	X	-	-	-	-	-	X	X	X	X
23BMC12.CO5	X	X	X	X	X	X	-	-	-	-	-	X	X	X	X

Unit-I Adaptive filters **9**

Introduction, Principle of an adaptive filter, the steepest descent algorithm, adaptive noise canceller, cancellation of interference in electrocardiography, applications of adaptive filters. Canceling Donor heart Adaptive filters, high frequency noise in ECG, motion artifact in ECG, cancellation of ECG signal from the electrical activity of the chest muscles, cancellation of high frequency noise in Electro-surgery.

Unit-II Data Compression Techniques **9**

Introduction, Loss and Lossless data reduction Algorithms. ECG data compression using Turning point, AZTEC, FAN coding techniques

Unit-III Cardio-logical Signal Processing **9**

Introduction, ECG Parameters and their estimations: ECG QRS Detection techniques, estimation of R-R interval, estimation of ST segment inclination, Rhythm analysis, arrhythmia analysis monitoring, and long term continuous ECG recording

Unit-IV Neurological signal processing **9**

Introduction, Linear prediction theory, the Autoregressive (AR) method, Recursive estimation of AR parameters, Spectral error measure, Adaptive segmentation, EEG Transient detection and elimination in epileptic patients and its overall performance

Unit-V Sleep EEG **9**

Introduction, Data acquisition and classification of sleep stages, The Markov model and Markov chains, Dynamics of sleep-wake transitions, Hypnogram model parameters, Event history analysis for modeling sleep.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	D.C.Reddy	Biomedical Signal Processing- principles and techniques	Tata McGraw-Hill	2005
2.	Rangaraj M. Rangayyan	Biomedical Signal Analysis	IEEE Press	2001

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Willis J.Tompkins	Biomedical Digital Signal Processing	PHI	Latest Edition
2.	Akay.M	Biomedical Signal Processing	Academic: Press	1994

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23BMC13	MICROPROCESSORS AND MICROCONTROLLERS IN MEDICINE	L	T	P	C
		3	0	0	3

Course Objective:

- To learn the fundamental concepts of 8086 microprocessors.
- To learn the fundamental concepts of 8051 microcontroller.
- To gain knowledge on I/O devices and its interfacing.
- To familiarize the architecture and programming of ARM microcontroller.
- To acquire knowledge on applications of microprocessor and microcontroller in biomedical domain

Course Outcomes:

23BMC13.CO1 Interpret the architecture of 8086 microprocessors and able to write programs.

23BMC13.CO2 Interpret the architecture of 8051 microcontroller and able to write programs.

23BMC13.CO3 Interface I/O devices with microcontrollers.

23BMC13.CO4 Interpret the architecture of ARM microcontroller and able to write programs.

23BMC13.CO5 Design microprocessor and microcontroller based system using biomedical signals.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BMC13.CO1	X	X	X	X	X	-	-	X	-	-	-	X	X	-	-
23BMC13.CO2	X	X	X	X	X	-	-	X	-	-	-	X	X	-	-
23BMC13.CO3	X	X	X	X	X	-	-	X	-	-	-	X	X	-	-
23BMC13.CO4	X	X	X	X	X	-	-	X	-	-	-	X	X	-	-
23BMC13.CO5	X	X	X	X	X	X	-	X	-	-	-	X	X	X	X

Unit-I Overview of 8086 Microprocessor **9**

Evolution of Microprocessor and its importance in biomedical domain, Architecture and signal description of 8086, Minimum and maximum mode, addressing modes, Instruction set, Programs.

Unit-II 8051 Microcontroller **9**

Introduction to 8 bit microcontroller, signal descriptions of 8051-Architecture of 8051-Register set of 8051-Instruction set-Addressing mode

Unit-III Interfacing Devices **9**

Timer-serial communication-interrupts programming - Interfacing to external memory- Basic techniques for reading & writing from I/O port pins- Interfacing 8051 to ADC-Liquid crystal display (LCD), keyboard-Stepper motor.

Unit-IV Arm Microcontroller **9**

Fundamentals: registers, current program status register - Pipeline, exceptions- Interrupts and vector table-ARM architecture - ARM instruction set, thumb instruction set

Unit-V Application in Medicine **9**

Mobile phone based bio signal recording - Design of pulse oximeter circuit using ARM microcontroller- Design of EOG based home appliances using PIC microcontroller - Design of heart rate monitoring circuit using ARM Microcontroller

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	A.K.Ray, K.M.Bhurchandi	Advanced Microprocessor and Peripherals	Tata McGraw-Hill	3rd Edition, 2013
2.	Douglas V. Hall	Microprocessor and Interfacing: Programming and Hardware	Glencoe	2nd Edition, 2006

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Andrew N.Sloss, Donimic Symes, Chris Wright	ARM System Developer's Guide	Elsevier	1st edition, 2007
2.	Muhammad Ali Mazidi and Janica Gilli Mazidi	The 8051 microcontroller and embedded systems'	Pearson Education	5th Indian reprint, 2003

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23BMC14	PATHOLOGY AND MICROBIOLOGY	L	T	P	C
		3	0	0	3

Course Objective:

- To gain a knowledge on the structural and functional aspects of living organisms.
- To understand the Fluid and Hemodynamic Derangements.
- To study and understand about various micro organisms.
- To study about Microscopes and its usage.
- To learn about Antibodies and its types

Course Outcomes:

23BMC14.CO1 Analyze structural and functional aspects of living organisms.

23BMC14.CO2 Apply the Fluid and Hemodynamic Derangements.

23BMC14.CO3 Identify various micro organisms.

23BMC14.CO4 Prepare samples and use Microscopes.

23BMC14.CO5 Identify antibodies and its types.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BMC14.CO1	X	X	X	X	X	-	-	-	-	-	-	X	X	X	-
23BMC14.CO2	X	X	X	X	X	-	-	-	-	-	-	X	X	X	-
23BMC14.CO3	X	X	X	X	X	-	-	-	-	-	-	X	X	X	-
23BMC14.CO4	X	X	X	X	X	-	-	-	-	-	-	X	X	X	-
23BMC14.CO5	X	X	X	X	X	-	-	-	-	-	-	X	X	X	-

Unit-I Cell Degeneration, Repair and Neoplasia **9**

Cell injury - Reversible cell injury and Irreversible cell injury and Necrosis, Apoptosis, Intracellular accumulations, Pathological calcification- Dystrophic and Metastatic. cellular adaptations of growth and differentiation, Inflammation and Repair including fracture healing, Neoplasia, Classification, Benign and Malignant tumours, carcinogenesis, spread of tumours Autopsy and biopsy

Unit-II Fluid and Hemodynamic Derangements **9**

Edema, Hyperemia/Ischemia, normal hemostasis, thrombosis, disseminated intravascular coagulation, embolism, infarction, shock, Chronic venous congestion. Hematological disorders-Bleeding disorders, Leukaemias, Lymphomas Haemorrhage

Unit-III Microbiology **9**

Structure of Bacteria and Virus. Routes of infection and spread; endogenous and exogenous infections, Morphological features and structural organization of bacteria and virus, growth curve, identification of bacteria, culture media and its types, culture techniques and observation of culture. Disease caused by bacteria, fungi, protozoal, virus and helminthes

Unit-IV Microscopes **9**

Light microscope – bright field, dark field, phase contrast, fluorescence, Electron microscope (TEM & SEM). Preparation of samples for electron microscope. Staining methods – simple, gram staining and AFB staining

Unit-V Immunopathology **9**

Natural and artificial immunity, types of Hypersensitivity, antibody and cell mediated tissue injury: opsonization, phagocytosis, inflammation, Secondary immunodeficiency including HIV infection. Auto-immune disorders: Basic concepts and classification, SLE. Antibodies and its types, antigen and antibody reactions, immunological

techniques: immune diffusion, immuno electrophoresis, RIA and ELISA, monoclonal antibodies

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Ramzi S Cotran, Vinay Kumar & Stanley L Robbins	Pathologic Basis of Diseases	WB Saunders Co.	7th Edition, 2005
2.	Ananthanarayanan & Panicker	Microbiology	Orient Blackswan	10th Edition, 2017

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Underwood JCE	General and Systematic Pathology	Churchill Livingstone	3rd Edition, 2000
2.	Dubey RC and Maheswari DK.	A Text Book of Microbiology	Chand Company Ltd.	2007
3.	Prescott, Harley and Klein	Microbiology	McGraw Hill	10th edition, 2017
4.	Jens Rietdorf	Microscopy Techniques	Springer	2005
5.	Parker, George	Immunopathology in Toxicology and Drug Development: Volume 2, Organ Systems	Humana Press	2017

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23BMC15	EMBEDDED SYSTEMS AND IOMT	L	T	P	C
		3	0	0	3

Course Objective:

- Acquire knowledge and understand fundamental embedded systems design paradigms, architectures, possibilities, and challenges, both with respect to software and hardware.
- Understand the hardware architecture and features of embedded microcontrollers and peripherals.
- Understand programming aspects of embedded system design.
- Understand IoT architecture and Build simple IoT Systems using embedded target boards.
    - Understand IoMT infrastructure for healthcare applications

Course Outcomes:

23BMC15.CO1	Explain fundamental embedded systems design paradigms, architectures, possibilities, and challenges, both with respect to software and hardware.
23BMC15.CO2	Describe the hardware architecture and features of embedded microcontrollers and peripherals.
23BMC15.CO3	Explain software design tools and embedded system design programming phases.
23BMC15.CO4	Describe IoT Architectures and Build simple IoT Systems using embedded target boards.
23BMC15.CO5	Exhibit understanding of IoMT infrastructure for healthcare applications.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BMC15.CO1	X	X	X	-	-	-	-	-	X	X	-	X	X	-	X
23BMC15.CO2	X	X	X	-	-	X	-	-	X	X	-	X	X	-	X
23BMC15.CO3	X	X	X	-	-	X	-	-	X	X	-	X	X	-	X
23BMC15.CO4	X	X	X	-	-	X	-	-	X	X	-	X	X	-	X
23BMC15.CO5	X	X	X	-	-	X	-	-	X	X	-	X	X	-	X

Unit-I INTRODUCTION TO EMBEDDED SYSTEM DESIGN 9

Introduction to embedded processors- Application Areas- Categories of embedded processors- Challenges in Embedded System Design, Design Process- Requirements- Specifications- Hardware architecture- Software architecture-Introduction to Harvard & Von Neuman architectures- CISC & RISC Architectures. CPU Bus- Bus Protocols- Bus Organisation, Memory Devices, and their Characteristics- RAM, EEPROM-Flash Memory- DRAM. BIOS, POST, Device Drivers

Unit-II PERIPHERAL INTERFACING 9

I/O Devices-Timers and Counters- Watchdog Timers, Interrupt Controllers- A/D and D/A, Interfacing- Memory interfacing with a case study- I/O Device Interfacing with case Study- Programmed IO-Memory Mapped IO, Interfacing Protocols-SPI, I2C, USB, CAN, Ethernet/WiFi, Bluetooth

Unit-III EMBEDDED SYSTEM SOFTWARE DESIGN 9

Application Software, System Software, Design techniques – State diagrams, sequence diagrams, flowcharts, etc., Model-based system engineering (MBSE), Use of High-Level Languages-embedded C / C++ Programming, Integrated Development Environment tools- Editor- Compiler- Linker- Automatic Code Generators- Debugger- Board Support Library- Chip Support Library, Analysis and Optimization-Execution Time- Energy & Power.

Unit-IV DESIGN AND DEVELOPMENT OF IOT 9

Definition and characteristics of IoT, Technical Building blocks of IoT, Communication Technologies, Physical design of IoT - system building blocks - sensors and sensor Node and interfacing using any Embedded target boards (Raspberry Pi / Intel Galileo/ARM Cortex/ Arduino), Benefits and impact of IoMT. Cybersecurity – vulnerability, penetration & encryption technologies

Unit-V INTERNET OF MEDICAL THINGS 9

Case studies – Novel Symmetrical Uncertainty Measure (NSUM) Technique for Diabetes Patients, Healthcare Monitoring system through Cyber-physical system, An loT Model for Neuro sensors, AdaBoost with feature selection using loT for somatic mutations evaluation in Cancer, A Fuzzy- Based expert System to diagnose Alzheimer's Disease, Secured architecture for loT enabled Personalized Healthcare Systems, Healthcare Application Development in Mobile and Cloud Environments

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	James K Peckol, John Weily	Embedded Systems – A Contemporary Design Tool	ISBN: 0- 444-51616-6	2008
2.	David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry	loT Fundamentals: Networking Technologies, Protocols and Use Cases for lnternet of Things	Cisco Press	2017
3.	Venkata Krishna, Sasikumar Gurumoorthy, Mohammad S. Obaidat	lnternet of Things and Personalized Healthcare Systems	Springer Briefs in Applied Sciences, and Technology, Forensic and Medical Bioinformatics	2019

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Shibu K V	Introduction to Embedded Systems	Tata McGraw Hill Education Private Limited	2009
2.	David E.Simon	Embedded Software Primer	Addison Wesley, ISBN-13: 978-0201615692	
3.	Barry B.Brey	The Intel Microprocessors, Architecture, Programming and Interfacing,	Pearson Education	6th Edition
4.	Arshdeep Bahga, Vijay Madisetti,	lnternet of Things – A hands-on approach	Universities Press	2015
5.	Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds)	Architecting the Internet of Things	Springer	2011

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23BMC16	MEDICAL IMAGING TECHNIQUES	L	T	P	C
		3	0	0	3

Course Objective:

- To familiarize the students with various medical imaging modalities.
- To understand the principles, detectors and operating procedures of X-ray, CT, MRI, ultrasound, PET and SPECT.
- To learn the advantages, disadvantages and hazards of various medical imaging equipment

Course Outcomes:

23BMC16.CO1	Interpret the working principle, operating procedure and applications of X-ray equipment.
23BMC16.CO2	Understand the image reconstruction techniques and applications of CT.
23BMC16.CO3	Summarize the image acquisition and reconstruction techniques in MRI.
23BMC16.CO4	Comprehend the working principle, modes and medical applications of ultrasound imaging.
23BMC16.CO5	Examine the operation and applications of PET, SPECT and radio nuclide instrumentation.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BMC16.CO1	X	-	-	-	-	X	X	X	X	X	-	X	X	X	X
23BMC16.CO2	X	-	-	-	-	X	X	X	X	X	-	X	X	X	X
23BMC16.CO3	X	X	-	-	-	X	X	X	X	X	-	X	X	X	X
23BMC16.CO4	X	X	-	-	-	X	X	X	X	X	-	X	X	X	X
23BMC16.CO5	X	X	-	-	-	X	X	X	X	X	-	X	X	X	X

Unit-I X Ray Imaging **9**

Electromagnetic spectrum, Production of X-rays, X-ray tubes- Stationary and Rotating Anode types, Block diagram of an X-Ray Machine, Collimators and Grids, Timing and Exposure controls. X-Ray Image visualization- Films, Fluorescent screens, Image Intensifiers. Dental X-Ray machines, Portable and mobile X-Ray units, Mammographic X-Ray equipment, Digital Radiography and flat panel detectors. Radiation safety, ALARA principle, Dose units and dose limits, Radiation dosimeters and detectors.

Unit-II Computed Tomography **9**

Basic principles, CT number scale, CT Generations. Major sub systems- Scanning system, processing unit, viewing unit, storage unit. Need and Principle of sectional imaging, 2D image reconstruction techniques - Iteration and Fourier methods. Applications of CT - Angio, Osteo, Dental, Perfusion (Body & Neuro), Virtual Endoscopy, Coronary Angiography.

Unit-III Magnetic Resonance Imaging **9**

Principles of NMR imaging systems, Image reconstruction techniques-Relaxation processes, imaging/ pulse sequences. Sub systems of an NMR imaging system, NMR detection system, types of coils, biological effects and advantages of NMR imaging. Functional MRI - The BOLD effect, intra and extra vascular field offsets, source of T2* effects, Creating BOLD contrast sequence optimization sources and dependences of physiological noise in fMRI

Unit-IV Ultrasound Imaging **9**

Principles of image formation -Imaging principles and instrumentation of A-mode, B-Mode, Gating Mode, Transmission mode and M-mode. Basics of multi-element linear array scanners, Digital scan conversion. Doppler Ultrasound and Colour Doppler imaging, Image artifacts, Biological effects, Ultrasound applications in diagnosis, therapy and surgery.

Unit-V Nuclear Medicine **9**

Radioisotopes in medical diagnosis, Basic instrumentation- Radiation detectors, Pulse height analyzer, Rectilinear scanner, Gamma camera. Emission Computed Tomography (ECT), Principle and instrumentation of Single Photon Emission Computed Tomography (SPECT) and Positron Emission Tomography (PET). Comparison of SPECT, PET and combined PET/ X-ray CT

Total Periods: 45

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	K.Kirk shung, Michael B.Smith Benjamin Tsui	Principles of Medical Imaging	Academic Press, New York	2010
2.	Khandpur R.S.	Handbook of Biomedical Instrumentation	Tata McGraw-Hill, New Delhi	3rd edition, 2014
3.	John G. Webster	Medical Instrumentation Application and Design	Wiley India Pvt. Ltd, New Delhi	4th edition , 2015
4.	Joseph J. Carr John M. Brown	Introduction to Biomedical Equipment Technology	Pearson Education	2004

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23BMC17	MEDICAL IMAGE PROCESSING	L	T	P	C
		3	0	0	3

Course Objective:

- Learn digital image fundamentals.
- Be exposed to simple image processing techniques.
- Be familiar with image compression and segmentation techniques.
- To learn Wavelets and Image compression
- Learn to represent image in form of features

Course Outcomes:

23BMC17.CO1 Describe Digital image fundamentals and Image transforms.

23BMC17.CO2 Apply Image enhancement Techniques.

23BMC17.CO3 Apply Image Restoration and Segmentation methods.

23BMC17.CO4 Analyze Wavelets and Image compression Techniques.

23BMC17.CO5 Apply Image Representation and Recognition Methods.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BMC17.CO1	X	X	X	X	-	-	X	-	X	X	X	X	X	X	X
23BMC17.CO2	X	X	X	X	-	-	X	-	X	-	X	X	X	X	X
23BMC17.CO3	X	X	X	X	-	-	X	-	X	-	X	X	X	X	X
23BMC17.CO4	X	X	X	X	-	-	X	-	X	-	X	X	X	X	X
23BMC17.CO5	X	X	X	X	-	-	X	-	X	-	X	X	X	X	X

Unit-I DIGITAL IMAGE FUNDAMENTALS 9

Introduction – Origin – Steps in Digital Image Processing – Components – Elements of Visual Perception – Image Sensing and Acquisition – Image Sampling and Quantization – Relationships between pixels – color Coordinate Systems –RGB, HSI, L*a*b* and Color conversion, Image Transforms, Introduction to Fourier Transform, 2D DFT, DCT, Hadamard, Haar, KL Transform.

Unit-II IMAGE ENHANCEMENT 9

Spatial Domain: Gray level transformations – Contrast Stretching, Digital Negative, Intensity level Slicing, Bit Extraction ,log transformation, Histogram processing , Equalization and Specification, of Spatial Filtering– Smoothing- Smoothing linear filters, Non linear filters, Sharpening Spatial Filtering –Foundation, the Laplacian, Unsharp Masking and High boost filtering, Frequency Domain: Smoothing and Sharpening frequency domain filters – Ideal, Butterworth, Gaussian filters and Homomorphic filtering

Unit-III IMAGE RESTORATION AND SEGMENTATION 9

Image Restoration :Noise models, Degradation model , Algebraic approach to Restoration – Mean Filters – Order Statistics – Adaptive filters – Band reject Filters – Band pass Filters – Notch Filters – Optimum Notch Filtering – Inverse Filtering, Least Mean Square Filtering, Constrained Least Squares Restoration– Wiener filtering Segmentation: Detection of Discontinuities: Lines and Edges –Edge Linking, Hough Transform and Boundary detection – Region based segmentation- Morphological processing- erosion, dilation, Opening Image Restoration: Noise models, and Closing

Unit-IV WAVELETS AND IMAGE COMPRESSION 9

Wavelets – Sub band coding - Multiresolution expansions - Compression: Fundamentals – Image Compression models – Error Free Compression – Variable Length Coding, LZW, Bit-Plane Coding, Lossless Predictive Coding – Lossy Compression, Lossy Predictive Coding – Compression Standards: JPEG, MPEG, Basics of Vector quantization

Unit-V IMAGE REPRESENTATION AND RECOGNITION 9

Boundary representation – Chain Code – Polygonal approximation, signature, boundary segments – Boundary description – Shape number – Fourier Descriptor, moments- Regional Descriptors –Topological feature, Texture - Patterns and Pattern classes - Recognition based on decision –theoretic methods: Matching, optimum statically classifiers and Neural network

Total Periods: 45

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	R.C. Gonzalez & R.E. Woods	Digital Image Processing	Pearson education	2nd Edition, 2015
2.	A K Jain	Fundamentals of Digital Image Processing	Pearson	2nd Edition, 2013
3.	Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins	Digital Image Processing Using MATLAB	McGraw Hill	2011
4.	Anil Jain K	Fundamentals of Digital Image Processing	PHI	2011
5.	R.C. Gonzalez & R.E. Woods	Digital Image Processing	Pearson education	2nd Edition, 2015

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23BMC18	ANALYTICAL & DIAGNOSTIC EQUIPMENTS	L	T	P	C
		3	0	0	3

Course Objective:

- Familiarize the working of Analytical equipments and use.
- Gain knowledge about measurements of parameters related to respiratory system
- Understand different types and uses of diathermy units.
- Know the principles of ultrasound and its use in diagnosis
- Know the application of robotics in medicine.

Course Outcomes:

23BMC18.CO1	Explain the working of Analytical equipments and use.
23BMC18.CO2	Explain about measurements of parameters related to respiratory system.
23BMC18.CO3	Analyze different types of diathermy units.
23BMC18.CO4	Understand the principle of ultrasound equipments.
23BMC18.CO5	Understand the application of robotics in medicine.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BMC18.CO1	X	-	-	-	-	X	X	X	X	X	-	X	X	X	X
23BMC18.CO2	X	-	-	-	-	X	X	X	X	X	-	X	X	X	X
23BMC18.CO3	X	X	-	-	-	X	X	X	X	X	-	X	X	X	X
23BMC18.CO4	X	X	-	-	-	X	X	X	X	X	-	X	X	X	X
23BMC18.CO5	X	X	-	-	-	X	X	X	X	X	-	X	X	X	X

Unit-I ANALYTICAL EQUIPMENTS 9

Analytical equipment used in the clinical environment Beer-Lambert's Law, Colorimeters, Spectrophotometers: Instrumentation – Filters-Monochromators - Detectors –UV & Visible, IR Spectrophotometer – Instrumentation-Radiation Source - Monochromators & Detectors-Applications, Electrolyte Analysers - Measurement methods - Ion selective electrode method (ISE)-Solid state ISE – Ion Selective Optodes, Lab On a Chip (LOC) biochemical sensor, Miniaturized Systems for BioChemical analysis and synthesis- glucometer - Point Of Care Test equipment (POCT).

Unit-II RESPIRATORY MEASUREMENT AND ASSIST SYSTEMS 9

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

Unit-III DIATHERMY 9

IR and UV lamp - application. Need for different diathermy units, Short wave diathermy, ultrasonic diathermy, Microwave diathermy. Electro surgery machine - Current waveforms, Tissue Responses, Electro surgical current level, Hazards and safety procedures

Unit-IV ULTRASOUND EQUIPMENT 9

Diagnosis: Tissue Reaction, Basic principles of Echo technique, display techniques A, B and M mode, B Scan, Application of ultrasound as diagnostic tool – Echocardiogram, Echoencephalogram, abdomen, obstetrics and gynecology, ophthalmology

Unit-V ROBOTICS IN MEDICINE 9

DaVinci Surgical System, Image guided robotic systems for focal ultrasound based surgical applications, System concept for robotic Tele-surgical system for off-pump CABG surgery, Urologic applications, Cardiac surgery, Neuro-surgery, Pediatric-, and General- Surgery, Gynecologic Surgery, General Surgery and Nano robotics

Total Periods: 45

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Albert M.Cook and Webster.J.G	Therapeutic Medical Devices	Prentice Hall Inc., New Jersey	1982
2.	Leslie Cromwell, Fred. J. Weibel, Erich.A.Pferffer	Biomedical Instrumentation and Measurements	Prentice Hall India, NewDelhi	2001
3.	Joseph .J.Carr and John .M.Brown	Introduction to Biomedical Equipment Technology	John Wiley&Sons Inc, New York	2002
4.	Khandpur R.S	Handbook of Biomedical Instrumentation	Tata McGraw Hill, New Delhi	3rd Edition, 2014

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23BMC19	BIOMECHANICS & REHABILITATION ENGINEERING	L	T	P	C
		3	0	0	3

Course Objective:

- To understand the biomechanics of human body.
- To understand the flow properties of blood and other fluids in the human body.
- To study various Principles of Rehabilitation Engineering.
- To understand different types of Therapeutic Exercise Techniques.
- To gain in-depth knowledge about different types of prosthetic devices and restoration techniques.

Course Outcomes:

23BMC19.CO1 Explain biomechanics of human body to competently analyze its movements.

23BMC19.CO2 Analyze the dynamics and flow properties of blood and other fluids in the human body.

23BMC19.CO3 ;cuss engineering concepts in sensory & motor rehabilitation.

23BMC19.CO4 ply the different types of Therapeutic Exercise Techniques of rehabilitation.

23BMC19.CO5 :ntify different types of prosthetic devices and restoration techniques.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BMC19.CO1	X	X	X	X	-	-	-	-	-	X	-	X	X	X	X
23BMC19.CO2	X	X	X	X	-	-	-	-	-	-	-	X	X	X	X
23BMC19.CO3	X	X	X	X	-	X	X	-	-	X	-	X	X	X	X
23BMC19.CO4	X	X	X	X	-	X	X	X	-	-	-	X	X	X	X
23BMC19.CO5	X	X	X	X	-	X	X	X	-	-	-	X	X	X	X

Unit-I INTRODUCTION TO BIOMECHANICS 9

Biomechanics, Mechanics in Physiology Definition of Stress, Strain and Strain Rate, The Non viscous Fluid, Newtonian Viscous Fluid, The Hookean Elastic Solid, Viscoelasticity, Response of a Viscoelastic Body to Harmonic Excitation, Use of Viscoelastic Models, Methods of Testing

Unit-II THE FLOW PROPERTIES OF BLOOD 9

Blood rheology, the constitutive equation of blood based on viscometric Data and Casson's equation, Laminar flow of blood in tube, blood with viscosity described by Casson's equation. Bioviscoelastic fluids: Introduction, small deformation experiments, mucus from the respiratory tract, saliva, cervical mucus and semen, synovial fluid, flow properties of synovial fluid

Unit-III INTRODUCTION TO REHABILITATION 9

What is Rehabilitation, Epidemiology of Rehabilitation, Health, Levels of Prevention, Preventive Rehabilitation, Diagnosis of Disability, Functional Diagnosis, Importance of Psychiatry in Functional diagnosis, Impairment disability handicap, Primary & secondary Disabilities.

Unit-IV REHABILITATION TEAM & THERAPEUTIC EXERCISE TECHNIQUE 9

Rehabilitation team Classification of members, The Role of Psychiatrist, Occupational therapist, Physical therapist, Recreation therapist, Prosthetist - Orthotist, Speech pathologist, Rehabilitation nurse, Social worker, Corrective therapist, Psychologist, Music therapist, Dance therapist & Biomedical engineer, Co-ordination exercises, Frenkels exercises, Gait analyses-Pathological Gaits, Gait Training, Relaxation exercises-Methods for training Relaxation, Strengthening exercises-Strength training, Types of Contraction, Mobilization exercises, Endurance exercises

Unit-V ORTHOTIC, PROSTHETIC DEVICES & RESTORATION TECHNIQUES 9

General orthotics, Classification of orthotics-functional & regional, General principles of Orthosis, Calipers- FO, AFO, KAFO, HKAFO. Prosthetic devices: Hand and arm replacement, Body powered prosthetics, Myo-electric controlled prosthetics and externally powered limb prosthetics. Functional Electrical Stimulation systems- Restoration of hand function, restoration of standing and walking, Hybrid Assistive Systems (HAS).

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Y.C.Fung	Biomechanics- Mechanical Properties of Living tissues	Springer Verlag	2nd Edition
2.	Sunder	Textbook of Rehabilitation	Jaypee Brothers Medical Publishers Pvt. Ltd, New Delhi	2nd Edition, 2007

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Schneck and Bronzino	Biomechanics principles and applications	CRC	2003
2.	Keswick. J	What is Rehabilitation Engineering, Annual Reviews of Rehabilitation	Springer	1982
3.	Warren E. Finn,Peter G. LoPresti	Handbook of Neuroprosthetic Methods	CRC	2002
4.	Rory A Cooper Hisaichi Ohnabe Douglas A. Hobson	An Introduction to Rehabilitation Engineering	CRC	2006

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23BMC21	DEVICES AND CIRCUITS LABORATORY	L	T	P	C
		0	0	2	1

Course Objective:

- To supplement the theory courses Electronic Devices and Circuit theory.
- To assist the students in obtaining a better understanding of the operation of electronic circuits and devices.
- To provide experience in analyzing network theorems.

Course Outcomes:

23BMC21.CO1	Experiment and determine the VI characteristics of given PN junction diode, Zener diode, Photo diode and Silicon Controlled Rectifier.
23BMC21.CO2	Experiment and determine the Input & output characteristics of BJT
23BMC21.CO3	Experiment and test half wave and full wave rectifier circuit using PN Junction diode and obtain the ripple factor, rectifier efficiency and experiment and test voltage regulation characteristics using Zener diode voltage regulator circuit.
23BMC21.CO4	Experiment and test the given electric circuit using Kirchhoff's laws and obtain the mesh current & node voltage and obtain the load current for the given circuit using Superposition, Thevenin's, and Norton's and Reciprocity theorems.
23BMC21.CO5	Construct and test RLC series and parallel circuits to compute the resonant frequency and bandwidth by plotting the frequency response.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BMC21.CO1	X	X	X	X	X	-	-	-	X	X	-	-	X	X	X
23BMC21.CO2	X	X	X	X	X	-	-	-	X	X	-	-	X	X	X
23BMC21.CO3	X	X	X	X	X	-	-	-	X	X	-	-	X	X	X
23BMC21.CO4	X	X	X	X	X	-	-	-	X	X	-	-	X	X	X
23BMC21.CO5	X	X	X	X	X	-	-	-	X	X	-	-	X	X	X

Sl.No.	List of Experiments
1.	Characteristics of PN and Zener diode.
2.	Characteristics of CE, CB configurations.
3.	Half wave and Full wave rectifier with capacitor filter.
4.	Voltage regulation using Zener diode.
5.	Study of characteristics of photo diodes
6.	Study of characteristics of SCR
7.	Verification of KVL and KCL
8.	Verification of Thevenin's and Norton's Theorems.
9.	Verification of superposition Theorem.

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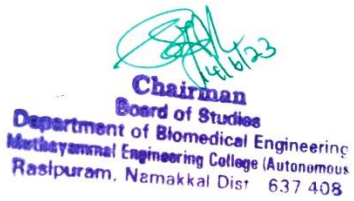
10. Verification of Maximum power transfer and reciprocity theorems.
11. Frequency response of RLC series and parallel resonance circuits.
12. Miniproject.

Total Periods:30



23BMC22	SENSORS AND MEASUREMENTS LABORATORY	L	T	P	C
		0	0	2	1

Course Objective:

- To introduce the relevance of this course to the existing technology through demonstrations, case studies, simulations, contributions of scientist, national/international policies with a futuristic vision along with socio-economic impact and issues.
- To study the characteristics of sensors, signal conditioning circuits and display devices.

Course Outcomes:

23BMC22.CO1 Understand the characteristics and calibration of various transducers.

23BMC22.CO2 Develop bridge circuits to find unknown variables.

23BMC22.CO3 Design and analyze filter characteristics.

23BMC22.CO4 Understand various read out and display devices.

23BMC22.CO5 Design measurement system for various applications.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BMC22.CO1	X	X	X	X	-	X	-	-	X	X	X	X	X	X	X
23BMC22.CO2	X	X	X	X	-	X	-	-	X	X	X	X	X	X	X
23BMC22.CO3	X	X	X	X	-	X	-	-	X	X	X	X	X	X	X
23BMC22.CO4	X	X	X	X	-	X	-	-	X	X	X	X	X	X	X
23BMC22.CO5	X	X	X	X	-	X	-	-	X	X	X	X	X	X	X

Sl.No.	List of Experiments
1	Characteristics of strain gauges.
2	Displacement measurement using LVDT & LVRT
3	Characteristics of temperature sensor-thermistor
4	Characteristics of temperature sensor-RTD.
5	Characteristics of thermocouple
6	Characteristics of Light sensors-LDR, Photo Diode, Photo Transistor.
7	Characteristics of Piezoelectric Transducer.
8	Wheatstone Bridge and Kelvins Bridge for Measurement of Resistance.
9	Measurement of capacitance using bridge circuits.
10	Measurement of inductance using bridge circuits.
11	Characteristics of passive filters.
12	Force measurement using force sensor and calibration.

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13 Study of Multimeter and Medical Oscilloscope.

14 Study of Input / Output characteristics using X – Y oscilloscope.

15 Miniproject.

Total Periods: 30

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23BMC23	ANALOG AND DIGITAL INTEGRATED CIRCUITS LABORATORY	L	T	P	C
		0	0	2	1

Course Objective:

- To design digital logic and circuits.
- To learn the function of different ICs.
- To understand the applications of operation amplifier.
- To learn the working of multivibrators.
- To design circuits for generating waveforms using ICs.

Course Outcomes:

23BMC23.CO1	Design and implement arithmetic circuits for different applications using opamp.
23BMC23.CO2	Design Combinational Circuits using logic gates.
23BMC23.CO3	Design Sequential Circuits using logic gates.
23BMC23.CO4	Design filters and oscillators and analyze their characteristics.
23BMC23.CO5	Simulate and analyze circuits using ICs.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BMC23.CO1	X	X	X	X	-	X	-	-	X	X	X	X	X	X	X
23BMC23.CO2	X	X	X	X	-	X	-	-	X	X	X	X	X	X	X
23BMC23.CO3	X	X	X	X	-	X	-	-	X	X	X	X	X	X	X
23BMC23.CO4	X	X	X	X	-	X	-	-	X	X	X	X	X	X	X
23BMC23.CO5	X	X	X	X	-	X	-	-	X	X	X	X	X	X	X

Sl.No.	List of Experiments
1	Inverting, non-inverting amplifier and comparator
2	Integrator and Differentiator
3	First order Low Pass and High Pass Active filters
4	Phase shift Oscillators and Wein bridge oscillators
5	Instrumentation amplifier using operational amplifier
6	Monostable and Astable Multivibrator using NE555 Timer
7	Code converters.
8	Multiplexers & demultiplexer
9	4-Bit shift registers using flip flops
10	Simulation and analysis of circuits using software.
11	Miniproject.

Total Periods: 30

BIOCHEMISTRY AND HUMAN PHYSIOLOGY LABORATORY

23BMC24	L	T	P	C
	0	0	2	1

Course Objective:

To provide practice on

- Estimation and quantification of biomolecules.
- Separation of macromolecules.
- Interpreting the metabolic changes in pathological conditions

Course Outcomes:

23BMC24.CO1	Use basic laboratory skills and apparatus to obtain reproducible data from biochemical experiments.
23BMC24.CO2	Separate and analyze the importance of macromolecules.
23BMC24.CO3	Discuss the various blood parameters in pathological conditions.
23BMC24.CO4	Analyze, interpret and report the results of the laboratory experiments.
23BMC24.CO5	Implement experimental protocols to plan and carry out simple investigations.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BMC24.CO1	X	X	X	X	-	X	-	-	X	X	X	X	X	X	X
23BMC24.CO2	X	X	X	X	-	X	-	-	X	X	X	X	X	X	X
23BMC24.CO3	X	X	X	X	-	X	-	-	X	X	X	X	X	X	X
23BMC24.CO4	X	X	X	X	-	X	-	-	X	X	X	X	X	X	X
23BMC24.CO5	X	X	X	X	-	X	-	-	X	X	X	X	X	X	X

Sl.No.	List of Experiments
1	General guidelines for working and functional component of biochemistry lab
2	Preparation of solutions: 1) percentage solutions, 2) molar solutions, 3) normal solutions
3	Standardization of pH meter, preparation of buffers, emulsions.
4	Spectroscopy: Determination of absorption maxima (λmax) of a given solution
5	General tests for carbohydrates, proteins and lipids.
6	Identification of Blood Collection Tubes and Phlebotomy equipments
7	Preparation of serum and plasma from blood.
8	Estimation of Hemoglobin
9	Estimation of blood glucose.
10	Estimation of creatinine.
11	Estimation of urea.

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12 Estimation of Uric acid
13 Estimation of cholesterol
14 Assay of SGOT/SGPT.
15 ELISA test
16 Separation of proteins by SDS electrophoresis (Demo)
17 Separation of amino acids by thin layer chromatography (Demo).
18 Miniproject.

Total Periods: 30

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23BMC25	BIOMEDICAL INSTRUMENTATION LABORATORY	L	T	P	C
		0	0	2	1

Course Objective:

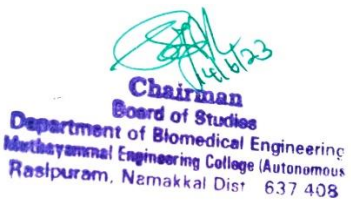
- To study and design Bio amplifiers.
- To provide hands on training on Measurement of physiological parameters.

Course Outcomes:

23BMC25.CO1	Design and analyze the amplifier for Bio signal measurements.
23BMC25.CO2	Measure heart rate and heart sounds.
23BMC25.CO3	Record and analyze pulse rate and respiration rate.
23BMC25.CO4	Measure blood pressure and blood flow.
23BMC25.CO5	Interpret electrical safety measurements.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO 1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BMC25.CO1	X	X	X	X	X	X	-	-	-	-	-	X	X	X	X
23BMC25.CO2	X	X	X	X	X	X	-	-	X	X	-	X	X	X	X
23BMC25.CO3	X	X	X	X	X	X	-	-	X	X	-	X	X	X	X
23BMC25.CO4	X	X	X	X	X	X	-	-	X	X	-	X	X	X	X
23BMC25.CO5	X	X	X	X	X	X	-	-	X	X	-	X	X	X	X

Sl.No.	List of Experiments
1	Simulation of ECG – detection of QRS complex and heart rate
2	Study of biotelemetry
3	Electrical safety measurements.
4	Measurement of Respiratory parameters using spirometry.
5	Study of medical stimulator.
6	Study of ESU – cutting and coagulation modes
7	Measurement and Recording of Hearing threshold using Audiometer and plot its characteristics.
8	Design and Analysis of ECG, EEG,EMG amplifier, recording and analysis using Lab View
9	Measurement of Blood Pressure using Sphygmomanometer & Digital meter.
10	Recording of Electromyogram/ nerve conduction velocity.
11	The Galvanic Skin Response Amplifier
12	Study of lung and cardiovascular models



13	Hospital department facility layout for installation and maintenance of biomedical equipment/systems in reference to regulatory guidelines.
14	Measurements using patient monitoring systems (BIOPAC).
15	Miniproject.

Total Periods: 30

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23BMC26	MEDICAL SIGNAL PROCESSING LABORATORY	L	T	P	C
		0	0	2	1

Course Objective:

- To implement generation of sequences
- To realize Linear and Circular Convolution
- To design and realize FIR and IIR filters
- To implement signal processing algorithms using digital signal processor

Course Outcomes:

23BMC26.CO1	Ability to comprehend and appreciate the significance and role of this course in the present contemporary world.
23BMC26.CO2	Carry out simulation of DSP systems.
23BMC26.CO3	Demonstrate their abilities towards DSP processor based implementation of DSP systems.
23BMC26.CO4	Analyze Finite word length effect on DSP systems.
23BMC26.CO5	Analyze various biomedical signals using DSP.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BMC26.CO1	X	X	X	X	X	X	-	-	-	-	-	X	X	X	X
23BMC26.CO2	X	X	X	X	X	X	-	-	X	X	-	X	X	X	X
23BMC26.CO3	X	X	X	X	X	X	-	-	X	X	-	X	X	X	X
23BMC26.CO4	X	X	X	X	X	X	-	-	X	X	-	X	X	X	X
23BMC26.CO5	X	X	X	X	X	X	-	-	X	X	-	X	X	X	X

Sl.No.	List of Experiments
1	Representation of basic discrete time signals.
2	Computation of convolution -linear convolution.
3	Response of a difference equation to initial conditions; stability.
4	DFT and FFT computation.
5	FIR filter design using windowing techniques
6	IIR filters design-digital Butterworth filter and Chebyshev filter
7	Simulation of Bio-signals.
8	Analysis of ECG signals.
9	Analysis of EEG signals
10	Analysis of EMG signals
11	Miniproject.

Total Periods: 30

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23BMC27	MICROPROCESSOR AND MICROCONTROLLER LABORATORY	L	T	P	C
		0	0	2	1

Course Objective:

- To introduce the relevance of this course to the existing technology through demonstrations, case studies, simulations, contributions of scientist, national/international policies with a futuristic vision along with socio-economic impact and issues
- To study introduce the programming language of 8085, 8086 and 805.
- To develop skill in program writing for microprocessors and controllers.

Course Outcomes:

23BMC27.CO1	Develop assembly language program for microprocessors.
23BMC27.CO2	Comprehend the architectural and pipelining concepts for Microprocessors.
23BMC27.CO3	Develop assembly language program for microcontrollers.
23BMC27.CO4	Comprehend the architectural and pipelining concepts for microcontrollers.
23BMC27.CO5	Develop assembly language program for ARM processor.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BMC27.CO1	X	X	X	-	-	-	-	-	-	-	-	X	X	-	X
23BMC27.CO2	X	X	X	-	-	-	-	-	-	-	-	X	X	-	-
23BMC27.CO3	X	X	X	-	-	-	-	-	-	-	-	X	X	-	X
23BMC27.CO4	X	X	X	-	-	-	-	-	-	-	-	X	X	-	-
23BMC27.CO5	X	X	X	-	-	-	-	-	-	-	-	X	X	-	X

Sl.No.	List of Experiments
1	Arithmetic operations using 8086 processor
2	Logic operations using 8086 processor
3	Sorting of numbers using 8086 processor
4	Searching of numbers in an array using 8086 processor
5	Palindrome and Fibonacci series using 8086 processor
6	Arithmetic operations using 8051 microcontroller
7	Logic operations using 8051 microcontroller
8	Sorting of numbers using 8051 microcontroller
9	Searching of numbers in an array using 8051 microcontroller
10	Palindrome and Fibonacci series using 8051 microcontroller
11	Basic programs using ARM controller
12	Miniproject.

Total Periods: 30

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23BMC28	MEDICAL IMAGE PROCESSING LABORATORY	L	T	P	C
		0	0	2	1

Course Objective:

- To study the various aspects of image processing techniques for medical images.

Course Outcomes:

23BMC28.CO1 Apply filtering techniques to medical images.

23BMC28.CO2 Apply segmentation techniques.

23BMC28.CO3 Perform Encryption in image.

23BMC28.CO4 Identify and perform feature extraction techniques.

23BMC28.CO5 Apply standards in Image storage and communication.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BMC28.CO1	X	X	X	X	X	-	-	-	X	X	X	X	X	X	X
23BMC28.CO2	X	X	X	X	X	-	-	-	X	X	X	X	X	X	X
23BMC28.CO3	X	X	X	X	X	-	-	-	X	X	X	X	X	X	X
23BMC28.CO4	X	X	X	X	X	-	-	-	X	X	X	X	X	X	X
23BMC28.CO5	X	X	X	X	X	-	-	-	X	X	X	X	X	X	X

Sl.No.	List of Experiments
1	Display of color and grayscale Images.
2	Conversion between color spaces
3	Histogram Equalization.
4	Spatial filtering
5	Non-linear Filtering.
6	Edge detection using Operators.
7	2-D DFT and DCT.
8	Filtering in frequency domain.
9	DWT of images.
10	Segmentation using watershed transform.
11	Steganography
12	Feature extraction in medical images.
13	Medical Image Compression techniques.
14	Medical image fusion
15	Study of DICOM standards.
16	Miniproject.

Total Periods: 30

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23BMC29	EMBEDDED SYSTEMS LABORATORY	L	T	P	C
		0	0	2	1

Course Objective:

- To introduce the relevance of this course to the existing technology through demonstrations, case studies, simulations, contributions of scientist, national/international policies with a futuristic vision along with socio-economic impact and issues
- To introduce microprocessor and microcontroller based system design.
- To impart knowledge on embedded S/W development.

Course Outcomes:

23BMC29.CO1	Interface peripherals and sensors in embedded systems.
23BMC29.CO2	Interface ADC and DAC in Embedded systems
23BMC29.CO3	Design microprocessor / microcontroller based realtime system.
23BMC29.CO4	Design, develop and trouble shoot microcontroller based system.
23BMC29.CO5	Interface peripherals and displays in embedded systems.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BMC29.CO1	X	X	X	-	-	-	-	-	X	X	X	X	X	X	X
23BMC29.CO2	X	X	X	-	-	-	-	-	X	X	X	X	X	X	X
23BMC29.CO3	X	X	X	X	-	-	-	-	X	X	X	X	X	X	X
23BMC29.CO4	X	X	X	X	-	-	-	-	X	X	X	X	X	X	X
23BMC29.CO5	X	X	X	-	-	-	-	-	X	X	X	X	X	X	X

Sl.No.	List of Experiments
1	Study of ARM Processor
2	Interface Switches and LEDs
3	Interface LCD
4	Interface 4X4 Matrix Keyboard
5	Interface Stepper Motor
6	Interface 7 Segment Display
7	Interfacing Analog to Digital Converter
8	Interface Digital to Analog Converter
9	Implementing Real Time Clock
10	Mini Project

Total Periods: 30

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23BME01	BASIC CLINICAL SCIENCES	L	T	P	C
		3	0	0	3

Course Objective:

- Know the kinds of renal failure and Haemodialysis types.
- Learn about Dialysing system components and Dialysate composition.
- Learn the components of Anesthesia system.
- Learn Anesthesia patient care.
- Study Anesthesia system maintenance.

Course Outcomes:

23BME01.CO1	Identify the kinds of renal failure and Haemodialysis types.
23BME01.CO2	Identify the dialysing system components and dialysate composition.
23BME01.CO3	Distinguish the components of Anesthesia system.
23BME01.CO4	Discuss the functioning of Anesthesia patient care systems.
23BME01.CO5	Examine Anesthesia system maintenance.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BME01.CO1	X	-	-	-	-	X	-	X	X	X	-	X	X	X	X
23BME01.CO2	X	-	-	-	-	X	-	X	X	X	-	X	X	X	X
23BME01.CO3	X	-	-	-	-	X	-	X	X	X	-	X	X	X	X
23BME01.CO4	X	-	-	-	-	X	-	X	X	X	-	X	X	X	X
23BME01.CO5	X	-	-	-	-	X	-	X	X	X	-	X	X	X	X

Unit-I Renal Failure and Haemodialysis types **9**

Laboratory evaluation of the kidney. Diagnostic application of Radio Nuclides in Renal Medicine. Acute Renal failure. Chronic Renal Failure. Haemodialysis, Acetate dialysis. Bicarbonate dialysis. Peritoneal dialysis. Chronic Ambulatory peritoneal dialysis. Haemoperfusion, sequential ultra-filtration. Haemofiltration, Adequacy of dialysis. Clearance, Dialysance.

Unit-II Dialysing system and Dialysate **9**

Components of dialysing system. Dialysate, composition of dialysate. Treatment of city water for Haemodialysis usage. Types of water purification systems. Water softeners. De-ionisers. Reverse osmosis. Renal transplantation. Basic Principles, Cadaver and donor types of transplantation, Tissue typing tests.

Unit-III Anesthesia systems **9**

General anesthesia. The uptake of anesthetic gases and vapours. Pre-anesthetic care and preparation. Clinical signs of anesthesia. Post-operative care. Laws of gases. Fires and Explosions. Recommendations for prevention. Anesthetic gases. Equipment. Components. Gas delivery systems. Testing Choice of anesthetic hypnosis. Electrical anesthesia. Regional Spinal. Care and sterilization of equipment. Patient monitoring during surgery-Invas---ive and non invasive. Organization of theaters.

Unit-IV Anesthesia Patient Care **9**

Hypoxia, Artificial respiration. Diagnostic and therapeutic indications. Study of ventilators. Humidifiers. Constant pressure and constant volume types. Selection Criteria. Premature baby incubators.

Unit-V Anesthesia system maintenance **9**

Gas pipe lines. Gas flow meters of various types. Boyles machine. Warning devices. Anesthesia circuits. Vaporizers. Principles of operation. Calibration. Repairs. Recalibration. Scavenging systems. Oxygen therapy and blood gas analysis. Measurement of Intra-vascular pressures. Blood flows. Plethysmography. Humidity and temperature measurements. Clinical significance.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Elaine.N. Marieb,	Essential of Human Anatomy and Physiology	Pearson Education New Delhi.	Eight edition, 2007
2.	Gillian Pocock, Christopher D. Richards	The Human Body An introduction for Biomedical and Health Sciences	Oxford University Press, USA	2009

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	William F. Ganong	Review of Medical Physiology	Mc Graw Hill, New Delhi	22nd edition
2.	Eldra Pearl Solomon	Introduction to Human Anatomy and Physiology	W.B.Saunders Company	2003
3.	Arthur C. Guyton	Text book of Medical Physiology	11 th Edition, Elsevier Saunders	11th Edition, 2006
4.	Juergen Mai George Paxinos	The Human nervous System	Academic Press 3rd Edition	2011
5.	Midthun Joseph	The Digestive and Urinary Systems	World Book, Inc	2011

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23BME02	BIOSTATISTICS	L	T	P	C
		3	0	0	3

Course Objective:

- To introduce the techniques used in statistical & regression analysis.
- To compare the various parameters used in statistical significance
- To interpret regression analysis
- To introduce data tables and community health
- To measure statistical and epidemiologic measures

Course Outcomes:

23BME02.CO1	Classify common statistical tests and tools.
23BME02.CO2	Distinguish between p-values and confidence intervals as measures of statistical significance.
23BME02.CO3	Interpret commonly used regression analysis.
23BME02.CO4	Explain the data tables and its interpretations in community health.
23BME02.CO5	Evaluate commonly used statistical and epidemiologic measures

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BME02.CO1	X	X	X	X	-	-	-	-	-	X	-	X	X	-	X
23BME02.CO2	X	X	X	X	-	-	-	-	-	X	-	X	X	-	X
23BME02.CO3	X	X	X	X	-	-	-	-	-	X	-	X	X	-	X
23BME02.CO4	X	X	X	X	-	-	-	-	-	X	-	X	X	-	X
23BME02.CO5	X	X	X	X	-	-	-	-	-	X	-	X	X	-	X

Unit-I INTRODUCTION **9**

Biostatistics - Statistical problems in Biomedical research– Basic concepts: Population, Samples and Variables - Basic probability, likelihood & odds, distribution variability.

Unit-II STATISTICAL PARAMETERS **9**

Statistical parameters p-values, computation and level chi square test and distribution.

Unit-III REGRESSION ANALYSIS **9**

Regression – Linear regression – Multiple linear regression – Multiple colinearity, Determining Best regression – Nonlinear regression – Logistic regression – Poison regression.

Unit-IV INTERPRETING DATA **9**

Life table: Interpreting life tables clinical trails, epidemical reading and interpreting of epidemical studies, application in community health.

Unit-V META ANALYSIS **9**

META analysis for research activities, purpose and reading of META analysis, Forest graph, Funnel plots, Radial plots, L'Abbe plots, Criticisms of Meta analysis.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Joseph A. Ingel finger, Frederick Mosteller, Lawrence A. Thibodeau, James H. Ware	Biostatistics in Clinical Medicine	Singapore	3rd Edition, 1994
2.	Gerald van Belle, Lloyd D. Fisher, Patrick J. Heagerty, Thomas Lumley	Biostatistics: A Methodology For the Health Sciences	John Wiley & Sons	2004

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Julien I.E. Hoffman	Biostatistics for Medical and Biomedical Practitioners	Elsevier Press	2015
2.	James F. Jekel	Epidemiology, Biostatistics, and Preventive Medicine	Elsevier Health Sciences	2007
3.	Ray M. Merrill	Fundamentals of Epidemiology and Biostatistics	Jones & Bartlett Learning	2013

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23BME03	MEDICAL SCIENCE	L	T	P	C
		3	0	0	3

Course Objective:

- To identify the various function and basics of tissues, cartilage propagation of action potential
- To identify the functional component and basics of Nervous system.
- To identify and understand complete cardiovascular system from blood vessel to parts of heart and also know about function of all parts of digestive system.
- To identify the function of all the parts of respiratory system
- To identify the various function and basics of tissues, cartilage propagation of action potential

Course Outcomes:

23BME03.CO1	Understand Essentials of structural and functional anatomy of the human body
23BME03.CO2	Understand Anatomy and physiology of human nervous system
23BME03.CO3	Understand Anatomy and physiology of cardiovascular system
23BME03.CO4	Understand Anatomy and physiology of digestive system
23BME03.CO5	Understand Anatomy and physiology of respiratory system

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BME03.CO1	X	X	X	-	-	-	-	-	-	-	-	X	X	-	-
23BME03.CO2	X	X	X	-	-	-	-	-	-	-	-	X	X	-	-
23BME03.CO3	X	X	X	-	-	-	-	-	-	-	-	X	X	-	-
23BME03.CO4	X	X	X	-	-	-	-	-	-	-	-	X	X	-	-
23BME03.CO5	X	X	X	-	-	-	-	-	-	-	-	X	X	-	-

Unit-I INTRODUCTION: HOMEOSTASIS, TISSUE, CARTILAGE **9**

The internal environment and homeostasis, movement of substances within the body, body fluids, action potential, propagation of action potential. Epithelial tissue- simple epithelium, stratified epithelium, connective tissue- cells of connective tissue, loose connective tissue, Adipose tissue, Dense connective tissue, Lymphoid tissue, Cartilage- Hyaline cartilage, Fibrocartilage, Elastic cartilage.

Unit-II NERVOUS SYSTEM **9**

Neurons: Properties of neurons, Cell bodies, Axon and Dendrites, Types of nerves, Synapse and neurotransmitters, neuromuscular junction. Central nervous system: neuroglia, meninges, ventricles of the brain and CSF. Brain: Cerebrum, functions of cerebrum, functional areas of the cerebrum. Brainstem: Cerebellum, Spinal cord- grey matter, white matter, motor nerve tracts, spinal nerves: nerve roots, plexuses, cranial nerves. Autonomic nervous system - functions and effects

Unit-III CARDIOVASCULAR SYSTEM **9**

Introduction, Blood vessels- Arteries and Arterioles, Veins and Venules, capillaries and sinusoids, control of blood vessel diameter, blood supply- internal respiration, cell nutrition. Heart- position, structure pericardium, myocardium, endocardium, interior of the heart, flow of blood through the heart, blood supply to heart, Conducting system of the heart, factors affecting heart rate, the Cardiac cycle, cardiac output, blood pressure, control of blood pressure, pulse and factors affecting the pulse rate. Circulation of the blood pulmonary circulation, systemic circulation, aorta, circulation of blood to head and neck, circulation of blood to upper limb,

portal circulation.

Unit-IV DIGESTIVE SYSTEM 9

Introduction, Organs of the digestive system- mouth: tongue, teeth, salivary glands, pharynx, oesophagus, stomach, gastric juice and functions of stomach- small intestine: structure, chemical digestion in small intestine, large intestine: structure, functions of the large intestine, rectum and anal canal. Pancreas, Liver.

Unit-V RESPIRATORY SYSTEM 9

Introduction, Nose and Nasal cavity- position, structure and functions, pharynx, position, structure, functions. Larynx: position, structure and functions. Trachea, bronchi, bronchioles and alveoli, lungs- position, associated structure, pleura and pleural cavity. Respiration- muscles of respiration cycle of respiration, variables affecting respiration, lung volumes and capacity.

Total Periods: 45

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Elaine.N. Marieb,	Essential of Human Anatomy and Physiology	Pearson Education NewDelhi,	Eighth edition, 2007
2.	Gillian Pocock, Christopher D. Richards	The Human Body An introduction for Biomedical and Health Sciences	Oxford University Press,USA	2009
3.	William F. Ganong	Review of Medical Physiology	Mc Graw Hill New Delhi	22nd edition
4.	Eldra Pearl Solomon	Introduction to Human Anatomy and Physiology	W.B.Saunders Company	2003

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23BME04	SPORTS PHYSICAL THERAPHY	L	T	P	C
		3	0	0	3

Course Objective:

- To study and understand the physiological basis of massage and its therapeutic applications.
- To study and understand the uses of various heat therapy.
- To study and understand the uses of various Hydrotherapy.
- To study and understand the effects of cryotherapy.
- To study and understand various Manual therapy.

Course Outcomes:

23BME04.CO1 Interpret the massage techniques for therapeutic uses.

23BME04.CO2 Interpret the use of various heat therapy.

23BME04.CO3 Interpret the use of various Hydrotherapy.

23BME04.CO4 Interpret the effects of cryotherapy.

23BME04.CO5 Interpret the various Manual therapy techniques.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BME04.CO1	X	X	X	-	-	-	-	-	-	-	-	X	X	-	-
23BME04.CO2	X	X	X	-	-	-	-	-	-	-	-	X	X	-	-
23BME04.CO3	X	X	X	-	-	-	-	-	-	-	-	X	X	-	-
23BME04.CO4	X	X	X	-	-	-	-	-	-	-	-	X	X	-	-
23BME04.CO5	X	X	X	-	-	-	-	-	-	-	-	X	X	-	-

Unit-I Massage **9**

Massage Historical development, Definition and classification of massage techniques, Physiological effects of massage, Description of the techniques of the classical massage. Connective tissue massage, physiological basis of sports massage and various categories, underwater massage, mechanical devices of massage, therapeutic applications and contraindications of massage.

Unit-II Heat Therapy **9**

Heat Therapy Production, Physiological effects, indications, contraindications and specific uses in sports of the following: Infrared rays, Parafin Wax Bath, Steam Bath, Sauna Bath, Moist Heat Pack, Fluidotherapy, Mud Bath and Pelloids.

Unit-III Hydrotherapy **9**

History & introduction, Effects of simple baths, raising temperature baths, baths with additives, Aromatic baths, Mineral baths, physical baths, Hydroelectric baths, Stammer baths, whirl pool bath, showers and steam showers.

Unit-IV Cryotherapy **9**

Physiological effects, Use of cold therapy in acute phase, rehabilitative phase, preventive phase of athletic injury, Methods of application, Indications and contraindications.

Unit-V Manual Therapy **9**

Introduction to manual therapy techniques, joint techniques, manual joint therapy, traction, basic principles of manipulation for various disorders of the spine and extremities. Clinical Reasoning and decision making.

Total Periods: 45

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Michel C Khoo	Physiological Control Systems -Analysis, simulation and estimation	Prentice Hall of India	2001
2.	David T. Westwick, Robert E. Kearney	Identification of Nonlinear Physiological Systems	Wiley-IEEE Press	2003
3.	V.Z. Marmarelis	Advanced methods of physiological modeling	Plenum Press	
4.	J. Candy	Signal Processing: The Model Based approach	Mc. Graw Hill	
5.	L.Stark,	Neurological Control System	Plenum Press	

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23BME05	TELEMEDICINE	L	T	P	C
		3	0	0	3

Course Objective:

- To learn the key principles for telemedicine and health.
- To study about electronic health recorders.
- To understand mobile health care technology.
- To know tele-medical standards, mobile telemedicine standards.
- To know tele-medical standards, mobile telemedicine and it applications

Course Outcomes:

23BME05.CO1	Apply multimedia technologies in telemedicine.
23BME05.CO2	Explain encryption techniques for secure transmission of data.
23BME05.CO3	Apply mobile-health in healthcare.
23BME05.CO4	Interpret tele-medical standards.
23BME05.CO5	Explain tele-medical Applications.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BME05.CO1	X	X	X	-	X	X	-	X	-	-	-	X	X	X	X
23BME05.CO2	X	X	X	-	-	-	-	-	-	X	-	X	X	-	-
23BME05.CO3	X	X	X	-	X	X	-	X	-	-	-	X	X	X	X
23BME05.CO4	X	X	X	-	X	X	-	X	-	-	-	X	X	X	X
23BME05.CO5	X	X	X	-	-	-	-	-	-	X	-	X	X	-	-

Unit-I INTRODUCTION **7**

Overview of Health Informatics, Healthcare Data, Information and Knowledge, Healthcare Data Analysis.

Unit-II ELECTRONIC HEALTH RECORDS **9**

Electronic Health Records, Health Information Exchange, Health Data Standards, Architectures of Information Systems, Consumer Health informatics.

Unit-III MOBILE HEALTH **9**

Mobile Technology and mHealth, Online Medical Resources, Medical Information Retrieval, Disease Management and Disease Registries, Telemedicine, Medical Imaging Informatics, Bioinformatics, Public Health Informatics.

Unit-IV TELEMEDICAL STANDARDS **11**

Data Security and Standards: Encryption, Cryptography, Mechanisms of encryption, phases of Encryption. Protocols: TCP/IP, ISO-OSI, Standards to followed DICOM, HL7, H. 320 series (Video phone based ISBN) T. 120, H.324 (Video phone based PSTN), Video Conferencing, 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-V TELEMEDICAL APPLICATIONS **9**

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

care, Business aspects - Project planning and costing, Usage of telemedicine.

Total Periods: 45

Reference Books:

S.No.	Author(s)	Title of the book	Publisher	Year of Publication
1.	Robert E. Hoyt and Ann K. Yoshihashi	Lasers and Optical Fibers in Medicine	Health Informatics: Practical Guide for Healthcare and Information Technology Professionals	Latest Edition
2.	Phillip Olla.	Mobile Health Solutions for Biomedical Applications	Hershey, Pa. : Information Science Reference	2009
3.	I stepanian, Robert, Laxminarayan, Swamy, Pattichis, Constantinos	M-Health- Emerging Mobile Health Systems	Springer Publications	2006
4.	Sasan Adibi	Mobile Health: A Technology Road Map	Springer Publications	Mar 2015
5.	Norris, A.C.	Essentials of Telemedicine and Telecare	Wiley	2002

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23BME06	BRAIN COMPUTER INTERFACE AND APPLICATIONS	L	T	P	C
		3	0	0	3

Course Objective:

- To understand the basic concepts of brain computer interface
- To study the various signal acquisition methods
- To study the signal processing methods used in BCI
- To learn about the real-time Medical Applications.

Course Outcomes:

23BME06.CO1	Describe BCI system and its potential applications.
23BME06.CO2	Analyze event related potentials and sensory motor rhythms.
23BME06.CO3	Compute features suitable for BCI.
23BME06.CO4	Design classifier for a BCI system.
23BME06.CO5	Implement BCI for various applications.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BME06.CO1	X	X	X	X	X	-	-	-	-	-	-	-	X	-	X
23BME06.CO2	X	X	X	X	X	-	-	-	-	-	-	-	X	-	X
23BME06.CO3	X	X	X	X	X	-	-	-	-	-	-	-	X	-	X
23BME06.CO4	X	X	X	X	X	-	-	-	-	-	-	-	X	-	X
23BME06.CO5	X	X	X	X	X	-	-	-	-	-	-	-	X	-	X

Unit-I INTRODUCTION TO BCI **9**

Fundamentals of BCI – Structure of BCI system – Classification of BCI – Invasive, Non-invasive and Partially invasive BCI – EEG signal acquisition - Signal Preprocessing – Artifacts removal.

Unit-II ELECTROPHYSIOLOGICAL SOURCES **9**

Sensorimotor activity – Mu rhythm, Movement Related Potentials – Slow Cortical Potentials-P300 - Visual Evoked Potential - Activity of Neural Cells - Multiple Neuromechanisms.

Unit-III FEATURE EXTRACTION METHODS **9**

Time/Space Methods – Fourier Transform, PSD – Wavelets – Parametric Methods – AR,MA,ARMA models – PCA – Linear and Non-Linear Features.

Unit-IV FEATURE TRANSLATION METHODS **9**

Linear Discriminant Analysis – Support Vector Machines - Regression – Vector Quantization– Gaussian Mixture Modeling – Hidden Markov Modeling – Neural Networks.

Unit-V APPLICATIONS OF BCI **9**

Functional restoration using Neuroprosthesis - Functional Electrical Stimulation, Visual Feedback and control - External device control, Case study: Brain actuated control of mobile Robot.

Total Periods: 45

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Bernhard Graimann Brendan Z. Allison GertPfurtscheller	Brain-Computer Interfaces: Revolutionizing Human-Computer Interaction	Springer	2010
2.	R. Spehlmann	EEG Primer	Elsevier Biomedical Press	1981
3.	Arnon Kohen	Biomedical Signal Processing	Vol I and II, CRC Press Inc., Boca Rato, Florida	1986
4.	Bishop C.M.	Neural Networks for Pattern Recognition	Oxford, Clarendon Press	1995

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23BME07	MEDICAL OPTICS	L	T	P	C
		3	0	0	3

Course Objective:

- Study the optical properties of the tissues and the interactions of light with tissues.
- Study the instrumentation and components in Medical Photonics.
- Study the Medical Lasers and their applications.
- Study the optical diagnostic applications.
- Study the emerging optical diagnostic and therapeutic techniques

Course Outcomes:

23BME07.CO1 Demonstrate knowledge of the fundamentals of optical properties of tissues.

23BME07.CO2 Analyze the components of instrumentation in Medical Photonics.

23BME07.CO3 Describe surgical applications of Medical lasers.

23BME07.CO4 Describe photonics and its diagnostic applications.

23BME07.CO5 Investigate emerging techniques in medical optics.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BME07.CO1	X	X	X	X	-	-	-	-	-	X	-	X	X	-	-
23BME07.CO2	X	X	X	X	-	X	-	-	-	-	-	X	X	-	-
23BME07.CO3	X	X	X	X	-	X	-	-	-	X	-	X	X	-	-
23BME07.CO4	X	X	X	X	-	X	-	-	-	X	-	X	X	-	-
23BME07.CO5	X	X	X	X	-	X	-	-	-	-	-	X	X	-	-

Unit-I OPTICAL PROPERTIES OF THE TISSUES 9

Fundamental Properties of light - Refraction, Reflection, Laws (Snell's law and Fresnel law) Scattering, Absorption, Light transport inside the tissue, Tissue properties, Laser Characteristics as applied to medicine and biology, Laser tissue Interactions – Photo chemical, Photo thermal and Photo mechanical interactions, Fluorescence, Speckles, Photo ablative processes.

Unit-II INSTRUMENTATION IN PHOTONICS 9

Instrumentation for absorption, Scattering and emission measurements, Excitation light sources – high pressure arc lamps, LEDs, Lasers, Optical filters – Prism and Mono-chromators, Polarizer's, Optical detectors – Single Channel and Multichannel detectors, Time resolved and phase resolved detection methods, Optical fibers – Total Internal Reflection.

Unit-III SURGICAL THERAPEUTIC APPLICATIONS OF LASERS 9

Lasers in ophthalmology, Dermatology, Dentistry, Urology, Otolaryngology, Tissue welding and Soldering.

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 applications of lasers in biology and medicine.

Unit-V DIAGNOSTIC AND THERAPEUTIC TECHNIQUES 9

Near field imaging of biological structures, In-vitro clinical diagnostics, Phototherapy, Photodynamic therapy (PDT) -Principles and mechanisms - Oncological and non-oncological applications of PDT – Bio-stimulation effect – applications - Laser Safety Procedures.

Total Periods: 45

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Tuan Vo Dirh	Biomedical Photonics	CRC Press	2014
2.	Paras N. Prasad	Introduction to Biophotonics	A. John Wiley and Sons, Inc. Publications	2003
3.	Markolf H.Niemz	Laser-Tissue Interaction Fundamentals and Applications	Springer	2007
4.	G.David Baxter	Therapeutic Lasers-Theory and practice	Churchill Livingstone publications	2001
5.	Leon Goldman, M.D.& R.James Rockwell	Lasers in Medicine	Gordon and Breach,	1975

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23BME08	MEDICAL INFORMATICS	L	T	P	C
		3	0	0	3

Course Objective:

- To teach ICT applications in medicine with an introduction to health informatics.
- To understand the theories and practices adopted in Hospital Information Systems in the light of medical standards, medical data formats and recent trends in Hospital Information Systems.

Course Outcomes:

23BME08.CO1	Explain health informatics and the function of Hospital Information Systems.
23BME08.CO2	Adopt medical standards in maintaining patient records.
23BME08.CO3	Discuss medical data acquisition and storage techniques in laboratories.
23BME08.CO4	Explain Public health informatics.
23BME08.CO5	Discuss the application of virtual reality and telehealth technology in medical industry

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BME08.CO1	X	-	-	X	X	-	-	X	-	X	-	X	X	X	X
23BME08.CO2	X	X	X	X	X	-	-	X	-	X	-	X	X	X	X
23BME08.CO3	X	X	X	X	X	-	-	X	-	X	-	X	X	X	X
23BME08.CO4	X	X	X	X	X	-	-	X	-	X	-	X	X	X	X
23BME08.CO5	X	X	X	X	X	-	-	X	-	X	-	X	X	X	X

Unit-I INTRODUCTION TO 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 Databases - 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 Periods: 45

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
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
3.	N.Mathivanan	PC-Based Instrumentation	Prentice Hall of India Pvt Ltd – New Delhi	2007
4.	Yi – Ping Phoebe Chen	Bioinformatics Technologies	Springer International Edition, New Delhi	2007

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23BME09	VIRTUAL REALITY	L	T	P	C
		3	0	0	3

Course Objective:

- To introduce the relevance of this course to the existing technology through demonstrations.
- To study the case studies and applications with a futuristic vision along with socio-economic impact and issues.
- To understand virtual reality and using it to build Biomedical engineering applications.
- To learn about the applications of VR in medical terms.

Course Outcomes:

23BME09.CO1	Analyze and Design a system or process to meet given specifications with realistic engineering constraints.
23BME09.CO2	Identify problem statements and function as a member of an engineering design team.
23BME09.CO3	Analyze the implications and issues pertaining to VR.
23BME09.CO4	Propose technical documents and give technical oral presentations related to design VR mini project results.
23BMC01.CO5	Develop simple and portable VR applications using appropriate software.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BME09.CO1	X	X	X	X	X	-	-	1	-	-	-	-	X	X	X
23BME09.CO2	X	X	X	X	X	-	-	1	-	-	-	-	X	X	X
23BME09.CO3	X	X	X	X	X	-	-	1	-	-	-	-	X	X	X
23BME09.CO4	X	X	X	X	X	-	-	1	-	-	-	-	X	X	X
23BMC01.CO5	X	X	X	X	X	-	-	1	-	-	-	-	X	X	X

Unit-I INTRODUCTION TO VIRTUAL REALITY 9

Virtual Reality and Virtual Environment: Introduction, Computer graphics, Real time computer graphics, Flight Simulation, Virtual environment requirement, benefits of virtual reality, Historical development of VR, Scientific Landmark.

Unit-II 3D COMPUTER GRAPHICS 9

Introduction, The Virtual world space, positioning the virtual observer, the perspective projection, human vision, stereo perspective projection, 3D clipping, Colour theory, Simple 3D modelling, Illumination models, Reflection models, Shading algorithms, Radiosity, Hidden Surface Removal, Realism-Stereographic image.

Unit-III VIRTUAL ENVIRONMENT 9

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

Unit-IV VR HARDWARE AND SOFTWARE 9

Human factors: Introduction, the eye, the ear, the somatic senses. VR Hardware: Introduction, sensor hardware, Head-coupled displays, Acoustic hardware, Integrated VR systems. VR Software: Introduction, Modelling virtual world, Physical simulation, VR toolkits, Introduction to VRML.

Unit-V APPLICATIONS 9

Use of Analysis Tools, Fourier transforms Power spectrum, Correlation methods, windowing & flittering.

Application of VR: Medical applications-military applications-robotics applications- Advanced Real time tracking other applications- simulations, therapy.

Total Periods: 45

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	John Vince	Virtual Reality Systems	Pearson Education Asia	2007
2.	Anand R	Augmented and Virtual Reality	Khanna Publishing House, Delhi	Latest Edition
3.	Adams	Visualizations of Virtual Reality	Tata McGraw Hill	2000
4.	Grigore C. Burdea, Philippe Coiffet	Virtual Reality Technology	Wiley Inter Science	2nd Edition,2006
5.	William R. Sherman, Alan B. Craig	Understanding Virtual Reality: Interface, Application and Design	Morgan Kaufmann	2008

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23BME10	WEARABLE SYSTEMS	L	T	P	C
		3	0	0	3

Course Objective:

- To study about need for wearable systems
- To gain knowledge about sensors in wearable systems.
- To acquaint with signal processing and wearability issues
- To handle with the energy harvesting for wearable devices
- Learn about applications of wearable systems.

Course Outcomes:

23BME10.CO1	Comprehend and appreciate the significance and role of this course in the present contemporary world
23BME10.CO2	Choose appropriate sensors and signal processing techniques for wearable systems
23BME10.CO3	Assess the energy requirement for a wearable system and analyse and experiment energy harvesting techniques for wearable systems
23BME10.CO4	Appreciate the need for BAN and the challenges involved in the design of BAN
23BME10.CO5	Design basic wearable systems for medical applications

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BME10.CO1	-	-	-	-		-	-	-	-	X	-	X	X	X	X
23BME10.CO2	-	-	-	-		X	X	X	X	X	-	X	X	X	X
23BME10.CO3	-	-	-	-	X	X	X	X	X	X	-	X	X	X	X
23BME10.CO4	-	-	-	-	X	X	X	X	X	X	X	X	X	X	X
23BME10.CO5	-	-	-	-	X	X	X	X	X	X	X	X	X	X	X

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 Periods: 45

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Annalisa Bonfiglio, Danilo De Rossi	Wearable Monitoring Systems	Springer	2011
2.	Sandeep K.S. Gupta,Tridib Mukherjee, Krishna Kumar, Venkatasubramanian	Body Area Networks Safety, Security, and Sustainability	Cambridge University Press	2013
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-Zhong Yang(Ed.)	Body Sensor Networks	Springer	2006

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23BME11	INTERNET OF THINGS	L	T	P	C
		3	0	0	3

Course Objective:

- To understand Smart Objects and IoT Architectures.
- To learn about various IOT-related protocols
- To build simple IoT Systems using Arduino and Raspberry Pi.
- To understand data analytics and cloud in the context of IoT
- To develop IoT infrastructure for popular applications

Course Outcomes:

23BME11.CO1	Explain the concept of IoT.
23BME11.CO2	Analyze various protocols for IoT.
23BME11.CO3	Design a PoC of an IoT system using Rasperry Pi/Arduino.
23BME11.CO4	Apply data analytics and use cloud offerings related to IoT.
23BME11.CO5	Analyze applications of IoT in real time scenario.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BME11.CO1	X	X	X	-	X	-	-	-	-	X	-	X	X	-	X
23BME11.CO2	X	X	X	-	X	-	-	-	-	X	-	X	X	-	X
23BME11.CO3	-	-	-	X	X	-	-	-	-	X	X	X	X	-	X
23BME11.CO4	-	-	-	X	X	X	X	X	-	X	X	X	X	-	X
23BME11.CO5	-	-	-	-	X	X	X	X	X	X	X	X	X	-	X

Unit-I FUNDAMENTALS OF IoT **9**

Evolution of Internet of Things - Enabling Technologies – IoT Architectures: oneM2M, IoT World Forum (IoTWF) and Alternative IoT models – Simplified IoT Architecture and Core IoT Functional Stack -– Fog, Edge and Cloud in IoT – Functional blocks of an IoT ecosystem – Sensors, Actuators, Smart Objects and Connecting Smart Objects.

Unit-II IoT PROTOCOLS **9**

IoT Access Technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4, 802.15.4g, 802.15.4e, 1901.2a, 802.11ah and LoRaWAN – Network Layer: IP versions, Constrained Nodes and Constrained Networks – Optimizing IP for IoT: From 6LoWPAN to 6Lo, Routing over Low Power and Lossy Networks – Application Transport Methods: Supervisory Control and Data Acquisition – Application Layer Protocols: CoAP and MQTT.

Unit-III DESIGN AND DEVELOPMENT **9**

Design Methodology - Embedded computing logic - Microcontroller, System on Chips - IoT system building blocks - Arduino - Board details, IDE programming - Raspberry Pi - Interfaces and Raspberry Pi with Python Programming.

Unit-IV DATA ANALYTICS AND SUPPORTING SERVICES **9**

Structured Vs Unstructured Data and Data in Motion Vs Data in Rest – Role of Machine Learning – No SQL Databases – Hadoop Ecosystem – Apache Kafka, Apache Spark – Edge Streaming Analytics and Network Analytics – Xively Cloud for IoT, Python Web Application Framework – Django – AWS for IoT – System Management with NETCONF-YANG.

Unit-V CASE STUDIES/INDUSTRIAL APPLICATIONS **9**

Cisco IoT system - IBM Watson IoT platform – Manufacturing - Converged Plantwide Ethernet Model (CPwE) – Power Utility Industry – GridBlocks Reference Model - Smart and Connected Cities: Layered architecture, Smart Lighting, Smart Parking Architecture and Smart Traffic Control

Total Periods: 45

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry	IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things	Cisco Press	2017
2.	Maciej Kranz	Building the Internet of Things: Implement New Business Models, Disrupt	John Wiley & Sons	Latest Edition
3.	Arshdeep Bahga, Vijay Madisetti	Internet of Things – A hands-on approach	Universities Press	2015
4.	Olivier Hersent, David Boswarthick, Omar Elloumi	The Internet of Things – Key applications and Protocols	Wiley	2012
5.	Jan Ho¨ ller, Vlasios Tsiatsis , Catherine Mulligan, Stamatis , Karnouskos, Stefan Avesand. David Boyle	From Machine-to-Machine to the Internet of Things - Introduction to a New Age of Intelligence	Elsevier	2014

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23BME12	HOSPITAL WASTE MANAGEMENT	L	T	P	C
		3	0	0	3

Course Objective:

- To know the basic knowledge of healthcare waste.
- To create the awareness of hazard of biomedical waste.
- To study about the hospital management and controlling of the wastages.
- To learn about the types of treatment technologies for wastes.
- To study about the professional ethics of biomedical waste handling.

Course Outcomes:

23BME12.CO1 Categorize hazardous healthcare waste.

23BME12.CO2 Explain the importance of the biomedical waste disposal in the society.

23BME12.CO3 Explain the infection control and monitoring.

23BME12.CO4 Know about the types of treatment technologies for wastes.

23BME12.CO5 Learn the laws of biomedical waste handling and the Healthcare waste Management.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BME12.CO1	X	-	-	-	-	X	X	X	-	X	-	X	-	X	X
23BME12.CO2	X	-	-	-	-	X	X	X	-	X	-	X	-	X	X
23BME12.CO3	X	-	-	-	-	X	X	X	-	X	-	X	-	X	X
23BME12.CO4	X	-	-	-	-	X	X	X	-	X	-	X	-	X	X
23BME12.CO5	X	-	-	-	-	X	X	X	-	X	-	X	-	X	X

Unit-I INTRODUCTION **9**

Definition of general and hazardous healthcare waste, Infectious waste, geno-toxic waste, waste sharps, categorization and composition of Biomedical waste, major and minor sources of biomedical waste, Segregation of waste, Color coding, waste handling and disposal

Unit-II HAZARD OF BIOMEDICAL WASTE **9**

Need for disposal of biomedical waste, Specifically Communicable diseases, Diseases epidemiology and mode of transmission of disease, Environmental pollution by biomedical waste-causes, consequences, mitigation and remedies.

Unit-III 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 controller of cross infection-Staff health.

Unit-IV TREATMENT TECHNOLOGIES FOR WASTES **9**

Mechanical Treatment & Chemical Disinfections, Conventional Treatment Technologies: Wet thermal technology, Incineration, Microwave Technology, Autoclave system, Hydroclave system, Electro Thermal Reactivation (ETP), Treatment Process Electron beam Technology, Plasma Pyrolysis / Gasification systems.

Unit-V LAWS OF BIOMEDICAL WASTE HANDLING **9**

Biomedical wastes, Disposal of biomedical waste products and deep burial, Segregation, Packaging, Transportation, Storage Legislation, policies and law regarding environment on Healthcare waste Management, Biomedical waste management and handling rules 1998 and its amendment. CPCB guidelines. World Health Organization guidelines on Management of wastes from hospital wastes

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Y.C.Fung	Biomechanics- Mechanical Properties of Living tissues	Springer Verlag	2nd Edition
2.	Sunder	Textbook of Rehabilitation	Jaypee Brothers Medical Publishers Pvt. Ltd, New Delhi	2nd Edition, 2007

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Schneck and Bronzino	Biomechanics principles and applications	CRC	2003
2.	Keswick. J	What is Rehabilitation Engineering, Annual Reviews of Rehabilitation	Springer	1982
3.	Warren E. Finn,Peter G. LoPresti	Handbook of Neuroprosthetic Methods	CRC	2002
4.	Rory A Cooper Hisaichi Ohnabe Douglas A. Hobson	An Introduction to Rehabilitation Engineering	CRC	2006

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23BME13	FIBER OPTICS AND LASERS IN MEDICINE	L	T	P	C
		3	0	0	3

Course Objective:

- To be familiar with objective property of fiber optics.
- To study about the losses in optics.
- To gain the knowledge in application of lasers in therapy and diagnosis.
- To be exposed to basics of endoscopy.
- To know about the clinical applications of fiber optic laser systems.

Course Outcomes:

23BME13.CO1	Understand the property of fiber optics.
23BME13.CO2	Apply lasers in different areas of medicine.
23BME13.CO3	Explain the special techniques of Lasers.
23BME13.CO4	Demonstrate the principle of endoscopy.
23BME13.CO5	Enumerate the clinical applications of fiber optic laser systems.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BME13.CO1	X	X	X	-	X	-	-	-	-	-	-	X	X	X	-
23BME13.CO2	X	X	X	-	X	-	-	-	-	-	-	X	X	X	-
23BME13.CO3	X	X	X	-	X	-	-	-	-	X	-	X	X	X	-
23BME13.CO4	X	X	X	-	X	-	-	-	-	X	-	X	X	X	-
23BME13.CO5	X	X	X	-	X	-	-	-	-	X	-	X	X	X	-

Unit-I OPTICAL FIBRES AND THEIR PROPERTIES 9

Principles of light propagation through a fibre - Different types of fibres and their properties, fibre characteristics – Absorption losses – Scattering losses – Dispersion – Connectors and splicers –Fibre termination – Optical sources – Optical detectors.

Unit-II LOSSES AND DISPERSION IN FIBER OPTICS 9

Absorption, Rayleigh scatter, Fresnel Reflection, Bending losses, dispersion Graded Index fiber, Single mode fiber, cables for fiber optics, Problems occurring in connecting optical fibers, Cleaving Process, Connectors and couplers Medical Laser: Introduction, Laser physics, medical lasers, Laser safety fundamentals

Unit-III APPLICATION OF LASERS IN THERAPY AND DIAGNOSIS 9

Introduction, laser assisted diagnosis and therapy fundamentals, Interaction of Laser beams and materials principles, Laser interaction with tissue, application of Lasers in Diagnosis and Imaging, Laser surgery and therapy, thermal interaction between laser and Tissue. Integrated laser-fiber systems and their applications, Complications in the use of Laser fiber optic system.

Unit-IV ENDOSCOPY 9

Endoscopic imaging system fundamentals, Angioscope, Videoscopy, Fluorescence endoscopy, Endoscopic therapy, Endoscopic ultrasound imaging principles. Fiber Optic Medical Diagnosis: introduction, fundamentals, fiber optic biomedical sensor-principles, Direct-indirect Sensor principles.

Unit-V CLINICAL APPLICATIONS OF FIBER OPTIC LASER SYSTEMS 9

Fiber optic Laser system in cardiovascular disease, Fiber optic Laser system in Gastroenterology, Fiber optic Laser system in general and thoracic surgery, Fiber optic Laser system in Neurosurgery, Fiber optic Laser system in Oncology, Fiber optic Laser system in Opthalmology, Fiber optic Laser system in Orthopedics, Fiber optic

Laser system in Otolaryngology, Fiber optic Laser system in Urology, Flow chart diagrams for clinical applications of laser –fiber systems.
TOTAL:45HRS

Total Periods: 45

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Abraham Katzir	Lasers and Optical Fibers in Medicine	Academic press Inc	
2.	John Crisp	Introduction to fiber optics	Mc Graw Hill	2nd Edition 2001
3.	G.David Baxterr Churchill Livingstone	Therapeutic Lasers - Theory and practice	Addison Wesley	

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23BME14	COMMUNICATION ENGINEERING	L	T	P	C
		3	0	0	3

Course Objective:

- To study the various analog and digital modulation techniques
- To study the principles behind various error control coding.
- To study the various digital communication techniques

Course Outcomes:

23BME14.CO1	Comprehend and appreciate the significance and role of this course in the present contemporary world.
23BME14.CO2	Apply analog modulation techniques.
23BME14.CO3	Apply digital modulation techniques.
23BME14.CO4	Identify various types of noises during transmission.
23BME14.CO5	Analyze various error control coding techniques.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BME14.CO1	X	X	X	-	X	-	-	-	-	X	-	X	X	X	-
23BME14.CO2	X	X	X	-	X	-	-	-	-	-	-	X	X	X	-
23BME14.CO3	X	X	X	-	X	-	-	-	-	-	-	X	X	X	-
23BME14.CO4	X	X	X	-	X	-	-	-	-	X	-	X	X	X	-
23BME14.CO5	X	X	X	-	X	-	-	-	-	-	-	X	X	X	-

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).

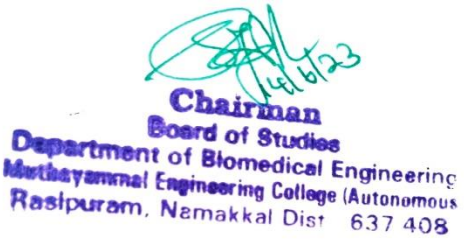
Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	H Taub, D L Schilling, G Saha	Principles of Communication Systems	TMH	3rd Edition, 2007
2.	S. Haykin	Digital Communications	John Wiley	2005

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	B.P.Lathi	Modern Digital and Analog Communication Systems	Oxford University Press	3rd Edition, 2007
2.	H P Hsu, Schaum	Outline Series, Analog and Digital Communications	TMH	2006
3.	B.Sklar	Digital Communications Fundamentals and Applications	Pearson Education	2nd Edition, 2007



23BME15	MEDICAL PHYSICS	L	T	P	C
		3	0	0	3

Course Objective:

- To study principles and effects of ionizing and non-ionizing radiation in human body
- To study the intensities of sensory stimuli
- To discuss the physics of the senses
- To explore the effects of radiation in matter and how isotopes are produced
- To understand various detectors for detecting the presence of ionizing radiation

Course Outcomes:

23BME15.CO1	Explain about non-ionizing radiation, interaction with tissue and its effects.
23BME15.CO2	Define and compare intensities of sensory stimuli
23BME15.CO3	Summarizes how ionizing radiation interacts with the human body, how to quantify it and its levels seen in the environment and healthcare
23BME15.CO4	Explain the fundamentals of radioactivity and radioactive isotopes
23BME15.CO5	Illustrates the methods of detecting and recording the ionizing radiation and its interaction with matter

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BME15.CO1	X	X	X	X	-	-	-	-	-	-	-	X	X	-	-
23BME15.CO2	X	X	X	X	-	X	-	-	-	-	-	X	X	-	-
23BME15.CO3	X	X	X	X	-	X	-	-	-	-	-	X	X	-	-
23BME15.CO4	X	X	X	X	-	X	-	-	-	-	-	X	X	-	-
23BME15.CO5	X	X	X	X	-	X	-	-	-	-	-	X	X	-	-

Unit-I IONIZING RADIATION AND ITS MEDICAL APPLICATIONS 9

Introduction and objectives - Tissue as a leaky dielectric - Relaxation processes, Debye model, Cole–Cole model, Overview of non-ionizing radiation effects-Low Frequency Effects- Higher frequency effects. Physics of light, Measurement of light and its unit- limits of vision and color vision an overview, Ultraviolet.

Unit-II PHYSICS OF THE SENSES 9

Introduction and objectives - Cutaneous sensation - The chemical senses – Audition –Vision – Psychophysics

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, Radionuclide used in Medicine and Technology ,Decay series, Production of radionuclide's – Cyclotron produced Radionuclide-Reactor produced Radio- nuclide-fission and electron Capture reaction, Target and Its Processing Equation for Production of Radionuclide's, radionuclide Generator-Technetium generator.

Unit-IV RADIOACTIVE DECAY AND INTERACTION OF RADIATION WITH MATTER 9

Spontaneous Fission- Isomeric Transition-Alpha Decay-Beta Decay-Positron Decay-Electron Capture-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 OF FIBER OPTIC LASER SYSTEMS 9

Fiber optic Laser system in cardiovascular disease, Fiber optic Laser system in Gastroenterology, Fiber optic Laser system in general and thoracic surgery, Fiber optic Laser system in Neurosurgery, Fiber optic Laser system in Oncology, Fiber optic Laser system in Opthalmology, Fiber optic Laser system in Orthopedics, Fiber optic Laser system in Otolaryngology, Fiber optic Laser system in Urology, Flow chart diagrams for clinical applications of laser –fiber systems.

Total Periods: 45

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Gopal B. Saha	Physics and Radiobiology of Nuclear Medicine4th Edition	Springer	2013
2.	B H Brown, R H Smallwood, D C Barber, P V Lawford, D R Hose	Medical Physics and Biomedical Engineering	IOP Publishers	2nd Edition, 2001
3.	S.Webb	The Physics of Medical Imaging	Taylor and Francis	1988
4.	J.P.Woodcock	Ultrasonic Medical Physics Handbook series 1	Adam Hilger, Bristol	2002
5.	HyltonB.Meire Pat Farrant	Basic Ultrasound	John Wiley & Sons	1995

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23BME16	ELECTRICAL SAFETY AND QUALITY ASSURANCE	L	T	P	C
		3	0	0	3

Course Objective:

- To provide electrical protection and maintenance in working environment.
- To ensure the electrical safety.
- To learn about Safety Aspects in Medical Imaging systems
- To study about the Standards and Regulations Background of electrical safety device
- To gain the knowledge of Diagnostic Medical Devices Directives

Course Outcomes:

23BME16.CO1	Develop knowledge and insight into the safety procedures.
23BME16.CO2	Knowledge used in quality control and assurance activities as well as safety measures to be followed in hospitals.
23BME16.CO3	Electrical safety and different standards Testing and verification of medical devices.
23BME16.CO4	Safety & precautions in electro surgical systems
23BME16.CO5	Guidelines on medical devices with the knowledge of Diagnostic Medical Devices Directives.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BME16.CO1	X	X	X	X	-	-	-	-	-	-	-	X	X	-	-
23BME16.CO2	X	X	X	X	-	X	-	-	-	-	-	X	X	-	-
23BME16.CO3	X	X	X	X	-	X	-	-	-	-	-	X	X	-	-
23BME16.CO4	X	X	X	X	-	X	-	-	-	-	-	X	X	-	-
23BME16.CO5	X	X	X	X	-	X	-	-	-	-	-	X	X	-	-

Unit-I INTRODUCTION **9**

Classification of Device: Device classes, types in medical field. Patient Safety: Electric shock hazards, Leakage currents, macro shock, micro shock hazards and preventions, safety codes and analyzer .Safety& precautions Safety aspect sin electro surgical systems.

Unit-II SAFETY ASPECTS IN MEDICAL IMAGING SYSTEMS **9**

Biological effects of ionizing radiation- Determinants of biological effects, Short term & long term effects Ultrasound bio-effects, Radio biology of nuclear medicine, biological effects of magnetic field Laser safety-fundamentals, safety consideration of lasers.

Unit-III DEFINITION **9**

Defining the device, The product definition process, Overview of quality function deployment, The QFD process, The business proposals Reliability: Types of Reliability, Optimizing reliability, Reliability effects on medical devices. Concept of Failure: Various methods of CAPA Safety and Risk Management: Personnel safety and hygiene, Medical device safety and risk management, The role of each participant/stakeholder, Shared responsibility for medical device safety and performance. Electrical safety and different standards. Testing and verification of medical devices.

Unit-IV STANDARDS AND REGULATIONS BACKGROUND **9**

Standards: Voluntary and mandatory standards, Standards development process, Conformity assessment with standards, National and international standards systems, Identification of standards, Current trends in the use of standards in medical device regulations. The ISO 9000Seriesof Standards.

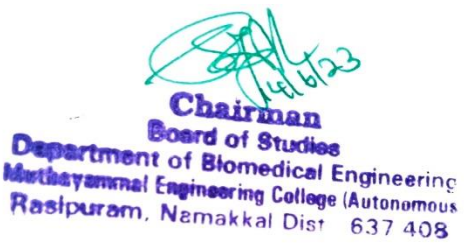
unit-V THE MEDICAL DEVICES DIRECTIVES 9

Definition of a medical device, The Medical Devices Directives process, Choosing the appropriate directive, Identifying the applicable essential requirements, Identification of corresponding harmonized standards, Essential requirements, Classification of the device based on conformity, Medical Devices Directives, Active Implantable Medical Devices Directives, In−vitro Diagnostic Medical Devices Directives. NABH, NABL, JCI, AERB, WHO guidelines on medical devices.

Total Periods: 45

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Richard Fries	Reliable Design of Medical Devices	CRC Press	2nd Edition, 2006
2.	Richard C Fries	Medical Device Quality Assurance and Regulatory Compliance	CRC Press	1998
3.	MichaelCheng	Medical device regulations: global overview and guiding Principles	World Health Organization	Latest Edition
4.	Gábor Czitán, Attila Gutassy, Ralf Wilde	Product Safety in the European Union	TÜV Rheinland Akadémia	2008



23BME17	ROBOTICS IN MEDICINE	L	T	P	C
		3	0	0	3

Course Objective:

- To learn basics of Robotics, Kinematics.
- To understand Inverse Kinematics to explore various kinematic motion planning solutions for different Robotic configurations

Course Outcomes:

23BME17.CO1 Understand the basics of robotic systems.

23BME17.CO2 Design basic Robotics system and formulate Kinematics.

23BME17.CO3 Construct Inverse Kinematic motion planning solutions for various Robotic configurations.

23BME17.CO4 Design Robotic systems for Medical application.

23BME17.CO5 Explore various applications of Robots in Medicine.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BME17.CO1	X	-	-	-	-	X	-	X	X	X	-	X	X	X	X
23BME17.CO2	X	-	-	-	-	X	-	X	X	X	-	X	X	X	X
23BME17.CO3	X	-	-	-	-	X	-	X	X	X	-	X	X	X	X
23BME17.CO4	X	-	-	-	-	X	-	X	X	X	-	X	X	X	X
23BME17.CO5	X	-	-	-	-	X	-	X	X	X	-	X	X	X	X

Unit-I Renal Failure and Haemodialysis types **9**

Introduction Automation and Robots, Classification, Application, Specification, Notations, Direct Kinematics Dot and cross products, Coordinate frames, Rotations, Homogeneous coordinates Link coordination arm equation – Five-axis robot, Four-axis robot, Six-axis robot.

Unit-II Dialysing system and Dialysate **9**

Inverse Kinematics – General properties of solutions tool configuration, Five axis robots, Three- Four axis, Six axis Robot, Workspace analysis and trajectory planning work envelope and examples, work space fixtures, Pick and place operations, Continuous path motion, Interpolated motion, Straight-line motion.

Unit-III Anesthesia systems **9**

Robot Vision Image representation, Template matching, Polyhedral objects, Shane analysis, Segmentation – Thresholding, region labeling, Shrink operators, Swell operators, Euler numbers, Perspective transformation, Structured illumination, Camera calibration.

Unit-IV Anesthesia patient care **9**

Task Planning Task level programming, Uncertainty, Configuration, Space, Gross motion, Planning, Grasp Planning, Fine-motion planning, Simulation of planar motion, Source and Goal scenes, Task Planner simulation.

Unit-V Anesthesia system maintenance **9**

Applications in Biomedical Engineering – Bio Engineering Biologically Inspired Robots, Neural Engineering, Application in Rehabilitation – Interactive Therapy, Bionic Arm, Clinical and Surgical
– Gynaecology, Orthopaedics, Neurosurgery.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Robert Schilling	Fundamentals of Robotics-Analysis and control	Prentice Hall	2003
2.	J.J.Craig	Introduction to Robotics	Pearson Education	2016

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Staugaard Andrew C	Robotics and Artificial Intelligence: An Introduction to Applied Machine Learning	Prentice Hall Of India	2006
2.	Grover, Wiess, Nagel, Oderey	Industrial Robotics: Technology, Programming and Applications	McGraw Hill,	2012.
3.	Wolfram Stadler	Analytical Robotics and Mechatronics	McGraw Hill	1995
4.	Saeed B. Niku	Introduction to Robotics: Analysis, SystemsApplications	Prentice Hall	2001
5.	K. S. Fu, R. C., Gonzales and C.S., G. Lee	Robotics	McGraw Hill	2008

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23BME18	MEMS AND ITS BIOMEDICAL APPLICATIONS	L	T	P	C
		3	0	0	3

Course Objective:

- To understand different types of sensors and actuators and their principles of operation at the micro scale level.
- To learn various MEMS fabrication techniques.
- To know the applications of MEMS in different fields of medicine

Course Outcomes:

23BME18.CO1	Discuss various MEMS fabrication techniques.
23BME18.CO2	Explain different types of sensors and actuators and their principles of operation at the micro scale level.
23BME18.CO3	Comprehend the characteristics of fluid flow and actuation through micro channels.
23BME18.CO4	Explain the need and use of CAD for MEMS design.
23BME18.CO5	Design MEMS devices for different medical applications.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BME02.CO1	X	X	X	X	-	-	-	-	-	-	-	X	-	X	X
23BME02.CO2	X	X	X	X	-	-	-	-	-	-	-	X	-	X	X
23BME02.CO3	X	X	X	X	-	X	X	X	X	X	-	X	-	X	X
23BME02.CO4	X	X	X	X	X	X	-	-	-	-	-	X	-	X	X
23BME02.CO5	X	X	X	X	X	X	X	X	X	X	X	X	-	X	X

Unit-I INTRODUCTION **9**

Typical MEMs and Microsystems, materials for MEMS - active substrate materials-Silicon and its compounds, Silicon piezoresistors, Gallium Arsenide, quartz, polymers. Micromachining-photolithography, thin film deposition, doping, etching, bulk machining, wafer bonding, LIGA.

Unit-II STATISTICAL PARAMETERS **9**

Mechanics for MEMs design- static bending of thin plates, mechanical vibration, thermo mechanics, fracture and thin film mechanics. Mechanical sensors and actuators – beam and cantilever – microplates, strain, pressure and flow measurements, Thermal sensors and actuators-actuator based on thermal expansion, thermal couples, thermal resistor, Shape memory alloys- Inertia sensor, flow sensor.

.

Unit-III REGRESSION ANALYSIS **9**

Parallel plate capacitor, pull in effect, Electrostatic sensors and actuators- Inertia sensor, Pressure sensor, flow sensor, tactile sensor, comb drive. Properties of piezoelectric materials, Piezoelectric sensor and actuator – inchworm motor, inertia sensor, flow sensor.

Unit-IV INTERPRETING DATA **9**

Fluid dynamics, continuity equation, momentum equation, equation of motion, laminar flow in circular conduits, fluid flow in microconduits, in submicrometer and nanoscale. Microscale fluid, expression for liquid flow in a channel. Fluid actuation methods- electro wetting, thermocapillary effect, electro osmosis, dielectrophoresis. Microfluid dispenser, microneedle, micro pumps-continuous flow system,

micromixers.

Unit-V META ANALYSIS **9**

CAD for MEMs, Drug delivery, micro total analysis systems (MicroTAS) detection and measurement methods, microsystem approaches to polymerase chain reaction (PCR),DNA sensor, MEMS based drug delivery, electronic nose. Introduction to 3D printing

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Chang Liu	Foundations of MEMS	Pearson Education International, New Jersey, US	2nd Edition, 2011
2.	Tai Ran Hsu	MEMS and Microsystems design and manufacture	Tata McGraw Hill Publishing Company, New Delhi	2002

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Wanjun Wang, Stephen A.Soper	BioMEMS: Technologies and applications	CRC Press, New York	2007
2.	Marc J. Madou,	Fundamentals of Microfabrication: the science of miniaturization	CRC Press	2002
3.	Nadim Maluf, Kirt Williams	An Introduction to Microelectro mechanical Systems Engineering	Artech House Inc, MA	Second Edition, 2004
4.	Nitaigour Premchand Mahalik	MEMS	Tata McGraw Hill Publishing Company, New Delhi	2007

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23BME19	NEURAL ENGINEERING	L	T	P	C
		3	0	0	3

Course Objective:

- To be familiar with the nervous system development.
- To be exposed to neuronal diseases and disorders.
- To be familiar with nerve reconstruction and repairing.

Course Outcomes:

23BME19.CO1	Explain the basic structure and functions of human nervous system.
23BME19.CO2	Understand diseases and degeneration related to nervous system.
23BME19.CO3	Analyze visualization and radiological assessment of nervous system.
23BME19.CO4	Apply neural tissue engineering for rehabilitation.
23BME19.CO5	Discuss about Regeneration of nervous system.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO 2	PSO 3
23BME19.CO1	X	X	-	-	-	-	-	-	-	X	-	X	X	X	X
23BME19.CO2	X	X	-	-	-	-	-	-	-	X	-	X	X	X	X
23BME19.CO3	X	X	X	X	X	-	X	-	-	-	-	X	X	X	X
23BME19.CO4	X	X	X	X	X	-	X	-	-	-	-	X	X	X	X
23BME19.CO5	X	X	-	-	-	-	-	-	-	X	-	X	X	X	X

Unit-I INTRODUCTION: HOMEOSTASIS, TISSUE, CARTILAGE 9

Nervous system development. Trophic factors, extra cellular matrix components in nervous system development. Neuron: structure – function – classification. Glial cells – myelination. Neurotransmitter – types and functions. Synapses - Transport of materials and impulse in neurons.

.

Unit-II NERVOUS SYSTEM 9

Brain: structures – lobes – functional areas. Brain stem: structures – functional areas. Spinal cord: structure – functions. Concepts of nuclei – sensory and motor Tracts - Reticular formation. Blood supply to Brain and spinal cord.

Unit-III CARDIOVASCULAR SYSTEM 9

Neuro degeneration: Degenerative, Demyelinated and injury related disorders associated with nervous system. Wallerian Degeneration. Neuronal plasticity – CNS acting drugs and their pharmacokinetics. Alzheimer‘s, Parkinson‘s and Prion diseases

Unit-IV DIGESTIVE SYSTEM 9

Physiology of nerve conduction. Peripheral nerves – structure & Functions. Synaptic transmission and cellular signaling of Neurons. Electrical activity of the Brain and recording of brain waves. Evoked potentials. Visualization of nervous system. Neuromotor-machine interface: human voluntary motor control system.

Unit-V RESPIRATORY SYSTEM 9

Neural plasticity; Neurological dysfunctions - Regeneration of the peripheral nervous system. Neural tissue engineering; Nerve graft; Drug delivery system in CNS. Rehabilitation: Mechanisms for Neuromotor rehabilitation; Robotics and virtual reality in physical therapy; Transcranial magnetic stimulation

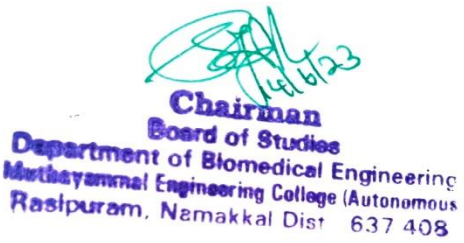
Total Periods: 45

Text books:

S.No.	Author(s)	Title of the book	Publisher	Year of Publication
1.	Mathews G.G.	Neurobiology	Blackwell Science,UK	2nd edition, 2000
2.	Malcom Carpenter	Textbooks of Neuroanatomy	Mc. Graw hill Edition	1996

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	W. Mark Saltzman	Tissue Engineering – Engineering principles for design of replacement organs and tissue	Oxford University Press Inc New York	2004
2.	Park J.B	ACS Biomaterials Science and Engineering	Plenum Press& Saunders	2014 & 2006



23BME20	FORENSIC SCIENCE IN HEALTHCARE	L	T	P	C
		3	0	0	3

Course Objective:

- Learn the history of the forensic sciences and its place in popular culture.
- Understand the roles of different types of professionals involved in evaluating a crime scene and the collected evidence.
- Learn about forensic microscope and Anthropology.
- Understand the Blood stain identification.
- Learn the methodology of collecting & interpreting data for fingerprint application.

Course Outcomes:

23BME20.CO1 Define the significance of forensic sciences

23BME20.CO2 Observe and document crime scenes

23BME20.CO3 Determine Trauma and Diseases.

23BME20.CO4 Describe the various sources of medical data related to forensic science.

23BME20.CO5 Demonstrate the visual analytical procedure of finger print application.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BME20.CO1	X	X	X	-	-	X	-	X	-	-	-	X	X	-	X
23BME20.CO2	X	X	X	-	-	X	-	X	-	-	-	X	X	-	X
23BME20.CO3	X	X	X	-	X	X	-	X	-	-	-	X	X	-	X
23BME20.CO4	X	X	X	-	X	X	-	X	-	-	-	X	X	-	X
23BME20.CO5	X	X	X	-	X	X	-	X	-	-	-	X	X	-	X

Unit-I BASICS OF FORENSIC SCIENCE 9

Forensic science, Introduction to the Forensic Sciences, History and Development of Forensic Science, Deductive Reasoning, Organization of a Crime Laboratory Case Studies: The Enrique Camarena Case. A Forensic Nightmare Organization of forensic science laboratories of center and state -NCRA AND NICFS, fundamental rights, criminal profiling, concept of quality control management in forensic institutions.

Unit-II OBSERVATION AND CRIME SCENE 9

Observational Skills - Sherlock Holmes and Deductive Reasoning - Observations by Witnesses. Case Studies. The Crime Scene -Locard's Exchange Principle, Securing and Recording the Crime Scene, Legal Considerations at the Crime Scene, Evidence Collection and Recordation Techniques. Mock Crime Scene: Processing and Documenting a Crime Scene

Unit-III FORENSIC MICROSCOPE AND ANTHROPOLOGY 9

Forensic Use of the Microscope -The Compound, Comparison, and Stereoscopic Microscope, The Scanning Electron Microscope (SEM). Forensic Anthropology- Introduction, Human Anatomy–The Skeletal System, Skeletal Determination of Demographic Data from Skeletal Remains, Determining Types of Trauma and Disease from Skeletal Remains, Case Studies.

Unit-IV BLOOD STAIN IDENTIFICATION 9

Detection and identification of Blood stains, Determination of species of origin, Blood Group systems, Techniques of Determination of Blood groups of Blood stains, Determination of seminal and other fluids and

their Blood Grouping, DNA, DNA Phenotyping and RNA Profiling & their applications. Wildlife forensics.

Unit-V FINGERPRINT APPLICATION 9

Fingerprints -Fundamental Principles of Fingerprint Analysis, Classification of Fingerprints, Collection of Fingerprint Evidence, Automated Fingerprint Identification Systems (AFIS), Track marks, Case Studies.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Nanda, B.B. and Tewari, R.K.	Forensic Science in India: A vision for the twenty first century	Select Publisher, New Delhi	2001
2.	James, S.H and Nordby, J.J.	Forensic Science: An introduction to scientific and investigative techniques	CRC Press	2003

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Saferstein	Criminalistics	Prentice Hall Inc., USA	1976
2.	Deforest, Gansellen & Lee	Introduction to Criminalistics		
3.	Sharma, B.R.	Forensic Science in Criminal Investigation and Trials	Central Law Agency, Allahabad	1974

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23BME21	MEDICAL ETHICS AND STANDARDS	L	T	P	C
		3	0	0	3

Course Objective:

- To know about the legal and ethical principles in health care settings & gain knowledge about the medical standards that to be followed in hospitals.
- To learn the professional ethics to be followed by Biomedical Engineers.
- To learn patient safety and regulatory aspects followed in hospitals

Course Outcomes:

23BME21.CO1 Learn legal and professional guidelines for the health professions.

23BME21.CO2 Understand social responsibility in healthcare systems.

23BME21.CO3 Understand bioethics and engineers role.

23BME21.CO4 Acquire knowledge on medical device maintenance.

23BME21.CO5 Understand safety aspects.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BME21.CO1	X	X				X	-	X	-		-	X	-	X	X
23BME21.CO2	-	X				X	X	X	-		-	X	-	X	X
23BME21.CO3	-	X				X	X	X	X	X	-	X	-	X	X
23BME21.CO4	X	X	X		X	X	-		X	X	X	X	-	X	X
23BME21.CO5	X	X			X	-	X	X	-		-	X	-	X	X

Unit-I INTRODUCTION TO MEDICAL ETHICS 9

Forensic science, Introduction to the Forensic Sciences, History and Development of Forensic Science, Deductive Reasoning, Organization of a Crime Laboratory Case Studies: The Enrique Camarena Case. A Forensic Nightmare Organization of forensic science laboratories of center and state -NCRA AND NICFS, fundamental rights, criminal profiling, concept of quality control management in forensic institutions.

Unit-II OBSERVATION AND CRIME SCENE 9

Definition of Medical ethics, Scope of ethics in medicine, International code of Ethics for occupational health professionals, Ethical Theories --Deontology & Utilitarianism ,Casuist theory, Virtue theory, The Right Theory. Role of ethics in Healthcare workplace – Autonomy, Non- Malfeasance, Beneficence, Veracity, Justice, OSHA, Decision Model for Healthcare Dilemmas- Applications of Plus decision making model.

Unit-III CODE OF ETHICS FOR BIOMEDICAL ENGINEER 9

Bioethics-The principle of Double effect, Code of Hammurabi, Engineering Competence, Ethical Issues in biomedical research-Cloning and stem cell research, Neuro ethics, Organ Transplantation, Hypothetico-deductive method, Research Conflict of Interest. Medical device failure- Five failure types, Bio-terrorism, Sustainable Bioethics-Life cycles and Concurrent Engineering, Environmental Health – case studies

Unit-IV MEDICAL DEVICE SAFETY 9

Shared Responsibility for Medical device safety. WHO – International Health Regulations (IHR), Stages of regulatory control of medical devices, Ethics committee- its members and functions, Global Harmonization Task Force (GHTF). Quality systems requirement –ISO, Voluntary and mandatory standards, Collateral Standards-

EMC radiation protection &programmable medical device system, Particular Standards-type of medical device

unit-V REGULATORY STANDARDS FOR MEDICAL DEVICE MAINTENANCE 9

International Standards- Medical Device Directive 93/42/EEC, Medical Electrical Equipment ISO 60601, Safety Testing of Medical Devices ISO 62353, Medical Device Inspection ISO17020. Indian Standards – National Health Mission , Biomedical Equipment Management and Maintenance Program (BMMP), ISO 9001-2008, AERB Compliance – Radiation protection AE(RP)R-2004, Safety Code AE/RF-MED/SC-3

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	William Charney	Handbook of Modern Hospital Safety	CRC Press	2nd Edition, 2009
2.	Almira Badnjevic, Mario Cifrek, Ratko Magjarevic, Zijad Dzemic	Inspection of Medical Devices: For Regulatory Purposes		Springer Nature, 2018
3.	Domiel A Vallero	Biomedical Ethics for Engineers	Elsevier Pub.	1st Edition, 2007

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Eileen E.Morrison,	Ethics in Health Administration: A Practical Approach for Decision Makers	Jonnes and Bartletts	2nd Edition, 2011
2.	Robert M Veatch	Basics of Bio Ethics	Prentice- Hall, Inc.	2nd Edition, 2003
3.		Physical Environment Online: A Guide to The Joint Commission's Safety Standards	HCPro, Inc.	2010
4.		Joint Commission Accreditation Standards for Hospitals		2nd Edition, 2003

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23BME22	BIOMETRIC SYSTEMS	L	T	P	C
		3	0	0	3

Course Objective:

- To introduce the relevance of this course to the existing technology through demonstrations, case studies, simulations, contributions of scientist, national/international policies with a futuristic vision along with socio-economic impact and issues.
- To understand the general principles of design of biometric systems and the underlying trade-offs
- To study the technologies of fingerprint, iris, face and speech recognition.
- To study of evaluation of biometrics systems.

Course Outcomes:

23BME22.CO1 Demonstrate the principles of biometric systems.

23BME22.CO2 Develop fingerprint recognition technique.

23BME22.CO3 Design face recognition and hand geometry system.

23BME22.CO4 Design iris recognition system.

23BME22.CO5 Develop speech recognition and multimodal biometric systems.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BME22.CO1	X	X	X	X	X	-	-	X	-	-	-	-	X	X	X
23BME22.CO2	X	X	X	X	X	-	-	X	-	-	-	-	X	X	X
23BME22.CO3	X	X	X	X	X	-	-	X	-	-	-	-	X	X	X
23BME22.CO4	X	X	X	X	X	-	-	X	-	-	-	-	X	X	X
23BME22.CO5	X	X	X	X	X	-	-	X	-	-	-	-	X	X	X

Unit-I INTRODUCTION TO BIOMETRICS 9

Introduction and back ground – biometric technologies – passive biometrics – active biometrics – Biometric characteristics, Biometric applications – Biometric Authentication systems- Taxonomy of Application Environment, Accuracy in Biometric Systems- False match rate- False non match rate- Failure to enroll rate-Derived metrics-Biometrics and Privacy.

Unit-II FINGERPRINT TECHNOLOGY 9

History of fingerprint pattern recognition - General description of fingerprints- fingerprint sensors, fingerprint enhancement, Feature Extraction- Ridge orientation, ridge frequency, fingerprint matching techniques-correlation based, Minutiae based, Ridge feature based, fingerprint classification, Applications of fingerprints, Finger scan- strengths and weaknesses, Evaluation of fingerprint verification algorithms.

Unit-III FACE RECOGNITION AND HAND GEOMETRY 9

Introduction to face recognition, face recognition using PCA, LDA, face recognition using shape and texture, face detection in color images, 3D model based face recognition in video images, Neural networks for face recognition, Hand geometry – scanning – Feature Extraction – classification.

Unit-IV IRIS RECOGNITION 9

Introduction, Anatomical and Physiological underpinnings, Iris sensor, Iris representation and localization- Daugman and Wilde's approach, Iris matching, Iris scan strengths and Weaknesses, System performance, future directions.

Unit-V VOICE SCAN AND MULTIMODAL BIOMETRICS 9

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

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	James Wayman& Anil Jain	Biometric Systems- Technology Design and Performance Evaluation,	Springer (SIE)	1st Edition, 2011
2.	Paul Reid	Biometrics for Network Security	Pearson Education	2004
3.	S.Y. Kung, S.H. Lin, M.W.	Biometric Authentication: A Machine Learning Approach	Prentice Hall	2004

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Nalini K Ratha, Ruud Bolle	Automatic fingerprint recognition system	Springer	2003
2.	L C Jain, I Hayashi, S B Lee, U Halici	Intelligent Biometric Techniques in Fingerprint and Face Recognition	CRC Press	1st Edition, 1999
3.	John Chirillo, Scott Blaul	Implementing Biometric Security	John Wiley & Sons	2003

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23BME23	HOSPITAL WASTE MANAGEMENT	L	T	P	C
		3	0	0	3

Course Objective:

- To understand the fundamentals of hospital administration and management.
- To study the importance of human resource management.
- To know the market related research process.
- To explore various information management systems and relative supportive services.
- To learn the quality and safety aspects in hospital

Course Outcomes:

23BME23.CO1	Explain the principles of Hospital administration.
23BME23.CO2	Identify the importance of Human resource management.
23BME23.CO3	List various marketing research techniques.
23BME23.CO4	Identify Information management systems and its uses.
23BME23.CO5	Understand safety procedures followed in hospitals

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BME23.CO1	X	-	-	-	-	X	X	X	X	X	-	X	-	X	X
23BME23.CO2	X	-	-	-	-	X	X	X	X	X	X	X	-	X	X
23BME23.CO3	X	-	-	-	-	X	X	X	X	X	X	X	-	X	X
23BME23.CO4	X	-	-	-	-	X	X	X	X	X	X	X	-	X	X
23BME23.CO5	X	-	-	-	-	X	X	X	X	-	X	X	-	-	-

Unit-I Overview of Hospital Administration **9**

Hospital and Industry relationship, Challenges in Hospital Administration – Hospital Planning- Equipment Planning – Functional Planning – Organizing - Current Issues in Hospital Management – Telemedicine - Bio-Medical Waste Management. – Color coding

Unit-II Human Resource Department Management **9**

Principles & Functions of HRM – Profile of HRD Manager – Tools of HRD –Human Resource Inventory – Manpower Planning. Departments - Hospital, Recruitment, Selection, Training Guidelines –Methods & Evaluation of Training – Leadership, Promotion – Transfer, Communication – nature, scope, barriers, styles and modes of communication.

Unit-III Marketing Research Process **9**

Marketing information systems - assessing information needs, developing & disseminating information - Market Research process - Other market research considerations – Consumer Markets & Consumer Buyer Behaviour - Model of consumer behaviour - The buyer decision process - Model of business buyer behavior – Major types of buying situations - WTO and its implications

Unit-IV Hospital Information Systems & Supportive Services **9**

Management Decisions and Related Information Requirement - Clinical Information Systems - Administrative Information Systems - Support Service Technical Information Systems - Medical Transcription, Medical Records Department – Central Sterilization and Supply Department – Pharmacy– Food Services - Laundry Services

Unit-V Quality and Safety Aspects In Hospital **9**

Quality system – Elements, implementation of quality system, Documentation, Quality auditing, International Standards ISO 9000 – 9004 – Features of ISO 9001 – ISO 14000 – Environment Management Systems. NABA, JCI, NABL. Security – Loss Prevention – Fire Safety – Alarm System – Safety Rules. Health Insurance & Managing Health Care – Medical Audit – Hazard and Safety in a hospital Setup

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	R.C.Goyal	Hospital Administration and Human Resource Management	Academic Press, New York	4th Edition, 2006
2.	G.D.Kunders	Hospitals Facilities Planning and Management	TMH, New Delhi, Fifth Reprint	2007

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Cesar A. Caceres Albert Zara	The Practice of Clinical Engineering	Academic Press, New York	1977
2.	Norman Metzger	Handbook of Health Care Human Resources Management	Aspen Publication Inc. Rockville, Maryland, USA	2nd edition, 1990
3.	Peter Berman	Health Sector Reform in Developing Countries	Harvard University Press	1995
4.	William A. Reinke	Health Planning for Effective Management	Oxford University Press	1988
5.	Blane, David, Brunner	Health and social Organization: Towards a Health Policy for the 21st Century	Eric Calrendon Press	2002

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23BME24	ADVANCED THERAPEUTIC EQUIPMENT	L	T	P	C
		3	0	0	3

Course Objective:

- To study about the microscopy
- To learn about the hybrid techniques and types of chromatography
- To study about the special techniques in advanced bio analytical.
- To learn the radiation therapy and radiation safety.
- To analysis about the basics of respiratory aids

Course Outcomes:

23BME24.CO1 Understand the imaging techniques in microscopy.

23BME24.CO2 Describe various analytical hybrid techniques.

23BME24.CO3 Describe various types of analytical special techniques.

23BME24.CO4 Demonstrate the functioning of respiratory aids.

23BME24.CO5 Understand the radiation therapy & radiation safety.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BME24.CO1	X	-	-	-	-	X	X	X	X	X	-	X	X	X	X
23BME24.CO2	X	-	-	-	-	X	X	X	X	X	-	X	X	X	X
23BME24.CO3	X	X	-	-	-	X	X	X	X	X	-	X	X	X	X
23BME24.CO4	X	X	-	-	-	X	X	X	X	X	-	X	X	X	X
23BME24.CO5	X	X	-	-	-	X	X	X	X	X	-	X	X	X	X

Unit-I ADVANCED IMAGING TECHNIQUES IN MICROSCOPY 9

Live cell imaging, Confocal microscopy and sample preparation for fluorescence microscopy - High content/throughput screening - Basics of SEM & Specimen preparation for SEM - Basics of TEM & Specimen preparation for TEM. Advanced EM techniques: Electron tomography and Serial block face imaging using SEM – CryoEM - Methods to study STED - Structured Illumination Microscopy – Multi-photon microscopy and In vivo imaging.

Unit-II ANALYTICAL HYBRID TECHNIQUES 9

Gas chromatography with mass spectrometric detection (GC-MS), liquid chromatography with mass spectrometric detection (LC-MS), inductively coupled plasma with mass spectrometric detection (ICP-MS). Metal analysis by ICP-MS; Analysis of data: HPLC chromatograms, including trouble shooting – how to achieve good separation on HPLC; GC-MS data; LC-MS spectra

Unit-III ANALYTICAL SPECIAL TECHNIQUES 9

Flow Cytometer: Introduction to flow cytometry- Fluorochromes and fluorescence - Experimental design and fluorescence quantitation Compensation and gating – Normalization - Comparing Univariate Cell Distributions - Probability Binning - Readings on flow cytometry data analysis. isoelectric focusing and 2-Dimensional polyacrylamide gel electrophoresis and their uses in protein research. Protein crystallization; Theory and methods..

Unit-IV RESPIRATORY AIDS 9

Korotkoff's method measurement of respiratory rate: Impedance Pneumograpy. Oximeters: Principle, pulse oximeter, Ventilator- Need, Types, Intermittent positive pressure, breathing apparatus operating sequence, electronic IPPB unit with monitoring for all respiratory parameters, Humidifier, Nebulizer, Aspirator.

unit-V RADIATION THERAPY AND RADIATION SAFETY 9

Effects of ionising radiation, Radiation therapy – Cobalt Cesium therapy, linear accelerator, betatron, cyclotron, brachy-therapy, Radiation protection in medicine- radiation protection principles.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Skoog, D.A., Crouch, S.R., and Holler, F.J	Principles of Instrumental Analysis	Brooks/Cole, USA	6th edition, 2006
2.	R.S.Khandpur	Hand book of Biomedical Instrumentation	Tata McGraw Hill, New Delhi	1998

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Albert M.Cook and Webster.J.G	Therapeutic Medical Devices	Prentice Hall Inc., New Jersey	1982
2.	Leslie Cromwell, Fred. J. Weibel, Erich.A.Pferffer	Biomedical Instrumentation and Measurements	Prentice Hall India, New Delhi	2001
3.	Rangaraj.M.Rangayyan	Biomedical Signal Analysis-A Case Study Approach	IEEE Press- John Wiley & Sons Inc, New York	2002
4.	Freifelder D., Physical Biochemistry	Application to Biochemistry and Molecular Biology	W.H. Freeman & Company, San Fransisco	2nd Edition, 1982
5.	Williams, D. and Fleming, I	Spectroscopic Methods in Organic Chemistry	6th edition, McGraw-Hill Higher Education, Maidenhead, UK	2008
6.	Joseph.J.Carr and John .M.Brown	Introduction to Biomedical Equipment Technology	John Wiley & Sons Inc, New York	2002

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23BME25	PATIENT SAFETY, STANDARDS AND ETHICS	L	T	P	C
		3	0	0	3

Course Objective:

- To understand the importance of patient safety against electrical hazards.
- To explain the patient safety laws and regulations.
- To understand the standards and testing of patient.
- To know the patient safety specialities in clinical.
- To know about the health care organization

Course Outcomes:

23BME25.CO1 Outline the importance of patient safety against electrical hazards.

23BME25.CO2 Brief out the patient safety laws and regulations.

23BME25.CO3 Explain the standards and testing of patient.

23BME25.CO4 Understand the concept of the patient safety specialities in clinical.

23BME25.CO5 Know about various health care organization.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BME25.CO1	X	X	X	X	X	-	-	X	-	X	-	X	-	X	X
23BME25.CO2	X	X	X	X	X	-	-	X	-	X	-	X	-	X	X
23BME25.CO3	X	X	X	X	X	-	-	X	-	X	-	X	-	X	X
23BME25.CO4	X	X	X	X	X	-	-	X	-	X	-	X	-	X	X
23BME25.CO5	X	X	X	X	X	-	-	X	-	X	-	X	-	X	X

Unit-I EFFECTS OF ELECTRICITY 9

Physiological effects of electricity - important susceptibility parameters - microshock - macroshock hazards - patients electrical environment - isolated power system - conductive surfaces

Unit-II PATIENT SAFETY LAWS AND REGULATIONS 9

Mandatory Reporting systems. Anatomy of a patient safety Law: Compliance Tips, Federal patient safety Legislation Initiatives, Medical Device Reporting, Clinical trials and Adverse-Event Reporting, Patient safety Goals and standards, The Quality Assessment and performance Improvement rule.

Unit-III STANDARDS AND TESTING 9

Guidelines and safety practices to improve patient safety, Electrical safety codes and standards - IEC 60601-1 2005 standard, Basic Approaches to protection against shock, protection equipment design, Electrical safety analyser - Testing the electric system

Unit-IV PATIENT SAFETY IN MAIN CLINICAL SPECIALITIES 9

Intensive care and Anesthesiology, safety surgery save lives, Emergency department clinical risk, Obstetric safety patient, Patient safety in internal medicine, Patient safety in Radiology

unit-V MEDICAL ETHICS 9

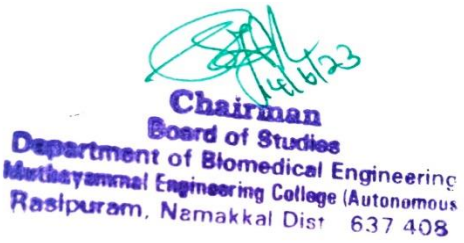
Definition of Medical ethics, Scope of ethics in medicine, American medical Association code of ethics, CMA code of ethics- Fundamental Responsibilities, The Doctor and The Patient, The Doctor and The Profession,

Professional Independence, The Doctor And Society, Case Studies.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	John G.Webster	Medical Instrumentation Application and design	Wiley India Pvt. Ltd, New Delhi	4th edition, 2015
2.	Liam Donaldson, Walter Ricciardi,	Textbook of patient safety and clinical Risk management	Springer	
3.	Fay A. Rozovsky, James R. Woods	The Handbook of Patient Safety Compliance		2016



23BMS01	MINIPROJECT	L	T	P	C
		0	0	2	1

Course Objective:

- To identify a specific problem in biomedical field in the current scenario.
- To enable analytical and practical exposure by giving hands on experience with learned knowledge.
- To provide solution to the identified problem through systematic approach.
- To learn project report writing and presentation.

Course Outcomes:

23BMS01.CO1 Identify the problem to solve and meet its requirements.

23BMS01.CO2 Design the solution of the problem identified by using modern tools.

23BMS01.CO3 Develop a project using advanced technologies.

23BMS01.CO4 Develop analytical thinking and professional skills to prepare for final year project.

23BMS01.CO5 Demonstrate the developed project and its outcome to the evaluators.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BMS01.CO1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
23BMS01.CO2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
23BMS01.CO3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
23BMS01.CO4	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
23BMS01.CO5	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Students form teams consisting maximum of 4 members per team. Each team has to work under a project supervisor. Based on the knowledge gained so far, any simple project must be identified for the miniproject with the consultation of the supervisor and the same must be implemented. The activities are to be registered in a report and submitted by the student which will be reviewed and evaluated for internal assessment by a Committee constituted by the Head of the Department. At the end of the semester, the miniproject is evaluated based on oral presentation and the miniproject report, by internal examiners.

Total Periods: 45

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23BMS02	PROJECT WORK PHASE - I	L	T	P	C
		0	0	2	1

Course Objective:

- To identify a specific problem in biomedical field in the current scenario.
- To provide solution to the identified problem through systematic approach.
- To learn project report writing and presentation.

Course Outcomes:

23BMS02.CO1 Discover technical ideas in the field of BME and express strategies and methodologies.

23BMS02.CO2 Summarize a survey of several available literatures in the preferred field of study.

23BMS02.CO3 Convert ideas of interest into a conceptual model by comparing several existing solutions.

23BMS02.CO4 monstrate an ability to work in teams in a collaborative and productive manner.

23BMS02.CO5 rmulate and propose a plan for creating a solution, prepare technical report and present the oral demonstrations.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BMS02.CO1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
23BMS02.CO2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
23BMS02.CO3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
23BMS02.CO4	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
23BMS02.CO5	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Students form teams consisting maximum of 4 members per team. Each team has to work under a project supervisor. Based on the current scenario, any relevant problem must be identified for the project work with the consultation of the supervisor. Literature review must be done related to the problem identified. The working methodology of the project work for the phase II is to be decided. These activities are to be registered in a report and submitted by the student which will be reviewed and evaluated for internal assessment by a Committee constituted by the Head of the Department. At the end of the semester, the project work is evaluated based on oral presentation and the project report, jointly by external and internal examiners.

Total Periods 150

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23BMS03	PROJECT WORK PHASE - II	L	T	P	C
		0	0	2	1

Course Objective:

- To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same.
- To design and implement a complete working project model.
- To exhibit the communication skills in presenting the project done.

Course Outcomes:

23BMS03.CO1	Demonstrate a sound technical knowledge of their selected project topic.
23BMS03.CO2	Design engineering solutions to complex problems with a systematic approach.
23BMS03.CO3	Utilize the new tools, algorithms, techniques that contribute to obtain the solution of the project.
23BMS03.CO4	Work independently as well as in teams and manage a project from start to finish.
23BMS03.CO5	Demonstrate the knowledge, skills and attitudes of a professional engineer.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BMS03.CO1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
23BMS03.CO2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
23BMS03.CO3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
23BMS03.CO4	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
23BMS03.CO5	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Students form teams consisting maximum of 4 members per team. Each team has to work under a project supervisor. Based on the current scenario, any relevant problem must be identified for the project work with the consultation of the supervisor. Literature review must be done related to the problem identified. The working methodology of the project work for the phase II is to be decided. These activities are to be registered in a report and submitted by the student which will be reviewed and evaluated for internal assessment by a Committee constituted by the Head of the Department. At the end of the semester, the project work is evaluated based on oral presentation and the project report, jointly by external and internal examiners..

Total Periods: 270

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23BMS04	PRESENTATION SKILL AND TECHNICAL SEMINAR	L	T	P	C
		0	0	2	1

Course Objective:

- To identify a topic or problem related to the curriculum
- To represent the collected detail in the form of charts, tables, block diagrams, etc.
- To demonstrate the analysis with better professionalism, communication and technical skills utilizing different tools in the presentation and report.

Course Outcomes:

23BMS04.CO1 Acquire technical knowledge along with communication and presentation skill.

23BMS04.CO2 Utilize new tools and techniques for report preparation and oral presentation.

23BMS04.CO3 Prepare technical report and present.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BMS04.CO1	X	X	-	X	X	-	-	-	X	X	X	X	X	X	-
23BMS04.CO2	X	X	X	X	X	-	-	-	X	X	X	X	X	X	-
23BMS04.CO3	X	X	X	X	X	X	-	X	X	X	X	X	X	X	-

The students individually work under a supervisor. The students identify a topic or problem related to the curriculum. Students will present collected detail in the form of charts, tables, block diagrams, etc., using power point presentation. It will be reviewed and evaluated for internal assessment by a Committee constituted by the Head of the Department. At the end of the semester, the technical seminar is evaluated based on oral presentation of each student by internal examiners constituted by the Head of the Department.

Total Periods: 30

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23BMS05	INNOVATIVE PRACTICES	L	T	P	C
		0	0	2	1

Course Objective:

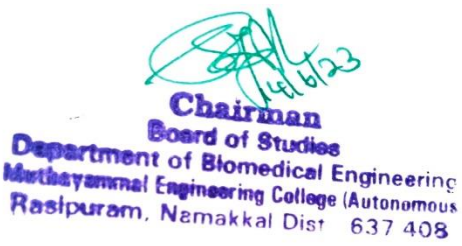
- To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same.

Course Outcomes:

23BMS05.CO1	Able to show competence in identifying relevant information, defining and explaining topics under discussion.
23BMS05.CO2	Demonstrate depth of understanding, use primary and secondary sources.
23BMS05.CO3	Able to show competence in working with a methodology, structuring their oral work, and synthesizing information
23BMS05.CO4	Able to make use of visual, audio and audio-visual material to support their presentation
23BMS05.CO5	Use appropriate vocabulary, and will demonstrate command of voice modulation, voice projection, and pacing.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BMS05.CO1	X	-	-	-	-	X	X	X	X	X	-	X	X	-	X
23BMS05.CO2	X	-	-	-	-	X	X	X	X	X	-	X	X	-	X
23BMS05.CO3	X	-	-	-	-	X	X	X	X	X	-	X	X	-	X
23BMS05.CO4	X	-	-	-	-	X	X	X	X	X	-	X	X	-	X
23BMS05.CO5	X	-	-	-	-	X	X	X	X	X	-	X	X	-	X

The students individually identify a technical topic and present the collected detail in the form of charts, tables, block diagrams, etc., using power point presentation. It will be reviewed and evaluated for internal assessment by a Committee constituted by the Head of the Department. At the end of the semester, the evaluation is based on oral presentation of each student by internal examiners constituted by the Head of the Department.



23BMS06	INTERNSHIP – I / HOSPITAL TRAINING - I	L	T	P	C
		0	0	2	1

Course Objective:

- To get connected with industry/ Hospital/ laboratory/research institute.
- To get practical knowledge on the procedures / processes and develop skills to solve related problems.

Course Outcomes:

23BMS06.CO1 Demonstrate creativity in solving problems related to real-life scenario.

23BMS06.CO2 Communicate effectively in issues related to process/projects undertaken.

23BMS06.CO3 Demonstrate and practice good work ethics.

23BMS06.CO4 Work independently or under very minimal supervision.

23BMS06.CO5 Demonstrate planning, management, monitoring and delivery of project undertaken.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BMS06.CO1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
23BMS06.CO2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
23BMS06.CO3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
23BMS06.CO4	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
23BMS06.CO5	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

The students individually undergo training in reputed firms/ Hospitals / laboratories research institute for the specified duration. After the completion of training, a detailed report should be submitted within ten days from the commencement of subsequent semester. The students will be evaluated as per the Regulations.

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23BMS07	INTERNSHIP - II / HOSPITAL TRAINING - II	L	T	P	C
		0	0	2	1

Course Objective:

- To get connected with industry/ Hospital/ laboratory/research institute.
- To get practical knowledge on the procedures / processes and develop skills to solve related problems.

Course Outcomes:

23BMS07.CO1 Demonstrate creativity in solving problems related to real-life scenario.

23BMS07.CO2 Communicate effectively in issues related to process/projects undertaken.

23BMS07.CO3 Demonstrate and practice good work ethics.

23BMS07.CO4 Work independently or under very minimal supervision.

23BMS07.CO5 Demonstrate planning, management, monitoring and delivery of project undertaken.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BMS07.CO1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
23BMS07.CO2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
23BMS07.CO3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
23BMS07.CO4	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
23BMS07.CO5	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

The students individually undergo training in reputed firms/ Hospitals / laboratories research institute for the specified duration. After the completion of training, a detailed report should be submitted within ten days from the commencement of subsequent semester. The students will be evaluated as per the Regulations

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23BMS08	PROFESSIONAL SKILLS FOR BIOMEDICAL ENGINEERS	L	T	P	C
		0	0	2	1

Course Objective:

- To make students practice essential academic skills, including college-level writing, speaking, problem-solving, critical thinking, collaboration and documentation.

Course Outcomes:

23BMS08.CO1	Able to show competence in identifying relevant information, defining and explaining topics under discussion.
23BMS08.CO2	Demonstrate depth of understanding, use primary and secondary sources.
23BMS08.CO3	Able to show competence in working with a methodology, structuring their oral work, and synthesizing information
23BMS08.CO4	Able to make use of visual, audio and audio-visual material to support their presentation
23BMS08.CO5	Use appropriate vocabulary, and will demonstrate command of voice modulation, voice projection, and pacing.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23BMS08.CO1	X	-	-	-	-	X	X	X	X	X	-	X	X	-	X
23BMS08.CO2	X	-	-	-	-	X	X	X	X	X	-	X	X	-	X
23BMS08.CO3	X	-	-	-	-	X	X	X	X	X	-	X	X	-	X
23BMS08.CO4	X	-	-	-	-	X	X	X	X	X	-	X	X	-	X
23BMS08.CO5	X	-	-	-	-	X	X	X	X	X	-	X	X	-	X

The students individually identify a technical topic and present the collected detail in the form of charts, tables, block diagrams, etc., using power point presentation. It will be reviewed and evaluated for internal assessment by a Committee constituted by the Head of the Department. At the end of the semester, the professional skill is evaluated based on oral presentation of each student by internal examiners constituted by the Head of the Department