



MUTHAYAMMAL ENGINEERING COLLEGE **(An Autonomous Institution)**

(Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai)

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

Curriculum/Syllabus

Programme Code : **BME**

Programme Name : **B.E-Biomedical Engineering**

Regulation : **R-2016**



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Rasipuram - 637 408, Namakkal Dt, Tamil Nadu.

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

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.

INSTITUTION MOTTO

Rural upliftment through Technical Education.

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Department of Biomedical Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram, Namakkal Dist 637 408



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DEPARTMENT VISION & MISSION

DEPARTMENT VISION

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

DEPARTMENT MISSION

- M1: To impart value-based education in Biomedical Engineering using medical equipments.
- M2: To prepare the students for placements and entrepreneurship in Healthcare industries through Hospital Training.
- M3: To provide solutions to healthcare industries and society through lifelong learning with ethical values.

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DEPARTMENT PROGRAM EDUCATIONAL OBJECTIVES, PROGRAM OUTCOMES
& PROGRAM SPECIFIC OUTCOMES

PROGRAM EDUCATIONAL OBJECTIVES:

- PEO1:** Apply biomedical engineering concepts to handle modern medical equipments in diagnosis process.
- PEO2:** Generate solutions that address real-time challenges in the healthcare sector.
- PEO3:** Maintain and improve technical competence in biomedical engineering through lifelong learning with ethical and moral values.

PROGRAM OUTCOMES:

1. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.
2. **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.
3. **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.
4. **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.


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5. **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.
6. **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.
7. **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.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **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.
11. **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.
12. **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.

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.


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B.E. –BIOMEDICAL ENGINEERING

FOUNDATION COURSE [FC]

S.No.	Course Code	Course Title	Category	Contact Hours	Instruction Hours/Week			C
					L	T	P	
1.	16SHA01	Technical English	HS	5	3	2	0	4
2.	16SHA02	Communicative English	HS	7	3	0	4	5
8.	16SHA08	Principles of Management and Engineering Ethics	HS	3	3	0	0	3
9.	16SHB01	Matrices, Calculus & Ordinary Differential Equations	BS	5	3	2	0	4
10.	16SHB02	Complex Variables ,Laplace Transforms & Vector Calculus	BS	5	3	2	0	4
11.	16SHB03	Transforms & Partial Differential Equations	BS	5	3	2	0	4
12.	16SHB04	Probability & Random Processes	BS	5	3	2	0	4
13.	16SHB21	Engineering Physics	BS	6	2	0	4	4
14.	16SHB22	Material Science	BS	3	3	0	0	3
15.	16SHB31	Engineering Chemistry	BS	6	2	0	4	4
16.	16SHB32	Environmental Science and Engineering	BS	3	3	0	0	3
17.	16BMC01	Fundamentals of Computing and Programming	ES	6	2	0	4	4
18.	16BMC02	Advanced C Programming	ES	6	2	0	4	4
19.	16BMC04	Basics Electrical and Electronics Engineering	ES	3	3	0	0	3
20.	16BMC09	Microprocessor and Microcontrollers	ES	5	3	0	2	4
21.	16BMC11	Data Structures	ES	6	2	0	4	4
22.	16BMC12	Electron Devices	ES	6	2	0	4	4
23.	16BMC16	Fundamentals of Biochemistry	ES	6	2	0	4	4
24.	16BMC17	Bio Mechanics	ES	3	3	0	0	3
25.	16BMC18	Medical Informatics	ES	5	3	2	0	4


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Programme Code & Name – B.E. & Biomedical Engineering

24.	16BMC17	Bio Mechanics	ES	3	3	0	0	3
25.	16BMC18	Medical Informatics	ES	5	3	2	0	4

PROFESSIONAL CORE [PC]

S.No.	Course Code	Course Title	Category	Contact Hours	Instruction Hours/Week			C
					L	T	P	
1.	16BMD01	Anatomy and Human Physiology	PC	3	3	0	0	3
2.	16BMD03	Bio Medical Instrumentation and Measurements	PC	5	3	0	2	4
3.	16BMD04	Digital Electronics	PC	5	3	0	2	4
4.	16BMD05	Signals and Systems	PC	5	3	2	0	4
5.	16BMD06	Therapeutic Equipments	PC	5	3	2	0	4
6.	16BMD07	Bio Control System	PC	5	3	2	0	4
7.	16BMD08	Analog Electronics	PC	5	3	0	2	4
8.	16BMD09	Linear Integrated Circuits	PC	5	3	0	2	4
9.	16BMD10	Human Assist Devices	PC	5	3	0	2	4
10.	16BMD11	Pathology and Microbiology	PC	5	3	0	2	4
11.	16BMD12	Hospital Management	PC	3	3	0	0	3
12.	16BMD14	Digital Signal Processing	PC	5	3	0	2	4
13.	16BMD15	Embedded System	PC	5	3	0	2	4
14.	16BMD17	Digital Image Processing	PC	3	3	0	0	3
15.	16BMD18	Medical Imaging Techniques	PC	3	3	0	0	3
16.	16BMD19	Electrical Safety and Quality Assurance	PC	3	3	0	0	3

PROFESSIONAL ELECTIVES [PE]

S. No.	Course Code	Course Title	Category	Contact Hours	Instruction Hours/Week			C
					L	T	P	
1.	16BME01	Advanced Bio analytical and Therapeutic Techniques	PE	3	3	0	0	3
2.	16BME02	Bio Signal Processing	PE	3	3	0	0	3
3.	16BME03	Biomaterials and Artificial Organs	PE	3	3	0	0	3
4.	16BME04	Biomedical Engineering	PE	3	3	0	0	3
5.	16BME05	Biomaterials and Characterization	PE	3	3	0	0	3

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6.	16BME06	Body Area Networks	PE	3	3	0	0	3
7.	16BME07	Brain Computer Interface and Applications	PE	3	3	0	0	3
8.	16BME08	Medical Optics	PE	3	3	0	0	3
9.	16BME09	Soft Computing	PE	3	3	0	0	3
10.	16BME10	Neural Engineering	PE	3	3	0	0	3
11.	16BME11	Physiological Modeling	PE	3	3	0	0	3
12.	16BME12	Multimedia Compression and Networks	PE	3	3	0	0	3
13.	16BME13	Rehabilitation Engineering	PE	3	3	0	0	3
14.	16BME14	Virtual Reality	PE	3	3	0	0	3
15.	16BME15	Wearable Systems	PE	3	3	0	0	3
16.	16BME16	Internet and JAVA Programming	PE	3	3	0	0	3
17.	16BME17	Cryptography and Network Security	PE	3	3	0	0	3
18.	16BME18	Hospital Waste Management	PE	3	3	0	0	3
19.	16BME19	Medical Physics	PE	3	3	0	0	3
20.	16BME20	Computer Architecture and organization	PE	3	3	0	0	3


EMPLOYABILITY ENHANCEMENT COURSES (EEC)


S.No.	Course Code	Course Title	Category	Contact Hours	Instruction Hours/Week			C
					L	T	P	
1.	16BMF01	Project Work Phase – I	EEC	6	0	0	6	3
2.	16BMF02	Project Work Phase –II	EEC	30	0	0	30	15
3.	16BMF05	Hospital Training	EEC	4	0	0	4	2


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		MUTHAYAMMAL ENGINEERING COLLEGE (Autonomous) (Approved by AICTE & Affiliated to Anna University) RASIPURAM – 637 408				CURRICULUM UG R – 2016	
Department		Biomedical Engineering					
Programme		B.E.					
SEMESTER – I							
Sl.No.	Course Code	Course Name	Hours/ Week			Credit C	Contact Hours
			L	T	P		
THEORY							
1.	16SHA02	Communicative English	3	0	4	5	7
2.	16SHB01	Matrices, Calculus & Ordinary Differential Equations	3	2	0	4	5
3.	16SHB21	Engineering Physics	2	0	4	4	6
4.	16SHB32	Environmental Science and Engineering	3	0	0	3	3
5.	16BMC01	Fundamentals of Computing and Programming	2	0	4	4	6
6.	16BMC04	Basics Electrical and Electronics Engineering	3	0	0	3	3
7.	16BMC06	Engineering Practices for Electrical Sciences	0	0	4	2	4
Total Credits						25	


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Department		Biomedical Engineering					
Programme		B.E.					
SEMESTER – II							
Sl.No.	Course Code	Course Name	Hours/ Week			Credit C	Contact Hours
			L	T	P		
THEORY							
1.	16SHA01	Technical English	3	2	0	4	5
2.	16SHB02	Complex Variables, Laplace Transforms & Vector Calculus	3	2	0	4	5
3.	16SHB22	Material Science	3	0	0	3	3
4.	16SHB31	Engineering Chemistry	2	0	4	4	6
5.	16BMC02	Advanced C Programming	2	0	4	4	6
6.	16BMC12	Electron Devices	2	0	4	4	6
7.	16BMC05	Engineering Graphics	0	0	4	2	4
Total Credits						25	


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 Estd. 2000		MUTHAYAMMAL ENGINEERING COLLEGE (Autonomous) (Approved by AICTE & Affiliated to Anna University) RASIPURAM – 637 408				CURRICULUM UG R – 2016	
Department		Biomedical Engineering					
Programme		B.E.					
SEMESTER – III							
Sl.No.	Course Code	Course Name	Hours/ Week			Credit C	Contact Hours
			L	T	P		
THEORY							
1.	16SHB03	Transforms & Partial Differential Equations	3	2	0	4	5
2.	16BMD05	Signals and Systems	3	2	0	4	5
3.	16BMD08	Analog Electronics	3	0	2	4	5
4.	16BMD04	Digital Electronics	3	0	2	4	5
5.	16BMD01	Anatomy and Human Physiology	3	0	0	3	3
6.	16BMC16	Fundamentals of Bio Chemistry	3	0	2	4	5
Total Credits						23	


 Estd. 2000		MUTHAYAMMAL ENGINEERING COLLEGE (Autonomous) (Approved by AICTE & Affiliated to Anna University) RASIPURAM – 637 408				CURRICULUM UG R – 2016	
Department		Biomedical Engineering					
Programme		B.E.					
SEMESTER – IV							
Sl.No.	Course Code	Course Name	Hours/week			Credit C	Contact Hours
			L	T	P		
THEORY							
1.	16SHB04	Probability & Random Processes	3	2	0	4	5
2.	16BMC09	Microprocessor and Microcontrollers	3	0	2	4	5
3.	16BMD09	Linear Integrated Circuits	3	0	2	4	5
4.	16BMC11	Data Structures	2	0	2	4	6
5.	16BMD11	Pathology and Microbiology	3	0	2	4	5
6.	16BMC17	Bio Mechanics	3	0	0	3	3
Total Credits						23	


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Department		Biomedical Engineering					
Programme		B.E.					
SEMESTER – V							
Sl.No.	Course Code	Course Name	Hours/ Week			Credit C	Contact Hours
			L	T	P		
THEORY							
1.	16BMD12	Hospital Management	3	0	0	3	3
2.	16BMD14	Embedded System	3	0	2	4	5
3.	16SHA08	Principles of Management and Engineering Ethics	3	0	0	3	3
4.	16BMD03	Bio medical Instrumentation and Measurements	3	0	2	4	5
5.	16BMD07	Bio Control System	3	2	0	4	5
6.		Professional Elective -I	3	0	0	3	3
7.		Professional Elective -II	3	0	0	3	3
Total Credits						24	


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Department		Biomedical Engineering					
Programme		B.E.					
SEMESTER – VI							
Sl.No.	Course Code	Course Name	Hours/ Week			Credit C	Contact Hours
			L	T	P		
THEORY							
1.	16BMD10	Human Assist Devices	3	0	2	4	5
2.	16BMD15	Embedded System	3	0	2	4	5
3.	16BMD06	Therapeutic Equipments	3	2	0	4	5
4.	16MDD18	Medical Imaging Techniques	3	0	0	3	3
5.		Professional Elective -III	3	0	0	3	3
6.		Professional Elective -IV	3	0	0	3	3
7.		Open Elective -I	3	0	0	3	3
Total Credits						24	


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Department		Biomedical Engineering					
Programme		B.E.					
SEMESTER – VII							
Sl.No.	Course Code	Course Name	Hours/ Week			Credit C	Contact Hours
			L	T	P		
THEORY							
1.	16BMD19	Electrical Safety and Quality Assurance	3	0	0	3	3
2.	16BMF01	Project Work Phase –I	0	0	6	3	6
3.	16BMF04	Hospital Training	0	0	4	2	4
4.	16BMC18	Medical Informatics	3	2	0	4	5
5.		Professional Elective - V	3	0	0	3	3
6.		Professional Elective - VI	3	0	0	3	3
7.		Open Elective –II	3	0	0	3	3
8.		Open Elective –III				3	
Total Credits						24	

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Department		Biomedical Engineering					
Programme		B.E.					
SEMESTER – VIII							
Sl.No.	Course Code	Course Name	Hours/ Week			Credit C	Contact Hours
			L	T	P		
PRACTICAL							
1.	16BMF02	Project Work Phase –II	0	0	30	15	30
Total Credits						15	


Total Credits to be earned for the award of Degree: 183


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COURSE COMPONENT SUMMARY

S.No.	Subject Area	Credits Per Semester								Credits Total	AICTE Credits
		I	II	III	IV	V	VI	VII	VIII		
1.	FC	25	25	8	15	3		4		80	74
2.	PC			15	8	15	15	3		56	50
3.	PE					6	6	6		18	20
4.	OE						3	6		09	12
5.	EEC							5	15	20	20
TOTAL		25	25	23	23	24	24	24	15	183	176

Total Credits: 183


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COURSE CODE	COURSE TITLE	L	T	P	C
16BMD01	ANATOMY & HUMAN PHYSIOLOGY	3	0	0	3

COURSE OBJECTIVES:

- 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 special sensory system
- Study about nervous system

COURSE OUTCOMES:

16BMD01.CO1	To Know basic structural and functional elements of human body.
16BMD01.CO2	To Learn organs and structures involving in system formation and functions.
16BMD01.CO3	To Understand circulatory system.
16BMD01.CO4	To Learn urinary and special sensory system
16BMD01.CO5	To Study about nervous system


Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BMD01.CO1	X	X	X	X	X	X	-	-	-	-	-	X	X	X	-
16BMD01.CO2	X	X	X	X	X	X	-	-	-	-	-	X	X	X	-
16BMD01.CO3	X	X	X	X	X	X	-	-	-	-	-	X	X	X	-
16BMD01.CO4	X	X	X	X	X	X	-	-	-	-	-	X	X	X	-
16BMD01.CO5	X	X	X	X	X	X	-	-	-	-	-	X	X	X	-

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BMD01.CO1	2	3	3	2	-	2	-	-	-	-	-	2	3	2	-
16BMD01.CO2	2	2	2	2	-	2	-	-	-	-	-	2	3	2	-
16BMD01.CO3	2	2	3	2	-	2	-	-	-	-	-	2	3	2	-
16BMD01.CO4	2	2	3	2	-	2	-	-	-	-	-	2	3	2	-
16BMD01.CO5	2	2	2	2	-	2	-	-	-	-	-	2	3	2	-

1-Low, 2- Medium, 3-High


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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: 45 HRS


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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	8 th 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	22 nd 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	Elsevier Saunders,	11 th 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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COURSE CODE	COURSE TITLE	L	T	P	C
16BMD03	BIOMEDICAL INSTRUMENTATION AND MEASUREMENTS	3	0	0	3

COURSE OBJECTIVES:

- To Illustrate origin of bio potentials and its propagations
- To understand the different types of electrodes and its placement for various recordings
- To design bio amplifier for various physiological recordings
- To learn the different measurement techniques for non-physiological parameters.
- To summarize different biochemical measurements.

COURSE OUTCOMES:

16BMD03.CO1	Differentiate different bio potentials and its propagations.
16BMD03.CO2	Illustrate different electrode placement for various physiological recordings
16BMD03.CO3	Design bio amplifier for various physiological recordings
16BMD03.CO4	Explain various technique for non-electrical physiological measurements
16BMD03.CO5	Demonstrate different biochemical measurement techniques.


Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BMD03.CO1	X	X	X	X	X	X	X	-	-	-	-	X	X	X	X
16BMD03.CO2	X	X	X	X	X	X	X	-	-	-	-	X	X	X	X
16BMD03.CO3	X	X	X	X	X	X	X	-	-	-	-	X	X	X	X
16BMD03.CO4	X	X	X	X	X	X	X	-	-	-	-	X	X	X	X
16BMD03.CO5	X	X	X	X	X	X	X	-	-	-	-	X	X	X	X

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BMD03.CO1	3	2	3	3	3	3	2	-	-	-	-	2	2	3	2
16BMD03.CO2	3	2	2	3	3	2	2	-	-	-	-	2	2	2	2
16BMD03.CO3	3	2	3	2	3	3	3	-	-	-	-	2	2	3	2
16BMD03.CO4	3	3	3	3	3	3	2	-	-	-	-	2	2	3	2
16BMD03.CO5	3	2	2	3	3	3	2	-	-	-	-	2	2	3	2

1-Low, 2- Medium, 3-High


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UNIT I ELECTROPHYSIOLOGY AND BIOPOTENTIAL ELECTRODES

9

Origin of bio potential, Electrode-electrolyte interface, electrode-skin interface, half-cell potential, Contact impedance, polarization effects of electrode – non polarizable electrodes. Types of electrodes - surface, needle and micro electrodes and their equivalent circuits. Recording problems - , measurement with two electrodes.

UNIT II BIO-POTENTIAL MEASUREMENTS OF PARAMETERS

9

Bio signals characteristics – frequency and amplitude ranges. ECG – Einthoven’s triangle, standard 12 lead system, Principles of vector cardiography. EEG – 10-20 electrode system, unipolar, bipolar and average mode. EMG – unipolar and bipolar mode. Recording of ERG, EOG and EGG

UNIT III BIO AMPLIFIER WITH SIGNAL CONDITIONING CIRCUITS

9

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

UNIT IV MEASUREMENT OF NON-ELECTRICAL PARAMETERS

9

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

UNIT V BIO-CHEMICAL MEASUREMENT

9

Biochemical sensors - pH, pO₂ and pCO₂, Ion selective Field effect Transistor (ISFET), Immunologically sensitive FET (IMFET), Blood glucose sensors, Blood gas analyzers - colorimeter, Sodium Potassium Analyzer, spectrophotometer, blood cell counter, auto analyzer (simplified schematic description)

TOTAL: 45 HRS

LIST OF EXPERIMENTS:

1. Real Time data Acquisition and Analysis of the following physiological parameters ECGs (EKGs), EMGs, and EEGs
2. Measurement of Blood Pressure using Sphygmomanometer & Digital meter.
3. Recording of Electromyogram/ nerve conduction velocity.
4. The Galvanic Skin Response Amplifier
5. Study of lung and cardiovascular models
6. Bridge Amplifier: Testing of various transducers including commonly available i)force, ii)pressure, and iii)displacement transducers, iv)temperature probes, v)light meters,
7. Study and usage of Automatic defibrillators.
8. Measurement of pH of a given solution using pH meter.
9. Determination of solution concentration using Colorimeter/Spectrophotometer.

TOTAL: 30 HRS



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TEXT BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Leslie Cromwell	Biomedical Instrumentation and measurement 2 nd edition	Prentice hall of India, New Delhi	2015
2.	Khandpur R.S,	Handbook of Biomedical Instrumentation 3 rd edition	Tata McGraw-Hill New Delhi	2014

REFERENCE 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	4 th Edition 2015
2.	Joseph J. Carr John M. Brown	Introduction to Biomedical Equipment Technology	Pearson Education	2004
3.	Myer Kutz	Standard Handbook of Biomedical Engineering and Design	McGraw Hill Publisher	2003


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Programme Code & Name – B.E. & Biomedical Engineering

COURSE CODE	COURSE TITLE	L	T	P	C
16BMD04	DIGITAL ELECTRONICS	3	0	2	4

COURSE OBJECTIVES:

- To introduce basic postulates of Boolean algebra and shows the correlation between Boolean expressions
- To outline the formal procedures for the analysis and design of combinational circuits
- To outline the formal procedures for the analysis and design of sequential circuits
- To illustrate the concept of synchronous and asynchronous sequential circuits
- To introduce the concept of Different Logic Families and programmable logic devices.

COURSE OUTCOMES:

16BMD04.CO1	Apply Boolean algebra, Karnaugh map and Tabulation method for simplification of Boolean expressions
16BMD04.CO2	Design combinational logic circuits for various applications
16BMD04.CO3	Design shift registers, Modulo-N asynchronous and synchronous counters
16BMD04.CO4	Design and analyze state machines for the given specifications
16BMD04.CO5	Discuss different logic families and Implement digital circuit in programmable logic devices


Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BMD04.CO1	X	X	X	X	X	-	-	-	X	-	-	X	X	X	X
16BMD04.CO2	X	X	X	X	X	-	-	-	X	-	-	X	X	X	X
16BMD04.CO3	X	X	X	X	X	-	-	-	X	-	-	X	X	X	X
16BMD04.CO4	X	X	X	X	X	-	-	-	X	-	-	X	X	X	X
16BMD04.CO5	X	X	X	X	X	-	-	-	X	-	-	X	X	X	X

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BMD04.CO1	2	2	2	2	1	-	-	-	2	-	-	2	2	3	2
16BMD04.CO2	2	2	2	2	1	-	-	-	2	-	-	2	2	2	2
16BMD04.CO3	2	2	2	1	2	-	-	-	2	-	-	2	2	3	2
16BMD04.CO4	2	2	2	1	2	-	-	-	2	-	-	2	2	2	2
16BMD04.CO5	2	2	2	1	1	-	-	-	2	-	-	2	2	3	2

1-Low, 2- Medium, 3-High


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UNIT I BASIC CONCEPTS OF DIGITAL SYSTEMS 9
Review of Number systems, Number Representation, Boolean algebra, Boolean postulates and laws - De-Morgan's Theorem - Principle of Duality, Simplification using Boolean algebra, Canonical forms - Sum of product and Product of sum - Minimization using Karnaugh map and Tabulation method.

UNIT II COMBINATIONAL CIRCUITS 9
Realization of combinational logic using gates , Design of combinational circuits : Adder, Subtractor, Parallel adder Subtractor, Carry look ahead adder, Magnitude Comparator, Parity generator and checker, Encoder, Decoder, Multiplexer, Demultiplexer - Function realization using Multiplexer, Decoder - Code converters.

UNIT III SEQUENTIAL CIRCUITS 9
Flip-flops - SR, JK, D and T- Master-Slave – Triggering - Characteristic table and equation – Application table – Asynchronous and synchronous counters - Shift registers - Types – Universal shift registers – Ring counter –Johnson Counters- Serial adder / Subtractor.

UNIT IV SYNCHRONOUS AND ASYNCHRONOUS SEQUENTIAL CIRCUITS 9
Mealy and Moore models – State diagram - State table – State minimization – State assignment - Excitation table - Design of Synchronous sequential circuits: Counters and Sequence generators- Circuit implementation - Asynchronous sequential circuits - Hazards and Races, Hazard free combinational circuits.

UNIT V LOGIC FAMILIES AND PROGRAMMABLE DEVICES 9
Introduction to Logic families – TTL & CMOS Logic and their characteristics – Tristate gates - Programmable Logic Devices – Programmable Logic Array (PLA) - Programmable Array Logic (PAL), Field Programmable Gate Arrays (FPGA) – Implementation of combinational logic circuits using PLA, PAL.

LIST OF EXPERIMENTS

1. Design and implementation of Combinational logic functions
2. Design and implementation of Adders and Subtractors
3. Design and implementation of Code Converters
4. Design and implementation of Parity Generator and Checker
5. Design and implementation of Magnitude Comparator
6. Design and implementation of Multiplexer and De-multiplexer
7. Design and implementation of Encoders and Decoders
8. Design and implementation of Asynchronous Counters
9. Design and implementation of Synchronous Counters
10. Design and implementation of Shift registers

TOTAL: 45 HRS

TOTAL: 30 HRS



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TEXT BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Morris Mano M. and Michael D. Ciletti	Digital Design	Pearson Education	5 th Edition, 2013
2.	Donald D.Givone,	Digital Principles and Design	Tata Mc-Graw Hill Publishing company limited, New Delhi	2002

REFERENCE BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Thomas L. Floyd	Digital Fundamentals	Pearson Education Inc	10 th Edition, 2011
2.	Charles H. Roth Jr,	Fundamentals of Logic Design	Jaico Publishing House	5 th Edition, 2003
3.	Leach D, Malvino A P & Saha	Digital Principles and Applications	Tata McGraw-Hill Publishing Company	8th Edition, 2014
4.	John F. Wakerly,	Digital Design Principles and Practices	Pearson Education	6 th Edition, 2007
5.	John.M Yarbrough	Digital Logic Applications and Design	Thomson – Vikas Publishing House	2002


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Programme Code & Name – B.E. & Biomedical Engineering

COURSE CODE	COURSE TITLE	L	T	P	C
16BMD05	SIGNALS & SYSTEMS	3	1	0	4

COURSE OBJECTIVES:

- To understand the basic properties of signal & systems and the various methods of classification.
- To learn Laplace Transform & Fourier transform and their properties.
- To Learn Continuous Time LTI System.
- To know Z transform & DTFT and their properties.
- To characterize LTI systems in the Time domain and various Transform domains.

COURSE OUTCOMES:

16BMD05.CO1	Able to describe classification of signals and systems
16BMD05.CO2	Analyze the Laplace transform, Fourier transform
16BMD05.CO3	Ability to analyze continuous time LTI systems using Fourier and Laplace Transforms
16BMD05.CO4	Analyze Z Transform and DTFT
16BMD05.CO5	Ability to analyze discrete time LTI systems using Z transform and DTFT

Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BMD05.CO1	X	X	X	X	X	-	-	-	-	-	-	X	X	X	X
16BMD05.CO2	X	X	X	X	X	-	-	-	-	-	-	X	X	X	X
16BMD05.CO3	X	X	X	X	X	-	-	-	-	-	-	X	X	X	X
16BMD05.CO4	X	X	X	X	X	-	-	-	-	-	-	X	X	X	X
16BMD05.CO5	X	X	X	X	X	-	-	-	-	-	-	X	X	X	X

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BMD05.CO1	3	3	3	3	2	-	-	-	-	-	-	2	2	3	2
16BMD05.CO2	3	3	3	2	2	-	-	-	-	-	-	2	2	3	3
16BMD05.CO3	3	3	3	3	2	-	-	-	-	-	-	2	2	3	2
16BMD05.CO4	3	3	3	2	2	-	-	-	-	-	-	2	2	3	3
16BMD05.CO5	3	3	3	3	2	-	-	-	-	-	-	2	2	3	2

1-Low, 2- Medium, 3-High


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UNIT I:	FUNDAMENTALS OF SIGNAL PROCESSING	9
Sampling and aliasing, simple signal conversion systems, spectral analysis - FFT -decimation in time algorithm - Decimation in Frequency algorithm - Different types of bioelectric signals and its basic characteristics.		
UNIT II	SIGNALS AND 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 III	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 IV	ANALYSIS OF BIOSIGNALS	9
P-wave detection, QRS complex detection-derivative based method, Pan Tompkins algorithm - Template matching method, - Signal averaged ECG - Analysis of heart rate variability-time domain method and frequency domain methods - Synchronized averaging of PCG envelopes, envelopogram, analysis of PCG signal, EMG signal analysis.		
UNIT V	CASE STUDIES IN BSP	9
ECG rhythm analysis, normal and ectopic ECG beats, analysis of exercise ECG - Analysis of respiration, spectral analysis of EEG signals - Case studies- in ECG and PCG - PCG and carotid pulse - ECG and atrial electrogram -Cardio respiratory interaction - EMG and Vibromyogram (VMG).		

TOTAL: 45 HRS


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Programme Code & Name – B.E. & Biomedical Engineering

TEXT BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Rangaraj.M .Rangayyan	Biomedical signal processing	Wiley-IEEE press,	2 nd Edition, 2015
2.	P. Ramakrishna Rao	Signals and Systems	McGraw Hill	2 nd Edition, 2013.

REFERENCE BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	B P Lathi	Signals and Systems	B S Publisher	2001
2.	Nagrath ,Sharan	Signals and Systems	McGraw Hill	2009
3.	S.Salivahanan, N.Sureshkumar and A.Vallavaraj	Signals and Systems	Tata McGraw Hill	2011
4.	D.Ganesh Rao, Sathish Tunga	Signals and Systems	Pearson	2011
5.	Reddy D.C,	Biomedical signal processing: Principles and techniques	Tata McGraw-Hill, New Delhi, 2nd edition,	2005


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Programme Code & Name – B.E. & Biomedical Engineering

COURSE CODE	COURSE TITLE	L	T	P	C
16BMD06	THERAPEUTIC EQUIPMENTS	3	0	0	3

COURSE OBJECTIVES:

- To Familiarize the working of cardiac equipments and use
- To introduce the principles of life- support and arrhythmia equipment in clinical use.
- To familiarize with design and system level analysis different therapeutic equipments.
- To identify the application and safety aspects of different equipments
- To learn the different monitoring techniques for internal organs

COURSE OUTCOMES:

16BMD06.CO1	Describe the working setup of all basic cardiac equipment.
16BMD06.CO2	Students will have acquired thorough life support equipment in clinical use.
16BMD06.CO3	Learned the design and system level analysis different therapeutic equipments
16BMD06.CO4	Analyzing the application and safety aspects of different equipments
16BMD06.CO5	Studied various internal organ monitoring devices


Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BMD06.CO1	X	X	X	X	X	X	X	-	-	-	-	X	X	X	X
16BMD06.CO2	X	X	X	X	X	X	X	-	-	-	-	X	X	X	X
16BMD06.CO3	X	X	X	X	X	X	X	-	-	-	-	X	X	X	X
16BMD06.CO4	X	X	X	X	X	X	X	-	-	-	-	X	X	X	X
16BMD06.CO5	X	X	X	X	X	X	X	-	-	-	-	X	X	X	X

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BMD06.CO1	3	3	3	2	3	3	2	-	-	-	-	2	3	3	3
16BMD06.CO2	3	2	3	2	3	2	3	-	-	-	-	2	3	3	3
16BMD06.CO3	2	2	3	2	2	3	2	-	-	-	-	2	3	3	3
16BMD06.CO4	3	2	2	2	3	3	2	-	-	-	-	2	3	3	3
16BMD06.CO5	3	3	2	1	3	3	2	-	-	-	-	2	3	3	3

1-Low, 2- Medium, 3-High


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UNIT I **CARDIAC EQUIPMENT** **9**

Cardiac Pacemaker – Need for cardiac pacemaker – External pacemakers- types - voltage pacemakers – current- pacemakers - current limited voltage pacemakers. Internal pacemakers - basic requirement – types: fixed rate, demand pacemakers, R wave triggered, R wave blocked, Atrial triggered pacemakers. Programmable pacemakers - Functional block diagram and description

UNIT II **DEFIBRILLATOR EQUIPMENT** **8**

Defibrillators - Need for a defibrillator- basic principle and comparison of output wave forms of different DC defibrillators - Defibrillator electrodes - DC defibrillator with synchronizer Functional block diagram. Automatic external defibrillators - Block diagram. Implantable defibrillators – components - block diagram defibrillator analyzers - RF ablation treatment for arrhythmia

UNIT III **VENTILATORS AND STIMULATORS** **10**

Ventilators: Physiological factors affecting Volume exchange - Compliance - respiratory resistance. Functional specification - inspiratory phase – change over from inspiratory to expiratory phase – inspiratory phase, expiratory phase Electrical stimulators, nerve and muscle stimulators - - Stimulators for pain and relief- functional electrical stimulation- Ultrasonic stimulator

UNIT IV **DIATHERMY** **10**

Surgical diathermy -Principles and applications, Functional block diagram - monopolar & bipolar techniques, Electrodes and Safety aspects in electrosurgical units, electro surgical analyzers. Principles of short wave and microwave diathermy

UNIT V **ENDOSCOPY AND ANESTHESIA** **8**

Endoscopy – Principles, types & applications. Block diagram of a fiber optic endoscope with integral TV cameras. Anesthetic machines: Need of anesthesia, gas used and their sources, gas blending and vaporizers, anesthesia delivery system. breathing circuits

TOTAL: 45 HRS


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TEXT BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Joseph J. Carr John M. Brown	Introduction to Biomedical Equipment Technology	Pearson education	2012
2.	R S Khandpur	Handbook of Bio medical Instrumentation	Tata McRaw Hill	2004

REFERENCE BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Bronzino	Hand book of Biomedical Engineering	IEEE press book	2000
2.	Mushin	Automatic Ventilation of Lung	Black Well	1980
3.	Joseph J. Carr, John M. Brown	Introduction to Biomedical Equipment Technology	Pearson Education	2001
4.	Geddes & Baker	Principles of Applied Biomedical Instrumentation	Wiley	1989
5.	John G. Webster	Medical Instrumentation Application and Design - 4 th edition	Wiley India Pvt Ltd, New Delhi	2015


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Programme Code & Name – B.E. & Biomedical Engineering

COURSE CODE	COURSE TITLE	L	T	P	C
16BMD07	BIO CONTROL SYSTEM	3	0	0	3

COURSE OBJECTIVES:

- To introduce the elements of control system and their modeling using various Techniques.
- To introduce methods for analyzing the time response, of systems
- To introduce methods for analyzing, the frequency response of systems
- To introduce methods for analyzing the stability of systems
- To introduce the state variable analysis method

COURSE OUTCOMES:

16BMD07.CO1	Analysis the knowledge of various control models
16BMD07.CO2	Perform time domain control systems required for system analysis.
16BMD07.CO3	Perform frequency domain analysis of control systems required for system analysis.
16BMD07.CO4	Performance analysis of control systems required for stability analysis
16BMD07.CO5	Design the state variable analysis method.


Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BMD07.CO1	X	X	X	X	X	-	X	-	-	-	-	X	X	X	X
16BMD07.CO2	X	X	X	X	X	-	X	-	-	-	-	X	X	X	X
16BMD07.CO3	X	X	X	X	X	-	X	-	-	-	-	X	X	X	X
16BMD07.CO4	X	X	X	X	X	-	X	-	-	-	-	X	X	X	X
16BMD07.CO5	X	X	X	X	X	-	X	-	-	-	-	X	X	X	X

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BMD07.CO1	3	3	3	3	2	-	2	-	-	-	-	2	2	2	2
16BMD07.CO2	3	2	3	2	2	-	2	-	-	-	-	2	2	2	1
16BMD07.CO3	3	3	3	3	2	-	2	-	-	-	-	2	2	2	2
16BMD07.CO4	3	3	2	3	2	-	2	-	-	-	-	2	1	2	1
16BMD07.CO5	3	3	2	3	2	-	2	-	-	-	-	2	2	2	2


1-Low, 2- Medium, 3-High


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UNIT I	CONTROL SYSTEM MODELING	9
Basic Elements of Control System – Open loop and Closed loop systems - Differential equation - Transfer function, Modeling of Electric systems, Translational and rotational mechanical systems - Block diagram reduction Techniques - Signal flow graph		
UNIT II	TIME RESPONSE ANALYSIS	9
Time response analysis - First Order Systems - Impulse and Step Response analysis of second order systems - Steady state errors – P, PI, PD and PID Compensation, Analysis using MATLAB		
UNIT III	FREQUENCY RESPONSE ANALYSIS	9
Frequency Response - Bode Plot, Polar Plot, Nyquist Plot - Frequency Domain specifications from the plots - Constant M and N Circles - Nichol's Chart - Use of Nichol's Chart in Control System Analysis.		
UNIT IV	STABILITY ANALYSIS	9
Stability, Routh-Hurwitz Criterion, Root Locus Technique, Construction of Root Locus, 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 space representation of Continuous Time 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: 45 HRS

TEXT BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	J.Nagrath and M.Gopal	J.Nagrath and M.Gopal	New Age International Publishers, 5th Edition	2007
2.	Benjamin.C.Kuo	Automatic control systems	Prentice Hall of India, 7th Edition	1995


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REFERENCE BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	M.Gopal	Control System – Principles and Design	Tata McGraw Hill, 2nd Edition	2002
2.	Schaum's Outline Series	Feed back and Control Systems	Tata Mc Graw-Hill	2007
3.	John J.D'Azzo & Constantine H.Houpis	Linear Control System Analysis and Design	Tata Mc Graw-Hill, Inc.,	1995
4.	Richard C. Dorf and Robert H. Bishop	Modern Control Systems	Addison – Wesley	1999
5.	K. Nagoor Kani	Control Systems	RBA publications	2017


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Programme Code & Name – B.E. & Biomedical Engineering

COURSE CODE	COURSE TITLE	L	T	P	C
16BMD08	ANALOG ELECTRONICS	3	0	2	4

COURSE OBJECTIVES:

- Design and construct amplifiers
- Construct JFET and MOSFET amplifiers
- Study rectifiers and power supplies
- Learn about feedback amplifiers
- Learn about oscillators

COURSE OUTCOMES:

16BMD08.CO1	To learn about Design and construct amplifiers
16BMD08.CO2	To Construct JFET and MOSFET amplifiers
16BMD08.CO3	To Study rectifiers and power supplies
16BMD08.CO4	To Learn about feedback amplifiers
16BMD08.CO5	To Learn about oscillators


Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BMD08.CO1	X	X	X	X	X	-	-	-	X	-	-	X	X	X	X
16BMD08.CO2	X	X	X	X	X	-	-	-	X	-	-	X	X	X	X
16BMD08.CO3	X	X	X	X	X	-	-	-	X	-	-	X	X	X	X
16BMD08.CO4	X	X	X	X	X	-	-	-	X	-	-	X	X	X	X
16BMD08.CO5	X	X	X	X	X	-	-	-	X	-	-	X	X	X	X

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BMD08.CO1	3	2	3	2	1	-	-	-	2	-	-	2	2	3	2
16BMD08.CO2	2	2	2	2	1	-	-	-	2	-	-	2	2	3	2
16BMD08.CO3	3	2	3	2	2	-	-	-	2	-	-	2	2	3	2
16BMD08.CO4	3	2	2	2	2	-	-	-	2	-	-	2	2	3	2
16BMD08.CO5	2	2	3	2	1	-	-	-	2	-	-	2	2	3	2

1-Low, 2- Medium, 3-High


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UNIT I **BJT AMPLIFIERS** **9**

CE, CB and CC amplifiers - Method of drawing small-signal equivalent circuit- Analysis of transistor amplifier Configurations-current and voltage gain, input and output impedance -Differential amplifiers-CMRR- Darlington Amplifier- Bootstrap technique - Multistage amplifiers -Cascaded stages - Cascode Amplifier. Large signal Amplifiers – Class A, Class B and Class C Power Amplifiers

UNIT II **JFET AND MOSFET AMPLIFIERS** **9**

Small signal analysis of JFET amplifiers- Small signal Analysis of MOSFET and JFET, Common source amplifier, Voltage swing limitations, Small signal analysis of MOSFET and JFET Source follower and Common Gate amplifiers, - BiCMOS, Cascode amplifier.

UNIT III **RECTIFIERS AND POWER SUPPLIES** **9**

Rectifiers - Half-wave, full-wave and bridge rectifiers – Rectifiers with filters- C, L, and CLC filters Voltage regulators - Zener diode regulator- regulator with current limiting, Over voltage protection, Switched mode power supply (SMPS).

UNIT IV **FEEDBACK AMPLIFIERS** **9**

General Feedback Structure – Properties of negative feedback – Basic Feedback Topologies –Feedback amplifiers – Series – Shunt, Series – Series, Shunt – Shunt and Shunt – Series Feedback – Determining the Loop Gain – Stability Problem.

UNIT V **OSCILLATORS** **9**


Classification, Barkhausen Criterion - Mechanism for start of oscillation and stabilization of amplitude, General form of an Oscillator, Analysis of LC oscillators - Hartley, Colpitts, Clapp, Tuned collector oscillators, RC oscillators - phase shift –Wienbridge - Twin-T Oscillators, Frequency range of RC and LC Oscillators, Quartz Crystal Construction, Electrical equivalent circuit of Crystal, Miller and Pierce Crystal Oscillators, frequency stability of oscillators.

TOTAL: 45 HRS

LIST OF EXPERIMENTS:

1. Frequency Response of CE amplifier
2. Frequency Response of CS amplifier
3. Frequency response of feedback amplifier circuit-current series
4. Frequency response of feedback amplifier circuit- voltage shunt
5. Transistor based design of RC phase Shift Oscillator circuit
6. Transistor based design of Wein Bridge Oscillator circuit
7. Supply circuit - Half wave rectifier and Full wave rectifier with simple capacitor filter
8. Mini Project

TOTAL: 30 HRS



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TEXT BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Donald .A. Neamen	Electronic Circuit Analysis and Design	Tata Mc Graw Hill	2 nd Edition, 2009
2.	Robert L. Boylestad and Louis Nasheresky	Electronic Devices and Circuit Theory	Pearson Education / PHI	10 th Edition, 2008

REFERENCE BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Adel .S. Sedra, Kenneth C. Smith	Micro Electronic Circuits	Oxford University Press	6 th Edition, 2010
2.	Behzad Razavi	Design of Analog CMOS Integrated Circuits	Tata Mc Graw Hill,	2007
3.	Paul Gray, Hurst, Lewis, Meyer	Analysis and Design of Analog Integrated Circuits	John Willey & Sons	4 th Edition, 2005
4.	Sedra and Smith	Micro Electronic Circuits	Oxford University Press	6 th Edition, 2011
5.	Floyd	Electronic Devices	Pearson Education	6 th Edition, 2002


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Programme Code & Name – B.E. & Biomedical Engineering

COURSE CODE	COURSE TITLE	L	T	P	C
16BMD14	DIGITAL SIGNAL PROCESSING	3	0	2	4

COURSE OBJECTIVES:

- To learn discrete Fourier transform and its properties
- To know the characteristics of IIR and FIR filters
- To learn the design of infinite and finite impulse response filters for filtering undesired signals
- To understand Finite word length effects
- To study the concept of Multi-rate and adaptive filters

COURSE OUTCOMES:

16BMD14.CO1	Apply DFT for the analysis of digital signals & systems
16BMD14.CO2	Design IIR and FIR filters
16BMD14.CO3	Characterize finite Word length effect on filters
16BMD14.CO4	Design the Multi-rate Filters
16BMD14.CO5	Apply Adaptive Filters to equalization


Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BMD14.CO1	X	X	X	X	X	X	X	-	-	-	-	X	X	X	X
16BMD14.CO2	X	X	X	X	X	X	X	-	-	-	-	X	X	X	X
16BMD14.CO3	X	X	X	X	X	X	X	-	-	-	-	X	X	X	X
16BMD14.CO4	X	X	X	X	X	X	X	-	-	-	-	X	X	X	X
16BMD14.CO5	X	X	X	X	X	X	X	-	-	-	-	X	X	X	X

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BMD14.CO1	2	3	3	3	3	2	2	-	-	-	-	3	2	3	3
16BMD14.CO2	1	2	3	3	3	2	2	-	-	-	-	2	2	2	3
16BMD14.CO3	2	3	3	3	2	1	2	-	-	-	-	3	2	2	2
16BMD14.CO4	2	3	2	3	3	2	2	-	-	-	-	3	2	3	2
16BMD14.CO5	2	3	2	3	3	2	2	-	-	-	-	2	2	3	3

1-Low, 2- Medium, 3-High


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UNIT I	DISCRETE FOURIER TRANSFORM	9
Introduction to DFT – Properties of DFT – Circular Convolution - Filtering methods based on DFT – FFT Algorithms – Decimation in time Algorithms, Decimation in frequency Algorithms.		
UNIT II	IIR FILTER DESIGN	9
Structures of IIR – Analog filter design – Discrete time IIR filter from analog filter – IIR filter design by Impulse Invariance, Bilinear transformation, Approximation of derivatives – (LPF, HPF, BPF, BRF) filter design using frequency translation.		
UNIT III	FIR FILTER DESIGN	9
Structures of Finite Impulse Response Filter – Linear phase Finite Impulse Response Filter – Fourier series - Filter design using windowing techniques (Rectangular Window, Hamming Window, Hanning Window), Frequency sampling Method.		
UNIT IV	FINITE WORDLENGTH EFFECTS	9
Fixed point and floating point number representations – ADC – Quantization- Truncation and Rounding errors - Quantization noise – coefficient quantization error -- Product quantization error - Overflow error – Round off noise power - limit cycle oscillations due to product round off and overflow errors – Principle of scaling.		
UNIT V	DSP APPLICATIONS	9
Multirate signal processing: Decimation, Interpolation, Cascading Sample Rate Converters , Efficient Transversal Structure for Decimator, Efficient Transversal Structure for Interpolator – Adaptive Filters: Introduction, Applications of adaptive filtering to equalization – Subband Coding - Channel Vocoders.		

TOTAL: 45 HRS

LIST OF EXPERIMENTS:

1. Linear and Circular Convolutions
2. Spectrum Analysis using DFT
3. F-filter design
4. Linear and Circular Convolutions

DSP Processor Based Implementation


5. Study of architecture of Digital Signal Processor
6. Convolution
7. FFT Implementation
8. Waveform generation
9. Implementation of Filter Design
10. Mini Project

TOTAL: 30 HRS


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REFERENCE BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	John G. Proakis & Dimitris G.Manolakis	Digital Signal Processing Principles Algorithms & Applications	Pearson Education / Prentice Hall	Fourth Edition, 2007
2.	Emmanuel C., Ifeachor, & Barrie.W.Jervis	Digital Signal Processing	Pearson Education, Prentice Hall	Second Edition, 2002
3.	B.P.Lathi, ZhiDing. Sanjit K. Mitra	Digital Signal Processing, A Computer Based Approach	Tata Mc Graw Hill	2007
4.	A.V.Oppenheim, R.W. Schafer and J.R. Buck	Discrete-Time Signal Processing	Pearson	8th Indian Reprint, 2004.
5.	Andreas Antoniou	Digital Signal Processing, Tata Mc Graw Hill, 2006.	Prentice-Hall	4th Edition,2001


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Programme Code & Name – B.E. & Biomedical Engineering

COURSE CODE	COURSE TITLE	L	T	P	C
16BMD17	DIGITAL IMAGE PROCESSING	3	0	0	3

COURSE OBJECTIVES:

- 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:

16BMD17.CO1	Describe Digital image fundamentals and Image transforms
16BMD17.CO2	Illustrate Image enhancement
16BMD17.CO3	Describe Image Restoration and Segmentation
16BMD17.CO4	Analysis Wavelets and Image compression
16BMD17.CO5	Describe Image Representation and Recognition


Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BMD17.CO1	X	X	X	X	X	X	-	-	-	-	-	X	X	X	X
16BMD17.CO2	X	X	X	X	X	X	-	-	-	-	-	X	X	X	X
16BMD17.CO3	X	X	X	X	X	X	-	-	-	-	-	X	X	X	X
16BMD17.CO4	X	X	X	X	X	X	-	-	-	-	-	X	X	X	X
16BMD17.CO5	X	X	X	X	X	X	-	-	-	-	-	X	X	X	X

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BMD17.CO1	3	3	3	3	2	3	-	-	-	-	-	2	3	3	3
16BMD17.CO2	3	3	2	3	2	2	-	-	-	-	-	2	3	3	3
16BMD17.CO3	2	3	2	2	2	3	-	-	-	-	-	2	2	3	3
16BMD17.CO4	3	2	2	3	2	3	-	-	-	-	-	2	2	3	2
16BMD17.CO5	3	2	3	3	2	3	-	-	-	-	-	2	2	3	3

1-Low, 2- Medium, 3-High


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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 ,2 D 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: 45 HRS


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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.	William K Pratt	Digital Image Processing	Tata McGraw Hill	2002


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Programme Code & Name – B.E. & Biomedical Engineering

COURSE CODE	COURSE TITLE	L	T	P	C
16BMD09	LINEAR INTEGRATED CIRCUITS	3	0	2	4

COURSE OBJECTIVES:

- To demonstrate the IC fabrication steps and basic building blocks of linear integrated circuits.
- To design and analyze the linear and non-linear applications of operational amplifiers.
- To illustrate the operating principle of PLL, Data Converters and various special function ICs.
- To design waveform generating circuits
- To design simple filter circuits for particular application and to gain knowledge in designing a stable voltage regulators

COURSE OUTCOMES:

16BMD09.CO1	Illustrate the Circuit Fabrication Process and internal structure of operational amplifiers
16BMD09.CO2	Characterize and design real time operational amplifiers applications
16BMD09.CO3	Design comparator and generate waveforms using operational amplifier
16BMD09.CO4	Demonstrate the functioning of PLL and Data converters
16BMD09.CO5	Acquire knowledge about special function ICs and its application in modern electronic equipment


Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BMD09.CO1	X	X	X	X	X	-	-	-	-	-	-	X	X	X	X
16BMD09.CO2	X	X	X	X	X	-	-	-	X	-	-	X	X	X	X
16BMD09.CO3	X	X	X	X	X	-	-	-	X	-	-	X	X	X	X
16BMD09.CO4	X	X	X	X	X	-	-	-	X	-	-	X	X	X	X
16BMD09.CO5	X	X	X	X	X	-	-	-	X	-	-	X	X	X	X

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BMD09.CO1	2	2	3	2	3	-	-	-	-	-	-	2	2	2	2
16BMD09.CO2	2	2	2	2	3	-	-	-	2	-	-	2	2	2	2
16BMD09.CO3	2	2	2	2	3	-	-	-	2	-	-	2	2	2	2
16BMD09.CO4	2	2	2	2	2	-	-	-	2	-	-	2	2	2	2
16BMD09.CO5	2	2	3	1	2	-	-	-	2	-	-	2	2	1	2

1-Low, 2- Medium, 3-High


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UNIT I	IC FABRICATION AND OPERATIONAL AMPLIFIER	9
Introduction to Integrated Circuits- Classification of ICs- Basic IC Fabrication Planar Process-Fabrication of Diode and BJT - Operational Amplifier: Basic Information of Op-Amp, Ideal Op Amp-Operational Amplifier Internal Circuit- Differential Amplifier- Analysis of current sources-Widlar-Wilson Current Sources .		
UNIT II	CHARACTERISTICS OF OP- AMP AND APPLICATIONS	9
Characteristics of Op- Amp - DC Characteristics, AC Characteristics - Frequency Response- Frequency Compensation - Slew Rate- Applications: Closed Loop Op Amp Configuration - Inverting and Non inverting Amplifiers- Inverter- Voltage Follower-Summing Amplifier, Averaging Circuits - Subtractor- Differential Amplifier- Multiplier- Differentiator- Integrator- Instrumentation amplifier, Precision rectifier- V/I & I/V Converter.		
UNIT III	COMPARATOR AND WAVEFORM GENERATORS	9
Comparators - Open Loop Op Amp Configuration - Inverting , Non Inverting Comparator- Applications of Comparator- Regenerative Comparator (Schmitt trigger)- Multivibrators - Astable, Monostable-Principles of Sine wave Oscillator- RC Phase Shift, Wien Bridge Oscillator.		
UNIT IV	PHASE LOCKED LOOP AND DATA CONVERTER	9
Block Diagram of PLL- Principles-Types- Phase Detector- Voltage Controlled Oscillator-IC 566 and IC 565 Internal Block Diagram- PLL Applications - Data Converter - Sample and Hold circuits D/A Techniques: Binary Weighted Resistor- R-2R and Inverted R-2R Ladder DAC- A/D converter: Flash - Counter - Successive Approximation Converter -Single Slope- Dual Slope.		
UNIT V	SPECIALIZED IC APPLICATIONS	9
555 Timer Internal Architecture- Astable and Monostable Multivibrators using 555 Timer - Applications- Voltage regulators, Fixed and Adjustable Voltage Regulators, Dual Power supply - Universal Active Filter- Switched Capacitor Filter.		

LIST OF EXPERIMENTS:

TOTAL: 45 HRS

Design and Testing of

1. Inverting, Non inverting and Differential amplifiers.
2. Integrator and Differentiator.
3. Instrumentation amplifier


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4. Schmitt Trigger using op-amp.
5. Phase shift and Wien bridge oscillators using op-amp.
6. Astable and monostable multivibrators using NE555 Timer.
7. Mini Projects.


TOTAL: 30 HRS

TEXT BOOKS:

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

REFERENCE BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Ramakant A.Gayakwad	OP-AMP and Linear IC's	Prentice Hall of India	2002
2.	David L.Terrell	Op Amps-Design, Application, and Troubleshooting	Elsevier publications	2005
3.	Sergio Franco	Design with operational amplifiers and analog integrated circuits	3 rd Edition, Tata McGraw-Hill	2002
4.	Taub and Schilling	Digital Integrated Electronics	McGraw-Hill	1997
5.	William D.Stanely	Operational Amplifiers with Linear Integrated Circuits	Pearson Education	2004


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Programme Code & Name – B.E. & Biomedical Engineering

COURSE CODE	COURSE TITLE	L	T	P	C
16BMD10	HUMAN ASSIST DEVICES	3	0	2	4

COURSE OBJECTIVES:

- To introduce the principles of various life- support equipment in clinical use.
- To familiarize with design and system level analysis different human assist equipments.
- To familiarize with design human vital organ equipments
- To design the implantable various types of cells
- To identify solutions of different implant parameters

COURSE OUTCOMES:

16BMD10.CO1	Describe the principles of various life support equipment for mobility.
16BMD10.CO2	Students will design and system level analysis different human assist equipments
16BMD10.CO3	Comprehend the design human vital organ equipments
16BMD10.CO4	Summarize the implantable various types of cells
16BMD10.CO5	Explain the solutions of different implant parameters

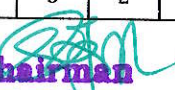
Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BMD10.CO1	X	X	X	X	X	X	-	-	-	-	-	X	X	X	X
16BMD10.CO2	X	X	X	X	X	X	-	-	-	-	-	X	X	X	X
16BMD10.CO3	X	X	X	X	X	X	-	-	-	-	-	X	X	X	X
16BMD10.CO4	X	X	X	X	X	X	-	-	-	-	-	X	X	X	X
16BMD10.CO5	X	X	X	X	X	X	-	-	-	-	-	X	X	X	X

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BMD10.CO1	3	3	3	2	3	3	-	-	-	-	-	2	3	2	2
16BMD10.CO2	3	3	3	2	3	2	-	-	-	-	-	2	3	2	2
16BMD10.CO3	3	3	3	2	3	3	-	-	-	-	-	2	3	2	2
16BMD10.CO4	3	2	3	2	3	3	-	-	-	-	-	2	3	3	2
16BMD10.CO5	3	3	3	2	3	3	-	-	-	-	-	2	3	2	2

1-Low, 2- Medium, 3-High


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UNIT I ASSISTIVE TECHNOLOGY IN MOBILITY 9

Basic assessment of evaluation for mobility. Control systems, navigation in virtual space by wheel chairs, wheel chair seating and pressure ulcers. Fuzzy logic expert system for automatic turning of myoelectric prostheses. Intelligent prostheses

UNIT II ASSIST DEVICES AND SENSORY IMPAIRMENTS 9

Visual and auditory impairments, assessment methods, Libraille, GRAB, mathematical Braille, Hearing Impairment – alternative methods, Use of multimedia technology to help hard of hearing children.

UNIT III ASSIST DEVICE - VITAL ORGANS , TRENDS IN TECHNOLOGY 9

Cardiac assist devices, Intra- Aortic Balloon Pump (IABP), auxiliary ventricles, Dialysis for kidney, feature trends in assistive technology, virtual reality based training system for disabled children

UNIT IV PRINCIPLES OF IMPLANT DESIGN 9

Cardiac implants – Clinical problems requiring implants for solutions – permanent versus absorbable devices, the missing organ and its replacements, tissue engineering, scaffolds, cells - criteria for material selections

UNIT V IMPLANT DESIGN PARAMETERS AND ITS SOLUTIONS 9

Biocompatibility, local and systemic effects of implants – design, specification for tissue bonding and modulus matching – degradation of devices – natural and synthetic polymers, corrosion, wear and tear – implant for bone – devices for nerve regeneration, dental and otologic implants.

TOTAL: 45 HRS

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. Recording of Audiogram
8. Measurement of Hearing threshold using Audiometer and plot its characteristics.
9. Design of ECG, EEG,EMG amplifier, recording and analysis using Lab View

TOTAL: 30 HRS



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TEXT BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Kenneth J. Turner	Advances in Home Care Technologies	Springer	2011
2.	Yannas, I. V.	Tissue and Organ Regeneration in Adults	Springer	2001

REFERENCE BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Levine S.N.	Advances in Bio-medical engineering and Medical physics	Interuniversity publications	1968
2.	Kopff W.J,	Artificial Organs	John Wiley and sons	1976
3.	Daniel Goldstein, Mehmet	Cardiac assist Devices	Wiley	2000
4.	Yadin David, Wolf W. von Maltzahn, Michael R. Neuman, Joseph.D, Bronzino,	“Clinical Engineering”	CRC Press	2010
5.	Albert Cook Janice Polgar	Assist Technologies	Elsevier	2014


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Programme Code & Name – B.E. & Biomedical Engineering

COURSE CODE	COURSE TITLE	L	T	P	C
16BMD11	PATHOLOGY & MICROBIOLOGY	3	0	2	4

COURSE OBJECTIVES:

- Gain knowledge on the structural and functional aspects of living organisms.
- Know the etiology and remedy in treating the pathological diseases.
- Empower the importance of public health.
- To study identification of bacteria
- To study Antibodies and its types

COURSE OUTCOMES:

16BMD11.CO1	Analyze structural and functional aspects of living organisms.
16BMD11.CO2	Explain the function of microscope
16BMD11.CO3	Discuss the importance of public health.
16BMD11.CO4	Describe methods involved in treating the pathological diseases.
16BMD11.CO5	Able to know study Antibodies and its types


Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BMD11.CO1	X	X	X	-	-	X	-	-	-	-	-	X	X	-	-
16BMD11.CO2	X	X	X	-	-	X	-	-	-	-	-	X	X	-	-
16BMD11.CO3	X	X	X	-	-	X	-	-	-	-	-	X	X	-	-
16BMD11.CO4	X	X	X	-	-	X	-	-	-	-	-	X	X	-	-
16BMD11.CO5	X	X	X	-	-	X	-	-	-	-	-	X	X	-	-

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BMD11.CO1	3	2	3	-	-	3	-	-	-	-	-	3	2	-	-
16BMD11.CO2	3	3	2	-	-	3	-	-	-	-	-	3	2	-	-
16BMD11.CO3	2	2	2	-	-	3	-	-	-	-	-	3	2	-	-
16BMD11.CO4	3	2	2	-	-	3	-	-	-	-	-	3	2	-	-
16BMD11.CO5	2	2	3	-	-	3	-	-	-	-	-	3	2	-	-

1-Low, 2- Medium, 3-High


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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: 45 HRS

LIST OF EXPERIMENTS:

1. Urine physical and chemical examination (protein, reducing substances, ketones, bilirubin and blood)
2. Study of parts of compound microscope
3. Histopathological slides of benign and malignant tumours.


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4. Manual paraffin tissue processing and section cutting (demonstration)
5. Cryo processing of tissue and cryosectioning (demonstration)
6. Basic staining – Hematoxylin and eosin staining.
7. Special stains – cresyl fast Blue (CFV)- Trichrome – oil red O – PAS
8. Capsule stain
9. Simple stain.
10. Gram stain.
11. AFB stain.
12. Antigen-Antibody reaction Immuno electrophoresis
13. Slides of malarial parasites, micro filaria and leishmania donovani.
14. Haematology slides of anemia and leukemia.
15. Study of bone marrow charts.

TOTAL: 30 HRS

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	7th edition, WB Saunders Co	2005
2.	Ananthanarayanan & Panicker,	Microbiology	Orientblackswan, 10 th 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, 3 rd edition	: 2000.
2.	Dubey RC and Maheswari DK.	A Text Book of Microbiology &	Chand Company Ltd	2007
3.	Prescott, Harley and Klein	Microbiology	10th edition, McGraw Hill	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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Programme Code & Name – B.E. & Biomedical Engineering

COURSE CODE	COURSE TITLE	L	T	P	C
16BMD12	HOSPITAL MANAGEMENT	3	0	0	3

COURSE OBJECTIVES:

- 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:

16BMD12.CO1	Explain the principles of Hospital administration.
16BMD12.CO2	Identify the importance of Human resource management.
16BMD12.CO3	List various marketing research techniques.
16BMD12.CO4	Identify Information management systems and its uses.
16BMD12.CO5	Understand safety procedures followed in hospitals


Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BMD12.CO1	-	-	-	-	-	X	X	X	X	X	X	X	X	X	-
16BMD12.CO2	-	-	-	-	-	X	X	X	X	X	X	X	X	X	-
16BMD12.CO3	-	-	-	-	-	X	X	X	X	X	X	X	X	X	-
16BMD12.CO4	-	-	-	-	-	X	X	X	X	X	X	X	X	X	-
16BMD12.CO5	-	-	-	-	-	X	X	X	X	X	X	X	X	X	-

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BMD12.CO1	-	-	-	-	-	2	3	2	2	2	2	3	2	2	-
16BMD12.CO2	-	-	-	-	-	2	2	2	2	2	2	2	2	2	-
16BMD12.CO3	-	-	-	-	-	2	3	2	2	2	2	3	2	2	-
16BMD12.CO4	-	-	-	-	-	2	3	2	2	2	2	3	2	2	-
16BMD12.CO5	-	-	-	-	-	2	3	2	2	2	2	3	2	2	-

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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: 45 HRS



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TEXT BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	R.C.Goyal	Hospital Administration and Human Resource Management – Fourth Edition	Academic Press, New York	2006.
2.	G.D.Kunders	Hospitals Facilities Planning and Management	Fifth Reprint , TMH, New Delhi	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 2 nd edition	Aspen Publication Inc. Rockville, Maryland, USA	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 21 st Century	Eric Calrendon Press	2002


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Programme Code & Name – B.E. & Biomedical Engineering

COURSE CODE	COURSE TITLE	L	T	P	C
16BMD15	EMBEDDED SYSTEMS	3	0	2	4

COURSE OBJECTIVES:

- To study the overview of Embedded System Architecture.
- To study about the ARM Architecture.
- To learn various embedded communication protocols.
- To learn the Real Time operating System Concepts.
- To Study about applications of Embedded System.

COURSE OUTCOMES:

16BMD15.CO1	Able to describe hardware and software architectures of Embedded Systems.
16BMD15.CO2	Able to understand the functions and syntax used in Embedded C.
16BMD15.CO3	Able to understand special features of ARM architecture.
16BMD15.CO4	Able to introduce devices and buses used for Embedded Networking.
16BMD15.CO5	Able to interpret the concepts of a Real Time Operating System.

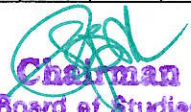
Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BMD15.CO1	X	X	X	X	X	-	-	-	X	-	-	X	X	X	X
16BMD15.CO2	X	X	X	X	X	-	-	-	X	-	-	X	X	X	X
16BMD15.CO3	X	X	X	X	X	-	-	-	X	-	-	X	X	X	X
16BMD15.CO4	X	X	X	X	X	-	-	-	X	-	-	X	X	X	X
16BMD15.CO5	X	X	X	X	X	-	-	-	X	-	-	X	X	X	X

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BMD15.CO1	3	3	3	3	3	-	-	-	2	-	-	2	2	2	3
16BMD15.CO2	3	3	2	2	3	-	-	-	2	-	-	2	2	2	2
16BMD15.CO3	3	2	3	2	3	-	-	-	2	-	-	2	2	2	3
16BMD15.CO4	3	3	3	2	3	-	-	-	2	-	-	2	2	2	2
16BMD15.CO5	3	3	3	3	3	-	-	-	2	-	-	2	3	2	2

1-Low, 2- Medium, 3-High


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UNIT I ARCHITECTURE OF EMBEDDED SYSTEMS 9

Architecture of Embedded Systems -Categories of embedded systems – specialties of embedded systems – Recent trends in embedded systems –Hardware architecture –Software architecture –Communication software – Process of generation of executable image –development/testing tools.

UNIT II ARM ARCHITECTURE 9

Advanced RISC Machine – Architecture Inheritance – ARM Programming Model – ARM Development Tools – 3 and 5 stages Pipeline ARM Organization – ARM Instruction Execution and Implementation – ARM Co-Processor Interface - Thumb bit in the CPSR – Thumb programmer's model.

UNIT III EMBEDDED COMMUNICATION PROTOCOLS 9

Serial/Parallel Communication - Serial communication protocols - UART - RS232 standard - Serial Peripheral Interface - Inter Integrated Circuits – Ethernet - Universal serial Bus - Controller Area Network - Parallel communication protocols – ISA / PCI Bus protocols, Internet of Things- Overview and Architecture.

UNIT IV REAL-TIME OPERATING SYSTEM CONCEPTS 9

Architecture of the Kernel– Foreground/Background Systems- Critical Sections of Code-Resources- Shared Resources- Multitasking- Tasks- Context Switches- Kernels- Schedulers-Non-Preemptive Kernels- Preemptive Kernels-Task Priorities-Static Priorities-Dynamic Priorities-Priority Inversion- Mutual Exclusion- Deadlock-Event Flags- Inter task Communication- Message Mailboxes- Message Queues- Interrupts- Interrupt Latency-Interrupt Response- Interrupt Recovery- RTOS: RT Linux - VX Works - μ COS.


UNIT V APPLICATIONS 9

Working Principle, State Diagram ,Architecture, Digital camera-washing machine-cell phones-home security systems-finger print identifiers-cruise control- printers -Automated teller machine-Washing machine- Software Modem-Audio Player.

TOTAL: 45 HRS

LIST OF EXPERIMENTS:

1. Interface Switches and LED's
2. Interface Switches
3. Interface LCD and Display "Hello World"
4. Interface 4*4 Matrix Keyboard


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Programme Code & Name – B.E. & Biomedical Engineering

5. Interface Stepper Motor
6. Interface 7 Segment Display using I2C
7. Interfacing Analog to Digital Converter
8. Interface Digital to Analog Converter
9. Implementing Real Time Clock
10. Mini Project


TOTAL: 30 HRS

TEXT BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Raj Kamal,	Embedded Systems Architecture programming and Design	TMH	2 nd , 2011
2.	Prasad.K.V.K.K,	Embedded Real-Time Systems: Concepts, Design & Programming	Dream tech press	2011

REFERENCE BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Wayne Wolf	Computers as Components - Principles of Embedded Computing System Design	Morgan Kaufman Publishers	Third Edition 2013
2.	Steve Furber,	ARM System on Chip Architecture	Addison- Wesley Professional	Second Edition, 2000
3.	Andrew N.Sloss, Dominic Symes, Chris Wright	ARM System Developer's Guide Designing and Optimizing System Software	Morgan Kaufmann Publishers, Elsevier	2004
4.	A.P.Godse & A.O.Mulani	Embedded Systems	Technical publications	Third Edition,2009
5.	B.Kanth Rao,	Embedded Systems	PHI Learning Private Limited	2011


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Programme Code & Name – B.E. & Biomedical Engineering

COURSE CODE	COURSE TITLE	L	T	P	C
16BMD18	MEDICAL IMAGING TECHNIQUES	3	0	0	3

COURSE OBJECTIVES:

- To become familiar with X-ray imaging fundamentals
- To get exposed from isotopic medical imaging techniques Computer Tomography
- To learn concepts and function of Nuclear imaging techniques.
- To study the mathematic calculation for image formation.
- To become familiar with image modeling methods

COURSE OUTCOMES:

16BMD18.CO1	Know and understand the basics and fundamentals X-ray imaging.
16BMD18.CO2	Operate on CT imaging techniques.
16BMD18.CO3	Understand the concepts and function of Nuclear imaging techniques
16BMD18.CO4	Learn the basics of mathematic calculation for image formation.
16BMD18.CO5	Familiar with medical image modeling methods

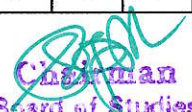
Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BMD18.CO1	X	X	X	-	-	X	-	-	X	-	X	X	X	X	X
16BMD18.CO2	X	X	X	-	-	X	-	-	X	-	X	X	X	X	X
16BMD18.CO3	X	X	X	-	-	X	-	-	X	-	X	X	X	X	X
16BMD18.CO4	X	X	X	-	-	X	-	-	X	-	X	X	X	X	-
16BMD18.CO5	X	X	X	-	-	X	-	-	X	-	X	X	X	X	X

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BMD18.CO1	3	3	3	-	-	3	-	-	3	-	3	3	3	2	3
16BMD18.CO2	3	3	3	-	-	3	-	-	2	-	3	2	2	2	2
16BMD18.CO3	3	3	3	-	-	3	-	-	3	-	3	3	3	2	2
16BMD18.CO4	3	3	3	-	-	3	-	-	3	-	3	3	2	2	-
16BMD18.CO5	3	3	3	-	-	3	-	-	3	-	3	3	3	2	3

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Quality assurance and image improvement in diagnostic radiology with X-Rays, specific Quality assurance tests for X-rays, need for sectional images, principles of sectional images recording, computer tomography. Mammographic X-Rays Equipment, Fluoroscopy.

UNIT – II **RADIOISOTOPIC IMAGES** **9**

Radio isotopic imaging equipments, radiation detectors, radionuclide for imaging, static and dynamic planar scintillography. Gamma Camera –Emission Computed Tomography – Single – Photon Emission Computed Tomography – Positron Emission Tomography – System Components Of Computer Tomography - Patient Dose In CT Scanners.

UNIT – III **NUCLEAR MAGNETIC RESONANCE IMAGING** **9**

Principles Of NMR Imaging Systems - Image Reconstruction Techniques – NMR Components – Biological Effects Of NMR Imaging - Advantages Of NMR Imaging System. Development of NMR, relaxation processes and their measurements, MRI-Image acquisition and reconstruction, MRI safety


UNIT – IV **MATHEMATICS OF IMAGE FORMATION AND IMAGE PROCESSING** **9**

Concept of object and image, general image processing problem, discrete fourier representation and models for imaging, image restoration, image sampling, perception of moving images. – Image reconstruction in computed tomography and MRI.

UNIT – V **COMPUTER REQUIREMENT FOR IMAGING SYSTEM** **9**

Image enhancement - Single/ multi user system, transferring of images, processing speed, display of medical images, pixel intensity calculation - 3-D image display and its clinical applications. 3D modeling of display image.

TOTAL: 45 HRS


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TEXT 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 3 rd edition	Tata McGraw-Hill New Delhi	2014

REFERENCE 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	4 th edition 2015
2.	Joseph J. Carr John M. Brown	Introduction to Biomedical Equipment Technology	Pearson Education	2004
3.	Paul Suetens	Fundamentals of Medical Imaging	Pearson Education	2009


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COURSE CODE	COURSE TITLE	L	T	P	C
16BMD19	ELECTRICAL SAFETY AND QUALITY ASSURANCE	3	0	0	3

COURSE OBJECTIVES:

- 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:

16BMD19.CO1	The purpose of this course is to help students to develop knowledge and insight into the procedures
16BMD19.CO2	Knowledge used in quality control and assurance activities as well as safety measures to be followed in hospitals.
16BMD19.CO3	Electrical safety and different standards Testing and verification of medical devices.
16BMD19.CO4	Safety & precautions Safety aspects in electro surgical systems
16BMD19.CO5	Guidelines on medical devices with the knowledge of Diagnostic Medical Devices Directives


Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BMD19.CO1	X	X	X	X	X	-	-	-	-	-	-	X	X	-	-
16BMD19.CO2	X	X	X	X	X	-	-	-	-	-	-	X	X	-	-
16BMD19.CO3	X	X	X	X	X	-	-	-	-	-	-	X	X	-	-
16BMD19.CO4	X	X	X	X	X	-	-	-	-	-	-	X	X	-	-
16BMD19.CO5	X	X	X	X	X	-	-	-	-	-	-	X	X	-	-

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BMD19.CO1	2	2	2	2	2	-	-	-	-	-	-	2	2	-	-
16BMD19.CO2	3	2	2	3	2	-	-	-	-	-	-	2	2	-	-
16BMD19.CO3	2	3	2	2	2	-	-	-	-	-	-	2	2	-	-
16BMD19.CO4	2	2	2	2	2	-	-	-	-	-	-	2	2	-	-
16BMD19.CO5	2	2	2	3	3	-	-	-	-	-	-	2	2	-	-

1-Low, 2- Medium, 3-High


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UNIT I CLASSIFICATION OF DEVICE 9

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 aspects in 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's 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 9000 Series of 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: 45 HRS



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TEXT BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Richard Fries	Reliable Design of Medical Devices	Second Edition by, CRC Press	2006
2.	Richard C Fries, CRC Press	Medical Device Quality Assurance and Regulatory Compliance	CRC Press	1998

REFERENCE BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Michael Cheng	Medical device regulations: global overview and guiding principles	World Health Organization	
2.	Gábor Czitán, Attila Gutassy, Ralf Wilde	Product Safety in the European Union	TÜV Rheinland Akadémia	2008


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Programme Code & Name – B.E. & Biomedical Engineering

COURSE CODE	COURSE TITLE	L	T	P	C
16BMC09	MICROPROCESSOR AND MICROCONTROLLERS	3	0	2	4

COURSE OBJECTIVES:

- To study the basic concept of 8085 microprocessor
- To study the basic concept of 8051 microcontroller
- To Introduce PIC microcontroller and Programming in 8085 and 8051
- To understand the basic concept of interfacing.
- To Study the Applications of Processors and Controllers.

COURSE OUTCOMES:

16BMC09.CO1	Able to understand the concept of 8085 microprocessor
16BMC09.CO2	Able to understand the concept of 8081 microcontroller
16BMC09.CO3	Impart the knowledge on programming in 8085, 8051 and concept of PIC Microcontroller.
16BMC09.CO4	Able to design and implement the interfacing ICs
16BMC09.CO5	Able to design an application based on 8085,8051 and PIC


Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BMC09.CO1	X	X	X	X	X	X	-	-	-	-	-	X	X	X	X
16BMC09.CO2	X	X	X	X	X	X	-	-	-	-	-	X	X	X	X
16BMC09.CO3	X	X	X	-	X	X	-	-	-	-	-	X	X	X	X
16BMC09.CO4	X	X	X	X	X	X	-	-	-	-	-	X	X	X	X
16BMC09.CO5	X	X	X	X	X	X	-	-	-	-	-	X	X	X	X

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BMC09.CO1	3	2	3	3	2	2	-	-	-	-	-	3	3	3	2
16BMC09.CO2	2	2	2	2	3	2	-	-	-	-	-	2	2	3	2
16BMC09.CO3	2	2	3	3	3	2	-	-	-	-	-	3	3	2	2
16BMC09.CO4	3	3	2	3	3	2	-	-	-	-	-	3	2	3	2
16BMC09.CO5	2	2	2	3	2	2	-	-	-	-	-	3	3	3	2

1-Low, 2- Medium, 3-High


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UNIT I	8085 PROCESSOR	9
Basics of Microprocessor - Architecture of 8085 - Pin Diagram - Instruction Set - Addressing Modes – Interrupts of 8085 - Timing diagram – Memory Organization.		
UNIT II	8051 CONTROLLER	9
Basics of Microcontroller - Architecture of 8051 - I/O Ports of 8051 - Pin Diagram - Instruction Set - Addressing Modes of 8051 - Timing Diagram.		
UNIT III	PROGRAMMING AND ADVANCED CONTROLLERS	9
Basic programing (ALP) of 8085 and 8051 - Loop Structures, counting and Indexing with programing concepts – Subroutine and its programing – PIC microcontroller Concepts - 16C6X Architecture – 16C7X Architecture.		
UNIT IV	PROGRAMMING AND INTERFACING OF 8085 & 8051	9
Interfacing: Architecture, configuration and interfacing, with ICs: Programmable Peripheral Interface (PPI) 8255 -programmable interrupt controller (PIC) 8259 - Programmable Interval Timer (PIT) 8254 - DMA Controller 8237 - USART 8251 - keyboard display controller 8279.		
UNIT V	APPLICATIONS OF PROCESSORS AND CONTROLLERS	9
Key board and display interface - stepper motor control - Washing Machine Control - LED Control, servo motor Control with 8085 & 8051.		

TOTAL: 45HRS

LIST OF EXPERIMENTS:

1. Programming with 8085 –Addition and Subtraction.
2. Calculate the sum of series of numbers.
3. Programming with 8085- Multiplication and Division.
4. Programming with 8085-Ascending and Descending Order.
5. Programming with 8085- Maximum and Minimum Number in A Group of Data.
6. Code Conversion ASCII/Binary/BCD.
7. Interfacing A/D with 8085 Microprocessor.
8. 8-Bit Addition and Subtraction using 8051.
9. 8-Bit Multiplication and Division using 8051.
10. Parallel Port Programming With 8051-Stepper Motor Control.
11. Keil C Programming

TOTAL: 30HRS


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Programme Code & Name – B.E. & Biomedical Engineering

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 Mc Graw Hill	3 RD Edition, 2013
2.	Douglas V. Hall	Microprocessor and Interfacing:Programming and Hardware	Glencoe,	2 nd 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 JanicaGilliMazidi	The 8051 microcontroller and embedded systems'	Pearson Education, 5th Indian reprint	2003


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Programme Code & Name – B.E. & Biomedical Engineering

COURSE CODE	COURSE TITLE	L	T	P	C
16BMC16	FUNDEMENTALS OF BIOCHEMISTRY	3	0	0	3

COURSE OBJECTIVES:

- To learn the concept of how to learn patterns and concepts of molecules
- To design and analyse various machine learning algorithms and techniques with a modern outlook focusing on recent advances
- Explore supervised and unsupervised learning paradigms of machine learning
- To explore Deep learning technique and various feature extraction strategies
- To learn the concept of how to learn patterns and concepts from data without being explicitly programmed in various IOT nodes

COURSE OUTCOMES:

16BMC16.CO1	Identify the perspectives of machine learning
16BMC16.CO2	Apply decision tree and Artificial neural networks for real world problems
16BMC16.CO3	Design a Bayesian classifier for solving a problem
16BMC16.CO4	Illustrate the principles of instance based learning and genetic algorithm
16BMC16.CO5	Describe the algorithms for rule and reinforcement learning


Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BMC16.CO1	X	X	X	-	-	X	-	-	X	X	-	X	X	-	-
16BMC16.CO2	X	X	X	-	-	X	-	-	X	X	-	X	X	-	-
16BMC16.CO3	X	X	X	-	-	X	-	-	X	X	-	X	X	-	-
16BMC16.CO4	X	X	X	-	-	X	-	-	X	X	-	X	X	-	-
16BMC16.CO5	X	X	X	-	-	X	-	-	X	X	-	X	X	-	-

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BMC16.CO1	2	2	2	-	-	-	-	-	-	2	-	2	2	-	-
16BMC16.CO2	2	2	2	-	-	3	-	-	2	2	-	2	2	-	-
16BMC16.CO3	2	2	2	-	-	3	-	-	2	2	-	2	2	-	-
16BMC16.CO4	2	2	2	-	-	3	-	-	2	2	-	2	2	-	-
16BMC16.CO5	2	2	1	-	-	3	-	-	2	2	-	2	2	-	-

1-Low, 2- Medium, 3-High


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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: 45 HRS

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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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Programme Code & Name – B.E. & Biomedical Engineering

COURSE CODE	COURSE TITLE	L	T	P	C
16BME01	ADVANCED BIO ANALYTICAL & THERAPEUTIC TECHNOLOGY	3	0	0	3

COURSE OBJECTIVES:

- 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:

16BME01.CO1	Idea about the imaging techniques in microscopy.
16BME01.CO2	Types of techniques in advanced bio analytical.
16BME01.CO3	Know about the types of special techniques.
16BME01.CO4	Knowledge about the types of respiratory aids.
16BME01.CO5	Know about the radiation & safety of radiation.


Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BME01.CO1	X	X	X	X	X	-	-	-	-	-	-	X	X	X	X
16BME01.CO2	X	X	X	X	X	-	-	-	-	-	-	X	X	X	X
16BME01.CO3	X	X	X	X	X	-	-	-	-	-	-	X	X	X	X
16BME01.CO4	X	X	X	X	X	-	-	-	-	-	-	X	X	X	X
16BME01.CO5	X	X	X	X	X	-	-	-	-	-	-	X	X	X	X

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BME01.CO1	3	3	3	2	3	-	-	-	-	-	-	3	3	2	2
16BME01.CO2	3	3	3	2	3	-	-	-	-	-	-	3	3	2	2
16BME01.CO3	3	2	3	2	3	-	-	-	-	-	-	3	3	2	2
16BME01.CO4	3	2	3	2	2	-	-	-	-	-	-	3	3	3	2
16BME01.CO5	3	3	3	2	3	-	-	-	-	-	-	3	3	2	2

1-Low, 2- Medium, 3-High



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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	6th edition, Brooks/Cole, USA	2006
2.	R.S.Khandpur	Hand book of Biomedical Instrumentation	Tata McGraw Hill, NewDelhi	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, NewDelhi	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	2nd Edition, W.H. Freeman & Company, San Fransisco	1982
5.	Williams, D. and Fleming, I	Spectroscopic Methods in Organic Chemistry	6th edition, McGraw-Hill Higher Education, Maidenhead, UK	2008


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Programme Code & Name – B.E. & Biomedical Engineering

COURSE CODE	COURSE TITLE	L	T	P	C
16BME02	BIO SIGNAL PROCESSING	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

16BME02.CO1	Choose filter for the ECG analysis.
16BME02.CO2	Write the types of algorithm for data compression.
16BME02.CO3	Idea about processing the ECG signal and their estimations.
16BME02.CO4	Study about EEG and their parameters.
16BME02.CO5	Study about the sleeping modes of EEG

Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BME02.CO1	X	X	X	-	X	X	-	-	X	-	-	X	X	-	X
16BME02.CO2	X	X	X	-	X	X	-	-	X	-	-	X	X	-	X
16BME02.CO3	X	X	X	-	X	X	-	-	X	-	-	X	X	-	X
16BME02.CO4	X	X	X	-	X	X	-	-	X	-	-	X	X	-	X
16BME02.CO5	X	X	X	-	X	X	-	-	X	-	-	X	X	-	X

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BME02.CO1	2	2	3	-	3	2	-	-	2	-	-	2	3	-	2
16BME02.CO2	2	2	3	-	3	2	-	-	2	-	-	2	3	-	3
16BME02.CO3	2	2	3	-	3	2	-	-	2	-	-	2	3	-	2
16BME02.CO4	2	2	3	-	3	2	-	-	2	-	-	2	3	-	3
16BME02.CO5	2	2	3	-	3	2	-	-	2	-	-	2	3	-	3

1-Low, 2- Medium, 3-High


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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: 45HRS


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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	1993
2.	Akay.M	Biomedical Signal Processing	Academic: Press	1994


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Programme Code & Name – B.E. & Biomedical Engineering

COURSE CODE	COURSE TITLE	L	T	P	C
16BME03	BIO-MATERIALS AND ARTIFICIAL ORGANS	3	0	0	3

COURSE OBJECTIVES:

- 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:

16BME03.CO1	Analyze different types of Biomaterials and its classification.
16BME03.CO2	Understand different metals and ceramics used as biomaterials.
16BME03.CO3	Learn about the polymeric materials and combinations.
16BME03.CO4	Perform combinations of materials that could be used as a tissue replacement implant.
16BME03.CO5	Know about the artificial organ development.

Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BME03.CO1	X	X	X	X	X	-	-	-	-	-	-	X	X	X	X
16BME03.CO2	X	X	X	X	X	-	-	-	-	-	-	X	X	X	X
16BME03.CO3	X	X	X	X	X	-	-	-	-	-	-	X	X	X	X
16BME03.CO4	X	X	X	X	X	-	-	-	-	-	-	X	X	X	X
16BME03.CO5	X	X	X	X	X	-	-	-	-	-	-	X	X	X	X

Course Articulation Matrix:


Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BME03.CO1	3	3	3	2	3	-	-	-	-	-	-	3	3	2	2
16BME03.CO2	3	3	3	2	3	-	-	-	-	-	-	3	3	2	2
16BME03.CO3	3	2	3	2	3	-	-	-	-	-	-	3	3	2	2
16BME03.CO4	3	2	3	2	2	-	-	-	-	-	-	3	3	3	2
16BME03.CO5	3	3	3	2	3	-	-	-	-	-	-	3	3	2	2

1-Low, 2- Medium, 3-High


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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, aluminium oxides, hydroxyl-apatite glass ceramics carbons, medical applications		
UNIT III	POLYMERIC MATERIALS	9
Polymerization, polyamides, Acrylic 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: 45 HRS


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Programme Code & Name – B.E. & Biomedical Engineering

TEXT 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

REFERENCE BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Park J.B	Biomaterials Science and Engineering	Plenum Press	1984
2.	Myer Kutz	Standard Handbook of Biomedical Engineering & Design	McGraw-Hill	2003
3.	John Enderle, Joseph D. Bronzino, Susan M. Blanchard	Introduction to Biomedical Engineering	Elsevier	2005


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Programme Code & Name – B.E. & Biomedical Engineering

COURSE CODE	COURSE TITLE	L	T	P	C
16BME04	BIO MEDICAL ENGINEERING	3	0	0	3

COURSE OBJECTIVES:

- To Understand the Human physiology and components of biomedical system
- To get exposed to electro physiological parameter measurements
- To get exposed to non-electro physiological parameter measurements
- To know about medical imaging and biotelemetry systems
- To Understand the principle of operation of Therapeutic equipments

COURSE OUTCOMES:

16BME04.C01	Basic knowledge on Human physiology and components of biomedical system
16BME04.C02	Exposure to electro physiological parameter measurements
16BME04.C03	Exposure to non - electro physiological parameter measurements
16BME04.C04	Knowledge of medical imaging and biotelemetry systems
16BME04.C05	Description on the principles of operation of Therapeutic equipments

Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BME04.C01	X	X	X	X	X	X	X	-	-	-	-	X	X	X	X
16BME04.C02	X	X	X	X	X	X	X	-	-	-	-	X	X	X	X
16BME04.C03	X	X	X	X	X	X	X	-	-	-	-	X	X	X	X
16BME04.C04	X	X	X	X	X	X	X	-	-	-	-	X	X	X	X
16BME04.C05	X	X	X	X	X	X	X	-	-	-	-	X	X	X	X

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BME04.C01	3	2	3	3	3	3	2	-	-	-	-	2	2	3	2
16BME04.C02	3	2	2	3	3	2	2	-	-	-	-	2	2	2	2
16BME04.C03	3	2	3	2	3	3	3	-	-	-	-	2	2	3	2
16BME04.C04	3	3	3	3	3	3	2	-	-	-	-	2	2	3	2
16BME04.C05	3	2	2	3	3	3	2	-	-	-	-	2	2	3	2


1-Low, 2- Medium, 3-High


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UNIT I	PHYSIOLOGY AND TRANSDUCERS	9
<p>Cell and its structure - Resting and Action Potential - Nervous system: Functional organization of the nervous system - Structure of nervous system, neurons - synapse - transmitters and neural communication - Cardiovascular system - respiratory system , Basic components of a biomedical system .Transducers - selection criteria – Piezo electric, ultrasonic transducers ,Temperature measurements , Fibre optic temperature sensors.</p>		
UNIT II	ELECTRO – PHYSIOLOGICAL MEASUREMENTS	9
<p>Electrodes - Limb electrodes-floating electrodes - pregelled disposable electrodes - micro- needle and surface electrodes - Amplifiers: Preamplifiers- differential amplifiers- chopper amplifiers -Isolation amplifier. Physiological measurements-ECG, EEG, EMG, ERG - Lead systems and recording methods- Typical waveforms. Electrical safety in medical environment: shock hazards-leakage current.</p>		
UNIT III	NON-ELECTRICAL PARAMETER MEASUREMENTS	9
<p>Measurement of blood pressure -Cardiac output -Heart rate-Heart sounds-Pulmonary function measurements – spirometer -Photo Plethysmography- Body Plethysmography-Blood Gas analyzers - pH of blood - measurement of blood pCO₂, pO₂, finger-tip oxymeter - ESR, GSR measurements.</p>		
UNIT IV	MEDICAL IMAGING AND BIOTELEMETRY	9
<p>Radio graphic and fluoroscopic techniques -Computer tomography-Magnetic Resonance Imaging - Ultrasonography-A mode,B mode ,M mode- Endoscopy-Thermography-Different types of biotelemetry systems and patient monitoring-Wireless Telemetry,single channel,multi channel,multi patient and implantable telemetry systems.</p>		
UNIT V	ASSISTING AND THERAPEUTIC EQUIPMENTS	9
<p>Pacemakers-External and internal pacemakers-Defibrillators-DC defibrillator, implantable defibrillators- Ventilators -Nerve and muscle stimulators -TENS-Surgical diathermy machine, safety aspects in Electro surgical units- Heart Lung machine- Audiometers-Dialysers-Lithotripsy.</p>		

TOTAL: 45 HRS



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TEXT 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

REFERENCE BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	M.Arumugam	Bio-Medical Instrumentation	Anuradha Agencies	2003
2.	L.A. Geddes and L.E.Baker	Principles of Applied Bio-Medical Instrumentation	John Wiley & Sons	1975
3.	J.Webster	Medical Instrumentation	John Wiley & Sons	1995
4.	William R Hendee, E. Russell Ritenour	Medical Imaging Physics	John Wiley & Sons	4 th ed, Inc., New York, 2002
5.	Paul Suetens	Fundamentals of Medical Imaging	Cambridge University press	2nd ed., 2009


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Programme Code & Name – B.E. & Biomedical Engineering

COURSE CODE	COURSE TITLE	L	T	P	C
16BME05	BIOMATERIALS & CHARACTERIZATION	3	0	0	3

COURSE OBJECTIVES:

- To learn characteristics and classification of Biomaterials.
- To study about the characteristics of thermal & mechanical properties of polymer & plastics.
- To understand the characteristics of ceramic, carbon biomaterials.
- To learn polymeric materials and its combinations that could be used as a tissue replacement implants
- Understand the concept of biocompatibility and the methods for biomaterials testing

COURSE OUTCOMES:

16BME05.C01	Know the basic knowledge of biomaterials.
16BME05.C02	Identify significant gap required to overcome challenges and further development in metallic and ceramic materials
16BME05.C03	Identify significant gap required to overcome challenges and further development in polymeric materials
16BME05.C04	Create combinations of materials that could be used as a tissue replacement implant.
16BME05.C05	Understand the testing standards applied for biomaterials


Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BME05.C01	x	X	X	-	X	x	-	-	X	-	-	x	x	-	X
16BME05.C02	x	X	X	-	X	x	-	-	X	-	-	x	x	-	X
16BME05.C03	x	X	X	-	X	x	-	-	X	-	-	x	x	-	X
16BME05.C04	x	X	X	-	X	x	-	-	X	-	-	x	x	-	X
16BME05.C05	x	X	X	-	X	x	-	-	X	-	-	x	x	-	X

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BME05.C01	2	2	3	-	3	2	-	-	2	-	-	2	3	-	2
16BME05.C02	2	2	3	-	3	2	-	-	2	-	-	2	3	-	3
16BME05.C03	2	2	3	-	3	2	-	-	2	-	-	2	3	-	2
16BME05.C04	2	2	3	-	3	2	-	-	2	-	-	2	3	-	3
16BME05.C05	2	2	3	-	3	2	-	-	2	-	-	2	3	-	3

1-Low, 2- Medium, 3-High


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UNIT I INTRODUCTION TO BIO-MATERIALS 9

Definition and classification of bio-materials, mechanical properties, visco elasticity, biomaterial performance, body response to implants, wound healing, blood compatibility, Nano scale phenomena

UNIT II POLYMER AND PLASTICS 9

Classification, thermal properties, factors influencing polymer properties. Polymer compatibility, polymer degradation, restorable polymers, tissue adhesives, dialysis membrane, sutures. . MECHANICAL PROPERTIES AND TESTS: For elasticity, plasticity, and elasticity, dislocation deformation and fracture.

UNIT III METALLIC AND CERAMIC BIOMATERIALS 9

Properties and use to titanium alloys stainless steel, cobalt based alloys degradable ceramics.

UNIT IV CARBON AND POLYMERIC BIOMATERIALS 9

Carbon, polythene, polypropylene, silicones rubber, acrylic implants, hydrogels. DENTAL

UNIT V IMPLANTS 9

Alveolar bone replacements. Orthopedic implants-types of orthopedic function devices, permanent joint replacements, hip joints, bone cement, Biological testing of biomaterials.

TEXT BOOKS:

TOTAL: 45 HRS

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Hench L.L. Ethridge E.C.	Biomaterials, An interfacial Approach	Academic Press	1982
2.	John G.Webster, Bols	Encyclopedia of Medical Devices and Instruments. I-IV		

REFERENCE BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Fred W. Billmeyer Jr	Text book of Polymer Sciences		
2.	Bronzins J.D	The Biomedical Engineering Hand book	CRC Press	1995
3.	J.B. Park	Biomaterials-An Introduction		
4.	L.Hench and E.G.Erhridge	Biomaterials an Interfacial approach		


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Programme Code & Name – B.E. & Biomedical Engineering

COURSE CODE	COURSE TITLE	L	T	P	C
16BME06	BODY AREA NETWORKS	3	0	0	3

COURSE OBJECTIVES:

- To learn about body area networks.
- To study the different types of hardwares related to it.
- To gain knowledge in the BAN communications.
- To analysis about the coexistence issues with BAN.
- To provide knowledge in the applications of Body Area Networks.

COURSE OUTCOMES:

16BME06.CO1	Explain about working of Body Area Network.
16BME06.CO2	Know the types of hardwares.
16BME06.CO3	Knowledge about the BAN communication.
16BME06.CO4	Analysis about the issues in BAN.
16BME06.CO5	Discuss the applications of BAN.


Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BME06.CO1	x	x	x	-	-	X	-	-	x	-	x	x	x	x	x
16BME06.CO2	x	x	x	-	-	X	-	-	x	-	x	x	x	x	x
16BME06.CO3	x	x	x	-	-	X	-	-	x	-	x	x	x	x	x
16BME06.CO4	x	x	x	-	-	X	-	-	x	-	x	x	x	x	x
16BME06.CO5	x	x	x	-	-	X	-	-	x	-	x	x	x	x	x

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BME06.CO1	3	3	3	-	-	3	-	-	3	-	3	3	3	2	3
16BME06.CO2	3	3	3	-	-	3	-	-	2	-	3	2	2	2	2
16BME06.CO3	3	3	3	-	-	3	-	-	3	-	3	3	3	2	2
16BME06.CO4	3	3	3	-	-	3	-	-	3	-	3	3	2	2	2
16BME06.CO5	3	3	3	-	-	3	-	-	3	-	3	3	3	2	3

1-Low, 2- Medium, 3-High


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UNIT I INTRODUCTION 9

Definition, BAN and Healthcare, Technical Challenges- Sensor design, biocompatibility, Energy Supply, optimal node placement, number of nodes, System security and reliability, BSN Architecture – Introduction

UNIT II HARDWARE FOR BAN 9

Processor-Low Power MCUs, Mobile Computing MCUs ,Integrated processor with radio transceiver, Memory ,Antenna-PCB antenna, Wire antenna, Ceramic antenna, External antenna, Sensor Interface, Power sources- Batteries and fuel cells for sensor nodes.

UNIT III WIRELESS COMMUNICATION AND NETWORK PROTOCOLS 9

RF communication in Body, Antenna design and testing, Propagation, Base Station-Network topology-Stand –Alone BAN, Wireless personal Area Network Technologies-IEEE 802.15.1,IEEE P802.15.13, IEEE 802.15.14, Zigbee.

UNIT IV COEXISTENCE ISSUES WITH BAN 9

Interferences – Intrinsic - Extrinsic, Effect on transmission, Counter measures- on physical layer and data link layer, Regulatory issues-Medical Device regulation in USA and Asia, Security and Self protection- Bacterial attacks, Virus infection, Secured protocols, Self protection.


UNIT V APPLICATIONS OF BAN 9

Monitoring patients with chronic disease, Hospital patients, Elderly patients, Cardiac arrhythmias monitoring, Multi patient monitoring systems, Multichannel Neural recording, Gait analysis, Sports Medicine, Electronic pill

TOTAL: 45 HRS


TEXT BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Annalisa Bonfiglio, Danilo De Rossi	Wearable Monitoring Systems(UNIT I,II,III,V)	Springer	2011
2.	Sandeep K.S. Gupta, Tridib Mukherjee, Krishna Kumar Venkatasubramanian	Body Area Networks Safety, Security, and Sustainability (UNIT IV)	Cambridge University Press	2013


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REFERENCE BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Hang, Yuan-Ting	wearable medical sensors and systems	Springer	2013
2.	Mehmet R. Yuce, Jamil Y.Khan	Wireless Body Area Networks Technology, Implementation and Applications	Pan Stanford Publishing Pvt.Ltd Singapore	2012
3.	Guang-Zhong Yang(Ed.),	Body Sensor Networks	Springer	2006
4.	Andreas Lymberis, Danilo de Rossi	'Wearable eHealth systems for Personalised Health Management - State of the art and future challenges	IOS press, The Netherlands	2004


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Programme Code & Name – B.E. & Biomedical Engineering

COURSE CODE	COURSE TITLE	L	T	P	C
16BME07	BRAIN COMPUTER INTERFACE AND APPLICATIONS	3	0	0	3

COURSE OBJECTIVES:

- To apply the knowledge of mathematics science and engineering fundamentals to understand the Brain Organization, Anatomy, and Function.
- To analyze and study the Signal Processing for BCI's
- To develop the basic understanding in Building a BCI
- To study about the human devices
- To learn about the real-time Medical Applications.

COURSE OUTCOMES:

16BME07.CO1	Equips the students with the knowledge of Brain Organization, Anatomy, and Function.
16BME07.CO2	Analyze and process the brain signals for artifact reduction.
16BME07.CO3	Understand types of BCI, in the Neurosciences domain.
16BME07.CO4	Understand the principles and its applications in the Neurosciences domain.
16BME07.CO5	Ability to have the ideas of human assist device with Medical Applications

Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BME07.CO1	X	X	X	-	X	X	-	-	X	-	-	X	X	-	X
16BME07.CO2	X	X	X	-	X	X	-	-	X	-	-	X	X	-	X
16BME07.CO3	X	X	X	-	X	X	-	-	X	-	-	X	X	-	X
16BME07.CO4	X	X	X	-	X	X	-	-	X	-	-	X	X	-	X
16BME07.CO5	X	X	X	-	X	X	-	-	X	-	-	X	X	-	X

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BME07.CO1	2	2	3	-	3	2	-	-	2	-	-	2	3	-	2
16BME07.CO2	2	2	3	-	3	2	-	-	2	-	-	2	3	-	3
16BME07.CO3	2	2	3	-	3	2	-	-	2	-	-	2	3	-	2
16BME07.CO4	2	2	3	-	3	2	-	-	2	-	-	2	3	-	3
16BME07.CO5	2	2	3	-	3	2	-	-	2	-	-	2	3	-	3

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UNIT I **BASIC NEUROSCIENCES** **9**
Basic Neuroscience: Neurons, Action Potentials or Spikes, Dendrites and Axons, Synapses, Spike Generation, Adapting the Connections: Synaptic Plasticity – LTP, LTD, STDP, Short-Term Facilitation and Depression, Brain Organization, Anatomy, and Function. Recording Signals from the Brain: Invasive Techniques & Noninvasive Techniques. Stimulating the Brain - Neurochip.


UNIT II **SIGNAL PROCESSING FOR BCIs** **9**
Time Domain Analysis: Hjorth Parameters, Fractal Dimension, Autoregressive (AR) Modeling, Bayesian Filtering, Kalman Filtering, Particle Filtering, Spatial Filtering: Bipolar, Laplacian, and Common Average Referencing, Principal Component Analysis (PCA), Independent Component Analysis (ICA), Common Spatial Patterns (CSP) Thresholding, Band-Stop and Notch Filtering,

UNIT III **BUILDING A BCI** **9**
Major Types of BCIs, Brain Responses Useful for Building BCIs, Conditioned Responses, Population Activity, Imagined Motor and Cognitive Activity, Stimulus-Evoked Activity. Invasive BCIs: Two Major Paradigms in Invasive Brain-Computer Interfacing: BCIs Based on Operant Conditioning, BCIs Based on Population Decoding.

UNIT IV **INVASIVE BCIs IN HUMANS** **9**
Cursor and Robotic Control Using a Multi electrode Array Implant, Cognitive BCIs in Humans, Long-Term Use of Invasive BCIs, Long-Term BCI Use and Formation of a Stable Cortical Representation, Long-Term Use of a Human BCI Implant ECoG BCIs in Humans, BCIs Based on Peripheral Nerve Signals, Nerve-Based BCIs, Targeted Muscle Innervation (TMR). Sensory Restoration, Restoring Sight: Cortical and Retinal Implants, Motor Restoration, Deep Brain Stimulation (DBS), Sensory Augmentation.

UNIT V **MEDICAL APPLICATIONS** **9**
Sensory Restoration, Motor Restoration, Cognitive Restoration, Rehabilitation, Restoring Communication with Menus, Cursors, and Spellers, Brain- Controlled Wheelchairs, Nonmedical Applications: Web Browsing and Navigating Virtual Worlds, Robotic Avatars, High Throughput Image Search Lie Detection and Applications in Law, Monitoring Alertness, Estimating Cognitive Load. Education and Learning, Security, Identification, and Authentication, Physical Amplification with Exoskeletons, Mnemonic and Cognitive Amplification, Brain-Controlled Art.

TOTAL: 45 HRS



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TEXT BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Rajesh P. N. Rao	Brain-Computer Interfacing: An Introduction (1st Edition)	Cambridge University Press	
2.	Bernhard Graimann (Editor), Brendan Z. Allison (Editor), Gert Pfurtscheller (Editor)	Brain-Computer Interfaces: Revolutionizing Human-Computer Interaction	The Frontiers Collection - Hardcover	13 Dec 2010

REFERENCE BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Anton Nijholt, José Del R. Millán, Stephen Dunne	Towards Practical Brain-Computer Interfaces: Bridging the Gap from Research to Real-World Applications	Springer Science & Business Media	2012
2.	Mehmet R. Yuce, Jamil Y.Khan	Wireless Body Area Networks Technology, Implementation and Applications	Pan Stanford Publishing Pvt.Ltd Singapore	2012
3.	Guang-Zhong Yang (Ed.)	Body Sensor Networks	Springer	2006
4.	Anton Nijholt	Brain-Computer Interfaces Handbook: Technological and Theoretical Advances	CRC Press	2018


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Programme Code & Name – B.E. & Biomedical Engineering

COURSE CODE	COURSE TITLE	L	T	P	C
16BME08	MEDICAL OPTICS	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

16BME08.CO1	Demonstrate knowledge of the fundamentals of optical properties of tissues
16BME08.CO2	Analyze the components of instrumentation in Medical Photonics and Configurations
16BME08.CO3	Describe surgical applications of lasers.
16BME08.CO4	Describe photonics and its diagnostic applications.
16BME08.CO5	Investigate emerging techniques in medical optics

Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BME08.CO1	X	X	X	X	X	X	-	-	-	-	-	X	X	X	-
16BME08.CO2	X	X	X	X	X	X	-	-	-	-	-	X	X	X	-
16BME08.CO3	X	X	X	X	X	X	-	-	-	-	-	X	X	X	-
16BME08.CO4	X	X	X	X	X	X	-	-	-	-	-	X	X	X	-
16BME08.CO5	X	X	X	X	X	X	-	-	-	-	-	X	X	X	-

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BME08.CO1	3	2	3	2	3	3	-	-	-	-	-	2	2	2	-
16BME08.CO2	3	3	2	2	2	2	-	-	-	-	-	2	2	2	-
16BME08.CO3	2	3	3	2	3	3	-	-	-	-	-	3	2	3	-
16BME08.CO4	3	2	3	2	3	3	-	-	-	-	-	2	2	2	-
16BME08.CO5	3	3	3	2	3	3	-	-	-	-	-	2	2	2	-

1-Low, 2- Medium, 3-High



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REFERENCE BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Markolf H.Niemz	Laser-Tissue Interaction Fundamentals and Applications	Springer	2007
2.	G.David Baxter	Therapeutic Lasers— Theory and practice	Churchill Livingstone publications	2001
3.	Leon Goldman, M.D & R. James Rockwell	Lasers in Medicine	Gordon and Breach, Science Publishers Inc	1975
4.	Alexix Mendez	Optics in Medicine	Research Gate	2016
5.	Robert Splinter Brett. A. Hooper	An Introduction to Biomedical Optics	Taylor & Francis	2006


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Programme Code & Name – B.E. & Biomedical Engineering

COURSE CODE	COURSE TITLE	L	T	P	C
16BME09	SOFT COMPUTING	3	0	0	3

COURSE OBJECTIVES:

- To provide adequate knowledge about neural networks
- To teach about the concept of fuzzy involved in various systems
- To provide adequate knowledge about genetic algorithm
- To gain knowledge on Hybrid Computing Techniques
- To provide adequate knowledge to modeling the system

COURSE OUTCOMES:

16BME09.CO1	Describe basics of ANN and its learning algorithms
16BME09.CO2	Develop various Fuzzy Models
16BME09.CO3	Explain the terminologies associated to Genetic algorithms
16BME09.CO4	Develop a hybrid Computing Techniques
16BME09.CO5	Apply the concepts to solve real time problems


Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BME09.CO1	X	X	X	-	-	X	-	-	X	X	-	X	X	-	X
16BME09.CO2	X	X	X	-	-	X	-	-	X	X	-	X	X	-	X
16BME09.CO3	X	X	X	-	-	X	-	-	X	X	-	X	X	-	X
16BME09.CO4	X	X	X	-	-	X	-	-	X	X	-	X	X	-	X
16BME09.CO5	X	X	X	-	-	X	-	-	X	X	-	X	X	-	X

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BME09.CO1	3	2	3	-	-	2	-	-	2	2	-	2	3	-	2
16BME09.CO2	3	2	3	-	-	3	-	-	2	2	-	2	3	-	2
16BME09.CO3	3	2	3	-	-	2	-	-	2	2	-	2	3	-	2
16BME09.CO4	3	2	3	-	-	3	-	-	2	2	-	2	3	-	2
16BME09.CO5	3	2	3	-	-	3	-	-	3	2	-	2	3	-	2

1-Low, 2-Medium, 3-High


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UNIT I **NEURAL NETWORKS** 9

Fundamentals of Neural Networks – History- Architectures- Learning methods-XOR problem-Delta rule-derivation-Back propagation- applications- parameters in BPN- Associative memory – Hetero associative-BAM- energy function problems-applications of associative memories- ART1- ART2- applications of adaptive networks.

UNIT II **BASIC CONCEPTS OF FUZZY LOGIC** 9

Introduction to fuzzy logic, Classical sets and Fuzzy sets, Fuzzy relations, Membership function: Features of membership function, Fuzzification, Methods of membership value assignments- Fuzzy rules and reasoning: Fuzzy if-then rules. Fuzzy Inference Systems (FIS): Introduction– Methods of FIS: Mamdani, Sugeno and Tsukamoto. Defuzzification: Lambda-Cuts for fuzzy sets and fuzzy relations, Defuzzification methods.

UNIT III **GENETIC ALGORITHMS** 9

Fundamentals of Genetic Algorithms-Difference between Traditional Algorithms and Genetic Algorithms – creation of off springs – encoding – fitness function reproduction– Crossover- insertion& deletion- mutation-bitwise operators –applications- Multi-objective Genetic Algorithm (MOGA)- genetic algorithms in search and optimization, GA based clustering Algorithm.


UNIT IV **HYBRID SOFT COMPUTING TECHNIQUES** 9

Hybrid systems – Neuro Fuzzy Modelling -Applications of Neural Networks- Pattern Recognition and classification – Neuro Genetic hybrids – fuzzy Genetic hybrids- GA based weight determination and applications- fuzzy BPN – simplified fuzzy ARTMAP.Other Soft Computing techniques: Simulated Annealing, Tabu search, Ant colony optimization (ACO), Particle Swarm Optimization (PSO).

UNIT V **PROGRAMMING AND APPLICATIONS** 9

Using Neural Network toolbox – Using Fuzzy Logic toolbox- Using Genetic Algorithm & directed search toolbox Application: Printed Character Recognition, Optimization of travelling salesman problem using genetic algorithm approach. Identification and control of linear and nonlinear dynamic systems using Matlab-Neural Network toolbox

TOTAL: 45 HRS


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Programme Code & Name – B.E. & Biomedical Engineering

TEXT BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	S.N.Sivanandam, S.N.Deepa	Principles of Soft Computing	Wiley	2nd Edition 2014
2.	Rajasekaran.S and VijayalakshmiPai.G.A	Neural Networks, Fuzzy Logic and Genetic Algorithms .	PHI	2011

REFERENCE BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	J.S.R.Jang, C.T.Sun, E.Mizutani	Neuro – Fuzzy and Soft Computing	PHI Learning Pvt. Ltd	2012
2.	Timothy J.Ross	Fuzzy Logic with Engineering applications	John Wiley and Sons	2010
3.	Simon Haykin	Neural Networks Comprehensive Foundation	Pearson Education	Second Edition 2005
4.	Samir Roy, Udit Chakraborty	Neuro Fuzzy and Genetic Algorithms	Pearson Education	2013
5.	Davis E.Goldberg	Genetic Algorithms in Search, Optimization, and Machine Learning	Pearson Education	2009


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Programme Code & Name – B.E. & Biomedical Engineering

COURSE CODE	COURSE TITLE	L	T	P	C
16BME10	NEURAL ENGINEERING	3	0	0	3

COURSE OBJECTIVES:

- To discuss the physiological concepts of nerve impulse generation and Electromyography
- To discuss about EEG and its various applications
- To Explore Evoked potentials and its importance in medicine
- To introduce various techniques to study central and peripheral nerve function
- To discuss the electrophysiological evaluation in special situations.

COURSE OUTCOMES:

16BME10.CO1	Understand the physiology behind generation of nerve impulses.
16BME10.CO2	Describe various techniques that are used to evaluate the functioning of central and peripheral nervous system Explain the fundamentals of bio-solid mechanics.
16BME10.CO3	Differentiate between a normal and abnormal signal coming from a healthy and a diseased nervous system respectively.
16BME10.CO4	Elaborate the methods of evoked potential.
16BME10.CO5	Describe the functions of neuroimaging and cognitive aging.


Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BME10.CO1	X	-	X	-	X	X	X	-	-	-	-	X	X	X	-
16BME10.CO2	X	-	X	-	X	X	X	-	-	-	-	X	X	X	-
16BME10.CO3	X	-	X	-	X	X	X	-	-	-	-	X	X	X	-
16BME10.CO4	X	-	X	-	X	X	X	-	-	-	-	X	X	X	-
16BME10.CO5	X	-	X	-	X	X	X	-	-	-	-	X	X	X	-

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BME10.CO1	2	-	2	-	2	3	2	-	-	-	-	3	2	2	-
16BME10.CO2	2	-	2	-	2	2	2	-	-	-	-	3	2	2	-
16BME10.CO3	2	-	2	-	2	3	2	-	-	-	-	3	2	2	-
16BME10.CO4	2	-	2	-	2	3	2	-	-	-	-	2	2	2	-
16BME10.CO5	2	-	2	-	2	3	2	-	-	-	-	3	2	2	-

1-Low, 2- Medium, 3-High


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UNIT I **EXCITABILITY** **9**

Nerve Excitability: Functional insights derived from axonal structures, Nerve excitability findings in Neurologic diseases: Chemotherapy induced neurotoxicity, Porphyric Neuropathy, Inflammatory Neuropathy and its Treatment, Spinal Cord Injury; Nerve conduction studies, Microneurography and its potential clinical applications.

UNIT II **ELECTROENCEPHALOGRAPHY** **9**

Electroencephalography (EEG): General Principles and Clinical Applications, Neonatal and Paediatric EEG, EEG Artefacts and Benign Variants, Video EEG monitoring for epilepsy, Invasive Clinical Neurophysiology in Epilepsy and movement disorders, Topographic mapping, Frequency analysis and other quantitative techniques in EEG, Intraoperative EEG monitoring during carotid endarterectomy and cardiac surgery, Magnetoencephalography

UNIT III **ELECTROMYOGRAPHY** **9**

Electromyography (EMG), Quantitative EMG, Neuromuscular Ultrasound as a compliment to the electrodiagnostic evaluation, Electrophysiologic study of Disorders of Neuromuscular Junction:, H-Reflex and F-Reflex, Blink reflex and other cranial nerve reflexes, Electrophysiological evaluation of movement disorders, Evaluation of autonomic nervous system.

UNIT IV **EVOKED POTENTIALS** **9**

Evoked Potentials and Related Techniques: Visual Evoked potentials (VEPs), Electroretinography and other diagnostic approaches to the Visual System, VEPs in infants and children, Brainstem Auditory Evoked Potentials (AEPs), Brainstem AEPs in infants and children, Somatosensory evoked potentials, Diagnostic and therapeutic role of Magnetic stimulation in neurology.

UNIT V **FUNCTIONAL NEUROIMAGING AND COGNITION** **9**

Historical and physiological perspective, Functional neuroimaging methods: PET and fMRI, Network analyses, Functional neuroimaging of: Attention, Visual recognition, Semantic memory, Language, Episodic memory, Working memory, Cognitive aging, Neuro-psychologically impaired patients

TOTAL: 45 HRS


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Programme Code & Name – B.E. & Biomedical Engineering

TEXT BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Michael J. Aminoff	Aminoff's electrodiagnosis in Clinical Neurology Sixth Edition	Elsevier Saunders	2012
2.	Kim E. Baretteet	Ganong's review of Medical Physiology	McGraw Hill Medical	2010

REFERENCE BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Eric R. Kandelet	Principles of Neural Science	McGraw-Hill	2012
2.	R. Cooper	Techniques in Clinical Neurophysiology: A Practical Manual	Elsevier, Amsterdam	2005
3.	Holodny, Andrei	Functional neuroimaging: a clinical approach	Informa Health Care	2008
4.	Bin He	Neural engineering	Plenum publishers	2005
5.	Metin Akay	Handbook of neural engineering	John wiley & sons	2007


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Programme Code & Name – B.E. & Biomedical Engineering

COURSE CODE	COURSE TITLE	L	T	P	C
16BME11	PHYSIOLOGICAL MODELING	3	0	0	3

COURSE OBJECTIVES:

- To understand and appreciate the value and application of Physiological models and vital organs.
- To model dynamically varying physiological system
- To understand methods and techniques for analysis and synthesis of dynamic models
- To develop differential equations to describe the dynamic models, simulate and visualize,
- To analysis the dynamic responses of physiological models using software.

COURSE OUTCOMES:

16BME11.CO1	Explain application of Physiological models.
16BME11.CO2	Model dynamically varying physiological system
16BME11.CO3	Discuss methods and techniques to analyze and synthesis dynamic models
16BME11.CO4	Develop differential equations to describe the dynamic models, simulate and visualize
16BME11.CO5	Implement physiological models using software to get dynamic responses

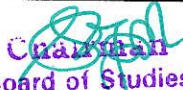
Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BME11.CO1	X	X	X	-	-	X	-	-	X	X	-	X	X	-	X
16BME11.CO2	X	X	X	-	-	X	-	-	X	X	-	X	X	-	X
16BME11.CO3	X	X	X	-	-	X	-	-	X	X	-	X	X	-	X
16BME11.CO4	X	X	X	-	-	X	-	-	X	X	-	X	X	-	X
16BME11.CO5	X	X	X	-	-	X	-	-	X	X	-	X	X	-	X

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BME11.CO1	3	2	3	-	-	2	-	-	2	2	-	2	3	-	2
16BME11.CO2	3	2	3	-	-	3	-	-	2	2	-	2	3	-	2
16BME11.CO3	3	2	3	-	-	2	-	-	2	2	-	2	3	-	2
16BME11.CO4	3	2	3	-	-	3	-	-	2	2	-	2	3	-	2
16BME11.CO5	3	2	3	-	-	3	-	-	3	2	-	2	3	-	2

1-Low, 2- Medium, 3-High


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UNIT I **APPROACHES TO MODELING** **9**

The technique of mathematical modeling, classification of models, characteristics of models. Purpose of physiological modeling and signal analysis, linearization of nonlinear models. Time invariant and time varying systems for physiological modeling.

UNIT II **NONPARAMETRIC MODELING** **9**

Volterra models. Wiener models. Efficient volterra kernel estimation Analysis of estimation errors. Parametric modeling: Basic parametric model forms and Estimation procedures. Volterra kernels of nonlinear differential equations. Discrete-time volterra kernels of NARMAX models. From Volterra kernel measurements to Parametric models. Equivalence between continuous and Discrete -parametric models.

UNIT III **QUIVALENT CIRCUIT MODEL** **9**

Electromotive, resistive and capacitive properties of cell membrane, change in membrane potential with distance, voltage clamp experiment and Hodgkin and Huxley's model of action potential, the voltage dependent membrane constant and simulation of the model, model for strength-duration curve, model of the whole neuron. Huxley model of isotonic muscle contraction, modeling of EMG, motor unit firing: amplitude measurement, motor unit & frequency analysis.


UNIT IV **PHYSIOLOGICAL MODELING** **9**

Electrical analog of blood vessels, model of systematic blood flow, model of coronary circulation, transfer of solutes between physiological compartments by fluid flow, counter current model of urine formation, model of Henle's loop, and Linearized model of the immune response: Germ, Plasma cell, Antibody, system equation and stability criteria.

UNIT V **ELECTRICAL CIRCUIT MODEL OF OXYGENATION** **9**

A model of immune response to disease - Modeling of multi input/multi output systems: The Two-input case. Application of two-input modeling to physiological systems. The Multi input case spatio temporal and spectro temporal modeling. Applications of Multi-input modeling to physiological systems

TOTAL: 45 HRS


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Programme Code & Name – B.E. & Biomedical Engineering

TEXT 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

REFERENCE BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Endarle, Blanchard & Bronzino	Introduction to Biomedical Engineering	Academic press	
2.	Suresh.R.Devas ahayam	Signals & Systems in Biomedical Engineering	Kluwer Academic/ Plenum Publishers.	
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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Programme Code & Name – B.E. & Biomedical Engineering

COURSE CODE	COURSE TITLE	L	T	P	C
16BME12	MULTIMEDIA COMPRESSION AND NETWORK	3	0	0	3

COURSE OBJECTIVES:

- To understand the encoding and decoding of digital data streams.
- To be familiar with the methods for the generation of these codes and their decoding techniques.
- To study the compression and decompression techniques.
- To learn the concepts of multimedia communication.
- To analyze the concept of multimedia network.

COURSE OUTCOMES:

16BME12.CO1	Identify the basic structure and functional units of multimedia components.
16BME12.CO2	Understand the effect of audio and video compression.
16BME12.CO3	Understand the text and image compression concepts.
16BME12.CO4	Describe the VOIP challenges and applicability.
16BME12.CO5	Apply the concepts of multimedia communication.


Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BME11.CO1	X	X	X	-	X	X	-	X	-	-	-	X	X	-	X
16BME11.CO2	X	X	X	-	X	X	-	X	-	-	-	X	X	-	X
16BME11.CO3	X	X	X	-	X	X	-	X	-	-	-	X	X	-	X
16BME11.CO4	X	X	X	-	X	X	-	X	-	-	-	X	X	-	X
16BME11.CO5	X	X	X	-	X	X	-	X	-	-	-	X	X	-	X

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BME11.CO1	3	2	3	-	3	2	-	2	-	-	-	2	3	-	2
16BME11.CO2	3	2	3	-	3	2	-	2	-	-	-	2	3	-	2
16BME11.CO3	3	2	3	-	3	2	-	2	-	-	-	2	3	-	2
16BME11.CO4	3	2	3	-	3	2	-	2	-	-	-	2	3	-	2
16BME11.CO5	3	2	3	-	3	2	-	2	-	-	-	2	3	-	2

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UNIT I	MULTIMEDIA COMPONENTS	9
Introduction – Multimedia skills – Multimedia components and their characteristics – Text, sound, images, graphics, animation, video, hardware		
UNIT II	AUDIO AND VIDEO COMPRESSION	9
Audio compression–DPCM-Adaptive PCM –adaptive predictive coding-linear Predictive coding-code excited LPC-perpetual coding Video compression –principles-H.261-H.263-MPEG 1, 2, and 4.		
UNIT III	TEXT AND IMAGE COMPRESSION	9
Compression principles-source encoders and destination encoders-lossless and lossy compression-entropy encoding –source encoding -text compression – static Huffman coding dynamic coding –arithmetic coding – Lempel Ziv-Welsh Compression-image compression.		
UNIT IV	VOIP TECHNOLOGY	9
Basics of IP transport, VoIP challenges, H.323/ SIP –Network Architecture, Protocols, Call establishment and release, VoIP and SS7, Quality of Service- CODEC Methods- VOIP applicability.		
UNIT V	MULTIMEDIA NETWORKING	9
Multimedia networking -Applications-streamed stored and audio-making the best Effort service-protocols for real time interactive Applications-distributing multimedia-beyond best effort service-secluding and policing Mechanisms-integrated services-differentiated Services-RSVP.		

TOTAL: 45 HRS


TEXT BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Fred Halshall	Multimedia Communication – Applications, Networks, Protocols and Standards	Pearson Education	2007
2.	Tay Vaughan	Multideai: Making it Work	Tata Mc Graw Hill	2008


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REFERENCE BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Kurose and W.Ross	Computer Networking	Pearson Education	2005
2.	Marcus Goncalves	Voice over IP Networks	Tata Mc Graw Hill	1999
3.	KR. Rao,Z S Bojkovic, D A Milovanovic	Multimedia Communication Systems: Techniques, Standards, and Networks	Pearson Education	2007
4.	R. Steimnetz, K. Nahrstedt	Multimedia Computing, Communications and Applications	Pearson Education Ranjan Parekh	2007
5.	Mihaela van der Schaar	Multimedia over IP and Wireless Networks : Compression, Networking, and Systems	Elsevier Science Publishing Co Inc	2007


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Programme Code & Name – B.E. & Biomedical Engineering

COURSE CODE	COURSE TITLE	L	T	P	C
16BME13	REHABILITATION ENGINEERING	3	0	0	3

COURSE OBJECTIVES:

- To understand the rehabilitation concepts and Rehabilitation team members for future development and applications.
- To study various Principles of Rehabilitation Engineering.
- To understand different types of Therapeutic Exercise Technique
- To understand the tests to assess the hearing loss, development of electronic devices to compensate for the loss and various for visually and auditory impaired.
- To study the various orthotic devices and prosthetic devices to overcome orthopedic problems.

COURSE OUTCOMES:

16BME13.CO1	Gain adequate knowledge about the needs of rehabilitations and its future development.
16BME13.CO2	Gain various principle of Rehabilitation Engineering
16BME13.CO3	Have an in depth idea about Engineering Concepts in Sensory & Motor rehabilitation. Apply the different types of Therapeutic Exercise Technique to benefit the society.
16BME13.CO4	Design and apply different types Hearing aids, visual aids and their application in biomedical field and hence the benefit of the society.
16BME13.CO5	Gain in-depth knowledge about different types of models of Hand and arm replacement.


Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BME13.CO1	X	X	X	X	X	X	-	-	-	-	-	X	X	-	-
16BME13.CO2	X	X	X	X	X	X	-	-	-	-	-	X	X	-	-
16BME13.CO3	X	X	X	X	X	X	-	-	-	-	-	X	X	-	-
16BME13.CO4	X	X	X	X	X	X	-	-	-	-	-	X	X	-	-
16BME13.CO5	X	X	X	X	X	X	-	-	-	-	-	X	X	-	-

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BME13.CO1	3	2	3	3	3	3	-	-	-	-	-	2	2	-	-
16BME13.CO2	3	2	2	3	3	2	-	-	-	-	-	2	2	-	-
16BME13.CO3	3	2	3	2	3	3	-	-	-	-	-	2	2	-	-
16BME13.CO4	3	2	3	3	3	3	-	-	-	-	-	2	2	-	-
16BME13.CO5	3	2	2	3	3	3	-	-	-	-	-	2	2	-	-

1-Low, 2- Medium, 3-High


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UNIT I 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 II REHABILITATION TEAM 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.

UNIT III THERAPEUTIC EXERCISE TECHNIQUE 9

Co-ordination exercises, Frenkels exercises, Gait analyses-Pathological Gaits, Gait Training, Relaxation exercises-Methods for training Relaxation, Strengthening exercises-Strength training, Types of Contraction, Mobilization exercises, Endurance exercises.


UNIT IV MANAGEMENT OF COMMUNICATION & VIRTUAL REALITY 9

Impairment-introduction to communication, Aphasia, Types of aphasia, Treatment of aphasic patient, Augmentative communication-general form of communication, types of visual aids, Hearing aids, Types of conventional hearing aid, Writing aids. Introduction to virtual reality, Virtual reality based rehabilitation, Hand motor recovery systems with Phantom haptics, Robotics and Virtual Reality Applications in Mobility Rehabilitation.

UNIT V ORTHOTIC, PROSTHETIC DEVICES & RESTORATION TECHNIQUES 9

General orthotics, Classification of orthotics-functional & regional, General principles of Orthosis, Calipers-FO, AFO, KAFO, HKAFO. Prosthetic devices: Hand and arm replacement, Body powered prosthetics, 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: 45 HRS


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Programme Code & Name – B.E. & Biomedical Engineering

TEXT BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Sunder	Textbook of Rehabilitation 2 nd Edition	Jaypee Brothers Medical Publishers Pvt. Ltd, New Delhi	2007
2.	Joseph D. Bronzino	The Biomedical Engineering Handbook - Third edition	Pearson Education	2006

REFERENCE BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Horia- Nocholai Teodorecu, L.C.Jain	Intelligent systems and technologies in rehabilitation Engineering	CRC	2000
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 Hisaiichi Ohnabe Douglas A. Hobson	An Introduction to Rehabilitation Engineering	CRC	2006
5.	Rory A Cooper Douglas A. Hobson	An Introduction to Rehabilitation Engineering	Taylor and Francis	2007


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Programme Code & Name – B.E. & Biomedical Engineering

COURSE CODE	COURSE TITLE	L	T	P	C
16BME14	VIRTUAL REALITY	3	0	0	3

COURSE OBJECTIVES:

- 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, augmented reality and using them to build Biomedical engineering applications.
- To know the intricacies of these platform to develop PDA applications with better optimality.
- To learn about the application used in medical terms.

COURSE OUTCOMES:

16BME14.CO1	Analyze & Design a system or process to meet given specifications with realistic engineering constraints.
16BME14.CO2	Identify problem statements and function as a member of an engineering design team.
16BME14.CO3	Utilize technical resources
16BME14.CO4	Propose technical documents and give technical oral presentations related to design mini project results.
16BME14.CO5	Application used in medical terms.


Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BME14.CO1	X	X	X	X	X	-	-	-	-	-	-	X	X	-	-
16BME14.CO2	X	X	X	X	X	-	-	-	-	-	-	X	X	-	-
16BME14.CO3	X	X	X	X	X	-	-	-	-	-	-	X	X	-	-
16BME14.CO4	X	X	X	X	X	-	-	-	-	-	-	X	X	-	-
16BME14.CO5	X	X	X	X	X	-	-	-	-	-	-	X	X	-	-

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BME14.CO1	2	2	3	2	2	-	-	-	-	-	-	2	2	-	-
16BME14.CO2	2	2	2	2	2	-	-	-	-	-	-	2	2	-	-
16BME14.CO3	2	2	3	2	2	-	-	-	-	-	-	3	2	-	-
16BME14.CO4	2	2	2	2	2	-	-	-	-	-	-	2	2	-	-
16BME14.CO5	2	2	2	2	2	-	-	-	-	-	-	2	2	-	-

1-Low, 2- Medium, 3-High


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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

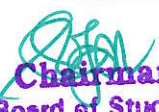
UNIT V 9

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: 45 HRS

TEXT 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	


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REFERENCE BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Adams	Visualizations of Virtual Reality	Tata McGraw Hill	2000
2.	Grigore C. Burdea, Philippe Coiffet	Virtual Reality Technology	Wiley Inter Science, 2nd Edition,	2006
3.	William R. Sherman, Alan B. Craig	Understanding Virtual Reality: Interface, Application and Design	Morgan Kaufmann	



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Programme Code & Name – B.E. & Biomedical Engineering

COURSE CODE	COURSE TITLE	L	T	P	C
16BME15	WEARABLE SYSTEMS	3	0	0	3

COURSE OBJECTIVES:

- 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:

16BME15.CO1	Enables the need for wearable devices.
16BME15.CO2	Know about the basic principles of sensors and with the input signal
16BME15.CO3	Provides idea with the energy management for wearable devices.
16BME15.CO4	Explain need of wireless health systems
16BME15.CO5	Equips with the knowledge of application with wearable systems


Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BME15.CO1	X	X	X	X	X	X	-	-	-	-	-	X	X	X	-
16BME15.CO2	X	X	X	X	X	X	-	-	-	-	-	X	X	X	-
16BME15.CO3	X	X	X	X	X	X	-	-	-	-	-	X	X	X	-
16BME15.CO4	X	X	X	X	X	X	-	-	-	-	-	X	X	X	-
16BME15.CO5	X	X	X	X	X	X	-	-	-	-	-	X	X	X	-

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BME15.CO1	3	3	3	2	3	3	-	-	-	-	-	2	3	2	-
16BME15.CO2	3	3	3	2	2	2	-	-	-	-	-	2	3	2	-
16BME15.CO3	3	3	3	2	3	3	-	-	-	-	-	2	3	3	-
16BME15.CO4	3	2	2	2	2	3	-	-	-	-	-	2	3	3	-
16BME15.CO5	3	3	3	2	3	3	-	-	-	-	-	2	3	3	-

1-Low, 2- Medium, 3-High


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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: 45 HRS

TEXT 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




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REFERENCE BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Hang, Yuan-Ting	Wearable medical sensors and systems	Springer	2013
2.	Mehmet R. Yuce, Jamil Y. Khan	Wireless Body Area Networks Technology, Implementation and Applications	Pan Stanford Publishing Pvt.Ltd Singapore,	2012
3.	Guang-Zhong Yang(Ed.)	Body Sensor Networks	Springer	2006
4.	Andreas Lymberis, Danilo de Rossi	Wearable eHealth systems for Personalised Health Management - State of the art and future challenges	IOS press, The Netherlands	2004


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Programme Code & Name – B.E. & Biomedical Engineering

COURSE CODE	COURSE TITLE	L	T	P	C
16BME16	INTERNET AND JAVA PROGRAMMING	3	0	0	3

COURSE OBJECTIVES:

- To obtain a basic knowledge in JAVA.
- To develop server side programs using Servlets and JSP.
- To construct simple web pages in PHP and to represent data in XML format.
- To gain knowledge about server side programming.
- To Use AJAX and web services to develop interactive web applications.

COURSE OUTCOMES:

16BME16.CO1	Discuss the basics of JAVA.
16BME16.CO2	Describe the basics and java networking in JAVA.
16BME16.CO3	Discuss the Client-side programming.
16BME16.CO4	Understand the Server-side programming.
16BME16.CO5	Describe the AJAX and web services.


Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BME16.CO1	X	X	X	-	-	X	-	-	X	-	X	X	X	X	X
16BME16.CO2	X	X	X	-	-	X	-	-	X	-	X	X	X	X	X
16BME16.CO3	X	X	X	-	-	X	-	-	X	-	X	X	X	X	X
16BME16.CO4	X	X	X	-	-	X	-	-	X	-	X	X	X	X	X
16BME16.CO5	X	X	X	-	-	X	-	-	X	-	X	X	X	X	X

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BME16.CO1	3	3	3	-	-	3	-	-	3	-	3	3	3	2	3
16BME16.CO2	3	3	3	-	-	3	-	-	2	-	3	2	2	2	2
16BME16.CO3	3	3	3	-	-	3	-	-	3	-	3	3	3	2	2
16BME16.CO4	3	3	3	-	-	3	-	-	3	-	3	3	2	2	2
16BME16.CO5	3	3	3	-	-	3	-	-	3	-	3	3	3	2	3

1-Low, 2- Medium, 3-High


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UNIT I **INTRODUCTION TO JAVA** **9**

Object oriented language – The JAVA environment – comparing JAVA C and C++– Keywords & operators – Identifiers – Literal – Expressions – Control flow – Arrays & Strings – Functions – Command line Arguments .Data members – methods – Overloading constructors – Class Assignment – This – Static members & methods-Inheritance – Abstract classes – exceptions .

UNIT II **INTERNET BASICS AND JAVA NETWORK PROGRAMMING** **9**

Internet Addressing, Browsers, Servers, Protocols – Web Application Architectures, Development – Scripting Languages – Databases – Search Engines – Web Services – Collective Intelligence – Mobile Web – Features of Web 3.0 Overview of Java Networking - TCP - UDP - InetAddress and Ports - Socket Programming - Working with URLs - Internet Protocols simulation - HTTP - SMTP - POP - FTP - Remote Method Invocation.

UNIT III **CLIENT-SIDE PROGRAMMING** **9**

Scripting for content structuring, form design, client side validation, dynamic page generation, adding interactivity, styles, using HTML, DHTML, XHTML, CSS, Java Script – XML - Document Type Definition - XML Schema - Document Object Model - Presenting XML - Using XML Parsers: DOM and SAX.


UNIT IV **SERVER SIDE PROGRAMMING** **9**

Types of servers - Configuring and Using Web servers, Setting up Databases, Java Database 48 Connectivity -Handling form data, validation, querying databases, information retrieval, response generation, Session management - using PHP, Servlets, JSP.

UNIT V **INTRODUCTION TO AJAX and WEB SERVICES** **9**

Ajax Client Server Architecture-XML Http Request Object-Call Back Methods; Web Services: Introduction- Java web services Basics – Creating, Publishing, Testing and Describing a Web services (WSDL)- Consuming a web service, Database Driven web service from an application –SOAP.

TOTAL: 45 HRS



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TEXT BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Herbert Schildt	Java The Complete Reference, 8th Edition	McGraw-Hill Osborne Media	2011
2.	Paul Deitel	Internet & World Wide Web: How to Program	Prentice Hall, 4th Edition	2007

REFERENCE BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Cay S. Horstmann and Gary Cornell	Core Java™, Volume I – Fundamentals	Prentice Hall	2007
2.	Cay S. Horstmann and Gary Cornell	Core Java, Vol. 2: Advanced Features	Prentice Hal	2008
3.	Robert W. Sebesta	Programming the World Wide Web	Addison-Wesley, Sixth Edition	2010
4.	Elliote Rusty Harold	Java Network Programming	O'Reilly	2004
5.	William J Buchanan	Mastering Java	Red Globe Press	2007


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Programme Code & Name – B.E. & Biomedical Engineering

COURSE CODE	COURSE TITLE	L	T	P	C
16BME17	CRPTOGRAPHY AND NETWORK SECURITY	3	0	0	3

COURSE OBJECTIVES:

- Understand the fundamental principles of access control models and techniques, authentication and secure system design
- Have a strong understanding of different cryptographic protocols and techniques and be able to use them.
- Apply methods for authentication, access control, intrusion detection and prevention.
- Identify and mitigate software security vulnerabilities in existing systems.
- Discuss about the private and public keys algorithms along with attacks types.

COURSE OUTCOMES:

16BME17.CO1	Understand cryptography and network security concepts and application.
16BME17.CO2	Apply security principles to system
16BME17.CO3	Identify and investigate network security.
16BME17.CO4	Analyze and design network security protocols
16BME17.CO5	Conduct research in network security.


Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BME17.CO1	X	X	X	-	X	X	-	-	X	-	-	X	X	-	X
16BME17.CO2	X	X	X	-	X	X	-	-	X	-	-	X	X	-	X
16BME17.CO3	X	X	X	-	X	X	-	-	X	-	-	X	X	-	X
16BME17.CO4	X	X	X	-	X	X	-	-	X	-	-	X	X	-	X
16BME17.CO5	X	X	X	-	X	X	-	-	X	-	-	X	X	-	X

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BME17.CO1	2	2	3	-	3	2	-	-	2	-	-	2	3	-	2
16BME17.CO2	2	2	3	-	3	2	-	-	2	-	-	2	3	-	3
16BME17.CO3	2	2	3	-	3	2	-	-	2	-	-	2	3	-	2
16BME17.CO4	2	2	3	-	3	2	-	-	2	-	-	2	3	-	3
16BME17.CO5	2	2	3	-	3	2	-	-	2	-	-	2	3	-	3

1-Low, 2- Medium, 3-High


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UNIT I CONVENTIONAL AND MODERN ENCRYPTION & BLOCK CIPHERS 9
Conventional Encryption Model – Steganography – Classical Encryption Techniques – Simplified DES – Block Cipher Principles – The Data Encryption Standard – The Strength of DES – Differential and Linear Cryptanalysis – Block Cipher Design Principles – Block Cipher Modes of operation – Conventional Encryption algorithms


UNIT II PUBLIC KEY ENCRYPTION AND HASH FUNCTIONS 9
Public Key Encryption and Hash Functions Public Key Cryptography – Principles of Public Key Cryptosystems – The RSA Algorithm – Key Management – Diffie Hellman Key Exchange – Elliptic Curve Cryptography Message Authentication and Hash Functions Authentication Requirements – Authentication Functions – Message Authentication Codes – Hash Functions – Security of Hash Functions.

UNIT III MESSAGE AUTHENTICATION 9
Discrete Logarithms – Computing discrete logs – Diffie-Hellman key exchange – ElGamal Public key cryptosystems – Hash functions – Secure Hash – Birthday attacks - MD5 – Digital signatures – RSA – ElGamal – DSA.

UNIT IV NETWORK SECURITY 9
Kerberos, X.509, PKI – Electronic Mail security – PGP – IP security – Web Security – SSL, TLS, SET.

UNIT V NETWORK SECURITY 9
Wireless Network Security- IEEE 802.11 Wireless LANs - Protocol Overview and Security - Wireless Application Protocol (WAP) - Protocol Overview - Wireless Transport Layer Security (WTLS).

TOTAL: 45 HRS



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TEXT BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	William Stallings	Cryptography and Network Security, 6th Edition	Pearson Education	2013
2.	Charlie Kaufman, Radia Perlman and Mike Speciner	Network Security.	Prentice Hall of India	2002

REFERENCE BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Behrouz A. Ferouzan	Cryptography & Network Security	Tata McGraw-Hill	2007
2.	Man Young Rhee	Internet Security: Cryptographic Principles, Algorithms and Protocols	Wiley Publication	2003
3.	Charles Pfleeger	Security in Computing 4th Edition	Prentice Hall of India	2006
4.	Ulysess Black	Internet Security Protocols	Pearson Education Asia	2000
5.	Peter Reiher S. Kami Makki	Mobile and Wireless Network Security and Privacy	Springer-Verlag New York Inc.	2007


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Programme Code & Name – B.E. & Biomedical Engineering

COURSE CODE	COURSE TITLE	L	T	P	C
16BME18	HOSPITAL WASTE MANAGEMENT	3	0	0	3

COURSE OBJECTIVES:

- 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:

16BME18.CO1	Handling of biomedical waste.
16BME18.CO2	Importance of the biomedical waste disposal in the society.
16BME18.CO3	Know about the types of treatment technologies for wastes.
16BME18.CO4	Learn the laws of biomedical waste handling and the Healthcare waste Management
16BME18.CO5	study about the professional ethics of biomedical waste handling


Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BME18.CO1	-	-	-	-	-	X	X	X	X	X	X	X	X	X	-
16BME18.CO2	-	-	-	-	-	X	X	X	X	X	X	X	X	X	-
16BME18.CO3	-	-	-	-	-	X	X	X	X	X	X	X	X	X	-
16BME18.CO4	-	-	-	-	-	X	X	X	X	X	X	X	X	X	-
16BME18.CO5	-	-	-	-	-	X	X	X	X	X	X	X	X	X	-

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BME18.CO1	-	-	-	-	-	3	2	2	2	2	2	3	3	2	-
16BME18.CO2	-	-	-	-	-	3	3	2	3	2	2	3	3	3	-
16BME18.CO3	-	-	-	-	-	2	2	2	2	2	2	3	2	2	-
16BME18.CO4	-	-	-	-	-	2	3	2	3	2	3	3	2	3	-
16BME18.CO5	-	-	-	-	-	2	3	3	3	3	3	3	2	3	-

1-Low, 2- Medium, 3-High


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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: 45 HRS


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Programme Code & Name – B.E. & Biomedical Engineering

TEXT BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Anantpreet Singh, SukhjitKaur	Biomedical Waste Disposal	Jaypee Publishers (P) Ltd, India	2012
2.	Sushma Sahai	Bio-Medical Waste Management	APH Publishing Corporation, India	2009

REFERENCE BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Sanskriti Sharma	Hospital Waste Management and Its Monitoring	Jaypee Publishers (P) Ltd, India	2002
2.		Environment and Pollution Laws (Containing Acts and Rules)	Universals Legal Manual	
3.	Paul T. Williams	Waste Treatment and Disposal	John Wiley & Sons, Ltd	2005


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Programme Code & Name – B.E. & Biomedical Engineering

COURSE CODE	COURSE TITLE	L	T	P	C
16BME19	MEDICAL PHYSICS	3	0	0	3

COURSE OBJECTIVES:

- 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:

16BME19.C01	Explain about non-ionizing radiation, interaction with tissue and its effects.
16BME19.C02	Define and compare intensities of sensory stimuli
16BME19.C03	Summarizes how ionizing radiation interacts with the human body, how to quantify it and its levels seen in the environment and healthcare
16BME19.C04	Explain the fundamentals of radioactivity and radioactive isotopes
16BME19.C05	Illustrates the methods of detecting and recording the ionizing radiation and its interaction with matter

Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BME19.C01	X	X	X	-	X	X	-	-	X	-	-	X	X	-	X
16BME19.C02	X	X	X	-	X	X	-	-	X	-	-	X	X	-	X
16BME19.C03	X	X	X	-	X	X	-	-	X	-	-	X	X	-	X
16BME19.C04	X	X	X	-	X	X	-	-	X	-	-	X	X	-	X
16BME19.C05	X	X	X	-	X	X	-	-	X	-	-	X	X	-	X

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BME19.C01	2	2	3	-	3	2	-	-	2	-	-	2	3	-	2
16BME19.C02	2	2	3	-	3	2	-	-	2	-	-	2	3	-	3
16BME19.C03	2	2	3	-	3	2	-	-	2	-	-	2	3	-	2
16BME19.C04	2	2	3	-	3	2	-	-	2	-	-	2	3	-	3
16BME19.C05	2	2	3	-	3	2	-	-	2	-	-	2	3	-	3

1-Low, 2- Medium, 3-High

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 SCINTILLATION, SEMICONDUCTOR and GAS FILLED DETECTORS 9

Scintillation Detectors - Solid Scintillation Counters - Gamma-Ray Spectrometry-Liquid Scintillation Counters-Characteristics of Counting Systems-Gamma Well Counters-Thyroid Probe-Principles of Gas-Filled Detectors - Ionization Chambers-Geiger–Muller Counters


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REFERENCE BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Gopal B. Saha	Physics and Radiobiology of Nuclear Medicine 4 th Edition	Springer	2013
2.	B H Brown, R H Smallwood, D C Barber, P V Lawford D R Hose	Medical Physics and Biomedical Engineering 2 nd Edition	IOP Publishers	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.	Hylton B. Meire Pat Farrant	Basic Ultrasound	John Wiley & Sons	1995


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Programme Code & Name – B.E. & Biomedical Engineering

COURSE CODE	COURSE TITLE	L	T	P	C
16BME20	COMPUTER ARCHITECTURE AND ORGANIZATION	3	0	0	3

COURSE OBJECTIVES:

- To understand the basic structure and operation of digital computer
- To study the design of arithmetic and logic unit and implementation of fixed point and floating-point arithmetic operations
- To study the two types of control unit techniques and the concept of pipelining
- To study the hierarchical memory system including cache memories and virtual memory
- To study the different ways of communicating with I/O devices and standard I/O interfaces

COURSE OUTCOMES:

16BME20.CO1	Identify the basic structure and functional units of a digital computer.
16BME20.CO2	Analyze the effect of addressing modes on the execution time of a program.
16BME20.CO3	Design processing unit using the concepts of ALU and control logic design.
16BME20.CO4	Identify the pros and cons of different types of control logic design in processors.
16BME20.CO5	Identify the roles of various functional units of a computer in instruction execution.


Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BME20.CO1	X	X	X	-	X	X	-	-	X	-	-	X	X		X
16BME20.CO2	X	X	X	-	X	X	-	-	X	-	-	X	X		X
16BME20.CO3	X	X	X	-	X	X	-	-	X	-	-	X	X		X
16BME20.CO4	X	X	X	-	X	X	-	-	X	-	-	X	X		X
16BME20.CO5	X	X	X	-	X	X	-	-	X	-	-	X	X		X

Course Articulation Matrix:


Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BME20.CO1	2	2	3	-	3	2	-	-	2	-	-	2	3		2
16BME20.CO2	2	2	3	-	3	2	-	-	2	-	-	2	3		3
16BME20.CO3	2	2	3	-	3	2	-	-	2	-	-	2	3		2
16BME20.CO4	2	2	3	-	3	2	-	-	2	-	-	2	3		3
16BME20.CO5	2	2	3	-	3	2	-	-	2	-	-	2	3		3

1-Low, 2- Medium, 3-High


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UNIT I	COMPUTING AND COMPUTERS	9
Functional units – Basic operational concepts - Bus structures - Software performance – Memory locations and addresses – Memory operations – Instruction and instruction sequencing – Addressing modes – Assembly language – Basic I/O operations .		
UNIT II	ARITHMETIC UNIT	9
Addition and subtraction of signed numbers – Design of fast adders – Multiplication of positive numbers – Signed operand multiplication and fast multiplication – Integer division – Floating point numbers and operations.		
UNIT III	BASIC PROCESSING UNIT	9
Fundamental concepts – Execution of a complete instruction – Multiple bus organization – Hardwired control – Micro programmed control – Pipelining – Basic concepts – Data hazards – Instruction hazards – Influence on Instruction sets – Data path and control consideration.		
UNIT IV	MEMORY SYSTEM	9
Basic concepts – Semiconductor RAMs – ROMs – Speed – size and cost – Cache memories – Performance consideration – Virtual memory – Memory Management requirements – Secondary storage		
UNIT V	I/O ORGANIZATION	9
Accessing I/O devices – Interrupts – Direct Memory Access – Buses – Interface circuits – Standard I/O Interfaces (PCI, SCSI, and USB).		

TOTAL: 45 HRS


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Programme Code & Name – B.E. & Biomedical Engineering

TEXT BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Carl Hamacher, Zvanko Vranesic, Safwat Zaky	Computer Organization	McGraw-Hill, Fifth Edition	2012
2.	Mano M. M	Digital Logic & Computer Design, 4/e	Pearson Education	2013

REFERENCE BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Patterson D.A. and J. L. Hennessey	Computer Organization and Design, 5/e	Morgan Kaufmann Publishers	2013
2.	William Stallings	Computer Organization and Architecture: Designing for Performance	Pearson	2013
3.	Chaudhuri P	Computer Organization and Design, 2/e	Prentice Hall of India	2008
4.	Rajaraman V. and T. Radhakrishnan	Computer Organization and Architecture	Prentice Hall	2011
5.	William Stallings	computer organization and architecture designing for performance	Prentice Hall	2008


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Programme Code & Name – B.E. & Biomedical Engineering

COURSE CODE	COURSE TITLE	L	T	P	C
16BMF01	PROJECT WORK PHASE - I	0	0	10	3

COURSE OBJECTIVES:

- To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same.
- To train the students in preparing project reports

COURSE OUTCOMES:

16BMF01.CO1	Able to handle any position to take up any challenging practical problems
16BMF01.CO2	Find solution by formulating proper methodology
16BMF01.CO3	To face reviews and viva voce examination.
16BMF01.CO4	Convert ideas into conceptual model by comparing with existing solutions
16BMF01.CO5	Prepare for paper writing and technical report

Mapping of COs with POs and PSOs:


Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BMF01.CO1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
16BMF01.CO2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
16BMF01.CO3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
16BMF01.CO4	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
16BMF01.CO5	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BMF01.CO1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
16BMF01.CO2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
16BMF01.CO3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
16BMF01.CO4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
16BMF01.CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

1-Low, 2- Medium, 3-High

The students in a group of 3 to 4 work on a topic approved by the head of the department under the guidance of a faculty member and prepare a comprehensive project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department.


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Programme Code & Name – B.E. & Biomedical Engineering

COURSE CODE	COURSE TITLE	L	T	P	C
16BMF02	PROJECT WORK PHASE – II	0	0	12	6

COURSE OBJECTIVES:

- To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same.
- To train the students in preparing project reports

COURSE OUTCOMES:

16BMF02.CO1	Utilize new tools, algorithms, software for finding the solution
16BMF02.CO2	Solve specific problems independently or as part of a team
16BMF02.CO3	Manage a project from start to finish
16BMF02.CO4	Work independently as well as in teams
16BMF02.CO5	Prepare for paper writing and technical report

Mapping of COs with POs and PSOs:


Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BMF02.CO1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
16BMF02.CO2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
16BMF02.CO3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
16BMF02.CO4	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
16BMF02.CO5	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BMF02.CO1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
16BMF02.CO2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
16BMF02.CO3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
16BMF02.CO4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
16BMF02.CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

1-Low, 2- Medium, 3-High

The students in a group of 3 to 4 work on a topic approved by the head of the department under the guidance of a faculty member and prepare a comprehensive project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department.


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Programme Code & Name – B.E. & Biomedical Engineering

COURSE CODE	COURSE TITLE	L	T	P	C
16BMF05	HOSPITAL TRAINING	0	0	0	1

COURSE OBJECTIVES:

- Observe medical professionals at work in the wards and the roles of Allied Health Professionals;
- Provide access to healthcare Professionals to get a better understanding of their work;
- Demonstrate patient-care in a hospital setting.

COURSE OUTCOMES:

16BMF05.CO1	Advocate a patient-centered approach in healthcare
16BMF05.CO2	Communicate with other health professionals in a respectful and responsible manner
16BMF05.CO3	Recognize the importance of inter-professional collaboration in healthcare.
16BMF05.CO4	Propose a patient-centered inter-professional health improvement plan based upon the patient's perceived needs
16BMF05.CO5	Use the knowledge of one's own role and those of other professions to address the healthcare needs of populations and patients served.


Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BMF05.CO1	-	-	-	-	-	X	X	X	-	-	-	X	-	X	-
16BMF05.CO2	-	-	-	-	-	X	X	X	-	-	-	X	-	X	-
16BMF05.CO3	-	-	-	-	-	X	X	X	-	-	-	X	-	X	-
16BMF05.CO4	-	-	-	-	-	X	X	X	-	-	-	X	-	X	-
16BMF05.CO5	-	-	-	-	-	X	X	X	-	-	-	X	-	X	-

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BMF05.CO1	-	-	-	-	-	2	3	2	-	-	-	3	-	2	-
16BMF05.CO2	-	-	-	-	-	3	2	2	-	-	-	2	-	3	-
16BMF05.CO3	-	-	-	-	-	2	3	2	-	-	-	3	-	2	-
16BMF05.CO4	-	-	-	-	-	3	3	2	-	-	-	3	-	3	-
16BMF05.CO5	-	-	-	-	-	2	3	2	-	-	-	3	-	2	-

1-Low, 2- Medium, 3-High


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