MUTHAYAMMAL ENGINEERING COLLEGE

(An Autonomous Institution)
(Approved by AICTE, New Delhi, Accredited by NAAC, NBA & Affiliated to Anna University)
Rasipuram - 637 408, Namakkal Dist., Tamil Nadu.

Curriculum/Syllabus

Programme Code   : BM

Programme Name   : B.E-Biomedical Engineering

Regulation   : R-2016

MUTHAYAMMAL ENGINEERING COLLEGE

(An Autonomous Institution)

(Approved by AICTE, Accredited by NAAC & NBA, Affiliated to Anna University)

Rasipuram - 637 408, Namakkal Dt, Tamil Nadu.

Ph. No.: 04287-220837

Email: principal@mec.edu.in.

MUTHAYAMMAL ENGINEERING COLLEGE
(An Autonomous Institution)
(Approved by AICTE, New Delhi, Accredited by NAAC, NBA & Affiliated to Anna University)
Rasipuram - 637 408, Namakkal Dist., Tamil Nadu.

Estd. 2000

INSTITUTION VISION &MISSION

INSTITUTION VISION

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

INSTITUTION MISSION

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

INSTITUTION MOTTO

Rural upliftment through Technical Education.

MUTHAYAMMAL ENGINEERING COLLEGE
(An Autonomous Institution)
(Approved by AICTE, New Delhi, Accredited by NAAC, NBA & Affiliated to Anna University)
Rasipuram - 637 408, Namakkal Dist., Tamil Nadu.

DEPARTMENT VISION & MISSION

DEPARTMENT VISION

To empower the students with Engineering and Medical knowledge in both theoretical and experimental practices with research attitude and ethics for healthcare applications.

DEPARTMENT MISSION

- To develop the technical skills with Engineering knowledge and enhance the clinical solutions in healthcare sector.
- To establish the state of art laboratories in preparing the students for facing the challenges in medical field.
- To enhance the students with highly skilled ethical social and economic implications of their work.

MUTHAYAMMAL ENGINEERING COLLEGE

(An Autonomous Institution)

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

DEPARTMENT PROGRAM EDUCATIONAL OBJECTIVES, PROGRAM OUTCOMES & PROGRAM SPECIFIC OUTCOMES

PROGRAM EDUCATIONAL OBJECTIVES

The Biomedical Engineering Graduates should be able to

PEO1: Graduate should be able to apply the principles and tools from physical science to engineering and medical sciences.

PEO2: Graduate should be able to create innovations that analyze real time problems and meet desire needs in healthcare sector.

PEO3: Graduate should be able to accomplish professional success with promise to the social responsibilities and engaging in lifelong learning

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.

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 essential knowledge and basic skills in addition to in depth knowledge of engineering sciences and medical sciences.

PSO2: Apply ICT tools and skills in multi disciplinary environment to develop innovative diagnostic and therapeutic devices for better healthcare.

PSO3: Develop algorithms for analyze, measurements and interpret data in medicine and life sciences.

MUTHAYAMMAL ENGINEERING COLLEGE

(An Autonomous Institution)

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

Rasipuram - 637 408, Namakkal Dist., Tamil Nadu

B.E. - BIOMEDICAL ENGINEERING

GROUPING OF COURSES

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

Chairman
Board of Studies
Department of Biomedical Engineering
Muthayammal Engineering College (A)
Rasipuram, Namakkal Dist

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	3	3	0	2	5
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	5
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	3	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
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

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

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	Contact Hours
			L	T	P	C	
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**	

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 – II

Sl. No.	Course Code	Course Name	Hours/ Week			Credit	Contact Hours
			L	T	P	C	
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**	

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

	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	Contact Hours
			L	T	P	C	
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	

	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	Contact Hours
			L	T	P	C	
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	

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

	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 – V

Sl. No.	Course Code	Course Name	Hours/ Week			Credit	Contact Hours
			L	T	P	C	
THEORY							
1.	16BMD12	Hospital Management	3	0	0	3	3
2.	16BMD14	Digital Signal Processing	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**	

	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 – VI

Sl. No.	Course Code	Course Name	Hours/ Week			Credit	Contact Hours
			L	T	P	C	
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**	

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

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 – VII

Sl. No.	Course Code	Course Name	Hours/ Week			Credit	Contact Hours
			L	T	P	C	
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	

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 – VIII

Sl. No.	Course Code	Course Name	Hours/ Week			Credit	Contact Hours
			L	T	P	C	
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

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

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

16BMD01	ANATOMY AND HUMAN PHYSIOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. Know basic structural and functional elements of human body.
2. Learn organs and structures involving in system formation and functions.
3. Understand circulatory system.
4. Learn urinary and special sensory system
5. Study about nervous system

COURSE OUTCOMES

1. To Know basic structural and functional elements of human body.
2. To Learn organs and structures involving in system formation and functions.
3. To Understand circulatory system.
4. To Learn urinary and special sensory system
5. To Study about nervous system

Course Outcomes	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	-	-
16BMD01.CO2	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BMD01.CO3	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BMD01.CO4	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BMD01.CO5	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-

UNIT I   BASIC ELEMENTS OF HUMAN BODY   9

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

UNIT II   SKELETAL SYSTEM   9

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

UNIT III   CIRCULATORY SYSTEM   9

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

UNIT IV   URINARY AND NERVOUS SYSTEM   9

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

UNIT V   MUSCLES AND JOINTS   9

Muscle tissue:Skeletal muscle, Smooth muscle, Cardiac muscle, functions of muscle tissue, muscle tone and fatigue. Types of joint- Fibrous, Cartilaginous, Synovial, characteristics of synovial joints, shoulder joint, elbow joint, radioulnar joint, wrist joint, joints of hands and fingers, Hip joint, Knee joint, ankle joint, joints of foot and toes.

REFERENCE BOOK

Sl.No	AUTHOR(s)	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1.	Elaine.N. Marieb,	Essential of Human Anatomy and Physiology	Pearson Education NewDelhi.	Eight edition,, 2007.

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

2.	Gillian Pocock, Christopher D. Richards	The Human Body An introduction for Biomedical and Health Sciences	Oxford University Press,USA	2009
3.	William F. Ganong	Review of Medical Physiology	Mc Graw Hill New Delhi	22nd edition
4.	Eldra Pearl Solomon	Introduction to Human Anatomy and Physiology	W.B.Saunders Company	2003
5.	Arthur C. Guyton	Text book of Medical Physiology	11 th Edition, Elsevier Saunders,	11th Edition, 2006

WEB REFERENCE(s)

1. https://nptel.ac.in/courses/104101093/3
2. https://nptel.ac.in/courses/122103039/19
3. https://nptel.ac.in/noc/individual_course.php?id=noc18-ch11
4. https://nptel.ac.in/courses/102104058/19
5. https://nptel.ac.in/courses/102104058/19

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

16BMD03	BIOMEDICAL INSTRUMENTATION AND MEASUREMENTS	L T P C 3 0 2 5

COURSE OBJECTIVES

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

COURSE OUTCOMES

1. Differentiate different bio potentials and its propagations.
2. Illustrate different electrode placement for various physiological recordings
3. Design bio amplifier for various physiological recordings
4. Explain various technique for non-electrical physiological measurements
5. Demonstrate different biochemical measurement techniques.

Course Outcomes	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	-	-
16BMD03.CO2	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BMD03.CO3	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BMD03.CO4	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BMD03.CO5	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-

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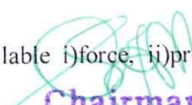
Temperature. respiration rate and pulse rate measurements. Blood Pressure: indirect methods - auscultatory method, oscillometric method, direct methods: electronic manometer, Pressure amplifiers, Systolic, diastolic, mean detector circuit. Blood flow and cardiac output measurement: Indicator dilution,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

UNIT V   BIO-CHEMICAL MEASUREMENT   9

Biochemical sensors - pH, pO_2 and pCO_2, 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)

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,

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

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

REFERENCE BOOK

Sl.No	AUTHOR(s)	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1.	Leslie Cromwell	Biomedical Instrumentation and measurement 2nd edition	Prentice hall of India, New Delhi	2015
2.	Khandpur R.S,	Handbook of Biomedical Instrumentation 3rd edition	Tata McGraw-Hill New Delhi	2014
3.	John G. Webster	Medical Instrumentation Application and Design 4th edition	Wiley India Pvt Ltd, New Delhi	2015
4.	Joseph J. Carr John M. Brown	Introduction to Biomedical Equipment Technology	Pearson Education	2004
5.	Myer Kutz	Standard Handbook of Biomedical Engineering and Design	McGraw Hill Publisher	2003.

WEB REFERENCE(s)

1. https://www.slideshare.net/jineshkj/ec09-l25-biomedical-instrumentation-module-1
2. https://www.slideshare.net/ErFarukBinPoyen/bio-potential-and-bio-electrode
3. https://www.slideshare.net/stootypal/biopotentials
4. https://www.slideshare.net/MariaRominaAngustia/measurement-and-control-of-nonelectrical-quantitie
5. https://www.slideshare.net/ShmmonAhmad/biochemical-analysis-techniques

Chairman
Board of Studies
Department of Biomedical Engineering
Muthayammal Engineering College (Autonomous
Rasip ram. an akkal Dist 637 408

		L	T	P	C
16BMD04	**DIGITAL ELECTRONICS**	3	0	2	4

COURSE OBJECTIVES

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

COURSE OUTCOMES

1. Apply Boolean algebra, Karnaugh map and Tabulation method for simplification of Boolean expressions
2. Design combinational logic circuits for various applications
3. Design shift registers, Modulo-N asynchronous and synchronous counters
4. Design and analyze state machines for the given specifications
5. Discuss different logic families and Implement digital circuit in programmable logic devices

Course Outcomes	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

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 LogicArray (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

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

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:30 Hrs

REFERENCE BOOK

Sl.No	AUTHOR(s)	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1.	Morris Mano M. and Michael D. Ciletti	Digital Design	Pearson Education	V Edition, 2013.
2.	Donald D.Givone,	Digital Principles and Design	Tata Mc-Graw Hill Publishing company limited, New Delhi	2002
3.	Thomas L. Floyd	Digital Fundamentals	Pearson Education Inc	10th Edition, 2011
4.	Charles H. Roth Jr,	Fundamentals of Logic Design	Jaico Publishing House	Fifth Edition–, Mumbai, 2003
5.	Leach D, Malvino A P & Saha	Digital Principles and Applications	Tata McGraw-Hill Publishing Company	8th Edition, , 2014

WEB REFERENCE(s)

1. www.nptel.ac.in/courses/117105080/7
2. www.nptel.ac.in/video.php?subjectId=117105080
3. www.nptelvideos.in/2012/12/digital-systems-design.html
4. www.allabout circuits.com
5. www.electronicsforu.com

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

				L	T	P	C
16BMD05		**SIGNALS AND SYSTEMS**		3	2	0	4

COURSE OBJECTIVES

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

COURSE OUTCOMES

1. Able to describe classification of signals and systems
2. Analyze the Laplace transform, Fourier transform
3. Ability to analyze continuous time LTI systems using Fourier and Laplace Transforms
4. Analyze Z Transform and DTFT
5. Ability to analyze discrete time LTI systems using Z transform and DTFT

Course Outcomes	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	-	-
16BMD05.CO2	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BMD05.CO3	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BMD05.CO4	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BMD05.CO5	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-

UNIT I   **FUNDAMENTAL OF 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 II   **ANALYSIS OF CONTINUOUS TIME SIGNALS**   **9**

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

UNIT III   **LINEAR TIME INVARIANT SYSTEMS**   **9**

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

UNIT IV   **ANALYSIS OF DISCRETE TIME SIGNALS**   **9**

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

UNIT V   **LINEAR TIME INVARIANT-DISCRETE TIME SYSTEMS**   **9**

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

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

REFERENCE BOOK

Sl.No	AUTHOR(s)	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1.	Alan V. Oppenheim, Alan S. Willsky	Signals and Systems	Pearson education	2nd Edition, 2015.
2.	P. Ramakrishna Rao	Signals and Systems	McGraw Hill	2ndEdition,2013
3.	B P Lathi	Signals and Systems	B S Publisher	2001
4.	Nagrath ,Sharan	Signals and Systems	McGraw Hill	2009
5.	S.Salivahanan, N.Sureshkumar and A.Vallavaraj	Signals and Systems	Tata McGraw Hill	2011

WEB REFERENCE(s)

1. www.youtube.com/watch?v=oJpUbfwvzKA
2. www.youtube.com/watch?v=oJpUbfwvzKA
3. www.youtube.com/watch?v=ghz_puTV198
4. www.youtube.com/watch?v=wG6VUnkrO90
5. www.youtube.com/watch?v=AkBaDKYmQQI

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

		L	T	P	C
16BMD06	THERAPEUTIC EQUIPMENTS	3	0	0	3

COURSE OBJECTIVES

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

COURSE OUTCOMES

1. Describe the working setup of all basic cardiac equipment.
2. Students will have acquired thorough life support equipment in clinical use.
3. Learned the design and system level analysis different therapeutic equipments
4. Analyzing the application and safety aspects of different equipments
5. Studied various internal organ monitoring devices

Course Outcomes	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	-	-
16BMD06.CO2	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BMD06.CO3	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BMD06.CO4	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BMD06.CO5	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-

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 — 9

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 — 9

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 — 9

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 — 9

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

REFERENCE BOOK

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
3.	Bronzino	Hand book of Biomedical Engineering	IEEE press book	2000

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

| 4. | Mushin | Automatic Ventilation of Lung | Black Well | 1980 |
| 5. | Joseph J. Carr, John M. Brown | Introduction to Biomedical Equipment Technology | Pearson Education | 2001 |

WEB REFERENCE(s)

1. https://www.slideshare.net/abhilashachaudhary4/pacemaker-71996509
2. https://www.slideshare.net/niteshkumarsinghh/defibrillator-ppt
3. https://www.slideshare.net/RajneeMishra/ventilator-61330983
4. https://www.slideshare.net/HemangiParmar4/neuromuscular-electrical-stimulation
5. https://www.slideshare.net/UthamalingamMurali/diathermy-in-surgery

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

16BMD07	BIO CONTROL SYSTEM	L T P C
		3 0 0 4

COURSE OBJECTIVES

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

COURSE OUTCOMES

1. Analysis the knowledge of various control models
2. Perform time domain control systems required for system analysis.
3. Perform frequency domain analysis of control systems required for system analysis.
4. Performance analysis of control systems required for stability analysis
5. Design the state variable analysis method.

Course Outcomes	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

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

REFERENCE BOOK

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
3.	M.Gopal	Control System – Principles and	Tata McGraw	2002

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

			Design	Hill, 2nd Edition	
4.	Schaum"s Outline Series		Feed back and Control Systems	Tata Mc Graw-Hill	2007
5.	John J.D"Azzo & Constantine H.Houpis		Linear Control System Analysis and Design	Tata Mc Graw-Hill, Inc.,	1995

WEB REFERENCE(s)

1. https://www.javatpoint.com/control-system-tutorial
2. https://lecturenotes.in/notes/6579-notes-for-control-system-engineering-cse-by-gyana-ranjan-biswal
3. https://nptel.ac.in/courses/108101037/
4. https://nptel.ac.in/noc/individual_course.php?id=noc18-ee41
5. https://www.tutorialspoint.com/control_systems/control_systems_introduction.htm

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

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

COURSE OBJECTIVES

1. Design and construct amplifiers
2. Construct JFET and MOSFET amplifiers
3. Study rectifiers and power supplies
4. Learn about feedback amplifiers
5. Learn about oscillators

COURSE OUTCOMES

1. To learn about Design and construct amplifiers
2. To Construct JFET and MOSFET amplifiers
3. To Study rectifiers and power supplies
4. ToLearn about feedback amplifiers
5. To Learn about oscillators

Course Outcomes	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

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.

LIST OF EXPERIMENTS

Frequency Response of CE amplifier

Frequency Response of CS amplifier

Frequency response of feedback amplifier circuit-current series

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

Frequency response of feedback amplifier circuit- voltage shunt

Transistor based design of RC phase Shift Oscillator circuit

Transistor based design of Wein Bridge Oscillator circuit

Power Supply circuit - Half wave rectifier and Full wave rectifier with simple capacitor filter

Mini Project

Total: 30 Hrs

REFERENCE BOOK

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	2nd Edition, 2009
2.	Robert L. Boylestad and Louis Nasheresky	Electronic Devices and Circuit Theory	Pearson Education / PHI	10th Edition 2008
3.	Adel .S. Sedra, Kenneth C. Smith	Micro Electronic Circuits	Oxford University Press	6th Edition, 2010
4.	Behzad Razavi	Design of Analog CMOS Integrated Circuits	Tata Mc Graw Hill,	2007
5.	Paul Gray, Hurst, Lewis, Meyer	Analysis and Design of Analog Integrated Circuits	John Willey & Sons	4th Edition 2005

WEB REFERENCE(s)
1.   www.nptel.ac.in/courses/117101106/7
2.   www.nptel.ac.in/courses/117101106/9
3.   www.nptel.ac.in/courses/117101106/8
4.   www.nptel.ac.in/courses/117106088/1
5.   www.nptel.ac.in/courses/117106088/14

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

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

COURSE OBJECTIVES

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

COURSE OUTCOMES

1. Illustrate the Circuit Fabrication Process and internal structure of operational amplifiers
2. Characterize and design real time operational amplifiers applications
3. Design comparator and generate waveforms using operational amplifier
4. Demonstrate the functioning of PLL and Data converters
5. Acquire knowledge about special function ICs and its application in modern electronic equipment

Course Outcomes	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	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

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 CONVETER**   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

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

Design and Testing of

1. Inverting, Non inverting and Differential amplifiers.

2. Integrator and Differentiator.

3. Instrumentation amplifier

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

REFERENCE BOOK

Sl.No	AUTHOR(s)	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1.	Sergio Franco	Design with operational amplifiers and analog integrated circuits	3rd Edition, Tata McGraw-Hill	2007
2.	D.Roy Choudhry, Shail Jain	Linear Integrated Circuits	New Age International Pvt. Ltd	2000
3.	RamakantA.Gayakwad	OP-AMP and Linear IC's	Prentice Hall of India	2002
4.	David L.Terrell	Op Amps-Design, Application, and Troubleshooting	Elsevier publications	2005
5.	Sergio Franco	Design with operational amplifiers and analog integrated circuits	3rd Edition, Tata McGraw-Hill	2002

WEB REFERENCE(s)

1. www.nptel.ac.in/courses/117107094/
2. www.youtube.com/watch?v=clTA0pONnMs
3. www.youtube.com/watch?v=7beZocF34AU
4. www.youtube.com/watch?v=7xVSL93ZZq8
5. www.youtube.com/watch?v=xki9taCqsWY

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

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

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

COURSE OUTCOMES
1. Describe the principles of various life support equipment for mobility.
2. Students will design and system level analysis different human assist equipments
3. Comprehend the design human vital organ equipments
4. Summarize the implantable various types of cells
5. Explain the solutions of different implant parameters

Course Outcomes	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	-	-
16BMD10.CO2	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BMD10.CO3	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BMD10.CO4	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BMD10.CO5	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-

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   IMPLÁNT 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.

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.

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

9. Design of ECG amplifier, recording and analysis using Lab View

TOTAL HRS : 30

REFERENCE BOOK

Sl.No	AUTHOR(s)	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1.	Kenneth J. Turner,	Advances in Home Care Technologies: Results of thematch Project	Springer,	2011
2.	Yannas, I. V,	Tissue and Organ Regeneration in Adults	Springer,	2001
3.	Levine S.N.	"Advances in Bio-medical engineering and Medical physics	Interuniversity publications,	1968
4.	Kopff W.J,	Artificial Organs	John Wiley and sons	1976
5.	Daniel Goldstein, Mehmet	Cardiac assist Devices	Wiley	2000

WEB REFERENCE(s)

1. https://www.slideshare.net/hansonk_uwa/assistive-technology-49278658
2. https://www.slideshare.net/jeneane123/sensory-impairments-presentation-7007219
3. https://www.slideshare.net/wonnietonnie/advances-in-medical-technology
4. https://www.slideshare.net/DrShilpaShiv/basic-aspects-of-implants
5. https://www.slideshare.net/iosrjce/a-review-on-design-process-of-orthopedic-implants

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

16BMD11	PATHOLOGY AND MICROBIOLOGY	L T P C
		3 0 2 4

COURSE OBJECTIVES

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

COURSE OUTCOMES

1. Analyze structural and functional aspects of living organisms.
2. Explain the function of microscope
3. Discuss the importance of public health.
4. Describe methods involved in treating the pathological diseases.
5. Able to know study Antibodies and its types

Course Outcomes	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	-	x	x	-	-
16BMD11.CO3	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BMD11.CO4	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BMD11.CO5	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-

UNIT I   CELL DEGENERATION, REPAIR AND NEOPLASIA   9

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

UNIT II   FLUID AND HEMODYNAMIC DERANGEMENTS   9

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

UNIT III   MICROBIOLOGY   9

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

UNIT IV   MICROSCOPES   9

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

UNIT V   IMMUNOPATHOLOGY   9

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

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.

4. Manual paraffin tissue processing and section cutting (demonstration)

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

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

REFERENCE BOOK

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 (Units I & II).
2.	Ananthanarayanan & Panicker,	Microbiology‖	Orientblackswan,10th edition. (Units III,IV and V).	2017
3.	Underwood JCE	General and Systematic Pathology	Churchill Livingstone, 3rd edition,	: 2000.
4.	Dubey RC and Maheswari DK.	A Text Book of Microbiology‖ &	Chand Company Ltd,	2007
5.	Prescott, Harley and Klein	Microbiology‖	10th edition, McGraw Hill	2017

WEB REFERENCE(s)
1.   https://nptel.ac.in/courses/102106025/36
2.   https://nptel.ac.in/courses/112104118/43
3.   https://nptel.ac.in/courses/102103015/
4.   https://nptel.ac.in/courses/115103030/9
5.   https://nptel.ac.in/courses/102103038/

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

16BMD12	HOSPITAL MANAGEMENT	L T P C
		3 0 0 3

COURSE OBJECTIVES

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

COURSE OUTCOMES

1. Explain the principles of Hospital administration.
2. Identify the importance of Human resource management.
3. List various marketing research techniques.
4. Identify Information management systems and its uses.
5. Understand safety procedures followed in hospitals

Course Outcomes	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	-	-
16BMD12.CO2	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BMD12.CO3	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BMD12.CO4	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BMD12.CO5	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-

UNIT I OVERVIEW OF HOSPITAL ADMINISTRATION 9

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

UNIT II HUMAN RESOURCE DEPARTMENT MANAGEMENT 9

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

UNIT III MARKETING RESEARCH PROCESS 9

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

UNIT IV HOSPITAL INFORMATION SYSTEMS & SUPPORTIVE SERVICES 9

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

UNIT V QUALITY AND SAFETY ASPECTS IN HOSPITAL 9

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

REFERENCE BOOK

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	TMH, New Delhi	2007

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

		Fifth Reprint		
3.	Cesar A. Caceres Albert Zara	The Practice of Clinical Engineering	Academic Press, New York	1977
4.	Norman Metzger	Handbook of Health Care Human Resources Management 2nd edition	Aspen Publication Inc. Rockville, Maryland, USA	1990.
5.	Peter Berman	Health Sector Reform in Developing Countries	Harvard University Press	1995

WEB REFERENCE(s)

1. https://www.slideshare.net/drjayeshpatidar/hospital-administration-53507341
2. https://www.slideshare.net/dharmendragahwai/human-resource-management-in-public-health-ppt
3. https://www.slideshare.net/RajeshKuthalingam/marketing-research-process-9625550
4. https://www.slideshare.net/vijayrajnazzi/information-technology-in-hospitals
5. https://www.slideshare.net/akhileshbhargava/quality-in-health-care

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

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

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

COURSE OUTCOMES
1. Apply DFT for the analysis of digital signals & systems
2. Design IIR and FIR filters
3. Characterize finite Word length effect on filters
4. Design the Multi-rate Filters
5. Apply Adaptive Filters to equalization

Course Outcomes	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
16BMD14.CO2	X	X	X	X	X	-	-	-	X	-	-	X	X	X	X
16BMD14.CO3	X	X	X	X	X	-	-	-	X	-	-	X	X	X	X
16BMD14.CO4	X	X	X	X	X	-	-	-	X	-	-	X	X	X	X
16BMD14.CO5	X	X	X	X	X	-	-	-	X	-	-	X	X	X	X

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

LIST OF EXPERIMENTS
Linear and Circular Convolutions

Spectrum Analysis using DFT

F-filter design

Linear and Circular Convolutions
DSP Processor Based Implementation
5. Study of architecture of Digital Signal Processor
6. Convolution
7. FFT Implementation
8. Waveform generation

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

9. Implementation of Filter Design

10. Mini Project

Total: 30 Hrs

REFERENCE BOOK

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

WEB REFERENCE(s)

1. www.nptel.ac.in/courses/117102060/
2. www.nptel.ac.in/courses/108105055/
3. www.nptelvideos.in/2012/12/digital-signal-processing.html
4. www.nptelvideos.in/2012/11/digital-signal-processing.html
5. www.youtube.com/watch?v=6dFnpz_AEyA

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

16BMD15	EMBEDDED SYSTEM	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES

1. To study the overview of Embedded System Architecture.
2. To study about the ARM Architecture.
3. To learn various embedded communication protocols.
4. To learn the Real Time operating System Concepts.
5. To Study about applications of Embedded System.

COURSE OUTCOMES

1. Able to describe hardware and software architectures of Embedded Systems.
2. Able to understand the functions and syntax used in Embedded C.
3. Able to understand special features of ARM architecture.
4. Able to introduce devices and buses used for Embedded Networking.
5. Able to interpret the concepts of a Real Time Operating System.

Course Outcomes	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

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 - μCOS.

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.

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
5. Interface Stepper Motor
6. Interface 7 Segment Display using I2C

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

7. Interfacing Analog to Digital Converter
8. Interface Digital to Analog Converter
9. Implementing Real Time Clock
10. Mini Project

Total: 30 Hrs

REFERENCE BOOK

Sl.No	AUTHOR(s)	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1.	Raj Kamal,	Embedded Systems Architecture programming and Design	TMH	Second Edition, 2011
2.	Prasad.K.V.K.K,	Embedded Real-Time Systems: Concepts, Design & Programming	Dream tech press	2011
3.	Wayne Wolf	Computers as Components - Principles of Embedded Computing System Design	Morgan Kaufman Publishers	Third Edition 2013
4.	Steve Furber,	ARM System on Chip Architecture	Addison-Wesley Professional	Second Edition, 2000
5.	Andrew N.Sloss, Dominic Symes, Chris Wright	ARM System Developer's Guide Designing and Optimizing System Software	Morgan Kaufmann Publishers, Elsevier	2004

WEB REFERENCE(s)

1. http://www.nptel.ac.in/courses/108102045/
2. http://freevideolectures.com/Course/2341/EmbeddedSystems
3. nptel.ac.in/courses/108105057/Pdf/Lesson-3.pdf
4. nptel.ac.in/downloads/108105057/
5. nptel.ac.in/courses/108102045/5

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

16BMD17	DIGITAL IMAGE PROCESSING	L T P C
		3 0 0 3

COURSE OBJECTIVES

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

COURSE OUTCOMES

1. Describe Digital image fundamentals and Image transforms
2. Ilustrate Image enhancement
3. Describe Image Restoration and Segmentation
4. Analysis Wavelets and Image compression
5. Describe Image Representation and Recognition

Course Outcomes	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

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.
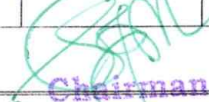
UNIT V   IMAGE REPRESENTATION AND RECOGNITION   9

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.

REFERENCE BOOK

Sl.No	AUTHOR(s)	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION

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

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.	Willliam K Pratt	Digital Image Processing	Tata McGraw Hill	2002

WEB REFERENCE(s)

1. www.youtube.com/watch?v=CVV0TvNK6pk
2. www.youtube.com/wa
3. www.youtube.com/watch?v=gIQ6S8U6Vpc
4. www.youtube.com/watch?v=IcBzsP-fvPo
5. www.youtube.com/watch?v=IcBzsP-fvPo

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

16BMD18	MEDICAL IMAGING TECHNIQUES	L T P C
		3 0 0 3

COURSE OBJECTIVES

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

COURSE OUTCOMES

1. Know and understand the basics and fundamentals X-ray imaging.
2. Operate on CT imaging techniques.
3. Understand the concepts and function of Nuclear imaging techniques
4. Learn the basics of mathematic calculation for image formation.
5. Familiar with medical image modeling methods

Course Outcomes	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	X
16BMD18.CO5	X	X	X	X	X	-	-	-	X	-	-	X	X	X	X

UNIT – I   DIFFERENT MODES OF MEDICAL RECORDING   9

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.

REFERENCE BOOK

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 3rd edition	Tata McGraw-Hill New Delhi	2014
3.	John G. Webster	Medical Instrumentation Application and Design 4th edition	Wiley India Pvt Ltd, New Delhi	2015

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

| 4. | Joseph J. Carr
John M. Brown | Introduction to Biomedical Equipment Technology | Pearson Education | 2004 |
| 5. | Paul Suetens | Fundamentals of Medical Imaging | Pearson Education | 2009 |

WEB REFERENCE(s)

1. https://www.slideshare.net/Aprnaa/medical-imaging-techniques
2. https://www.slideshare.net/brucelee55/radioisotope-imaging-equipment
3. https://www.slideshare.net/sandeepgupta0491/nuclear-magnetic-resonance-39763597
4. http://www.cse.iitm.ac.in/~vplab/courses/optimization/MAths_IM_DEBLUR_ENH_SD_EDT_2016.pdf
5. https://www.slideshare.net/VictorEkpo2/the-role-of-computers-in-medical-physics

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

16BMD19	ELECTRICAL SAFTEY & QUALITY ASSURANCE	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

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

COURSE OUTCOMES

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

Course Outcomes	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	-	-
16BMD19.CO2	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BMD19.CO3	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BMD19.CO4	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BMD19.CO5	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-

UNIT I   **CLASSIFICATION OF DEVICE**   9

Classification of Device: Device classes, types in medical field
PATIENT SAFETY:
Electric shock hazards, Leakage currents, macro shock, micro shock hazards and preventions, safety codes and analyzer. Safety & precautions Safety 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
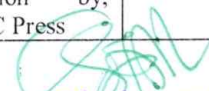
Standards: Voluntary and mandatory standards, Standards development process, Conformity assessment with standards, National and international standards systems, Identification of standards, Current trends in the use of standards in medical device regulations. The ISO 9000 Series of Standards.

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.

REFERENCE BOOK

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.
3.	Michael Cheng	Medical device regulations: global overview and guiding principles	World Health Organization	Latest Edition
4.	Gábor Czitán, Attila Gutassy, Ralf Wilde	Product Safety in the European Union	TÜV Rheinland Akadémia	2008.
5.				

WEB REFERENCE(s)

1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1121134/
2. https://www.ncbi.nlm.nih.gov/books/NBK2686. https://www.bnl.gov/nsls2/project/PDR/4-ESHQ_Ch_1_Intro_QA.pdf
3. https://www.americares.org/globalassets/publications/comm/misc/hws/hwsi-guide-standards-0413.pdf
4. http://fobi.us/wp-content/uploads/2018/05/Medical-Equipment-QA-Program.pdf.
5. https://www.qualityindicators.ahrq.gov/

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

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

COURSE OBJECTIVES

1. To study about the microscopy

2. To learn about the hybrid techniques and types of chromatography

3. To study about the special techniques in advanced bio analytical.

4. To learn the radiation therapy and radiation safety.

5. To analysis about the basics of respiratory aids

COURSE OUTCOMES

1. Idea about the imaging techniques in microscopy.
2. Types of techniques in advanced bio analytical.
3. Know about the types of special techniques.
4. Knowledge about the types of respiratory aids.
5. Know about the radiation & safety of radiation.

Course Outcomes	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	-	-
16BME01.CO2	x	x	x	-	-	x	-		x	x		x	x	-	-
16BME01.CO3	x	x	x	-	-	x	-		x	x	-	x	x	-	-
16BME01.CO4	x	x	x	-	-	x	-		x	x	-	x	x	-	-
16BME01.CO5	x	x	x	-	-	x	-		x	x	-	x	x	-	-

UNIT I   ADVANCED IMAGING TECHNIQUES IN MICROSCOPY   9

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

UNIT-II   ANALYTICAL HYBRID TECHNIQUES   9

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

UNIT III   ANALYTICAL SPECIAL TECHNIQUES   9

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

UNIT IV   RESPIRATORY AIDS   9

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

UNIT V   RADIATION THERAPY AND RADIATION SAFETY   9

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

REFERENCE BOOK

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,	2006

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

			USA	
2.	R.S.Khandpur	Hand book of Biomedical Instrumentation	Tata McGraw Hill, NewDelhi	1998
3.	Albert M.Cook and Webster.J.G	Therapeutic Medical Devices	Prentice Hall Inc., New Jersey	1982
4.	Leslie Cromwell, Fred. J. Weibel, Erich.A.Pferffer	Biomedical Instrumentation and Measurements	Prentice Hall India, NewDelhi	2001
5.	Rangaraj.M.Rangayyan	Biomedical Signal Analysis-A Case Study Approach	IEEE Press- John Wiley&Sons Inc, New York	2002

WEB REFERENCE(s)

1. https://analytika.pharmaceuticalconferences.com/events-list/advance-bio-analytical-techniques
2. https://onlinelibrary.wiley.com/doi/book/10.1109/9780470544204
3. http://www.biomedicahelp.altervista.org/SecondoAnno/StatisticaSegnali/Segnali/Segnali_BiomedicalSignalAnalysisBook_Libro.pdf
4. https://people.ucalgary.ca/~ranga/enel563/Lectures1stEdCh1-2-3.pdf
5. http://www.naweb.iaea.org/nahu/DMRP/documents/slides/Chapter_16_Radiation_protection_and_safety.pdf

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

16BME02	BIO SIGNAL PROCESSING	L T P C
		3 0 0 3

COURSE OBJECTIVES
1. To study about the adaptive filters and their analysis.
2. To discuss the Data Compression Techniques.
3. To study about the Cardio-logical Signal Processing.
4. To learn about the Neurological signal processing.
5. To study about the sleeping modes of EEG.

COURSE OUTCOMES
1. Choose a filter for the ECG analysis.
2. Write the types of algorithm for data compression.
3. Idea about processing the ECG signal and their estimations.
4. Study about EEG and their parameters.
5. Study about the sleeping modes of EEG.

Course Outcomes	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	-	-
16BME02.CO2	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BME02.CO3	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BME02.CO4	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BME02.CO5	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-

UNIT I	ADAPTIVE FILTERS	9

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

UNIT II	DATA COMPRESSION TECHNIQUES	9

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

UNIT III	CARDIO-LOGICAL SIGNAL PROCESSING	9

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

UNIT IV	NEUROLOGICAL SIGNAL PROCESSING	9

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

UNIT V	SLEEP EEG	9

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

REFERENCE BOOK

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
3.	Willis J.Tompkins	Biomedical Digital Signal Processing	PHI	1993
4.	Akay.M	Biomedical Signal Processing	Academic Press	1994

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

5.				

WEB REFERENCE(s)

1. ocw.mit.edu › Courses › Health Sciences and Technology MIT Open Course War http://ocw.mit.edu
2. www.vub.ac.be/en/study/fiches/30340/biomedical-signals-and-images
3. www.crcpress.com › Biomedical Science › Biomedical Imaging
4. http://www.swbh.nhs.uk/wp-content/uploads/2012/07/What-is-a-sleep-EEG-ML3791.pdf
5. http://www.cns.iisc.ernet.in/~sray/E9282.html

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

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

COURSE OBJECTIVES
1. To learn characteristics and classification of Biomaterials.
2. To understand different metals and ceramics used as biomaterials.
3. To learn polymeric materials and combinations
4. To study about tissue replacement implants.
5. To know artificial organ developed using these materials.

COURSE OUTCOMES
1. Analyze different types of Biomaterials and its classification.
2. Understand different metals and ceramics used as biomaterials.
3. Learn about the polymeric materials and combinations.
4. Perform combinations of materials that could be used as a tissue replacement implant.
5. Know about the artificial organ development.

Course Outcomes	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	-	-
16BME03..CO2	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BME03..CO3	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BME03..CO4	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BME03..CO5	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-

UNIT I   **STRUCTURE OF BIO-MATERIALS**   9

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

UNIT II   **IMPLANT MATERIALS**   9

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

UNIT III   **POLYMERIC MATERIALS**   9

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

UNIT IV   **TISSUE REPLACEMENT MATERIALS**   9

Soft-tissue replacements, sutures, surgical tapes, adhesive, Percutaneous and skin implants, maxillofacial augmentation, blood interfacing implants, hard tissue replacement implants, internal fracture fixation devices, joint replacements.
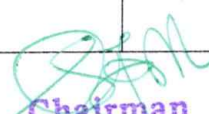
UNIT V   **ARTIFICIAL ORGANS**   9

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

REFERENCE BOOK

Sl.No	AUTHOR(s)	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1.	Sujata V. Bhatt	Biomaterials Second Edition	Narosa Publishing House	2005
2.	JoonB.Park Joseph D. Bronzino	Biomaterials - Principles and Applications	CRC Press	2003
3.	Park J.B	Biomaterials Science and Engineering	Plenum Press	1984
4.	Myer Kutz	Standard Handbook of Biomedical Engineering & Design	McGraw-Hill	2003
5.	John Enderle, Joseph D. Bronzino, Susan M. Blanchard	Introduction to Biomedical Engineering	Elsevier	2005

WEB REFERENCE(s)

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

1. https://www.elsevier.com/books/biomaterials-artificial-organs-and-tissueengineering/
2. https://sites.google.com/site/.../seweh/Biomaterials-An-Introduction.pdf
3. http://ocw.uc3m.es/ciencia-e-oin/materials-science-and-engineering/lecture-notes-1/Chapter_7_1.pdf
4. https://emedicine.medscape.com/article/843730-overview
5. https://www.mirm.pitt.edu/our-research/focus-areas/medical-devices-and-artificial-organs/

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

16BME04	BIO MEDICAL ENGINEERING	L T P C
		3 0 0 3

COURSE OBJECTIVES

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

COURSE OUTCOMES

1. Basic knowledge on Human physiology and components of biomedical system
2. Exposure to electro physiological parameter measurements
3. Exposure to non - electro physiological parameter measurements
4. Knowledge of medical imaging and biotelemetry systems
5. Description on the principles of operation of Therapeutic equipments

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BME04.CO1	X	X	X	-	-	-	-	-	-	X	-	X	X	-	-
16BME04.CO2	X	X	X	-	-	X	-	-	X	X	-	X	X	-	-
16BME04.CO3	X	X	X	-	-	X	-	-	X	X	-	X	X	-	-
16BME04.CO4	X	X	X	-	-	X	-	-	X	X	-	X	X	-	-
16BME04.CO5	X	X	X	-	-	X	-	-	X	X	-	X	X	-	-

UNIT I PHYSIOLOGY AND TRANSDUCERS 9

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.

UNIT II ELECTRO – PHYSIOLOGICAL MEASUREMENTS 9

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.

UNIT III NON-ELECTRICAL PARAMETER MEASUREMENTS 9

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 pCO_2, pO_2, finger-tip oxymeter - ESR, GSR measurements.

UNIT IV MEDICAL IMAGING AND BIOTELEMETRY 9

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.

UNIT V ASSISTING AND THERAPEUTIC EQUIPMENTS 9

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.
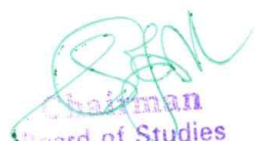
REFERENCE BOOK

Sl.No	AUTHOR(s)	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1.	R.S.Khandpur	Hand Book of Bio-Medical instrumentation	Tata McGraw Hill Publishing Co Ltd	2004
2.	Leslie Cromwell, Fred J.Weibell, Erich A.Pfeiffer	Bio-Medical Instrumentation and Measurements	Pearson Education	2nd edition, 2002
3.	M.Arumugam	Bio-Medical Instrumentation	Anuradha Agencies	2003.
4.	L.A. Geddes and L.E.Baker	Principles of Applied Bio-	John Wiley &	1975

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

		Medical Instrumentation	Sons	
5.	J.Webster	Medical Instrumentation	John Wiley & Sons	1995

WEB REFERENCE(s)

1. www.nptel.ac.in/courses/117108037/15
2. www.nptel.ac.in/courses/108102041/
3. www.nptel.ac.in/courses/103105054/
4. www.technicalsymposium.com/alllecturenotes_biomed.html
5. www.nptelvideos.in/2012/11/biochemical-engineering.html

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

		L T P C
16BME05	**BIOMATERIALS & CHARACTERIZATION**	3 0 0 3

COURSE OBJECTIVES

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

COURSE OUTCOMES

1. Know the basic knowledge of biomaterials.
2. Identify significant gap required to overcome challenges and further development in metallic and ceramic materials
3. Identify significant gap required to overcome challenges and further development in polymeric materials
4. Create combinations of materials that could be used as a tissue replacement implant.
5. Understand the testing standards applied for biomaterials

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BME05.CO1	x	x	x	-	-	-	-	-	-	x	-	x	x	-	-
16BME05.CO2	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BME05.CO3	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BME05.CO4	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BME05.CO5	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-

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.

REFERENCE BOOK

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.	Bronzins J.D	The Biomedical Engineering Hand book	CRC Press	1995
3.	John G.Webster, Bols	Encylopedia of Medical Devices and Instruments. I-IV		
4.	J.B. Park	Biomaterials-An Introduction		
5.	L.Hench and E.G.Erhridge	Biomaterials an Interfacial approach		

WEB REFERENCE(s)

1. https://brainmaster.com/software/pubs/brain/The_Biomedical_Engineering_Handbook_.pdf
2. https://onlinelibrary.wiley.com/doi/abs/10.1002/jbm.820190515
3. https://theeye.eu/public/Books/BioMed/Encyclopedia%20of%20Medical%20Devices%20and%20Instrum

entation%202e%20Vol%201%20All-Bra%20%28Wiley%202006%29.pdf

4. http://www.unhas.ac.id/tahir/BAHAN-KULIAH/BIO-MEDICAL/NEW/HANBOOK/13_Bioceramics.pdf

5. https://2019.febscongress.org/abstract_preview.aspx?idAbstractEnc=44241700940980930940944424170

16BME06	BODY AREA NETWORKS	L T P C
		3 0 0 3

COURSE OBJECTIVES

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

COURSE OUTCOMES

1. Explain about working of Body Area Network.
2. Know the types of hardwares.
3. Knowledge about the BAN communication.
4. Analysis about the issues in BAN.
5. Discuss the applications of BAN.

Course Outcomes	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	-	-
16BME06.CO2	X	X	X	-	-	X	-	-	X	X	-	X	X	-	-
16BME06.CO3	X	X	X	-	-	X	-	-	X	X	-	X	X	-	-
16BME06.CO4	X	X	X	-	-	X	-	-	X	X	-	X	X	-	-
16BME06.CO5	X	X	X	-	-	X	-	-	X	X	-	X	X	-	-

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 arrhymias monitoring, Multi patient monitoring systems, Multichannel Neural recording, Gait analysis, Sports Medicine, Electronic pill

REFERENCE BOOK

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
3.	Hang,Yuan-Ting	wearable medical sensors and systems	Springer	2013
4.	Mehmet R. Yuce,Jamil Y.Khan	Wireless Body Area Networks Technology, Implementation and Applications	Pan Stanford Publishing Pvt.Ltd Singapore,	2012
5.	Guang-Zhong Yang(Ed.),	Body Sensor Networks	Springer	2006

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

WEB REFERENCE(s)

1. https://www.springer.com/gp/book/9781441973832
2. https://ionlarqss.firebaseapp.com/aa620/body-area-networks-by-sandeep-k-s-gupta-tridib-mukherjee-krishna-kumar-venkatasubramanian-b00bm4titm.pdf.
3. https://research.monash.edu/en/publications/wireless-body-area-vetworks-technology-implementation-and-applica.
4. http://www.panstanford.com/pdf/9789814241571fm.pdf
5. http://cdn.intechopen.com/pdfs/9103/InTechWireless_body_area_network_wban_for_medical_applications.pdf.

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

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

COURSE OBJECTIVES

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

COURSE OUTCOMES

1. Equips the students with the knowledge of Brain Organization, Anatomy, and Function.
2. Analyze and process the brain signals for artifact reduction.
3. Understand types of BCI, in the Neurosciences domain.
4. Understand the principles and its applications in the Neurosciences domain.
5. Ability to have the ideas of human assist device with Medical Applications

Course Outcomes	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	-	-
16BME07.CO2	X	X	X	-	-	X	-	-	X	X	-	X	X	-	-
16BME07.CO3	X	X	X	-	-	X	-	-	X	X	-	X	X	-	-
16BME07.CO4	X	X	X	-	-	X	-	-	X	X	-	X	X	-	-
16BME07.CO5	X	X	X	-	-	X	-	-	X	X	-	X	X	-	-

UNIT I   BASIC NEUROSCIENCES

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 BCI'S

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

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

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

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.

REFERENCE BOOK

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	Latest Edition
2.	Bernhard Graimann	Brain-Computer Interfaces:	The Frontiers	Latest Edition

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

	(Editor), Brendan Z. Allison (Editor), GertPfurtscheller (Editor)	Revolutionizing Human-Computer Interaction	Collection - Hardcover	
3.	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
4.	Mehmet R. Yuce, Jamil Y.Khan	Wireless Body Area Networks Technology, Implementation and Applications	Pan Stanford Publishing Pvt.Ltd Singapore,	2012
5.	Guang-Zhong Yang(Ed.),	Body Sensor Networks	Springer	2006

WEB REFERENCE(s)

1. https://imotions.com/blog/beginners-guide-neuroscience/
2. https://sccn.ucsd.edu/wiki/Introduction_To_Modern_Brain-Computer_Interface_Design
3. https://www.udemy.com/brain-computer-interface/
4. https://towardsdatascience.com/a-beginners-guide-to-brain-computer-interface-and-convolutional-neural-networks-9f35bd4af948
5. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3497935/

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

16BME08	MEDICAL OPTICS	L T P C
		3 0 0 3

COURSE OBJECTIVES

1. The optical properties of the tissues and the interactions of light with tissues.
2. The instrumentation and components in Medical Optics.
3. The Medical Lasers and their applications
4. The optical diagnostic applications
5. The emerging optical diagnostic and therapeutic techniques

COURSE OUTCOMES

1. Demonstrate knowledge of the fundamentals of optical properties of tissues
2. Analyze the components of instrumentation in Medical Photonics and Configurations
3. Describe surgical applications of lasers.
4. Describe photonics and its diagnostic applications.
5. Investigate emerging techniques in medical optics

Course Outcomes	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	-	-
16BME08.CO2	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BME08.CO3	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BME08.CO4	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BME08.CO5	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-

UNIT I   OPTICAL PROPERTIES OF THE TISSUES   9

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

UNIT II   INSTRUMENTATION IN PHOTONICS   9

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

UNIT III   SURGICAL THERAPEUTIC APPLICATIONS OF LASERS   9

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

UNIT IV   NON THERMAL DIAGNOSTIC APPLICATIONS   9

Optical coherence tomography, Elastography, Laser Induced Fluorescence (LIF)-Imaging, FLIM Raman Spectroscopy and Imaging, FLIM – Holographic and Speckle applications of lasers in biology and medicine.

UNIT V   DIAGNOSTIC AND THERAPEUTIC TECHNIQUES   9

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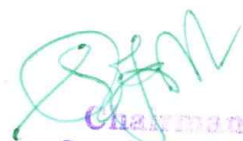
REFERENCE BOOK

Sl.No	AUTHOR(s)	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1.	Tuan Vo Dirh	Biomedical Photonics	CRC Press	2014
2.	Paras N. Prasad	Introduction to Biophotonics	A. John Wiley and Sons, Inc. Publications	2003
3.	Markolf H.Niemz	Laser-Tissue Interaction Fundamentals and Applications	Springer	2007
4.	G.David Baxter	Therapeutic Lasers— Theory and practice	Churchill Livingstone publications	200i
5.	Leon Goldman, M.D	Lasers in Medicine	Gordon and	1975

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

	& R.James Rockwell		Breach, Science Publishers Inc	

WEB REFERENCE(s)

1. https://www.slideshare.net/ChintanMorsiya/optical-properties-71404985
2. https://www.slideshare.net/ErFarukBinPoyen/optical-instrumentation-7-laser
3. https://www.slideshare.net/abhaydhanorkar5/advanced-diagnostic-tecniques
4. https://www.slideshare.net/priyanka1194/thermal-imaging-and-its-applications
5. https://www.slideshare.net/abhaydhanorkar5/advanced-diagnostic-tecniques

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

16BME09	SOFT COMPUTING	L T P C
		3 0 0 3

COURSE OBJECTIVES
1. To provide adequate knowledge about neural networks
2. To teach about the concept of fuzzy involved in various systems
3. To provide adequate knowledge about genetic algorithm
4. To gain knowledge on Hybrid Computing Techniques
5. To provide adequate knowledge to modeling the system

COURSE OUTCOMES
1. Describe basics of ANN and its learning algorithms
2. Develop various Fuzzy Models
3. Explain the terminologies associated to Genetic algorithms
4. Develop a hybrid Computing Techniques
5. Apply the concepts to solve real time problems

Course Outcomes	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	-	-
16BME09.CO2	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BME09.CO3	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BME09.CO4	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BME09.CO5	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-

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.
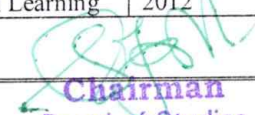Other Soft Computing techniques: Simulated Annealing, Tabu search, Ant colony optimization (ACO), Particle Swarm Optimization (PSO).

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
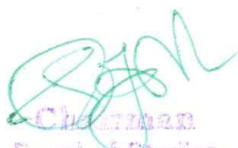
REFERENCE BOOK

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
3.	J.S.R.Jang, C.T.Sun, E.Mizutani	Neuro – Fuzzy and Soft	PHI Learning	2012

		Computing	Pvt. Ltd	
4.	Timothy J.Ross	Fuzzy Logic with Engineering applications	John Wiley and Sons	2010
5.	Simon Haykin	Neural Networks Comprehensive Foundation	Pearson Education	Second Edition 2005

WEB REFERENCE(s)

1. http://nptel.ac.in/courses/117105084/
2. http://nptel.ac.in/courses/108104049/13
3. http://nptel.ac.in/courses/106106126/15
4. http://nptel.ac.in/courses/108104049/27
5. http://www.nptelvideos.in/2012/12/neural-networks-and-applications.html

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

16BME10	NEURAL ENGINEERING	L T P C
		3 0 0 3

COURSE OBJECTIVES

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

COURSE OUTCOMES

1. Understand the physiology behind generation of nerve impulses.
2. Describe various techniques that are used to evaluate the functioning of central and peripheral nervous system Explain the fundamentals of bio-solid mechanics.
3. Differentiate between a normal and abnormal signal coming from a healthy and a diseased nervous system respectively.
4. Elloborate the methods of evoked potential.
5. Describe the functions of neuroimaging and cognitive aging.

Course Outcomes	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	-	-
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	-	-

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
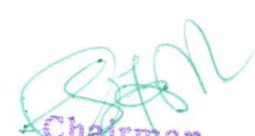
REFERENCE BOOK

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

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

3.	Eric R. Kandelet	Principles of Neural Science	McGraw-Hill	2012
4.	R. Cooper	Techniques in Clinical Neurophysiology: A Practical Manual	Elsevier, Amsterdam	2005
5.	Holodny, Andrei	Functional neuroimaging: a clinical approach	Informa Health Care	2008

WEB REFERENCE(s)

1. https://en.wikibooks.org/wiki/Biomedical_Engineering_Theory_And_Practice/Physiological_Modeling_and_Simulation

2. https://www.researchgate.net/publication/262185321_Physiological_Systems_Modeling_Simulation_and_Control.

3. https://nsec.lab.uconn.edu/home/courses-2/bme-3100-physiological-modeling/.

4. https://indico.egi.eu/indico/event/1222/session/22/contribution/34/material/slides/0.pdf.

5. https://epubs.siam.org/doi/pdf/10.1137/1.9780898718287.ch8

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

16 BME11	PHYSIOLOGICAL MODELING	L T P C
		3 0 0 3

COURSE OBJECTIVES

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

COURSE OUTCOMES

1. Explain application of Physiological models.
2. Model dynamically varying physiological system
3. Discuss methods and techniques to analyze and synthesis dynamic models
4. Develop differential equations to describe the dynamic models, simulate and visualize
5. Implement physiological models using software to get dynamic responses

Course Outcomes	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	-	-
16BME11.CO2	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BME11.CO3	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BME11.CO4	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BME11.CO5	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-

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 EQUIVALENT 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. Applications 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

REFERENCE BOOK

Sl.No	AUTHOR(s)	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1.	Michel C Khoo	Physiological Control Systems - Analysis, simulation and estimation	Prentice Hall of India	2001
2.	David T. Westwick, Robert E. Kearney	Identification of Nonlinear Physiological Systems	Wiley-IEEE Press	2003
3.	Endarle, Blanchard & Bronzino	Introduction to Biomedical Engg	Academic press	2012
4.	Suresh.R.Devasahayam	Signals & Systems in Biomedical Engineering	Kluwer Academic/	2007

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

			Plenum Publishers.	
5.	V.Z. Marmarelis	Advanced methods of physiological modeling	Plenum Press	2008

WEB REFERENCE(s)

1. https://en.wikibooks.org/wiki/Biomedical_Engineering_Theory_And_Practice/Physiological_Modeling_and_Simulation

2. https://www.researchgate.net/publication/262185321_Physiological_Systems_Modeling_Simulation_and_Control.

3. https://nsec.lab.uconn.edu/home/courses-2/bme-3100-physiological-modeling/.

4. https://indico.egi.eu/indico/event/1222/session/22/contribution/34/material/slides/0.pdf.

5. https://epubs.siam.org/doi/pdf/10.1137/1.9780898718287.ch8

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

			L	**T**	**P**	**C**
16BME12	**MULTIMEDIA COMPRESSION AND NETWORK**		3	0	0	3

COURSE OBJECTIVES

1. To understand the encoding and decoding of digital data streams.
2. To be familiar with the methods for the generation of these codes and their decoding techniques.
3. To study the compression and decompression techniques.
4. To Learn the concepts of multimedia communication.
5. To analyse the concept of multimedia network.

COURSE OUTCOMES

1. Identify the basic structure and functional units of multimedia components.
2. Understand the effect of audio and video compression.
3. Understand the text and image compression concepts.
4. Describe the VOIP challenges and applicability.
5. Apply the concepts of multimedia communication.

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BME12..CO1	X	X	X	-	-	-	-	-	-	X	-	X	X	-	-
16BME12.CO2	X	X	X	-	-	X	-	-	X	X	-	X	X	-	-
16BME12.CO3	X	X	X	-	-	X	-	-	X	X	-	X	X	-	-
16BME12.CO4	X	X	X	-	-	X	-	-	X	X	-	X	X	-	-
16BME12.CO5	X	X	X	-	-	X	-	-	X	X	-	X	X	-	-

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

REFERENCE BOOK

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
3.	Kurose and W.Ross	Computer Networking	Pearson Education	2005
4.	Marcus Goncalves	Voice over IP Networks	Tata Mc Graw Hill	1999
5.	KR. Rao,Z S Bojkovic, D A Milovanovic	Multimedia Communication Systems: Techniques, Standards, and Networks	Pearson Education	2007

WEB REFERENCE(s)
1. https://www.slideshare.net/azira96/chapter-1-introduction-to-multimedia
2. https://fenix.tecnico.ulisboa.pt/downloadFile/3779571620663/licao_5.pdf
3. http://www.eie.polyu.edu.hk/~enyhchan/mt-cmpti.pdf
4. https://www.slideshare.net/habib_786/voice-over-ip-voip-26670219
5. https://www.slideshare.net/HamdanSabri/multimedia-networking-80266423

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

16BME13	REHABILIATION ENGINEERING	L T P C
		3 0 0 3

COURSE OBJECTIVES

1. To understand the rehabilitation concepts and Rehabilitation team members for future development and applications.
2. To study various Principles of Rehabilitation Engineering.
3. To understand different types of Therapeutic Exercise Technique
4. 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.
5. To study the various orthotic devices and prosthetic devices to overcome orthopedic problems.

COURSE OUTCOMES

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

Course Outcomes	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	-	-
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	-	-

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).

REFERENCE BOOK

Sl.No	AUTHOR(s)	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1.	Sunder	Textbook of Rehabilitation 2nd Edition	Jaypee Brothers Medical Publishers Pvt. Ltd, New Delhi	2007 rint

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

2.	Joseph D. Bronzino	The Biomedical Engineering Handbook - Third edition	Pearson Education	2006
3.	Horia- Nocholai Teodorecu, L.C.Jain	Intelligent systems and technologies in rehabilitation Engineering	CRC;	2000
4.	Keswick. J	What is Rehabilitation Engineering, Annual Reviews of Rehabilitation	Springer	1982
5.	Warren E. Finn,Peter G. LoPresti	Handbook of Neuroprosthetic Methods	CRC	2002

WEB REFERENCE(s)

1. https://www.slideshare.net/nameeda15/rehabilitation-67292430
2. https://www.slideshare.net/Yogeshkewlani/virtual-reality-39791892
3. https://www.slideshare.net/drdsabat/orthotics-and-prosthetics-ug-lecture
4. https://www.slideshare.net/sundarganeshkandaswamy/therapeutic-exercise-physiotherapy
5. https://www.slideshare.net/kpml419/orthotics-15550568

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

16BME14	VIRTUAL REALITY	L T P C 3 0 0 3

COURSE OBJECTIVES

1. To introduce the relevance of this course to the existing technology through demonstrations.
2. To study the case studies and applications with a futuristic vision along with socio-economic impact and issues.
3. To understand virtual reality, augmented reality and using them to build Biomedical engineering applications.
4. To know the intricacies of these platform to develop PDA applications with better optimality.
5. To learn about the application used in medical terms.

COURSE OUTCOMES

1. Analyze & Design a system or process to meet given specifications with realistic engineering constraints.
2. Identify problem statements and function as a member of an engineering design team.
3. Utilize technical resources
4. Propose technical documents and give technical oral presentations related to design mini project results.
5. Application used in medical terms.

Course Outcomes	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	-	-
16BME14.CO2	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BME14.CO3	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BME14.CO4	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BME14.CO5	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-

UNIT I INTRODUCTION TO VIRTUAL REALITY 9

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

UNIT II 3D COMPUTER GRAPHICS 9

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

UNIT III VIRTUAL ENVIRONMENT 9

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

UNIT IV VR HARDWARE AND SOFTWARE 9

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

UNIT V APPLICATIONS 9

Use of Analysis Tools, Fourier transforms Power spectrum, Correlation methods, windowing & flittering. Application of VR: Medical applications-military applications-robotics applications- Advanced Real time tracking other applications- simulations, therapy.

REFERENCE BOOK

Sl.No	AUTHOR(s)	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1.	John Vince	Virtual Reality Systems	Pearson Education Asia	2007.
2.	Anand R	Augmented and Virtual Reality	Khanna Publishing House, Delhi	Latest Edition
3.	Adams	Visualizations of Virtual Reality	Tata McGraw Hill	2000
4.	Grigore C. Burdea, Philippe Coiffet	Virtual Reality Technology	Wiley Inter Science, 2nd Edition,	2006
5.	William R.	Understanding Virtual	Morgan Kaufmann	2008

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

	Sherman, Alan B. Craig	Reality: Interface, Application and Design		

WEB REFERENCE(s)

1. http://www.vresources.org/
2. http://www.vrac.iastate.edu/
3. http://www.w3.org/MarkUp/VRM
4. http://interscience.in/IJESS_Vol2Iss2-3-4/71-75.pdf
5. https://aabme.asme.org/categories/augmented-and-virtual-reality

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

		L	T	P	C
16BME15	**WEARABLE SYSTEMS**	3	0	0	3

COURSE OBJECTIVES

1. To study about need for wearable systems
2. To gain knowledge about sensors in wearable systems.
3. To acquaint with signal processing and Wearability issues
4. To handle with the energy harvesting for wearable devices
5. Learn about applications of wearable systems.

COURSE OUTCOMES

1. Enables the need for wearable devices.
2. Know about the basic principles of sensors and with the input signal
3. Provides idea with the energy management for wearable devices.
4. Explain need of wireless health systems
5. Equips with the knowledge of application with wearable systems

Course Outcomes	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	-	-
16BME15.CO2	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BME15.CO3	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BME15.CO4	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BME15.CO5	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-

UNIT I   **SENSORS**   **9**

Need for wearable systems, Sensors for wearable systems-Inertia movement sensors, Respiration activity sensor, Inductive plethysmography, Impedance plethysmography, pneumography, Wearable ground reaction force sensor, GSR, Radiant thermal sensor, Wearable motion sensors, CMOS – Based Biosensors, E-Textiles, Bio compatibility

UNIT II   **SIGNAL PROCESSING**   **9**

Wearability issues -physical shape and placement of sensor, Technical challenges - sensor design, signal acquisition, Constraint on sampling frequency for reduced energy consumption, light weight signal processing, Rejection of irrelevant information, Data mining

UNIT III   **ENERGY HARVESTING FOR WEARABLE DEVICES**   **9**

Solar cell, Vibration based, Thermal based, Human body as a heat source for power generation, Hybrid thermoelectric photovoltaic energy harvests, Thermopiles.

UNIT IV   **WIRELESS HEALTH SYSTEMS**   **9**

Need for wireless monitoring, Definition of Body area network, BAN and Healthcare, Technical Challenges- System security and reliability, BAN Architecture – Introduction, Wireless communication techniques

UNIT V   **APPLICATIONS OF WEARABLE SYSTEMS**   **9**

Medical Diagnostics, Medical Monitoring-Patients with chronic disease, Hospital patients, Elderly patients, Multi parameter monitoring, Neural recording, Gait analysis, Sports Medicine, Smart Fabrics.

REFERENCE BOOK

Sl.No	AUTHOR(s)	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1.	Annalisa Bonfiglio, Danilo De Rossi	Wearable Monitoring Systems	Springer	2011
2.	Sandeep K.S. Gupta,Tridib Mukherjee, Krishna Kumar Venkatasubramanian	Body Area Networks Safety, Security, and Sustainability	Cambridge University Press	2013
3.	Hang,Yuan-Ting	wearable medical sensors and systems	Springer	2013
4.	Mehmet R. Yuce,Jamil Y.Khan	Wireless Body Area Networks Technology, Implementation and Applications	Pan Stanford Publishing Pvt.Ltd Singapore,	2012
5.	Guang-Zhong Yang(Ed.),	Body Sensor Networks	Springer	2006

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

WEB REFERENCE(s)

1. https://www.springer.com/gp/book/9781441973832
2. https://ionlarqss.firebaseapp.com/aa620/body-area-networks-by-sandeep-k-s-gupta-tridib-mukherjee-krishna-kumar-venkatasubramanian-b00bm4titm.pdf.
3. https://research.monash.edu/en/publications/wireless-body-area-vetworks-technology-implementation-and-applica.
4. http://www.panstanford.com/pdf/9789814241571fm.pdf
5. http://cdn.intechopen.com/pdfs/9103/InTechWireless_body_area_network_wban_for_medical_applications.pdf.

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

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

COURSE OBJECTIVES

1. To obtain a basic knowledge in JAVA.
2. To Develop server side programs using Servlets and JSP.
3. To Construct simple web pages in PHP and to represent data in XML format.
4. To gain knowledge about server side programming.
5. To Use AJAX and web services to develop interactive web applications.

COURSE OUTCOMES

1. Discuss the basics of JAVA.
2. Describe the basics and java networking in JAVA.
3. Discuss the Client-side programming.
4. Understand the Server-side programming.
5. Describe the AJAX and web services.

Course Outcomes	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	-	-
16BME16.CO2	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BME16.CO3	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BME16.CO4	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BME16..CO5	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-

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

REFERENCE BOOK

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
3.	Robert W. Sebesta	Programming the World Wide Web	Addison-Wesley,Sixth Edition	2010

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

| 4. | Elliotte Rusty Harold | Java Network Programming | O'Reilly | 2004 |
| 5. | William J Buchanan | Mastering Java | Red Globe Press | 2007 |

WEB REFERENCE(s)

1. https://www.slideshare.net/VeerabadraBadra/introduction-to-java-9266993
2. https://www.slideshare.net/java2all/network-programming-in-java-ppt
3. https://www.slideshare.net/EleonoraCiceri/tiw-javascript
4. https://www.slideshare.net/OECLIBOdishaElectron/ajax-ppt-79369889
5. https://www.wikihow.com/Program-in-Ajax

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

		L	T	P	C
16BME17	**CRPTOGRAPHY AND NETWORK SECURITY**	3	0	0	3

COURSE OBJECTIVES

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

COURSE OUTCOMES

1. Understand cryptography and network security concepts and application.
2. Apply security principles to system
3. Identify and investigate network security .
4. Analyze and design network security protocols
5. Conduct research in network security.

Course Outcomes	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	-	-
16BME17.CO2	X	X	X	-	-	X	-	-	X	X	-	X	X	-	-
16BME17.CO3	X	X	X	-	-	X	-	-	X	X	-	X	X	-	-
16BME17.CO4	X	X	X	-	-	X	-	-	X	X	-	X	X	-	-
16BME17.CO5	X	X	X	-	-	X	-	-	X	X	-	X	X	-	-

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	WIRELESS 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).

REFERENCE BOOK

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
3.	Behrouz A. Ferouzan	Cryptography & Network Security	Tata McGraw-Hill	2007
4.	Man Young Rhee	Internet Security: Cryptographic Principles, Algorithms and Protocols	Wiley Publication	2003
5.	Charles Pfleeger	Security in Computing	Prentice	2006

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

		4th Edition	Hall of India	

WEB REFERENCE(s)

1. www.vssut.ac.in/lecture_notes/lecture1428550736.pdf
2. http://www.cse.iitd.ac.in
3. https://www.slideshare.net/SayedAhmed8/server-side-programming-66908809
4. https://www.slideshare.net/RajasekarVr/message-authentication-75333084
5. https://www.slideshare.net/anshumanbiswal/cjb0412001-advanced-wirelesssystemspc2520presentation

			L	T	P	C
16BME18		**HOSPITAL WASTE MANAGEMENT**	3	0	0	3

COURSE OBJECTIVES

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

COURSE OUTCOMES

1. Handling of biomedical waste.
2. Importance of the biomedical waste disposal in the society.
3. Know about the types of treatment technologies for wastes.
4. Learn the laws of biomedical waste handling and the Healthcare waste Management.
5.

Course Outcomes	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	-	
16BME18.CO2	X	X	X	-	-	X	-	-	X	X	-	X	X		
16BME18.CO3	X	X	X	-	-	X	-	-	X	X	-	X	X		
16BME18.CO4	X	X	X	-	-	X	-	-	X	X	-	X	X		
16BME18.CO5	X	X	X	-	-	X	-	-	X	X	-	X	X		

UNIT I INTRODUCTION 9

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

UNIT II HAZARD OF BIOMEDICAL WASTE 9

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

UNIT III CONTROL OF HOSPITAL ACQUIRED INFECTION 9

Types of infection – Common Nosocomial infection and their Causative Agents– Prevention of hospital acquired infection–Role of central sterile supply department–Infection control committee –Monitoring and controller of cross infection-Staff health.

UNIT IV TREATMENT TECHNOLOGIES FOR WASTES 9

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

UNIT V LAWS OF BIOMEDICAL WASTE HANDLING 9

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

REFERENCE BOOK

Sl.No	AUTHOR(s)	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1.	AnantpreetSingh, SukhjitKaur	Biomedical Waste Disposal	Jaypee Publishers (P) Ltd, India	2012
2.	Sushma Sahai	Bio-Medical Waste Management	APH Publishing Corporation, India	2009
3.	Sanskriti Sharma	Hospital Waste Management and Its Monitoring	Jaypee Publishers (P) Ltd, India	2002
4.	Paul T. Williams	Waste Treatment and Disposal	John Wiley & Sons, Ltd	2005
5.				

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

WEB REFERENCE(s)

1. https://www.slideshare.net/zulfiquer732/hospital-waste-management-93579083
2. http://www.ihatepsm.com/blog/hospital-waste-management-bio-%E2%80%93-medical-waste-management
3. https://www.biomedicalwastesolutions.com/medical-waste-disposal/
4. http://www.wastemanagement.in/what-is-hospital-waste-management.html
5. https://www.medprodisposal.com/what-is-medical-waste-medical-waste-definition-types-examples.

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

		L	**T**	**P**	**C**
16BME19	**MEDICAL PHYSICS**	3	0	0	3

COURSE OBJECTIVES

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

COURSE OUTCOMES

1. Explain about non-ionizing radiation, interaction with tissue and its effects.
2. Define and compare intensities of sensory stimuli
3. Summarizes how ionizing radiation interacts with the human body, how to quantify it and its levels seen in the environment and healthcare
4. Explain the fundamentals of radioactivity and radioactive isotopes
5. Illustrates the methods of detecting and recording the ionizing radiation and its interaction with matter

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
16BME19.CO1	x	x	x	-	-	-	-	-	-	x	-	x	x	-	-
16BME19.CO2	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BME19.CO3	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BME19.CO4	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BME19.CO5	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-

UNIT I   IONIZING RADIATION AND ITS MEDICAL APPLICATIONS   9

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

UNIT II   PHYSICS OF THE SENSES   9

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

UNIT III   PRINCIPLES OF RADIOACTIVE NUCLIDES   9

Radioactive Decay – Spontaneous Emission – Isometric Transition – Gamma ray emission, alpha, beta, Positron decay, electron capture, Sources of Radioisotopes Natural and Artificial radioactivity, Radionuclide used in Medicine and Technology ,Decay series, Production of radionuclide's – Cyclotron produced Radionuclide- Reactor produced Radio- nuclide-fission and electron Capture reaction, Target and Its Processing Equation for Production of Radionuclide's, radionuclide Generator-Technetium generator.

**UNIT IV   RADIOACTIVE DECAY AND INTERACTIONOF RADIATION   9
                    WITH MATTER**

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   9
                    DETECTORS**

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

REFERENCE BOOK

Sl.No	AUTHOR(s)	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1.	Gopal B. Saha	Physics and Radiobiology of Nuclear Medicine 4th Edition	Springer	2013
2.	B H Brown, R H Smallwood, D C Barber, P V Lawford	Medical Physics and Biomedical Engineering 2nd Edition	IOP Publishers	2001

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

3.	D R Hose S.Webb	The Physics of Medical Imaging	Taylor and Francis	1988
4.	J.P.Woodcock	Ultrasonic,Medical Physics Handbook series 1	Adam Hilger, Bristol	2002
5.	HyltonB.Meire Pat Farrant	Basic Ultrasound	John Wiley & Sons	1995

WEB REFERENCE(s)

1. http://www.sprawls.org/ppmi2/
2. https://shodhganga.inflibnet.ac.in/bitstream/10603/13696/9/09_chapter%203.pdf
3. https://www.slideshare.net/arundeepa/radioactive-isotopes-72515767
4. https://www.slideshare.net/drarnabradiotherapy/interaction-of-radiation-with-matter-13517926
5. https://www.slideshare.net/GirishpalvaiKumar/radiation-detector

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

		L	T	P	C
16BME20	**COMPUTER ARCHITECTURE AND ORGANIZATION**	3	0	0	3

COURSE OBJECTIVES

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

COURSE OUTCOMES

1. Identify the basic structure and functional units of a digital computer.
2. Analyze the effect of addressing modes on the execution time of a program.
3. Design processing unit using the concepts of ALU and control logic design.
4. Identify the pros and cons of different types of control logic design in processors.
5. Identify the roles of various functional units of a computer in instruction execution.

Course Outcomes	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	-	-
16BME20.CO2	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BME20.CO3	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BME20.CO4	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-
16BME20.CO5	x	x	x	-	-	x	-	-	x	x	-	x	x	-	-

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).

REFERENCE BOOK

Sl.No	AUTHOR(s)	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1.	Carl Hamacher, Zvnko Vranesic, Safwat Zaky	Computer Organization	McGraw-Hill, Fifth Edition	2012
2.	Mano M. M	Digital Logic & Computer Design, 4/e	Pearson Education	2013
3.	Patterson D.A. and J. L. Hennessey	Computer Organization and Design, 5/e	Morgan Kauffmann Publishers	2013
4.	William Stallings	Computer Organization and Architecture: Designing for Performance	Pearson	2013
5.	Chaudhuri P	Computer Organization and Design, 2/e	Prentice Hall of India	2008

WEB REFERENCE(s)

1. https://nptel.ac.in/courses/106103068/pdf/coa.pdf
2. https://www.slideshare.net/mustafakamal1297/arithmetic-logic-unit-alu
3. https://www.slideshare.net/chidabdu/unit-3-basic-processing-unit-12501523
4. https://www.slideshare.net/chidabdu/unit-4-memory-system
5. https://www.slideshare.net/MazinAlwaaly/computer-architecture-input-output-organization

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