MUTHAYAMMAL ENGINEERING COLLEGE

(An Autonomous Institution)

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

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

Curriculum/Syllabus

Programme Code : BME

Programme Name : B.E-Biomedical Engineering (Foundation Courses)

Regulation : R-2019

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

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Email: principal@mec.edu.in

Estd. 2000

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

INSTITUTION VISION &MISSION

INSTITUTION VISION

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

INSTITUTION MISSION

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

INSTITUTION MOTTO

Rural upliftment through Technical Education.

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Department of Biomedical Engineering
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DEPARTMENT PROGRAM EDUCATIONAL OBJECTIVES, PROGRAM OUTCOMES & PROGRAM SPECIFIC OUTCOMES

PROGRAM EDUCATIONAL OBJECTIVES:

Graduates will be able to

PEO1: Apply biomedical engineering concepts to handle modern medical equipments in diagnosis process.

PEO2: Generate solutions that address real-time challenges in the healthcare sector.

PEO3: Maintain and improve technical competence in biomedical engineering through lifelong learning with ethical and moral values.

PROGRAM OUTCOMES:

1. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.
2. **Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and Engineering sciences.
3. **Design/Development solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

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DEPARTMENT VISION & MISSION

DEPARTMENT VISION

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

DEPARTMENT MISSION

M1: To impart value-based education in Biomedical Engineering using medical equipments.

M2: To prepare the students for placements and entrepreneurship in Healthcare industries through Hospital Training.

M3: To provide solutions to healthcare industries and society through lifelong learning with ethical values.

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5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Lifelong learning:** Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES:

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

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

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

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Grouping of Courses

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GROUPING OF COURSES

B.E. – BIOMEDICAL ENGINEERING

1. Humanities and Social Sciences (HS)

S.No.	Course Code	Course Title	Category	Contact Hours	Instruction Hours/Week			Credit
					L	T	P	C
1.	19HSS01	Business English	HS	2	2	0	0	2
2.	19HSS02	English Communicative Skills Laboratory	HS	2	0	0	2	1
3.	19HSS03	Life Skills and Workplace Psychology	HS	2	2	0	0	2
4.	19HSS04	Technical English For Engineers	HS	2	2	0	0	2
5.	19HSS05	Communicative English for Engineers	HS	2	2	0	0	2
6.	19HSS06	Basics of Japanese Language	HS	2	2	0	0	2
7.	19HSS07	Basics of French Language	HS	2	2	0	0	2
8.	19HSS08	Professional Ethics and Human Values	HS	3	3	0	0	3

2. Basic Sciences (BS)

S.No.	Course Code	Course Title	Category	Contact Hours	Instruction Hours/Week			Credit
					L	T	P	C
1.	19BSS01	Engineering Physics	BS	3	3	0	0	3
2.	19BSS02	Physics and Chemistry Laboratory	BS	2	0	0	2	1
3.	19BSS03	Bio and Nanomaterials Sciences	BS	3	3	0	0	3
4.	19BSS04	Material Sciences	BS	3	3	0	0	3
5.	19BSS05	Physics for Mechanical Engineers	BS	3	3	0	0	3
6.	19BSS11	Engineering Chemistry	BS	3	3	0	0	3

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7.	19BSS12	Environmental Science and Engineering	BS	3	3	0	0	3
8.	19BSS13	Organic Chemistry	BS	3	3	0	0	3
9.	19BSS14	Physical Chemistry	BS	3	3	0	0	3
10.	19BSS15	Applied Chemistry	BS	3	3	0	0	3
11.	19BSS16	Organic Chemistry Laboratory	BS	2	0	0	2	1
12.	19BSS17	Physical Chemistry Laboratory	BS	2	0	0	2	1
13.	19BSS21	Algebra and Calculus	BS	4	3	1	0	4
14.	19BSS22	Differential Equations and Vector Analysis	BS	4	3	1	0	4
15.	19BSS23	Transform and Partial Differential Equations	BS	4	3	1	0	4
16.	19BSS24	Discrete Mathematics	BS	4	3	1	0	4
17.	19BSS25	Statistical and Queuing Model	BS	4	3	1	0	4
18.	19BSS26	Numerical Methods	BS	4	3	1	0	4
19.	19BSS27	Probability and Random Processes	BS	4	3	1	0	4
20.	19BSS28	Statistic and Numerical Methods	BS	4	3	1	0	4

3. Engineering Sciences (ES):

S.No.	Course Code	Course Title	Category	Contact Hours	Instruction Hours/Week			Credit
					L	T	P	C
1.	19GES01	Programming for Problem Solving Using C	GES	3	3	0	0	3
2.	19GES02	Programming for Problem Solving Technique	GES	3	3	0	0	3
3.	19GES03	Programming in C Laboratory	GES	2	0	0	2	1
4.	19GES04	Programming in C and Python Laboratory	GES	2	0	0	2	1
5.	19GES05	Electrical and Electronic Sciences	GES	3	3	0	0	3
6.	19GES06	Mechanical and Building Sciences	GES	3	3	0	0	3
7.	19GES07	Computer Aided Drafting Laboratory	GES	2	0	0	2	1
8.	19GES08	Python Programming	GES	3	3	0	0	3
9.	19GES09	Programming in Python Laboratory	GES	2	0	0	2	1
10.	19GES10	Soft Skills Laboratory	GES	2	0	0	2	1

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11.	19GES11	Electronic Devices	GES	3	3	0	0	3
12.	19GES12	Electronic Simulation Laboratory	GES	2	0	0	2	1
13.	19GES13	Electric Circuits	GES	3	2	1	0	3
14.	19GES14	Electric Circuits Laboratory	GES	2	0	0	2	1
15.	19GES15	Manufacturing Process	GES	3	3	0	0	3
16.	19GES16	Manufacturing Process Laboratory	GES	2	0	0	2	1
17.	19GES17	Mechanical and Building Sciences Laboratory	GES	2	0	0	2	1
18.	19GES18	Construction Materials	GES	3	3	0	0	3
19.	19GES19	Concepts in Product Design	GES	3	3	0	0	3
20.	19GES20	Renewable Energy Sources	GES	3	3	0	0	3
21.	19GES21	Electrical Drives and Control	GES	3	3	0	0	3
22.	19GES22	Electrical Drives and Control Laboratory	GES	2	0	0	2	1
23.	19GES23	Analog and digital communication	GES	3	3	0	0	3
24.	19GES24	Digital Principles and System Design	GES	3	3	0	0	3
25.	19GES25	Digital Principles and System Design Laboratory	GES	2	0	0	2	1
26.	19GES26	Engineering Drawing	GES	5	1	0	4	3
27.	19GES27	Engineering Geology	GES	3	3	0	0	3
28.	19GES28	Engineering Mechanics	GES	4	3	1	0	4
29.	19GES29	Wireless Communication	GES	4	3	1	0	4
30.	19GES30	Electronics and Microprocessor	GES	3	3	0	0	3
31.	19GES31	Electronics and Microprocessor Laboratory	GES	2	0	0	2	1
32.	19GES32	Data Structures using Python	GES	3	3	0	0	3

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4. Professional Core (PC):

S.No.	Course Code	Course Title	Category	Contact Hours	Instruction Hours/week			Credit
					L	T	P	C
1.	19BMC01	Human Anatomy and Physiology	PC	3	3	0	0	3
2.	19BMC02	Biomedical Sensors & Instruments	PC	3	3	0	0	3
3.	19BMC03	Digital Electronics	PC	3	3	0	0	3
4.	19BMC04	Signals and Systems	PC	4	3	1	0	4
5.	19BMC05	Biomechanics & Rehabilitation Engineering	PC	4	3	1	0	4
6.	19BMC06	Bio Control System	PC	4	3	1	0	4
7.	19BMC07	Analog Electronics	PC	3	3	0	0	3
8.	19BMC08	Microprocessor and Microcontrollers in Medicine	PC	3	3	0	0	3
9.	19BMC09	Linear Integrated Circuits	PC	3	3	0	0	3
10.	19BMC10	Biochemistry	PC	3	3	0	0	3
11.	19BMC11	Hospital Management	PC	3	3	0	0	3
12.	19BMC12	Biomedical Instrumentation	PC	3	3	0	0	3
13.	19BMC13	Medical Signal Processing	PC	4	3	1	0	4
14.	19BMC14	Embedded System	PC	3	3	0	0	3
15.	19BMC15	Therapeutic Equipments	PC	3	3	0	0	3
16.	19BMC16	Tissue Engineering	PC	4	3	1	0	4
17.	19BMC17	Medical Imaging Techniques	PC	4	3	1	0	4
18.	19BMC18	Electrical Safety and Quality Assurance	PC	3	3	0	0	3
19.	19BMC19	Human Assist Devices	PC	3	3	0	0	3
20.	19BMC20	Bio Medical Sensors and Instruments Laboratory	PC	2	0	0	2	1
21.	19BMC21	Digital Electronics Laboratory	PC	2	0	0	2	1
22.	19BMC22	Analog Electronics Laboratory	PC	2	0	0	2	1
23.	19BMC23	Linear Integrated Circuits Laboratory	PC	2	0	0	2	1
24.	19BMC24	Medical Signal Processing Laboratory	PC	2	0	0	2	1
25.	19BMC25	Pathology and Microbiology Laboratory	PC	2	0	0	2	1
26.	19BMC26	Biomedical Instrumentation Laboratory	PC	2	0	0	2	1
27.	19BMC27	Pathology and Microbiology	PC	2	0	0	2	1
28.	19BMC28	Embedded System Laboratory	PC	2	0	0	2	1

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29.	19BMC29	Computer Networks	PC	3	3	0	0	3
30.	19BMC30	Microprocessor and Microcontrollers Laboratory	PC	2	0	0	2	1
31.	19BMC31	Biomems and Microfluids	PC	3	3	0	0	3

5. Professional Electives (PE):

S.No.	Course Code	Course Title	Category	Contact Hours	Instruction Hours/week			Credit
					L	T	P	C
1.	19BME01	Advanced Bio analytical and Therapeutic Techniques	PE	3	3	0	0	3
2.	19BME02	Bio Signal Processing	PE	3	3	0	0	3
3.	19BME03	Internet of Things	PE	3	3	0	0	3
4.	19BME04	Biomedical Engineering	PE	3	3	0	0	3
5.	19BME05	Biomaterials and Characterization	PE	3	3	0	0	3
6.	19BME06	Body Area Networks	PE	3	3	0	0	3
7.	19BME07	Brain Computer Interface and Applications	PE	3	3	0	0	3
8.	19BME08	Medical Optics	PE	3	3	0	0	3
9.	19BME09	Soft Computing	PE	3	3	0	0	3
10.	19BME10	Neural Engineering	PE	3	3	0	0	3
11.	19BME11	Physiological Modeling	PE	3	3	0	0	3
12.	19BME12	Hospital Waste Management	PE	3	3	0	0	3
13.	19BME13	Virtual Reality	PE	3	3	0	0	3
14.	19BME14	Wearable Systems	PE	3	3	0	0	3
15.	19BME15	Medical Physics	PE	3	3	0	0	3

6. Employability Enhancement Courses (EEC):

S.No.	Course Code	Course Title	Category	Contact Hours	Instruction Hours/week			Credit
					L	T	P	C
1.	19BMS01	Project Work Phase – I	EEC	6	0	0	6	3
2.	19BMS02	Project Work Phase –II	EEC	12	0	0	12	6
3.	19BMS03	Comprehension	EEC	4	0	0	4	2
4.	19BMS04	Design Project	EEC	2	0	0	2	1
5.	19BMS05	Hospital Training	EEC	0	0	0	0	2

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7. Mandatory Courses (MC) :

S.No.	Course Code	Course Title	Category	Contact Hours	Instruction Hours/week			Credit
					L	T	P	C
1.	19MDH01	Organizational Behaviour	MC	3	3	0	0	0
2.	19MDH02	India Constitution (Common to all Branches)	MC	3	3	0	0	0
3.	19MDH03	Essence of Indian Traditional Knowledge	MC	3	3	0	0	0

COURSE COMPONENT SUMMARY

S.No.	Subject Area	Credits Per Semester								Credits Total	AICTE Credits
		I	II	III	IV	V	VI	VII	VIII		
1.	FC	21	20	7	4	-	-	-	-	52	66
2.	PC	-	-	20	19	15	13	6	-	73	55
3.	PE	-	-	-	-	6	6	6	-	18	12
4.	OE	-	-	-	-	-	3	3	-	6	12
5.	EEC	-	-	-	-	-	1	4	6	11	15
TOTAL		21	20	27	23	21	23	19	6	**160**	160

Total Credits: 160

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Curriculum

	MUTHAYAMMAL ENGINEERING COLLEGE (Autonomous) (Approved by AICTE & Affiliated to Anna University), RASIPURAM – 637 408	CURRICULUM UG R – 2019

Department	Biomedical Engineering
Programme	B.E

SEMESTER – I

S.No.	Course Code	Course Name	Hours/ Week			Credit	Contact Hours
			L	T	P	C	
THEORY							
1.	19HSS01	Business English	2	0	0	2	2
2.	19BSS21	Algebra and Calculus	3	1	0	4	4
3.	19BSS01	Engineering Physics	3	0	0	3	3
4.	19BSS11	Engineering Chemistry	3	0	0	3	3
5.	19GES02	Programming for Problem Solving Technique	3	0	0	3	3
6.	19GES06	Mechanical and Building Sciences	3	0	0	3	3
PRACTICALS							
7.	19BSS02	Physics and Chemistry Laboratory	0	0	2	1	2
8.	19GES03	Programming in C Laboratory	0	0	2	1	2
9.	19HSS02	Communicative English Laboratory	0	0	2	1	2
		Total Credits				**21**	

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SEMESTER – II

S.No.	Course Code	Course Name	Hours/ Week			Credit	Contact Hours
			L	T	P	C	
THEORY							
1.	19HSS03	Life Skill Psychology and Ethics	2	0	0	2	2
2.	19BSS22	Differential Equations and Vector Analysis	3	1	0	4	4
3.	19BSS03	Bio and Nanomaterials Sciences	3	0	0	3	3
4.	19BSS12	Environmental Science and Engineering	3	0	0	3	3
5.	19GES19	Concepts in Product Design	3	0	0	3	3
6.	19GES11	Electronic Devices	3	0	0	3	3
PRACTICALS							
7.	19GES12	Electronic Simulation Laboratory	0	0	2	1	2
8.	19GES09	Programming in Python Laboratory	0	0	2	1	2
		Total Credits				**20**	

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SEMESTER – III

S.No.	Course Code	Course Name	Hours/ Week			Credit	Contact Hours
			L	T	P	C	
THEORY							
1.	19BSS23	Transforms & Partial Differential Equations	3	1	0	4	4
2.	19BMC04	Signals and Systems	3	1	0	4	4
3.	19BMC07	Analog Electronics	3	1	0	4	4
4.	19BMC03	Digital Electronics	3	0	0	3	3
5.	19BMC01	Human Anatomy & Physiology	3	0	0	3	3
6.	19HSS08	Professional Ethics and Human Values	3	0	0	3	3
7.	19BMC02	Biomedical Sensors & Instruments	3	0	0	3	3
LABORATORY							
8.	19BMC22	Analog Electronics Laboratory	0	0	2	1	2
9.	19BMC21	Digital Electronics Laboratory	0	0	2	1	2
10.	19BMC20	Bio Medical Sensors and Instruments Laboratory	0	0	2	1	2
		Total Credits				**27**	

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Department	Biomedical Engineering
Programme	B.E

SEMESTER – IV

S.No.	Course Code	Course Name	Hours/ Week			Credit	Contact Hours
			L	T	P	C	
THEORY							
1.	19BSS27	Probability and Random Processes	3	1	0	4	4
2.	19BMC08	Microprocessor and Microcontrollers in Medicine	3	0	0	3	3
3.	19 BMC05	Biomechanics & Rehabilitation Engineering	3	1	0	4	4
4.	19 BMC09	Linear Integrated Circuits	3	0	0	3	3
5.	19 BMC10	Biochemistry	3	0	0	3	3
6.	19 BMC27	Pathology and Microbiology	3	0	0	3	3
LABORATORY							
8.	19BMC23	Linear Integrated Circuits Laboratory	0	0	2	1	2
9.	19BMC25	Pathology and Microbiology Laboratory	0	0	2	1	2
10.	19BMC30	Microprocessor and Microcontrollers Laboratory	0	0	2	1	2
		Total Credits				**23**	

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SEMESTER – V

S.No..	Course Code	Course Name	Hours/ Week			Credit	Contact Hours
			L	T	P	C	
THEORY							
1.	19BMC11	Hospital Management	3	0	0	3	3
2.	19BMC13	Medical Signal Processing	3	1	0	4	4
3.	19BMC06	Bio control system	3	0	0	3	3
4.	19BMC12	Biomedical Instrumentation	3	0	0	3	3
5.	19BMEXX	Professional Elective –I	3	0	0	3	3
6.	19BMEXX	Professional Elective –II	3	0	0	3	3
LABORATORY							
7.	19BMC24	Medical Signal Processing Laboratory	0	0	2	1	2
8.	19BMC26	Biomedical Instrumentation Laboratory	0	0	2	1	2
		Total Credits				**21**	

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6 → Biomch. ortho (NPTEL)

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Department	BIOMEDICAL ENGINEERING
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SEMESTER –VI

S.No.	Course Code	Course Name	Hours/ Week			Credit	Contact Hours
			L	T	P	C	
THEORY							
1.	19BMC14	Embedded System	3	0	0	3	3
2.	19BMC15	Therapeutic Equipments	3	0	0	3	3
3.	19BMC17	Medical Imaging Techniques	3	0	0	3	3
4.	19BMEXX	Professional Elective –III	3	0	0	3	3
5.	19BMEXX	Professional Elective - IV	3	0	0	3	3
6.	19XXXX	Open Elective – I	3	0	0	3	3
7.	19BMC19	Human Assist Device	3	0	0	3	3
LABORATORY							
8	19BMC28	Embedded System Laboratory	0	0	2	1	2
9.	19BMS04	Design Project	0	0	2	1	2
		Total Credits				**23**	

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SEMESTER – VII

S.No.	Course Code	Course Name	Hours/ Week			Credit	Contact Hours
			L	T	P	C	
THEORY							
1.	19BMC18	Electrical Safety & Quality Assurance	3	0	0	3	3
2.	19BMC31	Biomems and Microfluids	3	0	0	3	3
3.	19BMEXX	Professional Elective - V	3	0	0	3	3
4.	19XXXXX	Open Elective –II	3	0	0	3	3
5.	19BMEXX	Professional Elective - VI	3	0	0	3	3
LABORATORY							
5.	19BMS01	Project work Phase –I	0	0	6	3	6
6.	19BMS05	Hospital Training	0	0	0	1	0
		Total Credits				**19**	

	MUTHAYAMMAL ENGINEERING COLLEGE (Autonomous) (Approved by AICTE & Affiliated to Anna University), RASIPURAM – 637 408	CURRICULUM UG R – 2019

Department	Biomedical Engineering
Programme	BE

SEMESTER – VIII

S.No.	Course Code	Course Name	Hours/ Week			Credit	Contact Hours
			L	T	P	C	
THEORY							
1.	19BMS02	Project work Phase -II	0	0	12	6	12
2.		NPTEL Course	0	0	0	0	
		Total Credits				**6**	

Total Credits to be earned for the award of Degree: 160

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Professional Core Courses

COURSE CODE	COURSE TITLE	L	T	P	C
19BMC01	HUMAN ANATOMY & PHYSIOLOGY	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

19BMC01.CO1	Understand basic structural functional elements of human body
19BMC01.CO2	Explain the organs and structures involving in system formation and function
19BMC01.CO3	Understand circulatory system
19BMC01.CO4	Interpret urinary and special sensory system
19BMC01.CO5	Study about nervous system

Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC01.CO1	X	X	X	X	X	-	-	-	-	-	-	X	X	X	-
19BMC01.CO2	X	X	X	X	X	-	-	-	-	-	-	X	X	X	-
19BMC01.CO3	X	X	X	X	X	-	-	-	-	-	-	X	X	X	-
19BMC01.CO4	X	X	X	X	X	-	-	-	-	-	-	X	X	X	-
19BMC01.CO5	X	X	X	X	X	-	-	-	-	-	-	X	X	X	-

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC01.CO1	2	3	2	2	2	-	-	-	-	-	-	2	2	2	-
19BMC01.CO2	2	2	2	2	2	-	-	-	-	-	-	2	2	2	-
19BMC01.CO3	2	2	3	2	2	-	-	-	-	-	-	2	2	3	-
19BMC01.CO4	2	2	3	2	2	-	-	-	-	-	-	2	2	2	-
19BMC01.CO5	2	2	2	2	2	-	-	-	-	-	-	2	2	2	-

1-Low, 2- Medium, 3-High

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UNIT I **BASIC ELEMENTS OF HUMAN BODY** **9**

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

UNIT II **SKELETAL SYSTEM** **9**

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

UNIT III **CIRCULATORY SYSTEM** **9**

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

UNIT IV **URINARY AND NERVOUS SYSTEM** **9**

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

UNIT V **MUSCLES AND JOINTS** **9**

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

TOTAL: 45 HRS

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TEXT BOOKS:

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

REFERENCE BOOKS:

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

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

COURSE CODE	COURSE TITLE	L	T	P	C
19BMC02	BIOMEDICAL SENSORS & INSTRUMENTS	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

19BMC02.CO1	Differentiate different bio potentials and its propagations.
19BMC02.CO2	Illustrate different electrode placement for various physiological recordings
19BMC02.CO3	Design bio amplifier for various physiological recordings
19BMC02.CO4	Explain various technique for non-electrical physiological measurements
19BMC02.CO5	Demonstrate different biochemical measurement techniques.

Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC02.CO1	X	X	X	X	X	-	-	-	-	-	-	X	X	X	-
19BMC02.CO2	X	X	X	X	X	-	-	-	-	-	-	X	X	X	-
19BMC02.CO3	X	X	X	X	X	-	-	-	-	-	-	X	X	X	-
19BMC02.CO4	X	X	X	X	X	-	-	-	-	-	-	X	X	X	-
19BMC02.CO5	X	X	X	X	X	-	-	-	-	-	-	X	X	X	-

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC02.CO1	2	2	3	2	3	-	-	-	-	-	-	3	3	3	-
19BMC02.CO2	3	2	2	2	2	-	-	-	-	-	-	3	3	2	-
19BMC02.CO3	2	3	3	3	2	-	-	-	-	-	-	3	3	2	-
19BMC02.CO4	3	2	2	2	3	-	-	-	-	-	-	3	3	3	-
19BMC02.CO5	3	2	2	2	3	-	-	-	-	-	-	3	3	2	-

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UNIT I ELECTROPHYSIOLOGY AND BIOPOTENTIAL ELECTRODES **9**

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

UNIT II BIO-POTENTIAL MEASUREMENTS OF PARAMETERS **9**

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

UNIT III BIO AMPLIFIER WITH SIGNAL CONDITIONING CIRCUITS **9**

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

UNIT IV MEASUREMENT OF NON-ELECTRICAL PARAMETERS **9**

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

UNIT V BIO-CHEMICAL MEASUREMENT **9**

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

TOTAL: 45 HRS

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TEXT BOOK:

S.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

REFERENCE BOOKS:

S.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	John G. Webster	Medical Instrumentation Application and Design	Wiley India Pvt Ltd, New Delhi	4th Edition 2015
2.	Joseph J. Carr John M. Brown	Introduction to Biomedical Equipment Technology	Pearson Education	2004
3.	Myer Kutz	Standard Handbook of Biomedical Engineering and Design	McGraw Hill Publisher	2003

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

COURSE CODE	COURSE TITLE	L	T	P	C
19BMC03	DIGITAL ELECTRONICS	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

19BMC03.CO1	Apply Boolean algebra, Karnaugh map and Tabulation method for simplification of Boolean expressions
19BMC03.CO2	Design combinational logic circuits for various applications
19BMC03.CO3	Design shift registers, Modulo-N asynchronous and synchronous counters
19BMC03.CO4	Design and analyze state machines for the given specifications
19BMC03.CO5	Discuss different logic families and Implement digital circuit in programmable logic devices

Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC03.CO1	X	X	X	X	X	-	-	-	-	-	-	X	X	X	X
19BMC03.CO2	X	X	X	X	X	-	-	-	-	-	-	X	X	X	X
19BMC03.CO3	X	X	X	-	X	-	-	-	-	-	-	X	X	X	X
19BMC03.CO4	X	X	X	X	X	-	-	-	-	-	-	X	X	X	X
19BMC03.CO5	X	X	X	X	X	-	-	-	-	-	-	X	X	X	X

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC03.CO1	3	2	2	3	3	-	-	-	-	-	-	2	3	2	2
19BMC03.CO2	3	2	2	3	2	-	-	-	-	-	-	2	3	2	2
19BMC03.CO3	3	3	2	-	3	-	-	-	-	-	-	2	3	2	2
19BMC03.CO4	3	2	2	3	3	-	-	-	-	-	-	2	3	2	2
19BMC03.CO5	3	3	2	3	3	-	-	-	-	-	-	2	2	2	2

1-Low, 2- Medium, 3-High

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UNIT I BASIC CONCEPTS OF DIGITAL SYSTEMS **9**

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

UNIT II COMBINATIONAL CIRCUITS **9**

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

UNIT III SEQUENTIAL CIRCUITS **9**

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

UNIT IV SYNCHRONOUS AND ASYNCHRONOUS SEQUENTIAL CIRCUITS **9**

Mealy and Moore models – State diagram - State table – State minimization – State assignment - Excitation table - Design of Synchronous sequential circuits: Counters and Sequence generators- Circuit implementation - Asynchronous sequential circuits - Hazards and Races, Hazard free combinational circuits

UNIT V LOGIC FAMILIES AND PROGRAMMABLE DEVICES **9**

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

TOTAL: 45 HRS

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TEXT BOOKS:

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

REFERENCE BOOKS:

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

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

COURSE CODE	COURSE TITLE	L	T	P	C
19BMC04	SIGNALS & SYSTEMS	3	1	0	4

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

19BMC04.CO1	Able to describe classification of signals and systems
19BMC04.CO2	Analyze the Laplace transform, Fourier transform
19BMC04.CO3	Ability to analyze continuous time LTI systems using Fourier and Laplace Transforms
19BMC04.CO4	Analyze Z Transform and DTFT
19BMC04.CO5	Ability to analyze discrete time LTI systems using Z transform and DTFT

Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC04.CO1	X	X	X	X	X	-	-	-	-	-	-	X	X	-	-
19BMC04.CO2	X	X	X	X	X	-	-	-	-	-	-	X	X	-	-
19BMC04.CO3	X	X	X	X	X	-	-	-	-	-	-	X	X	-	-
19BMC04.CO4	X	X	X	X	X	-	-	-	-	-	-	X	X	-	-
19BMC04.CO5	X	X	X	X	X	-	-	-	-	-	-	X	X	-	-

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC04.CO1	3	3	3	3	2	-	-	-	-	-	-	3	2	-	-
19BMC04.CO2	3	3	3	3	2	-	-	-	-	-	-	3	3	-	-
19BMC04.CO3	3	3	3	3	2	-	-	-	-	-	-	2	3	-	-
19BMC04.CO4	3	3	3	3	2	-	-	-	-	-	-	3	3	-	-
19BMC04.CO5	3	3	3	3	2	-	-	-	-	-	-	2	3	-	-

1-Low, 2- Medium, 3-High

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UNIT I: FUNDAMENTALS OF SIGNAL PROCESSING 9

Sampling and aliasing, simple signal conversion systems, spectral analysis - FFT -decimation in time algorithm - Decimation in Frequency algorithm - Different types of bioelectric signals and its basic characteristics.

UNIT II SIGNALS AND SYSTEMS 9

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

UNIT III ANALYSIS OF CONTINUOUS TIME SIGNALS 9

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

UNIT IV ANALYSIS OF BIOSIGNALS 9

P-wave detection, QRS complex detection-derivative based method, Pan Tompkins algorithm - Template matching method, - Signal averaged ECG - Analysis of heart rate variability-time domain method and frequency domain methods - Synchronized averaging of PCG envelopes, envelogram, analysis of PCG signal, EMG signal analysis

UNIT V CASE STUDIES IN BSP 9

ECG rhythm analysis, normal and ectopic ECG beats, analysis of exercise ECG - Analysis of respiration, spectral analysis of EEG signals - Case studies- in ECG and PCG - PCG and carotid pulse - ECG and atrial electrogram -Cardio respiratory interaction - EMG and Vibromyogram (VMG)

TOTL: 45HRS

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TEXT BOOKS:

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

REFERENCE BOOKS:

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

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

COURSE CODE	COURSE TITLE	L	T	P	C
19BMC05	BIOMECHANICS & REHABILIATION ENGINEERING	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

19BMC05.CO1	Ability to apply knowledge of mathematics, science and engineering to understand the fundamentals of moving systems and familiarity with human anatomy to competently analyze the movement of the human body.
19BMC05.CO2	Ability to analyze the dynamics of human movement flow properties of blood and comprehend the biomechanical principles that relate to movement and communication disabilities.
19BMC05.CO3	Have an in depth idea about Engineering Concepts in Sensory & Motor rehabilitation.
19BMC05.CO4	Apply the different types of Therapeutic Exercise Technique to benefit the society.
19BMC05.CO5	Gain in-depth knowledge about different types of models of Hand and arm replacement.

Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC05.CO1	x	x	x	-	-	-	-	-	-	-	-	x	x	x	-
19BMC05.CO2	x	x	x	-	-	-	-	-	-	-	-	x	x	x	-
19BMC05.CO3	x	x	x	-	-	-	-	-	-	-	-	x	x	x	-
19BMC05.CO4	x	x	x	-	-	-	-	-	-	-	-	x	x	x	-
19BMC05.CO5	x	x	x	-	-	-	-	-	-	-	-	x	x	x	-

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC05.CO1	2	2	3	-	-	-	-	-	-	-	-	2	3	2	-
19BMC05.CO2	2	2	3	-	-	-	-	-	-	-	-	2	3	2	-
19BMC05.CO3	2	3	3	-	-	-	-	-	-	-	-	2	2	2	-
19BMC05.CO4	2	2	3	-	-	-	-	-	-	-	-	2	3	2	-
19BMC05.CO5	2	2	3	-	-	-	-	-	-	-	-	2	3	2	-

1-Low, 2- Medium, 3-High

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UNIT I INTRODUCTION TO BIOMECHANICS 9

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

UNIT II THE FLOW PROPERTIES OF BLOOD 9

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

UNIT III INTRODUCTION TO REHABILITATION 9

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

UNIT IV REHABILITATION TEAM & THERAPEUTIC EXERCISE TECHNIQUE 9

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

UNIT V ORTHOTIC, PROSTHETIC DEVICES & RESTORATION TECHNIQUES 9

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

TOTAL: 45 HRS

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TEXT BOOKS:

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

REFERENCES BOOKS:

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

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

COURSE CODE	COURSE TITLE	L	T	P	C
19BMC06	BIO CONTROL SYSTEM	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

19BMC06.CO1	Analysis the knowledge of various control models
19BMC06.CO2	Perform time domain control systems required for system analysis.
19BMC06.CO3	Perform frequency domain analysis of control systems required for system analysis.
19BMC06.CO4	Performance analysis of control systems required for stability analysis
19BMC06.CO5	Design the state variable analysis method.

Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC06.CO1	X	X	X	X	X	-	-	-	-	-	-	X	X	X	-
19BMC06.CO2	X	X	X	X	X	-	-	-	-	-	-	X	X	X	-
19BMC06.CO3	X	X	X	X	X	-	-	-	-	-	-	X	X	X	-
19BMC06.CO4	X	X	X	X	X	-	-	-	-	-	-	X	X	X	-
19BMC06.CO5	X	X	X	X	X	-	-	-	-	-	-	X	X	X	-

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC06.CO1	3	3	3	3	2	-	-	-	-	-	-	2	2	3	-
19BMC06.CO2	3	2	3	2	2	-	-	-	-	-	-	2	2	2	-
19BMC06.CO3	3	3	3	3	3	-	-	-	-	-	-	3	2	2	-
19BMC06.CO4	3	3	2	3	2	-	-	-	-	-	-	2	3	2	-
19BMC06.CO5	3	3	2	3	3	-	-	-	-	-	-	2	2	2	-

1-Low, 2- Medium, 3-High

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UNIT I **CONTROL SYSTEM MODELING** **9**

Basic Elements of Control System – Open loop and Closed loop systems - Differential equation - Transfer function, Modeling of Electric systems, Translational and rotational mechanical systems - Block diagram reduction Techniques - Signal flow graph.

UNIT II **TIME RESPONSE ANALYSIS** **9**

Time response analysis - First Order Systems - Impulse and Step Response analysis of second order systems - Steady state errors – P, PI, PD and PID Compensation, Analysis using MATLAB.

UNIT III **FREQUENCY RESPONSE ANALYSIS** **9**

Frequency Response - Bode Plot, Polar Plot, Nyquist Plot - Frequency Domain specifications from the plots - Constant M and N Circles - Nichol"s Chart - Use of Nichol"s Chart in Control System Analysis.

UNIT IV **STABILITY ANALYSIS** **9**

Stability, Routh-Hurwitz Criterion, Root Locus Technique, Construction of Root Locus, Stability, Dominant Poles, Application of Root Locus Diagram - Nyquist Stability Criterion - Relative Stability, Analysis using MATLAB.

UNIT V **STATE VARIABLE ANALYSIS AND BIOMEDICAL APPLICATIONS** **9**

State space representation of Continuous Time systems – State equations – Transfer function from State Variable Representation – Solutions of the state equations - Concepts of Controllability and Observability – Sampling Theorem – Sampler & Hold – Open loop & Closed loop sampled data systems - Lung mechanics model with proportional control

TOTAL: 45 HRS

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TEXT BOOKS:

S.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

REFERENCE BOOKS:

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

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

COURSE CODE	COURSE TITLE	L	T	P	C
19BMC07	ANALOG ELECTRONICS	3	1	0	4

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

19BMC07.CO1	To learn about Design and construct amplifiers
19BMC07.CO2	To Construct JFET and MOSFET amplifiers
19BMC07.CO3	To Study rectifiers and power supplies
19BMC07.CO4	To Learn about feedback amplifiers
19BMC07.CO5	To Learn about oscillators

Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC07.CO1	X	X	X	X	X	-	-	-	-	-	-	X	X	X	-
19BMC07.CO2	X	X	X	X	X	-	-	-	-	-	-	X	X	X	-
19BMC07.CO3	X	X	X	X	X	-	-	-	-	-	-	X	X	X	-
19BMC07.CO4	X	X	X	X	X	-	-	-	-	-	-	X	X	X	-
19BMC07.CO5	X	X	X	X	X	-	-	-	-	-	-	X	X	X	-

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC07.CO1	2	2	2	3	3	-	-	-	-	-	-	2	3	2	-
19BMC07.CO2	3	2	2	3	2	-	-	-	-	-	-	2	3	2	-
19BMC07.CO3	2	3	2	3	3	-	-	-	-	-	-	2	3	2	-
19BMC07.CO4	2	2	2	3	3	-	-	-	-	-	-	2	3	2	-
19BMC07.CO5	2	3	2	3	3	-	-	-	-	-	-	2	2	2	-

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

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

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

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

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

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

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

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

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

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

TOTAL: 45 HRS

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TEXT BOOKS:

S.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

REFERENCE BOOKS:

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

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

COURSE CODE	COURSE TITLE	L	T	P	C
19BMC08	MICROPROCESSOR AND MICROCONTROLLERS IN MEDICINE	3	0	0	3

COURSE OBJECTIVES:

- Understand the fundamental concepts of 8086 microprocessors
- Explain the basic concepts of 8051 microcontroller
- Obtain knowledge on interfacing devices
- Familiarize about ARM microcontroller
- Acquire knowledge on applications of microprocessor and microcontroller in biomedical domain.

COURSE OUTCOMES:

19BMC08.CO1	Understand and execute programs based on 8086 microprocessor.
19BMC08.CO2	Understand and execute programs based on 8051 microcontroller.
19BMC08.CO3	Design and interface I/O circuits.
19BMC08.CO4	Understand the fundamentals of register
19BMC08.CO5	Design and implement of microprocessor and microcontroller based systems.

Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC08.CO1	X	X	X	X	X	-	-	-	-	-	-	X	X	X	-
19BMC08.CO2	X	X	X	X	X	-	-	-	-	-	-	X	X	X	-
19BMC08.CO3	X	X	X	X	X	-	-	-	-	-	-	X	X	X	-
19BMC08.CO4	X	X	X	X	X	-	-	-	-	-	-	X	X	X	-
19BMC08.CO5	X	X	X	X	X	-	-	-	-	-	-	X	X	X	-

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC08.CO1	2	2	3	3	3	-	-	-	-	-	-	2	2	3	-
19BMC08.CO2	3	3	2	3	3	-	-	-	-	-	-	2	2	2	-
19BMC08.CO3	2	2	3	-	3	-	-	-	-	-	-	2	2	3	-
19BMC08.CO4	2	3	2	3	3	-	-	-	-	-	-	2	2	3	-
19BMC08.CO5	3	3	2	3	3	-	-	-	-	-	-	2	2	3	-

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UNIT I **OVERVIEW OF 8086 MICROPROCESSOR** **9**

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

UNIT II **8051 MICROCONTROLLER** **9**

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

UNIT III **INTERFACING DEVICES** **9**

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

UNIT IV **ARM MICROCONTROLLER** **9**

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

UNIT V **APPLICATION IN MEDICINE** **9**

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

TOTAL: 45 HRS

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TEXT BOOKS:

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

REFERENCE BOOKS:

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

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COURSE CODE	COURSE TITLE	L	T	P	C
19BMC09	LINEAR INTEGRATED CIRCUITS	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

19BMC09.CO1	Illustrate the Circuit Fabrication Process and internal structure of operational amplifiers
19BMC09.CO2	Characterize and design real time operational amplifiers applications
19BMC09.CO3	Design comparator and generate waveforms using operational amplifier
19BMC09.CO4	Demonstrate the functioning of PLL and Data converters
19BMC09.CO5	Acquire knowledge about special function ICs and its application in modern electronic equipment

Mapping of Cos with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC09.CO1	X	X	X	X	-	-	-	-	-	-	-	X	X	X	-
19BMC09.CO2	X	X	X	X	-	-	-	-	-	-	-	X	X	X	-
19BMC09.CO3	X	X	X	X	-	-	-	-	-	-	-	X	X	X	-
19BMC09.CO4	X	X	X	X	-	-	-	-	-	-	-	X	X	X	-
19BMC09.CO5	X	X	X	X	-	-	-	-	-	-	-	X	X	X	-

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC09.CO1	3	3	3	2	-	-	-	-	-	-	-	2	2	2	-
19BMC09.CO2	3	3	2	2	-	-	-	-	-	-	-	2	2	3	-
19BMC09.CO3	3	2	2	2	-	-	-	-	-	-	-	2	2	2	-
19BMC09.CO4	3	3	2	2	-	-	-	-	-	-	-	2	2	2	-
19BMC09.CO5	3	3	3	3	-	-	-	-	-	-	-	2	2	3	-

1-Low, 2- Medium, 3-High

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UNIT I **IC FABRICATION AND OPERATIONAL AMPLIFIER** **9**

Introduction to Integrated Circuits- Classification of ICs- Basic IC Fabrication Planar Process-Fabrication of Diode and BJT - Operational Amplifier: Basic Information of Op-Amp, Ideal Op Amp-Operational Amplifier Internal Circuit- Differential Amplifier- Analysis of current sources-Widlar-Wilson Current Sources.

UNIT II **CHARACTERISTICS OF OP- AMP AND APPLICATIONS** **9**

Characteristics of Op- Amp - DC Characteristics, AC Characteristics - Frequency Response- Frequency Compensation - Slew Rate- Applications: Closed Loop Op Amp Configuration - Inverting and Non inverting Amplifiers- Inverter- Voltage Follower-Summing Amplifier, Averaging Circuits - Subtractor- Differential Amplifier- Multiplier- Differentiator- Integrator- Instrumentation amplifier, Precision rectifier- V/I & I/V Converter.

UNIT III **COMPARATOR AND WAVEFORM GENERATORS** **9**

Comparators - Open Loop Op Amp Configuration - Inverting , Non Inverting Comparator- Applications of Comparator- Regenerative Comparator (Schmitt trigger)- Multivibrators - Astable, Monostable-Principles of Sine wave Oscillator- RC Phase Shift, Wien Bridge Oscillator.

UNIT IV **PHASE LOCKED LOOP AND DATA 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.

TOTAL: 45 HRS

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TEXT BOOKS:

S.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

REFERENCE BOOKS:

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

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

COURSE CODE	COURSE TITLE	L	T	P	C
19BMC10	FUNDEMENTALS OF BIOCHEMISTRY	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

19BMC10.CO1	Identify the perspectives of machine learning.
19BMC10.CO2	Apply decision tree and Artificial neural networks for real world problems.
19BMC10.CO3	Design a Bayesian classifier for solving a problem.
19BMC10.CO4	Illustrate the principles of instance based learning and genetic algorithm.
19BMC10.CO5	Describe the algorithms for rule and reinforcement learning.

Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC10.CO1	X	X	X	X	X	-	-	-	-	-	-	X	X	-	-
19BMC10.CO2	X	X	X	X	X	-	-	-	-	-	-	X	X	-	-
19BMC10.CO3	X	X	X	X	X	-	-	-	-	-	-	X	X	-	-
19BMC10.CO4	X	X	X	X	X	-	-	-	-	-	-	X	X	-	-
19BMC10.CO5	X	X	X	X	X	-	-	-	-	-	-	X	X	-	-

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC10.CO1	2	2	2	2	2	-	-	-	-	-	-	2	2	-	-
19BMC10.CO2	2	3	2	2	2	-	-	-	-	-	-	2	2	-	-
19BMC10.CO3	2	2	2	2	2	-	-	-	-	-	-	2	2	-	-
19BMC10.CO4	2	2	2	2	2	-	-	-	-	-	-	2	2	-	-
19BMC10.CO5	2	2	3	2	2	-	-	-	-	-	-	2	2	-	-

1-Low, 2- Medium, 3-High

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UNIT I **INTRODUCTION TO BIOCHEMISTRY** **9**

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

UNIT II **CARBOHYDRATES** **9**

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

UNIT III **LIPIDS** **9**

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

UNIT IV **NUCLEIC ACID & PROTEIN** **9**

Structure of purines and pyrimidines, nucleoside, nucleotide, DNA act as a genetic material, chargoffs rule. Watson and crick model of DNA. Structure of RNA and its type. Metabolism and Disorder of purines and pyrimidines nucleotide Classification, structure and properties of proteins, structural organization of proteins, classification and properties of amino acids. Separation of protein, Inborn Metabolic error of amino acid metabolism

UNIT V **ENZYME AND ITS CLINICAL APPLICATION** **9**

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

TOTAL: 45 HRS

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REFERENCE BOOKS:

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

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COURSE CODE	COURSE TITLE	L	T	P	C
19BMC11	HOSPITAL MANAGEMENT	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

19BMC11.CO1	Explain the principles of Hospital administration.
19BMC11.CO2	Identify the importance of Human resource management.
19BMC11.CO3	List various marketing research techniques.
19BMC11.CO4	Identify Information management systems and its uses.
19BMC11.CO5	Understand safety procedures followed in hospitals

Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC11.CO1	-	-	-	-	-	X	X	X	X	X	X	X	-	X	-
19BMC11.CO2	-	-	-	-	-	X	X	X	X	X	X	X	-	X	-
19BMC11.CO3	-	-	-	-	-	X	X	X	X	X	X	X	-	X	-
19BMC11.CO4	-	-	-	-	-	X	X	X	X	X	X	X	-	X	-
19BMC11.CO5	-	-	-	-	-	X	X	X	X	X	X	X	-	X	-

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC11.CO1	-	-	-	-	-	2	3	2	2	2	2	3	-	2	-
19BMC11.CO2	-	-	-	-	-	3	2	2	2	2	2	2	-	3	-
19BMC11.CO3	-	-	-	-	-	2	3	2	2	2	2	3	-	2	-
19BMC11.CO4	-	-	-	-	-	3	3	2	2	2	2	3	-	3	-
19BMC11.CO5	-	-	-	-	-	2	3	2	2	2	2	3	-	2	-

1-Low, 2- Medium, 3-High

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UNIT I OVERVIEW OF HOSPITAL ADMINISTRATION 9

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

UNIT II HUMAN RESOURCE DEPARTMENT MANAGEMENT 9

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

UNIT III MARKETING RESEARCH PROCESS 9

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

UNIT IV HOSPITAL INFORMATION SYSTEMS & SUPPORTIVE SERVICES 9

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

UNIT V QUALITY AND SAFETY ASPECTS IN HOSPITAL 9

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

TOTAL: 45 HRS

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TEXT BOOKS:

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

REFERENCE BOOKS:

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

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

COURSE CODE	COURSE TITLE	L	T	P	C
19BMC12	BIOMEDICAL INSTRUMENTATION	3	0	0	3

COURSE OBJECTIVES:

- Apply knowledge of mathematics science and engineering
- Learn fundamentals in designing, analyzing and/or working of biomedical circuits and instruments.
- Understand the health, safety, Environmental, legal and ethical issues
- Learn designing/working of a biomedical circuits and instruments.
- Work, document and present as an individual and as a team-member

COURSE OUTCOMES:

19BMC12.CO1	Design, formulate and implement experiments using modern equipment's & tools.
19BMC12.CO2	Present in a group and document the findings or suggestions for the problems in the current techniques,
19BMC12.CO3	modern tools and computing practice
19BMC12.CO4	Improve technology in health care instruments through hospital visits for lifelong learning.
19BMC12.CO5	Design, formulate and implement experiments using modern equipment's & tools.

Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC12.CO1	X	X	X	X	X	X	-	-	-	-	-	X	X	X	-
19BMC12.CO2	X	X	X	X	X	X	-	-	-	-	-	X	X	X	-
19BMC12.CO3	X	X	X	X	X	X	-	-	-	-	-	X	X	X	-
19BMC12.CO4	X	X	X	X	X	X	-	-	-	-	-	X	X	X	-
19BMC12.CO5	X	X	X	X	X	X	-	-	-	-	-	X	X	X	-

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC12.CO1	3	2	3	3	3	3	-	-	-	-	-	2	2	3	-
19BMC12.CO2	3	2	2	3	3	2	-	-	-	-	-	2	2	3	-
19BMC12.CO3	3	2	3	2	3	3	-	-	-	-	-	2	3	3	-
19BMC12.CO4	3	3	3	3	3	3	-	-	-	-	-	2	2	3	-
19BMC12.CO5	3	2	2	3	3	3	-	-	-	-	-	2	3	3	-

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UNIT I **PHYSIOLOGICAL TRANSDUCERS** **9**

Classification of transducers, performance characteristics of transducers. Pressure transducers, transducers for body temperature measurement, photoelectric transducers, optical fiber sensor, biosensor and smart sensor. Biomedical recorders and biofeedback instruments. Patient Monitoring Systems: System concepts, cardiac monitor, bedside patient monitoring system, central monitors, measurement of heart rate, measurement of pulse rate, blood pressure measurement, measurement of temperature, measurement of respiratory rate, catheterization laboratory instrumentation.

UNIT II **OXIMETERS** **9**

Oximetry, ear oximeter, pulse oximeter, skin reflectance oximeter and intravascular oximeter. Blood Flow Meters: Electromagnetic blood flow meters different types, Ultrasonic blood flow meters, NMR blood flow meters and Laser Doppler blood flow meters. Cardiac output measurements: Indicator dilution method, Dye dilution method, Thermal dilution techniques, Measurement of continuous cardiac output derived from the aortic pressure waveform, Impedance technique. Pulmonary Function Analyzer: Pulmonary function measurement, Spirometry, Pneumo tachometer, Measurement of volume by Nitrogen washout technique.

UNIT III **BLOOD GAS ANALYZERS** **9**

Acid-base balance, blood pH measurement, measurement of blood pCO_2, intra-arterial blood gas monitoring, complete blood gas analyzer. Audiometer and Hearing Aids: Mechanism of hearing, measurement of sound, basic audiometer, pure-tone audiometer, speech audiometer, audiometer system, Bekesy evoked response audiometer system, calibration of audiometer and hearing aids.

UNIT IV **CARDIAC PACEMAKERS AND DEFIBRILLATORS** **9**

Need for cardiac pacemaker, External ace maker, Implantable pacemaker, Types of Implantable pacemakers and recent developments. Programmable pacemaker, Rate-responsive pacemakers, pacing system Analyzers, Need for Defibrillator, Dc defibrillators, Implantable Defibrillators, Defibrillator analyzers.

UNIT V **INSTRUMENTS OF SURGERY** **9**

Principles of surgical diathermy, surgical diathermy Machine, Safety aspects in electro- surgical units, surgical diathermy Analyzer. Automated drug delivery Systems: Infusion pumps, components of drug infusion systems and implantable infusion systems.

TOTAL: 45 HRS

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Rasipuram, Namakkal Dist 637 408

TEXT BOOKS:

S.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	R.S.Khandpur	Hand Book of Bio-Medical instrumentation	Tata McGraw Hill Publishing Co Ltd	2004
2.	Leslie Cromwell, Fred J.Weibell, Erich A.Pfeiffer	Bio-Medical Instrumentation and Measurements	Pearson Education	2nd edition, 2002

REFERENCE BOOKS:

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

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

COURSE CODE	COURSE TITLE	L	T	P	C
19BMC13	MEDICAL SIGNAL PROCESSING	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

19BMC13.CO1	Choose filter for the ECG analysis.
19BMC13.CO2	Write the types of algorithm for data compression.
19BMC13.CO3	Idea about processing the ECG signal and their estimations.
19BMC13.CO4	Study about EEG and their parameters.
19BMC13.CO5	Study about the sleeping modes of EEG.

Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC13.CO1	X	X	X	X	X	X	X	-	-	-	-	X	X	X	X
19BMC13.CO2	X	X	X	X	X	X	X	-	-	-	-	X	X	X	X
19BMC13.CO3	X	X	X	X	X	X	X	-	-	-	-	X	X	X	X
19BMC13.CO4	X	X	X	X	X	X	X	-	-	-	-	X	X	X	X
19BMC13.CO5	X	X	X	X	X	X	X	-	-	-	-	X	X	X	X

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC13.CO1	2	3	3	3	3	2	2	-	-	-	-	3	2	3	3
19BMC13.CO2	3	2	3	3	3	2	2	-	-	-	-	2	3	2	3
19BMC13.CO3	2	3	3	3	2	2	2	-	-	-	-	3	2	2	2
19BMC13.CO4	2	3	2	3	3	2	2	-	-	-	-	3	2	3	2
19BMC13.CO5	2	3	2	3	3	2	2	-	-	-	-	2	2	3	3

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UNIT I **ADAPTIVE FILTERS** **9**

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

UNIT II **DATA COMPRESSION TECHNIQUES** **9**

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

UNIT III **CARDIO-LOGICAL SIGNAL PROCESSING** **9**

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

UNIT IV **NEUROLOGICAL SIGNAL PROCESSING** **9**

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

UNIT V **SLEEP EEG** **9**

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

TOTAL: 45 HRS

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TEXT BOOKS:

S.No.	Author	Title of book	Publisher	Year of publication
1.	D.C.Reddy	Biomedical Signal Processing-principles and techniques	Tata McGraw-Hill	2005
2.	Rangaraj M. Rangayyan	Biomedical Signal Analysis	IEEE Press	2001

REFERENCE BOOKS:

S.No.	Author	Title of book	Publisher	Year of publication
1.	Willis J.Tompkins	Biomedical Digital Signal Processing	PHI	Latest edition
2.	Akay.M	Biomedical Signal Processing	Academic: Press	1994

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

COURSE CODE	COURSE TITLE	L	T	P	C
19BMC14	EMBEDDED SYSTEMS	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

19BMC14.CO1	Able to describe hardware and software architectures of Embedded Systems.
19BMC14.CO2	Able to understand the functions and syntax used in Embedded C.
19BMC14.CO3	Able to understand special features of ARM architecture.
19BMC14.CO4	Able to introduce devices and buses used for Embedded Networking.
19BMC14.CO5	Able to interpret the concepts of a Real Time Operating System.

Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC14.CO1	X	X	X	X	X	X	-	-	-	-	-	X	X	X	-
19BMC14.CO2	X	X	X	X	X	X	-	-	-	-	-	X	X	X	-
19BMC14.CO3	X	X	X	X	X	X	-	-	-	-	-	X	X	X	-
19BMC14.CO4	X	X	X	X	X	X	-	-	-	-	-	X	X	X	-
19BMC14.CO5	X	X	X	X	X	X	-	-	-	-	-	X	X	X	-

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC14.CO1	3	3	3	3	3	3	-	-	-	-	-	2	2	2	-
19BMC14.CO2	3	3	2	2	3	2	-	-	-	-	-	3	3	2	-
19BMC14.CO3	3	2	3	2	3	3	-	-	-	-	-	2	2	2	-
19BMC14.CO4	3	3	3	2	3	3	-	-	-	-	-	3	2	2	-
19BMC14.CO5	3	3	3	3	3	3	-	-	-	-	-	2	3	2	-

1-Low, 2- Medium, 3-High

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UNIT I **ARCHITECTURE OF EMBEDDED SYSTEMS** **9**

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

UNIT II **ARM ARCHITECTURE** **9**

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

UNIT III **EMBEDDED COMMUNICATION PROTOCOLS** **9**

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

UNIT IV **REAL-TIME OPERATING SYSTEM CONCEPTS** **9**

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

TOTAL: 45 HRS

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TEXT BOOKS:

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

REFERENCE BOOKS:

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

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COURSE CODE	COURSE TITLE	L	T	P	C
19BMC15	THERAPEUTIC EQUIPMENTS	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

19BMC15.CO1	Describe the working setup of all basic cardiac equipment.
19BMC15.CO2	Students will have acquired thorough life support equipment in clinical use.
19BMC15.CO3	Learned the design and system level analysis different therapeutic equipments
19BMC15.CO4	Analyzing the application and safety aspects of different equipments
19BMC15.CO5	Studied various internal organ monitoring devices

Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC15.CO1	X	X	X	X	X	X	-	-	-	-	-	X	X	X	-
19BMC15.CO2	X	X	X	X	X	X	-	-	-	-	-	X	X	X	-
19BMC15.CO3	X	X	X	X	X	X	-	-	-	-	-	X	X	X	-
19BMC15.CO4	X	X	X	X	X	X	-	-	-	-	-	X	X	X	-
19BMC15.CO5	X	X	X	X	X	X	-	-	-	-	-	X	X	X	-

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC15.CO1	3	3	3	2	3	3	-	-	-	-	-	2	3	3	-
19BMC15.CO2	3	2	3	2	3	2	-	-	-	-	-	2	3	2	-
19BMC15.CO3	2	2	3	2	2	3	-	-	-	-	-	3	3	2	-
19BMC15.CO4	3	2	2	2	3	3	-	-	-	-	-	2	3	3	-
19BMC15.CO5	3	3	2	2	3	3	-	-	-	-	-	2	3	3	-

1-Low, 2- Medium, 3-High

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

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

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

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

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

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

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

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

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

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

TOTAL: 45 HRS

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TEXT BOOKS:

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

REFERENCE BOOKS:

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

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

COURSE CODE	COURSE TITLE	L	T	P	C
19BMC17	MEDICAL IMAGING TECHNIQUES	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

19BMC17.CO1	Know and understand the basics and fundamentals X-ray imaging.
19BMC17.CO2	Operate on CT imaging techniques.
19BMC17.CO3	Understand the concepts and function of Nuclear imaging techniques
19BMC17.CO4	Learn the basics of mathematic calculation for image formation.
19BMC17.CO5	Familiar with medical image modeling methods

Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC17.CO1	X	X	X	X	X	X	-	-	-	-	-	X	X	X	X
19BMC17.CO2	X	X	X	X	X	X	-	-	-	-	-	X	X	X	X
19BMC17.CO3	X	X	X	X	X	X	-	-	-	-	-	X	X	X	X
19BMC17.CO4	X	X	X	X	X	X	-	-	-	-	-	X	X	X	X
19BMC17.CO5	X	X	X	X	X	X	-	-	-	-	-	X	X	X	X

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC17.CO1	3	3	3	3	2	3	-	-	-	-	-	2	3	3	3
19BMC17.CO2	3	3	2	3	2	2	-	-	-	-	-	2	3	3	3
19BMC17.CO3	2	3	2	2	2	3	-	-	-	-	-	2	2	3	3
19BMC17.CO4	3	2	2	3	2	3	-	-	-	-	-	2	2	3	2
19BMC17.CO5	3	2	3	3	2	3	-	-	-	-	-	2	2	3	3

1-Low, 2- Medium, 3-High

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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.

TOTAL: 45 HRS

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TEXT BOOKS:

S.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

REFERENCE BOOKS:

S.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	John G. Webster	Medical Instrumentation Application and Design	Wiley India Pvt Ltd, New Delhi	4th edition 2015
2.	Joseph J. Carr John M. Brown	Introduction to Biomedical Equipment Technology	Pearson Education	2004
3.	Paul Suetens	Fundamentals of Medical Imaging	Pearson Education	2009

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COURSE CODE	COURSE TITLE	L	T	P	C
19BMC18	ELECTRICAL SAFETY AND QUALITY ASSURANCE	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

19BMC18.CO1	The purpose of this course is to help students to develop knowledge and insight into the procedures
19BMC18.CO2	Knowledge used in quality control and assurance activities as well as safety measures to be followed in hospitals.
19BMC18.CO3	Electrical safety and different standards Testing and verification of medical devices.
19BMC18.CO4	Safety & precautions Safety aspects in electro surgical systems
19BMC18.CO5	Guidelines on medical devices with the knowledge of Diagnostic Medical Devices Directives

Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC18.CO1	X	X	X	X	X	-	-	-	-	-	-	X	X	X	-
19BMC18.CO2	X	X	X	X	X	-	-	-	-	-	-	X	X	X	-
19BMC18.CO3	X	X	X	X	X	-	-	-	-	-	-	X	X	X	-
19BMC18.CO4	X	X	X	X	X	-	-	-	-	-	-	X	X	X	-
19BMC18.CO5	X	X	X	X	X	-	-	-	-	-	-	X	X	X	-

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC18.CO1	3	3	2	3	3	-	-	-	-	-	-	3	2	2	-
19BMC18.CO2	3	2	3	2	2	-	-	-	-	-	-	3	2	2	-
19BMC18.CO3	3	2	3	3	2	-	-	-	-	-	-	3	3	2	-
19BMC18.CO4	3	3	3	3	2	-	-	-	-	-	-	3	3	3	-
19BMC18.CO5	3	3	2	3	3	-	-	-	-	-	-	2	3	3	-

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UNIT I **CLASSIFICATION OF DEVICE** **9**

Device classes, types in medical field. **PATIENT SAFETY**: Electric shock hazards, Leakage currents, macro shock, micro shock hazards and preventions, safety codes and analyzer. Safety & precautions Safety aspects in electro surgical systems

UNIT II **SAFETY ASPECTS IN MEDICAL IMAGING SYSTEMS** **9**

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

UNIT III **DEFINITION** **9**

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

UNIT IV **STANDARDS AND REGULATIONS BACKGROUND** **9**

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

UNIT V **THE MEDICAL DEVICES DIRECTIVES** **9**

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

TOTAL: 45 HRS

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TEXT BOOKS:

S.No.	Author	Title of book	Publisher	Year of publication
1.	Richard Fries	Reliable Design of Medical Devices	Second Edition by CRC Press	2006
2.	Richard C Fries, CRC Press	Medical Device Quality Assurance and Regulatory Compliance	CRC Press	1998

REFERENCE BOOKS:

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

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COURSE CODE	COURSE TITLE	L	T	P	C
19BMC19	HUMAN ASSIST DEVICES	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

19BMC19.CO1	Describe the principles of various life support equipment for mobility.
19BMC19.CO2	Students will design and system level analysis different human assist equipments
19BMC19.CO3	Comprehend the design human vital organ equipments
19BMC19.CO4	Summarize the implantable various types of cells
19BMC19.CO5	Explain the solutions of different implant parameters

Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC19.CO1	X	X	X	X	X	X	-	-	-	-	-	X	X	X	-
19BMC19.CO2	X	X	X	X	X	X	-	-	-	-	-	X	X	X	-
19BMC19.CO3	X	X	X	X	X	X	-	-	-	-	-	X	X	X	-
19BMC19.CO4	X	X	X	X	X	X	-	-	-	-	-	X	X	X	-
19BMC19.CO5	X	X	X	X	X	X	-	-	-	-	-	X	X	X	-

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC19.CO1	3	3	3	2	3	3	-	-	-	-	-	2	3	3	-
19BMC19.CO2	3	3	3	2	2	2	-	-	-	-	-	2	3	3	-
19BMC19.CO3	3	3	3	2	3	3	-	-	-	-	-	3	3	2	-
19BMC19.CO4	3	2	2	2	3	3	-	-	-	-	-	2	3	3	-
19BMC19.CO5	3	3	3	2	3	3	-	-	-	-	-	2	3	3	-

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UNIT I **ASSISTIVE TECHNOLOGY IN MOBILITY** **9**

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

UNIT II **ASSIST DEVICES AND SENSORY IMPAIRMENTS** **9**

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

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

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

UNIT IV **PRINCIPLES OF IMPLANT DESIGN** **9**

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

UNIT V **IMPLANT DESIGN PARAMETERS AND ITS SOLUTIONS** **9**

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

TOTAL: 45 HRS

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TEXT BOOKS:

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

REFERENCE BOOKS:

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

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

COURSE CODE	COURSE TITLE	L	T	P	C
19BMC20	BIOMEDICAL SENSORS & INSTRUMENTS LABORATORY	0	0	2	1

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

19BMC20.CO1	Understand the characteristics and calibration of various transducers
19BMC20.CO2	Develop bridge circuits to find unknown variables
19BMC20.CO3	Design and analyze filter characteristics
19BMC20.CO4	Understand various read out and display devices
19BMC20.CO5	Design measurement system for various applications

Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC20.CO1	X	X	X	X	X	-	-	X	X	X	X	X	X	X	-
19BMC20.CO2	X	X	X	X	X	-	-	X	X	X	X	X	X	X	-
19BMC20.CO3	X	X	X	X	X	-	-	X	X	X	X	X	X	X	-
19BMC20.CO4	X	X	X	X	X	-	-	X	X	X	X	X	X	X	-
19BMC20.CO5	X	X	X	X	X	-	-	X	X	X	X	X	X	X	-

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC20.CO1	3	3	3	3	3	-	-	2	2	2	2	3	3	3	-
19BMC20.CO2	3	3	3	3	3	-	-	2	2	2	2	3	3	3	-
19BMC20.CO3	3	3	3	3	3	-	-	2	2	2	2	3	3	3	-
19BMC20.CO4	3	3	3	3	3	-	-	2	2	2	2	3	3	3	-
19BMC20.CO5	3	3	3	3	3	-	-	2	2	2	2	3	3	3	-

1-Low, 2- Medium, 3-High

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LIST OF EXPERIMENTS:

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

TOTAL: 30 HRS

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

COURSE CODE	COURSE TITLE	L	T	P	C
19BMC21	DIGITAL ELECTRONICS LABORATORY	0	0	2	1

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

19BMC21.CO1	Apply Boolean algebra, Karnaugh map and Tabulation method for simplification of Boolean expressions
19BMC21.CO2	Design combinational logic circuits for various applications
19BMC21.CO3	Design shift registers, Modulo-N asynchronous and synchronous counters
19BMC21.CO4	Design and analyze state machines for the given specifications
19BMC21.CO5	Discuss different logic families and Implement digital circuit in programmable logic devices

Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC21.CO1	X	X	X	X	X	-	-	-	X	X	X	X	X	X	X
19BMC21.CO2	X	X	X	X	X	-	-	-	X	X	X	X	X	X	X
19BMC21.CO3	X	X	X	X	X	-	-	-	X	X	X	X	X	X	X
19BMC21.CO4	X	X	X	X	X	-	-	-	X	X	X	X	X	X	X
19BMC21.CO5	X	X	X	X	X	-	-	-	X	X	X	X	X	X	X

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC21.CO1	3	3	3	3	3	-	-	-	2	2	2	3	3	3	3
19BMC21.CO2	3	3	3	3	3	-	-	-	2	2	2	3	3	3	3
19BMC21.CO3	3	3	3	3	3	-	-	-	2	2	2	3	3	3	3
19BMC21.CO4	3	3	3	3	3	-	-	-	2	2	2	3	3	3	3
19BMC21.CO5	3	3	3	3	3	-	-	-	2	2	2	3	3	3	3

1-Low, 2- Medium, 3-High

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LIST OF EXPERIMENTS:

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

TOTAL: 30 HRS

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

COURSE CODE	COURSE TITLE	L	T	P	C
19BMC22	ANALOG ELECTRONICS LABORATORY	0	0	2	1

COURSE OBJECTIVES:

- Study the Frequency response of CE, CB and CC Amplifier
- Learn the frequency response of CS Amplifiers
- Study the Transfer characteristics of differential amplifier

COURSE OUTCOMES:

19BMC22.CO1	Design and Test rectifiers, filters and regulated power supplies.
19BMC22.CO2	Design and Test BJT/JFET amplifiers.
19BMC22.CO3	Differentiate cascode and cascade amplifiers.
19BMC22.CO4	Analyze the limitation in bandwidth of single stage and multi stage amplifier
19BMC22.CO5	Design and Test the digital logic circuits.

Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC22.CO1	X	X	X	X	X	-	-	X	X	X	X	X	X	X	-
19BMC22.CO2	X	X	X	X	X	-	-	X	X	X	X	X	X	X	-
19BMC22.CO3	X	X	X	X	X	-	-	X	X	X	X	X	X	X	-
19BMC22.CO4	X	X	X	X	X	-	-	X	X	X	X	X	X	X	-
19BMC22.CO5	X	X	X	X	X	-	-	X	X	X	X	X	X	X	-

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC22.CO1	3	3	3	3	3	-	-	2	2	2	2	3	3	3	-
19BMC22.CO2	3	3	3	3	3	-	-	2	2	2	2	3	3	3	-
19BMC22.CO3	3	3	3	3	3	-	-	2	2	2	2	3	3	3	-
19BMC22.CO4	3	3	3	3	3	-	-	2	2	2	2	3	3	3	-
19BMC22.CO5	3	3	3	3	3	-	-	2	2	2	2	3	3	3	-

1-Low, 2- Medium, 3-High

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LIST OF EXPERIMENTS:

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

TOTAL: 30 HRS

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

COURSE CODE	COURSE TITLE	L	T	P	C
19BMC23	LINEAR INTEGRATED CIRCUITS LABORATORY	0	0	2	1

COURSE OBJECTIVES:

- To expose the students to linear and integrated circuits
- To understand the basics of linear integrated circuits and available ICs
- To understand characteristics of operational amplifier

COURSE OUTCOMES:

19BMC23.CO1	Design oscillators and amplifiers using operational amplifiers.
19BMC23.CO2	Design filters using Opamp and perform experiment on frequency response.
19BMC23.CO3	Analyze the working of PLL and use PLL as frequency multiplier.
19BMC23.CO4	Design DC power supply using ICs.
19BMC23.CO5	Acquire knowledge in using SPICE

Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC23.CO1	X	X	X	X	X	-	-	-	X	X	X	X	X	X	-
19BMC23.CO2	X	X	X	X	X	-	-	-	X	X	X	X	X	X	-
19BMC23.CO3	X	X	X	X	X	-	-	-	X	X	X	X	X	X	-
19BMC23.CO4	X	X	X	X	X	-	-	-	X	X	X	X	X	X	-
19BMC23.CO5	X	X	X	X	X	-	-	-	X	X	X	X	X	X	-

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC23.CO1	3	3	3	3	3	-	-	-	2	2	2	3	3	3	-
19BMC23.CO2	3	3	3	3	3	-	-	-	2	2	2	3	3	3	-
19BMC23.CO3	3	3	3	3	3	-	-	-	2	2	2	3	3	3	-
19BMC23.CO4	3	3	3	3	3	-	-	-	2	2	2	3	3	3	-
19BMC23.CO5	3	3	3	3	3	-	-	-	2	2	2	3	3	3	-

1-Low, 2- Medium, 3-High

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LIST OF EXPERIMENTS:

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

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

COURSE CODE	COURSE TITLE	L	T	P	C
19BMC24	MEDICAL SIGNAL PROCESSING LABORATORY	0	0	2	1

COURSE OBJECTIVES:

- To implement generation of sequences
- To realize linear and circular convolution
- To design and realize FIR and IIR filters
- To implement signal processing algorithms

COURSE OUTCOMES:

19BMC24.CO1	Ability to comprehend and appreciate the significance and role of this course
19BMC24.CO2	Carry out simulation of DSP systems
19BMC24.CO3	Demonstrate towards DSP processor and its implementation
19BMC24.CO4	Analyze finite word length effect on DSP systems
19BMC24.CO5	Analyze various biomedical signals using DSP

Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC24.CO1	X	X	X	X	X	X	X	-	X	X	X	X	X	X	X
19BMC24.CO2	X	X	X	X	X	X	X	-	X	X	X	X	X	X	X
19BMC24.CO3	X	X	X	X	X	X	X	-	X	X	X	X	X	X	X
19BMC24.CO4	X	X	X	X	X	X	X	-	X	X	X	X	X	X	X
19BMC24.CO5	X	X	X	X	X	X	X	-	X	X	X	X	X	X	X

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC24.CO1	3	3	3	3	3	3	3	-	2	2	2	3	3	3	3
19BMC24.CO2	3	3	3	3	3	3	3	-	2	2	2	3	3	3	3
19BMC24.CO3	3	3	3	3	3	3	3	-	2	2	2	3	3	3	3
19BMC24.CO4	3	3	3	3	3	3	3	-	2	2	2	3	3	3	3
19BMC24.CO5	3	3	3	3	3	3	3	-	2	2	2	3	3	3	3

1-Low, 2- Medium, 3-High

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LIST OF EXPERIMENTS:

1. Representation of basic discrete time signals
2. Computation of convolution linear convolution
3. Response of difference equation to stability
4. DFT and FFT
5. FIR filter design
6. IIR filter design
7. Analysis of ECG signal
8. Analysis of EMG signal
9. Analysis of EEG signal

TOTAL: 30 HRS

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

COURSE CODE	COURSE TITLE	L	T	P	C
19BMC25	PATHOLOGY & MICROBIOLOGY LABORATORY	0	0	2	1

COURSE OBJECTIVES:

- Use Compound microscope
- Practice on chemical examinations, Cryoprocessing, Histopathological examinations etc

COURSE OUTCOMES:

19BMC25.CO1	Perform practical experiments on tissue processing
19BMC25.CO2	Perform practical experiments on cryoprocessing,
19BMC25.CO3	Perform practical experiments on staining Processes
19BMC25.CO4	Perform practical experiments on Histopathological examinations
19BMC25.CO5	Perform practical experiments on using Compound microscope

Mapping of Cos with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC25.CO1	X	X	X	-	-	-	-	X	X	X	X	X	X	-	-
19BMC25.CO2	X	X	X	-	-	-	-	X	X	X	X	X	X	-	-
19BMC25.CO3	X	X	X	-	-	-	-	X	X	X	X	X	X	-	-
19BMC25.CO4	X	X	X	-	-	-	-	X	X	X	X	X	X	-	-
19BMC25.CO5	X	X	X	-	-	-	-	X	X	X	X	X	X	-	-

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC25.CO1	3	3	3	-	-	-	-	2	2	2	2	3	3	-	-
19BMC25.CO2	3	3	3	-	-	-	-	2	2	2	2	3	3	-	-
19BMC25.CO3	3	3	3	-	-	-	-	2	2	2	2	3	3	-	-
19BMC25.CO4	3	3	3	-	-	-	-	2	2	2	2	3	3	-	-
19BMC25.CO5	3	3	3	-	-	-	-	2	2	2	2	3	3	-	-

1-Low, 2- Medium, 3-High

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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)
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

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

COURSE CODE	COURSE TITLE	L	T	P	C
19BMC26	BIOMEDICAL INSTRUMENTATION LABORATORY	0	0	2	1

COURSE OBJECTIVES:

To provide hands-on training on design of bio signal acquisition system and measurement of physiological parameters and biochemical parameters.

COURSE OUTCOMES:

19BMC26.CO1	Measure Various Non-Electrical Parameters Using Suitable Transducers
19BMC26.CO2	Design Preamplifiers And Amplifiers For Various Bio Signal Recordings.
19BMC26.CO3	Measure Various Non-Electrical Parameters Using Suitable Sensors
19BMC26.CO4	Design PCB Layout for any Bio Amplifier.
19BMC26.CO5	Interpret Electrical Safety Measurements.

Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC26.CO1	X	X	X	X	X	X	-	-	X	X	X	X	X	X	-
19BMC26.CO2	X	X	X	X	X	X	-	-	X	X	X	X	X	X	-
19BMC26.CO3	X	X	X	X	X	X	-	-	X	X	X	X	X	X	-
19BMC26.CO4	X	X	X	X	X	X	-	-	X	X	X	X	X	X	-
19BMC26.CO5	X	X	X	X	X	X	-	-	X	X	X	X	X	X	-

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC26.CO1	3	3	3	3	3	3	-	-	2	2	2	3	3	3	-
19BMC26.CO2	3	3	3	3	3	3	-	-	2	2	2	3	3	3	-
19BMC26.CO3	3	3	3	3	3	3	-	-	2	2	2	3	3	3	-
19BMC26.CO4	3	3	3	3	3	3	-	-	2	2	2	3	3	3	-
19BMC26.CO5	3	3	3	3	3	3	-	-	2	2	2	3	3	3	-

1-Low, 2- Medium, 3-High

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LIST OF EXPERIMENTS:

1. Simulation of ECG – detection of QRS complex and heart rate
2. Study of biotelemetry
3. Electrical safety measurements.
4. Measurement of Respiratory parameters using spirometry.
5. Study of medical stimulator.
6. Study of ESU – cutting and coagulation modes
7. Recording of Audiogram
8. Measurement of Hearing threshold using Audiometer and plot its characteristics.
9. Design of ECG, EEG,EMG amplifier, recording and analysis using Lab View

TOTAL: 30 HRS

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

COURSE CODE	COURSE TITLE	L	T	P	C
19BMC27	PATHOLOGY AND MICROBIOLOGY	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

19BMC27.CO1	Analyze structural and functional aspects of living organisms.
19BMC27.CO2	Explain the function of microscope
19BMC27.CO3	Discuss the importance of public health.
19BMC27.CO4	Describe methods involved in treating the pathological diseases.
19BMC27.CO5	Able to know study Antibodies and its types

Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC27.CO1	X	X	X	-	-	-	-	-	-	-	-	X	X	-	-
19BMC27.CO2	X	X	X	-	-	-	-	-	-	-	-	X	X	-	-
19BMC27.CO3	X	X	X	-	-	-	-	-	-	-	-	X	X	-	-
19BMC27.CO4	X	X	X	-	-	-	-	-	-	-	-	X	X	-	-
19BMC27.CO5	X	X	X	-	-	-	-	-	-	-	-	X	X	-	-

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC27.CO1	2	2	2	-	-	-	-	-	-	-	-	2	2	-	-
19BMC27.CO2	3	2	2	-	-	-	-	-	-	-	-	2	2	-	-
19BMC27.CO3	2	2	2	-	-	-	-	-	-	-	-	2	2	-	-
19BMC27.CO4	2	3	2	-	-	-	-	-	-	-	-	2	2	-	-
19BMC27.CO5	3	2	3	-	-	-	-	-	-	-	-	2	2	-	-

1-Low, 2- Medium, 3-High

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UNIT I **CELL DEGENERATION, REPAIR AND NEOPLASIA** **9**

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

UNIT II **FLUID AND HEMODYNAMIC DERANGEMENTS** **9**

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

UNIT III **MICROBIOLOGY** **9**

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

UNIT IV **MICROSCOPES** **9**

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

UNIT V **IMMUNOPATHOLOGY** **9**

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

TOTAL : 45

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TEXT BOOKS:

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

REFERENCE BOOKS:

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

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

COURSE CODE	COURSE TITLE	L	T	P	C
19BMC28	EMBEDDED SYSTEMS LABORATORY	0	0	2	1

COURSE OBJECTIVES:

- Learn the architecture and programming of ARM processor
- Be exposed to the basic concepts of embedded programming
- Learn the real time operating systems

COURSSE OUTCOMES:

19BMC28.CO1	Interface peripherals, sensors and displays
19BMC28.CO2	Interface ADC and DAC in embedded system
19BMC28.CO3	Design, develop, and troubleshooting in embedded system
19BMC28.CO4	Be exposed to the basic concepts of embedded programming
19BMC28.CO5	Learn the real time operating systems

Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC28.CO1	X	X	X	X	X	X	-	-	X	X	X	X	X	X	-
19BMC28.CO2	X	X	X	X	X	X	-	-	X	X	X	X	X	X	-
19BMC28.CO3	X	X	X	X	X	X	-	-	X	X	X	X	X	X	-
19BMC28.CO4	X	X	X	X	X	X	-	-	X	X	X	X	X	X	-
19BMC28.CO5	X	X	X	X	X	X	-	-	X	X	X	X	X	X	-

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC28.CO1	3	3	3	3	3	3	-	-	2	2	2	3	3	3	-
19BMC28.CO2	3	3	3	3	3	3	-	-	2	2	2	3	3	3	-
19BMC28.CO3	3	3	3	3	3	3	-	-	2	2	2	3	3	3	-
19BMC28.CO4	3	3	3	3	3	3	-	-	2	2	2	3	3	3	-
19BMC28.CO5	3	3	3	3	3	3	-	-	2	2	2	3	3	3	-

1-Low, 2- Medium, 3-High

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LIST OF EXPERIMENTS:

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

TOTAL: 30 HRS

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COURSE CODE	COURSE TITLE	L	T	P	C
19BMC29	BIO-MATERIALS AND ARTIFICIAL ORGANS	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

19BMC29.CO1	Analyze different types of Biomaterials and its classification.
19BMC29.CO2	Understand different metals and ceramics used as biomaterials.
19BMC29.CO3	Learn about the polymeric materials and combinations.
19BMC29.CO4	Perform combinations of materials that could be used as a tissue replacement implant.
19BMC29.CO5	Know about the artificial organ development.

Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC29.CO1	X	X	X	X	X	-	-	-	-	-	-	X	X	X	X
19BMC29.CO2	X	X	X	X	X	-	-	-	-	-	-	X	X	X	X
19BMC29.CO3	X	X	X	X	X	-	-	-	-	-	-	X	X	X	X
19BMC29.CO4	X	X	X	X	X	-	-	-	-	-	-	X	X	X	X
19BMC29.CO5	X	X	X	X	X	-	-	-	-	-	-	X	X	X	X

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC29.CO1	3	3	3	2	3	-	-	-	-	-	-	3	3	2	2
19BMC29.CO2	3	3	3	2	3	-	-	-	-	-	-	3	3	2	2
19BMC29.CO3	3	2	3	2	3	-	-	-	-	-	-	3	3	2	2
19BMC29.CO4	3	2	3	2	2	-	-	-	-	-	-	3	3	3	2
19BMC29.CO5	3	3	3	2	3	-	-	-	-	-	-	3	3	2	2

1-Low, 2- Medium, 3-High

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

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

UNIT II **IMPLANT MATERIALS** **9**

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

UNIT III **POLYMERIC MATERIALS** **9**

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

UNIT IV **TISSUE REPLACEMENT MATERIALS** **9**

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

UNIT V **ARTIFICIAL ORGANS** **9**

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

Total: 45 Hrs

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TEXT BOOKS:

S.No.	Author	Title of Book	Publisher	Year of Publication
1.	Sujata V. Bhatt	Biomaterials Second Edition	Narosa Publishing House	2005
2.	JoonB.Park Joseph D. Bronzino	Biomaterials - Principles and Applications	CRC Press	2003

REFERENCE BOOKS:

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

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

COURSE CODE	COURSE TITLE	L	T	P	C
19BMC30	MICROPROCESSOR & MICROCONTROLLERS LABORATORY	0	0	2	1

COURSE OBJECTIVES:

- To Introduce ALP concepts, features and Coding methods
- Write ALP for arithmetic and logical operations in 8086 and 8051
- Differentiate Serial and Parallel Interface
- Interface different I/Os with Microprocessors

COURSE OUTCOMES:

19BMC30.CO1	Write ALP Programmes for fixed and Floating Point and Arithmetic operations
19BMC30.CO2	Interface different I/Os with processor
19BMC30.CO3	Generate waveforms using Microprocessors
19BMC30.CO4	Execute Programs in 8051
19BMC30.CO5	Explain the difference between simulator and Emulator

Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC30.CO1	X	X	X	X	X	X	-	X	X	X	X	X	X	X	-
19BMC30.CO2	X	X	X	X	X	X	-	X	X	X	X	X	X	X	-
19BMC30.CO3	X	X	X	X	X	X	-	X	X	X	X	X	X	X	-
19BMC30.CO4	X	X	X	,X	X	X	-	X	X	X	X	X	X	X	-
19BMC30.CO5	X	X	X	X	X	X	-	X	X	X	X	X	X	X	-

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMC30.CO1	3	3	3	3	3	3	-	2	2	2	2	3	3	3	-
19BMC30.CO2	3	3	3	3	3	3	-	2	2	2	2	3	3	3	-
19BMC30.CO3	3	3	3	3	3	3	-	2	2	2	2	3	3	3	-
19BMC30.CO4	3	3	3	3	3	3	-	2	2	2	2	3	3	3	-
19BMC30.CO5	3	3	3	3	3	3	-	2	2	2	2	3	3	3	-

1-Low, 2- Medium, 3-High

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LIST OF EXPERIMENTS:

1. Addition, subtraction, multiplication, division using 8086 processor
2. Sorting of numbers in ascending order using 8086 processor
3. Sorting of numbers in descending order using 8086 processor
4. Palindrome and Fibonacci series using 8086 processor
5. Sorting of even numbers in an array using 8086 processor
6. Finding the largest and smallest number in an array using 8086 processor
7. Addition of two numbers using 8051 processor
8. Subtraction of two numbers using 8051 processor
9. Multiplication of two numbers using 8051 processor
10. Sorting of numbers in ascending order using 8051 processor
11. Sorting of numbers in descending order using 8051 processor
12. Palindrome and Fibonacci series using 8051 processor
13. Sorting of even numbers in an array using 8051 processor
14. Basic programs using ARM controller

TOTAL: 30 HRS

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Professional Elective Courses

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

COURSE CODE	COURSE TITLE	L	T	P	C
19BME01	ADVANCED BIO ANALYTICAL & THERAPEUTIC TECHNOLOGY	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

19BME01.CO1	Idea about the imaging techniques in microscopy.
19BME01.CO2	Types of techniques in advanced bio analytical.
19BME01.CO3	Know about the types of special techniques.
19BME01.CO4	Knowledge about the types of respiratory aids.
19BME01.CO5	Know about the radiation & safety of radiation.

Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BME01.CO1	X	X	X	X	X	-	-	-	-	-	-	X	X	X	X
19BME01.CO2	X	X	X	X	X	-	-	-	-	-	-	X	X	X	X
19BME01.CO3	X	X	X	X	X	-	-	-	-	-	-	X	X	X	X
19BME01.CO4	X	X	X	X	X	-	-	-	-	-	-	X	X	X	X
19BME01.CO5	X	X	X	X	X	-	-	-	-	-	-	X	X	X	X

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BME01.CO1	3	3	3	2	3	-	-	-	-	-	-	3	3	2	2
19BME01.CO2	3	3	3	2	3	-	-	-	-	-	-	3	3	2	2
19BME01.CO3	3	2	3	2	3	-	-	-	-	-	-	3	3	2	2
19BME01.CO4	3	2	3	2	2	-	-	-	-	-	-	3	3	3	2
19BME01.CO5	3	3	3	2	3	-	-	-	-	-	-	3	3	2	2

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UNIT I ADVANCED IMAGING TECHNIQUES IN MICROSCOPY 9

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

UNIT-II ANALYTICAL HYBRID TECHNIQUES 9

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

UNIT III ANALYTICAL SPECIAL TECHNIQUES 9

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

UNIT IV RESPIRATORY AIDS 9

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

UNIT V RADIATION THERAPY AND RADIATION SAFETY 9

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

Total: 45 Hrs

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TEXT BOOKS:

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

REFERENCE BOOKS:

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

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COURSE CODE	COURSE TITLE	L	T	P	C
19BME02	BIO SIGNAL PROCESSING	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

19BME02.CO1	Choose filter for the ECG analysis.
19BME02.CO2	Write the types of algorithm for data compression.
19BME02.CO3	Idea about processing the ECG signal and their estimations.
19BME02.CO4	Study about EEG and their parameters.
19BME02.CO5	Study about the sleeping modes of EEG

Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BME02.CO1	X	X	X	-	X	X	-	-	X	-	-	X	X	-	X
19BME02.CO2	X	X	X	-	X	X	-	-	X	-	-	X	X	-	X
19BME02.CO3	X	X	X	-	X	X	-	-	X	-	-	X	X	-	X
19BME02.CO4	X	X	X	-	X	X	-	-	X	-	-	X	X	-	X
19BME02.CO5	X	X	X	-	X	X	-	-	X	-	-	X	X	-	X

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BME02.CO1	2	2	3	-	3	2	-	-	2	-	-	2	3	-	2
19BME02.CO2	2	2	3	-	3	2	-	-	2	-	-	2	3	-	3
19BME02.CO3	2	2	3	-	3	2	-	-	2	-	-	2	3	-	2
19BME02.CO4	2	2	3	-	3	2	-	-	2	-	-	2	3	-	3
19BME02.CO5	2	2	3	-	3	2	-	-	2	-	-	2	3	-	3

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UNIT I **ADAPTIVE FILTERS** **9**

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

UNIT II **DATA COMPRESSION TECHNIQUES** **9**

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

UNIT III **CARDIO-LOGICAL SIGNAL PROCESSING** **9**

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

UNIT IV **NEUROLOGICAL SIGNAL PROCESSING** **9**

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

UNIT V **SLEEP EEG** **9**

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

TOTAL: 45 HRS

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TEXTBOOKS:

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

REFERENCE BOOKS:

S.No.	Author	Title of Book	Publisher	Year of Publication
1.	Willis J.Tompkins	Biomedical Digital Signal Processing	PHI	1993
2.	Akay.M	Biomedical Signal Processing	Academic: Press	1994

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COURSE CODE	COURSE TITLE	L	T	P	C
19BME03	INTERNET OF THINGS	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

19BME03.CO1	Explain the concept of IoT.
19BME03.CO2	Analyze various protocols for IoT.
19BME03.CO3	Design a PoC of an IoT system using Rasperry Pi/Arduino
19BME03.CO4	Apply data analytics and use cloud offerings related to IoT.
19BME03.CO5	Analyze applications of IoT in real time scenario

Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BME03.CO1	X	X	X	-	X	X	-	-	X	-	-	X	X	-	X
19BME03.CO2	X	X	X	-	X	X	-	-	X	-	-	X	X	-	X
19BME03.CO3	X	X	X	-	X	X	-	-	X	-	-	X	X	-	X
19BME03.CO4	X	X	X	-	X	X	-	-	X	-	-	X	X	-	X
19BME03.CO5	X	X	X	-	X	X	-	-	X	-	-	X	X	-	X

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BME03.CO1	2	2	3	-	3	2	-	-	2	-	-	2	3	-	2
19BME03.CO2	2	2	3	-	3	2	-	-	2	-	-	2	3	-	3
19BME03.CO3	2	2	3	-	3	2	-	-	2	-	-	2	3	-	2
19BME03.CO4	2	2	3	-	3	2	-	-	2	-	-	2	3	-	3
19BME03.CO5	2	2	3	-	3	2	-	-	2	-	-	2	3	-	3

1-Low, 2- Medium, 3-High

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UNIT I **FUNDAMENTALS OF IoT** **9**

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

UNIT II **IoT PROTOCOLS** **9**

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

UNIT III **DESIGN AND DEVELOPMENT** **9**

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

UNIT IV **DATA ANALYTICS AND SUPPORTING SERVICES** **9**

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

UNIT V **CASE STUDIES/INDUSTRIAL APPLICATIONS** **9**

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

TOTAL: 45 HRS

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TEXT BOOKS:

S.No.	Author	Title of Book	Publisher	Year of Publication
1.	David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry	IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things	Cisco Press	2017
2.	Maciej Kranz	Building the Internet of Things: Implement New Business Models, Disrupt	John Wiley & Sons	Latest Edition

REFERENCE BOOKS:

S.No.	Author	Title of Book	Publisher	Year of Publication
1.	Arshdeep Bahga, Vijay Madisetti	Internet of Things – A hands-on approach	Universities Press	2015
2.	Olivier Hersent, David Boswarthick, Omar Elloumi	The Internet of Things – Key applications and Protocols	Wiley, (for Unit 2).	2012
3.	Jan Ho¨ ller, Vlasios Tsiatsis , Catherine Mulligan, Stamatis , Karnouskos, Stefan Avesand. David Boyle	From Machine-to-Machine to the Internet of Things - Introduction to a New Age of Intelligence	Elsevier	2014
4.	Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds),	Architecting the Internet of Things	Springer	2011
5.	Michael Margolis, Arduino Cookbook, Recipes to Begin	Expand, and Enhance Your Projects	O'Reilly Media, 2 nd Edition,	2011

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

COURSE CODE	COURSE TITLE	L	T	P	C
19BME04	BIO MEDICAL ENGINEERING	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

19BME04.C01	Basic knowledge on Human physiology and components of biomedical system
19BME04.C02	Exposure to electro physiological parameter measurements
19BME04.C03	Exposure to non - electro physiological parameter measurements
19BME04.C04	Knowledge of medical imaging and biotelemetry systems
19BME04.C05	Description on the principles of operation of Therapeutic equipments

Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BME04.C01	X	X	X	X	X	X	-	-	-	-	-	X	X	-	X
19BME04.C02	X	X	X	X	X	X	-	-	-	-	-	X	X	-	X
19BME04.C03	X	X	X	X	X	X	-	-	-	-	-	X	X	-	X
19BME04.C04	X	X	X	X	X	X	-	-	-	-	-	X	X	-	X
19BME04.C05	X	X	X	X	X	X	-	-	-	-	-	X	X	-	X

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BME04.C01	2	2	3	2	3	2	-	-	-	-	-	2	3	-	2
19BME04.C02	2	2	3	2	3	2	-	-	-	-	-	2	3	-	3
19BME04.C03	2	2	3	2	3	2	-	-	-	-	-	2	3	-	2
19BME04.C04	2	2	3	2	3	2	-	-	-	-	-	2	3	-	3
19BME04.C05	2	2	3	2	3	2	-	-	-	-	-	2	3	-	3

1-Low, 2- Medium, 3-High

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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 pCO2, pO2, 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.

Total:45 Hrs

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TEXT BOOKS:

S.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	R.S.Khandpur	Hand Book of Bio-Medical instrumentation	Tata McGraw Hill Publishing Co Ltd	2004
2.	Leslie Cromwell, Fred J.Weibell, Erich A.Pfeiffer	Bio-Medical Instrumentation and Measurements	Pearson Education	2nd edition, 2002

REFERENCE BOOKS:

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

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COURSE CODE	COURSE TITLE	L	T	P	C
19BME05	BIOMATERIALS & CHARACTERIZATION	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

19BME05.C01	Know the basic knowledge of biomaterials.
19BME05.C02	Identify significant gap required to overcome challenges and further development in metallic and ceramic materials
19BME05.C03	Identify significant gap required to overcome challenges and further development in polymeric materials
19BME05.C04	Create combinations of materials that could be used as a tissue replacement implant.
19BME05.C05	Understand the testing standards applied for biomaterials

Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BME05.C01	X	X	X	-	X	X	-	-	X	-	-	X	X	-	X
19BME05.C02	X	X	X	-	X	X	-	-	X	-	-	X	X	-	X
19BME05.C03	X	X	X	-	X	X	-	-	X	-	-	X	X	-	X
19BME05.C04	X	X	X	-	X	X	-	-	X	-	-	X	X	-	X
19BME05.C05	X	X	X	-	X	X	-	-	X	-	-	X	X	-	X

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BME05.C01	2	2	3	-	3	2	-	-	2	-	-	2	3	-	2
19BME05.C02	2	2	3	-	3	2	-	-	2	-	-	2	3	-	3
19BME05.C03	2	2	3	-	3	2	-	-	2	-	-	2	3	-	2
19BME05.C04	2	2	3	-	3	2	-	-	2	-	-	2	3	-	3
19BME05.C05	2	2	3	-	3	2	-	-	2	-	-	2	3	-	3

1-Low, 2- Medium, 3-High

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UNIT I **INTRODUCTION TO BIO-MATERIALS** **9**

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

UNIT II **POLYMER AND PLASTICS** **9**

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

UNIT III **METALLIC AND CERAMIC BIOMATERIALS** **9**

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

UNIT IV **CARBON AND POLYMERIC BIOMATERIALS** **9**

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

UNIT V **IMPLANTS** **9**

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

Total: 45 Hrs

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TEXT BOOKS:

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

REFERENCE BOOKS:

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

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COURSE CODE	COURSE TITLE	L	T	P	C
19BME06	BODY AREA NETWORKS	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

19BME06.CO1	Explain about working of Body Area Network.
19BME06.CO2	Know the types of hardwares.
19BME06.CO3	Knowledge about the BAN communication.
19BME06.CO4	Analysis about the issues in BAN.
19BME06.CO5	Discuss the applications of BAN.

Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BME06.CO1	X	X	X	X	X	X	-	-	-	-	-	X	X	-	X
19BME06.CO2	X	X	X	X	X	X	-	-	-	-	-	X	X	-	X
19BME06.CO3	X	X	X	X	X	X	-	-	-	-	-	X	X	-	X
19BME06.CO4	X	X	X	X	X	X	-	-	-	-	-	X	X	-	X
19BME06.CO5	X	X	X	X	X	X	-	-	-	-	-	X	X	-	X

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BME06.CO1	2	2	3	2	3	2	-	-	-	-	-	2	3	-	2
19BME06.CO2	2	2	3	2	3	2	-	-	-	-	-	2	3	-	3
19BME06.CO3	2	2	3	2	3	2	-	-	-	-	-	2	3	-	2
19BME06.CO4	2	2	3	2	3	2	-	-	-	-	-	2	3	-	3
19BME06.CO5	2	2	3	2	3	2	-	-	-	-	-	2	3	-	3

1-Low, 2- Medium, 3-High

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UNIT I **INTRODUCTION** **9**

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

UNIT II **HARDWARE FOR BAN** **9**

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

UNIT III **WIRELESS COMMUNICATION AND NETWORK PROTOCOLS** **9**

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

UNIT IV **COEXISTENCE ISSUES WITH BAN** **9**

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

UNIT V **APPLICATIONS OF BAN** **9**

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

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TEXT BOOKS:

S.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, KrishnaKumar Venkatasubramanian	Body Area Networks Safety, Security and Sustainability	Cambridge University Press	2013

REFERENCE BOOKS:

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

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COURSE CODE	COURSE TITLE	L	T	P	C
19BME07	BRAIN COMPUTER INTERFACE AND APPLICATIONS	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

19BME07.CO1	Equips the students with the knowledge of Brain Organization, Anatomy, and Function.
19BME07.CO2	Analyze and process the brain signals for artifact reduction.
19BME07.CO3	Understand types of BCI, in the Neurosciences domain.
19BME07.CO4	Understand the principles and its applications in the Neurosciences domain.
19BME07.CO5	Ability to have the ideas of human assist device with Medical Applications

Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BME07.CO1	X	X	X	-	X	X	-	-	X	-	-	X	X	-	X
19BME07.CO2	X	X	X	-	X	X	-	-	X	-	-	X	X	-	X
19BME07.CO3	X	X	X	-	X	X	-	-	X	-	-	X	X	-	X
19BME07.CO4	X	X	X	-	X	X	-	-	X	-	-	X	X	-	X
19BME07.CO5	X	X	X	-	X	X	-	-	X	-	-	X	X	-	X

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BME07.CO1	2	2	3	-	3	2	-	-	2	-	-	2	3	-	2
19BME07.CO2	2	2	3	-	3	2	-	-	2	-	-	2	3	-	3
19BME07.CO3	2	2	3	-	3	2	-	-	2	-	-	2	3	-	2
19BME07.CO4	2	2	3	-	3	2	-	-	2	-	-	2	3	-	3
19BME07.CO5	2	2	3	-	3	2	-	-	2	-	-	2	3	-	3

1-Low, 2- Medium, 3-High

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UNIT I **BASIC NEUROSCIENCES** **9**

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

UNIT II **SIGNAL PROCESSING FOR BCIs** **9**

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

UNIT III **BUILDING BCI** **9**

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

UNIT IV **INVASIVE BCIS IN HUMANS** **9**

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

UNIT V **MEDICAL APPLICATIONS** **9**

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

TOTAL: 45 HRS

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TEXT BOOKS:

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

REFERENCE BOOKS:

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

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COURSE CODE	COURSE TITLE	L	T	P	C
19BME08	MEDICAL OPTICS	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

19BME08.CO1	Demonstrate knowledge of the fundamentals of optical properties of tissues
19BME08.CO2	Analyze the components of instrumentation in Medical Photonics and Configurations
19BME08.CO3	Describe surgical applications of lasers.
19BME08.CO4	Describe photonics and its diagnostic applications.
19BME08.CO5	Investigate emerging techniques in medical optics

Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BME08.CO1	X	X	X	X	X	-	-	-	-	-	-	X	X	X	-
19BME08.CO2	X	X	X	X	X	-	-	-	-	-	-	X	X	X	-
19BME08.CO3	X	X	X	X	X	-	-	-	-	-	-	X	X	X	-
19BME08.CO4	X	X	X	X	X	-	-	-	-	-	-	X	X	X	-
19BME08.CO5	X	X	X	X	X	-	-	-	-	-	-	X	X	X	-

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BME08.CO1	3	2	3	2	3	-	-	-	-	-	-	2	2	2	-
19BME08.CO2	3	3	2	2	2	-	-	-	-	-	-	2	3	2	-
19BME08.CO3	2	3	3	2	3	-	-	-	-	-	-	2	2	3	-
19BME08.CO4	3	2	3	2	3	-	-	-	-	-	-	2	3	2	-
19BME08.CO5	3	3	3	2	3	-	-	-	-	-	-	2	2	2	-

1-Low, 2- Medium, 3-High

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UNIT I **OPTICAL PROPERTIES OF THE TISSUES** **9**

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

UNIT II **INSTRUMENTATION IN PHOTONICS** **9**

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

UNIT III **SURGICAL THERAPEUTIC APPLICATIONS OF LASERS** **9**

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

UNIT IV **NON THERMAL DIAGNOSTIC APPLICATIONS** **9**

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

UNIT V **DIAGNOSTIC AND THERAPEUTIC TECHNIQUES** **9**

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

TOTAL: 45HRS

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TEXT BOOKS:

S.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

REFERENCE BOOKS:

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

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COURSE CODE	COURSE TITLE	L	T	P	C
19BME09	SOFT COMPUTING	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

19BME09.CO1	Describe basics of ANN and its learning algorithms
19BME09.CO2	Develop various Fuzzy Models
19BME09.CO3	Explain the terminologies associated to Genetic algorithms
19BME09.CO4	Develop a hybrid Computing Techniques
19BME09.CO5	Apply the concepts to solve real time problems

Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BME09.CO1	X	X	X	-	-	X	-	-	X	X	-	X	X	-	X
19BME09.CO2	X	X	X	-	-	X	-	-	X	X	-	X	X	-	X
19BME09.CO3	X	X	X	-	-	X	-	-	X	X	-	X	X	-	X
19BME09.CO4	X	X	X	-	-	X	-	-	X	X	-	X	X	-	X
19BME09.CO5	X	X	X	-	-	X	-	-	X	X	-	X	X	-	X

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BME09.CO1	3	2	3	-	-	2	-	-	2	2	-	2	3	-	2
19BME09.CO2	3	2	3	-	-	3	-	-	2	2	-	2	3	-	2
19BME09.CO3	3	2	3	-	-	2	-	-	2	2	-	2	3	-	2
19BME09.CO4	3	2	3	-	-	3	-	-	2	2	-	2	3	-	2
19BME09.CO5	3	2	3	-	-	3	-	-	3	2	-	2	3	-	2

1-Low, 2- Medium, 3-High

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UNIT I **NEURAL NETWORKS** **9**

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

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

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

UNIT III **GENETIC ALGORITHMS** **9**

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

UNIT IV **HYBRID SOFT COMPUTING TECHNIQUES** **9**

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

UNIT V **PROGRAMMING AND APPLICATIONS** **9**

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

Total: 45 Hrs

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TEXT BOOKS:

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

REFERENCE BOOKS:

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

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COURSE CODE	COURSE TITLE	L	T	P	C
19BME10	NEURAL ENGINEERING	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

19BME10.CO1	Understand the physiology behind generation of nerve impulses.
19BME10.CO2	Describe various techniques that are used to evaluate the functioning of central and peripheral nervous system Explain the fundamentals of bio-solid mechanics.
19BME10.CO3	Differentiate between a normal and abnormal signal coming from a healthy and a diseased nervous system respectively.
19BME10.CO4	Elaborate the methods of evoked potential.
19BME10.CO5	Describe the functions of neuroimaging and cognitive aging.

Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BME10.CO1	X	X	X	-	-	X	-	-	X	X	-	X	X	-	X
19BME10.CO2	X	X	X	-	-	X	-	-	X	X	-	X	X	-	X
19BME10.CO3	X	X	X	-	-	X	-	-	X	X	-	X	X	-	X
19BME10.CO4	X	X	X	-	-	X	-	-	X	X	-	X	X	-	X
19BME10.CO5	X	X	X	-	-	X	-	-	X	X	-	X	X	-	X

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BME10.CO1	3	2	3	-	-	2	-	-	2	2	-	2	3	-	2
19BME10.CO2	3	2	3	-	-	3	-	-	2	2	-	2	3	-	2
19BME10.CO3	3	2	3	-	-	2	-	-	2	2	-	2	3	-	2
19BME10.CO4	3	2	3	-	-	3	-	-	2	2	-	2	3	-	2
19BME10.CO5	3	2	3	-	-	3	-	-	3	2	-	2	3	-	2

- 1-Low, 2- Medium, 3-High

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

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

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

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

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

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

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

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

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

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

TOTAL: 45 HRS

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TEXT BOOKS:

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

REFERENCES BOOKS:

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

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COURSE CODE	COURSE TITLE	L	T	P	C
19BME11	PHYSIOLOGICAL MODELING	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

19BME11.CO1	Explain application of Physiological models.
19BME11.CO2	Model dynamically varying physiological system
19BME11.CO3	Discuss methods and techniques to analyze and synthesis dynamic models
19BME11.CO4	Develop differential equations to describe the dynamic models, simulate and visualize
19BME11.CO5	Implement physiological models using software to get dynamic responses

Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BME11.CO1	X	X	X	-	-	X	-	-	X	X	-	X	X	-	X
19BME11.CO2	X	X	X	-	-	X	-	-	X	X	-	X	X	-	X
19BME11.CO3	X	X	X	-	-	X	-	-	X	X	-	X	X	-	X
19BME11.CO4	X	X	X	-	-	X	-	-	X	X	-	X	X	-	X
19BME11.CO5	X	X	X	-	-	X	-	-	X	X	-	X	X	-	X

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BME11.CO1	3	2	3	-	-	2	-	-	2	2	-	2	3	-	2
19BME11.CO2	3	2	3	-	-	3	-	-	2	2	-	2	3	-	2
19BME11.CO3	3	2	3	-	-	2	-	-	2	2	-	2	3	-	2
19BME11.CO4	3	2	3	-	-	3	-	-	2	2	-	2	3	-	2
19BME11.CO5	3	2	3	-	-	3	-	-	3	2	-	2	3	-	2

- 1-Low, 2- Medium, 3-High

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

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

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

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

UNIT III **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

Total: 45 Hrs

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TEXT BOOKS:

S.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Michel C Khoo	Physiological Control Systems -Analysis, simulation and estimation	Prentice Hall of India	2001
2.	David T. Westwick, Robert E. Kearney	Identification of Nonlinear Physiological Systems	Wiley-IEEE Press	2003

REFERENCE BOOKS:

S.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Endarle, Blanchard & Bronzino	Introduction to Biomedical Engg	Academic press	Endarle, Blanchard & Bronzino
2.	Suresh.R.Devasahayam	Signals & Systems in Biomedical Engineering	Kluwer Academic/ Plenum Publishers.	Suresh.R.Devasahayam
3.	V.Z. Marmarelis	Advanced methods of physiological modeling	Plenum Press	V.Z. Marmarelis
4.	J. Candy	Signal Processing: The Model Based approach	Mc. Graw Hill.	J. Candy
5.	L.Stark,	Neurological Control System	Plenum Press.	L.Stark,

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COURSE CODE	COURSE TITLE	L	T	P	C
19BME12	HOSPITAL WASTE MANAGEMENT	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

19BME12.CO1	Handling of biomedical waste.
19BME12.CO2	Importance of the biomedical waste disposal in the society.
19BME12.CO3	Know about the types of treatment technologies for wastes.
19BME12.CO4	Learn the laws of biomedical waste handling and the Healthcare waste Management
19BME12.CO5	study about the professional ethics of biomedical waste handling

Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BME12.CO1	-	-	-	-	-	X	X	X	X	X	X	X	X	X	-
19BME12.CO2	-	-	-	-	-	X	X	X	X	X	X	X	X	X	-
19BME12.CO3	-	-	-	-	-	X	X	X	X	X	X	X	X	X	-
19BME12.CO4	-	-	-	-	-	X	X	X	X	X	X	X	X	X	-
19BME12.CO5	-	-	-	-	-	X	X	X	X	X	X	X	X	X	-

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BME12.CO1	-	-	-	-	-	3	2	2	2	2	2	3	3	2	-
19BME12.CO2	-	-	-	-	-	2	3	2	3	2	3	3	3	3	-
19BME12.CO3	-	-	-	-	-	2	2	2	2	2	2	3	2	2	-
19BME12.CO4	-	-	-	-	-	2	3	2	3	2	2	3	2	3	-
19BME12.CO5	-	-	-	-	-	2	2	2	2	2	2	3	2	3	-

- 1-Low, 2- Medium, 3-High

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UNIT I **INTRODUCTION** **9**

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

UNIT II **HAZARD OF BIOMEDICAL WASTE** **9**

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

UNIT III **CONTROL OF HOSPITAL ACQUIRED INFECTION** **9**

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

UNIT IV **TREATMENT TECHNOLOGIES FOR WASTES** **9**

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

UNIT V **LAWS OF BIOMEDICAL WASTE HANDLING** **9**

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

TOTAL: 45 HRS

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TEXT BOOKS:

S.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

REFERENCE BOOKS:

S.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Sanskriti Sharma	Hospital Waste Management and Its Monitoring	Jaypee Publishers (P) Ltd, India	2002
2.	Paul T. Williams	Waste Treatment and Disposal	John Wiley & Sons, Ltd	2005

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COURSE CODE	COURSE TITLE	L	T	P	C
19BME13	VIRTUAL REALITY	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

19BME13.CO1	Analyze & Design a system or process to meet given specifications with realistic engineering constraints.
19BME13.CO2	Identify problem statements and function as a member of an engineering design team.
19BME13.CO3	Utilize technical resources
19BME13.CO4	Propose technical documents and give technical oral presentations related to design mini project results.
19BME13.CO5	Application used in medical terms.

Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BME13.CO1	X	X	X	-	X	X	-	X	-	-	-	X	X	-	X
19BME13.CO2	X	X	X	-	X	X	-	X	-	-	-	X	X	-	X
19BME13.CO3	X	X	X	-	X	X	-	X	-	-	-	X	X	-	X
19BME13.CO4	X	X	X	-	X	X	-	X	-	-	-	X	X	-	X
19BME13.CO5	X	X	X	-	X	X	-	X	-	-	-	X	X	-	X

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BME13.CO1	3	2	3	-	3	2	-	2	-	-	-	2	3	-	2
19BME13.CO2	3	2	3	-	3	2	-	2	-	-	-	2	3	-	2
19BME13.CO3	3	2	3	-	3	2	-	2	-	-	-	2	3	-	2
19BME13.CO4	3	2	3	-	3	2	-	2	-	-	-	2	3	-	2
19BME13.CO5	3	2	3	-	3	2	-	2	-	-	-	2	3	-	2

- 1-Low, 2- Medium, 3-High

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UNIT 1 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 APPLICATION OF VR 9

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

TOTAL: 45 HRS

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TEXT BOOKS:

S.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	

REFERENCE BOOKS:

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

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COURSE CODE	COURSE TITLE	L	T	P	C
19BME14	WEARABLE SYSTEMS	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

19BME14.CO1	Enables the need for wearable devices.
19BME14.CO2	Know about the basic principles of sensors and with the input signal
19BME14.CO3	Provides idea with the energy management for wearable devices.
19BME14.CO4	Explain need of wireless health systems
19BME14.CO5	Equips with the knowledge of application with wearable systems

Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BME14.CO1	X	X	X	X	X	X	-	-	-	-	-	X	X	X	-
19BME14.CO2	X	X	X	X	X	X	-	-	-	-	-	X	X	X	-
19BME14.CO3	X	X	X	X	X	X	-	-	-	-	-	X	X	X	-
19BME14.CO4	X	X	X	X	X	X	-	-	-	-	-	X	X	X	-
19BME14.CO5	X	X	X	X	X	X	-	-	-	-	-	X	X	X	-

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BME14.CO1	3	3	3	2	3	3	-	-	-	-	-	2	3	2	-
19BME14.CO2	3	3	3	2	2	2	-	-	-	-	-	2	3	2	-
19BME14.CO3	3	3	3	2	3	3	-	-	-	-	-	2	3	3	-
19BME14.CO4	3	2	2	2	2	3	-	-	-	-	-	2	3	2	-
19BME14.CO5	3	3	3	2	3	3	-	-	-	-	-	2	3	3	-

1-Low, 2- Medium, 3-High

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

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

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

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

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

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

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

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

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

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

TOTAL: 45 HRS

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TEXT BOOKS:

S.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

REFERENCE BOOKS:

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

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

COURSE CODE	COURSE TITLE	L	T	P	C
19BME15	MEDICAL PHYSICS	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

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

Mapping of COs with POs and PSOs:

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BME15.CO1	X	X	X	X	X	-	-	-	-	-	-	X	X	-	-
19BME15.CO2	X	X	X	X	X	-	-	-	-	-	-	X	X	-	-
19BME15.CO3	X	X	X	X	X	-	-	-	-	-	-	X	X	-	-
19BME15.CO4	X	X	X	X	X	-	-	-	-	-	-	X	X	-	-
19BME15.CO5	X	X	X	X	X	-	-	-	-	-	-	X	X	-	-

Course Articulation Matrix:

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BME15.CO1	2	3	3	2	2	-	-	-	-	-	-	2	3	-	-
19BME15.CO2	2	3	3	2	2	-	-	-	-	-	-	2	3	-	-
19BME15.CO3	2	3	3	2	2	-	-	-	-	-	-	2	3	-	-
19BME15.CO4	2	3	3	2	2	-	-	-	-	-	-	2	3	-	-
19BME15.CO5	2	3	3	2	2	-	-	-	-	-	-	2	3	-	-

1 - Low, 2 - Medium, 3 - High.

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UNIT I **IONIZING RADIATION AND ITS MEDICAL APPLICATIONS** **9**

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

UNIT II **PHYSICS OF THE SENSES** **9**

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

UNIT III **PRINCIPLES OF RADIOACTIVE NUCLIDES** **9**

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

UNIT IV **RADIOACTIVE DECAY AND INTERACTION OF RADIATION WITH MATTER** **9**

Spontaneous Fission- Isomeric Transition-Alpha Decay-Beta Decay-Positron Decay-Electron Capture-Interaction of charged particles with matter –Specific ionization, Linear energy transfer range, Bremsstrahlung, Annihilation, Interaction of X and Gamma radiation with matter-Photoelectric effect, Compton Scattering , Pair production, Attenuation of Gamma Radiation ,Interaction of neutron with matter and their clinical significance.

UNIT V **CLINICAL APPLICATIONS OF FIBER OPTIC LASER SYSTEMS** **9**

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

TOTAL:45

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REFERENCE BOOKS:

S.NO.	AUTHOR(s)	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1.	Gopal B. Saha	Physics and Radiobiology of Nuclear Medicine4th Edition	Springer	2013
2.	B H Brown, R H Smallwood, D C Barber, P V Lawford, D R Hose	Medical Physics and Biomedical Engineering	IOP Publishers	2nd Edition, 2001
3.	S.Webb	The Physics of Medical Imaging	Taylor and Francis	1988
4	J.P.Woodcock	Ultrasonic Medical Physics Handbook series 1	Adam Hilger, Bristol	2002
5	HyltonB.Meire Pat Farrant	Basic Ultrasound	John Wiley & Sons	1995

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Employability Enhancement Courses

COURSE CODE	COURSE TITLE	L	T	P	C
19BMS01	PROJECT WORK PHASE - I	0	0	10	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

19BMS01.CO1	Able to handle any position to take up any challenging practical problems
19BMS01.CO2	Find solution by formulating proper methodology
19BMS01.CO3	Face reviews and viva voce examination.
19BMS01.CO4	Convert ideas into conceptual model by comparing with existing solutions
19BMS01.CO5	Prepare for paper writing and technical report

Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMS01.CO1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
19BMS01.CO2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
19BMS01.CO3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
19BMS01.CO4	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
19BMS01.CO5	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMS01.CO1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
19BMS01.CO2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
19BMS01.CO3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
19BMS01.CO4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
19BMS01.CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

1-Low, 2- Medium, 3-High

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

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COURSE CODE	COURSE TITLE	L	T	P	C
19BMS02	PROJECT WORK PHASE - II	0	0	12	6

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

19BMS02.CO1	Utilize new tools, algorithms, software for finding the solution
19BMS02.CO2	Solve specific problems independently or as part of a team
19BMS02.CO3	Manage a project from start to finish
19BMS02.CO4	Work independently as well as in teams
19BMS02.CO5	Prepare for paper writing and technical report

Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMS02.CO1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
19BMS02.CO2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
19BMS02.CO3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
19BMS02.CO4	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
19BMS02.CO5	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMS02.CO1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
19BMS02.CO2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
19BMS02.CO3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
19BMS02.CO4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
19BMS02.CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

1-Low, 2- Medium, 3-High

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

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COURSE CODE	COURSE TITLE	L	T	P	C
19BMS04	DESIGN PROJECT	0	0	2	1

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

19BMS04.CO1	Able to handle any position to take up any challenging practical problems
19BMS04.CO2	Find solution by formulating proper methodology
19BMS04.CO3	Face reviews and viva voce examination.
19BMS04.CO4	Convert ideas into conceptual model by comparing with existing solutions
19BMS04.CO5	Prepare for paper writing and technical report

Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMS04.CO1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
19BMS04.CO2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
19BMS04.CO3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
19BMS04.CO4	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
19BMS04.CO5	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMS04.CO1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
19BMS04.CO2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
19BMS04.CO3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
19BMS04.CO4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
19BMS04.CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

1-Low, 2- Medium, 3-High

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

COURSE CODE	COURSE TITLE	L	T	P	C

19BMS05	HOSPITAL TRAINING	0	0	0	1

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

19BMS05.CO1	Advocate a patient-centered approach in healthcare
19BMS05.CO2	Communicate with other health professionals in a respectful and responsible manner
19BMS05.CO3	Recognize the importance of inter-professional collaboration in healthcare.
19BMS05.CO4	Propose a patient-centered inter-professional health improvement plan based upon the patient's perceived needs
19BMS05.CO5	Use the knowledge of one's own role and those of other professions to address the healthcare needs of populations and patients served.

Mapping of COs with POs and PSOs:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMS05.CO1	-	-	-	-	-	X	X	X	-	-	-	X	-	X	-
19BMS05.CO2	-	-	-	-	-	X	X	X	-	-	-	X	-	X	-
19BMS05.CO3	-	-	-	-	-	X	X	X	-	-	-	X	-	X	-
19BMS05.CO4	-	-	-	-	-	X	X	X	-	-	-	X	-	X	-
19BMS05.CO5	-	-	-	-	-	X	X	X	-	-	-	X	-	X	-

Course Articulation Matrix:

Course Outcomes (COs)	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
19BMS05.CO1	-	-	-	-	-	2	3	2	-	-	-	3	-	2	-
19BMS05.CO2	-	-	-	-	-	3	2	2	-	-	-	2	-	3	-
19BMS05.CO3	-	-	-	-	-	2	3	2	-	-	-	3	-	2	-
19BMS05.CO4	-	-	-	-	-	3	3	2	-	-	-	3	-	3	-
19BMS05.CO5	-	-	-	-	-	2	3	2	-	-	-	3	-	2	-

1-Low, 2- Medium, 3-High

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

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