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

Curriculum/Syllabus

Programme Code : **BME**

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

Regulation : **R-2021**

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

Rasipuram - 637 408, Namakkal Dt, Tamil Nadu.

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Estd. 2000

INSTITUTION VISION & MISSION

INSTITUTION VISION

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

INSTITUTION MISSION

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

INSTITUTION MOTTO

Rural upliftment through Technical Education.

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DEPARTMENT VISION & MISSION

DEPARTMENT VISION

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

DEPARTMENT MISSION

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

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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.

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.

Grouping of Courses

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B.E. - BIOMEDICAL ENGINEERING

GROUPING OF COURSES

1. Humanities and Social Sciences Courses (HS)

S.No.	Course Code	Course Title	Category	Contact Hours	Instruction Hours/Week			C
					L	T	P	
1.	21HSS01	Business English	HS	2	2	0	0	2
2.	21HSS02	Communicative English Practices Laboratory	HS	2	0	0	2	1
3.	21HSS03	Life Skills and Workplace Psychology	HS	2	2	0	0	2
4.	21HSS04	Technical English For Engineers	HS	2	2	0	0	2
5.	21HSS05	Communicative English for Engineers	HS	2	2	0	0	2
6.	21HSS06	Basics of Japanese Language	HS	2	2	0	0	2
7.	21HSS07	Basics of French Language	HS	2	2	0	0	2

2. Basic Sciences Courses (BS)

S. No.	Course Code	Course Title	Category	Contact Hours	Instruction Hours/Week			C
					L	T	P	
1.	21BSS01	Engineering Physics	BS	3	3	0	0	3
2.	21BSS02	Physics and Chemistry Laboratory	BS	2	0	0	2	1
3.	21BSS03	Bio and Nanomaterials Science	BS	3	3	0	0	3
4.	21BSS04	Materials Science	BS	3	3	0	0	3
5.	21BSS05	Physics for Mechanical Engineers	BS	3	3	0	0	3
6.	21BSS11	Engineering Chemistry	BS	3	3	0	0	3
7.	21BSS12	Environmental Science and Engineering	BS	3	3	0	0	3

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8.	21BSS13	Applied Chemistry	BS	3	3	0	0	3
9.	21BSS21	Algebra and Calculus	BS	4	3	1	0	4
10.	21BSS22	Advanced Calculus and Complex Analysis	BS	4	3	1	0	4
11.	21BSS23	Transforms and Partial Differential Equations	BS	4	3	1	0	4
12.	21BSS24	Discrete Mathematics	BS	4	3	1	0	4
13.	21BSS25	Statistic and Queuing Model	BS	4	3	1	0	4
14.	21BSS26	Numerical Methods	BS	4	3	1	0	4
15.	21BSS27	Probability and Random Processes	BS	4	3	1	0	4
16.	21BSS28	Statistics and Numerical Methods	BS	4	3	1	0	4

3. General Engineering Science Courses (GES)

S. No.	Course Code	Course Title	Category	Contact Hours	Instruction Hours/Week			
					L	T	P	C
1.	21GES01	Programming for Problem Solving Using C	GES	3	3	0	0	3
2.	21GES02	Programming for Problem Solving Techniques	GES	3	3	0	0	3
3.	21GES03	Programming in C Laboratory	GES	3	0	0	2	1
4.	21GES04	Programming in C and Python Laboratory	GES	3	0	0	2	1
5.	21GES05	Electrical and Electronic Sciences	GES	3	3	0	0	3
6.	21GES06	Mechanical and Building Sciences	GES	3	3	0	0	3
7.	21GES07	Computer Aided Drafting Laboratory	GES	3	0	0	3	1
8.	21GES08	Python Programming	GES	3	3	0	0	3
9.	21GES09	Programming in Python Laboratory	GES	3	0	0	2	1
10.	21GES10	Soft Skills Laboratory	GES	3	0	0	2	1
11.	21GES11	Electronic Devices	GES	3	3	0	0	3
12.	21GES12	Electronic Simulation Laboratory	GES	3	0	0	2	1
13.	21GES13	Electric Circuits	GES	3	2	1	0	3
14.	21GES14	Electric Circuits Laboratory	GES	3	0	0	2	1
15.	21GES15	Manufacturing Processes	GES	3	3	0	0	3

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16.	21GES16	Manufacturing Processes Laboratory	GES	3	0	0	2	1
17.	21GES17	Mechanical and Building Sciences Laboratory	GES	3	0	0	2	1
18.	21GES18	Fundamentals of Civil Engineering	GES	3	3	0	0	3
19.	21GES19	Concepts in Product Design	GES	3	3	0	0	3
20.	21GES20	Renewable Energy Sources	GES	3	3	0	0	3
21.	21GES21	Electrical Drives and Controls	GES	3	3	0	0	3
22.	21GES22	Electrical Drives and Controls Laboratory	GES	3	0	0	2	1
23.	21GES23	Analog and digital communication	GES	3	3	0	0	3
24.	21GES24	Digital Principles and System Design	GES	3	3	0	0	3
25.	21GES25	Digital Principles and System Design Laboratory	GES	3	0	0	2	1
26.	21GES26	Engineering Drawing	GES	4	1	0	2	2
27.	21GES27	Engineering Geology	GES	3	3	0	0	3
28.	21GES28	Engineering Mechanics	GES	4	3	1	0	4
29.	21GES29	Wireless Communication	GES	3	3	0	0	3
30.	21GES30	Electronics and Microprocessors	GES	3	3	0	0	3
31.	21GES31	Electronics and Microprocessors Laboratory	GES	2	0	0	2	1
32.	21GES32	Data Structure using Python	GES	3	3	0	0	3
33.	21GES33	Electronic Devices and Circuits	GES	3	3	0	0	3
34.	21GES34	Electronic Simulation Laboratory	GES	2	0	0	2	1

4. Professional Core (PC)

S.No.	Course Code	Course Title	Category	Contact Hours	Instruction Hours/Week			C
					L	T	P	
1.	21BMC01	Human Anatomy & Physiology	PC	3	3	0	0	3
2.	21BMC02	Biomedical Sensors & Instruments	PC	3	3	0	0	3
3.	21BMC03	Fundamentals of Biochemistry	PC	3	3	0	0	3
4.	21BMC04	Analog and Digital Integrated Circuits	PC	4	3	1	0	4
5.	21BMC05	Pathology and Microbiology	PC	3	3	0	0	3
6.	21BMC06	Hospital Management	PC	3	3	0	0	3

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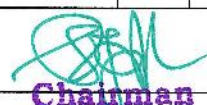| 7.	21BMC07	Biomedical Instrumentation – I	PC	3	3	0	0	3
8.	21BMC08	Signals and Systems	PC	4	3	1	0	4
9.	21BMC09	Biomedical Instrumentation – II	PC	3	3	0	0	3
10.	21BMC10	Control System for Biomedical Engineering	PC	4	3	1	0	4
11.	21BMC11	Medical Signal Processing	PC	4	3	1	0	4
12.	21BMC12	Microprocessors and Microcontrollers in Medicine	PC	3	3	0	0	3
13.	21BMC13	Biomaterials and Artificial Organs	PC	3	3	0	0	3
14.	21BMC14	Biomechanics & Rehabilitation Engineering	PC	3	3	0	0	3
15.	21BMC15	Embedded Systems and IoMT	PC	3	3	0	0	3
16.	21BMC16	Medical Image Processing	PC	4	3	1	0	4
17.	21BMC17	Medical Imaging Techniques	PC	3	3	0	0	3
18.	21BMC18	Advanced Therapeutic Equipment	PC	3	3	0	0	3
19.	21BMC19	Analytical & Diagnostic Equipments	PC	3	3	0	0	3
20.	21BMC20	Bio Medical Sensors and Instruments Laboratory	PC	2	0	0	2	1
21.	21BMC21	Biochemistry and Human Physiology Laboratory	PC	2	0	0	2	1
22.	21BMC22	Analog and Digital Integrated Circuits laboratory	PC	2	0	0	2	1
23.	21BMC23	Pathology and Microbiology Laboratory	PC	2	0	0	2	1
24.	21BMC24	Medical Signal Processing Laboratory	PC	2	0	0	2	1
25.	21BMC25	Biomedical Instrumentation Laboratory	PC	2	0	0	2	1
26.	21BMC26	Microprocessor and Microcontroller Laboratory	PC	2	0	0	2	1
27.	21BMC27	Embedded Systems Laboratory	PC	2	0	0	2	1
28.	21BMC28	Medical Image Processing Laboratory	PC	2	0	0	2	1

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5. Professional Electives (PE)

S. No.	Course Code	Course Title	Category	Contact Hours	Instruction Hours/Week			
					L	T	P	C
1.	21BME01	Basic Clinical Sciences	PE	3	3	0	0	3
2.	21BME02	Biostatistics	PE	3	3	0	0	3
3.	21BME03	Medical Science	PE	3	3	0	0	3
4.	21BME04	Sports Physical Therapy	PE	3	3	0	0	3
5.	21BME05	Telemedicine	PE	3	3	0	0	3
6.	21BME06	Brain Computer Interface and Applications	PE	3	3	0	0	3
7.	21BME07	Medical Optics	PE	3	3	0	0	3
8.	21BME08	Medical Informatics	PE	3	3	0	0	3
9.	21BME09	Virtual Reality	PE	3	3	0	0	3
10.	21BME10	Wearable Systems	PE	3	3	0	0	3
11.	21BME11	Internet of Things	PE	3	3	0	0	3
12.	21BME12	Hospital Waste Management	PE	3	3	0	0	3
13.	21BME13	Fiber optics and Lasers in Medicine	PE	3	3	0	0	3
14.	21BME14	Communication Engineering	PE	3	3	0	0	3
15.	21BME15	Medical Physics	PE	3	3	0	0	3
16.	21BME16	Electrical Safety and Quality assurance	PE	3	3	0	0	3

6. Employability Enhancement Courses (EEC)

S. No.	Course Code	Course Title	Category	Contact Hours	Instruction Hours/Week			
					L	T	P	C
1.	21BMS01	Project Work Phase – I	EEC	10	0	0	10	5
2.	21BMS02	Project Work Phase –II	EEC	18	0	0	18	9
3.	21BMS03	Internship / Hospital Training	EEC	0	0	0	0	1
4.	21BMS04	Presentation Skill and Technical Seminar	EEC	2	0	0	2	1

COURSE COMPONENT SUMMARY

S.No.	Subject Area	Credits Per Semester								Credits Total	AICTE Credits
		I	II	III	IV	V	VI	VII	VIII		
1.	HS	2	4	-	-	-	-	-	-	6	
2.	BS	11	10	4	4	-	-	3	-	32	66
3.	GES	7	8	3	3	-	-	-	-	21	
4.	PC	-	-	11	17	19	18	3	-	68	55
5.	PE	-	-	-	-	3	3	6	-	12	12
6.	OE	-	-	-	3	3	-	3	-	9	12
7.	EEC	-	-	-	-	-	-	6	10	16	15
TOTAL		20	22	18	27	25	21	21	10	164	160

Total Credits: 164

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Curriculum

MUTHAYAMMAL ENGINEERING COLLEGE (Autonomous)
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CURRICULUM UG R – 2021

Department	BIOMEDICAL ENGINEERING
Programme	B.E

SEMESTER - I

Sl. No.	Course Code	Course Name	Hours/ Week			Credit	Contact Hours
			L	T	P	C	
THEORY							
1.	21HSS01	Business English	2	0	0	2	2
2.	21BSS21	Algebra and Calculus	3	1	0	4	4
3.	21BSS01	Engineering Physics	3	0	0	3	3
4.	21BSS11	Engineering Chemistry	3	0	0	3	3
5.	21GES02	Programming for Problem Solving Technique	3	0	0	3	3
6.	21GES06	Mechanical and Building Sciences	3	0	0	3	3
PRACTICALS							
7.	21BSS02	Physics and Chemistry Laboratory	0	0	2	1	2
8.	21GES03	Programming in C Laboratory	0	0	2	1	2
Total Credits						**20**	

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CURRICULUM UG R – 2021

Department	BIOMEDICAL ENGINEERING
Programme	B.E

SEMESTER - II

Sl. No.	Course Code	Course Name	Hours/ Week			Credit	Contact Hours
			L	T	P	C	
THEORY							
1.	21HSS03	Life Skills and Workplace Psychology	2	0	0	2	2
2.	21BSS22	Advanced Calculus and Complex Analysis	3	1	0	4	4
3.	21BSS03	Bio and Nanomaterials Sciences	3	0	0	3	3
4.	21BSS12	Environmental Science and Engineering	3	0	0	3	3
5.	21GES19	Concepts in Product Design	3	0	0	3	3
6.	21GES11	Electronic Devices	2	0	0	3	2
7.	21HSS08	Heritage of Tamils	2	0	0	1	2
PRACTICALS							
8.	21GES12	Electronic Simulation Laboratory	0	0	2	1	2
9.	21GES09	Programming in Python Laboratory	0	0	2	1	2
10.	21HSS02	Communicative English Practices Laboratory	0	0	2	1	2
Total Credits						**22**	

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Department	BIOMEDICAL ENGINEERING
Programme	BE

SEMESTER – III

Sl. No.	Course Code	Course Name	Hours/ Week			Credit	Contact Hours
			L	T	P	C	
THEORY							
1.	21BSS23	Transforms & Partial Differential Equations	3	1	0	4	4
2.	21BMC01	Human Anatomy & Physiology	3	0	0	3	3
3.	21BMC02	Biomedical Sensors & Instruments	3	0	0	3	3
4.	21BMC03	Fundamentals of Biochemistry	3	0	0	3	3
5.	21GES20	Renewable Energy Sources	3	0	0	3	3
PRACTICALS							
6.	21BMC20	Bio Medical Sensors and Instruments Laboratory	0	0	2	1	2
7.	21BMC21	Biochemistry and Human Physiology Laboratory	0	0	2	1	2
Total Credits						18	

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Department	BIOMEDICAL ENGINEERING
Programme	BE

SEMESTER – IV

Sl. No.	Course Code	Course Name	Hours/ Week			Credit	Contact Hours
			L	T	P	C	
THEORY							
1.	21BSS27	Probability and Random Process	3	1	0	4	4
2.	21BMC04	Analog and Digital Integrated Circuits	3	1	0	4	4
3.	21BMC05	Pathology and Microbiology	3	0	0	3	3
4.	21BMC08	Signals and Systems	3	1	0	4	4
5.	21BMC10	Control System for Biomedical Engineering	3	1	0	4	4
6.	21GES33	Electronic Devices and Circuits	3	0	0	3	3
7.		Open Elective - I	3	0	0	3	3
PRACTICALS							
7.	21BMC22	Analog and Digital Integrated Circuits laboratory	0	0	2	1	2
8.	21BMC23	Pathology and Microbiology Laboratory	0	0	2	1	2
Total Credits						27	

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Department	BIOMEDICAL ENGINEERING
Programme	BE

SEMESTER – V

Sl. No.	Course Code	Course Name	Hours/ Week			Credit	Contact Hours
			L	T	P	C	
THEORY							
1.	21BMC07	Biomedical Instrumentation – I	3	0	0	3	3
2.	21BMC09	Biomedical Instrumentation – II	3	0	0	3	3
3.	21BMC11	Medical Signal Processing	3	1	0	4	4
4.	21BMC12	Microprocessors and Microcontrollers in Medicine	3	0	0	3	3
5.	21BMC06	Hospital Management	3	0	0	3	3
6.		Professional Elective – I	3	0	0	3	3
7.		Open Elective - II	3	0	0	3	3
PRACTICALS							
8.	21BMC24	Medical Signal Processing Laboratory	0	0	2	1	2
9.	21BMC25	Biomedical Instrumentation Laboratory	0	0	2	1	2
10.	21BMC26	Microprocessor and Microcontroller laboratory	0	0	2	1	2
Total Credits						25	

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Department	BIOMEDICAL ENGINEERING
Programme	BE

SEMESTER – VI

Sl. No.	Course Code	Course Name	Hours/ Week			Credit	Contact Hours
			L	T	P	C	
THEORY							
1.	21BMC13	Biomaterials and Artificial Organs	3	0	0	3	3
2.	21BMC14	Biomechanics & Rehabilitation Engineering	3	0	0	3	3
3.	21BMC15	Embedded Systems and IoMT	3	0	0	3	3
4.	21BMC16	Medical Image Processing	3	1	0	4	4
5.	21BMC17	Medical Imaging Techniques	3	0	0	3	3
6.		Professional Elective - II	3	0	0	3	3
7.	21BMM01	Mandatory Course – I (Indian Constitution)	2	0	0	0	2
PRACTICALS							
8.	21BMC27	Embedded Systems Laboratory	0	0	2	1	2
9.	21BMC28	Medical Image Processing Laboratory	0	0	2	1	2
Total Credits						21	

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Department	BIOMEDICAL ENGINEERING	
Programme	BE	

SEMESTER – VII

Sl. No.	Course Code	Course Name	Hours/ Week			Credit	Contact Hours
			L	T	P	C	
THEORY							
1.	21BMC19	Analytical & Diagnostic Equipments	3	0	0	3	3
2.	21BSS26	Numerical Methods	3	0	0	3	3
3.		Professional Elective -III	3	0	0	3	3
4.		Professional Elective -IV	3	0	0	3	3
5.		Open Elective - III	3	0	0	3	3
6.	21BMM02	Mandatory Course – II (Essence of Indian Traditional Knowledge)	2	0	0	0	2
PRACTICALS							
7.	21BMS04	Presentation Skill and Technical Seminar	0	0	2	1	2
8.	21BMS01	Project Work Phase -I	0	0	10	5	10
Total Credits						**21**	

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Department	BIOMEDICAL ENGINEERING	
Programme	BE	

SEMESTER – VIII

Sl.No.	Course Code	Course Name	Hours/ Week			Credit	Contact Hours
			L	T	P	C	
PRACTICALS							
1.	21BMS02	Project Work Phase -II	0	0	18	9	18
2.	21BMS03	Internship / Hospital Training	0	0	0	1	0
Total Credits						**10**	

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Professional Core

Courses

COURSE CODE	COURSE TITLE	L	T	P	C
21BMC01	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 nervous system.
- Study about muscles and joints.

COURSE OUTCOMES:

CO1:	Identify basic structural and functional elements of human body.
CO2:	Explain the structure and functions of skeletal system.
CO3:	Describe the functions of circulatory system.
CO4:	Discuss the physiological process of urinary system and nervous system.
CO5:	Identify various muscles and joints.

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
21BMC01.CO1	X	X	X	-	-	X	-	-	-	X	-	X	X	-	-
21BMC01.CO2	X	X	X	-	-	X	-	-	-	X	-	X	X	-	-
21BMC01.CO3	X	X	X	-	-	X	-	-	-	X	-	X	X	-	-
21BMC01.CO4	X	X	X	-	-	X	-	-	-	X	-	X	X	-	-
21BMC01.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
21BMC01.CO1	3	2	3	-	-	3	-	-	-	1	-	3	3	-	-
21BMC01.CO2	3	2	3	-	-	3	-	-	-	1	-	3	3	-	-
21BMC01.CO3	3	2	3	-	-	3	-	-	-	1	-	3	3	-	-
21BMC01.CO4	3	2	3	-	-	3	-	-	-	1	-	3	3	-	-
21BMC01.CO5	3	2	3	-	-	3	-	-	-	1	-	3	3	-	-

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

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 NewDelhi.	8th edition, 2007
2.	Gillian Pocock, Christopher D. Richards	The Human Body An introduction for Biomedical and Health Sciences	Oxford University Press, USA	2009

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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	11 th Edition, Elsevier Saunders	11th Edition, 2006
4.	Juergen Mai George Paxinos	The Human nervous System	Academic Press 3rd Edition	2011
5.	Midthun Joseph	The Digestive and Urinary Systems	World Book, Inc	2011

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COURSE CODE	COURSE TITLE	L	T	P	C
21BMC02	BIOMEDICAL SENSORS & INSTRUMENTS	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

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

Mapping of COs with POs and PSOs:

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	P O11	PO12	PSO1	PSO2	PSO3
21BMC02.CO1	X	X	X	X	-	-	-	-	-	-	-	X	X	-	-
21BMC02.CO2	X	X	X	X	X	X	-	-	-	-	-	X	X	-	-
21BMC02.CO3	X	X	X	X	X	X	-	-	-	-	-	X	X	-	-
21BMC02.CO4	X	X	X	X	X	X	-	-	-	-	-	X	X	-	-
21BMC02.CO5	X	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
21BMC02.CO1	3	2	3	1	-	-	-	-	-	-	-	3	3	-	-
21BMC02.CO2	3	2	3	1	3	3	-	-	-	-	-	3	3	-	-
21BMC02.CO3	3	2	3	1	3	3	-	-	-	-	✓	3	3	-	-
21BMC02.CO4	3	2	3	1	3	3	-	-	-	-	-	3	3	-	-
21BMC02.CO5	3	2	3	1	3	3	-	-	-	-	-	3	3	-	-

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

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UNIT I   Science of Measurement   7

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

UNIT II   Displacement, Pressure, Temperature Sensors   11

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

UNIT III   Photoelectric and Piezoelectric Sensors   9

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

UNIT IV   Signal Conditioning and Signal Analyzer   9

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

UNIT V   Display and Recording Devices   9

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

TOTAL: 45 HRS

TEXT BOOKS:

S.NO.	AUTHOR(S)	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1.	L.A Geddes and L.E.Baker.	Principles of Applied Biomedical Instrumentation	John Wiley and sons	3rd Edition, Reprint 2008
2.	Albert D.Helfrick	Modern Electronic Instrumentation and Measurement Techniques	William D.Cooper. Prentice Hall of India,	2007

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REFERENCE BOOKS:

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

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COURSE CODE	COURSE TITLE	L	T	P	C
21BMC03	FUNDAMENTALS OF BIOCHEMISTRY	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

CO1:	Describe the surface properties involved in biological systems.
CO2:	Explain about bio molecules such as Carbohydrates, Lipids, Nucleic Acid & Protein
CO3:	Explain functions of bio molecules
CO4:	Assess the significance of biomolecules in biological systems.
CO5:	Analyze the etiology and biological parameters in metabolic diseases.

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
21BMC03.CO1	X	X	X	-	X	-	X	-	-	X	-	X	X	-	-
21BMC03.CO2	X	X	X	X	X	-	X	-	-	X	-	X	X	-	-
21BMC03.CO3	X	X	X	X	X	-	X	-	-	X	-	X	X	-	-
21BMC03.CO4	X	X	X	X	X	-	X	-	-	-	-	X	X	-	-
21BMC03.CO5	X	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
21BMC03.CO1	3	2	2	-	1	-	1	-	-	2	-	3	3	-	-
21BMC03.CO2	3	2	2	1	1	-	1	-	-	2	-	3	3	-	-
21BMC03.CO3	3	2	2	1	1	-	1	-	-	2	-	3	3	-	-
21BMC03.CO4	3	2	2	3	1	-	1	-	-	-	-	3	3	-	-
21BMC03.CO5	3	2	2	3	1	-	1	-	-	-	-	3	3	-	-

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 MD	Text book of biochemistry for Medical Student	Second Edition, University Press	2014
2.	David.W.Martin, Peter.A.Mayes , Victor. W.Rodwell,.	Harper's Review of Biochemistry	LANGE Medical Publications	1981
3.	Keith Wilson & John Walke	Practical Biochemistry – Principles & Technique	Oxford University Press	2009
4.	Pamela.C.Champe & Richard.A.Harvey,	Lippincott Biochemistry	Lippincott's Illustrated Reviews, Raven publishers	1994

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COURSE CODE	COURSE TITLE	L	T	P	C
21BMC04	**ANALOG AND DIGITAL INTEGRATED CIRCUITS**	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

CO1:	Apply basic electronic devices and amplifier circuits.
CO2:	Apply operational amplifiers.
CO3:	Apply number systems and design combinational logic circuits.
CO4:	Apply flipflops and design sequential logic circuits
CO5:	Apply the principle of data converters.

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
21BMC04.CO1	X	X	X	X	X	-	-	-	-	-	-	X	X	X	-
21BMC04.CO2	X	X	X	X	X	-	-	-	-	-	-	X	X	X	-
21BMC04.CO3	X	X	X	X	X	-	-	-	-	-	-	X	X	X	-
21BMC04.CO4	X	X	X	X	X	-	-	-	-	-	-	X	X	X	-
21BMC04.CO5	X	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
21BMC04.CO1	3	3	3	2	1	-	-	-	-	-	-	3	3	3	-
21BMC04.CO2	3	3	3	2	1	-	-	-	-	-	-	3	3	3	-
21BMC04.CO3	3	3	3	2	1	-	-	-	-	-	-	3	3	3	-
21BMC04.CO4	3	3	3	2	1	-	-	-	-	-	-	3	3	3	-
21BMC04.CO5	3	3	3	2	1	-	-	-	-	-	-	3	3	3	-

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

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UNIT I — Diode Circuits — 9

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

UNIT II — Introduction to Operational amplifier and its Applications — 9

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

Unit III — The Basic Gates and Combinational Logic Circuits — 9

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

Unit IV — Sequential Logic Circuits — 9

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

UNIT-V — Data Converters — 9

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

TOTAL: 45 HRS

REFERENCE 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
3.	RamakantA.Gaya kwad	OP-AMP and Linear IC's	Prentice Hall of India	2002

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COURSE CODE	COURSE TITLE	L	T	P	C
21BMC05	PATHOLOGY AND MICROBIOLOGY	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

CO1:	Analyze structural and functional aspects of living organisms.
CO2:	Apply the Fluid and Hemodynamic Derangements.
CO3:	Identify various micro organisms.
CO4:	Prepare samples and use Microscopes.
CO5:	Identify antibodies and its types.

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
21BMC05.CO1	x	x	x	x	x	-	-	-	-	-	-	x	x	x	-
21BMC05.CO2	x	x	x	x	x	-	-	-	-	-	-	x	x	x	-
21BMC05.CO3	x	x	x	x	x	-	-	-	-	-	-	x	x	x	-
21BMC05.CO4	x	x	x	x	x	-	-	-	-	-	-	x	x	x	-
21BMC05.CO5	x	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
21BMC05.CO1	3	2	2	2	1	-	-	-	-	-	-	3	3	2	-
21BMC05.CO2	3	2	2	2	1	-	-	-	-	-	-	3	3	2	-
21BMC05.CO3	3	2	2	2	1	-	-	-	-	-	-	3	3	2	-
21BMC05.CO4	3	2	2	2	1	-	-	-	-	-	-	3	3	2	-
21BMC05.CO5	3	2	2	2	1	-	-	-	-	-	-	3	3	2	-

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

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UNIT I   Cell Degeneration, Repair and Neoplasia   9

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

UNIT II   Fluid and Hemodynamic Derangements   9

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

UNIT III   Microbiology   9

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

UNIT IV   Microscopes   9

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

UNIT V   Immunopathology   9

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

TOTAL: 45 HRS

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

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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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COURSE CODE	COURSE TITLE	L	T	P	C
21BMC06	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:

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

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
21BMC06.CO1	x	-	-	-	-	x	x	x	x	x	-	x	-	x	x
21BMC06.CO2	x	-	-	-	-	x	x	x	x	x	x	x	-	x	x
21BMC06.CO3	x	-	-	-	-	x	x	x	x	x	x	x	-	x	x
21BMC06.CO4	x	-	-	-	-	x	x	x	x	x	x	x	-	x	x
21BMC06.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
21BMC06.CO1	1	-	-	-	-	2	3	1	1	3	-	2	-	2	1
21BMC06.CO2	1	-	-	-	-	2	2	2	3	3	1	2	-	2	1
21BMC06.CO3	1	-	-	-	-	2	2	2	3	3	1	2	-	2	1
21BMC06.CO4	1	-	-	-	-	2	3	2	2	2	1	2	-	2	1
21BMC06.CO5	1	-	-	-	-	2	2	2	2	-	1	2	-	1	1

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

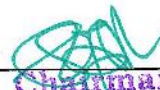**UNIT V   Quality and Safety Aspects In Hospital**   9

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

TEXT BOOKS:

S.NO.	AUTHOR(S)	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1.	R.C.Goyal	Hospital Administration and Human Resource Management	Academic Press, New York	4th Edition, 2006
2.	G.D.Kunders	Hospitals Facilities Planning and Management	TMH, New Delhi, Fifth Reprint	2007

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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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COURSE CODE	COURSE TITLE	L	T	P	C
21BMC07	BIOMEDICAL INSTRUMENTATION - I	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

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

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
21BMC07.CO1	X	-	-	X	X	X	X	X	-	-	-	X	X	X	-
21BMC07.CO2	X	-	-	X	X	X	X	X	-	-	-	X	X	X	-
21BMC07.CO3	X	-	-	X	X	X	X	X	-	-	-	X	X	X	-
21BMC07.CO4	X	-	-	X	X	X	X	X	-	-	-	X	X	X	-
21BMC07.CO5	X	-	-	X	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
21BMC07.CO1	1	-	-	1	2	3	3	1	-	-	-	3	1	3	-
21BMC07.CO2	1	-	-	1	2	3	3	1	-	-	-	3	1	3	-
21BMC07.CO3	1	-	-	1	2	3	3	1	-	-	-	3	1	3	-
21BMC07.CO4	1	-	-	2	2	3	3	1	-	-	-	3	1	3	-
21BMC07.CO5	1	-	-	2	2	3	3	1	-	-	-	3	1	3	-

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

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UNIT-I   General Metrology   9

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

UNIT-II   Electrosurgical Equipment   9

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

UNIT-III   Neonatal instrumentation   9

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

UNIT-IV   Respiratory measurements   9

Principles and techniques of impedance Pneumography and pneumotachograph. Ventilators: Artificial Ventilation, Types of ventilators, Modern Ventilators, High frequency Ventilators, Humidifiers, Nebulizers and Aspirators, calibration of a ventilator.

UNIT-V   General anesthesia   9

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

TOTAL: 45 HRS

REFERENCE 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
3.	M.Arumugam	Bio-Medical Instrumentation	Anuradha Agencies	2003
4.	A. Geddes and L.E.Baker	Principles of Applied Bio-Medical Instrumentation	John Wiley & Sons	1975
5.	J.Webster	Medical Instrumentation	John Wiley & Sons	1995

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COURSE CODE	COURSE TITLE	L	T	P	C
21BMC08	SIGNALS AND SYSTEMS	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

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

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
21BMC08.CO1	X	X	X	X	X	-	-	-	-	-	-	X	X	X	X
21BMC08.CO2	X	X	X	X	X	-	-	-	-	-	-	X	X	X	X
21BMC08.CO3	X	X	X	X	X	-	-	-	-	-	-	X	X	X	X
21BMC08.CO4	X	X	X	X	X	-	-	-	-	-	-	X	X	X	X
21BMC08.CO5	X	X	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
21BMC08.CO1	2	2	2	2	1	-	-	-	-	-	-	3	3	2	2
21BMC08.CO2	3	3	3	2	1	-	-	-	-	-	-	3	3	2	2
21BMC08.CO3	3	3	3	2	1	-	-	-	-	-	-	3	3	2	2
21BMC08.CO4	3	3	3	2	1	-	-	-	-	-	-	3	3	2	2
21BMC08.CO5	3	3	3	2	1	-	-	-	-	-	-	3	3	2	2

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

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UNIT-I   SIGNALS & SYSTEMS   9

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

UNIT II   ANALYSIS OF CONTINUOUS TIME SIGNALS   9

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

UNIT III   LINEAR TIME INVARIANT SYSTEMS   9

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

UNIT IV   ANALYSIS OF DISCRETE TIME SIGNALS   9

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

UNIT V   LINEAR TIME INVARIANT-DISCRETE TIME SYSTEMS   9

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

TOTAL :45 HRS

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REFERENCE 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
3.	B P Lathi	Signals and Systems	B S Publisher	2001
4.	Nagrath ,Sharan	Signals and Systems	McGraw Hill	2009
5.	S.Salivahanan, N.Sureshkumar and A.Vallavaraj	Signals and Systems	Tata McGraw Hill	2011

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COURSE CODE	COURSE TITLE	L	T	P	C
21BMC09	BIOMEDICAL INSTRUMENTATION - II	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

CO1:	Demonstrate the cardiac assist devices and ICU layout.
CO2:	Assess use of electrical stimulation principles to overcome cardiac rhythm disturbances.
CO3:	Enumerate various defibrillators along with their working principles.
CO4:	Perceive the governing principles of oxygenators and ophthalmic instruments.
CO5:	Comprehend the principles of hemodialysis machine and lithotripter.

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
21BMC09.CO1	X	X	X	X	-	X	-	-	-	X	-	x	x	x	x
21BMC09.CO2	X	X	X	X	-	X	-	-	-	X	-	x	x	x	x
21BMC09.CO3	X	X	X	X	-	X	-	-	-	X	-	x	x	x	x
21BMC09.CO4	X	X	X	X	-	X	-	-	-	X	-	x	x	x	x
21BMC09.CO5	X	X	X	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
21BMC09.CO1	2	1	1	1	-	2	-	-	-	2	-	2	2	2	1
21BMC09.CO2	2	1	1	1	-	2	-	-	-	2	-	2	2	2	1
21BMC09.CO3	2	1	1	1	-	2	-	-	-	2	-	2	2	2	1
21BMC09.CO4	2	1	1	1	-	2	-	-	-	2	-	2	2	2	1
21BMC09.CO5	2	1	1	1	-	2	-	-	-	2	-	2	2	2	1

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

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UNIT-I   **Critical physiological parameters**   **9**

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

UNIT-II   **Cardiac Pacemakers**   **9**

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

UNIT-III   **Defibrillators**   **9**

Need for Defibrillators, D.C. Defibrillator, Need for Synchronous Defibrillators, Types of electrodes and their features, Types of Waveforms, Automatic/Advisory External Defibrillators (AED), Implantable defibrillators. Cardioverters: Working principle, Defibrillator analyzers.

UNIT-IV   **Heart lung Machine**   **9**

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

UNIT-V   **Haemodialyzer**   **9**

Artificial Kidney, Dialyzers, Membranes for Haemodialysis, Haemodialysis Machine, Monitoring circuits for hemodialysis machine, Portable Kidney Machines. Lithotriptors: Principles and Applications, Need for Lithotriptor, First Lithotriptor Machine, Modern Lithotriptor Systems, Extra-corporeal shock-wave Therapy.

TOTAL: 45 HRS

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REFERENCE 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
3.	M.Arumugam	Bio-Medical Instrumentation	Anuradha Agencies	2003.
4.	A. Geddes and L.E.Baker	Principles of Applied Bio-Medical Instrumentation	John Wiley & Sons	1975
5.	J.Webster	Medical Instrumentation	John Wiley & Sons	1995

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COURSE CODE	COURSE TITLE	L	T	P	C
21BMC10	CONTROL SYSTEM FOR BIOMEDICAL ENGINEERING	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

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

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
21BMC10.CO1	X	X	X	X	X	-	-	-	-	-	-	X	X	-	X
21BMC10.CO2	X	X	X	X	X	-	-	-	-	-	-	X	X	-	X
21BMC10.CO3	X	X	X	X	X	-	-	-	-	-	-	X	X	-	X
21BMC10.CO4	X	X	X	X	X	-	-	-	-	-	-	X	X	-	X
21BMC10.CO5	X	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
21BMC10.CO1	3	3	2	2	1	-	-	-	-	-	-	2	3	-	2
21BMC10.CO2	3	3	2	2	1	-	-	-	-	-	-	2	3	-	2
21BMC10.CO3	3	3	2	2	1	-	-	-	-	-	-	2	3	-	2
21BMC10.CO4	3	3	3	2	1	-	-	-	-	-	-	2	3	-	2
21BMC10.CO5	3	3	3	2	1	-	-	-	-	-	-	2	3	-	2

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

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| UNIT I | CONTROL SYSTEM MODELING | 9 |

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

| UNIT II | TIME RESPONSE ANALYSIS | 9 |

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

| UNIT III | FREQUENCY RESPONSE ANALYSIS | 9 |

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

| UNIT IV | STABILITY ANALYSIS | 9 |

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

UNIT V   STATE VARIABLE ANALYSIS AND BIOMEDICAL APPLICATIONS   9

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

TOTAL: 45 HRS

TEXT BOOKS:

S.NO.	AUTHOR(s)	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1.	M. Gopal	Control Systems Principles and Design	Tata Mc Graw Hill, New Delhi	4th Edition, 2012
2.	K. Ogata	Modern Control Engineering	Prentice Hall of India	5th Edition 2012

REFERENCE BOOKS:

S.NO.	AUTHOR(S)	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1.	Arthur, G.O.Mutambara	Design and Analysis of Control Systems	CRC Press	2009
2.	Richard C. Dorf and Robert H. Bishop	Modern Control Systems	Pearson Prentice Hall	2012
3.	Benjamin C. Kuo	Automatic Control systems	Pearson Prentice Hall	2010

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COURSE CODE	COURSE TITLE	L	T	P	C
21BMC11	MEDICAL SIGNAL PROCESSING	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

CO1:	Identify filter for the ECG analysis.
CO2:	Write the types of algorithm for data compression.
CO3:	Analyze ECG signal and their parameters estimations.
CO4:	Analyze EEG and estimate their parameters.
CO5:	Analyze the sleeping modes of EEG.

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
21BMC11.CO1	X	X	X	X	X	X	-	-	-	-	-	X	X	X	X
21BMC11.CO2	X	X	X	X	X	X	-	-	-	-	-	X	X	X	X
21BMC11.CO3	X	X	X	X	X	X	-	-	-	-	-	X	X	X	X
21BMC11.CO4	X	X	X	X	X	X	-	-	-	-	-	X	X	X	X
21BMC11.CO5	X	X	X	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
21BMC11.CO1	3	3	2	2	1	1	-	-	-	-	-	2	3	3	2
21BMC11.CO2	3	3	2	2	1	1	-	-	-	-	-	2	3	3	2
21BMC11.CO3	3	3	3	2	1	1	-	-	-	-	-	2	3	3	2
21BMC11.CO4	3	3	3	2	1	1	-	-	-	-	-	2	3	3	2
21BMC11.CO5	3	3	3	2	1	1	-	-	-	-	-	2	3	3	2

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

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UNIT I   **Adaptive filters**   9

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

UNIT II   **Data Compression Techniques**   9

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

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

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

UNIT IV   **Neurological signal processing**   9

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

UNIT V   **Sleep EEG**   9

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

TOTAL: 45 HRS

TEXT BOOKS:

S.NO.	AUTHOR(S)	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1.	D.C.Reddy	Biomedical Signal Processing-principles and techniques	Tata McGraw-Hill	2005
2.	Rangaraj M. Rangayyan	Biomedical Signal Analysis	IEEE Press	2001

REFERENCE BOOKS:

S.NO.	AUTHOR(S)	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1.	Willis J.Tompkins	Biomedical Digital Signal Processing	PHI	Latest Edition
2.	Akay.M	Biomedical Signal Processing	Academic: Press	1994

COURSE CODE	COURSE TITLE	L	T	P	C
21BMC12	MICROPROCESSORS AND MICROCONTROLLERS IN MEDICINE	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

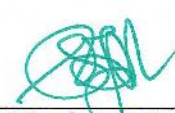| CO1:	Interpret the architecture of 8086 microprocessors and able to write programs.
CO2:	Interpret the architecture of 8051 microcontroller and able to write programs.
CO3:	Interface I/O devices with microcontrollers.
CO4:	Interpret the architecture of ARM microcontroller and able to write programs.
CO5:	Design microprocessor and microcontroller based system using biomedical signals.

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
21BMC12.CO1	x	x	x	x	x	-	-	x	-	-	-	x	x	-	-
21BMC12.CO2	x	x	x	x	x	-	-	x	-	-	-	x	x	-	-
21BMC12.CO3	x	x	x	x	x	-	-	x	-	-	-	x	x	-	-
21BMC12.CO4	x	x	x	x	x	-	-	x	-	-	-	x	x	-	-
21BMC12.CO5	x	x	x	x	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
21BMC12.CO1	3	2	2	2	2	-	-	1	-	-	-	2	3	-	-
21BMC12.CO2	3	2	2	2	2	-	-	1	-	-	-	2	3	-	-
21BMC12.CO3	3	2	2	2	2	-	-	1	-	-	-	2	3	-	-
21BMC12.CO4	3	2	2	2	2	-	-	1	-	-	-	2	3	-	-
21BMC12.CO5	3	3	3	2	2	3	-	3	-	-	-	2	3	3	3

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

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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

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 McGraw-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
21BMC13	BIOMATERIALS 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:

CO1:	Identify types of Biomaterials and its properties.
CO2:	Interpret different metals and ceramics used as implants.
CO3:	Interpret the polymeric materials and combinations.
CO4:	Recognize materials that could be used as tissue replacements.
CO5:	Discuss the artificial organ development.

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
21BMC13.CO1	x	x	x	-	-	-	-	-	-	-	-	x	x	x	-
21BMC13.CO2	x	x	x	-	-	x	x	-	-	-	-	x	x	x	-
21BMC13.CO3	x	x	x	-	-	x	x	-	-	-	-	x	x	x	-
21BMC13.CO4	x	x	x	X	-	x	x	-	-	-	-	x	x	x	-
21BMC13.CO5	x	x	x	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
21BMC13.CO1	2	3	2	-	-	-	-	-	-	-	-	2	2	2	-
21BMC13.CO2	2	3	2	-	-	2	1	-	-	-	-	2	2	2	-
21BMC13.CO3	2	3	2	-	-	2	1	-	-	-	-	2	2	2	-
21BMC13.CO4	2	3	2	1	-	2	1	-	-	-	-	2	2	2	-
21BMC13.CO5	2	3	2	1	-	2	1	-	-	2	-	2	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

REFERENCE BOOKS:

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

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COURSE CODE	COURSE TITLE	L	T	P	C
21BMC14	BIOMECHANICS & REHABILITATION ENGINEERING	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

CO1:	Explain biomechanics of human body to competently analyze its movements.
CO2:	Analyze the dynamics and flow properties of blood and other fluids in the human body.
CO3:	Discuss engineering concepts in sensory & motor rehabilitation.
CO4:	Apply the different types of Therapeutic Exercise Techniques of rehabilitation.
CO5:	Identify different types of prosthetic devices and restoration techniques.

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
21BMC14.CO1	X	X	X	X	-	-	-	-	-	X	-	X	X	X	X
21BMC14.CO2	X	X	X	X	-	-	-	-	-	-	-	X	X	X	X
21BMC14.CO3	X	X	X	X	-	X	X	-	-	X	-	X	X	X	X
21BMC14.CO4	X	X	X	X	-	X	X	X	-	-	-	X	X	X	X
21BMC14.CO5	X	X	X	X	-	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
21BMC14.CO1	2	2	2	1	-	-	-	-	-	2	-	2	3	2	2
21BMC14.CO2	2	2	2	1	-	-	-	-	-	-	-	2	3	2	2
21BMC14.CO3	2	2	2	1	-	2	2	1	-	2	-	2	3	2	2
21BMC14.CO4	2	2	2	1	-	2	2	1	-	-	-	2	3	2	2
21BMC14.CO5	2	2	2	1	-	2	2	1	-	-	-	2	3	2	2

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

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UNIT I   INTRODUCTION TO BIOMECHANICS   9

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

UNIT II   THE FLOW PROPERTIES OF BLOOD   9

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

UNIT III   INTRODUCTION TO REHABILITATION   9

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

UNIT IV   REHABILITATION TEAM & THERAPEUTIC EXERCISE TECHNIQUE   9

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

UNIT V   ORTHOTIC, PROSTHETIC DEVICES & RESTORATION TECHNIQUES   9

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

TOTAL: 45 HRS

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 Verlag	2nd Edition
2.	Sunder	Textbook of Rehabilitation	Jaypee Brothers Medical Publishers Pvt. Ltd, New Delhi	2nd Edition, 2007

REFERENCE 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 Neuroprosthetic Methods	CRC	2002
4.	Rory A Cooper Hisaichi Ohnabe Douglas A. Hobson	An Introduction to Rehabilitation Engineering	CRC	2006

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COURSE CODE	COURSE TITLE	L	T	P	C
21BMC15	EMBEDDED SYSTEMS AND IOMT	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:

CO1:	Describe hardware and software architectures of Embedded Systems.
CO2:	Explain the special features of ARM architecture.
CO3:	Interpret the Embedded Communication protocols.
CO4:	Interpret the concepts of a Real Time Operating System.
CO5:	Demonstrate the applications of Embedded System.

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
21BMC15.CO1	X	X	X	-	-	-	-	-	-	X	-	X	X	-	-
21BMC15.CO2	X	X	X	-	-	X	-	-	-	X	-	X	X	-	-
21BMC15.CO3	X	X	X	-	-	X	-	-	-	X	-	X	X	-	-
21BMC15.CO4	X	X	X	-	-	X	-	-	-	X	-	X	X	-	-
21BMC15.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
21BMC15.CO1	2	2	1	-	-	-	-	-	-	1	-	2	2	-	1
21BMC15.CO2	2	2	1	-	-	1	-	-	-	1	-	2	2	-	1
21BMC15.CO3	2	2	1	-	-	1	-	-	-	1	-	2	2	-	1
21BMC15.CO4	2	2	1	-	-	1	-	-	-	1	-	2	2	-	1
21BMC15.CO5	2	2	1	-	-	1	-	-	-	1	-	2	2	-	1

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

TEXT BOOKS:

S.NO.	AUTHOR(S)	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1.	Raj Kamal,	Embedded Systems Architecture programming and Design	TMH	Second Edition, 2011
2.	Prasad.K.V.K.K,	Embedded Real-Time Systems: Concepts, Design & Programming	Dream tech press	2011

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
21BMC16	MEDICAL IMAGE PROCESSING	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

CO1:	Describe Digital image fundamentals and Image transforms.
CO2:	Apply Image enhancement Techniques.
CO3:	Apply Image Restoration and Segmentation methods.
CO4:	Analyze Wavelets and Image compression Techniques.
CO5:	Apply Image Representation and Recognition Methods.

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
21BMC16.CO1	X	X	X	X	-	-	X	-	X	X	X	X	X	-	X
21BMC16.CO2	X	X	X	X	-	-	X	-	X	-	X	X	X	-	X
21BMC16.CO3	X	X	X	X	-	-	X	-	X	-	X	X	X	-	X
21BMC16.CO4	X	X	X	X	-	-	X	-	X	-	X	X	X	-	X
21BMC16.CO5	X	X	X	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
21BMC16.CO1	2	2	2	3	-	-	1	-	2	2	3	3	2	2	3
21BMC16.CO2	2	2	2	3	-	-	1	-	2	-	3	3	2	2	3
21BMC16.CO3	2	2	2	3	-	-	1	-	2	-	3	3	2	2	3
21BMC16.CO4	2	2	2	3	-	-	1	-	2	-	3	3	2	2	3
21BMC16.CO5	2	2	2	3	-	-	1	-	2	-	3	3	2	2	3

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

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UNIT I   **DIGITAL IMAGE FUNDAMENTALS**   9

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

UNIT II   **IMAGE ENHANCEMENT**   9

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

UNIT III   **IMAGE RESTORATION AND SEGMENTATION**   9

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

UNIT IV   **WAVELETS AND IMAGE COMPRESSION**   9

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

UNIT V   **IMAGE REPRESENTATION AND RECOGNITION**   9

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

TOTAL: 45 Hrs

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REFERENCE BOOKS:

S.NO.	AUTHOR(S)	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1.	R.C. Gonzalez & R.E. Woods	Digital Image Processing	Pearson education	2nd Edition, 2015
2.	A K Jain	Fundamentals of Digital Image Processing	Pearson	2nd Edition, 2013
3.	Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins	Digital Image Processing Using MATLAB	McGraw Hill	2011
4.	Anil Jain K	Fundamentals of Digital Image Processing	PHI	2011

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COURSE CODE	COURSE TITLE	L	T	P	C
21BMC17	MEDICAL IMAGING TECHNIQUES	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

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

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
21BMC17.CO1	X	-	-	-	-	X	X	X	X	X	-	X	X	X	X
21BMC17.CO2	X	-	-	-	-	X	X	X	X	X	-	X	X	X	X
21BMC17.CO3	X	X	-	-	-	X	X	X	X	X	-	X	X	X	X
21BMC17.CO4	X	X	-	-	-	X	X	X	X	X	-	X	X	X	X
21BMC17.CO5	X	X	-	-	-	X	X	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
21BMC17.CO1	2	-	-	-	-	2	2	2	1	2	-	2	2	2	2
21BMC17.CO2	2	-	-	-	-	2	2	2	1	2	-	2	2	2	2
21BMC17.CO3	2	1	-	-	-	2	2	2	1	2	-	2	2	2	2
21BMC17.CO4	2	1	-	-	-	2	2	2	1	2	-	2	2	2	2
21BMC17.CO5	2	1	-	-	-	2	2	2	1	2	-	2	2	2	2

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

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UNIT-I **X Ray Imaging** 9

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

UNIT-II **Computed Tomography** 9

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

UNIT-III **Magnetic Resonance Imaging** 9

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

UNIT- IV **Ultrasound Imaging** 9

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

UNIT-V **Nuclear Medicine** 9

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

TOTAL: 45 Hrs

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REFERENCE 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	Tata McGraw-Hill, New Delhi	3rd edition, 2014
3.	John G. Webster	Medical Instrumentation Application and Design	Wiley India Pvt. Ltd, New Delhi	4th edition , 2015
4.	Joseph J. Carr John M. Brown	Introduction to Biomedical Equipment Technology	Pearson Education	2004

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COURSE CODE	COURSE TITLE	L	T	P	C
21BMC18	ADVANCED THERAPEUTIC EQUIPMENT	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:

CO1:	Understand the imaging techniques in microscopy.
CO2:	Describe various analytical hybrid techniques.
CO3:	Describe various types of analytical special techniques.
CO4:	Demonstrate the functioning of respiratory aids.
CO5:	Understand the radiation therapy & radiation safety.

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
21BMC18.CO1	X	-	-	-	-	X	X	X	X	X	-	X	X	X	X
21BMC18.CO2	X	-	-	-	-	X	X	X	X	X	-	X	X	X	X
21BMC18.CO3	X	X	-	-	-	X	X	X	X	X	-	X	X	X	X
21BMC18.CO4	X	X	-	-	-	X	X	X	X	X	-	X	X	X	X
21BMC18.CO5	X	X	-	-	-	X	X	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
21BMC18.CO1	2	-	-	-	-	2	2	2	1	2	-	2	2	2	2
21BMC18.CO2	2	-	-	-	-	2	2	2	1	2	-	2	2	2	2
21BMC18.CO3	2	1	-	-	-	2	2	2	1	2	-	2	2	2	2
21BMC18.CO4	2	1	-	-	-	2	2	2	1	2	-	2	2	2	2
21BMC18.CO5	2	1	-	-	-	2	2	2	1	2	-	2	2	2	2

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

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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

TEXT BOOKS:

S.NO.	AUTHOR(s)	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1.	Skoog, D.A., Crouch, S.R., and Holler, F.J	Principles of Instrumental Analysis	Brooks/Cole, USA	6th edition, 2006
2.	R.S.Khandpur	Hand book of Biomedical Instrumentation	Tata McGraw Hill, New Delhi	1998

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REFERENCE BOOKS:

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

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COURSE CODE	COURSE TITLE	L	T	P	C
21BMC19	ANALYTICAL & DIAGNOSTIC EQUIPMENTS	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

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

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
21BMC19.CO1	X	-	-	-	-	X	X	X	X	X	-	X	X	X	X
21BMC19.CO2	X	-	-	-	-	X	X	X	X	X	-	X	X	X	X
21BMC19.CO3	X	X	-	-	-	X	X	X	X	X	-	X	X	X	X
21BMC19.CO4	X	X	-	-	-	X	X	X	X	X	-	X	X	X	X
21BMC19.CO5	X	X	-	-	-	X	X	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
21BMC19.CO1	2	-	-	-	-	2	2	2	1	2	-	2	2	2	2
21BMC19.CO2	2	-	-	-	-	2	2	2	1	2	-	2	2	2	2
21BMC19.CO3	2	1	-	-	-	2	2	2	1	2	-	2	2	2	2
21BMC19.CO4	2	1	-	-	-	2	2	2	1	2	-	2	2	2	2
21BMC19.CO5	2	1	-	-	-	2	2	2	1	2	-	2	2	2	2

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

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UNIT I   **ANALYTICAL EQUIPMENTS**   9

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

UNIT II   **RESPIRATORY MEASUREMENT AND ASSIST SYSTEMS**   9

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

UNIT III   **DIATHERMY**   9

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

UNIT IV   **ULTRASOUND EQUIPMENT**   9

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

UNIT V   **ROBOTICS IN MEDICINE**   9

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

TOTAL: 45 HrS

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.	Joseph .J.Carr and John .M.Brown	Introduction to Biomedical Equipment Technology	John Wiley&Sons Inc, New York	2002
4.	Khandpur R.S	Handbook of Biomedical Instrumentation	Tata McGraw Hill, New Delhi	3rd Edition, 2014

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COURSE CODE	COURSE TITLE	L	T	P	C
21BMC20	BIO MEDICAL SENSORS AND INSTRUMENTS LABORATORY	0	0	2	1

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

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

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
21BMC20.CO1	X	X	X	X	-	X	-	-	X	X	X	X	X	X	X
21BMC20.CO2	X	X	X	X	-	X	-	-	X	X	X	X	X	X	X
21BMC20.CO3	X	X	X	X	-	X	-	-	X	X	X	X	X	X	X
21BMC20.CO4	X	X	X	X	-	X	-	-	X	X	X	X	X	X	X
21BMC20.CO5	X	X	X	X	-	X	-	-	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
21BMC20.CO1	3	3	3	2	-	2	-	-	3	2	2	2	3	3	2
21BMC20.CO2	3	3	3	2	-	2	-	-	3	2	2	2	3	3	2
21BMC20.CO3	3	3	3	2	-	2	-	-	3	2	2	2	3	3	2
21BMC20.CO4	3	3	3	2	-	2	-	-	3	2	2	2	3	3	2
21BMC20.CO5	3	3	3	2	-	2	-	-	3	2	2	2	3	3	2

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

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LIST OF EXPERIMENTS:

1. Characteristics of strain gauges.
2. Displacement measurement using LVDT & LVRT
3. Characteristics of temperature sensor-thermistor
4. Characteristics of temperature sensor-RTD.
5. Characteristics of thermocouple
6. Characteristics of Light sensors-LDR, Photo Diode, Photo Transistor.
7. Characteristics of Piezoelectric Transducer.
8. Wheatstone Bridge and Kelvins Bridge for Measurement of Resistance.
9. Measurement of capacitance using bridge circuits.
10. Measurement of inductance using bridge circuits.
11. Characteristics of passive filters.
12. Force measurement using force sensor and calibration.
13. Study of Multimeter and Medical Oscilloscope.
14. Study of Input / Output characteristics using X – Y oscilloscope.

TOTAL: 30 HRS

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COURSE CODE	COURSE TITLE	L	T	P	C
21BMC21	BIOCHEMISTRY AND HUMAN PHYSIOLOGY LABORATORY	0	0	2	1

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

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

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
21BMC21.CO1	X	X	X	X	-	X	-	-	X	X	X	X	X	X	X
21BMC21.CO2	X	X	X	X	-	X	-	-	X	X	X	X	X	X	X
21BMC21.CO3	X	X	X	X	-	X	-	-	X	X	X	X	X	X	X
21BMC21.CO4	X	X	X	X	-	X	-	-	X	X	X	X	X	X	X
21BMC21.CO5	X	X	X	X	-	X	-	-	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
21BMC21.CO1	3	3	3	2	-	1	-	-	3	2	2	2	3	3	2
21BMC21.CO2	3	3	3	2	-	1	-	-	3	2	2	2	3	3	2
21BMC21.CO3	3	3	3	2	-	1	-	-	3	2	2	2	3	3	2
21BMC21.CO4	3	3	3	2	-	1	-	-	3	2	2	2	3	3	2
21BMC21.CO5	3	3	3	2	-	1	-	-	3	2	2	2	3	3	2

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

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LIST OF EXPERIMENTS:

1. General guidelines for working and functional component of biochemistry lab

2. Preparation of solutions: 1) percentage solutions, 2) molar solutions, 3) normal solutions

3. Standardization of pH meter, preparation of buffers, emulsions.

4. Spectroscopy: Determination of absorption maxima (λmax) of a given solution

5. General tests for carbohydrates, proteins and lipids.

6. Identification of Blood Collection Tubes and Phlebotomy equipments

7. Preparation of serum and plasma from blood.

8. Estimation of Hemoglobin

9. Estimation of blood glucose.

10. Estimation of creatinine.

11. Estimation of urea.

12. Estimation of Uric acid

13. Estimation of cholesterol

14. Assay of SGOT/SGPT.

15. ELISA test

16. Separation of proteins by SDS electrophoresis (Demo)

17. Separation of amino acids by thin layer chromatography (Demo).

TOTAL: 30 HRS

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COURSE CODE	COURSE TITLE	L	T	P	C
21BMC22	ANALOG AND DIGITAL INTEGRATED CIRCUITS LABORATORY	0	0	2	1

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

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

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
21BMC22.CO1	X	X	X	X	-	-	-	-	X	X	X	X	X	X	X
21BMC22.CO2	X	X	X	X	-	-	-	-	X	X	X	X	X	X	X
21BMC22.CO3	X	X	X	X	-	-	-	-	X	X	X	X	X	X	X
21BMC22.CO4	X	X	X	X	-	-	-	-	X	X	X	X	X	X	X
21BMC22.CO5	X	X	X	X	-	-	-	-	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
21BMC22.CO1	3	3	3	2	-	2	-	-	3	2	2	2	3	3	2
21BMC22.CO2	3	3	3	2	-	2	-	-	3	2	2	2	3	3	2
21BMC22.CO3	3	3	3	2	-	2	-	-	3	2	2	2	3	3	2
21BMC22.CO4	3	3	3	2	-	2	-	-	3	2	2	2	3	3	2
21BMC22.CO5	3	3	3	2	-	2	-	-	3	2	2	2	3	3	2

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

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LIST OF EXPERIMENTS:

1. Inverting, non-inverting amplifier and comparator

2. Integrator and Differentiator

3. Design and testing of first order Low Pass and High Pass Active filters

4. Design and testing of Phase shift Oscillators and Wein bridge oscillators

5. Instrumentation amplifier using operational amplifier

6. Design and testing of Monostable and Astable Multivibrator using NE555 Timer

7. Simulation and analysis of circuits using software

8. Implementation and testing of code converters.

9. Implementation and testing of multiplexers & demultiplexer

10. Implementation of 4-Bit shift registers using flip flops

TOTAL: 30 HRS

COURSE CODE	COURSE TITLE	L	T	P	C
21BMC23	PATHOLOGY AND MICROBIOLOGY LABORATORY	0	0	2	1

COURSE OBJECTIVES:

- To introduce the relevance of this course to the existing technology through demonstrations, case studies, simulations, contributions of scientist, national/international policies with a futuristic vision along with socio-economic impact and issues.
- To understand the structural and functional aspects of living organisms.
- To know the etiology and remedy in treating the pathological diseases.
- To practice on chemical and structural examinations, histopathological examinations etc.

COURSE OUTCOMES:

CO1:	Analyze structural and functional aspects of living organisms.
CO2:	Explain the parts and function of microscopes.
CO3:	Perform practical experiments on tissue processing, sterilization techniques and staining.
CO4	Identify pathological diseases caused due to microorganisms.
CO4:	Examine chemical, structural and histopathological aspects of tumours.

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
21BMC23.CO1	X	X	X	X	X	-	-	X	X	-	X	X	X	X	X
21BMC23.CO2	X	X	X	X	X	-	-	X	X	-	X	X	X	X	X
21BMC23.CO3	X	X	X	X	X	-	-	X	X	-	X	X	X	X	X
21BMC23.CO4	X	X	X	X	X	-	-	X	X	-	X	X	X	X	X
21BMC23.CO5	X	X	X	X	X	-	-	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
21BMC23.CO1	2	3	3	2	-	-	-	1	1	-	1	2	3	2	1
21BMC23.CO2	2	3	3	2	2	-	-	1	1	-	1	2	3	2	1
21BMC23.CO3	2	3	3	2	2	-	-	1	1	-	1	2	3	2	1
21BMC23.CO4	2	3	3	2	-	-	-	1	1	-	1	2	3	2	1
21BMC23.CO5	2	3	3	2	-	-	-	1	1	-	1	2	3	2	1

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, Simple stain, Gram stain, AFB stain.

9. Antigen-Antibody reaction Immuno electrophoresis

10. Slides of malarial parasites, micro filaria and leishmania donovani.

11. Haematology slides of anemia and leukemia.

12. Study of bone marrow charts.

TOTAL: 30 HRS

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COURSE CODE	COURSE TITLE	L	T	P	C
21BMC24	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 using digital signal processor

COURSE OUTCOMES:

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

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
21BMC24.CO1	X	X	X	X	X	X	-	-	-	-	-	X	X	X	X
21BMC24.CO2	X	X	X	X	X	X	-	-	X	X	-	X	X	X	X
21BMC24.CO3	X	X	X	X	X	X	-	-	X	X	-	X	X	X	X
21BMC24.CO4	X	X	X	X	X	X	-	-	X	X	-	X	X	X	X
21BMC24.CO5	X	X	X	X	X	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
21BMC24.CO1	3	2	2	2	1	2	-	-	-	-	-	2	3	1	2
21BMC24.CO2	3	2	2	2	1	2	-	-	2	1	-	2	3	1	2
21BMC24.CO3	3	2	2	2	1	2	-	-	2	1	-	2	3	1	2
21BMC24.CO4	3	2	2	2	1	2	-	-	2	1	-	2	3	1	2
21BMC24.CO5	3	2	2	2	1	2	-	-	2	1	-	2	3	1	2

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 a difference equation to initial conditions; stability.
4. DFT and FFT computation.
5. FIR filter design using windowing techniques
6. IIR filters design-digital Butterworth filter and Chebyshev filter
7. Simulation of Bio-signals.
8. Analysis of ECG signals.
9. Analysis of EEG signals
10. Analysis of EMG signals

Following National Instrument (NI)'s products will be used as a supplement:

11. NI Vision Development Module
12. NI Vision Acquisition Software
13. Vision Builder for Automated Inspection tools

TOTAL: 30 HRS

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COURSE CODE	COURSE TITLE	L	T	P	C
21BMC25	BIOMEDICAL INSTRUMENTATION LABORATORY	0	0	2	1

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

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

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
21BMC25.CO1	X	X	X	X	X	X	-	-	-	-	-	X	X	X	X
21BMC25.CO2	X	X	X	X	X	X	-	-	X	X	-	X	X	X	X
21BMC25.CO3	X	X	X	X	X	X	-	-	X	X	-	X	X	X	X
21BMC25.CO4	X	X	X	X	X	X	-	-	X	X	-	X	X	X	X
21BMC25.CO5	X	X	X	X	X	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
21BMC25.CO1	3	2	2	2	1	2	-	-	-	-	-	2	3	3	3
21BMC25.CO2	3	2	2	2	1	2	-	-	2	1	-	2	3	3	3
21BMC25.CO3	3	2	2	2	1	2	-	-	2	1	-	2	3	3	3
21BMC25.CO4	3	2	2	2	1	2	-	-	2	1	-	2	3	3	3
21BMC25.CO5	3	2	2	2	1	2	-	-	2	1	-	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. Measurement and Recording of Hearing threshold using Audiometer and plot its characteristics.
8. Design and Analysis of ECG, EEG,EMG amplifier, recording and analysis using Lab View
9. Measurement of Blood Pressure using Sphygmomanometer & Digital meter.
10. Recording of Electromyogram/ nerve conduction velocity.
11. The Galvanic Skin Response Amplifier
12. Study of lung and cardiovascular models
13. Hospital department facility layout for installation and maintenance of biomedical equipment/systems in reference to regulatory guidelines.
14. Measurements using patient monitoring systems (BIOPAC).

TOTAL: 30 HRS

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COURSE CODE	COURSE TITLE	L	T	P	C
21BMC26	MICROPROCESSOR AND MICROCONTROLLER LABORATORY	0	0	2	1

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

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

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
21BMC26.CO1	X	X	X	-	-	-	-	-	-	-	-	X	X	-	X
21BMC26.CO2	X	X	X	-	-	-	-	-	-	-	-	X	X	-	-
21BMC26.CO3	X	X	X	-	-	-	-	-	-	-	-	X	X	-	X
21BMC26.CO4	X	X	X	-	-	-	-	-	-	-	-	X	X	-	-
21BMC26.CO5	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
21BMC26.CO1	2	2	2	-	-	-	-	-	-	-	-	2	3	-	2
21BMC26.CO2	2	2	2	-	-	-	-	-	-	-	-	2	3	-	-
21BMC26.CO3	2	2	2	-	-	-	-	-	-	-	-	2	3	-	2
21BMC26.CO4	2	2	2	-	-	-	-	-	-	-	-	2	3	-	-
21BMC26.CO5	2	2	2	-	-	-	-	-	-	-	-	2	3	-	2

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

COURSE CODE	COURSE TITLE	L	T	P	C
21BMC27	EMBEDDED SYSTEMS LABORATORY	0	0	2	1

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

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

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
21BMC27.CO1	X	X	X	-	-	-	-	-	X	X	X	X	X	X	X
21BMC27.CO2	X	X	X	-	-	-	-	-	X	X	X	X	X	X	X
21BMC27.CO3	X	X	X	X	-	-	-	-	X	X	X	X	X	X	X
21BMC27.CO4	X	X	X	X	-	-	-	-	X	X	X	X	X	X	X
21BMC27.CO5	X	X	X	-	-	-	-	-	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
21BMC27.CO1	3	2	2	-	-	-	-	-	2	1	1	2	3	2	1
21BMC27.CO2	3	2	2	-	-	-	-	-	2	1	1	2	3	2	1
21BMC27.CO3	3	3	3	3	-	-	-	-	2	1	1	2	3	2	1
21BMC27.CO4	3	3	3	3	-	-	-	-	2	1	1	2	3	2	1
21BMC27.CO5	3	2	2	-	-	-	-	-	2	1	1	2	3	2	1

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 4X4 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
21BMC28	MEDICAL IMAGE PROCESSING LABORATORY	0	0	2	1

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

CO1:	Apply filtering techniques to medical images.
CO2:	Apply segmentation techniques.
CO3:	Perform Encryption in image.
CO4:	Identify and perform feature extraction techniques.
CO5:	Apply standards in Image storage and communication.

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
21BMC28.CO1	X	X	X	X	X	-	-	-	X	X	X	X	X	X	X
21BMC28.CO2	X	X	X	X	X	-	-	-	X	X	X	X	X	X	X
21BMC28.CO3	X	X	X	X	X	-	-	-	X	X	X	X	X	X	X
21BMC28.CO4	X	X	X	X	X	-	-	-	X	X	X	X	X	X	X
21BMC28.CO5	X	X	X	X	X	-	-	-	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
21BMC28.CO1	3	2	2	3	2	-	-	-	2	1	1	2	3	3	3
21BMC28.CO2	3	2	2	3	2	-	-	-	2	1	1	2	3	3	3
21BMC28.CO3	3	2	2	3	2	-	-	-	2	1	1	2	3	3	3
21BMC28.CO4	3	2	2	3	2	-	-	-	2	1	1	2	3	3	3
21BMC28.CO5	3	2	2	3	2	-	-	-	2	1	1	2	3	3	3

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

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LIST OF EXPERIMENTS:

1. Display of color and grayscale Images.
2. Conversion between color spaces
3. Histogram Equalization.
4. Spatial filtering
5. Non-linear Filtering.
6. Edge detection using Operators.
7. 2-D DFT and DCT.
8. Filtering in frequency domain.
9. DWT of images.
10. Segmentation using watershed transform.
11. Steganography
12. Feature extraction in medical images.
13. Medical Image Compression techniques.
14. Medical image fusion
15. Study of DICOM standards.

TOTAL: 30 HRS

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Professional Elective Courses

COURSE CODE	COURSE TITLE	L	T	P	C
21BME01	BASIC CLINICAL SCIENCES	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

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

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
21BME01.CO1	X	-	-	-	-	X	-	X	X	X	-	X	X	X	X
21BME01.CO2	X	-	-	-	-	X	-	X	X	X	-	X	X	X	X
21BME01.CO3	X	-	-	-	-	X	-	X	X	X	-	X	X	X	X
21BME01.CO4	X	-	-	-	-	X	-	X	X	X	-	X	X	X	X
21BME01.CO5	X	-	-	-	-	X	-	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
21BME01.CO1	2	-	-	-	-	2	-	2	1	1	-	2	3	2	2
21BME01.CO2	2	-	-	-	-	2	-	2	1	1	-	2	3	2	2
21BME01.CO3	2	-	-	-	-	2	-	2	1	1	-	2	3	2	2
21BME01.CO4	2	-	-	-	-	2	-	2	1	1	-	2	3	2	2
21BME01.CO5	2	-	-	-	-	2	-	2	1	1	-	2	3	2	2

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

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UNIT-I   Renal Failure and Haemodialysis types   9

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

UNIT-II   Dialysing system and Dialysate   9

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

UNIT-III   Anesthesia systems   9

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

UNIT-IV   Anesthesia patient care   9

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

UNIT-V   Anesthesia system maintenance   9

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

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 NewDelhi.	Eight edition, 2007.
2.	Gillian Pocock, Christopher D. Richards	The Human Body An introduction for Biomedical and Health Sciences	Oxford University Press, USA	2009

REFERENCE BOOKS:

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	11 th Edition, Elsevier Saunders	11th Edition, 2006
4.	Juergen Mai George Paxinos	The Human nervous System	Academic Press 3rd Edition	2011
5.	Midthun Joseph	The Digestive and Urinary Systems	World Book, Inc	2011

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COURSE CODE	COURSE TITLE	L	T	P	C
21BME02	BIOSTATISTICS	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

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

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
21BME02.CO1	x	x	x	x	-	-	-	-	-	x	-	x	x	-	x
21BME02.CO2	x	x	x	x	-	-	-	-	-	x	-	x	x	-	x
21BME02.CO3	x	x	x	x	-	-	-	-	-	x	-	x	x	-	x
21BME02.CO4	x	x	x	x	-	-	-	-	-	x	-	x	x	-	x
21BME02.CO5	x	x	x	x	-	-	-	-	-	x	-	x	x	-	x

Course Articulation Matrix:

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PC6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
21BME02.CO1	3	3	2	2	-	-	-	-	-	2	-	2	3	-	2
21BME02.CO2	3	3	2	2	-	-	-	-	-	2	-	2	3	-	2
21BME02.CO3	3	3	2	2	-	-	-	-	-	2	-	2	3	-	2
21BME02.CO4	3	3	2	2	-	-	-	-	-	2	-	2	3	-	3
21BME02.CO5	3	3	2	2	-	-	-	-	-	2	-	2	3	-	3

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

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

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

UNIT II   **STATISTICAL PARAMETERS**   **9**

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

UNIT III   **REGRESSION ANALYSIS**   **9**

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

UNIT IV   **INTERPRETING DATA**   **9**

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

UNIT V   **META ANALYSIS**   **9**

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

TOTAL: 45 HRS

TEXT BOOKS:

S.NO.	AUTHOR(s)	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1.	Joseph A. Ingel finger, Frederick Mosteller, Lawrence A. Thibodeau, James H. Ware	Biostatistics in Clinical Medicine	Singapore	3rd Edition, 1994
2.	Gerald van Belle, Lloyd D. Fisher, Patrick J. Heagerty, Thomas Lumley	Biostatistics: A Methodology For the Health Sciences	John Wiley & Sons	2004

REFERENCES BOOKS:

S.NO.	AUTHOR(s)	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1.	Julien I.E. Hoffman	Biostatistics for Medical and Biomedical Practitioners	Elsevier Press	2015
2.	James F. Jekel	Epidemiology, Biostatistics, and Preventive Medicine	Elsevier Health Sciences	2007
3.	Ray M. Merrill	Fundamentals of Epidemiology and Biostatistics	Jones & Bartlett Learning	2013

COURSE CODE	COURSE TITLE	L	T	P	C
21BME03	MEDICAL SCIENCE	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

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

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
21BME03.CO1	X	X	X	-	-	-	-	-	-	-	-	X	X	-	-
21BME03.CO2	X	X	X	-	-	-	-	-	-	-	-	X	X	-	-
21BME03.CO3	X	X	X	-	-	-	-	-	-	-	-	X	X	-	-
21BME03.CO4	X	X	X	-	-	-	-	-	-	-	-	X	X	-	-
21BME03.CO5	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
21BME03.CO1	3	2	2	-	-	-	-	-	-	-	-	2	2	-	-
21BME03.CO2	3	2	2	-	-	-	-	-	-	-	-	2	2	-	-
21BME03.CO3	3	2	2	-	-	-	-	-	-	-	-	2	2	-	-
21BME03.CO4	3	2	2	-	-	-	-	-	-	-	-	2	2	-	-
21BME03.CO5	3	2	2	-	-	-	-	-	-	-	-	2	2	-	-

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

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UNIT I INTRODUCTION: HOMEOSTASIS, TISSUE, CARTILAGE 9

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

UNIT II NERVOUS SYSTEM 9

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

UNIT III CARDIOVASCULAR SYSTEM 9

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

UNIT IV DIGESTIVE SYSTEM 9

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

UNIT V RESPIRATORY SYSTEM 9

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

TOTAL:45 HRS

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REFERENCE 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 NewDelhi,	Eighth edition, 2007
2.	Gillian Pocock, Christopher D. Richards	The Human Body An introduction for Biomedical and Health Sciences	Oxford University Press, USA	2009
3.	William F. Ganong	Review of Medical Physiology	Mc Graw Hill New Delhi	22nd edition
4.	Eldra Pearl Solomon	Introduction to Human Anatomy and Physiology	W.B.Saunders Company	2003

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COURSE CODE	COURSE TITLE	L	T	P	C
21BME04	SPORTS PHYSICAL THERAPHY	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

CO1:	Interpret the massage techniques for therapeutic uses.
CO2:	Interpret the use of various heat therapy.
CO3:	Interpret the use of various Hydrotherapy.
CO4:	Interpret the effects of cryotherapy.
CO5:	Interpret the various Manual therapy techniques.

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
21BME04.CO1	X	X	X	-	-	-	-	-	-	-	-	X	X	-	-
21BME04.CO2	X	X	X	-	-	-	-	-	-	-	-	X	X	-	-
21BME04.CO3	X	X	X	-	-	-	-	-	-	-	-	X	X	-	-
21BME04.CO4	X	X	X	-	-	-	-	-	-	-	-	X	X	-	-
21BME04.CO5	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
21BME04.CO1	3	2	2	-	-	-	-	-	-	-	-	2	2	-	-
21BME04.CO2	3	2	2	-	-	-	-	-	-	-	-	2	2	-	-
21BME04.CO3	3	2	2	-	-	-	-	-	-	-	-	2	2	-	-
21BME04.CO4	3	2	2	-	-	-	-	-	-	-	-	2	2	-	-
21BME04.CO5	3	2	2	-	-	-	-	-	-	-	-	2	2	-	-

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UNIT I — Massage — 9

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

UNIT II — Heat Therapy — 9

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

UNIT III — Hydrotherapy — 9

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

UNIT IV — Cryotherapy — 9

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

UNIT V — Manual Therapy — 9

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

REFERENCE 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
3.	V.Z. Marmarelis	Advanced methods of physiological modeling	Plenum Press	
4.	J. Candy	Signal Processing: The Model Based approach	Mc. Graw Hill	
5.	L.Stark,	Neurological Control System	Plenum Press	

COURSE CODE	COURSE TITLE	L	T	P	C
21BME05	TELEMEDICINE	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

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

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
21BME05.CO1	X	X	X	-	X	X	-	X	-	-	-	X	X	X	X
21BME05.CO2	X	X	X	-	-	-	.	-	-	X	-	X	X	-	-
21BME05.CO3	X	X	X	-	X	X	-	X	-	-	-	X	X	X	X
21BME05.CO4	X	X	X	-	X	X	-	X	-	-	-	X	X	X	X
21BME05.CO5	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
21BME05.CO1	2	3	3	-	3	2	-	2	-	-	-	2	2	2	2
21BME05.CO2	2	-	-	-	-	-	-	-	-	2	-	2	2	-	-
21BME05.CO3	2	3	3	-	3	2	-	2	-	-	-	2	2	2	2
21BME05.CO4	2	3	3	-	3	2	-	2	-	-	-	2	2	2	2
21BME05.CO5	2	-	-	-	-	-	-	-	-	2	-	2	2	-	-

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

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UNIT I	INTRODUCTION	7

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

UNIT II	ELECTRONIC HEALTH RECORDS	9

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

UNIT III	MOBILE HEALTH	9

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

UNIT IV	TELEMEDICAL STANDARDS	11

Data Security and Standards: Encryption, Cryptography, Mechanisms of encryption, phases of Encryption. Protocols: TCP/IP, ISO-OSI, Standards to followed DICOM, HL7, H. 320 series (Video phone based ISBN) T. 120, H.324 (Video phone based PSTN), Video Conferencing, Real-time Telemedicine integrating doctors / Hospitals, Clinical laboratory data, Radiological data, and other clinically significant biomedical data, Administration of centralized medical data, security and confidentially of medical records and access control, Cyber laws related to telemedicine.

UNIT V	TELEMEDICAL APPLICATIONS	9

Telemedicine access to health care services - health education and self care. Introduction to robotics surgery, telesurgery. Telecardiology, Teleoncology, Telemedicine in neurosciences, Electronic Documentation, e-health services security and interoperability, Telemedicine access to health care services – health education and self care, Business aspects - Project planning and costing, Usage of telemedicine.

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REFERENCE BOOKS:

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

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COURSE CODE	COURSE TITLE	L	T	P	C
21BME06	BRAIN COMPUTER INTERFACE AND APPLICATIONS	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

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

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
21BME06.CO1	X	X	X	X	X	-	-	-	-	-	-	-	X	-	X
21BME06.CO2	X	X	X	X	X	-	-	-	-	-	-	-	X	-	X
21BME06.CO3	X	X	X	X	X	-	-	-	-	-	-	-	X	-	X
21BME06.CO4	X	X	X	X	X	-	-	-	-	-	-	-	X	-	X
21BME06.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
21BME06.CO1	3	2	1	1	2	-	-	-	-	-	-	-	3	-	2
21BME06.CO2	3	2	1	1	2	-	-	-	-	-	-	-	3	-	2
21BME06.CO3	3	2	1	1	2	-	-	-	-	-	-	-	3	-	2
21BME06.CO4	3	2	1	1	2	-	-	-	-	-	-	-	3	-	2
21BME06.CO5	3	2	1	1	2	-	-	-	-	-	-	-	3	-	2

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

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| UNIT I | INTRODUCTION TO BCI | 9 |

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

| UNIT II | ELECTROPHYSIOLOGICAL SOURCES | 9 |

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

| UNIT III | FEATURE EXTRACTION METHODS | 9 |

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

| UNIT IV | FEATURE TRANSLATION METHODS | 9 |

Linear Discriminant Analysis – Support Vector Machines - Regression – Vector Quantization– Gaussian Mixture Modeling – Hidden Markov Modeling – Neural Networks.
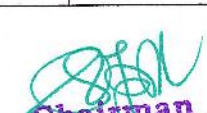
| UNIT V | APPLICATIONS OF BCI | 9 |

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

TOTAL:45 HRS

REFERENCE BOOKS:

S.NO.	AUTHOR(s)	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1.	Bernhard Graimann Brendan Z. Allison GertPfurtscheller	Brain-Computer Interfaces: Revolutionizing Human-Computer Interaction	Springer	2010
2.	R. Spehlmann	EEG Primer	Elsevier Biomedical Press	1981
3.	Arnon Kohen	Biomedical Signal Processing	Vol I and II, CRC Press Inc., Boca Rato, Florida	1986
4.	Bishop C.M.	Neural Networks for Pattern Recognition	Oxford, Clarendon Press	1995

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COURSE CODE	COURSE TITLE	L	T	P	C
21BME07	MEDICAL OPTICS	3	0	0	3

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

COURSE OUTCOMES:

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

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
21BME07.CO1	X	X	X	-	-	-	-	-	-	X	-	X	X	-	-
21BME07.CO2	X	X	X	-	-	X	-	-	-	-	-	X	X	-	-
21BME07.CO3	X	X	X	-	-	X	-	-	-	X	-	X	X	-	-
21BME07.CO4	X	X	X	-	-	X	-	-	-	X	-	X	X	-	-
21BME07.CO5	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
21BME07.CO1	3	2	3	1	-	-	-	-	-	2	-	1	2	-	-
21BME07.CO2	3	2	3	1	-	-	-	-	-	-	-	1	2	-	-
21BME07.CO3	3	2	3	1	-	-	-	-	-	2	-	1	2	-	-
21BME07.CO4	3	2	3	1	-	-	-	-	-	2	-	1	2	-	-
21BME07.CO5	3	2	3	1	-	-	-	-	-	-	-	1	2	-	-

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

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

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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: 45 HRS

REFERENCE 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
3.	Markolf H.Niemz	Laser-Tissue Interaction Fundamentals and Applications	Springer	2007
4.	G.David Baxter	Therapeutic Lasers-Theory and practice	Churchill Livingstone publications	2001
5.	Leon Goldman, M.D.& R.James Rockwell	Lasers in Medicine	Gordon and Breach, Science Publishers Inc	1975

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COURSE CODE	COURSE TITLE	L	T	P	C
21BME08	MEDICAL INFORMATICS	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

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

Mapping of COs with POs and PSOs:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
21BME08.CO1	X	-	-	X	X	-	-	X	-	X	-	X	X	X	X
21BME08.CO2	X	X	X	X	X	-	-	X	-	X	-	X	X	X	X
21BME08.CO3	X	X	X	X	X	-	-	X	-	X	-	X	X	X	X
21BME08.CO4	X	X	X	X	X	-	-	X	-	X	- '	X	X	X	X
21BME08.CO5	X	X	X	X	X	-	-	X	-	X	-	X	X	X	X

Course Articulation Matrix:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
21BME08.CO1	2	-	-	1	2	-	-	2	-	1	-	1	2	1	2
21BME08.CO2	2	2	2	1	2	-	-	1	-	1	-	1	2	1	2
21BME08.CO3	2	2	2	1	2	-	-	1	-	1	-	1	2	1	2
21BME08.CO4	2	2	2	1	2	-	-	1	-	1	-	1	2	1	2
21BME08.CO5	2	2	2	1	2	-	-	1	-	1	-	1	2	1	2

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

UNIT I	INTRODUCTION TO MEDICAL INFORMATICS	9

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Introduction - Medical Informatics – Bioinformatics – Health Informatics - Structure of Medical Informatics –Functional capabilities of Hospital Information System - On-line services and off – line services - History taken by computer, Dialogue with the computer.

UNIT II   MEDICAL STANDARDS   9

Evolution of Medical Standards – IEEE 11073 - HL7 – DICOM – IRMA - LOINC – HIPPA – Electronics Patient Records –Healthcare Standard Organizations – JCAHO (Join Commission on Accreditation of Healthcare Organization) - JCIA (Joint Commission International Accreditation) - Evidence Based Medicine - Bioethics.

UNIT III   MEDICAL DATA ACQUISITION AND STORAGE   9

Plug-in Data Acquisition and Control Boards – Data Acquisition using Serial Interface - Medical Data formats – Signal, Image and Video Formats – Medical Databases - Automation in clinical laboratories - Intelligent Laboratory Information System - PACS, Data mining.

UNIT IV   HEALTH INFORMATICS   9

Bioinformatics Databases, Bio-information technologies, Semantic web and Bioinformatics, Genome projects, Clinical informatics, Nursing informatics, Public health informatics -Education and Training.
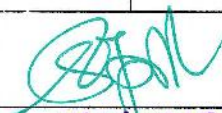
UNIT V   RECENT TRENDS IN MEDICAL INFORMATICS   9

Medical Expert Systems, Virtual reality applications in medicine, Virtual Environment - Surgical simulation - Radiation therapy and planning – Telemedicine – virtual Hospitals - Smart Medical Homes – Personalized e-health services – Biometrics - GRID and Cloud Computing in Medicine.

TOTAL: 45 HRS

REFERENCE BOOKS:

S.NO.	AUTHOR(s)	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1.	.R.D.Lele,	Computers in Medicine: Progress in Medical Informatics	Tata McGraw Hill Publishing computers Ltd, New Delhi	2005
2.	Mohan Bansal	Medical informatics	Tata McGraw Hill Publishing computers Ltd, New Delhi	2003
3.	N.Mathivanan	PC-Based Instrumentation	Prentice Hall of India Pvt Ltd – New Delhi	2007
4.	Yi – Ping Phoebe Chen	Bioinformatics Technologies	Springer International Edition, New Delhi	2007

COURSE CODE	COURSE TITLE	L	T	P	C
21BME09	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 and using it to build Biomedical engineering applications.
- To learn about the applications of VR in medical terms.

COURSE OUTCOMES:

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

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
21BME09.CO1	X	X	X	-	-	-	-	1	-	-	-	·	X	X	X
21BME09.CO2	X	X	X	-	-	-	-	1	-	-	-	-	X	X	X
21BME09.CO3	X	X	X	-	-	-	-	1	-	-	-	-	X	X	X
21BME09.CO4	X	X	X	-	-	-	-	1	-	-	-	-	X	X	X
21BMC01.CO5	X	X	X	-	-	-	-	1	-	-	-	-	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
21BME09.CO1	3	2	1	1	2	-	-	1	-	-	-	-	1	2	2
21BME09.CO2	3	2	1	1	2	-	-	1	-	-	-	-	1	2	2
21BME09.CO3	3	2	1	1	2	-	-	1	-	-	-	-	1	2	2
21BME09.CO4	3	2	1	1	2	-	-	1	-	-	-	-	1	2	2
21BMC01.CO5	3	2	1	1	2	-	-	1	-	-	-	-	1	2	2

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

UNIT I   INTRODUCTION TO VIRTUAL REALITY

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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.

9

UNIT II   3D COMPUTER GRAPHICS

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

UNIT III   VIRTUAL ENVIRONMENT   9

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

UNIT IV   VR HARDWARE AND SOFTWARE   9

Human factors: Introduction, the eye, the ear, the somatic senses. VR Hardware: Introduction, sensor hardware, Head-coupled displays, Acoustic hardware, Integrated VR systems. VR Software: Introduction, Modelling virtual world, Physical simulation, VR toolkits, Introduction to VRML.
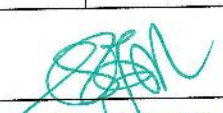
UNIT V   APPLICATIONS   9

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

TOTAL: 45 HRS

REFERENCE 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	Latest Edition
3.	Adams	Visualizations of Virtual Reality	Tata McGraw Hill	2000
4.	Grigore C. Burdea, Philippe Coiffet	Virtual Reality Technology	Wiley Inter Science	2nd Edition,2006
5.	William R. Sherman, Alan B. Craig	Understanding Virtual Reality: Interface, Application and Design	Morgan Kaufmann	2008

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COURSE CODE	COURSE TITLE	L	T	P	C
21BME10	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:

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

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
21BME10.CO1	-	-	-	-		-	-	-	-		-	X	X	X	-
21BME10.CO2	-	-	-	-	X	X	X	X	-	-	-	X	X	X	-
21BME10.CO3	-	-	-	-	X	X	X	X	X	X	-	X	X	X	-
21BME10.CO4	-	-	-	-	-	X	X	X	X	X	X	X	X	X	-
21BME10.CO5	-	-	-	-	X	X	X	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
21BME10.CO1	-	-	-	-	-	-	-	-	-	2	-	1	2	-	2
21BME10.CO2	-	-	-	-	2	1	-	-	2	2	-	1	2	-	2
21BME10.CO3	-	-	-	-	2	1	-	-	2	2	-	1	2	-	2
21BME10.CO4	-	-	-	-	-	1	-	-	2	2	-	1	2	-	2
21BME10.CO5	-	-	-	-	2	1	-	-	2	2	-	1	2	-	2

1 - Low, 2 - Medium, 3 – High

UNIT I   SENSORS

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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

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

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COURSE CODE	COURSE TITLE	L	T	P	C
21BME11	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:

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

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
21BME11.CO1	X	X	X	-	X	-	-	-	-	-	-	X	X	-	X
21BME11.CO2	X	X	X	-	X	-	-	-	-	-	-	X	X	-	X
21BME11.CO3	-	-	-	X	X	-	-	-	-	-	X	X	X	-	X
21BME11.CO4	-	-	-	X	X	X	X	X	-	-	X	X	X	-	X
21BME11.CO5	-	-	-	-	X	X	X	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
21BME11.CO1	3	2	2	-	2	-	-	-	-	2	-	2	2	-	3
21BME11.CO2	3	2	2	-	2	-	-	-	-	2	-	2	2	-	3
21BME11.CO3	-	-	-	2	2	-	-	-	-	2	-	2	2	-	3
21BME11.CO4	-	-	-	2	2	1	-	-	-	2	-	2	2	-	3
21BME11.CO5	-	-	-	-	2	1	-	-	2	2	-	2	2	-	3

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

UNIT I   FUNDAMENTALS OF IoT   9

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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   9
**   SERVICES**

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   9
**   APPLICATIONS**

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

REFERENCE BOOKS:

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

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COURSE CODE	COURSE TITLE	L	T	P	C
21BME12	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:

CO1:	Categorize hazardous healthcare waste.
CO2:	Explain the importance of the biomedical waste disposal in the society.
CO3:	Explain the infection control and monitoring.
CO4:	Know about the types of treatment technologies for wastes.
CO5:	Learn the laws of biomedical waste handling and the Healthcare waste Management.

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
21BME12.CO1	X	-	-	-	-	X	X	X	-	X	-	X	-	X	X
21BME12.CO2	X	-	-	-	-	X	X	X	-	X	-	X	-	X	X
21BME12.CO3	X	-	-	-	-	X	X	X	-	X	-	X	-	X	X
21BME12.CO4	X	-	-	-	-	X	X	X	-	X	-	X	-	X	X
21BME12.CO5	X	-	-	-	-	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
21BME12.CO1	1	-	-	-	-	2	3	3	-	2	-	1	-	2	1
21BME12.CO2	1	-	-	-	-	2	3	3	-	2	-	1	-	2	1
21BME12.CO3	1	-	-	-	-	2	3	3	-	2	-	1	-	2	1
21BME12.CO4	1	-	-	-	-	2	3	3	-	2	-	1	-	2	1
21BME12.CO5	1	-	-	-	-	2	3	3	-	2	-	1	-	2	1

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

UNIT I   INTRODUCTION

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9

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

| UNIT II | HAZARD OF BIOMEDICAL WASTE | 9 |

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

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

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

| UNIT IV | TREATMENT TECHNOLOGIES FOR WASTES | 9 |

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

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

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

REFERENCE BOOKS:

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

COURSE CODE	COURSE TITLE	L	T	P	C
21BME13	FIBER OPTICS AND LASERS IN MEDICINE	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

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

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
21BME13.CO1	X	X	X	-	X	-	-	-	-	-	-	X	X	X	-
21BME13.CO2	X	X	X	-	X	-	-	-	-	-	-	X	X	X	-
21BME13.CO3	X	X	X	-	X	-	-	-	-	X	-	X	X	X	-
21BME13.CO4	X	X	X	-	X	-	-	-	-	X	-	X	X	X	-
21BME13.CO5	X	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
21BME13.CO1	2	1	1	-	2	-	-	-	-	-	-	1	1	2	-
21BME13.CO2	2	1	1	-	2	-	-	-	-	-	-	1	1	2	-
21BME13.CO3	2	1	1	-	2	-	-	-	-	2	-	1	1	2	-
21BME13.CO4	2	1	1	-	2	-	-	-	-	2	-	1	1	2	-
21BME13.CO5	2	1	1	-	2	-	-	-	-	2	-	1	1	2	-

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

UNIT I   **OPTICAL FIBRES AND THEIR PROPERTIES**   9

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

UNIT II   LOSSES AND DISPERSION IN FIBER OPTICS   9

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

UNIT III   APPLICATION OF LASERS IN THERAPY AND DIAGNOSIS   9

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

UNIT IV   ENDOSCOPY   9

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

UNIT V   CLINICAL APPLICATIONS OF FIBER OPTIC LASER   9
SYSTEMS

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

REFERENCE BOOKS:

S.NO.	AUTHOR(s)	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1.	Abraham Katzir	Lasers and Optical Fibers in Medicine	Academic press Inc	
2.	John Crisp	Introduction to fiber optics	Mc Graw Hill	2nd Edition 2001
3.	G.David Baxterr Churchill Livingstone	Therapeutic Lasers - Theory and practice	Addison Wesley	

COURSE CODE	COURSE TITLE	L	T	P	C
21BME14	COMMUNICATION ENGINEERING	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

CO1: Comprehend and appreciate the significance and role of this course in the present contemporary world.

CO2: Apply analog modulation techniques.

CO3: Apply digital modulation techniques.

CO4: Identify various types of noises during transmission.

CO5: Analyze various error control coding techniques.

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
21BME14.CO1	X	X	X	-	X	-	-	-	-	X	-	X	X	X	-
21BME14.CO2	X	X	X	-	X	-	-	-	-	-	-	X	X	X	-
21BME14.CO3	X	X	X	-	X	-	-	-	-	-	-	X	X	X	-
21BME14.CO4	X	X	X	-	X	-	-	-	-	X	-	X	X	X	-
21BME14.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
21BME14.CO1	2	1	1	-	1	-	-	-	-	2	-	1	1	1	-
21BME14.CO2	2	1	1	-	1	-	-	-	-	-	-	1	1	1	-
21BME14.CO3	2	1	1	-	1	-	-	-	-	-	-	1	1	1	-
21BME14.CO4	2	1	1	-	1	-	-	-	-	2	-	1	1	1	-
21BME14.CO5	2	1	1	-	1	-	-	-	-	-	-	1	1	1	-

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

UNIT I   ANALOG MODULATION

9

Amplitude Modulation – AM, DSBSC, SSBSC, VSB – Angle modulation – PM and FM – Modulators and Demodulators.

UNIT II   **RECEIVER CHARACTERISTICS**   **9**

Noise sources and types – Noise figure and noise temperature – Noise in cascaded systems – Single tuned receivers – Super heterodyne receivers.

UNIT III   **INFORMATION THEORY**   **9**

Measure of information – Entropy – Source coding theorem – Discrete memoryless channels – lossless, deterministic, noiseless, BEC, BSC – Mutual information – Channel capacity – Shannon-Fano coding, Huffman Coding, run length coding, LZW algorithm.

UNIT IV   **BANDPASS SIGNALING**   **9**

Geometric representation of signals – Correlator and matched filter – ML detection – generation and detection, PSD, BER of coherent BPSK, BFSK, QPSK – Principles of QAM – Structure of non-coherent receivers – BFSK, DPSK

UNIT V   **ERROR CONTROL CODING TECHNIQUES**   **9**

Channel coding theorem – Linear block codes – Hamming codes – Cyclic codes (CRC) – Convolutional codes – Viterbi decoding (Soft/Hard decision decoding).

TOTAL: 45 HRS

TEXT BOOKS:

S.NO.	AUTHOR(S)	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1.	H Taub, D L Schilling, G Saha	Principles of Communication Systems	TMH	3rd Edition, 2007
2.	S. Haykin	Digital Communications	John Wiley	2005

REFERENCE BOOKS:

S.NO.	AUTHOR(S)	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1.	B.P.Lathi	Modern Digital and Analog Communication Systems	Oxford University Press	3rd Edition, 2007
2.	H P Hsu, Schaum	Outline Series, Analog and Digital Communications	TMH	2006
3.	B.Sklar	Digital Communications Fundamentals and Applications	Pearson Education	2nd Edition, 2007

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COURSE CODE	COURSE TITLE	L	T	P	C
21BME15	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
21BME15.CO1	X	X	X	X	-	-	-	-	-	-	-	X	X	-	-
21BME15.CO2	X	X	X	X	-	X	-	-	-	-	-	X	X	-	-
21BME15.CO3	X	X	X	X	-	X	-	-	-	-	-	X	X	-	-
21BME15.CO4	X	X	X	X	-	X	-	-	-	-	-	X	X	-	-
21BME15.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
21BME15.CO1	2	3	3	2	-	-	-	-	-	-	-	2	3	-	-
21BME15.CO2	2	3	3	2	-	2	-	-	-	-	-	2	3	-	-
21BME15.CO3	2	3	3	2	-	2	-	-	-	-	-	2	3	-	-
21BME15.CO4	2	3	3	2	-	2	-	-	-	-	-	2	3	-	-
21BME15.CO5	2	3	3	2	-	2	-	-	-	-	-	2	3	-	-

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

UNIT I	IONIZING RADIATION AND ITS MEDICAL APPLICATIONS	9

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

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overview, Ultraviolet.

UNIT II   **PHYSICS OF THE SENSES**   9

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

                                                        9

UNIT III   **PRINCIPLES OF RADIOACTIVE NUCLIDES**

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**   9
                OF RADIATION WITH MATTER

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

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

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

REFERENCE BOOKS:

S.NO.	AUTHOR(s)	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1.	Gopal B. Saha	Physics and Radiobiology of Nuclear Medicine 4th Edition	Springer	2013
2.	B H Brown, R H Smallwood, D C Barber, P V Lawford, 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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COURSE CODE	COURSE TITLE	L	T	P	C
21BME16	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:

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

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
21BME16.CO1	X	X	X	X	-	-	-	-	-	-	-	X	X	-	-
21BME16.CO2	X	X	X	X	-	X	-	-	-	-	-	X	X	-	-
21BME16.CO3	X	X	X	X	-	X	-	-	-	-	-	X	X	-	-
21BME16.CO4	X	X	X	X	-	X	-	-	-	-	-	X	X	-	-
21BME16.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
21BME16.CO1	2	3	3	2	-	-	-	-	-	-	-	2	3	-	-
21BME16.CO2	2	3	3	2	-	2	-	-	-	-	-	2	3	-	-
21BME16.CO3	2	3	3	2	-	2	-	-	-	-	-	2	3	-	-
21BME16.CO4	2	3	3	2	-	2	-	-	-	-	-	2	3	-	-
21BME16.CO5	2	3	3	2	-	2	-	-	-	-	-	2	3	-	-

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

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UNIT I   **INTRODUCTION**   9

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

UNIT II   SAFETY ASPECTS IN MEDICAL IMAGING SYSTEMS   9

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

UNIT III   **Definition**   9

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

UNIT IV   **Standards and Regulations Background**   9

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

UNIT V   **The Medical Devices Directives**   9

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

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REFERENCE BOOKS:

S.NO.	AUTHOR(s)	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1.	Richard Fries	Reliable Design of Medical Devices	CRC Press	2nd Edition, 2006
2.	Richard C Fries	Medical Device Quality Assurance and Regulatory Compliance	CRC Press	1998
3.	MichaelCheng	Medical device regulations: global overview and guiding Principles	World Health Organization	Latest Edition
4.	Gábor Czitán, Attila Gutassy, Ralf Wilde	Product Safety in the European Union	TÜV Rheinland Akadémia	2008

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Employability Enhancement Courses

COURSE CODE	COURSE TITLE	L	T	P	C
21BMS01	PROJECT WORK PHASE - I	0	0	10	5

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

CO1:	Discover technical ideas in the field of BME and express strategies and methodologies.
CO2:	Summarize a survey of several available literatures in the preferred field of study.
CO3:	Convert ideas of interest into a conceptual model by comparing several existing solutions.
CO4:	Demonstrate an ability to work in teams in a collaborative and productive manner.
CO5:	Formulate and propose a plan for creating a solution, prepare technical report and present the oral demonstrations.

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
21BMS01.CO1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
21BMS01.CO2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
21BMS01.CO3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
21BMS01.CO4	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
21BMS01.CO5	X	X	X	X	X	X	X	X	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
21BMS01.CO1	3	3	3	3	3	3	3	3	3	2	3	3	3	3	3
21BMS01.CO2	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3
21BMS01.CO3	3	3	3	3	3	2	3	3	3	2	3	3	3	3	3
21BMS01.CO4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
21BMS01.CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

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

TOTAL: 150 Hrs

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COURSE CODE	COURSE TITLE	L	T	P	C
21BMS02	PROJECT WORK PHASE - II	0	0	18	9

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 design and implement a complete working project model.
- To exhibit the communication skills in presenting the project done.

COURSE OUTCOMES:

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

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
21BMS02.CO1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
21BMS02.CO2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
21BMS02.CO3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
21BMS02.CO4	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
21BMS02.CO5	X	X	X	X	X	X	X	X	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
21BMS02.CO1	3	3	3	3	3	3	3	3	3	3	3	3	2	2	3
21BMS02.CO2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
21BMS02.CO3	3	3	3	3	3	3	3	3	3	2	3	3	3	3	3
21BMS02.CO4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
21BMS02.CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Based on the work methodology decided in the Phase I, the project is further developed. Necessary modeling and analysis is done using required software / the prototype of the project is fabricated. The analytical results and the experimental results are validated. Three reviews will be conducted periodically by a committee constituted by the Head of the Department. A project report prepared by the students along with the prototype of the project has to be submitted for the final viva voce examination.

TOTAL: 270 Hrs

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COURSE CODE	COURSE TITLE	L	T	P	C
21BMS03	PRESENTATION SKILL AND TECHNICAL SEMINAR	0	0	2	1

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

CO1:	Acquire technical knowledge along with communication and presentation skill.
CO2:	Utilize new tools and techniques for report preparation and oral presentation.
CO3:	Prepare technical report and present.

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
21BMS03.CO1	X	X	-	X	X	-	-	-	X	X	X	X	X	X	-
21BMS03.CO2	X	X	X	X	X	-	-	-	X	X	X	X	X	X	-
21BMS03.CO3	X	X	X	X	X	X	-	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
21BMS03.CO1	3	3	-	3	3	-	-	-	3	3	3	3	3	3	-
21BMS03.CO2	3	3	3	3	3	-	-	-	3	3	3	3	3	3	-
21BMS03.CO3	3	3	3	3	3	3	-	3	3	3	3	3	3	3	-

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

TOTAL: 30 Hrs

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COURSE CODE	COURSE TITLE	L	T	P	C
21BMS04	INTERNSHIP / HOSPITAL TRAINING	0	0	0	1

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

CO1:	Demonstrate creativity in solving problems related to real-life scenario.
CO2:	Communicate effectively in issues related to process/projects undertaken.
CO3:	Demonstrate and practice good work ethics.
CO4:	Work independently or under very minimal supervision.
CO5:	Demonstrate planning, management, monitoring and delivery of project undertaken.

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
21BMS04.CO1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
21BMS04.CO2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
21BMS04.CO3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
21BMS04.CO4	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
21BMS04.CO5	X	X	X	X	X	X	X	X	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
21BMS04.CO1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
21BMS04.CO2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
21BMS04.CO3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
21BMS04.CO4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
21BMS04.CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

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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Foundation Courses

21HSS01 - BUSINESS ENGLISH

COURSE OBJECTIVES

* To make effective communication in business situations.
* To use English accurately, appropriately and fluently in different situations (academic, social and professional) and familiarize themselves with all speech sounds in English
* To inculcate the effective email writing skills for better business communication.
* To ensure that learners to understand the fundamentals of Business writing and interviews.
* To prepare for and participate in presentations on business topics.

COURSE OUTCOMES

* Execute strategies to become a successful employee or employer in the workplace.
* Write cohesively and coherently and flawlessly avoiding grammatical errors, using a wide vocabulary range, organizing their ideas logically on a topic.
* Execute to use electronic technology in business communication
* Exemplify lectures, talks and interviews on business topics delivered by authentic business specialists
* Choose phrases and sentences clearly during their presentation and communication.

CO – PO MAPPING :

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

ARTICULATION MATRIX:

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

UNIT I COMMUNICATION AND BUSINESS ENGLISH   6

Communication - Objectives - Importance - Process of Communication - Barriers to Communication - Effective Communication - Text about Business- Business Operations - Conversation - Situational Role Play - between examiner and candidate, teacher and student, customer and sales manager, hotel manager and organizer, team leader and team member, - Reading Comprehension (Reading short passages and answering multiple choice and open-ended questions)

UNIT II GRAMMAR & VOCABULARY   6

Phrases & Clauses - Kinds of Sentences - Sentence Patterns - GRE Vocabulary - Prefix & Suffix - Synonyms - Antonyms - Word Formation - Error Spotting - Idioms and Phrases - 'If' Conditionals - Numerical Expressions

UNIT III   WRITING CV AND LETTER OF APPLICATION   6

Writing for communicative purposes [Letters - Official and Personal , Messages / Notices, Reports , Emails, Advertisements - Application for a job (covering letter and CV) - Creative Writing
(Stories, Poems, Dialogues) - Academic Writing [Paragraphs , Essays]

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UNIT IV   JOB INTERVIEWS AND RECRUITMENT   6

Job Interviewing - Appearance and Body language - Attending Interviews - Public Speaking - Overcome Nervousness- Listening to different kinds of Interviews (face-to-face, radio, TV and telephone interviews) - Recruitment

UNIT V   PRESENTATION AND GRAMMAR USAGE   6

Presentation - Types and Importance of Presentation - First Impressions in Presentations - Simple Present, Past and Future - Standards of Punctuation - Subject-Verb Agreement

TOTAL HOURS: 30

TEXT BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Lesikar, Bamford	Basic Business Communication"	1st Canadian Edition (IRWIN DORSEY), Von Hoffmann Press,	1993
2.	Simon Sweeney	English For Business	Cambridge University Press	2008

REFERENCE BOOKS:

SL.No	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Mindscapes	English For Technologists and Engineers	Department of English, Anna University, Chennai,	2012
2.	Rutherford, Andrea.	J Basic Communication Skills for Technology.	Pearson New Delhi.	2001
3.	Viswamohan, Aysha.	English for Technical Communication	Tata McGraw-Hill, New Delhi.	2008
4.	Aspinall Tricia, Bethell George.	Test your Business Vocabulary in Use.	Cambridge University Press	2003
5.	Cambridge ESOL.	BEC 1, 3.	Cambridge University Press,	2001

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21BSS21	ALGEBRA AND CALCULUS	L T P C
		3 1 0 4

COURSE OBJECTIVES

* Remember the use of matrix and algebra techniques in engineering applications and to develop for future applications
* Understanding the differential calculus concepts. This is needed in almost all branches of engineering.
* Applying the knowledge on the functions with several variables which finds applications in many engineering branches
* Students should understand the integral calculus concepts.
* Remember the mathematical tools and is needed in evaluating multiple integrals and their usage.

COURSE OUTCOMES

* This course equips students to have basic knowledge in matrix algebra techniques with its engineering applications..
* The students will have knowledge on functions with several variables.
* This course helps students in understanding the concepts of differential calculus
* The students will gain understanding of the basic techniques of integration.
* The students will have the ability to solve the real time engineering problems with multiple integrals and their usage.

CO – PO MAPPING :

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

ARTICULATION MATRIX:

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

UNIT - I   MATRICES   9+3

Characteristic equation – Eigenvalues and Eigenvectors – Properties of eigen values and eigen vectors – Cayley-Hamilton Theorem (Without Proof) – Diagonalization - Orthogonal transformation (Symmetric Matrix)– Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of Quadratic form.

UNIT – II   GEOMETRICAL APPLICATIONS OF DIFFERENTIAL CALCULUS   9+3

Representation of Functions, Limits, Continuity, Derivatives, Differentiability Rules-Maxima and Minima of functions of one variable- Mean Value Theorem.

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UNIT – III   FUNCTIONS OF SEVERAL VARIABLES   9+3

Functions of two variables – Taylor series - Partial derivatives – Jacobians - Maxima and minima — Lagrange`s multipliers method.

UNIT – IV   INTEGRAL CALCULUS   9+3

Definite and Indefinite Integrals-Substitution Rule-Integration by parts-Trigonometric Integrals, Integration of rational and irrational functions by partial fractions -Improper Integrals.

UNIT – V   MULTIPLE INTEGRALS   9+3

Double integrals in Cartesian and Polar coordinates – Change of order of integration – Area of double integral - Triple integration in Cartesian coordinates – Volume as triple integrals.

TOTAL: 45 + 15 = 60 Hours

TEXT BOOKS:

Sl. No	Author(s)	Title of the Book	Publisher	Year of Publication
1	James Stewart	Calculus with Early Transcendental Functions	Cengage Learning, New Delhi	2008
2.	Grewal. B.S	Higher Engineering Mathematics, 43rd Edition	Khanna Publications, Delhi	2014

REFERENCE BOOKS:

Sl. No	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Veerarajan. T	Engineering Mathematics for first year	Tata McGraw-Hill Publishing Company Ltd., New Delhi	2015
2.	Erwin Kreyszig	Advanced Engineering Mathematics, 9th Edition	John Wiley and Sons, New Delhi	2018
3.	Jain R.K., Iyengar S.R.K.	Advanced Engineering Mathematics, 4th edition	Alpha Science International Ltd	2014
4.	Bali N. P Manish Goyal	A Text book of Engineering Mathematics, 9th edition	Laxmi Publications Pvt Ltd.	2016
5.	Dass, H.K., Er. RajnishVerma	Higher Engineering Mathematics, 3rd Revised Edition	S. Chand Private Ltd	2014

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21BSS01   ENGINEERING PHYSICS

L T P C
3 0 0 3

COURSE OBJECTIVES

* To acquire the knowledge in acoustical engineering and ultrasonic
* To enrich the principles involved in laser technology and its applications
* To acquire the knowledge on applications of fiber optics
* To acquire the knowledge on classification and properties of different types of crystal structures
* To understand the concepts in elasticity and transfer of heat energy through materials

COURSE OUTCOMES (COS):

* Implement the contemporary issues on acoustics and ultrasonic studies
* Associate the properties of laser technology for engineering applications
* Illustrate the types of optical fibers and its applications
* Summaries the atomic structure in crystalline materials
* Describe the elastic and thermal conductivity properties of materials

CO – PO MAPPING :

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

ARTICULATION MATRIX:

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

UNIT I   ACOUSTICS AND ULTRASONICS   9

Introduction of acoustics – Classification of sound-Weber-Fechner law- Reverberation – Reverberation time – Factors affecting acoustics of building and its remedy - Absorption coefficient – Measurement of Absorption coefficient. Introduction– properties - Detection of ultrasonic waves, Magnetostriction effect - Magnetostriction generator – piezoelectric effect - piezoelectric generator– Cavitations - - SONAR - Non Destructive Testing – pulse echo system, through transmission and reflection modes.

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UNIT II   LASERS   9

Introduction – Principle of Spontaneous emission and stimulated emission. Population inversion - pumping methods. Einstein's A and B coefficients – derivation - Types of lasers – He-Ne, Nd-YAG, Semiconductor lasers (homojunction & heterojunction) - Industrial Applications - Lasers in welding, cutting, heat treatment – Medical applications - Holography (construction & reconstruction).

UNIT III FIBRE OPTICS AND ITS APPLICATIONS   9

Principle and propagation of light in optical fibers – Numerical aperture and Acceptance angle - Classification based on materials, refractive index profile – Double crucible technique of fibre drawing – Splicing - Loss in optical fiber – attenuation, dispersion, bending - Fibre optical communication system (Block diagram) – Fiber optic Light sources - Detectors - Endoscope.

UNIT IV - CRYSTAL PHYSICS   9

Lattice – Unit cell – Bravais lattice – Lattice planes – Miller indices – d spacing in cubic lattice – Calculation of number of atoms per unit cell – Atomic radius –Coordination number – Packing factor for SC, BCC, FCC and HCP structures –Crystal defects – point, line and surface defects- Burger vector.

UNIT V PROPERTIES OF MATTER AND THERMAL PHYSICS   9

Elasticity – Hook's law – Relationship between three modulii of elasticity (Qualitative) – stress and strain diagram – Poisson's ratio – factors affecting elasticity – bending moment – depression of a cantilever – young's modulus by uniform bending – I shaped girders. Modes of heat transfer – thermal conductivity – Newton's law of cooling – linear heat flow – lee's disc method – radial heat flow – rubber tube method – conduction through compound media (series and parallel method)

TOTAL: 45 Hours

TEXT BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1.	B.N.Sankar & S.O.Pillai,	Engineering Physics I	New Age International Publishers	2015
2	Rajagopal K	Engineering Physics	PHI, New Delhi	2011

REFERENCE BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Tamilarasan,K &Prabhu,K	Engineering Physics-I	Mc Graw Hill Education	2015
2	Palanisamy P.K	Engineering Physics	SCITECH Publications	2011
3	Senthilkumar G	Engineering Physics I	VRB Publishers	2011
4	Gaur R.K. and Gupta S.L.	Engineering Physics	Dhanpat Rai publishers	2009
5	Sudarmozhi.G.	Engineering Physics I	Bharathi Publishers	2015

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21BSS11   **ENGINEERING CHEMISTRY**   L T P C
                                                        3 0 0 3

COURSE OBJECTIVES

- The students understand the softening of hard water by using various purification techniques
- The students able to apply these principles towards the prevention of corrosion
- The students will understand the basic concepts of polymers chemistry and its applications. The students have sound knowledge of plastics and rubbers
- The students understand the reaction of nuclear fission and fusion reaction and promote the knowledge about process of nuclear reactors. To understand various chemical reactions involved in the batteries
- The students will have knowledge on industrial important abrasives refractories and glass

COURSE OUTCOMES

- Recognize appropriate water purification techniques to convert hard water to soft water
- Apply principles of electrochemistry to prevent corrosion
- Exploit the polymeric materials for various engineering applications
- Utilize batteries and fuel cell in various fields
- Choose suitable abrasives, refractories and glass for various engineering applications

CO – PO MAPPING :

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

ARTICULATION MATRIX:

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

UNIT I   WATER TECHNOLOGY   9

Characteristics of water – hardness of water – types of hardness – estimation of hardness by EDTA method – alkalinity – types of alkalinity – estimation of alkalinity – Biological oxygen demand (BOD) and Chemical Oxygen Demand (COD) – Boiler feed water – requirements – disadvantages of using hard water in boilers – boiler troubles – scale and sludge – priming and foaming – caustic embrittlement – boiler corrosion – internal conditioning (phosphate, calgon, colloidal and carbonate conditioning methods) – external conditioning – zeolite and demineralization process – desalination and reverse osmosis.

UNIT II   CORROSION AND CORROSION CONTROL   9

Corrosion – chemical corrosion – electrochemical corrosion – mechanism of dry and wet corrosion – types of corrosion – galvanic corrosion – differential aeration corrosion – factors influencing rate of corrosion – corrosion control methods – sacrificial anodic method and impressed current cathodic protection method – protective coatings – Introduction, metal coatings: Galvanization and Tinning – Inorganic coatings: Phosphating and Anodising – electroplating – electroless platting

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UNIT III   POLYMERS   9

Polymers – definition – polymerization – types of polymerization (addition, condensation and copolymerization only) – mechanism of addition polymerization (free radical mechanism only) – preparation, properties and uses of polyvinyl chloride (PVC), Teflon, polyamides (nylon – 11, nylon – 6 and nylon – 6,6) and polyethylene terephthalate (PET) – Rubber – vulcanization of rubber – preparation, properties, uses of butyl rubber and SBR – Biodegradable Polymers – synthesis and properties of Poly lactic acid, Applications of biodegradable polymers in medical industry – Photo Conducting Polymers – Synthesis of Poly vinyl carbazole and its applications in laser printing

UNIT IV   NON CONVENTIONAL ENERGY SOURCES AND STORAGE DEVICES   9

Nuclear energy – fission and fusion reactions – nuclear chain reactions – characteristics of nuclear chain reaction – light water nuclear reactor for power generation – breeder reactor – solar energy conversion – solar cells – wind energy – Fuel cells – working of hydrogen and oxygen fuel cell – batteries – types of batteries – construction and working of batteries – alkaline battery – lead acid battery, nickel – cadmium battery and lithium battery

UNIT V   ENGINEERING MATERIALS   9

Refractories – classification – acidic, basics and neutral refractories – properties – manufacture of alumina, magnesite and zirconia bricks – Abrasives – natural and synthetic abrasives – hardness of abrasives – Mohs scale – manufacture, properties and uses of silicon carbide and boron carbide – application of abrasives – Glass manufacture, properties and uses

TOTAL: 45 Hours

TEXT BOOKS

Sl. No	Author(s)	Title of the Book	Publisher	Year of Publication
1.	B P.C.Jain and Monica Jain	Engineering Chemistry	Dhanpat Rai Pub, Co., New Delhi	2013
2.	Dr.A.Ravikrishnan	Engineering Chemistry I & II	Sri Krishna Hitech Publishing Company Pvt. Ltd	2016

REFERENCE BOOKS

Sl. No	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Dr.P.Santhi & S.Elavarasan	Engineering Chemistry	Sri Kandhan Publications	Aug 2016
2.	S.S. Dara	A text book of engineering chemistry	S.Chand & Co.Ltd., New Delhi	2013
3.	Shradha Sinha	Advanced Engineering Chemistry	Krishna Prakasan Media (P) Ltd., Meerut	2015
4.	B.Sivasankar	Engineering Chemistry	Tata McGraw-Hill Publishing Company, Ltd., New Delhi	2008
5.	V.R.Gowariker N.V.Viswanathan and Jayadev Sreedhar	Polymer Science	New Age International Pvt. Ltd., Chennai	2006

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21GES02   PROGRAMMING FOR PROBLEM SOLVING TECHNIQUE   L T P C   3 0 0 3

COURSE OBJECTIVES
- To understand basic programming concepts
- To provide knowledge for problem solving through programming
- To provide hands-on experience with the concepts
- To understand basic concepts using python
- To implement list, tuples and dictionaries program using python.

COURSE OUTCOMES:
At the end of the course, the students will able to

21GES02.CO1	Understand the fundamentals of C programming
21GES02.CO2	Summarize the looping statement and decision making statements to work out various C programs.
21GES02.CO3	Implement different Operations on arrays and Use functions to pass the arguments.
21GES02.CO4	Develop Simple Python Programs using basic data types, Control Structures, looping statements and Functions.
21GES02.CO5	Apply String, Tuples, List, and Dictionary concepts in real time applications.

CO – PO MAPPING :

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

ARTICULATION MATRIX :

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

UNIT I   INTRODUCTION TO C PROGRAMMING   9
Introduction to computer software, Program Design Tools: Algorithms, Flowcharts, Pseudo codes, Structure of a C program, Writing the first C program, Keywords, Identifiers, Basic Data Types in C, Variables, Constants, Input / Output Statements in C, Operators in C Arithmetic, Relational, Logical, Conditional, Type conversion and Typecasting.

UNIT II   CONDITIONAL AND LOOPING STATEMENTS   9
Conditional branching statements, if, if-else, if-else-if and switch statements, Iterative statements, while, do-while and for loop statements, Nested loops, the break and continue statements.

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UNIT III   FUNCTIONS AND ARRAYS   9

Functions: Function Declaration/Function Prototype, Function definition, Function call, passing parameters to functions. Arrays: Declaration of arrays, accessing the elements of an array, storing values in arrays , operations on 1-d arrays – Inserting an Element of an array, Deleting an Element from an Array, searching for a Value in an Array, two-dimensional arrays, operations on two dimensional arrays – Sum, Difference.

UNIT IV   INTRODUCTION TO PYTHON PROGRAMMING   9

Introduction- Python interpreter and interactive mode- Creating and executing Python program- Data types: Numeric, Boolean, string, List, tuple and Dictionary-Comments- Expressions- Conditional statements: if, if-else and if-elif-else- Iterative statements: while, for, continue and pass- Functions- Fruitful functions- Recursive functions- Illustrative programs: Linear search and Binary search

UNIT V   STRINGS, LISTS, TUPLES AND DICTIONARIES   9

Strings: Assignment- String slices and String methods- Lists: List operations and list methods-Tuples: Tuple assignment and Tuple operations- Dictionaries: Operations and methods. Illustrative Programs: Quick sort and Merge sort.

TOTAL: L: 45

TEXT BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Reema Thareja	Computer Fundamentals and Programming in C	Oxford University Press	Second Edition
2.	John V Guttag	Introduction to Computation and Programming Using Python	Revised and expanded Edition. MIT Press	2011

REFERENCE BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Reema Thareja	Programming in C	Oxford University Press, Second Edition	2006
2.	Robert Sedgewick, Kevin Wayne, Robert Dondero	Introduction to Programming in Python: An Inter-disciplinary Approach	Pearson India Education Services Pvt. Ltd.,	2016
3.	Timothy A. Budd	Exploring Python	Mc-Graw Hill Education (India) Private Ltd	2015
4.	Kenneth A. Lambert	Fundamentals of Python: First Programs	CENGAGE Learning	2012

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21GES06	MECHANICAL AND BUILDING SCIENCES	L T P C
		3 0 0 3

COURSE OBJECTIVES

* Summaries the basic infrastructure services MEP, HVAC, elevators, escalators and ramps.
* Differentiate Materials for engineering applications
* Demonstrate the metal joining, removing and addition process.
* To posses knowledge about Surveying
* To know about the Civil Engineering materials.
* To get the knowledge on various type of Building Elements.

COURSE OUTCOMES

21GES06.CO1	To summarise the basic infrastructure services of Refrigeration, pumps and basic drives
21GES06.CO2	To select appropriate materials for engineering applications
21GES06.CO3	To perform welding, machining and 3D printing operations
21GES06.CO4	Understand the principles of field measurement in surveying.
21GES06.CO5	Acquired knowledge in civil engineering materials.
21GES06.CO6	Familiarize on about the of Building Elements.

CO – PO MAPPING :

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	X	X	-	-	-	X	-	-	-	X	-	X	X	-	-
CO2	X	X	-	-	-	X	-	-	-	X	-	X	X	-	-
CO3	X	X	-	-	X	X	-	-	-	-	-	X	X	-	-
CO4	X	X	-	-	-	X	-	-	-	-	-	X	X	-	-
CO5	X	X	-	-	-	X	-	-	-	-	-	X	X	-	-
CO6	X	X	-	-	-	X	-	-	-	-	-	X	X	-	-

ARTICULATION MATRIX :

Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	-	-	-	2	-	-	-	2	-	1	3	-	-
CO2	3	2	-	-	-	2	-	-	-	2	-	1	3	-	-
CO3	3	2	-	-	2	2	-	-	-	-	-	1	3	-	-
CO4	3	2	-	-	-	2	-	-	-	-	-	1	3	-	-
CO5	3	2	-	-	-	2	-	-	-	-	-	1	3	-	-
CO6	3	2	-	-	-	2	-	-	-	-	-	1	3	-	-

A. MECHANICAL ENGINEERING

UNIT I:REFRIGERATION:

Unit of refrigeration, reversed Carnot cycle, COP, vapour compression cycle (only description and no problems); Definitions of dry, wet & dew point temperatures, specific humidity and relative humidity, Cooling and dehumidification, Layout of unit and central air conditioners. Description about working with sketches of: Reciprocating pump, Centrifugal pump, Pelton turbine, Francis turbine and Kaplan turbine. Description about working with sketches of: Belt and Chain drives, Gear and Gear trains, Single plate clutches.

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UNIT II:BASICS OF ENGINEERING MATERIALS:

Metals-Stainless steel, Magnesium, Titanium-properties, applications ceramics-Alunima,SiO2,PZT-properties,applications, and polymeric materials-PMMA,PEEK,PTFE- properties, applications, metal matrix composites-types, fabrication methods, properties and applications.

UNIT III:METAL JOINING PROCESSES:

List types of welding, Description with sketches of Arc Welding, Soldering and Brazing and their applications. Basic Machining operations; Turning, Drilling, Milling and Grinding. Principle of CAD/CAM, and 3 D printing.

B. BUILDING SCIENCES

UNIT IV : FUNDAMENTALS OF SURVEYING   7

Surveying – Objectives – Divisions – Classification – Principles – Measurements of distances – Angles – Leveling.

UNIT V : BUILDING MATERIALS   7

Civil Engineering Materials: Bricks – Stones – Sand – Cement – Concrete – Steel Sections – Timber – Modern Materials.

UNIT VI : BUILDING ELEMENTS   8

Substructure: Foundation – Types of foundation – Requirement of good foundation – Plinth beam.
Superstructure: Brick masonry – Stone masonry – Beams – Columns – Lintels – Roofing – Flooring – Plastering.

TOTAL: 45 Hours

TEXT BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Shanmugam G and Palanichamy M S	Basic Civil and Mechanical Engineering	McGraw Hill Publishing Co., New Delhi	1996
2.	Ramamrutham S	Basic Civil Engineering	DhanpatRai Publishing Co. (P) Ltd.	2015

REFERENCE BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Benjamin,J.,	Basic Mechanical Engineering	Pentex Books,9th Edition	2018
2.	G Shanmugam, M S Palanichamy	Basic Civil and Mechanical Engineering	McGraw Hill Education; First edition	2018
3.	Clifford, M., Simmons, K. and Shipway, P.,	An Introduction to Mechanical Engineering Part I	CRC Press	2009
4.	Seetharaman S	Basic Civil Engineering	Anuradha Agencies	2015
5.	SatheeshGopi	Basic Civil Engineering	Pearson Publishers	2009

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PHYSICS AND CHEMISTRY LABORATORY

L T P C
0 0 2 1

COURSE OBJECTIVES

- The students will understand the ultrasonic sounds in liquid medium
- The students can demonstrate laser and its propagation through optics
- To understand thermal conductivity of bad conductors
- The students familiar with characteristics of water and able to estimate hardness and alkalinity of water sample
- The students will understand the basic concepts condunctometric and pH metric titrations

COURSE OUTCOMES

- Ability to determine the velocity of ultrasonic sound in any liquid
- Capable of understanding the concept of laser and its propagation through Optical fiber
- Ability to determine the thermal conductivity of the bad conductor and determine the modulus of elasticity
- Able to analyze hardness and alkalinity of water sample
- Able to estimate the amount of acid by conductometric, potentiometric and pH metric titrations

CO – PO MAPPING :
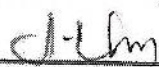
Course Outcomes	Program Outcomes												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	X	X	-	-	X	-	X		-	-	-	X	-	-	-
CO2	X	X	-	X	X	-	-	-	X	-	-	X	-	-	-
CO3	X	X	-	X	X	-	-	-	X	-	-	X	-	-	-
CO4	X	X	X	-	X	X	X	X	-	-	-	X	-	-	-
CO5	X	X	X	-	X	-	-	-	X	-	-	X	-	-	-

ARTICULATION MATRIX:

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

LIST OF EXPERIMENTS IN PHYSICS

1. (a) Determination of Wavelength and particle size using Laser, (b) Determination of acceptance angle in an optical fiber
2. Determination of Velocity of sound and Compressibility of liquid – Ultrasonic Interferometer
3. Determination of Thermal Conductivity of a bad conductor – Lee's Disc method
4. Determination of Young's Modulus by uniform bending method
5. Determination of Moment of Inertia by rigidity modulus

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LIST OF EXPERIMENTS IN CHEMISTRY
1. Determination of hardness of water by EDTA Method
2. Determination of alkalinity in water sample
3. Conductometric titration of HCl vs NaOH
4. Estimation of hydrochloric acid by pH meter
5. Determination of molecular weight of polymer using Oswald Viscometer

REFERENCE BOOKS

Sl. No	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Dr.G.Senthilkumar	Physics Laboratory Manual	VRB Publishers	2017
2.	Dr.P.Mani	Engineering Physics Practical	Dhanm Publictions	2017
3.	R.Veeraswamy, V.Venkateswaran	Basic Principles of Practical Chemistry	Sultan Chand & Sons	2013
4.	P.Meena Sundari	Engineering Chemistry Laboratory Manual	KKS Publishers	2015

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21GES03   **PROGRAMMING IN C LABORATORY**   **L T P C**
                                                            0 0 2 1

COURSE OBJECTIVES
- Write a basic C Program
- Learn the knowledge about Array.
- Execute the programs using String.
- Understand the concept about Structure and pointer.
- Develop the program using File concept.

COURSE OUTCOMES:
At the end of the course, the students will able to

21GES03.CO1	Summarize the looping statement and decision making statements to work out various C programs.
21GES03.CO2	Illustrate one dimensional and two dimensional array for matrix.
21GES03.CO3	Construct Structures to store student information.
21GES03.CO4	Formulate to handling string operations.
21GES03.CO5	Implement file handling operations to read and write the files.

CO – PO MAPPING :

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

ARTICULATION MATRIX :

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

LIST OF EXPERIMENTS
1. Develop a program to find the largest of three numbers.
2. Develop an interactive program to calculate roots of quadratic equation by accepting the coefficients.
3. Develop a program to sum the series: $1/1! + 4/2! + 27/3! + \ldots$ using functions.
4. Develop a program to insert a number at a given location in an array.
5. Implement a program to perform a binary search on 1D sorted Array.
6. Develop a program to read a two dimensional array "marks" which stores marks of 5 students in three

subjects. Display the highest marks in each subject

7. Develop a program to concatenate two strings and determine the length of the concatenated string.

8. Develop a program to read and display the information about a student using structures.

9. Implement a program to enter a character and then determine whether it is a vowel or not using pointers.

10. Develop a program to read data from the keyboard, write it to a file called "Input", again read the same data from the "Input" file and display it on the screen.

11. Mini Projects

TOTAL : P : 30

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21HSS03 - LIFE SKILLS AND WORKPLACE PSYCHOLOGY

L T P C
2 0 0 2

COURSE OBJECTIVES:

* To inculcate critical thinking process and to prepare them on problem solving skills.
* To enable learners to perform in a team.
* To learn leadership qualities and practice them.
* To make the learners to use grammar error free sentences.
* To introduce the essentials of psychology at workplace and gain insights about work place behavior.

COURSE OUTCOMES:

* Able to think critically on a particular problem.
* Implement of good performance in a team.
* Turn into an effective leader.
* Write cohesively and coherently and flawlessly avoiding grammatical errors, using a wide vocabulary range, organizing their ideas logically on a topic.
* Execute their knowledge in psychology in the process of employment.

CO – PO MAPPING :

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

ARTICULATION MATRIX:

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

UNIT I LIFE SKILLS & THINKING SKILLS   6

Life Skills based education, Creativity, Lateral thinking, Critical thinking, Multiple Intelligence, Problem Solving. Six thinking hats of Mind Mapping & Analytical Thinking.

UNIT II   TEAMWORK   6

Group Vs Teams, Team or Group Formation Process, Group Dynamics, Managing Team Performance & Team Conflicts.

UNIT III   LEADERSHIP SKILLS   6

Leadership, Qualities of a leader, Levels of Leadership, , Types of leadership, Professional Etiquette .

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UNIT IV   GRAMMAR & VOCABULARY   6

Single Word substitutes – Verb patterns- – Voices – comparative Adjectives – Nominal Compounds – Articles – Use of Prepositions - Phrasal Verbs – British and American vocabulary – Abbreviations and Acronyms - Instructions – Recommendation- Use of Dialogue writing – Checklist.

UNIT V WORKPLACE PSYCHOLOGY   6

Nature and Development of Industrial/Work Psychology - Employee Selection Techniques, Fair Employment Practices- Biographical Information, Interviews, Job Analysis and its Types, - Interpreting Visual Information - Flow Chart, Pie Chart, (Transcoding).

TOTAL HOURS: 30

TEXT BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Matthewman, L., Rose, A. & Hetherington, A	Work Psychology	Oxford University Press, India.	2009
2.	Dr.K.Ravikanth Roa , Dr. P. Dhinakar	Life skills Education	Neel Kamal	2016

REFERENCE BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Larry James	The First Book of Life Skills	First Edition; Embassy Books	2016
2.	Shalini Verma	Development of Life Skills and Professional Practice	First Edition; Sultan Chand (G/L) & Company	2014
3.	Viswamohan, Aysha.	English for Technical Communication.	Tata McGraw-Hill, New Delhi.	2008
4.	Landy, F. J. & Conte, J. M	Work in the 21st Century: An Introduction to Industrial and Organizational Psychology.	Wiley India: NewDelhi: 2nd Edition.	2010
5.	Schultz, D. & Schultz, S. E.	Psychology and Work Today	Pearson Education : New Delhi.	2002

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COURSE CODE	COURSE TITLE	L	T	P	C
21BSS22	ADVANCED CALCULUS AND COMPLEX ANALYSIS	3	1	0	4

COURSE OBJECTIVES:

- To acquire sound knowledge of techniques in solving ordinary differential equations that model engineering.
- To apply the relatively simple quantitative models of change and to deduce their consequences.
- To understand the Laplace transforms and learn the inverse Laplace transformations for solving real time Engineering problems
- To understand and apply the standard techniques of analytic theory.
- To understand and apply complex integration theory with confidence, in application areas of engineering fields.

COURSE OUTCOMES:

CO1:	Provide a strong platform to solve the research problems in model engineering.
CO2:	Provides a framework for modeling systems. Use Gauss divergence, Stoke's and Green's theorems to simplify calculations of integrals and prove simple results.
CO3:	Makes models of projects and then simulates its models in real world conditions.
CO4:	Apply complex integration efficiently solving the problems that occurs in various branches of engineering disciplines.
CO5:	Acquire knowledge in inverse Laplace transforms with its engineering applications.

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
21BSS22.CO1	X	X	X	-	-	-	- -	-	-	-	-	X	-	X	-
21BSS22.CO2	X	X	X	-	-	-	-	-	-	-	-	X	-	X	-
21BSS22.CO3	X	X	X	-	-	-	-	-	-	-	-	X	-	X	-
21BSS22.CO4	X	X	X	-	-	-	-	-	-	-	-	X	-	X	-
21BSS22.CO5	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
21BSS22.CO1	3	3	3	-	-	-	-	-	-	-	-	3	-	3	-
21BSS22.CO2	3	2	2	-	-	-	-	-	-	-	-	3	-	3	-
21BSS22.CO3	3	3	2	-	-	-	-	-	-	-	-	2	-	2	-
21BSS22.CO4	2	3	3	-	-	-	-	-	-	-	-	2	-	3	-
21BSS22.CO5	3	3	2	-	-	-	-	-	-	-	-	2	-	3	-

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

UNIT - I ORDINARY DIFFERENTIAL EQUATIONS 9+3

Linear differential equations of second and higher order with constant coefficients– Cauchy's and Legendre's linear equations – simultaneous first order linear equations with constant coefficients – Method of variation of parameter – Method of undetermined coefficients.

UNIT - II VECTOR CALCULUS 9+3

Gradient, divergence and curl – Line, Surface and Volume integrals - Green's, Gauss divergence and Stoke's theorem (excluding proofs) – Verification of the above theorems and evaluation of integrals using them

UNIT – III LAPLACE TRANSFORMS 9+3

Laplace transforms – Basic properties – Initial and final value theorems - Problems - Transform of periodic functions. Inverse Laplace transforms – statement of convolution theorem – Partial fraction method – Problems – Solution of linear ODE of second order with constant co-efficients.

UNIT – IV ANALYTIC FUNCTIONS 9+3

Functions of a complex variable – Analytic function– Cauchy-Riemann equations – Properties of analytic function – Harmonic conjugate – Conformal mapping and bilinear transformations.

UNIT – V COMPLEX INTEGRATION 9+3

Cauchy's integral theorem (excluding proof) and Cauchy's integral formula (excluding proof) – Taylor's and Laurent's series expansions (excluding proof) – Singular points – Classifications – Cauchy's residue theorem – Contour integration.

TOTAL: 45 + 15 = 60 HRS

TEXT BOOKS:

S.NO.	AUTHOR(S)	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1.	Glyn James	Advanced Modern Engineering Mathematics	Pearson Education, 4th Edition	2016
2.	Grewal. B.S	Higher Engineering Mathematics	Khanna Publications, Delhi, 43rd Edition	2014

REFERENCE BOOKS:

S.NO.	AUTHOR(S)	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1.	Bali N. P Manish Goyal	A Text book of Engineering Mathematics	Laxmi Publications Pvt Ltd. , 9th edition	2016
2.	Erwin Kreyszig	Advanced Engineering Mathematics	John Wiley and Sons, New Delhi, 9th edition	2014
3.	Tony Croft, Anthony Croft, Robert Davison, Martin Hargreaves, James Flint	Engineering Mathematics: A Foundation for Electronic, Electrical, Communications and Systems Engineers	Pearson Education, 4th Revised Edition	2012
4.	Peter V. O.Neil	Advanced Engineering Mathematics	Cengage learning, 7th edition	2012
5.	Dass.H.K. , Er. RajnishVerma	Higher Engineering Mathematics	S. Chand Private Ltd , 3rd Revised Edition	2014

| 21BSS03 | BIO AND NANOMATERIAL SCIENCES | L T P C |
| | | 3 0 0 3 |

COURSE OBJECTIVES

- To underastand the classification of materials based on conductiviy
- To acquire the knowledge in basics of magnetic and superconductors
- To understand the applications of biomaterials
- To understand the synthesis techniques of nanomaterials.
- To educate the basic concepts of carbon nanotubes

Course Outcomes:

- Summaries the properties of conducting and semiconducting materials
- Describe the classification and application of magnetic and superconducting materials
- Explain the applications of biomaterials
- Illustrate the synthesize of nanomaterials
- Explain the structure and properties of Carbon nanotubes

CO – PO MAPPING :

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

ARTICULATION MATRIX:

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

UNIT I Conducting and Semiconducting Materials: 9

Conducting Materials: Classical free electron theory of metals- Electrical conductivity –Thermal conducrivity - Wiedemann-Franz law - Lorentz number - Draw backs of classical free electron theory.
Semiconducting Materials: Classification of semiconducting materials:-elemental-compound-intrinsic-extrinsic semiconductors-properties- Hall effect: Theory and experimental determination of Hall coefficient and Applications.

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UNIT II Magnetic and Superconducting Materials: 9

Magnetic Materials: Classification - Domain theory of ferromagnetism – Hysteresis-Hysteresis loss - Soft and hard magnetic materials – applications
Superconducting materials: Properties of superconductors - Type I and Type II superconductors – BCS theory-Application of superconductors: Magnetic levitation-cryotron.

UNIT III Biomaterials and its applications: 9

Definition of biomaterials and biocompatibility- classification of biomaterials- Metallic implant materials- properties and application of alumina- polymers in biomedical use- schematic diagram and working of heart lung machine. Materials for ophthalmology: contact lens, Intraocular lens.

UNIT IV Nanomaterials and its applications: 9

Introduction- -Definition-Classification of nanostructures-surface to volume ratio-properties-Synthesis of Nanomaterials : Bottom up and top down process-Electro deposition method-Chemical vapour deposition-Pulsed laser deposition method-Applications.
Characterization Of Nanomaterials: Scanning electron microscope principle, construction and working - Transmission electron microscope: principle, construction and working

Unit V Carbon Nano Materials   9

Bonding in carbon structures–Carbon nanotube types - Single walled and multi walled carbon nanotubes-structure and properties – Synthesis of carbon nanotube: arc discharge- chemical vapour deposition method –Applications.

TOTAL: 45 Hours

TEXT BOOKS:

SLNo	Author(s)	Title of the Book	Publisher	Year of Publication
1.	V Rajendran	Materials Science	Tata McGraw Hill publications	2008
2	Sujata V. Bhatt	Biomaterials	Second Edition Narosa Publishing House	2005
3	T.Pradeep	TheEssentials:Understanding Nanoscience and Nanotecnology	TataMcGraw-Hill PublishingCompany Limited,NewDelhi,	2008

REFERENCE BOOKS:

SLNo	Author(s)	Title of the Book	Publisher	Year of Publication
1.	James F. Shackelford, Madanapalli K. Muralidhara	Introduction to Materials Science for Engineers	Sixth Edition, Pearson Education Inc.	2007
2	C.M.Agrawal, J.L.Ong, M.R.Appleford ,Gopinath Mani	Introduction to Biomaterials basic theory with Engineering Applications	Cambridge University PressNew York	2014
3	B.D. Ratner, A.S. Hoffman F.J. Schoen, J.E. Lemons	Biomaterials Science an Introduction to Materials in Medicine	2nd Edition Elsevier Academic Press, California, USA	2004
4	C.P. Poole and F.J. Owens.	Introduction to Nanotechnology	Wiley, New Delhi	2007
5	M. Meyyappan	Carbon Nanotubes Science & Applications	CRC Pres, Boca Ranton, London, New York, Washington D.C	2005

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21BSS12 ENVIRONMENTAL SCIENCE AND ENGINEERING   L T P C
                                                      3 0 0 3

COURSE OBJECTIVES

- To give a comprehensive insight into ecosystem, biodiversity and natural recourses
- To create an awareness on the various environmental pollution aspects and issues
- To educate the ways and means to protect the environment from various types of pollution
- To import some fundamental knowledge on human welfare measures
- Discuss the impact of human population on the environment

COURSE OUTCOMES

- Elaborate ecosystem, biodiversity and loss of biodiversity
- Apply equitable use of natural resources for sustainable life style
- Manipulate the sources, effects and control methods of various environmental pollution
- Implement various environmental act and non-government organization for human welfare
- Analyse human population and its impacts on the environment

CO – PO MAPPING :

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

ARTICULATION MATRIX:

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

UNIT I   ECOSYSTEMS AND BIODIVERSITY   9

Definition, scope and importance of environment – need for public awareness – concept of an ecosystem – structure and function of an ecosystem – producers, consumers and decomposers – energy flow in the ecosystem – ecological succession – food chains, food webs and ecological pyramids – Introduction to biodiversity definition – value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values – hot – spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man – wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and exsitu conservation of biodiversity

UNIT II   NATURAL RESOURCES   9

Forest resources: Use and over – exploitation, deforestation, cause – effect – control measures – Water resources: Use and over – utilization of surface and ground water, floods, drought, conflicts over water, dams – benefits and problems – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer – pesticide problems. water logging, salinity – Land resources: Land as a resource, land

degradation, man induced landslides, soil erosion and desertification – role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles

UNIT III   ENVIRONMENTAL POLLUTION   9

Definition – causes, effects and control measures of: (a) Air pollution (b) Water pollution(c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards – soil waste management: causes, effects and control measures of municipal solid wastes – role of an individual in prevention of pollution – disaster management: floods, earthquake, cyclone and landslides

UNIT IV   SOCIAL ISSUES AND THE ENVIRONMENT   9

From unsustainable to sustainable development – urban problems related to energy – water conservation, rain water harvesting, watershed management – resettlement and rehabilitation of people – environmental ethics: Issues and possible solutions – climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, – environment protection act – Air (Prevention and Control of Pollution) act – Water (Prevention and control of Pollution) act – Forest conservation act – role of nongovernmental organization – Public awareness

UNIT V   HUMAN POPULATION AND THE ENVIRONMENT   9

Population growth, variation among nations – population explosion – family welfare programme – environment and human health – human rights – value education – HIV/AIDS – women and child welfare – role of information technology in environment and human health

TOTAL: 45 Hours

TEXT BOOKS

Sl. No	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Dr.A.Ravikrishnan	Environmental Science and Engineering	Sri Krishna Hitech Publishing Company Pvt. Ltd	June 2016
2.	Gilbert M. Masters	Introduction to Environmental Engineering and Science	Pearson Education Pvt., Ltd., Second Edition. ISBN 81-297-0277-0	2004

REFERENCE BOOKS

Sl. No	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Dharmendra S. Sengar	Environmental Law	Prentice hall of India PVT LTD, New Delhi	2007
2.	R.K.Trivedi	Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards, Vol-I and II	BS Publications	2010
3.	R.Rajagopalan	Environmental Studies	From Crisis to Cure, Oxford University Press	2015
4.	Benny Joseph	Environmental Science and Engineering	Tata McGraw-Hill, New Delhi	2006
5.	T.G.Miller	Environmental Science	Wadsworth Publishing Co.	2007

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21GES19   **CONCEPTS IN PRODUCT DESIGN**   **L T P C**
                                                                           3 0 0 3

COURSE OBJECTIVES
* To apply different ideas to manage innovation and development
* To analyze the product specification
* To know the concepts of CAD ,CAM ,CAE
* To develop product geometry, fundamental and conceptualization management
* To estimate and also to analyse the manufacturing components and assembly cost

COURSE OUTCOMES
21GES19.CO1	Apply different ideas enabling people to manage to work with innovation and development in organization.
21GES19.CO2	Examine the product specification select concept, product performance and manufacturing
21GES19.CO3	Develop product geometry, layout, fundamental and incidental interaction
21GES19.CO4	Design the integrated process robust design, conceptualization and management of industrial design.
21GES19.CO5	Estimate and Analyze the manufacturing components and assembly cost, planning for prototypes.

CO – PO MAPPING :

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

ARTICULATION MATRIX :

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

UNIT I: INTRODUCTION   9
Strategic importance of Product development - integration of customer, designer, material supplier and process planner, Competitor and customer - behavior analysis. Understanding customer-promoting customer understanding-involve customer in development and managing requirements

UNIT II: CONCEPT GENERATION, SELECTION AND TESTING   9
Plan and establish product specifications. Task - Structured approaches - clarification — search externally and internally- reflect on the solutions and processes -concept selection - methodology - benefits. Implications - product performance – manufacturability.

UNIT III: PRODUCT ARCHITECTURE 9
Product development management - creation - clustering -geometric layout development - Fundamental and incidental interactions - related system level design issues - secondary systems -architecture of the chunks - creating detailed interface specifications-Portfolio Architecture.

UNIT IV: INDUSTRIAL DESIGN 9
Integrate process design - Managing costs - Robust design - Integrating CAE, CAD, CAM tools – Simulating product performance and manufacturing processes electronically - Need for industrial design-impact – design process - investigation of customer needs – conceptualization- refinement - management of the industrial design process.

UNIT V: DESIGN FOR MANUFACTURING AND PRODUCT DEVELOPMENT 9
Definition - Estimation of Manufacturing cost-reducing the component costs and assembly costs – Minimize system complexity - Prototype basics - Principles of prototyping – Planning for prototypes - Economic Analysis.

TOTAL: L: 45 Hours

TEXT BOOKS

Sl. No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Ulrich K.T. and Eppinger S.D	Product Design and Development	McGraw –Hill International Editions	1999
2	Kevin Otto	Product Design	Pearson Education,	2004

REFERENCE BOOKS

Sl. No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Rosenthal S	Business One Orwin Homewood	Business One Orwin, Homewood	1992
2	Rosenthal S	Effective Product Design and Development	Business One Orwin, Homewood	1992
3	Pugh S	Total Design – Integrated Methods for successful Product Engineering	Addison Wesley Publishing	1991
4	Clive L.Dym	Engineering Design: A Project-based Introduction	John Wiley & Sons	2009
5	Yousef Haik	Engineering Design Process	Cengage Learning	2010

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21GES11	ELECTRONIC DEVICES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the basics of Semiconductor Diodes
- To impart knowledge on the working principle and characteristics of BJT.
- To learn the operation and characteristics of FET.
- To familiarize the biasing techniques of BJT and FET.
- To understand the working principle of special diodes and optoelectronic devices.

COURSE OUTCOMES:

After the completion of the course, the students can able to

CO1   Explain the construction and operation of semiconductor diodes
CO2   Demonstrate the characteristics of BJT
CO3   Demonstrate the characteristics of BJT
CO4   Explain the biasing techniques of BJT and FET
CO5   Explain the construction and principle of special purpose diodes

CO – PO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	x	x	x	x	x	-	-	-	x	-	x	-	x	x	x
CO2	x	x	x	x	x	-	-	-	x	-	x	-	x	x	x
CO3	x	x	x	x	x	-	-	-	x	-	x	x	x	x	x
CO4	x	x	x	x	x	-	-	-	x	-	x	x	x	x	x
CO5	x	x	x	x	x	-	-	-	x	-	x	x	x	x	x

ARTICULATION MATRIX :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	-	-	-	2	-	2	-	2	2	3
CO2	3	3	3	3	2	-	-	-	2	-	2	-	2	2	3
CO3	3	3	3	3	2	-	-	-	3	-	3	3	2	3	3
CO4	3	3	3	3	3	-	-	-	3	-	3	3	2	3	3
CO5	3	3	3	3	3	-	-	-	3	-	3	3	2	3	3

UNIT I: SEMICONDUCTOR DIODES   9
Review of Semiconductor Physics-Drift and diffusion currents-Continuity Equation-Theory of PN Junction Diode-Diode Current Equation-Current Voltage Characteristics-Effect of Temperature on PN Junction diodes-Diffusion Capacitance-Applications: Rectifiers, Clippers, Clampers-Avalanche Breakdown Mechanism-Zener Diode as a Voltage Regulator.

UNIT II: BIPOLAR JUNCTION TRANSISTORS   9
Bipolar Junction Transistor Operations-Configurations: CC, CB, CE-Transistor Current Components-Ebermoll's Model of Transistor-Small Signal Low Frequency Hybrid-High Frequency Effects-Transistor as an Amplifier and Switch.

UNIT III: FIELD EFFECT TRANSISTORS   9
Operation and Characteristics of JFET-Configurations of JFET-JFET as Amplifier, Switch, Voltage Variable Resistor-Metal Oxide Semiconductor Field Effect Transistor (MOSFET)-Enhancement and Depletion Mode MOSFET-Characteristics of n-MOS and p-MOS-Introduction to CMOS.

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UNIT IV: BIASING OF BJT AND FET 9

DC operating point and Load line-Q point-Bias Stability-Transistor Biasing Methods: Fixed Bias-Collector to Base Bias-Self biasing, Thermal Runaway, Thermal Stability-FET biasing methods: Self bias-Source bias-Voltage divider bias-Biasing MOSFETs.

UNIT V: SPECIAL DIODES AND OPTO ELECTRONIC DEVICES 9

Theory and Characteristics of Schottky Diode-Tunnel Diode-Varactor Diode-SCR-TRIAC-LDR-UJT-Photoemissivity and Photoconductivity-Photoconductive Cell-Photo Voltaic Cell-Photodiode-Phototransistors-Construction and Characteristics of LCD and LED-LASER Diodes- Opto Couplers, FINFET.

TOTAL: 45

TEXT BOOKS

Sl. No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Jacob Millman, Christos Halkias & Satyabrata Jit, Millman's	Electronic Devices and Circuits	McGraw Hill	2008
2	Robert L. Boylestad, Louis Nashelsky	Electronic Devices and Circuit Theory	Pearson education	2012

REFERNCE BOOKS

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1	Allen Mottershead	Electronic Devices and Circuits	Prentice Hall of India	2008
2	Douglas. A.Pucknell, Kamran Eshraghian	Basic VLSI Design, Principles and Application	Prentice Hall of India	2009
3	S.Salivahanan, N.Sureshkumar and A.Vallavaraj	Electronic Devices and Circuits	Tata McGraw Hill	2008
4	Donald A. Neamen	Semiconductor Physics and Devices	Tata McGraw Hill	2017
5	S. M. Sze	Semiconductor Devices: Physics and Technology	Wiley	2016

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21GES12	ELECTRONIC SIMULATION LABORATORY	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES:

1. To understand the operation of semiconductor devices
2. To understand the characteristics of electronic devices and circuits
3. To impart knowledge on using Electronic Lab simulation tools

COURSE OUTCOMES:

After the completion of the course, the students can able to

CO1	Explain the construction and operation of semiconductor diodes
CO2	Demonstrate the characteristics of semiconductor devices and circuits
CO3	Design electronic circuits using simulation tools

CO – PO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	x	x	x	x	x	-	-	-	x	-	x	-	x	x	x
CO2	x	x	x	x	x	-	-	-	x	x	x	-	x	x	x
CO3	x	x	x	x	x	-	-	-	x	x	x	x	x	x	x

ARTICULATION MATRIX :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	-	-	-	3	-	2	-	3	2	3
CO2	3	3	3	3	3	-	-	-	3	3	3	-	3	3	3
CO3	3	3	3	3	3	-	-	-	3	3	3	3	3	3	3

LIST OF EXPERIMENTS:

1. Analyze the characteristics of semiconductor diode
2. Analyze the characteristics of bipolar junction transistor
3. Design and analysis of BJT as an amplifier
4. Analyze the characteristics of FETs
5. Design and analysis of voltage regulator
6. Design and analysis of rectifier
7. Design and analysis of clipper and clamper
8. Analyze the characteristics of UJT
9. Analyze the characteristics of SCR
10. Analyze the characteristics of LDR and Photodiode

REFERNCE BOOKS

SLNo	Author(s)	Title of the Book	Publisher	Year of Publication
1	Robert L. Boylestad, Louis Nashelsky	Electronic Devices and Circuit Theory	Pearson education	2012
2	Donald A. Neamen	Semiconductor Physics and Devices	Tata McGraw Hill	2017

21GES09	PROGRAMMING IN PYTHON LABORATORY	L T P C
		0 0 2 1

COURSE OBJECTIVES
- Write basic Python program.
- Learn the knowledge about searching and sorting techniques.
- Implement coding for matrices.
- Understand command line arguments.
- Simulate the game.

COURSE OUTCOMES:
At the end of the course, the students will able to

21GES09.CO1	Summarize the basic programs using python.
21GES09.CO2	Build various searching and sorting techniques.
21GES09.CO3	Implement the coding for matrices.
21GES09.CO4	Evaluate Command line arguments.
21GES09.CO5	Simulate game using python program.

CO – PO MAPPING :

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

ARTICULATION MATRIX :

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

LIST OF EXPERIMENTS

1. Compute the GCD of two numbers.

2. Find the square root of a number (Newton's method)

3. Exponentiation (power of a number)

4. Find the maximum of a list of numbers

5. Linear search and Binary search

6. Selection sort, Insertion sort

7. Merge sort

8. First n prime numbers
9. Multiply matrices
10. Programs that take command line arguments (word count)
11. Find the most frequent words in a text read from a file
12. Simulate elliptical orbits in Pygame
13. Simulate bouncing ball using Pygame

PLATFORM NEEDED
Python 3 interpreter for Windows/Linux

TOTAL : P : 30

21HSS02 - COMMUNICATIVE ENGLISH PRACTICES LABORATORY

```
L T P C
0 0 2 1
```

COURSE OBJECTIVES

* To instill the basic communication concepts to enhance students' communication skills through various lab sessions.
* To understand the importance of listening and speaking in language acquisition process
* To speak English accurately, appropriately and fluently in different situations (academic, social and professional) and familiarize themselves with all speech sounds in English
* To help students develop the ability to communicate effectively in spoken English and develop their soft skills and interpersonal skills.
* To increase employability by developing students' communication skills in English.

COURSE OUTCOMES

* Speak clearly, confidently, comprehensibly, and communicate with one or many listeners using appropriate communicative strategies.
* Understand the basic narrative techniques to converse confidently and comprehensibly.
* Write cohesively and flawlessly by avoiding grammatical errors and organizing their ideas logically.
* Comprehend different spoken discourses/excerpts in different accents during presentation
* Communicate with others confidently in interviews.

CO – PO MAPPING :

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

ARTICULATION MATRIX:

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

UNIT I   FORMAL & INFORMAL CONVERSATION PRACTICE   6

Role Play conversations - With family members, neighbors, friends, relatives etc. Simple expressions - agreeing / disagreeing, persuading, wishing, consoling, advising, arguing, expressing opinions etc.- Professional dialogues with superiors - Conversation with different professionals in government and corporate Offices, Official Meetings, educational Institutions, (At the railway junction, malls, post office, bank) etc- every day usage of English

UNIT II   ORAL REVIEW, RADIO SHOW & NARRATIVE TECHNIQUES   6

Oral review of books - Presentation of various radio programs like news, announcements, advertisements, entertainment programs etc. as a team activity. Understanding the basic narrative techniques - Narrating short stories. Narrating real life experiences, Interpretation of charts, tables, graphs.

UNIT III   RESUME / LETTER WRITING   6

Preparation of Resume - Structure - Types of resume - Writing the Vision Statement - Objectives - Types of Letter - Job Application - accepting / declining a Job offer.

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UNIT IV   PRESENTATION SKILLS & GROUP DISCUSSION   6

Elements of Effective Presentation - Structure of a Presentation - Speech Acts - Effective use to Presentation Tools - Audience Analysis - Preparing the PPT slides - Video samples- Importance of GD – in the selection process - Structure of a GD - Moderator - led and other GDs - Strategies in GD – Team work - Body Language - Mock GD -Video samples

UNIT V   INTERVIEW SKILLS   6

Kinds of Interviews – One to one, Group interview, Telephone interview, Online interview, Stress interview - Required Skills – Corporate culture – Mock interviews-Video samples.

TOTAL HOURS: 30

TEXT BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Sobana.S, Manivannan.R and Immanuel. G,	Communication and Soft Skills	VK Publications, Sivakasi.	2016

REFERENCE BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Anderson, P.V.	Technical Communication	Thomson Edition, New Delhi	2007
2.	Rizvi, Ashraf. M	Effective Technical Communication	Tata McGraw-Hill, New Delhi	2005
3.	Dutt, Kiranmai P and Geetha Rajeevan	Basic Communication Skills .	Foundation Books, New Delhi.	2007

21BSS23 TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS

L T P C
3 1 0 4

COURSE OBJECTIVES

* To introduce the effective mathematical tools for the solutions of partial differential equations that model several physical processes
* To introduce Fourier series analysis which is central to many applications in engineering
* To develop the basic knowledge in solving the boundary value problems
* To acquaint the student with Fourier transform techniques used in wide variety of situations.
* To develop Z transform techniques for discrete time systems

COURSE OUTCOMES

* It equips students to find the solutions of partial differential equations that model real time processes
* Provides the students to have sound knowledge Fourier series analysis.
* The students will have the ability to solve boundary value problems
* This course enables the students to apply Fourier transform techniques to many engineering problems.
* Using this course, a student develops Z transform techniques for discrete time systems for real world problems.

CO – PO MAPPING :

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

ARTICULATION MATRIX:

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

UNIT – I   PARTIAL DIFFERENTIAL EQUATIONS   9+3

Formation of partial differential equations – Singular integrals – Solutions of standard types of first order partial differential equations - Lagrange''s linear equation - Linear partial differential equations of second and higher order with constant coefficients of homogeneous.

UNIT - II   FOURIER SERIES   9+3

Dirichlet's conditions – General Fourier series – odd and even functions – Half range sine series – Half range cosine series – Parseval's identity – Harmonic analysis

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UNIT – III   BOUNDARY VALUE PROBLEMS   9+3

Classification of PDE - Solutions of one dimensional wave equation – One dimensional equation of heat conduction – Fourier series solution in Cartesian coordinates – Steady state solution of two dimensional heat equation (excluding insulated edges) on finite square plates (excluding circular plates).

UNIT – IV   FOURIER TRANSFORMS   9+3

Statement of Fourier integral theorem - Fourier transforms pair – Fourier sine and cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity – Problems.

UNIT – V   Z - TRANSFORMS AND DIFFERENCE EQUATIONS   9+3

Z- transforms - Elementary properties – Initial and final value theorem – Inverse Z - transforms – Partial fraction method – Residue method – Convolution theorem - Formation of difference equations – Solution of difference equations using Z - transforms

TOTAL: 45 + 15 = 60Hrs

TEXT BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Erwin Kreyszig	Advanced Engineering Mathematics, 9th Edition	John Wiley and Sons, New Delhi	2014
2.	Grewal. B.S	Higher Engineering Mathematics, 43rd Edition	Khanna Publications, Delhi	2014

REFERENCE BOOKS:

Sl.No	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Glyn James	Advanced Modern Engineering Mathematics, 4th Edition	Pearson Education	2016
2.	Bali N. P Manish Goyal	A Text book of Engineering Mathematics, 9th edition	Laxmi Publications Pvt Ltd.	2016
3.	Datta.K.B.	Mathematical Methods of Science and Engineering	Cengage Learning India Pvt Ltd, Delhi	2013
4.	Ray Wylie. C, Barrett.L.C	Advanced Engineering Mathematics, 6th Edition	Tata Mc Graw Hill Education Pvt Ltd, New Delhi	2012
5.	Ramana.B.V.	Higher Engineering Mathematics	Tata Mc Graw Hill Publishing Company, New Delhi	2008

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

COURSE CODE	COURSE TITLE	L	T	P	C
21GES20	RENEWABLE ENERGY SOURCES	3	0	0	3

COURSE OBJECTIVES:

- To identify the new methodologies/ technologies for effective utilization of renewable energy sources.
- To understand reverse of energy recourses.
- To understand solar energy production and applications.
- To understand wind energy systems.
- To study other energy recourses.

COURSE OUTCOMES:

CO1:	Understand the fundamentals of energy scenario.
CO2:	Illustrate the techniques used in utilization and measurement of solar energy
CO3:	Demonstrate the types and performance of wind energy systems
CO4:	Comprehend and identify the bio-mass energy sources and applications.
CO5:	Outline the utilization techniques of tidal, wave, Hydro, geothermal, fuel cell systems and hybrid system energy sources.

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
21GES20.CO1	X	X	X	X	-	-	X	-	X	-	-	X	X	X	-
21GES20.CO2	X	X	X	X	-	-	X	-	X	-	-	X	X	X	-
21GES20.CO3	X	X	X	X	-	-	X	-	X	-	-	X	X	X	-
21GES20.CO4	X	X	X	X	-	-	X	-	X	-	-	X	X	X	-
21GES20.CO5	X	X	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
21GES20.CO1	2	1	1	1	-	-	2	-	1	-	-	1	2	1	-
21GES20.CO2	2	1	1	1	-	-	2	-	1	-	-	1	2	1	-
21GES20.CO3	2	1	1	1	-	-	2	-	1	-	-	1	2	1	-
21GES20.CO4	2	1	1	1	-	-	2	-	1	-	-	1	2	1	-
21GES20.CO5	2	1	1	1	-	-	2	-	1	-	-	1	2	1	-

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

UNIT I: INTRODUCTION 9

World Energy Use – Reserves of Energy Resources – Environmental Aspects of Energy Utilisation – Renewable Energy Scenario in Tamilnadu, India and around the World - Potentials - Achievements / Applications – Economics of renewable energy systems.

UNIT II: SOLAR ENERGY 9

Solar Radiation – Measurements of Solar Radiation - Flat Plate and Concentrating Collectors – Solar direct Thermal Applications – Solar thermal Power Generation - Fundamentals of Solar Photo Voltaic Conversion – Solar Cells – Solar PV Power Generation – Solar PV Applications.

UNIT III: WIND ENERGY 9

Wind Data and Energy Estimation – Types of Wind Energy Systems – Performance - Site Selection – Details of Wind Turbine Generator – Safety and Environmental Aspects.

UNIT IV: BIO - ENERGY 9

Biomass direct combustion – Biomass gasifiers – Biogas plants – Digesters – Ethanol production – Bio diesel – Cogeneration - Biomass Applications.

UNIT V: OTHER RENEWABLE ENERGY SOURCES 9

Tidal energy – Wave Energy – Open and Closed OTEC Cycles – Small Hydro-Geothermal Energy Hydrogen and Storage - Fuel Cell Systems – Hybrid Systems.

TOTAL: 45 HRS

TEXT BOOKS:

S.NO.	AUTHOR(S)	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1.	G.D. Rai	Non Conventional Energy Sources,	Khanna Publishers, New Delhi,	2011.
2.	Twidell, J.W. & Weir A.	Renewable Energy Sources	EFN Spon Ltd., UK,	2006

REFERENCE BOOKS:

S.NO.	AUTHOR(S)	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1.	David M. Mousdale	Introduction to Biofuels,	CRC Press Taylor & Francis Group, USA	2010
2.	Chetan Singh Solanki	Solar Photovoltaic, Fundamentals, Technologies and Applications,	PHI Learning Private Limited, New Delhi	2009
3.	S.P. Sukhatme	Solar Energy	Tata McGraw Hill Publishing Company Ltd., New Delhi,	1997.
4.	Sinduja S	Renewable Energy Sources	Anuradha Publications	2012
5.	Tasneem abbasi and T.A Abbasi	Renewable Energy Sources: Their Impact on Global Warming and Pollution	Prentice Hail India Learning Private Limited	2010

COURSE CODE	COURSE TITLE	L	T	P	C
21BSS27	PROBABILITY AND RANDOM PROCESSES	3	1	0	4

COURSE OBJECTIVES:
- Analyze random or unpredictable experiments and investigate important features of random experiments.
- Construct probabilistic models for observed phenomena through distributions which play an important role in many engineering applications.
- To acquire the knowledge the concept of convergence of random sequence and the study of random signals
- To be familiar with application of auto correlation and cross correlation functions.
- To learn the concept of spectral density

COURSE OUTCOMES:

CO1:	Have a fundamental knowledge of the probability concepts.
CO2:	Use standard distributions to the real life problems.
CO3:	Associate random variables by designing joint distributions and correlate the random variables.
CO4:	Understand and characterize phenomenon which evolve with respect to time in a probabilistic manner.
CO5:	Gain knowledge in correlation and spectral densities

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
21BSS27.CO1	X	X	X	X	-	-	-	-	-	-	-	X	X	X	-
21BSS27.CO2	X	X	X	X	-	-	-	-	-	-	-	X	X	X	-
21BSS27.CO3	X	X	X	X	-	-	-	-	-	-	-	X	X	X	-
21BSS27.CO4	X	X	X	X	-	-	-	-	-	-	-	X	X	X	-
21BSS27.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
21BSS27.CO1	3	3	2	2	-	-	-	-	-	-	-	2	2	1	-
21BSS27.CO2	3	3	2	2	-	-	-	-	-	-	-	2	2	1	-
21BSS27.CO3	3	3	2	2	-	-	-	-	-	-	-	2	2	1	-
21BSS27.CO4	3	3	2	2	-	-	-	-	-	-	-	2	2	1	-
21BSS27.CO5	3	3	2	2	-	-	-	-	-	-	-	2	2	1	-

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

UNIT - I PROBABILITY AND RANDOM VARIABLES   9+3

Axioms of probability–conditional probability– Baye's theorem, random variables– Discrete and continuous random variables – MGF

UNIT – II STANDARD DISTRIBUTIONS   9+3

Discrete distributions : Binomial, Poisson, Geometric, Negative Binomial and their properties – Continuous distributions : Uniform, Exponential, Gamma, Normal distributions and their properties

UNIT – III TWO - DIMENSIONAL RANDOM VARIABLES   9+3

Joint distributions – Marginal and conditional distributions – Covariance – Correlation and regression – Transformation of random variables

UNIT – IV RANDOM PROCESSES   9+3

Classification – Stationary process – Markov process - Poisson process – Discrete parameter Markov chain – Chapman Kolmogorov equations

UNIT – V CORRELATION AND SPECTRAL DENSITIES   9+3

Auto correlation - Cross correlation - Properties – Power spectral density – Cross spectral density - Properties – Wiener-Khintchine relation – Relationship between cross power spectrum and cross correlation function

TOTAL: 45 + 15 = 60Hrs

TEXT BOOKS:

S.NO.	AUTHOR(S)	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1.	Oliver. C Ibe.	Fundamentals of Applied Probability and Random Processes, 2nd Edition	Academic Press	2014
2.	Stark. H., Woods. J.W.	Probability and Random Processes with Applications to Signal Processing, 4th Edition	Pearson Education, Asia	2014

REFERENCE BOOKS:

S.NO.	AUTHOR(S)	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1.	HweiP.Hsu	Schaum"s Outline of Theory and Problems of Probability, Random Variables and Random Processes	Mc Graw Hill Publishing Company, New Delhi	2014
2.	Henry Stark , John W. Woods	Probability, Statistics, and Random Processes for Engineers" , 2nd Edition	Pearson Education	2014
3.	Miller. S.L., Childers. D.G.	Probability and Random Processes with Applications to Signal Processing and Communications , 2nd Edition	Academic Press (Elsevier)	2012
4.	Yates. R.D., Goodman. D.J.	Probability and Stochastic Processes, 2nd Edition	Wiley India Pvt. Ltd., Bangalore	2012
5.	Peyton Peebles	Problems and Solutions in Probability, Random Variables and Random Signal Principles (SIE), 1st Edition	Mc Graw Hill Publishing Company, New Delhi	2012

COURSE CODE	COURSE TITLE	L	T	P	C
21GES33	ELECTRONIC DEVICES AND CIRCUITS	3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

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

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
21GES33.CO1	X	X	X	X	X	-	-	-	-	-	-	-	-	X	X
21GES33.CO2	X	X	X	X	X	-	-	-	-	-	X	-	X	X	X
21GES33.CO3	X	X	X	X	X	-	-	-	X	-	X	X	X	X	X
21GES33.CO4	X	X	X	X	X	-	-	-	X	-	X	X	X	X	X
21GES33.CO5	X	X	X	X	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
21GES33.CO1	3	3	2	2	2	-	-	-	-	-	-	-	-	1	1
21GES33.CO2	3	3	2	2	2	-	-	-	-	-	2	-	2	1	1
21GES33.CO3	3	3	2	2	2	-	-	-	2	-	2	3	2	1	1
21GES33.CO4	3	3	3	3	3	-	-	-	2	-	2	3	2	1	1
21GES33.CO5	3	3	2	2	2	-	-	-	2	-	3	3	2	1	1

1 - Low, 2 - Medium, 3 – High

UNIT I APPLICATIONS OF SEMICONDUCTOR DEVICES 9

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

UNIT II TRANSISTORS 9

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

UNIT III AMPLIFIERS 9

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

UNIT IV MULTISTAGE AMPLIFIERS AND DIFFERENTIAL AMPLIFIER 9

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

UNIT V FEEDBACK AMPLIFIERS AND OSCILLATORS 9

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

TOTAL = 45 HRS

TEXT BOOKS:

S.NO.	AUTHOR(S)	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1.	Jacob. Millman, Christos C.Halkias	Electronic Devices and Circuits	Tata Mc Graw Hill	2012
2.	Sedha.R.S	A Text Book of Applied Electronics	Sultan Chand Publishers	2010

REFERENCE BOOKS:

S.NO.	AUTHOR(S)	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1.	David A.Bell	Electronic Devices and Circuits	Prentice Hall of India Pvt. Limited	2013
2.	Gupta.J.B	Electron Devices and Circuits	S.K.Kataria & Sons	2012
3.	Mathur.S.P, Kulshreshtha.D.C and Chanda.P.R	Electronic Devices — Applications and Integrated circuits	Umesh Publications	2010
4.	Malvino	Electronic Principles	Tata McGraw Hill	2010
5.	Boylestad & Nashelsky	Electronic Devices & Circuit Theory	Prentice Hall of India Pvt. Ltd	2009

COURSE CODE	COURSE TITLE	L	T	P	C
21BSS26	NUMERICAL METHODS	3	1	0	4

COURSE OBJECTIVES:

- Remember the algebraic equations representing steady state models formed in engineering problems.
- Understand the interpolation and approximation for the application of finite element analysis.
- Apply the trend information from discrete data set through numerical differentiation and summary information through numerical integration.
- Understand the system dynamic behavior through solution of Ordinary Differential Equations modeling the system.
- Apply the Partial Differential Equation models representing spatial and temporal variations in physical systems through numerical methods.

COURSE OUTCOMES:

CO1:	Have a clear perception of the power of numerical techniques.
CO2:	Solve a set of algebraic equations representing steady state models formed in engineering problems.
CO3:	Deal with interpolation and approximation for the application of finite element analysis.
CO4:	Acquire knowledge in numerical differentiation and numerical integration.
CO5:	Solve initial and boundary value problems.

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
21BSS26.CO1	X	X	X	X	-	-	-	-	-	-	X	X	X	X	X
21BSS26.CO2	X	X	X	X	-	-	-	-	-	-	X	X	X	X	X
21BSS26.CO3	X	X	X	X	-	-	-	-	-	-	X	X	X	X	X
21BSS26.CO4	X	X	X	X	-	-	-	-	-	-	X	X	X	X	X
21BSS26.CO5	X	X	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
21BSS26.CO1	2	3	2	2	-	-	-	-	-	-	2	3	2	1	1
21BSS26.CO2	2	3	2	2	-	-	-	-	-	-	2	3	2	1	1
21BSS26.CO3	3	3	2	2	-	-	-	-	-	-	2	2	2	1	1
21BSS26.CO4	3	3	2	2	-	-	-	-	-	-	2	2	2	1	1
21BSS26.CO5	3	3	2	2	-	-	-	-	-	-	2	2	2	1	1

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

UNIT - I SOLUTION OF EQUATIONS AND EIGEN VALUE PROBLEMS 9+3

Solution of algebraic and transcendental equations – Newton- Raphson method – Solution of linear system of a equations - Gauss elimination method – Gauss Jordon method - Iterative methods of Gauss Jacobi and Gauss-Seidel -Eigen values of a matrix by power method

UNIT – II INTERPOLATION AND APPROXIMATION 9+3

Interpolation with unequal intervals – Lagrange's interpolation – Newton's divided difference interpolation – Interpolation with equal intervals – Newton's forward and backward difference formulae.

UNIT – III NUMERICAL DIFFERENTIATION AND INTEGRATION 9+3

Approximation of derivatives using interpolation polynomials – Numerical integration using Trapezoidal, Simpson's 1/3 rule – Two point and three point Gaussian quadrature formulae – Evaluation of double integrals by trapezoidal and Simpsons's 1/3 rules.

UNIT – IV INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS 9+3

Single step methods – Taylor's series method – Euler's method – Modified Euler's method – Fourth order Runge-Kutta method for solving first order equations – Multi step methods – Milne's and Adam's-Bash forth predictor corrector methods for solving first order equations.

UNIT – V BOUNDARY VALUE PROBLEMS IN ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS 9+3

Finite difference methods for solving two-point linear boundary value problems – Finite difference techniques for the solution of Laplace's and Poisson's equations on rectangular domain – one dimensional heat equation by explicit and implicit (Crank Nicholson) methods – One dimensional wave equation by explicit method.

TOTAL: 45 + 15 = 60 Hrs

TEXT BOOKS:

S.NO.	AUTHOR(S)	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1.	S. K. Gupta	Numerical Methods for Engineers	New Age International Pvt Ltd Publishers,	3rd Edition, 2015
2.	Chapra. S.C., Canale.R.P.	Numerical Methods for Engineer	Tata McGraw Hill, New Delhi	6th Edition, 2012

REFERENCE BOOKS:-

S.NO.	AUTHOR(S)	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1.	Grewal. B.S.	Numerical Methods in Engineering & Science: with Programs in C and C++	Khanna Publishers, New Delhi	10th Edition, 2010
2.	M.K.Jain	Numerical Methods for Scientific & Engineering Computation	New Age International Publishers	6th Edition, 2010
3.	Sankara Rao. K.	Numerical methods for Scientists and Engineers	Prentice Hall of India Private, New Delhi	3rd Edition, 2007
4.	Brian Bradie	A friendly introduction to Numerical analysis	Pearson Education, Asia, New Delhi	1st edition, 2007
5.	Gerald. C. F. Wheatley. P. O.	Applied Numerical Analysis	Pearson Education, Asia, New Delhi	6th Edition, 2006

Mandatory Courses

COURSE CODE	COURSE TITLE	L	T	P	C
21HSS08	HERITAGE OF TAMILS	1	0	0	1

UNIT I   LANGUAGE AND LITERATURE   3

Language Families in India - Dravidian Languages – Tamil as a Classical Language - Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.

UNIT II   HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE   3

Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils.

UNIT III   FOLK AND MARTIAL ARTS   3

Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leather puppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

UNIT IV   THINAI CONCEPT OF TAMILS   3

Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas.

UNIT V   CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT
AND INDIAN CULTURE   3

Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books.

TOTAL : 15 HRS

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).

2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).

3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)

4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)

5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)

6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.

7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).

COURSE CODE	COURSE TITLE	L	T	P	C
21BMM01	INDIAN CONSTITUTION	2	0	0	0

COURSE OBJECTIVES:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

COURSE OUTCOMES:

CO1:	Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
CO2:	Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
CO3:	Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
CO4:	Discuss the passage of the Hindu Code Bill of 1956.
CO5	Understand the role of Election Commission.

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
21BMM01.CO1	-	-	-	-	-	X	X	X	X	-	X	X	-	-	-
21BM M01.CO2	-	-	-	-	-	X	X	X	X	-	X	-	-	-	-
21BM M01.CO3	-	-	-	-	-	X	X	X	X	-	-	X	-	-	-
21BM M01.CO4	-	-	-	-	-	X	X	X	X	-	-	-	-	-	-
21BM M01.CO5	-	-	-	-	-	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
21BMM01.CO1	-	-	-	-	-	2	2	2	2	-	2	1	-	-	-
21BM M01.CO2	-	-	-	-	-	2	2	2	2	-	2	-	-	-	-
21BM M01.CO3	-	-	-	-	-	2	2	2	2	-	-	1	-	-	-
21BM M01.CO4	-	-	-	-	-	2	2	2	2	-	-	-	-	-	-
21BM M01.CO5	-	-	-	-	-	2	2	2	2	-	1	1	-	-	-

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

UNIT I   **HISTORY OF MAKING OF THE INDIAN CONSTITUTION**   **3 Hrs**

History, Drafting Committee, (Composition & Working), Preamble, Salient Features

UNIT II   **CONTOURS OF CONSTITUTIONAL RIGHTS & DUTIES**   **3 Hrs**

Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT III   **ORGANS OF GOVERNANCE**   **3 Hrs**

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions

UNIT IV   **LOCAL ADMINISTRATION**   **3 Hrs**

District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation, Pachayati raj: Introduction, PRI: Zila Pachayat, Elected officials and their roles, CEO Zila Pachayat: Position and role, Block level: Organizational Hierarchy (Different departments),Village level: Role of Elected and Appointed officials, Importance of grass root democracy

UNIT V   **ELECTION COMMISSION**   **3 Hrs**

Election Commission: Role and Functioning, Chief Election Commissioner and Election Commissioners, State Election Commission: Role and Functioning, Institute and Bodies for the welfare of SC/ST/OBC and women.

TOTAL: 15 HRS

TEXT BOOKS:

S.NO.	AUTHOR(s)	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1.	Dr. S. N. Busi	Dr. B. R. Ambedkar framing of Indian Constitution	1st Edition, Lexis Nexis	2015
2.	M. P. Jain	Indian Constitution Law	7th Edn., Lexis Nexis	2014

REFERENCE BOOKS:

S.NO.	AUTHOR(s)	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1.	D.D. Basu	Introduction to the Constitution of India	Lexis Nexis	2015
2.	Bare ACT	The Constitution of India, 1950 (Bare Act)	Commercial Law Publishers (India) Pvt, Ltd.	2004

COURSE CODE	COURSE TITLE	L	T	P	C
21BMM02	ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE	2	0	0	0

COURSE OBJECTIVES:

- To facilitate the students with the concepts of Indian traditional knowledge and to make them understand the Importance of roots of knowledge system.
- To make the students understand the traditional knowledge and analyze it and apply it to their day to day life.

COURSE OUTCOMES:

CO1:	Identify the concept of Traditional knowledge and its importance.
CO2:	Explain the need and importance of protecting traditional knowledge.
CO3:	Illustrate the various enactments related to the protection of traditional knowledge.
CO4:	Interpret the concepts of Intellectual property to protect the traditional knowledge.
CO5	Explain the importance of Traditional knowledge in Agriculture and Medicine.

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
21BMM01.CO1	-	-	-	-	-	X	X	X	X	-	X	X	-	-	-
21BM M01.CO2	-	-	-	-	-	X	X	X	X	-	X	-	-	-	-
21BM M01.CO3	-	-	-	-	-	X	X	X	X	-	-	X	-	-	-
21BM M01.CO4	-	-	-	-	-	X	X	X	X	-	-	-	-	-	-
21BM M01.CO5	-	-	-	-	-	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
21BMM01.CO1	-	-	-	-	-	2	2	2	2	-	2	1	-	-	-
21BM M01.CO2	-	-	-	-	-	2	2	2	2	-	2	-	-	-	-
21BM M01.CO3	-	-	-	-	-	2	2	2	2	-	-	1	-	-	-
21BM M01.CO4	-	-	-	-	-	2	2	2	2	-	-	-	-	-	-
21BM M01.CO5	-	-	-	-	-	2	2	2	2	-	1	1	-	-	-

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

UNIT I INTRODUCTION TO TRADITIONAL KNOWLEDGE 3 Hrs

Define traditional knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, Indigenous Knowledge (IK), characteristics, traditional knowledge vis-a-vis indigenous knowledge, traditional knowledge Vs western knowledge traditional knowledge

UNIT II PROTECTION OF TRADITIONAL KNOWLEDGE 3 Hrs

The need for protecting traditional knowledge Significance of TK Protection, value of TK in global economy, Role of Government to harness TK.

UNIT III LEGAL FRAMEWORK AND TK 3 Hrs

The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, Plant Varieties Protection and Farmer's Rights Act, 2001 (PPVFR Act); The Biological Diversity Act 2002 and Rules 2004, the protection of traditional knowledge bill, 2016.

UNIT IV TRADITIONAL KNOWLEDGE AND INTELLECTUAL PROPERTY 3 Hrs

Systems of traditional knowledge protection, Legal concepts for the protection of traditional knowledge, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge.

UNIT V TRADITIONAL KNOWLEDGE IN DIFFERENT SECTORS 3 Hrs

Traditional knowledge and engineering, Traditional medicine system, TK in agriculture, Traditional societies depend on it for their food and healthcare needs, Importance of conservation and sustainable development of environment, Management of biodiversity, Food security of the country and protection of TK

TOTAL: 15 HRS

TEXT BOOKS:

S.NO.	AUTHOR(s)	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1.	Amit Jha	Traditional Knowledge System in India	Atlantic	2009
2.	Basanta Kumar Mohanta, VipinKumarSingh, Pratibha Prakashan	Traditional Knowledge System and Technology in India	Pratibha Prakashan	2012

REFERENCE BOOKS:

S.NO.	AUTHOR(s)	TITLE OF THE BOOK	PUBLISHER	YEAR OF PUBLICATION
1.	Amit Jha	Traditional Knowledge System in India	Atlantic	2002
2.	Kapil Kapoor, Michel Danino	Knowledge Traditions and Practices of India	Ancient Sci Life	2012