NANDHA ENGINEERING COLLEGE

(An Autonomous Institution affiliated to Anna University Chennai and approved by AICTE, New Delhi)
Erode - 638 052, Tamilnadu, India, Phone: 04294 – 225585

Curriculum and Syllabi

for

B.E – Biomedical Engineering [R22]

[CHOICE BASED CREDIT SYSTEM]

[This Curriculum and Syllabi are applicable to Students admitted from the Academic year 2024 - 2025 onwards]

APRIL 2025

INSTITUTE VISION AND MISSION	
VISION	• To be an Institute of excellence providing quality Engineering, Technology and Management education to meet the ever changing needs of the society
MISSION	• To provide quality education to produce ethical and competent professionals with social Responsibility • To excel in the thrust areas of Engineering, Technology and Entrepreneurship by solving real- world problems • To create a learner centric environment and improve continually to meet the changing global needs

B.E – BIOMEDICAL ENGINEERING	
VISION	• To foster academic excellence imparting knowledge in Biomedical and allied disciplines to meet the ever growing needs of the society
MISSION	• To impart quality education and develop an aptitude for professional career and continuous learning with ethics and social responsibility • To provide a framework for research and innovation to meet the emerging challenges through regular interaction with healthcare industry • To create a learner centric environment by upgrading knowledge and skills to cater the needs and challenges of the society
PROGRAMME EDUCATIONAL OBJECTIVES (PEO)	The graduates of Biomedical Engineering will be **PEO1: Core Competency:** Successful professionals with core competency and inter-disciplinary skills to satisfy the Industrial needs **PEO2: Research, Innovation and Entrepreneurship:** Capable of identifying technological requirements for the society and providing innovative ideas for real time problems **PEO3: Ethics, Human values and Life-long learning:** Able to demonstrate ethical practices and managerial skills through continuous learning
PROGRAMME SPECIFIC OUTCOMES (PSO)	The students of Biomedical Engineering will be able to • Design and develop the electronic systems to offer healthcare solutions by applying the knowledge of Mathematics, Life Sciences, Engineering and Technology • Apply software skills, Information and Communication Technologies (ICT) for solving the clinical problems

PROGRAM OUTCOMES:

At the end of this programme the students will be able to

a-l	GRADUATE ATTRIBUTES	PO No.	PROGRAMME OUTCOMES
a	Engineering Knowledge	PO1	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems
b	Problem Analysis	PO2	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
c	Design and Development of Solutions	PO3	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
d	Investigation of Complex Problems	PO4	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
e	Modern Tool Usage	PO5	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
f	The Engineer and Society	PO6	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
g	Environment and Sustainability	PO7	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development
h	Ethics	PO8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice
i	Individual and Team Work	PO9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings
j	Communication	PO10	Communication 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
k	Project Management and Finance	PO11	Demonstrate knowledge and understanding of the engineering and 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
l	Lifelong Learning	PO12	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

MAPPING OF PROGRAMME EDUCATIONAL OBJECTIVES WITH PROGRAMME OUTCOMES

A broad relation between the Programme Educational Objectives and the Outcomes is given in the following table

PROGRAMME EDUCATIONAL OBJECTIVES	PROGRAMME OUTCOMES											
	A	B	C	D	E	F	G	H	I	J	K	L
1	3	3	2	3	2	1	1	2	1	1	3	1
2	3	3	3	3	3	1	1	1	1	1	1	2
3	3	3	3	3	3	2	2	3	1	2	2	2

MAPPING OF PROGRAM SPECIFIC OUTCOMES WITH PROGRAMME OUTCOMES

A broad relation between the Program Specific Objectives and the outcomes is given in the following table

PROGRAM SPECIFIC OUTCOMES	PROGRAMME OUTCOMES											
	A	B	C	D	E	F	G	H	I	J	K	L
1	3	3	3	3	2	2	1	1	2	1	1	2
2	1	3	2	3	3	2	2	1	2	1	1	3

Contribution 1: Reasonable 2: Significant 3: Strong

SEMESTER: I									
S. No.	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PRE-REQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
1.	22MAN01	Induction Programme	MC	-	-	-	-	-	-
THEORY									
2.	22EYA01	Professional Communication – I	HSMC	-	4	2	0	2	3
3.	22MYB01	Calculus and Linear Algebra*	BSC	-	4	3	1	0	4
4.	22CYB01	Introduction to Biochemistry	BSC	-	3	3	0	0	3
5.	22CSC01	Problem Solving and C Programming	ESC	-	3	3	0	0	3
6.	22ECC02	Basics of Electrical and Instrumentation Engineering	ESC	-	3	3	0	0	3
7.	22GYA01	தமிழர் மரபு / Heritage of Tamils *	HSMC	-	1	1	0	0	1
PRACTICAL									
8.	22GEP01	Engineering Practices Laboratory	ESC	-	4	0	0	4	2
9.	22CSP01	Problem Solving and C Programming Laboratory	ESC	-	4	0	0	4	2
10.	22CYP01	Chemistry Laboratory*	BSC	-	2	0	0	2	1
MANDATORY NON CREDIT COURSES									
11.	22MAN01	Induction Programme	MC	-	-	0	0	0	0
12.	22MAN03	Yoga – I*	MC	-	1	0	0	1	0
				TOTAL	**29**	**15**	**1**	**13**	**22**

*Ratified by Eleventh Academic Council

SEMESTER: II									
S. No.	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PRE-REQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
THEORY									
1.	22EYA02	Professional Communication- II	HSMC	22EYA01	4	2	0	2	3
2.	22MYB04	Transforms and Partial Differential Equations*	BSC	-	4	3	1	0	4
3.	22PYB03	Solid State Physics	BSC	-	3	3	0	0	3
4.	22CSC02	Data Structures using C*	ESC	22CSC01	3	3	0	0	3
5.	22ECC04	Electronic Devices and Circuits (Theory + Lab)	ESC	-	5	3	0	2	4
6.	22GYA02	தமிழரும் தொழில்நுட்பமும் / Tamils and Technology *	HSMC	-	1	1	0	0	1
PRACTICAL									
7.	22CSP02	Data Structures Laboratory*	ESC	22CSP01	4	0	0	4	2
8.	22PYP01	Physics Laboratory*	BSC	-	2	0	0	2	1
9.	22MEP01	Engineering Graphics Laboratory	ESC	-	4	0	0	4	2
MANDATORY NON CREDIT COURSES									
10.	22MAN02R	Soft/Analytical Skills – I	MC	-	3	1	0	2	0
11.	22MAN05	Yoga – II*	MC	-	1	0	0	1	0
				TOTAL	**34**	**16**	**1**	**17**	**23**

*Ratified by Eleventh Academic Council

SEMESTER: III									
S. No.	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PRE-REQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
THEORY									
1.	22MYB06	Probability and Random Processes	BSC	-	4	3	1	0	4
2.	22BMC01	Analog and Digital Electronics	PCC	22ECC04	3	3	0	0	3
3.	22BMC02	Anatomy and Human Physiology (Theory + Lab)	PCC	-	5	3	0	2	4
4.	22BMC03	Sensors and Measurements	PCC	22ECC02	3	3	0	0	3
5.	22ECC06	Signals and Systems	PCC	22MYB01, 22MYB04	3	3	0	0	3
6.	22CYB06	Environmental Science and Sustainability	BSC	-	3	3	0	0	3
PRACTICAL									
7.	22BMP01	Analog and Digital Electronics Laboratory	PCC	-	4	0	0	4	2
8.	22BMP02	Sensors and Measurements Laboratory	PCC	-	4	0	0	4	2
Mandatory Non Credit Courses									
9.	22MAN04R	Soft / Analytical Skills – II	MC	-	3	1	0	2	0
10.	22MAN09	Indian Constitution	MC	-	1	1	0	0	0
				TOTAL	**33**	**20**	**1**	**12**	**24**

SEMESTER: IV									
S. NO.	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PRE-REQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
THEORY									
1.	22ITC06	Java Programming	ESC	-	3	3	0	0	3
2.	22MEC13	Engineering Mechanics for Biomedical Engineers	PCC	-	3	3	0	0	3
3.	22BMC04	Biomedical Instrumentation	PCC	22BMC03	3	3	0	0	3
4.	22BMC05	Biosignal Processing	PCC	22ECC06	3	3	0	0	3
5.	22BMC06	Biocontrol System	PCC	-	3	3	0	0	3
6.	22BMC07	Biomaterials and Artificial Organs	PCC	22BMC02	3	3	0	0	3
PRACTICAL									
7.	22ITP04	Java Programming Laboratory	ESC	-	4	0	0	4	2
8.	22BMP03	Biosignal Processing Laboratory	PCC	-	4	0	0	4	2
9.	22BMP04	Biomedical Instrumentation Laboratory	PCC	-	4	0	0	4	2
Mandatory Non Credit Courses									
10.	22MAN07R	Soft/Analytical Skills – III	MC	-	3	1	0	2	0
11.	22GED01	Personality and Character Development	EEC	-	0	0	0	1	0
				TOTAL	**33**	**19**	**0**	**15**	**24**

SEMESTER: V									
S. NO.	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PRE-REQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
THEORY									
1.	22BMC08	Microprocessors and Microcontrollers Interfacing	PCC	22BMC01	3	3	0	0	3
2.	22BMC09	Radiology Equipment	PCC	-	3	3	0	0	3
3.	22BMC10	Diagnostic and Therapeutic Equipment	PCC	22BMC04	3	3	0	0	3
4.	E1	Elective(PEC)	PEC	-	3	3	0	0	3
5.	E2	Elective(OEC/PEC)	OEC/PEC	-	3	3	0	0	3
6.	E3	Elective(PEC)	PEC	-	3	3	0	0	3
PRACTICAL									
7.	22BMP05	Microprocessors and Microcontrollers Interfacing Laboratory	PCC	-	4	0	0	4	2
8.	22BMP06	Diagnostic and Therapeutic Equipment Laboratory	PCC	22BMP04	4	0	0	4	2
Mandatory Non Credit Courses									
9.	22MAN08R	Soft/Analytical Skills – IV	MC	-	3	1	0	2	0
				TOTAL	**30**	**19**	**0**	**11**	**22**

SEMESTER: VI									
S. NO.	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PRE-REQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
THEORY									
1.	22BMC11	Fundamentals of Healthcare Analytics	PCC	-	3	3	0	0	3
2.	22BMC12	Medical Image Processing	PCC	-	3	3	0	0	3
3.	EM1	Elective (Management)	HSMC	-	3	3	0	0	3
4.	E4	Elective(OEC)	OEC	-	3	3	0	0	3
5.	E5	Elective(PEC)	PEC	-	3	3	0	0	3
6.	E6	Elective(PEC)	PEC	-	3	3	0	0	3
PRACTICAL									
7.	22BMP07	Medical Image Processing Laboratory	PCC	-	4	0	0	4	2
				TOTAL	**26**	**19**	**0**	**7**	**20**

SEMESTER: VII									
S. NO.	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PRE-REQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
THEORY									
1.	22GEA01	Universal Human Values	HSMC	-	2	2	0	0	2
2.	E7	Elective(OEC/PEC)	OEC/PEC	-	3	3	0	0	3
3.	E8	Elective(PEC)	PEC	-	3	3	0	0	3
4.	E9	Elective(PEC)	PEC	-	3	3	0	0	3
5.	E10	Elective(OEC)	OEC	-	3	3	0	0	3
PRACTICAL									
6.	22GED02	Internship / Industrial Training	EEC	-	2	0	0	0	2
				TOTAL	**16**	**14**	**0**	**0**	**16**

SEMESTER: VIII									
S. NO.	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PRE-REQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
PRACTICAL									
1.	22BMD01	Project Work	EEC	-	20	0	0	20	10
				TOTAL	**20**	**0**	**0**	**20**	**10**

B.E. BIOMEDICAL ENGINEERING

REGULATIONS – 2022 **CHOICE BASED CREDIT SYSTEM**

(A) HSMC, BSC, ESC and MC Courses

a) Humanities Science including Management Courses (HSMC)

S. No.	COURSE CODE	COURSE TITLE	CATEGORY	PRE-REQUISITE	CONTACT PERIODS	L	T	P	C
1.	22EYA01	Professional Communication – I	HSMC	-	4	2	0	2	3
2.	22GYA01	தமிழர் மரபு / Heritage of Tamils	HSMC	-	1	1	0	0	1
3.	22EYA02	Professional Communication- II	HSMC	22EYA01	4	2	0	2	3
4.	22GYA02	தமிழரும் தொழில்நுட்பமும் / Tamils and Technology	HSMC	-	1	1	0	0	1
5.	22GEA01	Universal Human Values	HSMC	-	2	2	0	0	2
6.	EM1	Elective(Management)	HSMC	-	3	3	0	0	3

b) Basic Science Courses (BSC)

S. No.	COURSE CODE	COURSE TITLE	CATEGORY	PRE-REQUISITE	CONTACT PERIODS	L	T	P	C
1.	22MYB01	Calculus and Linear Algebra	BSC	-	4	3	1	0	4
2.	22CYB01	Introduction to Biochemistry	BSC	-	3	3	0	0	3
3.	22CYP01	Chemistry Laboratory	BSC	-	2	0	0	2	1
4.	22MYB04	Transforms and Partial Differential Equations	BSC	-	4	3	1	0	4
5.	22PYB03	Solid State Physics	BSC	-	3	3	0	0	3
6.	22PYP01	Physics Laboratory	BSC	-	2	0	0	2	1
7.	22MYB06	Probability and Random Processes	BSC	-	4	3	1	0	4
8.	22CYB06	Environmental Science and Sustainability	BSC	-	3	3	0	0	3

c) Engineering Science Courses (ESC)									
S. No.	COURSE CODE	COURSE TITLE	CATEGORY	PRE-REQUISITE	CONTACT PERIODS	L	T	P	C
1.	22CSC01	Problem Solving and C Programming	ESC	-	3	3	0	0	3
2.	22ECC02	Basics of Electrical and Instrumentation Engineering	ESC	-	3	3	0	0	3
3.	22GEP01	Engineering Practices Laboratory	ESC	-	4	0	0	4	2
4.	22CSP01	Problem Solving and C Programming Laboratory	ESC	-	4	0	0	4	2
5.	22CSC02	Data Structures using C	ESC	22CSC01	3	3	0	0	3
6.	22ECC04	Electronic Devices and Circuits (Theory + Lab)	ESC	-	5	3	0	2	4
7.	22CSP02	Data Structures Laboratory	ESC	22CSP01	4	0	0	4	2
8.	22MEP01	Engineering Graphics Laboratory	ESC	-	4	0	0	4	2
9.	22ITC06	Java Programming	ESC	-	3	3	0	0	3
10.	22ITP04	Java Programming Laboratory	ESC	-	4	0	0	4	2

d) Mandatory Non Credit Courses (MC)									
S. No.	COURSE CODE	COURSE TITLE	CATEGORY	PRE-REQUISITE	CONTACT PERIODS	L	T	P	C
1.	22MAN01	Induction Programme	MC	-	0	0	0	0	0
2.	22MAN03	Yoga - I	MC	-	1	0	0	1	0
3.	22MAN02R	Soft /Analytical Skills - I	MC	-	3	1	0	2	0
4.	22MAN05	Yoga - II	MC	-	1	0	0	1	0
5.	22MAN04R	Soft /Analytical Skills - II	MC	-	3	1	0	2	0
6.	22MAN09	Indian Constitution	MC	-	1	1	0	0	0

7.	22MAN07R	Soft / Analytical Skills - III	MC	-	3	1	0	2	0
8.	22MAN08R	Soft/Analytical Skills - IV	MC	-	3	1	0	2	0

(B) Programme Core Courses (PCC)									
S. No.	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PRE-REQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
1.	22BMC01	Analog and Digital Electronics	PCC	22ECC04	3	3	0	0	3
2.	22BMC02	Anatomy and Human Physiology (Theory + Lab)	PCC	-	5	3	0	2	4
3.	22BMC03	Sensors and Measurements	PCC	22ECC02	3	3	0	0	3
4.	22ECC06	Signals and Systems	PCC	22MYB01, 22MYB04	3	3	0	0	3
5.	22BMP01	Analog and Digital Electronics Laboratory	PCC	-	4	0	0	4	2
6.	22BMP02	Sensors and Measurements Laboratory	PCC	-	4	0	0	4	2
7.	22MEC13	Engineering Mechanics for Biomedical Engineers	PCC	-	3	3	0	0	3
8.	22BMC04	Biomedical Instrumentation	PCC	22BMC03	3	3	0	0	3
9.	22BMC05	Biosignal Processing	PCC	22ECC06	3	3	0	0	3
10.	22BMC06	Biocontrol System	PCC	-	3	3	0	0	3
11.	22BMC07	Biomaterials and Artificial Organs	PCC	22BMC02	3	3	0	0	3
12.	22BMP03	Biosignal Processing Laboratory	PCC	-	4	0	0	4	2
13.	22BMP04	Biomedical Instrumentation Laboratory	PCC	-	4	0	0	4	2
14.	22BMC08	Microprocessors and Microcontrollers Interfacing	PCC	22BMC01	3	3	0	0	3
15.	22BMC09	Radiology Equipment	PCC	-	3	3	0	0	3

16.	22BMC10	Diagnostic and Therapeutic Equipment	PCC	22BMC04	3	3	0	0	3
17.	22BMP05	Microprocessors and Microcontrollers Interfacing Laboratory	PCC	-	4	0	0	4	2
18.	22BMP06	Diagnostic and Therapeutic Equipment Laboratory	PCC	22BMP04	4	0	0	4	2
19.	22BMC11	Fundamentals of Healthcare Analytics	PCC	-	3	3	0	0	3
20.	22BMC12	Medical Image Processing	PCC	-	3	3	0	0	3
21.	22BMP07	Medical Image Processing Laboratory	PCC	-	4	0	0	4	2

(C) Employability Enhancement Courses (EEC)

S. No.	COURSE CODE	COURSE TITLE	CATEGORY	PREREQUISITE	CONTACT PERIODS	L	T	P	C
1.	22GED01	Personality and Character Development	EEC	-	0	0	0	1	0
2.	22GED02	Internship / Industrial Training	EEC	-	2	0	0	0	2
3.	22BMD01	Project Work	EEC	-	20	0	0	20	10

(D) Programme Elective Courses (PEC)

S. No.	COURSE CODE	COURSE TITLE	CATEGORY	PRE-REQUISITE	CONTACT PERIODS	L	T	P	C
Vertical 0 - Technology in Biomedicine									
1.	22BMX01	Cell Biology	PEC	-	3	3	0	0	3
2.	22BMX02	Genetic Engineering	PEC	-	3	3	0	0	3
3.	22BMX03	Genomics	PEC	-	3	3	0	0	3
4.	22BMX04	Cancer Biology	PEC	-	3	3	0	0	3
5.	22BMX05	Principles of Tissue Engineering	PEC	-	3	3	0	0	3
6.	22BMX06	Neuroscience	PEC	-	3	3	0	0	3

7.	22BMX07	Nuclear Medicine	PEC	-	3	3	0	0	3
8.	22BMX08	Radiotherapy and Its Application	PEC	-	3	3	0	0	3
Vertical 1 - Wearable Technology									
1.	22BMX11	Communication Systems	PEC	-	3	3	0	0	3
2.	22BMX12	Medical Optics	PEC	-	3	3	0	0	3
3.	22BMX13	Body Area Networks	PEC	-	3	3	0	0	3
4.	22BMX14	Medical Wearable Devices	PEC	-	3	3	0	0	3
5.	22BMX15	Telemedicine and Medical IoT	PEC	-	3	3	0	0	3
6.	22BMX16	Medical Informatics	PEC	-	3	3	0	0	3
7.	22BMX17	Medical Textiles	PEC	-	3	3	0	0	3
8.	22BMX18	Virtual Reality	PEC	-	3	3	0	0	3
Vertical 2 – Artificial Intelligence in Medicine									
1.	22BMX21	Soft Computing	PEC	-	3	3	0	0	3
2.	22BMX22	Pattern Recognition Techniques and Its Applications	PEC	-	3	3	0	0	3
3.	22BMX23	Machine Learning for Healthcare	PEC	-	3	3	0	0	3
4.	22BMX24	Artificial Intelligence in Healthcare	PEC	-	3	3	0	0	3
5.	22BMX25	Deep Learning Techniques	PEC	-	3	3	0	0	3
6.	22BMX26	Machine Vision	PEC	-	3	3	0	0	3
7.	22BMX27	Biometric System	PEC	-	3	3	0	0	3
8.	22BMX28	Brain Computer Interface and Applications	PEC	-	3	3	0	0	3
Vertical 3 – Mechanics									
1.	22BMX31	Biomechanics	PEC	-	3	3	0	0	3
2.	22BMX32	Ergonomics	PEC	-	3	3	0	0	3
3.	22BMX33	Finite Element Analysis	PEC	-	3	3	0	0	3
4.	22BMX34	Physiological Modelling	PEC	-	3	3	0	0	3
5.	22BMX35	Cardiovascular Engineering	PEC	-	3	3	0	0	3

6.	22BMX36	Rehabilitation Engineering	PEC	-	3	3	0	0	3
7.	22BMX37	Prosthetic and Orthotic Devices	PEC	-	3	3	0	0	3
8.	22BMX38	Haptics	PEC	-	3	3	0	0	3
Vertical 4 - Management in Healthcare									
1.	22BMX41	Hospital Planning, Organization and Management	PEC	-	3	3	0	0	3
2.	22BMX42	Hospital Architecture	PEC	-	3	3	0	0	3
3.	22BMX43	Finance Management in Hospitals	PEC	-	3	3	0	0	3
4.	22BMX44	Human Resources Management in Hospital	PEC	-	3	3	0	0	3
5.	22BMX45	Health Policy and Equipment Management	PEC	-	3	3	0	0	3
6.	22BMX46	Hospital Waste Management	PEC	-	3	3	0	0	3
7.	22BMX47	Patient Safety and Standards	PEC	-	3	3	0	0	3
8.	22BMX48	Medical Device Regulations	PEC	-	3	3	0	0	3
Vertical 5 - Modern Healthcare Devices									
1.	22BMX51	Bio-MEMS Technology	PEC	-	3	3	0	0	3
2.	22BMX52	Nanotechnology in Medicine	PEC	-	3	3	0	0	3
3.	22BMX53	Robotics in Healthcare	PEC	-	3	3	0	0	3
4.	22BMX54	Advanced Healthcare System Design	PEC	-	3	3	0	0	3
5.	22BMX55	Critical Care Equipment	PEC	-	3	3	0	0	3
6.	22BMX56	Human Assist Devices	PEC	-	3	3	0	0	3
7.	22BMX57	Ambulatory Services	PEC	-	3	3	0	0	3
8.	22BMX58	Home Medicare Technology	PEC	-	3	3	0	0	3

(E) Management Electives									
S. No.	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PRE-REQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
1.	22GEA02	Principles of Management	HSMC	-	3	3	0	0	3
2.	22GEA03	Total Quality Management	HSMC	-	3	3	0	0	3

3.	22GEA04	Professional Ethics	HSMC	-	3	3	0	0	3

(F) Open Elective Courses (OEC)									
S. No.	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PRE-REQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
1.	22BMZ01	Cellular Biology	OEC	-	3	3	0	0	3
2.	22BMZ02	Biomedical Photonics and Laser Applications	OEC	-	3	3	0	0	3
3.	22BMZ03	Wearable Sensor Technologies	OEC	-	3	3	0	0	3
4.	22BMZ04	Home Healthcare Systems	OEC	-	3	3	0	0	3

(G) Minor Degree Courses									
S. No.	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PRE-REQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
Healthcare Technology									
1.	22BMM01	Introduction to Biomedical Engineering	OEC	-	3	3	0	0	3
2.	22BMM02	Bio Physics	OEC	-	3	3	0	0	3
3.	22BMM03	Biomedical Sensors	OEC	-	3	3	0	0	3
4.	22BMM04	Analytical Instrumentation	OEC	-	3	3	0	0	3
5.	22BMM05	Radiation and Nuclear Medicine	OEC	-	3	3	0	0	3
6.	22BMM06	Radiological Imaging Techniques	OEC	-	3	3	0	0	3
7.	22BMM07	ICU and Operation Theatre Equipment	OEC	-	3	3	0	0	3
8.	22BMM08	Biomaterials	OEC	-	3	3	0	0	3

SUMMARY

B.E – BIOMEDICAL ENGINEERING											
S. No.	SUBJECT AREA	CREDITS AS PER SEMESTER								TOTAL CREDITS	PERCENTAGE (%)
		I	II	III	IV	V	VI	VII	VIII		
1.	HSMC	4	4	-	-	-	3	2	-	13	8.1
2.	BSC	8	8	7	-	-	-	-	-	23	14.3
3.	ESC	10	11	-	5	-	-	-	-	26	16.1
4.	PCC	-	-	17	19	13	8	-	-	57	35.4
5.	PEC	-	-	-	-	9	9	6	-	24	14.9
6.	OEC	-	-	-	-	-	-	6	-	6	3.7
7.	EEC	-	-	-	-	-	-	2	10	12	7.5
CREDITS TOTAL		22	23	24	24	22	20	16	10	161	100

22EYA01 - PROFESSIONAL COMMUNICATION - I (Common to All Branches)					
		L	**T**	**P**	**C**
		2	**0**	**2**	**3**
PRE-REQUISITE : NIL					
Course Objectives:	• To build essential English skills to address the challenges of communication • To enhance communication employing LSRW skills				

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Communicate effectively in various work environments.	R	20%
CO2	Involve in diverse discourse forms utilizing LSRW Skills.	U	20%
CO3	Participate actively in communication activities that enhance the creative skill.	U	20%
CO4	Associate with the target audience and contexts using varied types of communication.	Ap	20%
CO5	Convey the ideas distinctly both in verbal and non-verbal communication in work culture.	U	20%

UNIT I –INTRODUCTORY SKILLS	(6+6)
Grammar – Parts of Speech – Verb (Auxiliaries – Primary & Modal, Main Verb) -**Listening** – Listening toShort Conversations or Monologues - Listening to Experiences – Listening to Descriptions- **Speaking** – Introducing Oneself – Exchanging Personal information - Talking about food and culture – **Reading** – Reading for Interrogation – Reading Newspaper, Advertisements and Interpreting - **Writing** – Seeking Permission for Industrial Visit & In-plant Training	
UNIT II – LANGUAGE ACUMEN	(6+6)
Grammar – Word Formation – Tenses (Present Tense) – Synonyms & Antonyms - **Listening** – Listeningto Announcements – Listening to Interviews - Listening and Note-taking - **Speaking** – Talking aboutHolidays & Vacations – Narrating Unforgettable Anecdotes - **Reading** – Skimming – Scanning (Short Textsand Longer Passages) – Critical Reading - **Writing** – Instruction – Process Description	
UNIT III – COMMUNICATION ROOTERS	(6+6)
Grammar– Cause and Effect – Tenses (Past Tense) – Discourse Markers - **Listening** – Listening to Telephonic Conversations – Listening to Podcasts - **Speaking** – Talking about neoteric Technologies – Eliciting information to fill a form - **Reading** –Book Reading(Motivational) - Practicing Speed Reading (reading newspaper reports & biographies) - **Writing** – Checklist – Circular, Agenda & Minutes of the Meeting	
UNIT IV - DISCOURSE FORTE	(6+6)
Grammar – Tenses (Future Tense) –Yes/No & WH type questions – Negatives - **Listening** – Listening toTED/ Ink talks -**Speaking** – Participating in Short Conversations - **Reading** – Reading Comprehension (Multiple Choice / Short / Open Ended Questions) - **Writing** - E-Mail Writing	

UNIT V - LINGUISTIC COMPETENCIES	(6+6)
Grammar – Articles – Homophones & Homonyms – Single line Definition – Phrasal Verb - **Listening** – Intensive listening to fill in the gapped text - **Speaking** –Expressing opinions through Situations & Role play - **Reading** – Cloze Texts - **Writing** – Paragraph Writing	
LIST OF SKILLS ASSESSED IN THE LABORATORY **1. Grammar** **2. Listening Skills** **3. Speaking Skills** **4. Reading Skills** **5. Writing Skills**	
TOTAL (L:30 , P:30) = 60 PERIODS	

TEXT BOOK:

1. Shoba K N., Deepa Mary Francis. *English for Engineers and Technologists.* Volume 1, 3rd Edition, Orient Blackswan Pvt. Ltd, Telangana, 2022.

REFERENCES:

1. Koneru, Aruna. *English Language Skills.* Tata McGraw Hill Education (India) Private Limited, Chennai, 2006.
2. Hewings, M. *Advanced English Grammar.* Cambridge University Press, Chennai, 2000.
3. Jack C Richards, Jonathan Hull and Susan Proctor. *Interchange.* Cambridge University Press, New Delhi, 2015 (Reprint 2021).

WEB REFERENCE:

1. https://youtu.be/f0uqUzEf3A8?si=vyzu5KGIfbu35_IQ

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1									2	3				
2									2	3				
3									2	3				
4									2	3				
5									2	3				
CO (W.A)									2	3				

22MYB01-CALCULUS AND LINEAR ALGEBRA *(Common to All Branches)*					
		L	**T**	**P**	**C**
		3	**1**	**0**	**4**
PRE-REQUISITE : NIL					
Course Objectives:	• To understand the mathematical concepts of matrices and analytical geometry in real time problems. • To formulate differential and integral equations to model physical, biological, and engineering systems				

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the concepts of matrix theory for find solutions to complex problems efficiently.	Ap	20%
CO2	Analyze the geometric configurations and relationships by using Analytical geometry.	An	20%
CO3	Interpret the partial derivatives which involve heat conduction problems modeled by the heat equation.	Ap	20%
CO4	Apply the differential and integral techniques to solve the differential equations and multiple integrals in heat conduction, fluid mechanics and potential theory.	Ap	40%
CO5	Demonstrate the importance of matrix theory, analytical geometry and integral methods using programming tools.	Ap	Internal Assessment

UNIT I – MATRICES	**(9+3)**
Characteristic Equation-Eigen values and Eigen vectors of a matrix- Cayley Hamilton Theorem (excluding proof) and its applications-Quadratic Form-Reduction of a Quadratic form to canonical form by orthogonal transformation.	
UNIT II – ANALYTICAL GEOMETRY OF THREE DIMENSIONS	**(9+3)**
Equation of plane–Angle between two planes–Equation of straight lines-Coplanar lines–Equation of sphere –Orthogonal spheres.	
UNIT III - GEOMETRICAL APPLICATIONS OF DIFFERENTIAL CALCULUS	**(9+3)**
Curvature–Curvature in Cartesian co-ordinates-Centre and Radius of curvature-Circle of curvature-Evolutes and Involutes.	
UNIT IV - FUNCTIONS OF SEVERAL VARIABLES	**(9+3)**
Partial derivatives-Euler's theorem on homogeneous function-Jacobian-Maxima and Minima of functions of Two variables-Constrained Maxima and Minima by Lagrange's multiplier method.	

UNIT V - MULTIPLE INTEGRALS	**(9+3)**
Double integration in Cartesian Co-ordinates-Change of order of integration-Area as double integral-Triple Integration in Cartesian Co-ordinates-Volume as triple integrals.	
TOTAL(L:45+T:15) :60PERIODS	

LIST OF PROGRAMS USING MATLAB (Assignment/Online Test):

1. Introduction to MATLAB
2. Matrix operations–Addition, Multiplication, Transpose and Inverse
3. Characteristic equation of a Matrix
4. Eigen values and Eigen vectors of Higher order Matrices.
5. Curve Tracing
6. Determining Maxima and Minima of a function of one variable.
7. Determining Maxima and Minima of a function of two variables.
8. Evaluating double integrals
9. Evaluating triple integrals
10. Finding area between two curves.

TEXT BOOKS:

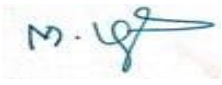
1. Grewal,B.S., "Higher Engineering Mathematics", Khanna publications,42nd Edition,2012.
2. ErwinKreyszig, "Advanced Engineering mathematics", JohnWiley & Sons, 9th Edition, 2013.
3. Veerarajan,T.,"Engineering Mathematics of semester I & II", TataMcGrawHill, 3rdEdition,2016.

REFERENCES:

1. Bali,N.P. ,Manish Goyal, "A Textbook of Engineering Mathematics-Sem-II", Laxmi Publications,6th Edition,2014.
2. Kandasamy, P., Thilagavathy, K., Gunavathy, K., "Engineering Mathematics for first year", Scand & Co Ltd, 9th Revised Edition, 2013.
3. GlynJames, "Advanced Engineering Mathematics", Wiley India, 7th Edition, 2007.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												1	
2		2											1	
3		2											1	
4	3												1	
5	3				2				3			2	1	
CO (W.A)	**3**	**2**			**2**				**3**			**2**	**1**	



*Approved by Eleventh Academic Council

22CYB01 – INTRODUCTION TO BIOCHEMISTRY (For BME Branch Only)				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE : NIL				
Course Objectives:	• To make the students conversant with water treatment, boiler feed water techniques, energy storage devices. • To recognize the basic concepts of biotechnology, structural and basic properties of carbohydrates, lipids and clinical application of enzymes.			

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Identify the types of hardness in water and its removal by various water treatment techniques.	An	20%
CO2	Investigate on renewable energy sources like nuclear, solar, wind energy and also on storage devices.	E	20%
CO3	Interpret the various properties of carbohydrates, lipids and fatty acids.	Ap	20%
CO4	Analyze the factors affecting enzymatic activity by adding activators and inhibitors.	An	20%
CO5	Predict the nature, oxidation and reduction potential of an electrode.	An	20%

UNIT I - WATER TECHNOLOGY AND NANO MATERIALS	(9)
Municipal water treatment - disinfection methods (UV, ozonation, chlorination) - desalination of brackish water - reverse osmosis - boiler troubles (scale, sludge, priming, foaming and caustic embrittlement) - treatment of boiler feed water - internal treatment (carbonate, phosphate and calgon conditioning) - external treatment - demineralization process. Nano materials - synthesis (laser ablation, and chemical vapour deposition method), properties and applications of nanomaterials in medicine, energy, electronics and catalysis.	
UNIT II - ENERGY SOURCES AND STORAGE DEVICES	(9)
Nuclear energy - nuclear fission - nuclear fusion - light water nuclear power plants - breeder reactor - solar energy conversion - solar cells - solar water heater - wind energy - batteries - types of batteries - lead acid storage battery –lithium - ion battery, Electric vehicles - working principles.	
UNIT III - CARBOHYDRATES AND LIPIDS	(9)
Carbohydrate - classification of carbohydrates - monosaccharides - Structure: trioses - properties of monosaccharides. Disaccharides - Structure: sucrose. Oligosaccharides - Raffinose - Polysaccharides - starch. Lipids - Classification of lipids - simple - complex - derived lipids - Nomenclature of fatty acids - physical	

and chemical properties of fat.	
UNIT IV – ENZYMOLOGY	(9)
Enzymes - Classifications of enzymes - Kinetics of Enzymes - Michaelis - Menten equation - Factors affecting enzymatic activity - temperature - pH - concentration of substrate - Enzyme concentration - product concentration – activators - Enzyme inhibitors - reversible inhibitors - competitive - non competitive - irreversible inhibitors - active site directed irreversible inhibitors - Suicide inhibitors - Difference between reversible and irreversible inhibitors.	
UNIT V - BIOTECHNOLOGY AND ELECTROCHEMISTRY	(9)
Biotechnology - Importance - types - applications. Electrochemistry - Electrode potential - Nernst equation - derivation and problems - reference electrodes - standard hydrogen electrode -calomel electrode - potentiometric titrations (redox) - conductometric titrations (acid-base).	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

1. Dr.Ravikrishnan A., "Engineering Chemistry I & Engineering Chemistry II", 13th Edition, Sri Krishna Hitech Publishing Company Pvt. Ltd., Chennai, 2020.
2. Lehninger A L., Nelson D L and Cox M M., "Principles of Biochemistry", 4th Edition, Freeman Publishers, New York, 2017.

REFERENCES:

1. Jain P C. and Monica Jain, "Engineering Chemistry", Volume I and II, 15th Edition, Dhanpat Rai Publishing Company, New Delhi 2018.
2. Keith Wilson and John Walker, "Practical Bio Chemistry – Principles & Techniques", Oxford University Press, 2018.
3. Donald Voet and Judith G. Voet, "Biochemistry", 3rd Edition, Wiley, John & Sons, 2019.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3		2						2					
2		2							2					
3		2							2				1	
4			2				2						1	
5						2	2					2	1	
CO (W.A)	3	2	2			2	2		2			2	1	

22CSC01 - PROBLEM SOLVING AND C PROGRAMMING *(Common to All Branches)*				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

PRE-REQUISITE : NIL

Course Objective:	To equip students with the essential skills and knowledge to solve computational problems using the C programming language.

Course Outcomes The student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply basic syntax and semantics of C language to write clear and structured code.	Ap	20%
CO2	Make use of both conditional statements and iterative control structures for developing applications.	Ap	20%
CO3	Apply knowledge of arrays and strings to solve computational problems.	Ap	20%
CO4	Identify modular solutions that integrate problem-solving techniques to solve complex computational problems.	An	20%
CO5	Analyze the performance implications using pointers and to manage file operations efficiently.	An	20%

UNIT I -PROBLEM SOLVING AND C PROGRAMMING BASICS	**(9)**
General Problem Solving: Algorithms, Flowcharts and Pseudo-codes, implementation of algorithms **Basics of C Programming** : Introduction to C - Structure of C program - Programming Rules – Compilation – Errors - C Declarations: Tokens - keywords - identifiers - constants - data types - variable declaration and initialization - type conversion - constant and volatile variables - operators and expressions.	
UNIT II - DECISION CONTROL STATEMENTS	**(9)**
Managing Input and Output operations, Decision Control Statements: Decision control statements, Selection/conditional branching Statements: if, if-else, nested if statements. Basic loop Structures/Iterative statements: while loop, for loop, selecting appropriate loop. Nested loops break and continue statements.	
UNIT III - ARRAYS AND STRINGS	**(9)**
Introduction to Array - Definition - Array initialization - Characteristics - One Dimensional Array - Array operations -Two dimensional arrays -Strings and String handling functions.	
UNIT IV - FUNCTIONS	**(9)**
Functions: Basics - definition - Elements of User defined Functions - return statement, Function types, Parameter Passing Techniques, Function returning more values - Passing Array to Functions - Recursion - Storage classes.	
UNIT V - POINTERS AND FILE MANAGEMENT	**(9)**
Pointer concepts - Pointers & Arrays, Structure concepts - Defining, Declaring, Accessing Member Variables, Structure within Structure - Union - File Management in C- Dynamic Memory Allocation	
TOTAL (L:45) :45 PERIODS	

TEXT BOOKS:

1. Ashok N. Kamthane, "Programming in C", 2nd Edition, Pearson Education, 2013.
2. Sumitabha Das, "Computer Fundamentals and C Programming", 1st Edition, McGraw Hill, 2018.

REFERENCES:

1. R. G. Dromey, "How to Solve it by Computer", Pearson Education India; 1st Edition, ISBN10: 8131705625, ISBN-13: 978-8131705629
2. Maureen Spankle, "Problem Solving and Programming Concepts", Pearson; 9th Edition, India, ISBN-10: 9780132492645, ISBN-13: 978- 0132492645
3. Yashavant Kanetkar, "Let us C", 16th Edition, BPB Publications, 2018.
4. ReemaThareja., "Programming in C ", 2nd Edition, Oxford University Press, New Delhi, 2018.
5. Balagurusamy E., "Programming in ANSI C", 7th Edition, Mc Graw Hill Education, 2017.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2	3													
3	3											3		
4		3										3		2
5		3												2
CO (W.A)	3	3										3		2

22ECC02 - BASICS OF ELECTRICAL AND INSTRUMENTATION ENGINEERING *(Common to ECE and BME Branches)*				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

PRE-REQUISITE : NIL

Course Objectives:	• To understand the basics of Electrical Motor concepts, electrical transformer induction motor and synchronous motor. • To impart knowledge on the concepts of measuring and electronics instruments and various types of transducers.

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the principles of electromagnetic induction in electrical applications.	Ap	30%
CO2	Apply the EMF equation and different starting methods in transformers and induction motors.	Ap	20%
CO3	Apply knowledge of various transducers and digital meters to select appropriate types for specific measurement applications.	Ap	30%
CO4	Analyze the various parameters to employ appropriate instruments to measure given sets of parameters.	An	20%
CO5	Give a presentation on recent technological development in the Analog Electronics domain.	U	Internal Assessment

UNIT I - D.C. MACHINES	**(9)**
DC Generators: Constructional details – Principle of operation – EMF Equation – Methods of excitation – Applications – DC Motor: Constructional details – Principle of operation – Torque Equation – Applications – Types of starters.	
UNIT II - TRANSFORMERS	**(9)**
Single phase Transformers: Constructional details – Principle of operation – EMF Equation – Transformation ratio – Equivalent circuit – Efficiency and Voltage Regulation – Applications.	
UNIT III - INDUCTION MOTORS	**(9)**
Three phase Induction Motor: Construction – Types – Principle of operation – Applications – Single phase Induction Motor: Construction – Principle of operation – Starting methods – Applications.	
UNIT IV - MEASUREMENTS AND INSTRUMENTATION	**(9)**
Functional elements of an instrument – Standards and calibration – Measurement Errors - types of error – Moving coil meters – Moving iron meters – CRO – Digital voltmeter: successive Approximation type.	
UNIT V -TRANSDUCERS	**(9)**
Transducers: Basic Requirements – Classification – Resistive: Strain gauge – Resistance Thermometer – Thermistor – Inductive: LVDT – Piezoelectric – Thermocouples.	
	TOTAL (L:45) : 45 PERIODS

TEXT BOOKS:

1. Kothari DP and I.J Nagrath, "Basic Electrical and Electronics Engineering", 2nd Edition, McGraw Hill Education, 2020.
2. A.K. Sawhney, Puneet Sawhney "A Course in Electrical & Electronic Measurements & Instrumentation", Dhanpat Rai and Co, New Delhi, 2015.

REFERENCES:

1. S. K, Bhattacharya, "Basic Electrical and Electronics Engineering", 2nd Edition, Pearson Education, 2017.
2. R. K. Rajput, "Electronic Measurements and Instrumentation", S. Chand & company Ltd, 2015.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												1	
2	3												1	
3	3												2	
4		3											1	
5						2			2	2				
CO (W.A)	**3**	**3**				**2**			**2**	**2**			**1.25**	

22GEP01 - ENGINEERING PRACTICES LABORATORY *(Common to AGRI, BME, CHEM, CIVIL, ECE, EEE and MECH Branches)*				
	L	**T**	**P**	**C**
	0	**0**	**4**	**2**

PRE-REQUISITE : NIL

Course Objectives:	• To provide hands on training on various basic engineering practices in civil engineering • To provide hands on training on welding in mechanical engineering • To provide hands on training on various basic engineering practices in mechanical engineering • To understand the basic working principle of electric components • To understand the basic working principle of electronic components

Course Outcomes The Student will be able to		**Cognitive Level**
CO1	Design new layouts of civil work for residential and industrial buildings.	Ap
CO2	Apply the concepts of welding in repairing works and making various components	Ap
CO3	Design new components using machining processes in real life and industries	Ap
CO4	Apply the skills of basic electrical engineering for wiring in different areas and Measure various electrical quantities	Ap
CO5	Apply electronic principles to measure various parameters of a signal.	Ap

GROUP-A (MECHANICAL AND CIVIL ENGINEERING)

I - CIVIL ENGINEERING PRACTICE (15)

Buildings:

a. Study of plumbing and carpentry components of residential and industrial buildings, Safety aspects

Plumbing:

a. Study of tools and operations

b. Hands-on-exercise: External thread cutting and joining of pipes

Carpentry:

a. Study of tools and operations

b. Hands-on-exercise: "L" joint and "T" joint

II - MECHANICAL ENGINEERING PRACTICE (15)

Welding:

a. Study of arc welding, gas welding tools and equipments

b. Arc welding- Butt joints, Lap joints and Tee joints

Basic Machining:

a. Study of lathe and drilling machine

b. Facing and turning

c. Drilling and Tapping

Sheet Metal Work:

a. Study of tools and operations

b. Rectangular tray

GROUP - B (ELECTRICAL AND ELECTRONICS)

I - ELECTRICAL ENGINEERING PRACTICE (15)

a. Residential house wiring using Switches, fuse, indicator, lamp.

b. Fluorescent lamp wiring.

c. Stair Case Wiring.

d. Measurement of electrical quantities –Voltage, current, power in R Circuit.

e. Study of Electrical apparatus-Iron box & water heater.

f. Study of Electrical Measuring instruments- Megger.

II - ELECTRONICS ENGINEERING PRACTICE (15)

a. Study of Electronic components and various use of multi meter.

b. Measurement of AC signal parameter (peak-peak, RMS period, frequency) using CRO.

c. Study of logic gates AND, OR, XOR and NOT.

d. Study of Clock Signal.

e. Soldering practice -Components Devices and Circuits - Using general purpose PCB.

f. Study of Half Wave Rectifier (HWR) and Full Wave Rectifier (FWR).

g. Study of Telephone, FM Radio and Cell Phone.

TOTAL (P: 60) = 60 PERIODS

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2		3												
3			2											
4	3													
5	3													1
CO (W.A)	3	3	2											1

22CSP01 - PROBLEM SOLVING AND C PROGRAMMING LABORATORY *(Common to All Branches)*				
	L	**T**	**P**	**C**
	0	**0**	**4**	**2**

PRE-REQUISITE : NIL

Course Objective:	To develop programs to solve basic problems by understanding basic concepts in C language

Course Outcomes The student will be able to		**Cognitive Level**
CO1	Formulate the algorithms for simple problems	Ap
CO2	Apply the concept of pointers of different types	Ap
CO3	Apply and manipulate data with arrays, strings and structures	Ap
CO4	Apply the concept of functions and dynamic memory allocation	Ap
CO5	Analyze and correct logical errors encountered during execution	An

C-Programming:

1. Draw the flowchart for the following using Raptor tool.
   a) Simple interest calculation
   b) Greatest among three numbers
   c) Find the sum of digits of a number
2. Programs for demonstrating the use of different types of operators like arithmetic, logical, relational and ternary operators (Sequential and Selection structures)
3. Programs for demonstrating repetitive control statements like 'for', 'while' and 'do-while' (Iterative structures)
4. Programs for demonstrating one-dimensional and two-dimensional numeric array
5. Programs to demonstrate modular programming concepts using functions
6. Programs to implement various character and string operations with and without built-in library functions.
7. Programs to demonstrate the use of pointers
8. Programs to illustrate the use of user-defined data types
9. Programs to implement various file management.
10. Program Using Dynamic memory allocation functions

HARDWARE / SOFTWARE REQUIRED FOR A BATCH OF 30 STUDENTS:
Hardware: • LAN System with 33 nodes (OR) Standalone PCs – 33 Nos. • Printers – 3 Nos. **Software:** • RAPTOR Tool • Compiler – C
TOTAL (P:60) : 60 PERIODS

Mapping of COs with POs / PSOs														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3													2
2	3													2
3	3													2
4	3													2
5		3			2							2		2
CO (W.A)	**3**	**3**			**2**							**2**		**2**

22CYP01- CHEMISTRY LABORATORY (Common to AGRI, BME, CHEM, CIVIL, ECE, EEE and MECH Branches)					
		L	**T**	**P**	**C**
		0	**0**	**2**	**1**
PRE-REQUISITE : NIL					
Course Objectives:	• To determine the copper in brass in the given solution and explain the origin of hardness, alkalinity, chloride and dissolved oxygen in water. • To perform a potentiometric, conductometric titration and pH of an acidic solution of known Normality.				

Course Outcomes The Student will be able to		**Cognitive Level**
CO1	Predict the various water quality parameters by volumetric analysis.	An
CO2	Evaluate the amount of copper in the given solution by titration method.	E
CO3	Analyze the conductance and emf of the different solutions.	An
CO4	Analyze and gain experimental skill about potential of hydrogen ion.	An
CO5	Examine the pH of various acidic, basic and neutral solutions.	An

LIST OF EXPERIMENTS :

1. Determination of total, temporary & permanent hardness of water by EDTA method.
2. Determination of alkalinity in water sample.
3. Determination of chloride content of water sample by Argentometric method.
4. Determination of DO content of water sample by Winkler's method.
5. Estimation of copper in brass by EDTA.
6. Conductometric titration of strong acid vs strong base.
7. Estimation of iron content of the given solution using potentiometer.
8. Determination of strength of given hydrochloric acid using pH meter.

Total (30 P) = 30 periods

Mapping of COs with POs / PSOs														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1					3									
2							2							
3							2							
4					3									
5							2							
CO (W.A)					**3**		**2**							

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22MAN01 INDUCTION PROGRAMME
(For Common To All Branches)

L	T	P	C
-	-	-	-

PRE-REQUISITE : NIL

This is a mandatory 2 week programme to be conducted as soon as the students enter the institution. Normal classes start only after the induction program is over.

The induction programme has been introduced by AICTE with the following objective:

"Engineering colleges were established to train graduates well in the branch/department of admission, have a holistic outlook, and have a desire to work for national needs and beyond. The graduating student must have knowledge and skills in the area of his/her study. However, he/she must also have broad understanding of society and relationships. Character needs to be nurtured as an essential quality by which he/she would understand and fulfill his/her responsibility as an engineer, a citizen and a human being. Besides the above, several meta-skills and underlying values are needed."

"One will have to work closely with the newly joined students in making them feel comfortable, allow them to explore their academic interests and activities, reduce competition and make them work for excellence, promote bonding within them, build relations between teachers and students, give a broader view of life, and build character. "

Hence, the purpose of this programme is to make the students feel comfortable in their new environment, open them up, set a healthy daily routine, create bonding in the batch as well as between faculty and students, develop awareness, sensitivity and understanding of the self, people around them, society at large, and nature.

The following are the activities under the induction program in which the student would be fully engaged throughout the day for the entire duration of the program.

(i) Physical Activity

This would involve a daily routine of physical activity with games and sports, yoga, gardening, etc.

(ii) Creative Arts

Every student would choose one skill related to the arts whether visual arts or performing arts. Examples are painting, sculpture, pottery, music, dance etc. The student would pursue it everyday for the duration of the program. These would allow for creative expression. It would develop a sense of aesthetics and also enhance creativity which would, hopefully, grow into engineering design later.

(iii) Universal Human Values

This is the anchoring activity of the Induction Programme. It gets the student to explore oneself and allows one to experience the joy of learning, stand up to peer pressure, take decisions with courage, be aware of relationships with colleagues and supporting stay in the hostel and department, be sensitive to others, etc. A module in Universal Human Values provides the base. Methodology of teaching this content is extremely important. It must not be through do's and dont's, but get students to explore and think by engaging them in a dialogue. It is best taught through group discussions and real life activities rather than lecturing.

Discussions would be conducted in small groups of about 20 students with a faculty mentor each. It would be effective that the faculty mentor assigned is also the faculty advisor for the student for the full duration

of the UG programme.

(iv) Literary Activity

Literary activity would encompass reading, writing and possibly, debating, enacting a play etc.

(v) Proficiency Modules

This would address some lacunas that students might have, for example, English, computer familiarity etc.

(vi) Lectures by Eminent People

Motivational lectures by eminent people from all walks of life should be arranged to give the students exposure to people who are socially active or in public life.

(vii) Visits to Local Area

A couple of visits to the landmarks of the city, or a hospital or orphanage could be organized. This would familiarize them with the area as well as expose them to the under privileged.

(viii) Familiarization to Dept./Branch & Innovations

They should be told about what getting into a branch or department means what role it plays in society, through its technology. They should also be shown the laboratories, workshops & other facilities.

(ix) Department Specific Activities

About a week can be spent in introducing activities (games, quizzes, social interactions, small experiments, design thinking etc.) that are relevant to the particular branch of Engineering/Technology/Architecture that can serve as a motivation and kindle interest in building things (become a maker) in that particular field. This can be conducted in the form of a workshop. For example, CSE and IT students may be introduced to activities that kindle computational thinking, and get them to build simple games. ECE students may be introduced to building simple circuits as an extension of their knowledge in Science, and so on. Students may be asked to build stuff using their knowledge of science.

Induction Programme is totally an activity based programme and therefore there shall be no tests / assessments during this programme.

REFERENCES:

1.Guide to Induction program from AICTE

22MAN03 - YOGA – I (For Common To All Branches)				
	L	**T**	**P**	**C**
	0	**0**	**I**	**0**

PRE-REQUISITE : NIL

Course Objectives:	• To make students in understanding the importance of yoga in shaping mental and physical wellness. • To provide awareness about the significance of leading a peaceful life by following yoga exercises and principles. • To develop mental wellbeing through meditation and breathing exercises. • To strengthen the body through physical exercises. • To inculcate the knowledge about different types of Asanas and their benefits

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Understand the importance of yoga for physical and mental goodness.	U	Internal Assessment
CO2	Perform the yoga exercises for hand, leg, eye and sun salutation etc.	Ap	
CO3	Learn and practice meditation techniques for keeping good mental health	Ap	
CO4	Develop their body by performing yoga exercises.	Ap	
CO5	Demonstrate different types of yoga Asanas for improving their personal fitness.	Ap	

UNIT I – INTRODUCTION TO YOGA	**(3)**
Meaning and Importance of Yoga - Elements of Yoga - Introduction - Asanas, Pranayama, Meditation and Yogic Kriyas - Yoga for concentration & related Asanas (Sukhasana; Tadasana; Padmasana and Shashankasana) - Relaxation Techniques for improving concentration - Yog-nidra.	
UNIT II - YOGA AND LIFE STYLE	**(3)**
Asanas as Preventive measures – Hypertension:Tadasana, Vajrasana, Pavan Muktasana, Ardha Chakrasana, Bhujangasana, Sharasana – Obesity: Procedure, Beneits and contraindications for Vajrasana, Hastasana, Trikonasana, Ardh Matsyendrasana – Back Pain: Tadasana, Ardh Matsyendrasana, Vakrasana, Shalabhasana, Bhujangasana - Diabetes: Procedure, Benefits and contraindications for Bhujangasana, Paschimottasana, Pavan Muktasana, Ardh Matsyendrasana – Asthema: Procedure, Benfits and contraindications for Sukhasana, Chakrasana, Gomukhasana, Parvatasana, Bhujangasana, Paschimottasana, Matsyasana.	
UNIT III – MIND EXERCISES	**(3)**
Naadi sudhi – Thanduvada sudhi – Breathing meditation – Silent meditation – Relax meditation.	

UNIT IV – PHYSICAL EXERCISES (PART– I)	(3)
Hand Exercises – Leg Exercises – Eye Exercises – Sun Salutation.	
UNIT V – ASANAS (PART-I)	**(3)**
Asanas –Tadasana – Yegapadhasana – Chakrasana – Udkaddasana – Thirikosana – Thandasana – Paschimottanasana.	
TOTAL (P:15) : 15 PERIODS	

TEXT BOOK/ REFERENCE:
1. Light On Yoga by B.K.S. Iyengar.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1								3	2			3		
2								3	2			3		
3								3	2			3		
4								3	2			3		
5								3	2			3		
CO (W.A)								**3**	**2**			**3**		

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22EYA02- PROFESSIONAL COMMUNICATION- II (Common to All Branches)					
		L	**T**	**P**	**C**
		2	**0**	**2**	**3**
PRE-REQUISITE : 22EYA01					
Course Objectives:	• To enhance the students with necessary English language skills • To enable students to communicate effectively in an academic setting				

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Frame sentences both in written and spoken forms with accuracy and fluency.	R	20%
CO2	Use linguistic structures to read and understand well-structured texts encountered in academic or social contexts.	U	20%
CO3	Gain essential competency to express one's thoughts orally and in writing in a meaningful way.	U	20%
CO4	Attain and enhance competence in the four modes of literacy: Listening, Speaking, Reading and Writing.	Ap	20%
CO5	Perform various tasks, such as role plays, debates, group discussions apart from the use of correct spelling and punctuation.	U	20%

UNIT I - LANGUAGE RUDIMENTS	**(6+6)**
Grammar – Active and Passive Voice – Impersonal Passive Voice – Numerical Expressions - Listening – Listening for Specific Information and Match / Choose / Fill in the texts - Speaking – Describing a Person - Making Plans -Reading – Intensive Reading -Writing – Job Application with Resume	
UNIT II - RHETORIC ENHANCERS	**(6+6)**
Grammar – Reported Speech – Infinitive and Gerund - Listening – Listening to Iconic Speeches and making notes - Listening news / documentaries - Speaking –Talking over Phone – Narrating Incidents - Reading – Extensive Reading (Motivational Books) - Writing – Recommendation	
UNIT III - TECHNICAL CORRESPONDENCE	**(6+6)**
Grammar – If Conditionals – Blended Words - Listening – Listening to business conversation on audio and video of Short Films, News, Biographies - Speaking – Synchronous communication and Asynchronous communication - Opportunities and threats in using digital platform- Reading - Finding key information in a given text - Writing –Netiquettes- Inviting Dignitaries - Accepting & Declining Invitation	
UNIT IV - CORPORATE COMMUNICATION	**(6+6)**
Grammar – Concord – Compound Words - Listening – Listening to Roles and Responsibilities in Corporate - Listening to technical videos - Speaking – Introduction to Technical Presentation - Story Telling - Reading – Reading and Understanding Technical Articles - Writing – Report Writing (Accident, Survey and feasibility)	

UNIT V - LANGUAGE BOOSTERS	(6+6)
Grammar - Idiomatic Expressions – Relative Clauses – Confusable words - Listening – Listening to different kinds of Interviews - Listening to Group Discussion - Speaking – Group Discussion - Reading – Reading and Interpreting Visual Materials - Writing – Analytical Paragraph Writing	

LIST OF SKILLS ASSESSED IN THE LABORATORY

1. **Grammar**
2. **Listening Skills**
3. **Speaking Skills**
4. **Reading Skills**
5. **Writing Skills**

TOTAL (L:30 , P:30) = 60 PERIODS

TEXT BOOKS:

1. Sudharshana, N.P and Saveetha.C. *English for Technical Communication*. Cambridge University Press, New Delhi, 2016 (Reprint 2017).

REFERENCES:

1. Rizvi, M Ashraf. "Effective Technical Communication". Second Edition, McGraw Hill Education India PvtLtd, 2017.
2. Rodney Huddleston, Geoffrey K. Pullum and Brett Reynolds," A Student's Introduction to English Grammar", Second Edition, Cambridge University Press, New Delhi, 2022.

WEB REFERENCE:

1. http://youtu.be/URtdGiutVew

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1									2	3				
2									2	3				
3									2	3				
4									2	3				
5									2	3				
CO (W.A)									2	3				

22MYB04 – TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS *(Common to BME and ECE Branches)*				
	L	**T**	**P**	**C**
	3	**1**	**0**	**4**
PRE-REQUISITE : NIL				
Course Objectives:	• To make the Conversant with concepts of Z-transforms, Fourier series, Fourier transforms to represent periodical physical problems in engineering analysis. • To provide adequate knowledge in partial differential equation and to analyze the boundary value problems.			

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Interpret the Fourier series in various fields such as signal processing, communications, control systems, and biomedical engineering.	Ap	30%
CO2	Solve the initial and boundary value problems by using Fourier series in wave equation.	Ap	30%
CO3	Apply the methods of partial differential equations in Circuit Analysis and Biomedical Signal Processing.	Ap	20%
CO4	Analyze the concepts of Transform Techniques to solve the engineering problem.	An	20%
CO5	Identify the mathematical tools for solving transform techniques in real time applications.	Ap	Internal Assessment

UNIT I – FOURIER SERIES	**(9+3)**
Dirichlet's condition – Fourier series – Odd and even functions – Half range sine series – Half range cosine series – Parseval's identity – RMS value – Harmonic Analysis.	
UNIT II – PARTIAL DIFFERENTIAL EQUATIONS	**(9+3)**
Formulation of partial differential equations by eliminating arbitrary constants and functions – Solution of standard types first order partial differential equations of the type f(p,q)=0,Clairaut's form – Lagrange's linear equations –Linear partial differential equation of second and higher order with constant coefficient of homogeneous types.	
UNIT III – APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS	**(9+3)**
Classification of second order Quasi linear partial differential equations – Solution of one dimensional wave equation (Zero and non-zero velocity) – One dimensional heat equation (Temperature reduced to zero and non zero boundary conditions) – Steady state solution of two dimensional heat equation(Finite and infinite plate).	
UNIT IV – FOURIER TRANSFORM	**(9+3)**
Fourier integral theorem(Statement only) – Fourier transform pair - Sine and Cosine transforms – Properties -Transforms of simple functions – Convolution theorem – Parseval's identity(Excluding proof).	
UNIT V – Z-TRANSFORM AND DIFFERENCE EQUATIONS	**(9+3)**

Z-transforms – Elementary properties – Inverse Z-transform (Partial fraction method and Residue method) – Convolution theorem (Excluding proof) – formation of difference equations – Solution of difference equation using Z transform.
TOTAL (L:45+T:15) :60 PERIODS

TEXT BOOKS:

1. Veerajan.T, "Engineering Mathematics (for semester III), 3rd ed., Tata Mc Graw Hill, New Delhi.
2. Kandasamy. P, Thilagavathy. K and Gunavathy. K., "Engineering Mathematics; Volume III", S. Chand & Co. Ltd., 2008.
3. Grewal B.S,"Higher Engineering Mathematics", 42nd Edition, Khanna Publishers, New Delhi, 2012.

REFERENCES:

1. Goyal Manish and Bali. N.P,"A Text book of Engineering mathematics", 6th Edition, Laxmi Publication (P) Ltd, New Delhi, 2012.
2. Kreyszig, Erwin, "Advanced Engineering Mathematics", 9th Edition, Wiley Publications, New Delhi, 2006.
3. Singaravelu. A,"Transforms and Partial Differential Equations", Reprint Edition 2013, Meenakshi Publications, Tamilnadu.

WEB REFERENCES:

1. **https://youtu.be/B025y1UWkvI**
2. **https://youtu.be/IkAvgVUvYvY**
3. **https://youtu.be/RtVE2Gt-KQ4**
4. **https://youtube.com/playlist?list=PLs7oDAL8_ouKSagWiC_IwrEsRwvD2WJ73**

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												2	
2	3												2	
3	3												2	
4		2											2	
5	3				2				3			3	2	
CO (W.A)	3	2			2				3			3	2	

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22PYB03 - SOLID STATE PHYSICS (Common to ECE, EEE & BME)				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**
PRE-REQUISITE: NIL				
Course Objectives:	• To gain adequate information about the properties of matter and properties of nanostructures. • To expose the concepts of Photonics and fiber optics and Advanced new engineering materials			

Course Outcomes The student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply principles of semiconductor physics to the design and optimization of semiconductor-based biomedical equipment.	Ap	20%
CO2	Employ their knowledge of dielectric properties to optimize and enhance the performance of electronic components such as capacitors and transformer.	Ap	20%
CO3	Examine how magnetic moments and superconductivity are utilized in the design of biomedical devices like MRI machines and magnetic sensors.	An	20%
CO4	Analyze the impact of fabrication techniques on enhancing the performance and efficiency of microprocessors.	An	20%
CO5	Evaluate how the properties and preparation methods of advanced materials can be utilized to develop innovative solutions in material science.	Ev	20%

UNIT I - SEMICONDUCTING MATERIALS	**(9)**
Introduction to semiconducting materials –Elemental and compound semiconductors – Intrinsic semiconductor – carrier concentration derivation – variation of Fermi level with temperature – electrical conductivity – band gap determination – extrinsic semiconductors (qualitative) – Hall effect – determination of Hall coefficient – Applications	
UNIT II - DIELECTRIC MATERIALS	**(9)**
Electrical susceptibility – dielectric constant – electronic, ionic, orientation and space charge polarization – frequency and temperature dependence of polarization – internal field – Claussius – Mosotti relation (derivation) – dielectric loss – dielectric breakdown – uses of dielectric materials (capacitor and transformer) – ferro electricity and applications.	
UNIT III - MAGNETIC AND SUPERCONDUCTING MATERIALS	**(9)**
Origin of magnetic moment – Bohr Magneton – Types of magnetic materials – Domain theory – Hysteresis – soft and hard magnetic materials – Ferrites – applications – Superconductivity – properties – types of superconductors – BCS theory of superconductivity (qualitative) – High T_c superconductors – Application of superconductors – Magnetic levitation.	
UNIT IV - FABRICATION PROCESS OF INTERGATED CIRCUITS	**(9)**

Bulk crystal growth – Epitaxial growth – masking and etching-diffusion of impurities-selective diffusion – formation of PN junction – resistors – capacitors – inductors – isolation methods – metal semiconductor contact – Introduction to integrated circuit – monolithic and hybrid circuits – thin film and thick film technology – Definition of LSI, MSI, VLSI circuits.	
UNIT V - ADVANCED MATERIALS AND NANO TECHNOLOGY	**(9)**
Metallic glasses: preparation, properties and applications – Shape Memory Alloys (SMA): Characteristics, properties of NiTi alloy, application – Nano materials: Properties, Preparation – Pulsed laser deposition – chemical vapour deposition of nano particles and applications – Carbon nano tubes: fabrication – arc method – structure – properties and application.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. M. N. Avadhanulu and P. G. Kshirsagar, "A text book of Engineering Physics", S. Chand and Company, New Delhi, 2019.
2. A. Marikani, "Materials Science", PHI Learning Private Limited, Eastern Economy Edition, 2017.
3. M. A. Wahab, "Solid State Physics", 3rd Edition, Narosa Publishing House Pvt. Ltd., 2016.

REFERENCES:

1. B. Rogers, J. Adams and S.Pennathur, "Nanotechnology: Understanding Small System" CRC Press, 2017.
2. Jacob Millman, Charistos C Halkilas, SatyabrataJit "Electronic Devices & Circuits", 3rd Edition, Tata McGraw Hill. Education Private Limited, 2016,
3. Subrahmanyam N, Brijlal, "A Text Book of Optics" S. Chand & Co. Ltd, New Delhi, 2019.

WEB LINKS:

1. https://bayanbox.ir/view/7764531208313247331/Kleppner-D.-Kolenkow-R.J.-Introduction-to-Mechanics-2014.pdf.
2. https://physicaeducator.files.wordpress.com/2017/11/electricity_and_magnetism-by-purcell-3ed-ed.pdf.
3. https://rajeshvcet.home.blog/regulation-2021/ph3151-engineering-physics-study-materials/
4. https://zenodo.org/record/243407#.ZEgPZXZBzIU
5. https://farside.ph.utexas.edu/teaching/qmech/qmech.pdf.
6. https://web.pdx.edu/~pmoeck/phy381/workbook%20nanoscience.pdf.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2											2	
2	3												2	
3	3												2	
4	3		3				2							
5	3					2	2					2		
CO (W.A)	**3**	**2**	**2**			**2**	**2**					**2**	**2**	

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22CSC02 –DATA STRUCTURES USING C *(Common to 22AIC01, 22CCC01, 22CIC01 and 22ITC01)*				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

PRE-REQUISITE : 22CSC01

Course Objectives:	• To develop skills to apply appropriate data structures in problem solving. • To apply abstract data types (ADTs), recursion, algorithms for searching and sorting, and basic algorithm analysis.

Course Outcomes The student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply pointer and array concepts in functions.	Ap	20%
CO2	Solve problems using various implementations of linked list.	Ap	20%
CO3	Make use of ADTs like stack and queue for solving real world problems.	Ap	20%
CO4	Analyze the tree traversal algorithms for various non-linear data structures.	An	20%
CO5	Analyze appropriate graph algorithms for computing problems.	An	20%

UNIT I - POINTERS USING ARRAYS AND STRINGS	**(9)**
Pointers : Introduction – Pointers and arrays– passing an array to a function– returning an array from function – NULL pointers –Array of pointers – Pointer-to-pointer – Dangling Pointer. Function pointers: calling a function using function pointer- Using pointer as a function argument	
UNIT II - LIST	**(9)**
Abstract Data Types (ADTs) – List ADT – Array-based implementation – Linked list implementation – Singly linked lists – Circularly linked lists – Doubly-linked lists – Applications of lists – Polynomial ADT	
UNIT III - STACKS AND QUEUES	**(9)**
Stack ADT – Operations – Applications – Balancing Symbols – Evaluating arithmetic expressionsInfix to Postfix conversion – Function Calls – Queue ADT – Operations – Circular Queue – DeQueue – Applications of Queues	
UNIT IV - TREE	**(9)**
Tree ADT – Tree Traversals - Binary Tree ADT – Expression trees – Binary Search Tree ADT – AVL Trees – Priority Queue (Heaps) – Binary Heap.	
UNIT V - GRAPHS	**(9)**
Definitions – Representation of Graphs – Types of Graph – Graph Traversal: Depth-First Search (DFS) – Breadth-First Search (BFS) – Topological Sort – Applications of DFS: Bi-connectivity – Euler Circuits – Finding Strongly Connected Components – Applications of BFS: Bipartite Graph.	
TOTAL (L:45) : 45 PERIODS	

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TEXT BOOKS:

1. Sumitabha Das, "Computer Fundamentals &C Programming", McGraw Hill Education (India) Private Limited, 1st Edition, 2018.
2. Weiss M. A., "Data Structures and Algorithm Analysis in C", 2nd Edition, Pearson Education, 2016.

REFERENCES:

1. Yashavant Kanetkar, "Pointers in C", BPP Publications, 4th Edition, 2017.
2. Pradip Dey, Manas Ghosh, "Programming in C", Oxford Higher Education, 2nd Edition, 2016.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3											3		2
2	3											3		2
3	3											3		2
4		3										3		2
5		3										3		2
CO (W.A)	**3**	**3**										**3**		**2**

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22ECC04 - ELECTRONIC DEVICES AND CIRCUITS *(Common to ECE and BME Branches)*					
		L	**T**	**P**	**C**
		3	**0**	**2**	**4**
PRE-REQUISITE : NIL					
Course Objectives:	• To examine the basics of Semiconductor Diodes and its characteristics • To analyze the characteristics of Bipolar Junction Transistor and FET and operation of Special semiconductor diodes. • To design simple network by exploring circuit theorems using basics of Electrical circuits				

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the Ohm's law and Kirchhoff's law to investigate the behavior of electric circuits by analytical techniques	Ap	20%
CO2	Analyze the characteristics and operational principles of Diodes, BJT, FET and MOSFET.	An	30%
CO3	Analyze the laws applicable for Mesh current method and Nodal voltage method and solve the circuits.	An	30%
CO4	Design a fundamental electrical network using circuit theorems, encompassing both AC and DC principles.	E	20%
CO5	Engage in collaborative learning sessions aimed at creating fundamental electronic projects.	U	Internal Assessment

UNIT I – PN DIODE AND BJT	**(9)**
Formation of PN junction – working principle – VI characteristics – PN diode currents – Switching Characteristics. NPN and PNP transistors – Current equations – Input and Output characteristics of CE, CB, CC Configurations.	
UNIT II – FET AND SPECIAL DIODES	**(9)**
JFET – Drain and Transfer Characteristics - MOSFET – Characteristics. Zener diode, Varactor diode, Tunnel diode, PIN diode, LDR	
UNIT III – BASICS OF CIRCUIT ANALYSIS	**(9)**
Ohms Law, Kirchhoff's Current Law, Kirchhoff's voltage law, Resistors in Series and Parallel, voltage and current division, Nodal analysis, Mesh analysis. Delta-Wye Conversion	
UNIT IV - NETWORK THEOREMS FOR DC	**(9)**
Linearity and superposition, Thevenin and Norton Equivalent Circuits, Maximum Power Transfer, Reciprocity theorem.	
UNIT V - NETWORK THEOREMS FOR AC	**(9)**
Thevenin's theorem, Norton's theorem, Superposition theorem, Maximum power transfer theorem-Reciprocity theorem	

LIST OF EXPERIMENTS :

1. Plot the Characteristics of PN Junction Diode and Zener Diode.
2. Plot the Input-Output characteristics of common Emitter and common Base configuration.
3. Plot FET Characteristics.
4. Verification of KVL and KCL
5. Verification of Thevenin and Nortons Theorem.
6. Verification of Superposition Theorem and Reciprocity Theorem.

TOTAL (L:45+P:30) : 75 PERIODS

TEXT BOOKS:

1. Robert L. Boylestad, Louis Nashelsky, "Electronic Devices and Circuit Theory", 2nd Edition, Pearson Education, 2019.
2. Charles K. Alexander, Matthew N. O. Sadiku, "Fundamentals of Electric Circuits", 2nd Edition, McGraw-hill Education, 2017.

REFERENCES:

1. S. Salivahanan, N. Suresh Kumar and A. Vallavanraj, "Electronic Devices and Circuits", 3rd Edition, Tata McGraw Hill, 2013
2. David A. Bell, "Electronic Devices and Circuits", Oxford University Press, 5th Edition, 2008
3. William H. Hayt Jr, Jack E. Kemmerly and Steven M. Durbin, "Engineering Circuits Analysis", 8th Edition, Tata McGraw Hill publishers, New Delhi, 2013

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												2	
2		3											2	
3		3											2	
4			3										2	
5									2		2	3		
CO (W.A)	**3**	**3**	**3**						**2**		**2**	**3**	**2**	

22CSP02 – DATA STRUCTURES LABORATORY *(Common to 22AIP01, 22CCP01, 22CIP01 and 22ITP01)*				
	L	**T**	**P**	**C**
	0	**0**	**4**	**2**

PRE-REQUISITE : 22CSP01

Course Objective:	To understand the fundamental concepts of data structures, including arrays, linked lists, stacks, queues, trees, and graphs.

Course Outcomes The students will be able to		**Cognitive Level**
CO1	Applying pointers and implement array operations	Ap
CO2	Analyze different steps on linked lists.	An
CO3	Capable of working with stack and queue principles.	An
CO4	Cable to creating and modifying a variety of tree operations.	C
CO5	Possible for executing numerous graph functions	Ap

LIST OF EXPERIMENTS:

1. Pointer using 1D, 2D array
2. Implementation of singly linked list and its operations
3. Implementation of doubly linked list and its operations
4. Implementation of circular linked list and its operations
5. Implementation of Infix to postfix conversion using stack ADT
6. Implement the application for evaluating postfix expressions using array of stack ADT
7. Implementation of reversing a queue using stack
8. Binary Search Tree
9. AVL Tree
10. Priority Queues (Heaps)
11. Implementation of Graph Traversals(BFS, DFS)

HARDWARE / SOFTWARE REQUIRED FOR A BATCH OF 30 STUDENTS:

Hardware:

LAN System with 33 nodes (OR) Standalone PCs – 33 Nos.

Software:

Compiler – C

TOTAL (P:60) : 60 PERIODS

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Mapping of COs with POs / PSOs														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3		3									3		2
2	3	3		3										2
3			3											2
4		3		3			3					3		2
5			3	3					3			3		2
CO (W.A)	**3**	**3**	**3**	**3**			**3**		**3**			**3**		**2**

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22PYP01 - PHYSICS LABORATORY (Common to All Branches)					
		L	**T**	**P**	**C**
		0	**0**	**2**	**1**
PRE-REQUISITE : 22CHC09					
Course Objectives:	• To infer the practical knowledge by applying the experimental methods to correlate with the Physics theory. • To introduce different experiments to test basics of physics concepts applied in optics and electronics.				
Course Outcomes The Student will be able to					**Cognitive Level**
CO1	Examine the effects of material type and loading conditions on the results of the non-uniform bending experiment.				An
CO2	Utilize principles of light interaction to determine the particle size of materials using laser diffraction techniques.				Ap
CO3	Evaluate the accuracy of the wavelength of different colors with the accepted values in the literature				Ev
CO4	Measure the effectiveness of the solar cell based on its V-I characteristics.				Ev
CO5	Analyze the principles underlying the Air wedge method for the determination of the thickness of a thin wire.				An

LIST OF EXPERIMENTS:

1. Determination of Young's modulus by non-uniform bending method
2. Determination of (a) wavelength and (b) particle size using Laser.
3. Determination of thermal conductivity of a bad conductor – Lee 's Disc method.
4. Determination of wavelength of mercury spectrum – spectrometer grating
5. Determination of band gap of a semiconductor.
6. Determination of thickness of a thin wire – Air wedge method.
7. Determination of V-I characteristics of solar cell.

TOTAL (P:30) = 30 PERIODS

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Mapping of COs with POs / PSOs														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3												
2	3											2	1	
3	3	3											1	
4	3											2		
5	3	3												
CO (W.A)	**3**	**3**										**2**	**1**	

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22MEP01 – ENGINEERING GRAPHICS LABORATORY				
	L	T	P	C
	0	0	4	2
PRE-REQUISITE : : NIL				
Course Objectives:	• To provide fundamentals concepts of electric circuits. • To understand and analyze the basic theorems of Circuit theory. • To get an insight into solution of three phase power measurements.			

Course Outcomes The Student will be able to		**Cognitive Level**
CO1	Use simulation and experimental methods to verify the fundamental electrical laws for the given DC/AC circuit	Ap
CO2	Use simulation and experimental methods to verify the various electrical theorems (Superposition, Thevenin, Norton and maximum power transfer) for the given DC/AC circuit	An
CO3	Analyze transient behavior of the given RLC circuit using simulation and experimental methods	Ap
CO4	Analyze frequency response of the given series and parallel RLC circuit using simulation and experimentation methods	An
CO5	Analyze the performance of the given three-phase circuit using simulation and experimental methods	C

LIST OF EXPERIMENTS:

1. Experimental verification of Ohm's law
2. Experimental verification of Kirchhoff's voltage and current laws
3. Experimental verification of Superposition theorem
4. Experimental verification of Thevenin's theorem
5. Experimental verification of Norton's theorem
6. Experimental verification of Reciprocity theorem
7. Verification of KVL and KCL by using digital simulation
8. Verification of Superposition theorem & Thevenin's theorem by using digital simulation
9. Verification of Reciprocity theorem & Maximum power transfer theorem by using digital simulation
10. RLC series resonance circuits by using digital simulation

ADDITIONAL EXPERIMENTS:

1. Study of DSO and measurement of sinusoidal voltage, frequency and power factor
2. Experimental determination of power in three phase circuits by two-watt meter method

TOTAL (P:60) = 60 PERIODS

Mapping of COs with POs / PSOs														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3												3	
2	3												3	
3		3												
4			3	3									3	
5							3							
CO (W.A)	**3**	**3**	**3**				**3**						**3**	

22MAN02R - SOFT/ANALYTICAL SKILLS – I (Common to All Branches)				
	L	**T**	**P**	**C**
	1	**0**	**2**	**0**

PREREQUISITE : NIL

Course Objective:	• To analyze wide range of texts, understand and express interpretations • To learn various methods for faster numerical computations and to develop logical reasoning skills

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in Continuous Assessment Test**
CO1	Respond to diverse texts, enhancing their comprehensive and expressive capabilities.	U	40%
CO2	Apply various techniques for quicker calculations.	Ap	30%
CO3	Solve mathematical problems by applying logical thinking.	An	30%

UNIT I – VERBAL ABILITY	**(5+10)**
Grammar- Synonyms - Antonyms - Articles - Preposition - **Listening -** IELTS Listening (Beginners) **- Speaking -** Presentation - JAM **- Reading -** Reading Comprehension **- Writing -** E-mail writing.	
UNIT II – APTITUDE	**(5+10)**
Square Root - Squaring of Numbers - Cube root -Cube of Numbers - Number Systems - L.C.M & H.C.F - Simplification - Problems on Numbers - Calendars - Clocks.	
UNIT III - REASONING	**(5+10)**
Odd Man Out & Number Series - Letter Series - Coding and Decoding - Analogy - Mirror and Water Images.	
TOTAL(L:45) = 45 PERIODS	

REFERENCES:

1. Rizvi, M.Ashraf. *Effective Technical Communication.* Tata McGraw-Hill Education, 2017.
2. Aggarwal R S. *Quantitative* Aptitude for Competitive Examinations. S.Chand Publishing Company Ltd(s)., 2022.
3. Sharma, Arun. *How to Prepare for Quantitative Aptitude for the CAT*. Tata McGraw – Hill Publishing, 2022.
4. Praveen R V. *Quantitative Aptitude and Reasoning.* PHI Learning Pvt. Ltd., 2016.

Mapping of COs with POs / PSOs														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1									2	3				
2		2		2										
3		2		2										
CO (W.A)		**2**		**2**					**2**	**3**				

22MAN05 - YOGA – II (For Common To All Branches)					
		L	**T**	**P**	**C**
		0	**0**	**I**	**0**
PRE-REQUISITE : NIL					
Course Objectives:	• To strengthen the body through physical exercises. • To understand the importance of value system and ethics. • To know the life philosophy of yogis and maharishis. • To understand the nature laws, cause and effect theory. • To inculcate knowledge about different types of Asanas and their benefits.				

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Perform physical exercises like spine exercises, massage and acupressure.	Ap	Internal Assessment
CO2	Learn the human values, ethics, time management and the importance of introspection.	U	
CO3	Analyze various life philosophies of yogi's and rishi's.	An	
CO4	Understand life lessons and nature laws.	U	
CO5	Demonstrate different types of yoga Asanas and improve their personal fitness.	Ap	

UNIT I – PHYSICAL EXCERCISES (PART-II)	**(3)**
Breathing Exercises – Kapalapathi – Maharasanam (Spine Exerices) – Massage and Acupressure.	
UNIT II – HUMAN VALUE	**(3)**
Divine power – Life force (Bio magnetism) – Importance of Introspection – Time management – Punctuality – self confidence – mind control.	
UNIT III – PHILOSOPHY OF LIFE	**(3)**
Basic needs for life – Hunger and thirst – climatic/weather changes – Body wastes – pressure of excretory organs – safety measures – protection from natural disaster – protection from enmity – protection from accidents – ethics – morality – duty – charity – Wisdom of perfection stages – faith – understanding – realization.	
UNIT IV – NATURE'S LAW OF CAUSE AND EFFECT	**(3)**
Food transformation into seven minerals – Natural actions – pattern – precision – regularity – Required skills – planned work – awareness – introspection.	

UNIT V – ASANAS (PART-II)	(3)
Ustrasana – Vakrasana –Komugasana – Padmasana – Vajrasana – Sukhasana – Yogamudra – mahamudra.	
TOTAL (P:15) : 15 PERIODS	

TEXT BOOKS/REFERENCES:
1. Light On Yoga by B.K.S. Iyengar.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1								3	2			3		
2								3	2			3		
3								3	2			3		
4								3	2			3		
5								3	2			3		
CO (W.A)								3	2			3		

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22MYB06 – PROBABILITY AND RANDOM PROCESSES *(Common to BME and ECE Branches)*				
	L	**T**	**P**	**C**
	3	**I**	**0**	**4**
PRE-REQUISITE : NIL				
Course Objectives:	• Develop probability distribution of discrete and continuous random variables, Joint probability distribution occurs in digital signal processing, design engineering and microwave engineering • To learn about the classification of random processes and strict stationary, wide sense stationary and Ergodic, correlation functions and power spectral density and solve the signal problems.			

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the basic principles of probability to solve the problems involving multiple events and practical problems in communication engineering, including signal processing and information theory.	Ap	30%
CO2	Interpret the distribution to model and solve problems involving binary outcomes, such as error detection and correction in digital communications.	Ap	30%
CO3	Determine and enhance problem-solving skills through practical examples, case studies, and applications in fields such as signal processing, time series analysis, and system modeling.	An	20%
CO4	Analyze and interpret signals and their interactions in the frequency domain.	An	20%
CO5	Demonstrate the methods to solve the spectrum estimation and spectral density function by using mathematical tools in analog communication.	Ap	Internal Assessment mode

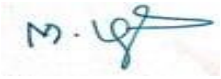
UNIT I – ONE DIMENSIONAL RANDOM VARIABLES	**(9+3)**
Probability: Random variable – Probability mass function – Probability density functions – Properties – Moments – Moment generating functions and their properties	
UNIT II - STANDARD DISTRIBUTIONS	**(9+3)**
Discrete distributions: Binomial, Poisson and Geometric distribution – Continuous distributions: Uniform, Exponential and Normal distribution and its properties.	
UNIT III – TWO DIMENSIONAL RANDOM VARIABLES	**(9+3)**
Joint distributions – Marginal distributions and conditional distribution – Covariance – correlation and Regression – Transformation of random variables – Central limit theorem (Excluding proof).	
UNIT IV – RANDOM PROCESSES	**(9+3)**
Definition and examples – first order, second order strictly stationary, wide-sense stationary and Ergodic process- Markov process – Binomial, Poisson processes.	
UNIT V – CORRELATION AND SPECTRAL DENSITIES	**(9+3)**

Auto correlation – Cross correlation – Properties –Power spectral density – Cross spectral density – Properties – Wiener – Khintchine relation (statement only) – Relationship between cross power spectrum and cross correlation function.
TOTAL (L:45+T:15) :60 PERIODS

TEXT BOOKS:
1. Veerarajan.T, "Probability, Statistics and Random Processes,"3rded.,NewDelhi,Tata McGraw-Hill,2008. 2. Venkatarama Krishnan, "Probability and Random Process,"2ndEdition,John Wiley & Sons , New Jersey,2016 3. Scott L. Miller and Donald Childers, "Probability and Random Processes with applications to Signal Processingand communications," Elsevier, 2012.
REFERENCES:
1. GubnerA.John, "Probability and Random Processes for Electrical and Computer Engineers", Cambridge University Press, Newyork, 2006. 2. Charles W. Therrien, Murali Tummala, "Probability and Random Process for Electrical and Computer Engineers", CRC Press, Newyork, 2012. 3. Singaravelu. A, Sivasubramanian, Ramaa, "Probability, Statistics and Random Processes," 2nd Edition, Meenakshi Publication, Chennai, 2003.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2												
2		2												2
3	3													2
4		2												2
5	3				2				3			2		
CO (W.A)	3	2			2				3			2		2



22BMC01 - ANALOG AND DIGITAL ELECTRONICS *(BIOMEDICAL ENGINEERING)*				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

PRE-REQUISITE : 22ECC04

Course Objectives:	• To study the circuit configuration and introduce applications of linear integrated circuits. • To introduce the design of various combinational & sequential digital circuits using logic gates

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply boolean laws and theorems to design different digital circuits.	Ap	20%
CO2	Analyze the various op-amp circuits & to convert real time data into data suitable for transmission and reception.	An	20%
CO3	Deduce the operation of various analog linear circuits & digital circuits.	An	40%
CO4	Design and analyze various combinational & sequential digital circuits.	An	20%
CO5	Collaborate in teams for efficient project management.	Ap	Internal Assessment

UNIT I – INTRODUCTION TO OPERATIONAL AMPLIFIERS AND ITS APPLICATIONS	**(9)**
Operational amplifier – Ideal Characteristics, Performance Parameters, Voltage Follower, Inverting Amplifier, Non-inverting Amplifiers, Differentiator, Integrator, Voltage to Current Converter, Current to Voltage Converter, Differential Amplifier, Instrumentation amplifier, Low pass, High pass and Band Pass Filters, Comparator.	
UNIT II – DIGITAL TO ANALOG AND ANALOG TO DIGITAL CONVERTERS	**(9)**
Analog Switches, High Speed Sample and Hold Circuit and ICs, Types of D/A converter - Weighted Resistor, R-2R ladder DAC, D/A Accuracy and Resolution. A/D converter - Flash, Dual Slope, Successive Approximation, A/D Accuracy and Resolution.	
UNIT III – NUMBER SYSTEMS, LOGIC GATES AND LOGIC FAMILES	**(9)**
Number Systems – Decimal, Binary, Octal, Hexadecimal, 1's and 2's complements, Codes – Binary, BCD, 8421, 2421, Excess 3, Biquinary, Gray, Alphanumeric codes, Boolean theorems, Logic gates, Universal gates, Sum of Products and Product of Sums, Minterms and Maxterms, Karnaugh map and Tabulation methods.	
UNIT IV – COMBINATIONAL LOGIC CIRCUITS	**(9)**
Problem Formulation and Design of Combinational Circuits - Code - Converters, Half and Full Adders, Half and Full Subtractors, Magnitude Comparator, Decoder, Encoder, Priority Encoder, Mux/Demux.	

Parity Generator and Checker.
UNIT V – SEQUENTIAL LOGIC CIRCUITS **(9)**
Flip Flops – SR, JK, T, D, Master/Slave FF, Analysis and Design of Clocked Sequential Circuits – State Minimization, State Assignment, Circuit Implementation. Counters – Ripple & Ring counter, Shift registers – SISO, SIPO, PISO, PIPO.
TOTAL (L:45) = 45 PERIODS

TEXT BOOKS:

1. D. Roy Choudhury and Shail B. Jain, "Linear Integrated Circuits", 4th Edition, New Age International Publishers, 2018.
2. M. Morris Mano and Michael D.Ciletti, "Digital Design", Pearson, 5th Edition, 2013.
3. John. F. Wakerly, "Digital Design Principles and Practices", Pearson Education, 5th Edition, 2018.

REFERENCES:

1. Taub and Schilling, "Digital Integrated Electronics", Mc Graw Hill, 2017.
2. Sergio Franco, "Design with Operational Amplifiers and Analog Integrated Circuits", 3rd Edition, Mc Graw Hill Education, 2017.
3. Charles H.Roth, Jr, "Fundamentals of Logic Design", 7th Edition, Jaico Books, 2013.
4. S Salivahanan and V S Kanchana Bhaaskaran, Linear Integrated Circuits, 3rd Edition, McGraw Hill Education, 2018.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2		3												
3	3												2	
4			3	2									2	
5						2			2		2			
CO (W.A)	3	3	3	2		2			2		2		2	

22BMC02 - ANATOMY AND HUMAN PHYSIOLOGY (THEORY + LAB)				
	L	T	P	C
	3	0	2	4

PRE-REQUISITE : NIL

Course Objectives:	• To provide students with a comprehensive understanding of human physiology by exploring cell, tissue, and organ system functions. • To emphasize functional anatomy and develop a cohesive understanding of the interactions between components that maintains homeostasis and overall health.

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply the concepts of science in understanding human anatomy and physiology.	Ap	40%
CO2	Identify and analyze various human anatomical systems to understand their functionality.	An	40%
CO3	Correlate the effects of major diseases with their impact on human organ systems to understand their overall influence on health.	An	20%
CO4	Deduce results from phlebotomy and diagnostic techniques by performing blood collection, analyzing samples and conducting sensory tests.	An	Laboratory Assessment
CO5	Design a functional model of a human organ, demonstrating understanding of its structure, physiology and role within the body.	C	Internal Assessment

UNIT I - BASIC ELEMENTS OF HUMAN BODY	**(9)**
Cell – Cell Structure and organelles - Functions of each component in the cell. Cell membrane –Transport across membrane - Action potential (Nernst, Goldman equation), Homeostasis. Tissue: Types, Functions.	
UNIT II - SKELETAL AND MUSCULAR SYSTEM	**(9)**
Skeletal: Types of Bone and function – Physiology of Bone formation – Division of Skeleton -Types of joints and function – Types of cartilage and function. –Types of muscles – Structure and Properties of Skeletal Muscle- Changes during muscle contraction- Neuromuscular junction.	
UNIT III - CARDIOVASCULAR AND RESPIRATORY SYSTEM	**(9)**
Cardiovascular System: Structure – Conduction System of heart – Cardiac Cycle – Cardiac output. Blood: Composition – Functions - Haemostasis – Blood groups and typing. Blood Vessels – Structure and types - Blood pressure - Respiratory system: Parts of respiratory system – Respiratory physiology – Lung volumes and capacities – Gaseous exchange.	
UNIT IV - DIGESTIVE AND EXCRETORY SYSTEMS	**(9)**
Structure and functions of gastrointestinal system - secretory functions of the alimentary tract - digestion and absorption in the gastrointestinal tract - structure of nephron - mechanism of urine formation - skin and sweat gland - temperature regulation.	

UNIT V - NERVOUS AND SENSORY SYSTEM	(9)
Structure and function of nervous tissue – Brain and spinal cord – Functions of CNS – Nerve conduction and synapse – Reflex action – Somatic and Autonomic Nervous system. Physiology of Vision, Hearing, Integumentary, Olfactory systems. Taste buds.	
TOTAL (L:45 + P:30) = 75 PERIODS	

LIST OF EXPERIMENTS

1. Identification of Blood Collection Tubes and Phlebotomy Equipments.
2. Collection of Blood Samples.
3. Identification of Blood Group.
4. Determination of Bleeding and Clotting Time.
5. Estimation of Haemoglobin.
6. Total RBC Count.
7. Total WBC Count.
8. Differential Count of Different WBC.
9. Visual Activity- Snellen's Chart and Jaeger's Chart.
10. Hearing Test – Tuning Fork.

TEXT BOOKS:

1. Guyton & Hall, "Text Book of Medical Physiology", 13th Edition, Saunders, 2015.
2. Elaine. N. Marieb, "Essential of Human Anatomy and Physiology", 9th Edition, Pearson Education, New Delhi, 2018.

REFERENCES:

1. Ranganathan T S, "Text Book of Human Anatomy", S. Chand & Co. Ltd., New Delhi, 2012.
2. Sarada Subramanyam, K Madhavan Kutty, Singh H D, "Textbook of Human Physiology", S. Chand and Company Ltd, New Delhi, 2012.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2		3												
3		3		3	2									
4		3			3								3	
5					3				2	2	2		3	
CO (W.A)	3	3		3	2.7				2	2	2		3	

22BMC03 - SENSORS AND MEASUREMENTS				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE : 22ECC02

Course Objectives:	• To provide comprehensive understanding of sensor technologies, including photoelectric and piezoelectric sensors, bio-potential electrodes, biosensors, signal conditioning circuits, measurement bridges, and display and recording devices.

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply engineering principles and sensing concepts to create effective diagnostic devices for biomedical applications	Ap	20%
CO2	Analyze engineering challenges to determine suitable methods for measuring biomedical parameters using appropriate sensors and techniques.	An	20%
CO3	Identify and analyze appropriate sensors and electrodes for specific needs.	An	40%
CO4	Analyze the measurement systems tailored to specific needs, demonstrating their ability to innovate and solve complex problems.	An	20%
CO5	Engage in independent study/ self-study by preparing a 5 min video on Applications of sensors	Ap	Internal Assessment

UNIT I - PHOTOELECTRIC AND PIEZO ELECTRIC SENSORS	**(9)**
Phototube, Scintillation Counter, Photo Multiplier Tube (PMT), Photovoltaic, Photo Conductive Cells, Photo Diodes, Phototransistor, Comparison of Photoelectric Transducers. Optical Displacement Sensors and Optical Encoders. Piezoelectric Active Transducer – Equivalent Circuit and its Characteristics.	
UNIT II - BIO POTENTIAL ELECTRODES	**(9)**
Electrodes Electrolyte Interface, Half-Cell Potential, Polarization, Polarizable and Non Polarizable Electrodes, Calomel Electrode, Electrode Circuit Model, Electrode Skin-Interface and Motion Artifact. Body Surface Electrodes. Ion Exchange Membrane Electrodes, Oxygen Electrodes, CO2 Electrodes, Enzyme Electrode, ISFET for Glucose, Urea.	
UNIT III - BIOSENSORS	**(9)**
Biosensors: Introduction, Advantages and Limitations, Various Components of Biosensors, Biocatalysts based Biosensors, Bio-affinity based Biosensors & Microorganisms based Biosensors, Types of Membranes used in Biosensor Constructions, Electronic Nose.	
UNIT IV - SIGNAL CONDITIONINGCIRCUITS	**(9)**
Functions of Signal Conditioning Circuits, Preamplifiers, Concepts of Passive Filters, Impedance Matching Circuits, Isolation Amplifier. AC and DC Bridges – Wheat stone Bridge, Kelvin, Maxwell, Hay, Schering.	

UNIT V - DISPLAY AND RECORDING DEVICES	(9)
Multimeter, DSO, LCD/LED displays, PMMC writing systems, servo recorders, photographic recorder, magnetic tape recorder.	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

1. Sawhney A K and Puneet Sawhney, "A Course in Electrical & Electronic Measurements & Instrumentation", Dhanpat Rai and Company, New Delhi, 2015.
2. John G. Webster, "Medical Instrumentation Application and Design", 4th Edition, Wiley India Pvt. Ltd., New Delhi, 2015.

REFERENCES:

1. Kalsi H S, "Electronic Instrumentation and Measurement", Tata McGraw Hill, 2011.
2. Nandini K. Jog, "Electronics in Medicine and Biomedical Instrumentation, 2nd Edition, PHI, 2013.
3. Harry N, Norton, "Biomedical Sensors: Fundamentals and Application", Noyes Publications, 2001.
4. Tatsuo Togawa, Toshiyo Tamma and P. Ake Ã–berg, "Biomedical Transducers and Instruments", CRC Press, 2018.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2		3											3	
3			3											
4				3										
5									3	3		2		
CO (W.A)	3	3	3	3					3	3		2	3	

22ECC06 – SIGNALS AND SYSTEMS				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE : 22MYB01, 22MYB04				
Course Objectives:	• To make the basic properties of signal & systems and its various methods of classification. • To learn Laplace Transform & Fourier transform and their properties. • To know the frequency representation of CT signals with Fourier series and transform. • To motivate the students to implement the discrete time system using impulse response and inputs. • To characterize LTI systems in the discrete time domain and various Transform domains.			

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Obtain the specified parameter/representation for the given continuous time signal/system using time domain, frequency domain and transform domain representation	Ap	20%
CO2	Apply the Fourier Series and Transform to CT signals to convert them from the time domain to the frequency domain.	Ap	20%
CO3	Analyze and classify the given signal/system using time domain, frequency domain and transform domain representation	An	30%
CO4	Analyze the response of discrete-time LTI systems for various input signals	An	20%
CO5	Make an oral presentation of the application concepts of the course for transmission of audio /image/ video/ data signal for benefit of society	U	Internal Assessment

UNIT I - CLASSIFICATION OF SIGNALS AND SYSTEMS	**(9)**
Standard Signals: Unit impulse, unit step, unit ramp, exponential, and sinusoidal signals, Classification of Continuous and discrete time signals, Types of signals: power, energy, periodic, even and odd, Basic Operations on Signals, Basic System Properties: Linearity, Time Invariant, causality, stability and invertibility, LTI.	
UNIT II - TIME DOMAIN CHARACTERISATION OF CONTINUOUS TIME LTI SYSTEM	**(9)**
Classification of systems - CT systems and DT systems - Linear & Nonlinear, Time-variant & Time-invariant, Causal & Non-causal, Stable & Unstable - Convolution Integral, Properties of continuous time LTI system-Causality, stability, Causal continuous time LTI system described by differential equations	
UNIT III- FREQUENCY DOMAIN REPRESENTATION IN CT SIGNALS	**(9)**

Fourier series representation of continuous time periodic signals, properties of continuous time Fourier series, Fourier transform of continuous time aperiodic signals and periodic signals, properties of continuous time Fourier transform, Laplace transform, Region of Covergence, Inverse Laplace transform.	
UNIT IV – TIME DOMAIN CHARACTERISATION OF DISCRETE TIME LTI SYSTEM	**(9)**
Sampling theorem (Low Pass) – Reconstruction of a Signal from its samples, aliasing, Convolution sum, properties of discrete time LTI system, Causal discrete time LTI system described by difference equations.	
UNIT V- FREQUENCY DOMAIN REPRESENTATION IN DT SIGNALS	**(9)**
Z Transform, Inverse Z transform – Long division – partial fraction, ROC, Properties of Z Transform: Linearity, time shifting, change of scale, Z-domain differentiation, differencing, accumulation, convolution in discrete time, initial and final value theorems.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:
1. Simon S. Haykin and Barry Van Veen, "Signals and Systems,"2 Nd Edition. Wiley India, 2008(Reprint).
REFERENCES:
1. B. P. Lathi, "Principles of Linear Systems and Signals", Second Edition, Oxford, 2009.
2. R.E.Zeimer, W.H.Tranter and R.D.Fannin, "Signals & Systems - Continuous and Discrete", Pearson, 2007.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													2
2		3												
3		2												
4		2												2
5						1				1		1	2	
CO (W.A)	3	2				1				3		1	2	2

22CYB06 - ENVIRONMENTAL SCIENCE AND SUSTAINABILITY (Common to CHEM-2nd, BME-3rd, ECE-5th AND EEE-4th SEM)				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**
PRE-REQUISITE : NIL				

Course Objectives:	• To impart knowledge on ecosystem, biodiversity, environmental pollution and familiarize about sustainable development, carbon credit and green materials. • To make the students conversant with the global and Indian scenario of renewable resources, causes of their degradation and measures to preserve them.

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Illustrate the values and conservation methods of biodiversity.	Ap	20%
CO2	Predict the causes, effects of environmental pollution and contribute the preventive measures to the society.	An	20%
CO3	Analyse the renewable and non-renewable resources and preserve them for future generations.	An	20%
CO4	Examine the different goals of sustainable development and apply them for suitable technological advancement and societal development.	Ap	20%
CO5	Execute the sustainability practices, identify green materials and energy cycles.	E	20%

UNIT I - ENVIRONMENT AND BIODIVERSITY	**(9)**
Environment - scope and importance - Eco-system- Structure and function of an ecosystem - types of biodiversity- genetic - species and ecosystem diversity– Values of biodiversity - India as a mega-diversity nation – 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 ex-situ.	
UNIT II - ENVIRONMENTAL POLLUTION	**(9)**
Pollution – Causes - Effects and Preventive measures of Water – Soil - Air - Noise Pollution - Solid waste management - methods of disposal of solid waste – various steps of Hazardous waste management - E-Waste management - Environmental protection – Air acts – water acts.	
UNIT III - RENEWABLE SOURCES OF ENERGY	**(9)**
Energy management and conservation - New Energy Sources - Different types new energy sources – Hydrogen energy – Geothermal energy - Solar energy – wind energy – biomass energy - Applications of Hydrogen energy - Ocean energy resources -Tidal energy conversion.	
UNIT IV – SUSTAINABILITY AND MANAGEMENT	**(9)**

Development – Factors affecting development – advantages – disadvantages – GDP - Sustainability- needs – concept - from unsustainability to sustainability - millennium development goal - Sustainable Development goals - Climate change – Concept of carbon credit – carbon footprint - Environmental management.	
UNIT V – SUSTAINABILITY PRACTICES	**(9)**
Zero waste and R concept - ISO 14000 Series - Environmental Impact Assessment - Sustainable habitat - Green buildings - Green materials- Sustainable energy - Non-conventional Sources - Energy Cycles- carbon cycle and carbon emission - Green Engineering - Sustainable urbanization.	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

1. Dr. A.Ravikrishan, Envrionmental Science and Engineering., Sri Krishna Hitech Publishing Co. Pvt.Ltd., Chennai,15thEdition, 2023.
2. Anubha Kaushik and C. P. Kaushik's "Perspectives in Environmental Studies", 6th Edition, New Age International Publishers , 2018.

REFERENCES:

1. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press, Third Edition, 2015.
2. Erach Bharucha "Textbook of Environmental Studies for Undergraduate Courses" Orient Blackswan Pvt. Ltd. 2013.

WEB LINK:

1. http://www.jnkvv.org/PDF/08042020215128Amit1.pdf
2. https://www.conserve-energy-future.com/types-of-renewable-sources-of-energy.php
3. https://ugreen.io/sustainability-engineering-addressing-environmental-social-and-economic-issues/

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1		2												
2			2				3							
3	2		2					2						
4							3							
5						3						2		
CO (W.A)	2	2	2			3	3	2				2		

22BMP01 - ANALOG AND DIGITAL ELECTRONICS LABORATORY				
	L	T	P	C
	0	0	4	2

PRE-REQUISITE : NIL

Course Objectives:	• To make the students to understand and apply the principles and applications of operation amplifier. • To make the students to understand and apply boolean principles to design the combinational logic circuits & sequential logic circuits.

The Student will be able to **Course Outcomes**		**Cognitive Level**
CO1	Demonstrate the operation of various analog linear circuits & digital circuits.	Ap
CO2	Apply boolean laws and theorems to design different digital circuits.	Ap
CO3	Design and analyze the various op-amp circuits using IC741.	An
CO4	Design and implementation of different combinational & sequential digital circuits.	An
CO5	Collaborate in teams and embracing lifelong learning.	C

LIST OF EXPERIMENTS :

1. Inverting and Non-inverting amplifier
2. Integrator and Differentiator
3. Design and analysis of active filters using op-amp
4. Study of logic gates.
5. Design of Half adder and Full adder
6. Design of Code Converters
7. Design of Magnitude Comparator.
8. Multiplexer and Demultiplexer using Digital ICs
9. Design of Flip flops – SR, JK, T, D
10. Design of counters.

TOTAL (P:60) = 60 PERIODS

Mapping of COs with POs / PSOs														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3													
2	3													
3			3										2	
4			3										2	1
5									2	1	1	2		
CO (W.A)	**3**		**3**						**2**	**1**	**1**	**2**	**2**	**1**

22BMP02 - SENSORS AND MEASUREMENTS LABORATORY				
	L	T	P	C
	0	0	4	2

PRE-REQUISITE : NIL

Course Objective:	To Equip students with a comprehensive understanding of different transducers, temperature sensors, photodiodes, phototransistors, LDRs, bridge circuits, and various measurement methods using Hall effect transducers, strain gauges, and load cells.

Course Outcomes The Student will be able to		**Cognitive Level**
CO1	Apply appropriate sensor technologies and measurement techniques to solve practical engineering problems.	Ap
CO2	Conduct experiments and analyze sensor data to validate measurement results.	An
CO3	Compare the performance and limitations of different sensors and measurement systems.	An
CO4	Conduct investigations with sensor-based measurement systems for specific applications.	An
CO5	Experiment, document, analyze and present the test results of the experiment, working both independently and in teams.	An

LIST OF EXPERIMENTS :

1. Characteristics of Potentiometric Transducer.
2. Characteristics of Thermistor.
3. Characteristics of Thermocouple.
4. Characteristics of LDR.
5. Characteristics of Photo Diode and Photo Transistors.
6. Characteristics of RTD.
7. Characteristics of LVDT.
8. Measurement of unknown Resistance using Kelvin Double Bridge and Wheatstone Bridge.
9. Measurement of unknown Capacitance using Schering Bridge.
10. Measurement of unknown Inductance using Anderson Bridge.
11. Characteristics of Hall effect Transducer.
12. Characteristics of strain gauge and Load cell.

TOTAL (P:60) = 60 PERIODS

Mapping of COs with POs / PSOs														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3												3	
2		3												
3				3										
4			3											
5									3	3				
CO (W.A)	**3**	**3**	**3**		**3**				**3**	**3**			**3**	

22MAN04R - SOFT/ANALYTICAL SKILLS – II

(Common to All Branches)

L	T	P	C
1	0	2	0

PRE-REQUISITE : NIL

Course Objectives:

- To develop comprehensive English language skills
- To enhance logical reasoning skills and enhance problem-solving abilities

	Course Outcomes The Student will be able to	Cognitive Level	Weightage of COs in Continuous Assessment Test
CO1	Comprehend grammar, analyze texts, understand spoken language, articulate ideas in speech, and produce well-structured written compositions.	U	40%
CO2	Analyze quantitative aptitude problems and find solutions.	Ap	30%
CO3	Demonstrate the ability to solve problems through logical reasoning.	An	30%

UNIT I – VERBAL ABILITY	**(5+10)**
Grammar - One Word Substitutions - Phrasal Verbs - Listening - IELTS Listening (Intermediate) - Speaking - Group Discussion - Reading - Reading Newspaper / Articles -Writing - Proverb Expansion.	
UNIT II – APTITUDE	**(5+10)**
Ratio and Proportion - Allegation and Mixture - Partnership - Average - Problems on Ages - Percentage - Profit and Loss - Height and Distance.	
UNIT III - REASONING	**(5+10)**
Blood Relationship - Direction Sense - Paper Cutting and Folding - Logical Arrangements and Ranking - Venn Diagram.	
TOTAL(L:45) = 45 PERIODS	

REFERENCES:

1. Rizvi, M. Ashraf. "Effective Technical Communication", Tata McGraw-Hill Education, 2017.
2. Aggarwal R S. "Quantitative Aptitude for Competitive Examinations", S. Chand Publishing Company Ltd(s)., 2022.
3. Sharma, Arun. "How to Prepare for Quantitative Aptitude for the CAT", Tata McGraw – Hill Publishing, 2022.
4. Praveen R V. "Quantitative Aptitude and Reasoning", PHI Learning Pvt. Ltd., 2016.

Mapping of COs with POs / PSOs														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1									2	3				
2		2		2										
3		2		2										
CO (W.A)		**2**		**2**					**2**	**3**				

22MAN09 - INDIAN CONSTITUTION (*Common to All Branches*)				
	L	**T**	**P**	**C**
	I	**0**	**0**	**0**
PRE-REQUISITE : NIL				

Course Objectives:	• To educate students to learn about the Constitutional Law of India. • To motivate students to understand the role of Union Government. • To make students to understand about State Government. • To understand about District Administration, Municipal Corporation and Zila Panchayat. • To encourage students to Understand about the election commission.

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Gain Knowledge about the Constitutional Law of India.	U	Internal Assessment
CO2	Know the Union Government and role of President and Prime Minister.	R	
CO3	Gain knowledge about State Government and role of Governor, Chief Minister.	U	
CO4	Understand the District Administration, Municipal Corporation and Zila Panchayat.	U	
CO5	Understand the role and function of election commission.	U	

UNIT I - THE CONSTITUTION INTRODUCTION	(3)
The History of the Making of the Indian Constitution - Preamble and the Basic Structure, and its interpretation - Fundamental Rights and Duties and their interpretation - State Policy Principles.	
UNIT II - UNION GOVERNMENT	(3)
Structure of the Indian Union - President - Role and Power - Prime Minister and Council of Ministers - Lok Sabha and Rajya Sabha	
UNIT III - STATE GOVERNMENT	(3)
Governor - Role and Power - Chief Minister and Council of Ministers - State Secretariat	
UNIT IV - LOCAL ADMINISTRATION	(3)
District Administration - Municipal Corporation - Zila Panchayat	
UNIT V - ELECTION COMMISSION	(3)
Role and Functioning - Chief Election Commissioner - State Election Commission	
TOTAL (L:15) : 15 PERIODS	

TEXT BOOKS:

1. Rajeev Bhargava, "Ethics and Politics of the Indian Constitution", Oxford University Press, New Delhi, 2008.
2. B.L. Fadia, "The Constitution of India", Sahitya Bhawan; New edition (2017).
3. DD Basu, "Introduction to the Constitution of India", Lexis Nexis; Twenty-Third 2018 Edition.

REFERENCES:

1. Steve Blank and Bob Dorf, "The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company", K & S Ranch ISBN – 978-0984999392
2. Eric Ries, "The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses" , Penguin UK ISBN - 978-0670921607
3. Adrian J. Slywotzky with Karl Weber, "Demand: Creating What People Love Before They Know They Want It", Headline Book Publishing ISBN - 978-0755388974
4. Clayton M. Christensen, "The Innovator's Dilemma: The Revolutionary Book That Will Change the Way You Do Business", Harvard business ISBN: 978-142219602.

REFERENCES: Web link

1. https://www.fundable.com/learn/resources/guides/startup
2. https://corporatefinanceinstitute.com/resources/knowledge/finance/corporate- structure/
3. https://www.finder.com/small-business-finance-tips
4. https://www.profitbooks.net/funding-options-to-raise-startup-capital-for-your-business/

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1						3		3		2		3		
2						3		3		2		3		
3						3		3		2		3		
4						3		3		2		3		
5						3		3		2		3		
CO (W.A)						3		3		2		3		

22ITC06 - JAVA PROGRAMMING *(Common to 22AIC04 ,22CSC07, 22CCC06,22CIC06 and 22ITC06)*				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

PRE-REQUISITE : NIL

Course Objectives:	• To understand object-oriented programming concepts, and apply them in solving problems. • To introduce the design of Graphical User Interface using applets and swing controls.

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the concepts of classes and objects to solve simple problems using Java	Ap	20%
CO2	Analyze how oops concepts like inheritance, polymorphism improves code organization and enhances flexibility.	An	20%
CO3	Build interactive applications using applets and swing	An	20%
CO4	Conduct practical experiments for demonstrating exception handling, multithreaded applications with synchronization.	An	40%
CO5	Build the Java Project for engineering applications and make an individual study being member of team.	An	Internal Assessment

UNIT I -INTRODUCTION TO OOP AND JAVA FUNDAMENTALS	**(9)**
Object Oriented Programming - Abstraction – objects and classes - Encapsulation- Inheritance - Polymorphism- OOP in Java – Characteristics of Java – The Java Environment - Java Source File -Structure – Compilation. Fundamental Programming Structures in Java – Defining classes in Java – constructors, methods -access specifiers - static members -Comments, Data Types, Variables, Operators, Control Flow, Arrays , Strings, Packages - JavaDoc comments.	
UNIT II - INHERITANCE AND INTERFACES	**(9)**
Inheritance – Super classes- sub classes – Protected members – constructors in sub classes- the Object class – abstract classes and methods-Keywords: Static-final-this- final methods and classes – Method overloading-Method overriding-Interfaces – defining an interface, implementing interface, differences between classes and interfaces and extending interfaces	
UNIT III -EXCEPTION HANDLING AND I/O	**(9)**
Exceptions - exception hierarchy - throwing and catching exceptions – built-in exceptions, creating own exceptions, Stack Trace Elements. Input / Output Basics – Streams – Byte streams and Character streams – Reading and Writing Console – Reading and Writing File	

UNIT – IV –THREADS	(9)
Java Thread Model – Main Thread – Creating a Thread – Creating Multiple Threads — Thread Priorities – Synchronization – Inter thread Communication – Suspending, Resuming, and Stopping Threads – Using Multithreading.	
UNIT – V EVENT DRIVEN PROGRAMMING	**(9)**
Graphics programming - Frame – Components Basics of event handling - event handlers - adapter classes - actions - mouse events - AWT event hierarchy - Introduction to Swing – layout management - Swing Components – Text Fields , Text Areas – Buttons- Check Boxes – Radio Buttons – Lists- choices- Scrollbars – Windows –Menus – Dialog Boxes.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. Herbert Schildt, "Java: The Complete Reference", 11th Edition, McGraw Hill Education, New Delhi, 2019 for Units I, II, III, IV.
2. Herbert Schildt, "Introducing JavaFX 8 Programming", 1st Edition, McGraw Hill Education, New Delhi, 2015 for Unit V.

REFERENCES:

1. Cay. S. Horstmann, Gary Cornell, "Core Java-JAVA Fundamentals", Prentice Hall, 10th ed., 2016.
2. Paul Deitel, Harvey Deitel, "Java SE 8 for programmers", 3rd Edition, Pearson, 2015.3. SCJP Sun Certified Programmer for Java 6 Study Guide. 6th edition, McGraw Hill.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2		3												2
3		3												
4		3												
5		3				2			2		2	1		2
CO (W.A)	3	3				2			2		2	1		2

22MEC13 - ENGINEERING MECHANICS FOR BIOMEDICAL ENGINEERS				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE : NIL

Course Objectives:	• To get exposed to the fundamental principles of mechanics • To analyse the behaviour of the rigid body under the action of force • To get exposed to the dynamics concepts and fundamental concepts of friction • To introduce the concept of stress and properties of surfaces. • To learn basics of fluid mechanics and relate it to bio-fluids

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Calculate the resultant and equilibrant of forces acting on particles and rigid bodies	Ap	30 %
CO2	Analyze flow characteristics of the object by applying the dynamic equilibrium equation and concept of friction	An	30 %
CO3	Determine the stress induced in the material and centroid, moment of inertia and principal moment of inertia of various surfaces.	Ap	20 %
CO4	Estimate the flow characteristics fluid by applying fluid mechanics laws and concepts	Ap	20 %
CO5	Understand the fundamental concepts of mechanics by working in a team and communicate the same through effective presentations	U	Internal Assessment

UNIT I - BASICS AND STATICS OF PARTICLES	**(9)**
Introduction – Units and Dimensions – Laws of Mechanics – Principle of Transmissibility – Lami's Theorem, Parallelogram and Triangular Law of Forces — Coplanar Forces – Rectangular Components – Equilibrium of a Particle – Equivalent Systems of Forces.	
UNIT II - EQUILIBRIUM OF RIGID BODIES	**(9)**
Free Body Diagram – Types of Supports and its Reaction Forces – Stable Equilibrium – Moments and Couples – Varignon's Theorem – Single Equivalent Force - Equilibrium of Rigid Bodies in Two Dimensions - Resolution of a Force into a Force - Couple System.	
UNIT III - DYNAMICS OF PARTICLES	**(9)**
Displacements, Velocity and Acceleration, Their Relationship – Newton's Laws of Motion – Work Energy Equation. Frictional Force – Laws of Colomb Friction.	
UNIT IV - MECHANICS OF SOLIDS	**(9)**
Rigid Bodies and Deformable Solids – Tension, Compression and Shear Stresses – Deformation of Non-rigid Bodies- Stress-Strain Curve. Centroids – Moment of Inertia – Principal Moments of Inertia of Composite Plane Areas.	

UNIT V - BASICS OF FLUID MECHANICS	(9)
Fluids – Density – Pressure – Blood Pressure and Gravity – Buoyancy – Moments of Force and Stability – Movement in Water –Newton's Laws of Viscosity – Definitions and simple problems on Newtonian fluid, Non-Newtonian fluid, Euler equations and Navier Stoke's equations, Viscoelasticity, Laminar Flow, Couette Flow, Turbulent Flow and Hagen-Poiseuille equation.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. Dr. N. Kottiswaran, "Engineering Mechanics", 10th Edition, Sri Balaji Publisher, 2020 (Unit I, II, III, IV)
2. Dr. R. K. Bansal, A Text Book of Fluid Mechanics, 10th Edition, Laxmi Publications (P) Ltd., New Delhi, 2019 (Unit V).

REFERENCES:

1. Beer, F. Pand Johnston Jr. E. R., "Vector Mechanics for Engineers (In SI Units): Statics and Dynamics", 8th Edition, Tata McGraw-Hill Publishing Company, New Delhi, 2004.
2. Dr. R. K. Bansal, "A Text Book of Strength of Materials", 5th Edition, Laxmi Publications (P) Ltd., New Delhi, 2012.
3. Frank Bell, "Principles of Mechanics and Biomechanics", Stanley Thorne (Publishers) Ltd., 1998.
4. Lee Waite, "Biofluid Mechanics in Cardiovascular Systems", 1st Edition, McGraw-Hill Companies, 2006.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2	3	3											1	
3	3												1	
4	3												1	
5									3	3				
CO (W.A)	3	3							3	3			1	

22BMC04 – BIOMEDICAL INSTRUMENTATION				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

PRE-REQUISITE : 22BMC03

Course Objectives:	• To understand the basic theory of Bio potential Electrodes and Bio potential measurement. • To understand the fundamentals of Bio potential recording. • To design Bio potential amplifiers for acquisition of bio signals. • To study the various non-electrical physiological parameter measurement. • To study the various biochemical measurements.

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply principles and concepts of bio potential generation and propagation and engineering to analyze bio potentials recording techniques for electrical & non-electrical physiological parameter Measurements.	Ap	30%
CO2	Identify and analyze engineering problems to arrive at suitable techniques for the measurement of biomedical parameters, Artifacts and Removal.	An	30%
CO3	Analyze and interpret various physiological parameter with Bio potential recorder results.	An	30%
CO4	Design solutions by recognizing needs of bio amplifiers and filters.	C	10%
CO5	Document and communicate effectively as an individual/ in a team of an implemented work.	Ap	Internal Assessment

UNIT I - BIOPOTENTIAL ELECTRODES	**(9)**
Origin of Bio potential and its Propagation: Nernst equation for Membrane Resting Potential, Generation and Propagation of Action Potential, Conduction through Nerve to Neuromuscular Junction. Bio Electrodes: Electrode-electrolyte Interface, Electrode–skin Interface, Half-cell Potential, Impedance, Polarization effects of Electrode – Non Polarizable Electrodes, Types of Electrodes - Surface, Needle and Micro electrodes and their equivalent circuits. Recording problems - Measurement with two electrodes.	
UNIT II - BIOPOTENTIAL MEASUREMENTS	**(9)**
Bio Signal Characteristics – Frequency and Amplitude ranges. ECG – Einthoven's Triangle, Standard 12 lead system, Block Diagram. Measurements of Heart Sounds - PCG. EEG – 10-20 electrode system, Unipolar, Bipolar and Average Mode, Functional Block Diagram. EMG – Unipolar and Bipolar mode, Block Diagram, EOG and ERG.	
UNIT III - BIOPOTENTIAL AMPLIFIER	**(9)**
Need for Bio-amplifier - Single ended Bio-amplifier, Instrumentation Amplifier, Differential Bio-amplifier, Right leg driven ECG amplifier. Bandpass Filtering, Isolation Amplifiers – Transformer, Optical Isolation, Isolated DC Amplifier and AC Carrier Amplifier, Artifacts and Removal.	

UNIT IV - NON-ELECTRICAL PHYSIOLOGICAL PARAMETER MEASUREMENT	(9)
Temperature, Respiration Rate and Pulse Rate Measurements, Plethysmography, Pulse Oximetry, Blood Pressure: Direct Methods - Pressure Amplifiers - Systolic, Diastolic, Mean Detector Circuit, Indirect Methods - Auscultatory Method, Oscillometric Method, Ultrasonic Method. Blood flow - Electromagnetic and Ultrasound Blood flow Measurement. Cardiac output Measurement- Indicator dilution, Dye dilution and Thermodilution method.	
UNIT V - BIOCHEMICAL MEASUREMENT	**(9)**
Biochemical Sensors - pH, pO2 and pCO2, Ion Selective Field Effect Transistor (ISFET), Immunologically sensitive FET (IMFET), Blood Glucose Sensors - Blood Gas Analyzers, Spectrophotometer, Blood Cell Counter, Auto analyzer.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", 4th Edition, Pearson Education, 2014.
2. John G. Webster, "Medical Instrumentation Application and Design", 4th Edition, John Wiley and Sons, New York, 2009.

REFERENCES:

1. Khandpur R. S, "Handbook of Biomedical Instrumentation", 3rd Edition, Tata McGraw Hill, New Delhi, 2014.
2. L.A Geddes and L. E. Baker, "Principles of Applied Biomedical Instrumentation", 3rd Edition Reprint, John Wiley and Sons, 2008.
3. Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, "Biomedical Instrumentation and Measurements", 2nd Edition, Pearson Education India, 2015.
4. Myer Kutz, "Standard Handbook of Biomedical Engineering & Design", McGraw-Hill Publisher, 2003.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2		3												
3				3										
4			3										3	
5									3	2			3	
CO (W.A)	3	3	3	3					3	2			3	

22BMC05 – BIOSIGNAL PROCESSING				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE : 22ECC06

Course Objectives:	• To learn discrete fourier transforms and fast fourier transform and its properties. • To understand the characteristics and design of filters.

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply the signal and image processing concepts.	Ap	20%
CO2	Design and analyze the various types of filter circuits in signal processing.	An	20%
CO3	Apply various techniques to convert an analog filter to a digital filter and for more efficient processing and analysis.	Ap	40%
CO4	Investigate the performance of different biomedical signals and their applications.	An	20%
CO5	Collaborate in interdisciplinary teams, providing engineering solutions, and embracing lifelong learning.	U	Internal Assessment

UNIT I – DISCRETE AND FAST FOURIER TRANSFORM	**(9)**
Introduction to DFT – Efficient Computation of DFT – Properties of DFT – FFT Algorithms – Decimation in Time (DIT) and Decimation in Frequency (DIF) Algorithms – Linear and Circular Convolution – Overlap Save and Add Methods.	
UNIT II - IIR FILTER DESIGN	**(9)**
Analog Filter Design – Discrete time IIR filter from analog filter (Butterworth Filter, Chebyshev Filter) – IIR Filter Design: Impulse Invariance, Bilinear Transformation Technique – Realization using Direct form – Cascade and Parallel forms.	
UNIT III - FIR FILTER DESIGN	**(9)**
Linear phase FIR filters – Filter design: Windowing Techniques (Rectangular Window, Hamming Window, Hanning Window), Frequency Sampling Techniques – Realization of FIR filters Transversal – Linear phase.	
UNIT IV - INTRODUCTION TO BIOMEDICAL SIGNALS	**(9)**
Biosignal Characteristics of Electro Cardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Phonocardiogram (PCG), Electrogastrogram (EGG), Objectives of Biomedical Signal Analysis, Difficulties in Biomedical signal analysis.	
UNIT V - ANALYSIS OF NONSTATIONARY AND MULTICOMPONENT SIGNALS	**(9)**
Time-variant Systems - Fixed Segmentation - Adaptive Segmentation - Application of Adaptive Segmentation in EEG and PCG Signals - Introduction to Wavelets.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. John G. Proakis & Dimitris G Manolakis, "Digital Signal Processing – Principles, Algorithms & Applications", 4th Edition, Pearson Education / Prentice Hall, 2007.
2. Rangaraj M. Rangayyan, "Biomedical Signal Analysis - A Case Study Approach", Wiley, 2nd Edition, 2016.

REFERENCES:

1. Emmanuel C. Ifeachor, Barrie W. Jervis, "Digital Signal Processing - A Practical Approach", Pearson Education Ltd., 2004.
2. Arnon Cohen, "Bio-Medical Signal Processing Vol I and Vol II", CRC Press Inc., Boca Rato, Florida, 2019.
3. Willis J. Tompkins, "Biomedical Digital Signal Processing", Prentice Hall of India, New Delhi, 2003.
4. D C Reddy, "Biomedical Signal Processing – Principals and Techniques", Tata Mc Graw Hill Publications, 2007.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2			3											
3	3													
4				3										
5									2			2	1	1
CO (W.A)	3		3	3					2			2	1	1

22BMC06 – BIOCONTROL SYSTEM				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE : NIL

Course Objectives:	• To study the mathematical techniques for analysis of given system. • To study the given system in time domain analysis. • To study the stability analysis of the given system. • To study the given system in frequency domain analysis. • To study the concept of physiological control system.

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the knowledge of engineering and mathematics to develop mathematical models for classical control systems.	Ap	30%
CO2	Identify and analyze the time responses of conventional control system.	An	30%
CO3	Analyze the complex problems in physiological control systems time domain, frequency domain and stability analysis.	An	30%
CO4	Design and Investigate the stability of control systems using both time response and frequency response analysis.	C	10%
CO5	Function effectively to communicate as an individual to present the outcome of the implemented work in a team.	Ap	Internal Assessment

UNIT I - CONTROL SYSTEM MODELING	**(9)**
Terminology and Basic Structure of Control System, Example of a Closed Loop System, Transfer Function, Modeling of Electrical Systems, Translational and Rotational Mechanical Systems, Block Diagram and Signal Flow Graph Representation of Systems, Reduction of Block Diagram and Signal Flow Graph, Conversion of Block Diagram to Signal Flow Graph. Need for Modeling Physiological System.	
UNIT II - TIME RESPONSE AND STABILITY ANALYSIS	**(9)**
Step and Impulse Responses of First Order and Second Order Systems - Time Domain Specifications of First and Second Order Systems - Steady State Error Constants. Introduction to PI, PD and PID Controllers.	
UNIT III - STABILITY ANALYSIS	**(9)**
Definition of Stability, Routh - Hurwitz Criteria of Stability, Root Locus Technique - Construction of Root Locus and Study of Stability.	
UNIT IV - FREQUENCY RESPONSE ANALYSIS	**(9)**
Frequency Response, Nyquist Stability Criterion, Nyquist Plot and Determination of Closed Loop Stability, Definition of Gain Margin and Phase Margin, Bode plot, Determination of Gain Margin and Phase Margin using Bode plot, use of Nichol's chart to compute Frequency and Bandwidth.	

UNIT V - PHYSIOLOGICAL CONTROL SYSTEM	(9)
Example of Physiological Control System, Difference between Engineering and Physiological Control Systems, Generalized System Properties, Models with Combination of System Elements, Linear Models of Physiological Systems - Examples, Introduction to Simulation. Illustration with Real Time Applications.	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

1. J. Nagarath and M. Gopal, "Control Systems Engineering", New Age International Publishers, September, 2021.
2. Michael C K Khoo, "Physiological Control Systems", IEEE Press, Prentice Hall India, 2005.

REFERENCES:

1. Salivahanan S. Rengaraj R. and Venkatakrishnan G. R., "Control Systems Engineering", Pearson Education India, 2015.
2. Benjamin C. Kuo, "Automatic Control Systems", Prentice Hall of India, 1995.
3. Ogata, Katsuhiko and Yanjuan Yang, "Modern Control Engineering", Vol 4, Prentice-Hall, 2002.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2		3		3										
3		3												
4			3											
5					3				3			3		2
CO (W.A)	**3**	**3**	**3**	**3**	**3**				**3**			**3**		**2**

22BMC07 – BIOMATERIALS AND ARTIFICIAL ORGANS				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE : 22BMC02				

Course Objectives:	• To study the characteristics and classification of biomaterials • To understand the response of biomaterials in living system • To learn about the polymeric materials and composites in tissue replacements. • To study the soft and hard tissue replacement in biomedical applications. • To know the compatibility and functioning of artificial organs inside the living system.

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply the principles and properties of biomaterials used in medical applications.	Ap	30%
CO2	Apply the knowledge of biomaterials and artificial organs to solve practical problems in the medical field.	Ap	20%
CO3	Analyze the properties and select appropriate biomaterials based on their mechanical, chemical, and biological properties.	An	30%
CO4	Analyze the design and development of artificial organs and the challenges associated with their implementation.	An	20%
CO5	Recognize the ethical, regulatory and safety considerations related to the use of biomaterials and artificial organs.	U	Internal Assessment

UNIT I – BIO-MATERIALS STRUCTURE AND BIO-COMPATIBILITY	**(9)**
Definition and Classification of Bio-materials, Mechanical Properties of Biomaterials, Structure Property Relationship of Biological and Biomaterials Viscoelasticity, Wound Healing Process, Body Response to Implants, Blood Compatibility, Carcinogenicity.	
UNIT II – IMPLANT MATERIALS I	**(9)**
Metallic Implant Materials: Stainless Steels, Co-based Alloys, Ti-Based Alloys, Dental Metals, Deterioration of Metallic Implant Materials. Ceramic Implant Materials: Structure–Property Relationship of Ceramics, Aluminum Oxides, Zirconia, Hydroxyapatite, Glass Ceramics, Carbons. Bio Dissolvers.	
UNIT III – IMPLANT MATERIALS II	**(9)**
Polymerization, Polyamides, Acryrilic Polymers, Rubbers, High Strength Thermoplastics, Deterioration of Polymers, Bio Polymers: Collagen and Elastin. Composites – Structure, Mechanics, Biocompatibility, Applications. Materials for Ophthalmology: Contact Lens, Intraocular Lens.	

UNIT IV – TISSUE REPLACEMENT IMPLANTS	(9)
Soft Tissue Replacements, Sutures, Surgical Tapes, Adhesive, Percutaneous and Skin Implants, Maxillofacial Augmentation, Vascular Grafts, Hard Tissue Replacement Implants, Internal Fracture Fixation Devices, Joint Replacements.	
UNIT V – ARTIFICIAL ORGANS	**(9)**
Blood Substitutes, Artificial Skin, Artificial Heart, Prosthetic Cardiac Valves, Artificial Lung (Oxygenator), Artificial Kidney (Dialyser Membrane), Artificial Pancreas, Dental Implants.	
TOTAL (L) = 45 PERIODS	

TEXT BOOKS:

1. Sujata V. Bhatt, "Biomaterials", 7th Edition, Narosa Publishing House, 2005.
2. Michael Lysaght, Thomas J Webster, "Biomaterials for Artificial Organs", Elsevier Science, 2018.

REFERENCES:

1. Park Joseph D.Bronzino, "Biomaterials-Principles and Applications", CRC Press, 2003.
2. J. Park, "Biomaterials: An Introduction", Springer Science & Business Media, 2012.
3. Myer Kutz, "Standard Handbook of Biomedical Engineering & Design", McGraw-Hill, 2003.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												2	
2			3										3	
3		3											2	
4		3											2	
5									2	2	2	2	2	
CO (W.A)	3	3	3						2	2	2	2	2.2	

22ITP04 - JAVA PROGRAMMING LABORATORY *(Common to 22AIP03, 22CSP06, 22CCP05, 22CIP05 and 22ITP04)*				
	L	**T**	**P**	**C**
	0	**0**	**4**	**2**

PRE-REQUISITE : NIL

Course Objective:	To learn Java Programming concepts and develop applications based on Java.

	Course Outcomes The Student will be able to	**Cognitive Level**
CO1	Apply the concepts of Java to solve problems	Ap
CO2	Analyze the efficiency of using appropriate programming constructs.	An
CO3	Demonstrate the usage of different programming structures through example programs	Ap
CO4	Develop simple applications using swing.	C
CO5	Engage in independent study and learn to use Java for real time applications.	An

LIST OF EXPERIMENTS

1. Write simple Java programs using operators, arrays and control statement
2. Programs using Static, final and this keyword.
3. Demonstrate the concepts of inheritance
4. Programs illustrating overloading and overriding methods in Java
5. Programs to use packages and Interfaces in Java.
6. Implement exception handling and creation of user defined exception.
7. Implement program to demonstrate multithreading and inter thread communication.
8. Write a program to perform file operations
9. Develop Applications using Swing Layouts.

TOTAL (P:60) = 60 PERIODS

HARDWARE OR SOFTWARE REQUIREMENT:

HARDWARE:

1. LAN System with 33 nodes (OR) Standalone PCs – 33 Nos.
2. Printers – 3 Nos.

SOFTWARE:

1. Java / Equivalent Compiler

Mapping of COs with POs / PSOs														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3													2
2		3												2
3	3													2
4			3											2
5						2			2					2
CO (W.A)	**3**	**3**	**3**			**2**			**2**					**2**

22BMP03 - BIOSIGNAL PROCESSING LABORATORY				
	L	**T**	**P**	**C**
	0	**0**	**4**	**2**

PRE-REQUISITE : NIL

Course Objectives:	• To make the students to understand the characteristics and design of filters. • To analyze the ECG and EEG Signal Processing.

	Course Outcomes The Student will be able to	**Cognitive Level**
CO1	Demonstrate the various signal concepts.	Ap
CO2	Apply DFT and FFT for the analysis of biomedical signals.	Ap
CO3	Design and simulate digital IIR filters & FIR filters for biosignals.	An
CO4	Examine the performance of ECG and EEG data acquisition and processing.	An
CO5	Collaborate in interdisciplinary teams and embracing lifelong learning.	Ap

LIST OF EXPERIMENTS :

1. (a)Representation of Basic Signals (Sine, Cosine, Unit impulse, Unit Step, Square, Exponential, Sawtooth)
   (b) Introduction of various Biomedical Signals (ECG, EEG, EMG).
2. DFT and FFT computation of Biosignals.
3. Digital IIR Butterworth filter-LPF & HPF.
4. Digital IIR Chebyshev filter-LPF & HPF.
5. FIR Filter Design Using Windowing Technique.
6. Up sampling and down sampling.
7. Design of IIR filter for ECG signal.
8. Event Detection: QRS in ECG.
9. Event Detection: Alpha activity in EEG.
10. Separation of Mixtures of Signals using PCA and ICA.

TOTAL (P:60) = 60 PERIODS

Mapping of COs with POs / PSOs														
COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2	3													
3			3											
4				3										
5									2			2	1	1
CO (W.A)	3		3	3					2			2	1	1

22BMP04 – BIOMEDICAL INSTRUMENTATION LABORATORY				
	L	T	P	C
	0	0	4	2
PRE-REQUISITE : NIL				

Course Objectives:	• To design preamplifiers and amplifiers for various bio signal recordings • To learn measurement of physiological parameters. • To understand the measurement of biochemical parameters. • To impart knowledge on designing of bio signal acquisition system. • To measure various non-electrical parameters using suitable sensors/transducers.

Course Outcomes The Student will be able to		**Cognitive Level**
CO1	Measure and analyze blood pressure accurately using a sphygmomanometer and other physiological parameters with suitable transducers.	An
CO2	Design and analyze the circuits to detect QRS complexes and measure heart rate, pulse rate, pH, conductivity, and SPO2 using appropriate transducers and measurement techniques.	An
CO3	Evaluate the performance of optical isolation amplifiers and design multiplexing and demultiplexing circuits for processing multiple bio signals.	E
CO4	Develop preamplifiers and amplifiers with impedance matching and filtering capabilities to acquire and process ECG, EMG, and EEG signals, removing artifacts like power line interference.	C
CO5	Integrate and test comprehensive bio measurement systems, ensuring accurate and reliable detection, amplification, and measurement of bio signals and physiological parameters.	An

LIST OF EXPERIMENTS

1. Design a suitable circuit to detect QRS complex and measure heart rate.
2. Design of pre amplifiers to acquire bio signals along with impedance matching circuit using suitable ICs.
3. Design of ECG amplifiers with appropriate filter to remove power line and other artifacts.
4. Design of EMG amplifier.
5. Design of frontal EEG amplifier.
6. Design and study the characteristics of optical isolation amplifier.
7. Measurement of blood pressure using sphygmomanometer.
8. Design a Multiplexer and Demultiplexer for any two bio signals.
9. Measurement of pulse rate using photo transducer.
10. Measurement of pH and Conductivity.
11. Measurement of SPO_2

TOTAL (P: 60) = 60 PERIODS

Mapping of COs with POs / PSOs														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3					3								
2		3		3										
3			3			3							3	
4				3				3						
5						3		3						
CO (W.A)	**3**	**3**	**3**	**3**		**3**		**3**					**3**	

22MAN07R - SOFT / ANALYTICAL SKILLS – III (Common to All Branches)				
	L	**T**	**P**	**C**
	1	**0**	**2**	**0**
PRE-REQUISITE : NIL				

Course Objectives:	• To improve language proficiency for personal or professional reasons • To enhance students' mathematical problem-solving and critical thinking skills

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of Continuous Assessment test**
CO1	Demonstrate effective communication skills by listening actively, speaking clearly, reading critically, and writing coherently in contexts.	U	40%
CO2	Develop proficiency in applying mathematical concepts of time, speed, distance, and financial calculations involving simple and compound interest.	Ap	30%
CO3	Analyse logical reasoning skills through various forms of statements.	An	30%

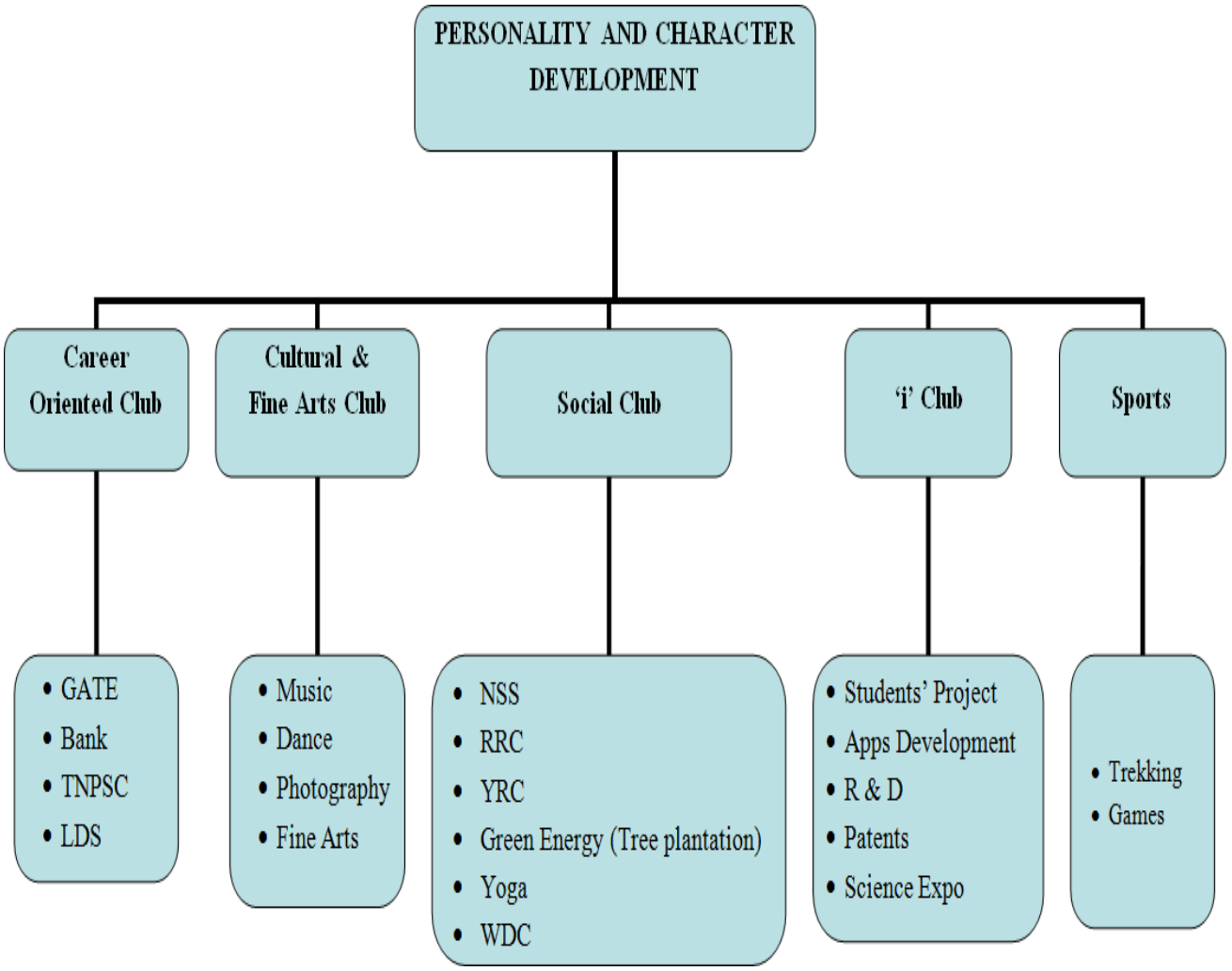
UNIT I - VERBAL	**(5+10)**
Grammar - Concord - Relative Clause - Listening - IELTS Listening (Advanced) and Gap Filling - Speaking - Introducing Others - Formal Conversations - Reading - Reading Comprehension - Writing - Hints Development.	
UNIT II - APTITUDE	**(5+10)**
Simple and Compound Interest - Time, Speed and Distance - Problems on Trains - Boats and Streams - Chain Rule - Time and Work - Pipe and Cisterns.	
UNIT III - LOGICAL AND REASONING	**(5+10)**
Seating Arrangements - Syllogism - Statement and Conclusion - Statement and Assumption - Statement and Course of Action.	
TOTAL (L:45) = 45 PERIODS	

REFERENCES:

1. Rizvi, M.Ashraf. Effective Technical Communication. Tata McGraw-Hill Education, 2017.
2. Aggarwal R S. Quantitative Aptitude for Competitive Examinations. S.Chand Publishing Company Ltd(s)., 2022.
3. Sharma, Arun. How to Prepare for Quantitative Aptitude for the CAT. Tata McGraw – Hill Publishing, 2022.
4. Praveen R V. Quantitative Aptitude and Reasoning. PHI Learning Pvt. Ltd., 2016.

Mapping of COs with POs / PSOs														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1									2	3				
2		2		2										
3		2		2										
CO (W.A)		**2**		**2**					**2**	**3**				

22GED01 – PERSONALITY AND CHARACTER DEVELOPMENT				
	L	T	P	C
	0	0	I	0
PRE-REQUISITE : NIL				



*LDS - Leadership Development Skills

OBJECTIVES :				
Career Oriented Club	**Cultural & Fine Arts Club**	**Social Club**	**'i' club**	**Sports**
• To provide support for identifying specific career field of interests and career path • To provide support for preparing for competitive exams	• To bring out the hidden talent of students in music, dance and other fine arts. • To promote photography skill among the students • To develop and enhance the performance of students by participating in various events. • To inculcate managerial capabilities such as event management and stage organization.	•To create social awareness and develop a sense of social and civic responsibility •To inculcate socially and environmentally sound practices and be aware of the benefits •To encourage the students to work along with the people in rural areas, thereby developing their character, social consciousness, commitment, discipline and being helpful towards the community.	•To inculcate the basic concepts of innovation •To foster the networking between students, build teams, exchange ideas, do projects and discuss entrepreneurial opportunities. •To enrich the academic experience, build competencies and relationships beyond the classroom	•To provide opportunities to excel at sports •To promote an understanding of physical and mental well-being through an appreciation of stress, rest and relaxation. •To develop an ability to observe, analyze and judge the performance of self and peers in sporting activities. •To develop leadership skills and nurture the team building qualities. **<u>Trekking:</u>** •To provide opportunities to explore nature and educating about the purityof nature •To improve physical and mental health.

OUTCOMES : At the end of this course, the students will be able to				
• Find a better career of their interest. • Make use of their knowledge during competitive exams and interviews.	• Take part in various events. • Develop team spirit, leadership and managerial qualities.	• Develop socially responsive qualities by applying acquired knowledge. • Build character, social consciousness, commitment and discipline.	• Apply the acquired knowledge in creating better solutions that meet new requirements and market needs. • Develop skills on transforming new knowledge or new technology into viable products and services on commercial markets as a team.	• Demonstrate positive leadership skills that contribute to the organizational effectiveness • Take part an active role in their personal wellness (emotional, physical, and spiritual) that supports a healthy lifestyle • Create inclination towards outdoor activity like nature study and Adventure.

TOTAL [2 x (P: 15)]: 30 PERIODS

(Cumulatively for Two Semesters)

22BMC08 - MICROPROCESSORS AND MICROCONTROLLERS INTERFACING				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: 22BMC01				
Course Objectives:	• To make the students to Understand and demonstrate the principles, architectures, and functionalities of microprocessors, microcontrollers, and their associated peripherals. • To make the students to Develop and implement assembly and higher-level language programs to solve real-world problems, with an emphasis on debugging including those involving biosensors.			

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply the knowledge of Microprocessor and Microcontrollers architectures and their instruction sets to develop assembly programs.	Ap	40%
CO2	Analyze the functioning of Microprocessor and Microcontroller systems, including interrupt handling and peripheral interfacing.	An	40%
CO3	Analyze the performance and efficiency of different Microcontroller.	An	15%
CO4	Develop skills to program Microcontrollers and debug using MPLAB X IDE.	An	5%
CO5	Apply knowledge to design and develop projects using biosensors.	C	Internal Assessment

UNIT I – 8085 MICROPROCESSOR	**(9)**
Introduction – Pin Configuration – Architecture of 8085 – Interrupts - Addressing Modes – Instruction Set, Timing diagram of 8085.	
UNIT II – 8051 MICROCONTROLLER	**(9)**
Architecture of 8051 – Signals – Memory Organization - Interrupts – Counters and Timers - Serial communication.	
UNIT III – 8051 PROGRAMMING	**(9)**
8051 Addressing mode – Instruction Set – Timer Programming – Serial Port programming – Interrupt Programming.	
UNIT IV – PIC MICROCONTROLLER	**(9)**
PIC 16F877 Microcontroller Architecture - Memory organization - Interrupts - Timer/Counter - Compare/Capture/PWM modules (CCP) - Master Synchronous Serial Port module (MSSP) - MPLAB X IDE.	

UNIT V – PIC EXTERNAL INTERFACING	(9)
LCD & Keyboard Interfacing - ADC, DAC & LM35 Temperature Sensor Interfacing - External Memory Interface - Servo Motor Interfacing. Interfacing Protocols - SPI, I2C, Biosensors interfacing.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. Senthilkumar, Saravanan, Jeevanantham, Shan "Microprocessor & Interfacing", Oxford University Press, 2012.
2. John B Peatman, "Design with PIC Microcontrollers", 23rd Impression, Pearson Education Asia, 2013.

REFERENCES:

1. Ramesh S. Gaonkar, 'Microprocessor Architecture Programming and Application', 6th Edition, Penram International (P) Ltd., Mumbai, 2013.
2. Mohamed Ali Mazidi, Janice Gillispie Mazidi, Rolin McKinlay, "The 8051 Microcontroller and Embedded Systems: Using Assembly and C", 2nd Edition, Pearson Education, 2011.

WEB LINK:

1. https://onlinecourses.nptel.ac.in/noc20_ee42/preview

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2		3												
3				3										
4					3									3
5									3		2		3	
CO (W.A)	3	3		3	3				3		2		3	3

22BMC09 – RADIOLOGY EQUIPMENT				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE: NIL

Course Objectives:	• To understand the generation of X-ray and its uses in Medical imaging • To describe the principle of Computed Tomography. • To know the techniques used for visualizing various sections of the body. • To learn the principles of different radio diagnostic equipment in Imaging. • To discuss the radiation therapy techniques and radiation safety.

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply the knowledge of the fundamental principles of various imaging techniques for efficient healthcare.	Ap	30%
CO2	Analyze the need for different medical imaging modalities.	An	30%
CO3	Correlate the most suitable diagnostic technique for a given clinical case.	An	20%
CO4	Assess the biological effects of medical imaging modalities related to human safety.	E	20%
CO5	Examine the published reports and observations from hospital visits for the chosen imaging modality, and record and share the information with the engineering community.	An	Internal Assessment

UNIT I – X RAYS	**(9)**
Nature of X-Rays- X-Ray Absorption – Tissue Contrast. X- Ray Equipment (Block Diagram) – X-Ray Tube, The Collimator, Bucky Grid, Power Supply, Digital Radiography - Discrete Digital Detectors, Storage Phosphor And Film Scanning, X-Ray Image Intensifier Tubes – Fluoroscopy – Digital Fluoroscopy. Angiography, Cine Angiography. Digital Subtraction Angiography. Mammography. X-Ray types.	
UNIT II - COMPUTED TOMOGRAPHY	**(9)**
Principles of Tomography, CT Generations, X- Ray Sources- Collimation- X- Ray Detectors – Viewing Systems – Spiral CT Scanning – Ultra Fast CT Scanners – CT Scan slices. Image Reconstruction Techniques – Back Projection And Iterative Method.	
UNIT III – MAGNETIC RESONANCE IMAGING	**(9)**
Fundamentals of Magnetic Resonance- Properties of Electromagnetic Waves : Speed , Amplitude, Phase, Orientation And Waves In Matter - Interaction of Nuclei With Static Magnetic Field And Radio Frequency Wave- Rotation And Precession – Induction of Magnetic Resonance Signals – Bulk Magnetization – Relaxation Processes T1 And T2. Block Diagram Approach of MRI System – System Magnet (Permanent, Electromagnet And Superconductors), Generations of Gradient Magnetic Fields, Radio Frequency Coils (Sending And Receiving), Shim Coils, Electronic Components, fMRI.	

UNIT IV – NUCLEAR IMAGING	(9)
Radioisotopes- Alpha, Beta, And Gamma Radiations. Radio Pharmaceuticals. Radiation Detectors – Gas Filled, Ionization Chambers, Proportional Counter, GM Counter And Scintillation Detectors, Gamma Camera – Principle of Operation, Collimator, Photomultiplier Tube, X-Y Positioning Circuit, Pulse Height Analyzer. Principles of SPECT and PET	
UNIT V – RADIATION THERAPY AND RADIATION SAFETY	**(9)**
Radiation Therapy – Linear Accelerator, Telegamma Machine. SRS – SRT – Recent Techniques In Radiation Therapy – 3D CRT – IMRT – IGRT and Cyber Knife – Radiation Measuring Instruments Dosimeter, Film Badges, Thermo Luminescent Dosimeters – Electronic Dosimeter – Radiation Protection In Medicine – Radiation Protection Principles	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

1. Isaac Bankman, I. N. Bankman, "Handbook of Medical Imaging: Processing and Analysis (Biomedical Engineering)", Academic Press, 2008.
2. Fitzpatrick J, Michael and Sonka, Milan, "Handbook of Medical Imaging, Volume 2. Medical Image Processing and Analysis", SPIE Press 2009.
3. Khin Wee Lai and Dyah Ekashanti Octorina Dewi, "Medical Imaging Technology: Reviews and Computational Applications", Springer Singapore, 2016.

REFERENCES:

1. Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw – Hill, New Delhi, 2014.
2. Dougherty, Geoff (Editor), "Medical Image Processing - Techniques and Applications", Springer-Verlag New York, 2011.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												2	
2		2	3										2	
3				3									2	
4			3					2						
5									3	3				
CO (W.A)	3	2	3	3				2	3	3			2	

22BMC10 - DIAGNOSTIC AND THERAPEUTIC EQUIPMENT				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: 22BMC04				
Course Objectives:	• To understand the devices for measurement of parameters related to cardiology. • To illustrate the recording and measurement of EEG. • To demonstrate EMG recording unit and its uses. • To explain diagnostic and therapeutic devices related to respiratory parameters. • To understand the various sensory measurements that hold clinical importance.			

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply the principles and operational characteristics of various diagnostic equipment used in medical diagnostics.	Ap	40%
CO2	Analyze and interpret data obtained from biomedical equipment to diagnose and monitor medical conditions.	An	40%
CO3	Investigate complex problems related to biomedical equipment and propose effective solutions based on experimental data.	An	15%
CO4	Assess solutions for maintaining and troubleshooting biomedical equipment.	E	5%
CO5	Acquire hands-on experience with various biomedical instruments across different medical specialties and embracing lifelong learning.	E	Internal Assessment

UNIT I – CARDIAC EQUIPMENT	**(9)**
Electrocardiograph, Normal and Abnormal Waves, Heart Rate Monitor, Holter Monitor, Phonocardiography, ECG Machine Maintenance and Troubleshooting, Cardiac Pacemaker - Internal and External Pacemaker– Batteries, AC and DC Defibrillator- Internal and External, Defibrillator Protection Circuit, Cardiac Ablation Catheter.	
UNIT II – NEUROLOGICAL EQUIPMENT	**(9)**
Clinical Significance of EEG, Multi-Channel EEG Recording System, Epilepsy, Evoked Potential– Visual, Auditory And Somatosensory, MEG (Magneto Encephalo Graph). EEG Bio Feedback Instrumentation. EEG System Maintenance And Troubleshooting.	
UNIT III – MUSCULAR AND BIOMECHANICAL EQUIPMENT	**(9)**
Recording and Analysis of EMG Waveforms, Fatigue Characteristics, Muscle Stimulators, Nerve Stimulators, Nerve Conduction Velocity Measurement, EMG Bio Feedback Instrumentation. Static Measurement – Load Cell, Pedobarograph. Dynamic Measurement – Velocity, Acceleration, GAIT, Limb	

Position.

UNIT IV – RESPIRATORY MEASUREMENT AND ASSIST SYSTEM	(9)

Instrumentation for Measuring The Mechanics of Breathing – Spirometer - Lung Volume and Vital Capacity, Measurements Of Residual Volume, Pneumotachometer – Airway Resistance Measurement, Whole Body Plethysmograph, Intra-Alveolar and Thoracic Pressure Measurements, Apnoea Monitor. Types Of Ventilators – Pressure, Volume, and Time Controlled. Flow, Patient Cycle Ventilators, Humidifiers, Nebulizers, Inhalators.

UNIT V – SENSORY DIAGNOSTIC EQUIPMENT	(9)

Psychophysiological Measurements – Polygraph, Basal Skin Resistance (BSR), Galvanic Skin Resistance (GSR), Sensory Responses – Audiometer – Pure Tone, Speech, Eye Tonometer, Applanation Tonometer, Slit Lamp, Auto Refractometer.

TOTAL (L:45) = 45 PERIODS

TEXT BOOKS:

1. John G. Webster, "Medical Instrumentation: Application and Design", 5th Edition, Wiley India PvtLtd,New Delhi, 2021.
2. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", 4th Edition, Pearson Education, 2000.

REFERENCES:

1. L. A Geddes and L. E. Baker, "Principles of Applied Biomedical Instrumentation", 3rd Edition, 2008.
2. Khandpur. R.S., "Handbook of Biomedical Instrumentation". Second Edition. Tata McGrawHill Pub. Co.,Ltd. 2003.
3. Antony Y. K. Chan, "Biomedical Device Technology, Principles and Design", 3rd Edition, Charles Thomas Publisher Ltd., Illinois, USA, 2023.
4. Leslie Cromwell, "Biomedical Instrumentation and Measurement", 2nd Edition, Pearson Education, New Delhi, 2015.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												2	
2				2									2	
3		2		2									2	
4			2										2	
5						2						3		
CO (W.A)	3	2	2	2		2						3	2	

22BMP05 - MICROPROCESSORS AND MICROCONTROLLERS INTERFACING LABORATORY				
	L	**T**	**P**	**C**
	0	**0**	**4**	**3**

PRE-REQUISITE: NIL

Course Objectives:	• To make the students to understand and apply the principles and techniques of coding, interfacing, and system design using various microcontrollers and development platforms to solve real-world problems. • To make the students to develop and enhance problem-solving, debugging, and collaboration skills to create efficient and effective solutions independently and as part of a team.

Course Outcomes The Student will be able to		**Cognitive Level**
CO1	Examine the different interface modules using 8051 Microcontroller.	An
CO2	Develop and make a code to perform arithmetic and logical operations using 8085 and 8051/PIC.	C
CO3	Design and develop solutions for real time problems using Arduino/Raspberry pi.	C
CO4	Implement high-level language programs for peripheral interfacing and data processing using modern tools.	C
CO5	Develop an ability to work independently and collaboratively to provide valid solutions to real time problems.	An

LIST OF EXPERIMENTS

Assembly Language Programming:

1. Assembly language programming for 8/16 bit Arithmetic operators Using 8085.

2. Assembly language programming with control instructions Using 8085 (Increment / Decrement, Ascending / Descending order, Maximum / Minimum of numbers).

3. Assembly language programming for arithmetic and logical operations using 8051.

4. Interfacing and Programming of DC Motor Speed control using 8051.

5. Interfacing and Programming of Stepper Motor control using 8051.

High Level Language Programming:

The following programs have to be tested on 8051/PIC Development board or equivalent Embedded C Language on KEIL IDE or Equivalent.

6. Program to toggle all the bits of Port P1 continuously with delay.

7. Program to toggle P1.5 continuously with delay. Use Timer in mode 0, mode 1, mode 2 and mode 3 to create delay.

8. Program to interface 7 segment display to display a message on it .

9. Program to interface keypad. Whenever a key is pressed, it should be displayed on LCD.

10. Program to get analog input from Temperature sensor and display the temperature Value on LCD using ADC.
Sensor Interfacing:
11. To interface LED/Buzzer with platform/ Arduino /Raspberry Pi.
12. To interface Biosensors with platform/ Arduino /Raspberry Pi.
TOTAL (60 P) = 60 Periods

Mapping of COs with POs / PSOs														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1		3												
2	3													
3			3										3	
4					3									3
5									3					
CO (W.A)	**3**	**3**	**3**		**3**				**3**				**3**	**3**

22BMP06 - DIAGNOSTIC AND THERAPEUTIC EQUIPMENT LABORATORY				
	L	T	P	C
	0	0	4	3
PRE-REQUISITE : 22BMP04				

Course Objectives:	• To demonstrate recording and analysis of different bioelectrical signals. • To record and analysis of different Bio potentials. • To examine different diagnostic and therapeutic modalities. • To gain knowledge of various electrical hazards. • To interpret different bio signals using suitable tools.

Course Outcomes The Student will be able to		**Cognitive Level**
CO1	Analyze and interpret data from various biomedical signals for clinical applications.	An
CO2	Conduct and analyze experiments measuring physiological signals and responses.	An
CO3	Evaluate the performance and safety of biomedical equipment and models.	E
CO4	Develop proficiency in using diagnostic and therapeutic medical instruments.	C
CO5	Document the observation of diagnostic and therapeutic equipment through practical lab work and real-world clinical visits.	An

LIST OF EXPERIMENTS

1. Measurement of visually evoked potential.
2. Galvanic skin resistance (GSR) measurement.
3. Shortwave and Ultrasound Diathermy.
4. Measurement of various physiological signals using biotelemetry.
5. Performance analysis of Hemodialysis model.
6. Electrical safety measurements.
7. Measurement of Respiratory parameters using Spirometry.
8. Analysis of Waveform Variations and Intensity Settings in Medical Stimulation Therapy.
9. Analyze the working of ESU – cutting and coagulation modes.
10. Recording of Audiogram.
11. Functionality of Defibrillator and Pacemakers.
12. Analysis of ECG, EEG and EMG signals.
13. Analyze the performance of ventilators.
14. Ultrasound Scanners.
15. Functionality analysis of a Heart-Lung Machine.

TOTAL (60 P) = 60 Periods

WEB LINKS:
1. http://bmsp-coep.vlabs.ac.in/List%20of%20experiments.html?domain=Biotechnology

Mapping of COs with POs / PSOs														
COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1				2										2
2	3													
3			3											2
4		3			3								2	
5									3	3	3		2	
CO (W.A)	3	3	3	2	3				3	3	3		2	2

22MAN08R - SOFT/ANALYTICAL SKILLS – IV (Common to All Branches)				
	L	T	P	C
	1	0	2	0

PREREQUISITE : NIL

Course Objective:	• To enhance the ability to communicate coherently and effectively across contexts • To develop quantitative aptitude and analytical reasoning skills

	Course Outcomes The Student will be able to	**Cognitive Level**	**Weightage of COs in Continuous Assessment Test**
CO1	Develop proficiency to communicate accurately, fluently, and appropriately in various academic, professional and social contexts.	U	40%
CO2	Solve quantitative aptitude problems with more confidence.	Ap	30%
CO3	Draw valid conclusions, identify patterns, and solve problems.	An	30%

UNIT I – VERBAL ABILITY	**(15)**
Grammar - Sentence Completion – Sentence Improvement - Error Spotting - **Listening** - TOEFL Listening Practice Tests - **Speaking** – Interview Skills - **Reading** - GRE Reading Passages - **Writing** - Paragraph Writing.	
UNIT II – APTITUDE	**(15)**
Probability - Permutations and Combinations - Data Interpretation on Multiple Charts - Mensuration - Area, Shapes, Perimeter - Races and Games.	
UNIT III - REASONING	**(15)**
Data Sufficiency - Mathematical Operations - Pattern Completion - Cubes - Embedded Images.	
TOTAL(L:45) = 45 PERIODS	

REFERENCES:

1. Rizvi, M.Ashraf. *Effective Technical Communication.* Tata McGraw-Hill Education, 2017.
2. Aggarwal R S. *Quantitative* Aptitude for Competitive Examinations. S.Chand Publishing Company Ltd(s)., 2022.
3. Sharma, Arun. *How to Prepare for Quantitative Aptitude for the CAT*. Tata McGraw – Hill Publishing, 2022.
4. Praveen R V. *Quantitative Aptitude and Reasoning.* PHI Learning Pvt. Ltd., 2016.

Mapping of COs with POs / PSOs														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1									2	3				
2		2		2										
3		2		2										
CO (W.A)		**2**		**2**					**2**	**3**				

22BMC11 – FUNDAMENTALS OF HEALTHCARE ANALYTICS				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: NIL				

Course Objectives:	• To understand the statistical methods for the design of biomedical research. • To comprehend the fundamental of mathematical and statistical theory in the application of Healthcare. • To apply the regression and correlation analyze in the healthcare data. • To understand the Meta analysis and variance analysis. • To interpret the results of the investigational methods.

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply fundamental statistical concepts and their application in biomedical data analysis.	Ap	30%
CO2	Analyze biomedical data and interpret findings using statistical software tools.	An	30%
CO3	Interpret statistical results to support or reject biomedical hypotheses.	An	20%
CO4	Employ regression and correlation analysis techniques to model relationships and patterns in biomedical datasets.	An	20%
CO5	Connect through expert talks on societal implications and ethical considerations of biomedical research and data analysis.	C	Internal Assessment

UNIT I – INTRODUCTION	**(9)**
Introduction, Computers and Bio Statistical Analysis, Introduction to Probability, Likelihood & Odds, Distribution Variability. Finding the Statistical Distribution using Appropriate Software Tool like R/ Python.	
UNIT II - STATISTICAL PARAMETERS	**(9)**
Statistical Parameters P-Values, Computation, Level Chi Square Test, Distribution and Hypothesis Testing -Single Population Proportion, Difference Between two Population Proportions, Single Population Variance, Tests of Homogeneity. Testing of Statistical Parameters using appropriate Software R / Python.	
UNIT III – REGRESSION AND CORRELATION ANALYSIS	**(9)**
Regression Model, Evaluating the Regression Equation, Correlation Model, Correlation Coefficient. Finding Regression, Correlation for the data using appropriate software like R / Python.	
UNIT IV – ANALYSIS OF VARIANCE	**(9)**
META analysis for research activities, purpose and reading of META analysis, kind of data used for META analysis, completely randomized design, randomized complete block design, repeated measures design,	

factorial experiment. Testing the variance using appropriate software tool like R / Python.	
UNIT V – CASE STUDIES	**(9)**
Epidemical reading and interpreting of epidemical studies, application in community health, Case study on Medical Imaging like MRI, CT. Case study on respiratory data, Case study on ECG data.	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

1. Wayne W. Daniel, "Biostatistics-A Foundation for Analysis in the Health Sciences", John Wiley & Sons Publication, 10th Edition, 2013.
2. Peter Armotage, Geoffrey Berry and J. N. S.Mathews, "Statistical methods in Medical Research", Wiley-Blackwell, 4th Edition, 2001.
3. Bernard Rosner, "Fundamentals of biostatistics", Nelson Education, 8th Edition 2015 ISBN: 978- 1-305-26892-0.

REFERENCES:

1. Marcello Pagano and Kimberlee Gauvreu, Principles of Biostatistics, Chapman and Hall/CRC, 2nd Edition, 2018.
2. Ronald N Forthofer and EunSul Lee, Introduction to Biostatistics, Academic Press, 1st Edition, 2014.
3. Animesh K. Dutta, Basic Biostatistics and its Applications, New Central Book Agency, 1st Edition, 2006.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													2
2		3												2
3				2										2
4					2									2
5						3		3				3		
CO (W.A)	3	3		2	2	3		3				3		2

22BMC12 – MEDICAL IMAGE PROCESSING				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE: NIL

Course Objectives:	• To learn the fundamental concepts of medical Image Processing techniques. • To understand the concepts of various image intensity transformation and filtering operations. • To be familiar in the techniques of segmentation and restoration of medical images. • To gain knowledge in medical image registration and visualization. • To be familiar with the application of medical image analysis.

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply the basic concepts of digital image representation and the objectives of biomedical image analysis.	Ap	30%
CO2	Apply digital image processing algorithms for medical image enhancement, restoration and segmentation	Ap	30%
CO3	Apply various medical image compression standards and analyze CAD techniques.	Ap	20%
CO4	Analyze various registration and visualization techniques for medical images.	An	20%
CO5	Engage in self-study as an individual and a team-member to design and implement an open-ended experiment for medical image segmentation.	C	Internal Assessment

UNIT I – FUNDAMENTALS OF MEDICAL IMAGE PROCESSING AND TRANSFORMS	**(9)**

Overview of Image Processing system and human Visual system - Image representation – Pixel and Voxels, Gray scale and color models -Medical image file formats- DICOM- Discrete sampling model and Quantization- Relationship between the pixels, Arithmetic and logical operations- Image quality and Signal to Noise ratio- Image Transforms- 2D DFT, DCT, KLT.

UNIT II - ENHANCEMENT TECHNIQUES	**(9)**

Gray level transformation - Log transformation, Power law transformation, Piecewise linear transformation. Histogram processing - Histogram equalization, Histogram Matching. Spatial domain Filtering-Smoothing filters, sharpening filters. Frequency domain filtering- Smoothing filters, Sharpening filters- Homomorphic filtering -Medical image enhancement using Hybrid filters- Performance measures for enhancement techniques.

UNIT III – SEGMENTATION AND RESTORATION TECHNIQUES	**(9)**

ROI definition -Detection of discontinuities–Edge linking and boundary detection – Region based segmentation- Morphological processing, Active contour models. Image Restoration- Noise models–

Restoration in the presence of Noise – spatial filtering, Periodic noise reduction by frequency domain filtering- linear position- Invariant degradation- Estimation of degradation function, Inverse filter, Weiner filtering.	
UNIT IV – REGISTRATION AND VISUALISATION	**(9)**
Registration–Rigid body transformation, principal axes registration, and feature based. Visualisation- Orthogonal and perspective projection in medicine, Surface based rendering, Volume visualization in medical image. Explain the significance of registration of various imaging modalities	
UNIT V – APPLICATIONS OF MEDICAL IMAGE ANALYSIS	**(9)**
Medical Image compression- DCT and Wavelet transform based image compression, Computer-aided diagnosis in mammography, Tumor imaging and treatment, Angiography, Bone strength and osteoporosis, Tortuosity, Applications: Contrast enhancement of mammograms - Detection of calcification by region growing,Feature Extraction - Shape and texture analysis of tumors.	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

1. John G. Webster, "Medical Instrumentation Application and Design", 4th Edition, Wiley India Pvt. Ltd., New Delhi, 2015.
2. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", Pearson Education, 2012.

REFERENCES:

1. L. A Geddes and L. E. Baker, "Principles of Applied Biomedical Instrumentation", 3rd Edition, 2008.
2. Khandpur. R. S.,"Handbook of Biomedical Instrumentation". Second Edition. Tata Mc Graw Hill Pub. Co., Ltd. 2003.
3. Antony Y. K. Chan, "Biomedical Device Technology, Principles and design", Charles Thomas Publisher Ltd, Illinois, USA, 2008.
4. Leslie Cromwell, "Biomedical Instrumentation and Measurement", Pearson Education, New Delhi, 2007.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												2	
2		3	3										2	
3		3		3										2
4				3										2
5					3				3	2		2	2	
CO (W.A)	3	3	3	3	3				3	2		2	2	2

22BMP07 - MEDICAL IMAGE PROCESSING LABORATORY				
	L	**T**	**P**	**C**
	0	**0**	**4**	**3**

PRE-REQUISITE : NIL

Course Objectives:	• To learn the basics and fundamentals of image processing. • To analyze various applications of different transforms. • To demonstrate the different enhancement techniques. • To describe the applications of image segmentation process. • To illustrate the advancements and formatting in image processing.

The Student will be able to **Course Outcomes**		**Cognitive Level**
CO1	Apply different image enhancement algorithms in spatial and frequency domain filtering on the images.	Ap
CO2	Analyze the impact of image manipulation techniques.	An
CO3	Interpret images with various segmentation techniques.	An
CO4	Analyze various restoration techniques in the presence of noise and degradation.	An
CO5	Examine the various morphological operations on images.	An

LIST OF EXPERIMENTS

1. Basic operations on images.
2. Analysis of spatial and intensity resolution of images.
3. Analysis of images with different color models.
4. DFT analysis of images.
5. Histogram Processing.
6. Image Enhancement using Spatial and frequency domain filters.
7. Image segmentation using edge and region-based methods.
8. Translational and rotational operation of images.
9. Morphological operations on images.
10. Thresholding functions on images.
11. Image restoration in the presence of noise and degradation.
12. Extraction of shape and texture features from an image.

TOTAL (60 P) = 60 Periods

Mapping of COs with POs / PSOs														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3												2
2	3				3									2
3		3												2
4				3										2
5		3		3										2
CO (W.A)	**3**	**3**		**3**	**3**									**2**

22GEA01 UNIVERSAL HUMAN VALUES (For Common To All Branches)					
		L	T	P	C
		2	0	0	2
PRE-REQUISITE : NIL					
Course Objectives:	• To help the students appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity. • To facilitate the development of a holistic perspective among students towards life and profession. • To highlight plausible implications of holistic understanding in terms of ethical human conduct. • To understand the nature and existence. • To understand human contact and holistic way of living.				

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Evaluate the significance of value inputs in formal education and start applying them in their life and profession.	E	Internal Assessment
CO2	Distinguish between values and skills, happiness and accumulation of physical facilities, the Self and the Body, Intention and Competence of an individual.	Ap	
CO3	Analyze the value of harmonious relationship based on trust and respect in their life and profession.	An	
CO4	Examine the role of a human being in ensuring harmony in society and nature.	Ap	
CO5	Apply the understanding of ethical conduct to formulate the strategy for ethicallife and profession.	Ap	

UNIT I: Introduction-Basic Human Aspiration, its fulfillment through All-encompassing Resolution	**(6)**
The basic human aspirations and their fulfillment through Right understanding and Resolution, Right understanding and Resolution as the activities of the Self, Self being central to Human Existence; All-encompassing Resolution for a Human Being, its details and solution of problems in the light of Resolution	
UNIT II: Right Understanding (Knowing)- Knower, Known & the Process	**(6)**
The domain of right understanding starting from understanding the human being (the knower, the experiencer and the doer) and extending up to understanding nature/existence – its interconnectedness and co-existence; and finally understanding the role of human being in existence (human conduct).	
UNIT III: Understanding Human Being	**(6)**
Understanding the human being comprehensively as the first step and the core theme of this course; human being as co-existence of the self and the body; the activities and potentialities of the self; Basis for harmony/contradiction in the self	
UNIT IV: Understanding Nature and Existence	**(6)**

A comprehensive understanding (knowledge) about the existence, Nature being included; the need and process of inner evolution (through self-exploration, self- awareness and self-evaluation), particularly awakening to activities of the Self: Realization, Understanding and Contemplation in the Self (Realization of Co-Existence, Understanding of Harmony in Nature and Contemplation of Participation of Human in this harmony/ order leading to comprehensive knowledge about the existence).	
UNIT V: Understanding Human Conduct, All-encompassing Resolution and Holistic Way of Living	**(6)**
Understanding Human Conduct, different aspects of All-encompassing Resolution (understanding, wisdom, science etc.), Holistic way of living for Human Being with All- encompassing Resolution covering all four dimensions of human endeavor viz., realization, thought, behavior and work (participation in the larger order) leading to harmony at all levels from Self to Nature and entire Existence	
TOTAL (L:30) : 30 PERIODS	

TEXT BOOK:

1. R R Gaur, R Asthana, G P Bagaria, 2019 (2nd Revised Edition), A Foundation Course in Human Values and Professional Ethics. ISBN 978-93-87034-47-1, Excel Books, New Delhi.

REFERENCES:

1. Ivan Illich, 1974, Energy & Equity, The Trinity Press, Worcester, and Harper Collins,USA
2. E.F. Schumacher, 1973, Small is Beautiful: a study of economics as if people mattered, Blond & Briggs, Britain.
3. Sussan George, 1976, How the Other Half Dies, Penguin Press. Reprinted 1986, 1991
4. Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, William W. Behrens III,1972, Limits to Growth – Club of Rome's report, Universe Books.
5. A Nagraj, 1998, Jeevan Vidya EkParichay, Divya Path Sansthan, Amarkantak.
6. P L Dhar, RR Gaur, 1990, Science and Humanism, Common wealth Publishers.
7. A N Tripathy, 2003, Human Values, New Age International Publishers
8. E G Seebauer & Robert L. Berry, 2000, Fundamentals of Ethics for Scientists&Engineers, Oxford University Press
9. M Govindrajran, S Natrajan & V.S. Senthil Kumar, Engineering Ethics (including Human Values), Eastern Economy Edition, Prentice Hall of India Ltd.
10. Subhas Palekar, 2000, How to practice Natural Farming, Pracheen (Vaidik) Krishi Tantra Shodh, Amravati
11. B P Banerjee, 2005, Foundations of Ethics and Management, Excel Books
12. B L Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow. Reprinted 2008.

Mapping of COs with POs / PSOs														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1						2	2	3	2	2		3		
2						2	2	3	2	2		3		
3						2	2	3	2	2		3		
4						2	2	3	2	2		3		
5						2	2	3	2	2		3		
CO (W.A)						**2**	**2**	**3**	**2**	**2**		**3**		

22GED02 – INTERNSHIP / INDUSTRIAL TRAINING					
		L	**T**	**P**	**C**
		0	**0**	**0**	**2**
PRE-REQUISITE : NIL					
Course Objectives:	• To obtain a broad understanding of the emerging technologies in Industry • To gain knowledge about I/O models.				

Course Outcomes The Student will be able to		**Cognitive Level**
CO1	Engage in Industrial activity which is a community service.	U
CO2	Prepare the project report, three minute video and the poster of the work.	Ap
CO3	Identify and specify an engineering product that can make their life comfortable.	An
CO4	Prepare a business plan for a commercial venture of the proposed product, together with complying to relevant norms.	Ap
CO5	Identify the community that shall benefit from the product.	E

During semester breaks, students are encouraged to engage in industrial training or undergo internship in an industry related to the field of study. The duration of the activity shall be of 4 to 6 weeks. The work carried out in the semester break is assessed through an oral seminar accompanied by a written report. It is expected that this association will motivate the student to develop simple Electronic (or other) products to make their life comfortable and convert new ideas into projects.

Every student is required to complete 12 to 16 weeks of internship (with about 40 hours per week), during the Summer/Winter semester breaks. The Internships are evaluated through Internship Reports and Seminars during the VI and VIII semesters. The internships can be taken up in an industry, a government organization, a research organization or an academic institution, either in the country or outside the country, that include activities like:

- Successful completion of Internships/ Value Added Programs/Training
- Programs/ workshops organized by academic Institutions and Industries
- Soft skill training by the Placement Cell of the college
- Active association with incubation/ innovation /entrepreneurship cell of the institute
- Participation in Inter-Institute innovation related competitions like Hackathons
- Working for consultancy/ research project within the institutes
- Participation in activities of Institute's Innovation Council, IPR cell, Leadership Talks, Idea/ Design/ Innovation contests
- Internship with industry/ NGO's/ Government organizations/ Micro/ Small/Medium enterprises
- Development of a new product/ business plan/ registration of a start-up

Mapping of COs with POs / PSOs														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1						2								
2										3				
3		1												
4							2	3			2			
5						2								
CO (W.A)		**1**				**2**	**2**	**3**		**3**	**2**			

22BMD01- PROJECT WORK					
		L	T	P	C
		0	0	20	10
PRE-REQUISITE : NIL					
Course Outcomes The Student will be able to		**Cognitive Level**		**Weightage of COs in End Semester Examination**	
CO1	Engage in independent study to research literature in the identified area and consolidate the literature search to identify and formulate the engineering problem.	Ap		20 % - First Review (Internal)	
CO2	Prepare the Gantt Chart for scheduling the project , engage in budget analysis, and designate responsibility for every member in the team and identify the community that shall benefit through the solution to the identified research work and also demonstrate concern for environment	Ap, E		20 % - Second Review (Internal)	
CO3	Identify, apply the mathematical concepts, science concepts, and engineering concepts necessary to implement the identified engineering problem, select the engineering tools /components required to reproduce the identified project, design, implement, analyze and interpret results of the implemented project	Ap, An, C		20 % - Third Review (External)	
CO4	Engage in effective written communication through the project report, the one-page poster presentation, and preparation of the video about the project and the four page IEEE format of the work and effective oral communication through presentation of the project work and demonstration of the project.	E		20 % - Third Review (External)	
CO5	Perform in the team, contribute to the team and mentor/lead the team, demonstrate compliance to the prescribed standards/ safety norms and abide by the norms of professional ethics and clearly specify the outcome of the project work (leading to start-up/ product/ research paper/ patent)	Ap, An		20 % - Third Review (External)	

DESCRIPTION
Project work may be allotted to a single student or to a group of students not exceeding 3 per group. The title of project work is approved by head of the department under the guidance of a faculty member and student(s) shall prepare a comprehensive project report after completing the work to the satisfaction of the guide. The Head of the department shall constitute a review committee for project work. There shall be three reviews during the semester by the committee to review the progress. Student(s) shall make presentation on the progress made by him / her / them before the committee and evaluation is done as per Rules and Regulations
TOTAL (P: 120) = 120 PERIODS

Mapping of COs with POs / PSOs														
COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1		3										3	3	3
2						3	3				3		3	3
3	3	3	3	3	3								3	3
4								3		3			3	3
5									3		3	3	3	3
CO (W.A)	3	3	3	3	3	3	3	3	3	3	3	3	3	3

22BMX01 - CELL BIOLOGY				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: NIL				
Course Objectives:	• To explore cell structure, functions and types. • To understand essential concepts like cellular processes and regulatory mechanisms. • To compare and contrast cellular processes and mechanisms across different cell types. • To investigate recent advancements in cell and molecular research. • To gain practical knowledge in cell culture techniques.			

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the knowledge of cell structures and their functions to explain biological processes.	Ap	30%
CO2	Analyze different methods of cellular transport and their roles in cell function.	An	30%
CO3	Evaluate the structure and function of key cell organelles.	E	20%
CO4	Critique cell signaling pathways and their components.	E	20%
CO5	Assess cutting-edge cell biology concepts effectively through interactive discussions and real-world observations during hospital visits.	E	Internal Assessment

UNIT I – CELL STRUCTURE	**(9)**
Cells - definition, Eukaryotic cell and prokaryotic cell -differences and key organelles, Relationship and evolution of Eukaryotic cell and prokaryotic cell, plant cells and animal cells - differences and general structure - Cellular environment, tissues, various types of cell, Extra cellular matrix, cytoskeletal proteins, Cell Cycle - Mitosis and meiosis.	
UNIT II – CELL ORGANELLES	**(9)**
Cell Organelles and function - Nucleus, Cytoplasm, Endoplasmic reticulum, Golgi complex, lysosomes, cell membranes, chloroplast, mitochondria - structure, importance and function.	
UNIT III – CELLULAR TRANSPORT	**(9)**
Transport across cell membranes - importance, classification - Active and passive, passive transport movement of water, small lipid across membrane. Active - Na+ K+ ATPase Pump, Lysosomal and Vacuolar pumps. Cotransport - Symport, antiport - examples, Endocytosis and Exocytosis transport across prokaryotic membrane, entry of viruses and toxins.	

UNIT IV – CELL SIGNALING AND SIGNAL TRANSDUCTION	(9)
Cell signaling - process importance, various kinds of Receptors and ligands - Examples, Different modes of action of ligands, Qualification and characterization of receptors, different modes of signal transduction and amplification with examples, signaling through G-Proteins (Monomeric and trimeric), signaling for growth factors, second messengers, protein kinases, Ca ions and cAMP molecule in signaling.	
UNIT V – CELL CULTURE	**(9)**
Definition, Media preparation, Propagation of eukaryotic and prokaryotic cell, cell lines, primary cultures, stock cell cultures, maintenance of cell lines in cell culture, explants cultures, differentiation and contamination.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. James E Darnell, Harvey F Lodish, David Baltimore, "Molecular Biology of the Cell", W.H. Freeman publishers, 2012.
2. Geoffrey Cooper, "The Cell: A molecular approach", OUP USA; 8th edition, 2019.
3. Verma and Aggarval, "Cytology", S. Chand Publications, 2003.

REFERENCES:

1. Bruce Alberts, Alexander Johnson, Julian Lewis and Martin Raff, "Molecular Biology of the Cell", fifth edition, Taylor and Francis group, 2012.
2. De Robertis, E.D.P and DeRobertis, E.M.F. (2010), "Cell and Molecular Biology", (8th edition) Lippincott Williams and Wilkins, Philadelphia.
3. Gerald Karp," Cell and Molecular Biology", John Wiley and sons Inc, 2013.

WEB LINK:

1. https://onlinecourses.nptel.ac.in/noc20_ee42/preview

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2		3												
3				3										
4					3									3
5									3		2		3	
CO (W.A)	3	3		3	3				3		2		3	3

22BMX02 - GENETIC ENGINEERING				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: NIL				
Course Objectives:	• To understand the concepts of Genetics. • To introduce the practice of recombinant DNA technologies. • To solve genetic engineering problems. • To design target gene expression with advanced genetic engineering techniques. • To explore with genetic engineering techniques for cloning target gene or protein expression.			

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply basic genetic concepts and the roles of biomolecules in genetic processes.	Ap	40%
CO2	Illustrate techniques to perform gene cloning and create gene libraries.	An	40%
CO3	Analyze methods in disease diagnosis, forensic science and genetic research.	An	15%
CO4	Assess the impact and ethical implications of recent advancements in genetic engineering.	E	5%
CO5	Evaluate the societal, ethical and professional consequences of genetic engineering through interactive discussions.	E	Internal Assessment

UNIT I – BASICS OF GENETICS	**(9)**
Biomolecules: Carbohydrates, Proteins, Lipid, Amino Acid and Nucleic Acids. Nucleic Acids: Introduction, History, DNA and RNA - Genetic Material, Types, Mutation. Chromosome, Gene, Expression of Genetic Information, Regulation of mRNA Stability.	
UNIT II – RECOMBINANT DNA TECHNOLOGY	**(9)**
Gene Cloning - Concept and Basic Steps; Restriction Modification Enzymes used in Recombinant DNA Technology, Endonucleases, Ligases and Other Enzymes useful in Gene Cloning; Vectors: Plasmid, Bacteriophage and Other Viral Vectors, Cosmids, Artificial Chromosomes, Ti Plasmid, Shuttle Vectors, Expression Vectors; DNA Delivery Methods; Construction of Genomic and cDNA Libraries; Techniques for Selection, Screening and Characterization of Transformants.	
UNIT III – ROLE OF POLYMERASE CHAIN REACTION	**(9)**
Concept of PCR; DNA Polymerases; Primer Designing, Linkers, Adapters, Setting up PCR Reactions; Various types of PCR; Applications of PCR in Disease Diagnostics, Forensic Sciences and Genetic Engineering.	
UNIT IV – ADVANCED APPROACHES IN GENETIC ENGINEERING	**(9)**
Gene Expression in Prokaryotes & Eukaryotes, Tissue Specific Promoter, Wound Inducible Promoters, Strong and Regulatable Promoters, Promoter Analysis (EMSA and DNA Foot Printing), Gene Expression Profiling (Real Time PCR, SAGE, Differential Display, Microarray); DNA Sequencing Methods; Molecular Markers: RAPD, RFLP, AFLP, SNP; Site Directed Mutagenesis, Gene Silencing Techniques.	

UNIT V – APPLICATIONS OF GENETIC ENGINEERING	(9)
Genetic Engineering and Biotechnology; Creation of Recombinant Microorganisms, Transgenic Plants and Animals; Cloning of Sheep (Dolly) & Other Mammals; Applications in Conservation; Therapeutic Vs. Reproductive Cloning; Ethical Issues and the Prospects for Human Cloning; Gene Therapy; DNA Drugs and Vaccines.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. Old RW and Primrose SB, "Principles of Gene Manipulation, An Introduction to Genetic Engineering", Blackwell Science Publications, 1993.
2. B. Primrose and R. M. Twyman "Principles of Genome Analysis and Genomics", 3rd Edition, Blackwell Publishing, 2022.

REFERENCES:

1. Patrick Faraday, "Genetic Engineering: Emerging Concepts and Technologies", Syrawood Publishers, 2018.
2. "The Biotech Primer: An Insider"s Guide to the Science Driving the Biopharma Industry", The Biotech Primer for Non-Scientists Series, November 15, 2019.
3. Sandhya Mitra, "Genetic Engineering", 2nd Edition, Mcgraw Hill, 2017.
4. Desmond S. T. Nicholl, "An Introduction to Genetic Engineering", Cambridge University Press, 2023.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												2	
2		3											2	
3				3										2
4	3					3		3					2	
5									3	2		3	2	
CO (W.A)	3	3		3		3		3	3	2		3	2	2

22BMX03 - GENOMICS				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE: NIL

Course Objectives:	• To describe modern sequencing technologies • To apply principles of structural genomics to construct chromosome maps • To evaluate the ethical implications of genome sequencing projects. • To apply functional genomics techniques to study gene interactions. • To assess the role of genomics in predicting disease in pre-symptomatic individuals.

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply genomic sequencing technologies and tools to analyze and interpret genomic data.	Ap	40%
CO2	Analyze the importance and necessities to map chromosomes and organize genomic data.	An	40%
CO3	Evaluate major genome sequencing projects and their impact.	E	15%
CO4	Assess methods for genomic screening and personalized medicine to help treat genetic disorders.	E	5%
CO5	Explain advancements and ethical considerations in genomics through seminars and discussions.	U	Internal Assessment

UNIT I – INTRODUCTION	**(9)**
Introduction, Genomics, Sequencing Technologies: Polymerase Chain Reaction (PCR), Sanger Sequencing, High-Throughput Sequencing Technologies, Illumina, Ion Torrent, PacBio, Nanopore.	
UNIT II – STRUCTURAL GENOMICS	**(9)**
Eukaryotic Organelle Genomes (human and other organisms); Assigning Loci to Specific Chromosome; High Resolution Chromosome Mapping; Markers for Mapping (RFLP, Single Nucleotide Polymorphism, Microsatellite Markers, Copy Number Variation, Methods for Detection of Markers), Physical Mapping of Genome; Linkage Mapping; Using Genome Maps for Genetic Analysis - Organizational Principles of Human Genes: Application of Comparative Genomics to Understand the Molecular Mechanism.	
UNIT III – GENOME SEQUENCING	**(9)**
Whole Genome Shotgun Sequencing; Introduction to Various Databases, Genome Browsers & Associated Tools: ENSEMBL, Genecards, UCSC Genome Browser, Galaxy and their Application; Overview of Various Genome Scale Projects: Human Genome Project, Hapmap Project, 1000 Genome Projects, Expressed Sequence Tag (EST) Project; Ethical, Legal and Social Implications Addressed by The Human Genome Project; Concept of Epigenomics, Microrna, Long Non-Coding RNA; Concept of Three Dimensional Genome.	
UNIT IV – FUNCTIONAL GENOMICS	**(9)**
SAGE, Characterize The Proteome by ORF Analysis, Study of Gene Interactions by Yeast Two-Hybrid System, Study of Developmental Regulation by Using DNA Chips, Biomedical Genomics: Introduction to NGS-Based Targeted Re-Sequencing; Single Cell Sequencing; Experimental Design: WES, Transcriptome,	

WGBS, Chip-Seq; Concept of Metabolomics; Molecular Basis of Genetic Variations Leading to Medical Disorders: Types of Genetic Variations; Identification of Human Biomarkers using Genomics; Concept of Genome-Wide Association Studies (GWAS), Related Databases and its Limitations.

UNIT V – IMPACTS OF GENOMICS IN HEALTHCARE **(9)**

Screening for Genomic Disorders: Newborn Screening, Preconception Carrier Screening; Genomics of Cardiovascular Disease and Cancer; Concept of Pharmacogenomics; Concept of Genetic Counseling; Predicting Disease in Healthy (Pre-Symptomatic) People and its Ethical Concern.

TOTAL (L:45) = 45 PERIODS

TEXT BOOKS:

1. Primrose SB and R. Twyman "Principles Of Gene Manipulation &Geneomics Blackwell Science Publications, 2006.
2. Principles of Genome Analysis and Genomics by S.B.Primrose and R.M.Twyman, Third Edition (Blackwell Publishing), 2003.

REFERENCES:

1. Ansubel FM, Brent R, Kingston RE, Moore DD, "Current Protocols In Molecular Biology", Greene Publishing Associates, NY, 1988.
2. Berger SI, Kimmer AR, "Methods In Enzymology", Vol 152, Academic Press, 1987.
3. Genomes 3 by T. A. Brown, Third Edition (Garland Science Publishing), 2007.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2		3												
3				3										
4			2	3									2	
5									3	3		3		
CO (W.A)	3	3	2	3					3	3		3	2	

22BMX04 - CANCER BIOLOGY				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: NIL				

Course Objectives:	• To import knowledge on Cancer Biology fundamentals and principles of carcinogenesis. • To discuss about molecular cancer cell biology and metastasis. • To introduce various therapeutic procedures for treating carcinoma. • To emphasize knowledge of the historical background for the development of the tumor microenvironment. • To understand cell signaling processes including receptors, ligands, signal transduction, and the roles of G-Proteins, second messengers, protein kinases, Ca ions and cAMP.

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Analyze the fundamentals of Cancer Biology and the principles of carcinogenesis.	Ap	40%
CO2	Apply therapeutic procedures for treating carcinoma.	Ap	40%
CO3	Evaluate molecular cancer cell biology and metastasis mechanisms.	E	15%
CO4	Assess the historical development of the tumor microenvironment.	E	5%
CO5	Relate theoretical knowledge to real-world scenarios and gain practical insights into cancer biology, clinical practices by assigning case studies.	An	Internal Assessment

UNIT I – FUNDAMENTALS OF CANCER BIOLOGY	**(9)**
Regulation of cell cycle, Mutations that cause changes in signal molecules, Cancer genes – Tumour suppressor genes, oncogenes and their mutations, Modulation of cell cycle in cancer, Different forms of cancers, Clinical examination, Radiological examination, Biopsy and its type, Prediction of aggressiveness of cancer, tumour markers, Molecular tools for early diagnosis.	
UNIT II – PRINCIPLES OF CARCINOGENESIS	**(9)**
Theory of carcinogenesis, Chemical carcinogenesis, Metabolism of carcinogemnesis, Principles of physical carcinogenesis, X-ray radiation, Mechanisms of radiation carcinogenesis, Diet and cancer.	
UNIT III – CELLULAR TRANSPORT	**(9)**
Transport across cell membranes - importance, classification - Active and passive, passive transport - movement of water, small lipid across membrane. Active - Na+ K+ ATPase Pump, Lysosomal and Vacuolar pumps. Cotransport - Symport, antiport - examples, Endocytosis and Exocytosis transport across prokaryotic membrane, entry of viruses and toxins.	
UNIT IV – CELL SIGNALING AND SIGNAL TRANSDUCTION	**(9)**

Cell signaling - process importance, various kinds of Receptors and ligands - Examples, Different modes of action of ligands, Qualification and characterization of receptors, different modes of signal transduction and amplification with examples, signaling through G-Proteins (Monomeric and trimeric), signaling for growth factors, second messengers, protein kinases, Ca ions and cAMP molecule in signaling.	
UNIT V – CELL CULTURE	**(9)**
Definition, Media preparation, Propagation of eukaryotic and prokaryotic cell, cell lines, primary cultures, stock cell cultures, maintenance of cell lines in cell culture, explants cultures, differentiation and contamination.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. James E Darnell, Harvey F Lodish, David Baltimore, "Molecular Biology of the Cell", W.H. Freeman Publishers, 2012
2. Geoffrey Cooper, "The Cell: A molecular approach", OUP USA; 8th Edition, 2019.
3. Vermaand Aggarval," Cytology", S. Chand Publications, 2003.

REFERENCES:

1. Bruce Alberts, Alexander Johnson, Julian Lewis and Martin Raff, "Molecular Biology of the Cell", 5th Edition, Taylor and Francis group, 2012.
2. De Robertis, E.D.P and DeRobertis, E.M.F. (2010), "Cell and Molecular Biology", 8th Edition Lippincott Williams and Wilkins, Philadelphia.
3. Gerald Karp," Cell and Molecular Biology", John Wiley and sons Inc, 2013.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2			3											
3		3		3										
4				3		3							2	
5							3		3			3		
CO (W.A)	3	3	3	3		3	3		3			3	2	

22BMX05 - PRINCIPLES OF TISSUE ENGINEERING				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: NIL				
Course Objectives:	• To study the cell types and differentiation. • To infer knowledge on the basic concepts of tissue engineering. • To study basics about stem cells and its applications. • To understand the methods and design involved in tissue engineering. • To study the clinical application on tissue repair/ engineering.			

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply Cell Biology and Tissue Engineering Principles.	Ap	40%
CO2	Analyze Stem Cell Applications and Engineering Methods in regenerative medicine and personalized healthcare solutions.	An	40%
CO3	Investigate Techniques in Tissue Engineering and Stem Cell Research of novel treatments for disease and injuries.	An	15%
CO4	Explain the engineering approaches and design methodologies in tissue engineering.	An	5%
CO5	Enhance their knowledge of complex scientific concepts in cell biology and tissue engineering by preparing and delivering seminars.	Ap	Internal Assessment

UNIT I – INTRODUCTION TO CELL BIOLOGY	**(9)**
Cell Types - Progenitor Cells - Cell Growth and Differentiation - Cell Culture: Expansion - Transfer - Storage and Characterization - Cell Signalling Molecules - Growth Factors - Cell Attachment: Differential Cell Adhesion, Receptor - Ligand Binding - Cell Surface Markers.	
UNIT II – FUNDAMENTALS OF TISSUE ENGINEERING	**(9)**
History and Scope of Tissue Engineering - Tissue Organization - Tissue Types: Epithelial, Connective - Vascularity and Angiogenesis - Wound Healing - Extra Cellular Matrix: Matrix Molecules and their Ligands - Tissue Culture – Materials in Tissue Engineering.	
UNIT III – STEM CELLS	**(9)**
Definition of Stem Cells – Types of Stem Cells – Differentiation, Dedifferentiation Maturation, Proliferation, Pleuripotency and Immortalization - Sources of Stem Cells: Haematopoetic – Fetal – Cord Blood – Placenta - Bone Marrow - Primordial Germ Cells - Cancer Stem Cells - Induced Pleuripotent Stem Cells.	
UNIT IV – ENGINEERING METHODS AND DESIGN	**(9)**
Soft Lithography - Self-assembled Monolayer, Micro Contact Printing, Micro Fluidic Patterning – Laminar Flow Patterning - Cell Interaction with Polymer Scaffolds and Gels - Polymer Scaffolds Fabrications: Electro Spinning - Solvent Casting and Particulate Leaching - Micro Fabrication of Cell Seeded Scaffolds.	
UNIT V – APPLICATION OF TISSUE ENGINEERING	**(9)**

Replacement Engineering: Bone, Cartilage, Skin, Blood, Pancreas, Kidney, Heart Valve and Liver - Regenerative Engineering: Peripheral Nerve Regeneration, Cardiac Tissue Regeneration, Muscle Regeneration – Regulation, Commercialization and Patenting.
TOTAL (L:45) = 45 PERIODS
TEXT BOOKS:
1. Robert P Lanza, Robert Langer and Joseph Vacanti, "Principles of Tissue Engineering", Academic Press, United States, 2020. 2. Donglu Shi and Qing Liu, "Tissue Engineering and Nanotheranostics", World Scientific Publications, Singapore, 2018.
REFERENCES:
1. Gary E. Wnek, Gary L Browlin, "Encyclopedia of Biomaterials and Biomedical Engineering", Marcel Dekker Inc, New York, 2008. 2. R. Lanza, Anthony Atala (Eds), "Essential of Stem Cell Biology", Academic Press, USA, 2013. 3. R. Lanza, Anthony Atala,"Handbook of Stem Cells", Academic Press, USA, 2012.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2		3												
3				3										
4					2								2	
5									3	3		3		
CO (W.A)	3	3		3	2				3	3		3	2	

22BMX06 - NEUROSCIENCE				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: NIL				
Course Objectives:	• To understand the basics of nervous systems and their functions • To characterize neuronal cells. • To identify the effects of neuronal functions and neural disorders. • To select suitable testing methods for analyzing neural behavior. • To apply theoretical knowledge to real-world scenarios.			

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the knowledge of the structure and function of the central and peripheral nervous systems, including signaling molecules and neurotransmitters.	Ap	40%
CO2	Analyze neuronal structures, synaptic functions and the effects of neurotransmitters and hormones.	An	40%
CO3	Identify the causes and features of common neurological and psychiatric disorders.	An	15%
CO4	Assess the basic research tools and techniques to study neuroscience.	E	5%
CO5	Apply theoretical knowledge of the nervous system, neuroanatomy and neurophysiology to analyze and solve real-world case studies related to neurological disorders.	An	Internal Assessment

UNIT I – INTRODUCTION TO NERVOUS SYSTEM	**(9)**
Nervous system: Introduction, Central and peripheral nervous system, Signalling molecules, First growth factor, First Neuro transmitters in brain, functional organization, Synaptic potentials and Receptor potentials.	
UNIT II – NEURO ANATOMY	**(9)**
Structures and functions of neurons, Synapse: function, signals produced by neurons, Sensors function, Glial cells, molecular and cellular organization of neuronal differentiation, characterization of neuronal cells.	
UNIT III – NEUROPHYSIOLOGY AND NEUROPHARMACOLOGY	**(9)**
Resting and action potentials; Mechanism of action potential conduction; Voltage dependent channels; nodes of Ranvier; Chemical and electrical synaptic transmission. Synaptic transmission, neurotransmitters and their release; fast and slow neurotransmission; characteristics of neurites; hormones and their effect on neuronal function.	
UNIT IV – NEUROLOGICAL DISORDERS	**(9)**
Pathogenesis, Genetic basis of neurological disorders, Psychiatric Disorders: Psychiatric epidemiology, Unipolar depression, Bipolar depression, Seasonal affective disorder, Panic disorder, Autism, Stroke, Huntington disease.	
UNIT V – BEHAVIOUR SCIENCE	**(9)**

Neuronal mechanism of behaviour, Animal behaviour, Behaviour in various environments, Behavioural and cognitive neuroscience, Behavioural studies using animal model, Testing motor functions, Grip Strength Test, Testing Cognitive Functions, Learning and memory related test.
TOTAL (L:45) = 45 PERIODS

TEXT BOOKS:

1. Georg Goldenberg, Bruce L. Miller, "Neuropsychology and Behavioral Neurology" Handbook of Clinical Neurology, Elsevier - libgen.lc., 2008.
2. Michael J. Aminoff, Handbook of Clinical Neurology, Elsevier, London, 2012.

REFERENCES:

1. Mason P., Medical Neurobiology, Oxford University Press, 2011.
2. Mathews G.G. Neurobiology, 2nd edition, Blackwell Science, UK, 2000.
3. Gordon M. Shepherd G.M, and Shepherd Neurobiology, 3rd Edition Oxford University Press, USA, 1994.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2		3												
3				3										
4					2									2
5						3	3					3		
CO (W.A)	3	3		3	2	3	3					3		2

22BMX07 - NUCLEAR MEDICINE				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE: NIL

Course Objectives:	• To understand the concepts of physics used in nuclear medicine. • To understand the construction and principle of operation of various nuclear medicine instruments. • To study the diagnostic applications of nuclear medicine. • To study the therapeutic applications of nuclear medicine. • To analyze radiation safety procedures and regulations.

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply diagnostic and therapeutic techniques using radionuclides to diagnose and treat medical conditions.	Ap	40%
CO2	Illustrate the principles and mechanisms of radioactivity and radiation interaction in nuclear medicine.	An	40%
CO3	Interpret nuclear medicine instrumentation effectively, including gamma cameras, radiation detectors and electronic systems.	An	15%
CO4	Evaluate and implement radiation safety protocols and ethical standards in the use of radioactive materials in healthcare environments.	E	5%
CO5	Analyze information, identify key issues and propose effective solutions in complex biomedical contexts engaging with case studies.	An	Internal Assessment

UNIT I – BASICS OF NUCLEAR MEDICINE	**(9)**
Radioactivity and Interaction of Radiation; Alpha, Beta and Gamma Emission, Laws of Radioactive Decay, Mechanisms of Radioactive Delay, Radiation Intensity and Exposure, Decay Schemes and Energy Levels, Compton Scattering, Pair Productions, Particle Interactions.	
UNIT II - NUCLEAR MEDICINE INSTRUMENTATION	**(9)**
Construction and Principle Operation of Gamma Camera, Rectilinear Scanner, Basic Principles of Pulse Height Analyzer, Radiation Detectors-Ionization Chamber, Geiger Muller Counter, Semiconductor Detectors, Scintillation Detectors, Electronic Instrumentation for Radiation Detection System.	
UNIT III – DIAGNOSTIC APPLICATIONS OF RADIONUCLIDE	**(9)**
PET-CT, Single Photon Emission Computed Tomography (SPECT), Radio Iodine Therapy for Thyrotoxicosis, Differentiated Thyroid Cancers, Palliative Treatment for Bone Metastasis - 32P and 89 Strontium Dosage	

UNIT IV – THERAPEUTIC APPLICATIONS OF RADIONUCLIDE	(9)
Intravascular Particulate Radio Nuclide Therapy, Receptor Targeted Therapy, 1311- MIBG Therapy, Targeted Internal Radiation in HCC: 90 Y, Radio - Synovectomy using Yttrium	
UNIT V – RADIATION SAFETY	**(9)**
Radiation Protection in Different Nuclear Isotope Therapy Procedures, Management of Radiation Accidents, Radiation Effect on Pregnancy and Fertility, Diagnosis, Evaluation and Treatment of Radiation Overexposure, Instruments used in Radiation Survey & Monitoring, Handling of Radioactive Patients, Role of National and International Bodies in Radiation Safety, ICRP Recommendations, BARC Regulations Regarding Limits of Radiation Exposure.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. Simon Cherry, James Sorenson and Michael Phelps. "Physics in Nuclear Medicine", 4th Edition, Elsevier Saunders, 2012.
2. Essential Nuclear Medicine Physics, Rachel A Powsner and Edward R Powsner, 2nd Edition, Blackwell publishing, 2006.

REFERENCES:

1. Max. H. Lombardi, "Radiation Safety in Nuclear Medicine", 2nd Edition, CRC Press, Florida, USA, 1999.
2. Fred A Mettler and Milton J Guiberteau, "Essentials of Nuclear Medicine and Molecular Imaging", 7th Edition, Elsevier, 2018.
3. Harvey Ziessman, Janis O Malley and James Thrall, "Nuclear Medicine", 4th Edition, Elsevier, 2013.
4. Pete Shackett, "Nuclear Medicine Technology", 2nd Edition, Lipkott William Wilkkins, USA, 2008.
5. Jennifer Prekeges, "Nuclear Medicine Instrumentation", 2nd Revised Edition, John and Barelett Publishers, Inc USA, 2012.
6. Christian, Paul E., and Kristen M. Waterstram-Rich. Nuclear Medicine and PET/CT-E-Book: Nuclear Medicine and PET/CT-E-Book. Elsevier Health Sciences, 2013.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3			2										
2	3	2												
3			2	2									2	
4		2			2			3						
5						3	2			2				
CO (W.A)	3	2	2	2	2	3	2	3		2			2	

22BMX08 - RADIOTHERAPY BASICS & APPLICATION				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: NIL				
Course Objectives:	• To provide a knowledge on the interaction of Non-Ionizing radiation. • To infer knowledge on the principles and applications of optical radiations, lasers, and laser-tissue interactions. • To analyze the various techniques and instruments used in radiation dosimetry for medical applications. • To have a better understanding about radiation monitoring instruments. • To understand dosimetric concepts and factors influencing dose distribution in radiation therapy.			

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the knowledge of sources, properties and applications of non-ionizing radiation in medical contexts.	Ap	40%
CO2	Analyze Interactions Between Radiation and Biological Tissues.	An	40%
CO3	Evaluate and utilize various radiation detection and dosimetry techniques for accurate measurement and safety in medical practices.	An	15%
CO4	Assess the effective radiation monitoring techniques and understand key parameters for radiation treatment planning in clinical settings.	E	5%
CO5	Deduce insights from expert talks to enhance their understanding and problem-solving skills in medical radiation applications.	An	Internal Assessment

UNIT I – REVIEW OF NONIONISING RADIATION PHYSICS IN MEDICINE	**(9)**
Different Sources of Non Ionising Radiation -Their Physical; Properties - First Law of Photochemistry - Law of Reciprocity - Electrical Impedance and Biological Impedance - Principle and Theory of Thermography – Applications.	
UNIT II – TISSUE OPTICS	**(9)**
Various Types of Optical Radiations - UV, Visible and IR Sources - Lasers: Theory and Mechanism - Laser Surgical Systems - Measurement of Fluence from Optical Sources - Optical Properties of Tissues – Theory and Experimental Techniques - Interaction of Laser Radiation with Tissues – Photothermal - Photochemical – Photoablation – Electromechanical Effect.	
UNIT III – PRINCIPLES OF RADIATION DETECTION AND DOSIMETERS	**(9)**
Principles of Radiation Detection – Properties of Dosimeters - Theory of Gas Filled Detectors – Ion Chamber Dosimetry Systems - Free Air Ion Chamber – Parallel Plate Chamber - Ionization Chamber – Proportional Chamber - GM Counter – Condenser Type Chambers and Thimble Chambers Working and Different Applications – Film Dosimetery Luminescence Dosimetry – Semiconductor Dosimetry – Gel Dosimetry – Radiographic and Radiochromic Films – Scintillation Detections.	
UNIT IV – RADIATION MONITORING INSTRUMENTS	**(9)**

Introduction – Operational Quantities for Radiation Monitoring – Area Survey Meters – Ionization Chambers – Proportional Counters – Neutron Area Survey Meters – GM Survey Meters – Scintillation Detectors – Personal Monitoring – Film Badge – TLD – Properties of Personal Monitors – Radio photo Luminescent Glass Dosimetry System – OSLD.

UNIT V – RADIATION TREATMENT PLANNING PARAMETERS	**(9)**

Build-up, Central Axis Depth Doses for Different Energies and their Determination - Tissue Air Ratio, Tissue Maximum Ratio and Tissue Phantom Ratio - their Relationship - Back Scatter Factor – Phantom Scatter Factor – Collimator Scatter Factor - Source to Surface Distance – Dependence of SSD.

TOTAL (L:45) = 45 PERIODS

TEXT BOOKS:

1. F M Khan, "Physics of Radiation Therapy", 3rd Edition, Liippincott Williams & Wilkins, USA, 2003.
2. W. R. Hendee, "Medical Radiation Physics", Year Book Medical Publishers Inc., London, 2003.

REFERENCES:

1. E. B. Podgorsak, "Radiation Oncology Physics: A Handbook for teachers and students", IAEA publications 2005.
2. F. M. Khan, "The Physics of Radiation Therapy", 3rd Edition, Lippincott Williams and Wilkins, U.S.A., 2003.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2				3										
3			3											
4		3	3										3	
5						3	3					3		1
CO (W.A)	3	3	3	3		3	3					3	3	1

22BMX11 - COMMUNICATION SYSTEMS				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE : NIL

Course Objectives:	• To infer knowledge on various types analog and digital modulation techniques • To study the principles behind various error control coding.

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Demonstrate the performance of various transmission and reception techniques.	Ap	20%
CO2	Apply various coding techniques to convert real time data into data suitable for transmission and reception.	Ap	40%
CO3	Analyze the various types of analog modulation techniques.	An	20%
CO4	Examine the performance of different transmitters and receivers.	An	20%
CO5	Collaborate in interdisciplinary teams, providing engineering solutions, and embracing lifelong learning.	U	Internal Assessment

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 (L:45) = 45 PERIODS

TEXT BOOKS:

1. B. P. Lathi, "Modern Digital and Analog Communication Systems", 3rd Edition, Oxford University Press, 2007.
2. H Taub, D L Schilling and G Saha, "Principles of Communication Systems", 3rd Edition, TMH, 2007.
3. S. Haykin, "Digital Communications", John Wiley, 2005.

REFERENCES:

1. H P Hsu, Schaum, "Outline Series, Analog and Digital Communications", TMH, 2006.
2. B. Sklar, "Digital Communications Fundamentals and Applications", 2nd Edition, Pearson Education, 2007.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												1	
2	3													
3			3											
4				3										
5						1			2			2	1	1
CO (W.A)	3		3	3		1			2			2	1	1

22BMX12 - MEDICAL OPTICS				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE: NIL

Course Objectives:	• To introduce the basic instrumentation related to photonics. • To acquire knowledge about the physical properties of light and optical properties of tissues. • To understand the practical applications of optics related to surgical applications. • To understand the practical applications of optics related to diagnostic applications. • To understand the phenomenon of laser tissue interaction and practical applications of optics related to therapeutic applications.

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Explain about essential instruments used in medical optics.	Ap	30%
CO2	Apply appropriate Laser for surgical applications.	Ap	30%
CO3	Apply optics concept for Non-thermal diagnostic and therapeutic applications.	Ap	20%
CO4	Analyze the optical properties of tissues for visualizing its structure.	An	20%
CO5	Present and document the case study on usage of Diagnostic and Therapeutic equipments.	An	Internal Assessment

UNIT I – INSTRUMENTATION IN PHOTONICS	**(9)**
Review of Basic Properties of Light – Reflection, Refraction, Scattering, Fluorescence and Phosphorescence. Instrumentation for Absorption, Scattering and Emission Measurements, Excitation Light Sources – High Pressure Arc Lamp, LEDs, Lasers. Optical Filters. Optical Detectors - Time Resolved and Phase Resolved Detectors, Optical Tweezers.	
UNIT II – OPTICAL PROPERTIES OF THE TISSUES	**(9)**
Light Transport Inside the Tissue, Optical Properties of Tissue. Laser Characteristics as applied to Medicine and Biology - Laser Tissue Interaction - Chemical, Thermal, and Electro mechanical. Photo Ablative Processes.	
UNIT III – SURGICAL APPLICATIONS OF LASERS	**(9)**
Lasers in Ophthalmology - Dermatology – Dentistry – Urology – Otolaryngology - Tissue Welding.	
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 Application of Lasers in Biology and Medicine.	

UNIT V – THERAPEUTIC APPLICATIONS	(9)
Phototherapy, Photodynamic Therapy (PDT) - Principle and Mechanism - Oncological and Non-oncological Applications of PDT - Biostimulation Effect – Applications - Laser Safety Procedures.	
TOTAL(L:45) = 45PERIODS	

TEXTBOOKS:

1. Markolf H. Niemz, "Laser-Tissue Interaction Fundamentals and Applications", Springer, 2007.
2. Paras N. Prasad, "Introduction to Bio photonics", A. John Wiley and sons, Inc. Publications, 2003.

REFERENCES:

1. Helena Jelinkova, "Lasers for Medical Applications: Diagnostics, Therapy and Surgery", 1st Edition, Woodhead Publishing, 2013.
2. Mark E. Brezinski, "Optical Coherence Tomography: Principles and Applications", Academic Press, 2006.
3. R. Splinter and B.A. Hooper, "An Introduction to Biomedical Optics", Taylor and Francis, 2007.
4. Tuan Vo Dinh, "Biomedical Photonics – Handbook", CRC Press LLC, 2014.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												2	
2		3											2	
3		3				2								2
4		3				2							2	
5				3					3			2	2	
CO (W.A)	3	3		3		2			3			2	2	2

22BMX13 - BODY AREA NETWORKS				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE: NIL

Course Objectives:	• To know about BAN network. • To know the hardware requirement of BAN. • To understand the various communication standards. • To understand the communication and security aspects in the BAN. • To know the applications of BAN in the field of medicine.

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Explain the importance and role of body area networks.	Ap	30%
CO2	Analyze the various components used for BAN.	An	30%
CO3	Analyze and demonstrate the various communication standards and security aspects.	An	20%
CO4	Examine advanced monitoring systems for diverse healthcare applications.	An	20%
CO5	Demonstrate and communicate effectively the various applications of BAN.	Ap	Internal Assessment

UNIT I – INTRODUCTION BAN	**(9)**
Definition, BAN and Healthcare, Technical Challenges - Sensor Design, Biocompatibility, Energy Supply, Optimal Node Placement, Number of Nodes, System Security and Reliability, BAN Architecture – Introduction.	
UNIT II – HARDWARE FOR BAN	**(9)**
Processor - Low Power MCUs, Mobile Computing MCUs, Integrated Processor with Radio Transceiver, Memory, Antenna - PCB Antenna, Wire Antenna, Ceramic Antenna, External Antenna, Sensor Interface, Power Sources - Batteries and Fuel Cells for Sensor Nodes.	
UNIT III – WIRELESS COMMUNICATION AND NETWORK	**(9)**
RF Communication in Body, Antenna Design and Testing, Propagation, Base Station - Network topology – Stand-alone BAN, Wireless Personal Area Network Technologies - IEEE 802.15.1, IEEE P802.15.13, IEEE 802.15.14, Zigbee.	
UNIT IV – COEXISTENCE ISSUES WITH BAN	**(9)**
Interferences – Intrinsic - Extrinsic, Effect on Transmission, Counter Measures - on Physical Layer and Data Link Layer, Regulatory Issues - Medical Device Regulation in USA and Asia, Security and Self-protection - Bacterial Attacks, Virus Infection, Secured Protocols.	
UNIT V – APPLICATIONS OF BAN	**(9)**
Monitoring Patients with Chronic Disease, Hospital Patients, Elderly Patients, Cardiac Arrythmias Monitoring, Multi patient Monitoring Systems, Multichannel Neural Recording, Gait Analysis, Sports Medicine, Electronic Pill.	
TOTAL(L:45) = 45PERIODS	

TEXTBOOKS:
1. Mehmet R. Yuce and Jamil Y .Khan, "Wireless Body Area Networks Technology, Implementation, and Applications", Pan Stanford Publishing Pte. Ltd., Singapore, 2012 2. Sandeep K.S. Gupta, Tridib Mukherjee and Krishna Kumar Venkata Subramanian, "Body Area Networks Safety, Security, and Sustainability", Cambridge University Press, 2013.
REFERENCES:
1. Zhang, Yuan-Ting, "Wearable Medical Sensors and Systems", Springer, 2013. 2. Guang-ZhongYang, "Body Sensor Networks", 2nd Edition, Springer, 2014. 3. Annalisa Bonfiglio, Danilo De Rossi, "Wearable Monitoring Systems", Springer, 2011.

Mapping of Cos with Pos / PSOs														
COs	**Pos**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3													
2		3												
3					3									
4				3									3	
5									3		2	2		
CO (W.A)	**3**	**3**		**3**	**3**				**3**		**2**	**2**	**3**	

22BMX14 - MEDICAL WEARABLE DEVICES				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE: NIL

Course Objectives:	• To understand about the various sensors used for physiological system measurements. • To gain knowledge about bio signal acquisition methods and signal processing methods for human systems. • To know the energy harvesting from various sources. • To understand the affiliation of wireless communication and BAN in Tele health technology. • To understand various applications of wearable devices in Tele health technology.

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of Cos in End Semester Examination**
CO1	Explain various sensors used for measurements in physiological systems.	Ap	30%
CO2	Analyze the bio signal acquisition methods and signal processing methods for human systems.	An	30%
CO3	Analyze the usage of optimized energy techniques for wearable devices.	An	20%
CO4	Analyze the wireless communication and BAN in Tele health technology.	An	20%
CO5	Function effectively to communicate as an individual to present case study on wireless health systems.	Ap	Internal Assessment

UNIT I – SENSORS	**(9)**
Need for Wearable Systems, Sensors for Wearable Systems – Inertia Movement Sensors, Respiration Activity Sensor, Inductive Plethysmography, Impedance Plethysmography, Pneumography, Wearable Ground Reaction Force Sensor, GSR, Radiant Thermal Sensor, Wearable Motion Sensors, CMOS – Based Biosensors, E-Textiles, Bio compatibility.	
UNIT II – SIGNAL PROCESSING	**(9)**
Wearability Issues – Physical Shape and Placement of Sensor, Technical Challenges – Sensor Design, Signal Acquisition, Constraint on Sampling Frequency for Reduced Energy Consumption, Light Weight Signal Processing, Rejection of Irrelevant Information, Data Mining.	
UNIT III – ENERGY HARVESTING FOR WEARABLE DEVICES	**(9)**
Solar Cell, Vibration Based, Thermal Based, Human Body as a Heat Source for Power Generation, Hybrid Thermoelectric Photovoltaic Energy Harvests, Thermopiles.	
UNIT IV – WIRELESS HEALTH SYSTEMS	**(9)**

Need for Wireless Monitoring, Definition of Body Area Network, BAN and Healthcare, Technical Challenges – System Security and Reliability, BAN Architecture – Introduction, Wireless Communication Techniques.
UNIT V – APPLICATIONS OF WEARABLE SYSTEMS **(9)**
Medical Diagnostics, Medical Monitoring – Patients with Chronic Disease, Hospital Patients, Elderly Patients, Multi parameter Monitoring, Neural Recording, Gait Analysis, Sports Medicine, Smart Fabrics.
TOTAL(L:45)=45PERIODS

TEXTBOOKS:

1. Edward Sazonov and Michael R Neuman, "Wearable Sensors: Fundamentals, Implementation and Applications", Academic Press, USA, 2014.
2. Annalisa Bonfiglio and Danilo De Rossi, "Wearable Monitoring Systems", Springer, 2011.

REFERENCES:

1. Sandeep K.S. Gupta, Tridib Mukherjee and Krishna Kumar Venkatasubramanian, "Body Area Networks Safety, Security, and Sustainability," Cambridge University Press, 2013.
2. Andreas Lymberis and Danilo de Rossi, "Wearable eHealth Systems for Personalized Health Management – State of the Art and Future Challenges", IOS press, The Netherlands, 2004.
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-ZhongYang, "Body Sensor Networks", 2nd Edition, Springer, 2014.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2											2	
2		3											2	
3			3											2
4		2		3									2	
5									3	3		2	2	
CO (W.A)	3	2.3	3	3					3	3		2	2	2

22BMX15 - TELEMEDICINE AND MEDICAL IoT				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: NIL				

Course Objectives:	• To learn the key principles for telemedicine and multimedia technologies in telemedicine. • To know telemedical standards. • To understand telemedical technology and mobile telemedicine. • To understand aspects of IoT in telemedicine. • To gain knowledge on application of telehealth in healthcare.

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Explain the evolution, principles, and communication infrastructure of telemedicine technology.	Ap	30%
CO2	Apply mobile telemedicine technologies for effective healthcare delivery.	Ap	30%
CO3	Analyze data security standards and protocols used in telemedicine.	An	15%
CO4	Assess the impact of IoT and telehealth technologies on healthcare services.	E	5%
CO5	Involve in independent/team learning, Communicate effectively and engage in lifelong learning.	Ap	Internal Assessment

UNIT I – TELEMEDICAL TECHNOLOGY	**(9)**
Evolution of Telemedicine, Functional Diagram of Telemedicine System, Telemedicine, Telehealth, Tele care, Organs of Telemedicine, Principles of Multimedia, PSTN, POTS, ANT, ISDN, Internet, Air/ Wireless Communications, Types of Antenna, Integration and Operational Issues, Communication Infrastructure for Telemedicine. Mobile Hand Held Devices and Mobile Communication. Internet Technology and Telemedicine using World Wide Web (www). Clinical Data – Local and Centralized.	
UNIT II – TELEMEDICAL STANDARDS	**(9)**
Data Security and Standards - 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 III – MOBILE TELEMEDICINE	**(9)**
Tele radiology: Definition, Basic parts, Tele pathology, Multimedia Databases, Color Images of Sufficient Resolution, Dynamic Range, Spatial Resolution, Compression Methods, Interactive Control of Color, Medical Information Storage and Management for Telemedicine - Patient Information Medical History, Test Reports, Medical Images Diagnosis and Treatment. Hospital Information System - Doctors, Paramedics, Facilities Available. Pharmaceutical Information System.	
UNIT IV – INTRODUCTION TO IoT	**(9)**

Introduction to Internet of Things (IoT). Review of CC3200 Core and its Architecture, Introduction to Advanced ARM Cortex M4 Architecture, Peripherals Overview, User API, Power Challenges with IoT, CC3200 Simple Link Applications, Starting with Code Composer Studio V6. Various Wireless Protocols and its Applications: ZigBee, Bluetooth Low Energy, 6LowPAN, Wi-Fi.
UNIT V – APPLICATIONS OF TELEHEALTH TECHNOLOGY **(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 - Introduction to WLAN, WLAN Parameters, AP/STATION Modes and its Security Types, Socket Connection, WLAN AP and WLAN STATION Configuration Settings.
TOTAL(L:45) = 45PERIODS
TEXTBOOKS:
1. R. S. Khandpur, "Telemedicine Technology and Applications (mhealth, Telehealth and ehealth)", PHI Learning Pvt. Ltd., Delhi, 2017. 2. Wootton, R., Craig, J., and Patterson, V., "Introduction to Telemedicine", Royal Society of Medicine Press Ltd., Taylor & Francis, 2006.
REFERENCES:
1. Latifi, R, "Current Principles and Practices of Telemedicine and e-Health", IOHS Press, Washington DC, 2008. 2. Bashshur, R. L. and Shannon G. W., "History of Telemedicine", New Rochelle NY: Mary Ann Liebert Publishers, 2009. 3. Victor Lyuboslavsky, "Telemedicine and Telehealth 2.0: A Practical Guide for Medical Providers and Patients", 1st Edition, Create Space Independent Publishing Platform, 2015.

Mapping of COs with POs / PSOs														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3													
2	2	3												
3			3		2									2
4				3										
5									3	2		3		
CO (W.A)	**2.5**	**3**	**3**	**3**	**2**				**3**	**2**		**3**		**2**

22BMX16 - MEDICAL INFORMATICS				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: NIL				
Course Objectives:	• To learn 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. • To know medical data formats and recent trends in Hospital Information systems for data acquisition and storage. • To introduce the basics of bioinformatics, resources in the field and to apply the standards in proper health care delivery. • To understand the recent trends in medical informatics.			

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Explain the applications of GRID and cloud computing in personalized e-health services and biometrics.	Ap	40%
CO2	Analyze the structure and functional capabilities of medical informatics and hospital information systems.	An	40%
CO3	Investigate systems for the acquisition, storage, and management of medical data.	An	15%
CO4	Assess the development and impact of medical standards, including IEEE 11073, HL7, DICOM, and others.	E	5%
CO5	Engage in self-study as an individual to present a case studies / seminar on advanced topics.	C	Internal Assessment

UNIT I – MEDICAL INFORMATICS	**(9)**
Introduction - Medical Informatics – Bioinformatics – Health Informatics - Structure of Medical Informatics – Functional Capabilities of Hospital Information System - On-line Services and Off – Line Services - History taken by Computer, Dialogue with the Computer.	
UNIT II – MEDICAL STANDARDS	**(9)**
Evolution of Medical Standards – IEEE 11073 - HL7 – DICOM – IRMA - LOINC – HIPPA – Electronics Patient Records – Healthcare Standard Organizations – JCAHO (Join Commission on Accreditation of Healthcare Organization) – JCIA (Joint Commission International Accreditation) - Evidence Based Medicine - Bioethics.	
UNIT III – MEDICAL DATA ACQUISITION AND STORAGE	**(9)**
Plug-in Data Acquisition and Control Boards – Data Acquisition using Serial Interface - Medical Data Formats – Signal, Image and Video Formats – Medical Data bases - 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(L:45) = 45 PERIODS
TEXTBOOKS:
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.
REFERENCES:
1. Mathivanan. N, "PC-Based Instrumentation", Prentice Hall of India Pvt. Ltd., New Delhi, 2007. 2. Yi – Ping Phoebe Chen, "Bioinformatics Technologies", Springer International Edition, New Delhi, 2007. 3. Orpita Bosu and Simminder Kaur Thukral, "Bioinformatics Databases, Tools and Algorithms", Oxford University Press, 2007.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1			2	3										
2		3												
3			3		2									2
4	3	3												
5									3		2	2		
CO (W.A)	3	3	2.5	3	2				3		2	2		2

22BMX17 - MEDICAL TEXTILES				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: NIL				
Course Objectives:	• Provide students with a foundational understanding of medical textiles, including their properties, classifications, and various applications in healthcare. • Equip students with the knowledge to explore advanced materials, smart textiles, and their innovative uses in medical treatments, while considering relevant legal and ethical aspects.			

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Explain textile-based systems for various medical applications, including bandages, compression garments, sutures, implantables, extracorporeal materials and drug delivery textiles.	Ap	40%
CO2	Analyze the properties, applications, and testing methods of medical textiles, including antimicrobial fibers, nano fibrous materials and super absorbent polymers.	An	40%
CO3	Investigate the use of textile sensors and electronics in medical textiles, and address the legal and ethical issues involved.	An	15%
CO4	Assess the properties, applications and role of biopolymers in tissue engineering.	E	5%
CO5	Document and present the comparative study of various smart textiles.	E	Internal Assessment

UNIT I – INTRODUCTION	**(9)**
Medical textiles , classification, current market scenario in international and national level , government initiatives; antimicrobial fibres and finishes; nano fibrous materials and films; super absorbent polymers; operating room garments; personal health care and hygiene products and their testing methods; applications of non, wovens in medicine; textiles in infection prevention control.	
UNIT II – BIOPOLYMERS	**(9)**
Biopolymers: classification and their properties, requirements, and applications, testing methods; In vitro tests , direct contact, agar diffusion & elution methods , in vivo assessment of tissue compatibility. Tissue engineering: properties and materials of scaffolds, relationship between textile architecture and cell behavior , applications of textile scaffolds in tissue engineering.	
UNIT III – IMPLANTABLES, NON - IMPLANTABLES AND DRUG DELIVERY	**(9)**
Bandages, types, properties and applications; compression garments, types, properties and applications; sutures: types and properties; implantable textiles: hernia mesh , vascular prostheses , stents; Extra corporeal materials: Cartilage nerves , liver ligaments, kidney, tendons, cornea; Drug delivery textiles: Classification, mechanism various fabrication methods, characterization , applications.	
UNIT IV – WOUND CARE AND REUSABLE MEDICAL TEXTILES	**(9)**

Wound: types and healing mechanism, textile materials for wound dressing , bio active dressing , anti microbial textiles dressing , composite dressing , , testing of wound care materials; Wound 97 compression textiles; Reusable medical textiles: types, advantages, physical properties and performance, reusable processing methods.
UNIT V – SMART MEDICAL TEXTILES AND LEGAL ISSUES **(9)**
Smart textiles , types, characteristics , smart textiles in wound care; applications of phase change and shape memory materials , monitoring pregnancy, children and cardio patients , mobile health monitoring; electronics in medical textiles; Smart textiles in rehabilitation and applications; textile sensors for healthcare; legal and ethical values involved in the medical textile materials.
TOTAL (L:45) = 45 PERIODS
TEXT BOOKS:
1. Joon B. Park., and Joseph D. Bronzino., Biomaterials , Principles and Applications , CRCPress, Boca Raton London, New York, Washington, D.C. 2002. 2. Anand S.C., Kennedy J.F.,Miraftab M., and Rajendran S., Medical Textiles and Biomaterials for Health Care , Wood head Publishing Ltd., 2006. 3. Horrocks A R, Anand S C , Handbook of Technical Textiles, Woodhead Publishing and Textile Institute, USA, 2000.
REFERENCES:
1. Adanur S., Wellington Sears Handbook of Industrial Textiles , Technomic Publishing Co. Inc., Lancaster Pennylvania, 1995, ISBN 1, 56676, 340, 14. 2. Michael Szycher and Steven James Lee, Modern Wound Dressing: A Systematic Approach to Wound Healing , Journal of Biomaterials Applications, 1992.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1			3	3										
2	3	3												
3				3									2	
4		3		3										
5									3	2		2		
CO (W.A)	3	3	3	3					3	2		2	2	

22BMX18 - VIRTUAL REALITY				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: NIL				

Course Objectives:	• To learn the key components and commercial technologies of virtual reality, including input and output devices. • To understand the different types of modeling in VR, including geometric, kinematic, physical, behavior modeling, and model management. • To assess the impact of VR on users, including performance, health and safety issues, usability, and side effects like cyber sickness. • To develop practical skills in VR programming with Java 3D, including loading models, creating shapes, and designing animated 3D sprites and particle systems. • To explore various applications of VR technology in fields such as medicine, robotics, real-time tracking, gaming, movies, simulations, and therapy.

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the knowledge of the components and technologies of Virtual Reality (VR) systems including input and output devices.	Ap	40%
CO2	Implement VR programming concepts and techniques using Java 3D and other tools.	Ap	40%
CO3	Analyze modeling techniques in VR, including geometric, kinematics, physical, and behavior modeling.	An	15%
CO4	Assess human factors in VR systems, including user performance, health and safety issues, and usability.	E	5%
CO5	Function effectively to communicate as an individual to present the outcome of the implemented work in a team.	C	Internal Assessment

UNIT I – INTRODUCTION	**(9)**
The Three I's of Virtual Reality - Commercial VR Technology and the Five Classic Components of a VR System – Input. Devices :(Trackers, Navigation, and Gesture Interfaces): Three-Dimensional Position Trackers, Navigation and Manipulation-Interfaces and Gesture Interfaces-Output Devices: Graphics Displays-Sound Displays & Haptic Feedback	
UNIT II – MODELING	**(9)**
Geometric Modelling - Kinematics Modelling- Physical Modelling - Behavior Modelling - Model Management.	
UNIT III – HUMAN FACTORS	**(9)**
Methodology and Terminology - User Performance Studies - VR Health and Safety Issues - Usability of Virtual Reality System - Cyber Sickness - Side Effects of Exposures to Virtual Reality Environment.	
UNIT IV – VR PROGRAMMING	**(9)**

Introducing Java 3D - Loading and Manipulating External Models - Using a Lathe to make Shapes. 3D Sprites - Animated 3D Sprites - Particle Systems.	
UNIT V – APPLICATIONS	**(9)**
Medical Applications - Robotics Applications - Advanced Real Time Tracking - Other Applications - Games, Movies, Simulations, Therapy.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. C. Burdea & Philippe Coiffet, "Virtual Reality Technology", 2nd Edition, Gregory, John Wiley & Sons, Inc., 2008.
2. Andrew Davison, "Killer Game Programming in Java", Oreilly SPD, 2005.

REFERENCES:

1. John Vince, "Introduction to Virtual Reality", Springer-Verlag Ltd., 2004.
2. William R.Sherman and Alan B.Craig, "Understanding Virtual Reality – Interface, Application, Design", The Morgan Kaufmann Series, 2003.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2					3									3
3		3												
4			3			3								
5					3				3	3		3		
CO (W.A)	3	3	3		3	3			3	3		3		3

22BMX21 - SOFT COMPUTING				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: NIL				

Course Objectives:	• To understand the basics of artificial neural networks (ANNs) and their learning methods • To learn how to design and use different types of neural networks for practical biomedical problems. • To introduce the concepts of fuzzy logic and how it can help in making decisions with uncertain data.. • To understand genetic algorithms and how they can optimize solutions for biomedical problems • To explore hybrid computing techniques combining neural networks, fuzzy logic, and genetic algorithms.

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply artificial neural networks and learning methods to solve biomedical problems.	Ap	40%
CO2	Analyze the effectiveness of various neural network architectures, fuzzy logic systems and genetic algorithms in real-world biomedical applications.	An	40%
CO3	Assess hybrid computational systems combining neural networks, fuzzy logic and genetic algorithms for optimized biomedical solutions.	E	15%
CO4	Evaluate the performance and potential improvements of computational models in biomedical engineering.	E	5%
CO5	Assess ethical considerations and societal impacts of advanced computational techniques through seminars and discussions.	E	Internal Assessment

UNIT I – INTRODUCTION TO ARTIFICIAL NEURAL NETWORKS	**(9)**
Characteristics - Learning Methods – Taxonomy – Evolution of Neural Networks – Mcculloch - Pitts Neuron - Linear Separability - Hebb Network - Supervised Learning Network: Perceptron Networks - Adaptive Linear Neuron, Multiple Adaptive Linear Neuron.	
UNIT II – TYPES OF NEURAL NETWORKS	**(9)**
BPN, RBF, TDNN - Associative Memory Network: Auto-Associative Memory Network, Hetero-Associative Memory Network, BAM, Hopfield Networks, Iterative Autoassociative Memory Network & Iterative Associative Memory Network – Unsupervised Learning Networks: Kohonen Self Organizing Feature Maps, LVQ – CP Networks, ART Network. Case Studies On Biomedical Applications.	
UNIT III – FUZZY LOGIC	**(9)**
Membership Functions: Features, Fuzzification, Methods of Membership Value Assignments - Defuzzification: Lambda Cuts - Methods - Fuzzy Arithmetic and Fuzzy Measures: Fuzzy Arithmetic - Extension Principle - Fuzzy Measures - Formation of Rules-Decomposition of Rules, Fuzzy Inference Systems - Overview of Fuzzy Expert System - Fuzzy Decision Making. Case Studies on Biomedical	

Applications.
UNIT IV – GENETIC ALGORITHM **(9)**
Genetic Algorithm and Search Space - General Genetic Algorithm, Operators - Generational Cycle, Stopping Condition, Constraints. Classification, Genetic Programming, Multilevel Optimization, Real Life Problem, Advances In GA. Case Studies on Biomedical Applications.
UNIT V – HYBRID SOFT COMPUTING TECHNIQUES **(9)**
Neuro-fuzzy Hybrid Systems - Genetic Neuro Hybrid Systems - Genetic Fuzzy Hybrid and Fuzzy Genetic Hybrid Systems - Simplified Fuzzy ARTMAP. Case Studies on Biomedical Applications.
TOTAL (L:45) = 45 PERIODS

TEXT BOOKS:

1. Laurene V. Fausett, "Fundamentals of Neural Networks: Architectures, Algorithms and Applications" Pearson Education, 2010.
2. S. N. Sivanandam and S.N.Deepa, "Principles of Soft Computing", Wiley India Pvt. Ltd, 2011.
3. J. S. R. Jang, C.T. Sun and E.Mizutani, "Neuro-Fuzzy and Soft Computing", Pearson Education 2004.

REFERENCES:

1. S. Rajasekaran and G. A .Vijayalakshmi Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis & Applications", Prentice-Hall of India Pvt. Ltd., 2006.
2. George J. Klir, Ute St. Clair, Bo Yuan, "Fuzzy Set Theory: Foundations and Applications", Prentice Hall, New Delhi. 1997.
3. Simon Haykin, "Neural Networks Comprehensive Foundation", 2nd Edition, Pearson Education, 2005.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	3												
2				3	3									
3			3			3								
4				3			2						2	
5									3	2		2		
CO (W.A)	3	3	3	3	3	3	2		3	3		3	2	

22BMX22 - PATTERN RECOGNITION TECHNIQUES AND ITS APPLICATIONS				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: NIL				
Course Objectives:	• To understand pattern recognition and classification techniques. • To introduce clustering methods for unsupervised learning and classification. • To study about feature extraction and structural pattern recognition. • To equip students with knowledge of Hidden Markov Models (HMM) and Support Vector Machines (SVM). • To explore recent advances and practical applications of pattern recognition.			

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply Advanced Pattern Recognition Techniques.	Ap	40%
CO2	Analyze and Solve Complex Problems Using Clustering and Machine Learning Algorithms.	An	40%
CO3	Assess Biomedical Applications of Pattern Recognition.	E	15%
CO4	Design and Develop Pattern Classification Systems.	C	5%
CO5	Interpret modern pattern recognition tools and techniques in practical scenarios through assignments.	C	Internal Assessment

UNIT I – PATTERN CLASSIFIER	**(9)**
Overview of Pattern recognition – Discriminant functions – Supervised learning – Parametric estimation – Maximum Likelihood Estimation – Bayesian parameter Estimation – Problems with Bayes approach– Pattern classification by distance functions – Minimum distance pattern classifier.	
UNIT II – CLUSTERING	**(9)**
Clustering for unsupervised learning and classification – Clustering concept –Hierarchial clustering, Partitional clustering- k-means algorithm – Validity of Clusters.	
UNIT III – FEATURE EXTRACTION AND STRUCTURAL PATTERN RECOGNITION	**(9)**
KL Transforms – Feature selection through functional approximation – Binary selection -Elements of formal grammars - Syntactic description - Stochastic grammars - Structural representation.	
UNIT IV – HIDDEN MARKOV MODELS AND SUPPORT VECTOR MACHINE	**(9)**
State Machines – Hidden Markov Models – Training – Classification – Support vector Machine – Feature Selection.	
UNIT V – RECENT ADVANCES AND APPLICATIONS	**(9)**

Fuzzy logic – Fuzzy Pattern Classifiers – Case Study Using Fuzzy Pattern Classifiers CAD system in breast cancer detection, ECG signal classification, Fingerprint recognition, cell cytology classification.
TOTAL (L:45) = 45 PERIODS

TEXT BOOKS:
1. Andrew Webb, —Stastical Pattern Recognition, Arnold publishers, London,2002. 2. C.M.Bishop, —Pattern Recognition and Machine Learning, Springer, 2006. 3. Earl Gose, Richard Johnsonbaugh Steve Jost, —Pattern Recognition and Image Analysis, Prentice Hall of India Pvt Ltd., New Delhi, 1996.
REFERENCES:
1. M. Narasimha Murthy and V. Susheela Devi, —Pattern Recognition, Springer 2011. 2. Robert J.Schalkoff, —Pattern Recognition Statistical, Structural and Neural Approaches, John Wiley & Sons Inc., New York, 1992. 3. R.O.Duda, P.E.Hart and D.G.Stork, —Pattern Classification, John Wiley, 2001. 4. S.Theodoridis and K.Koutroumbas, —Pattern Recognition, 4th Ed., Academic Press, 2008.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2				3										
3		3					3						3	
4			3											
5					3				3			2		3
CO (W.A)	3	3	3	3	3		3		3			2	3	3

22BMX23 - MACHINE LEARNING FOR HEALTHCARE				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: NIL				
Course Objectives:	• To provide a comprehensive understanding of supervised learning techniques. • To introduce unsupervised learning methods • To equip with the skills to evaluate machine learning algorithms and model selection techniques • To delve into advanced topics in machine learning. • To explore scalable machine learning approaches.			

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply diverse machine learning techniques for data analysis and pattern recognition.	Ap	40%
CO2	Illustrate scalable machine learning solutions.	Ap	40%
CO3	Analyze applications in healthcare for improved diagnostics and treatment strategies.	An	15%
CO4	Assess model performance, conduct model selection and validation for effective decision-making.	E	5%
CO5	Determine practical application of machine learning concepts through assignments, fostering hands-on proficiency in algorithm implementation, model evaluation and real-world problem-solving.	Ap	Internal Assessment

UNIT I – SUPERVISED LEARNING	**(9)**
Basic Methods: Distance-Based Methods, Nearest-Neighbours, Decision Trees, Naive Bayes Linear Models: Linear Regression, Logistic Regression, Generalized Linear Models Support Vector Machines, Nonlinearity and Kernel Methods-Beyond Binary Classification: Multi-Class/Structured Outputs, Ranking.	
UNIT II – UNSUPERVISED LEARNING	**(9)**
Clustering: K-means/Kernel K-means, Dimensionality Reduction: PCA and kernel PCA, Matrix Factorization and Matrix Completion, Generative Models (Mixture Models and Latent Factor Models)	
UNIT III – EVALUATING ALGORITHMS	**(9)**
Machine Learning Algorithms and Model Selection, Introduction to Statistical Learning Theory, Ensemble Methods, Boosting, Bagging, Random Forests.	
UNIT IV – SPARSE MODELING AND ESTIMATION	**(9)**
Modeling Sequence/Time-Series Data, Deep Learning and Feature Representation Learning. Medical applications case study.	

UNIT V – SCALABLE MACHINE LEARNING	(9)
Online and Distributed Learning, A Selection from Some Other Advanced Topics, e.g., Semi-Supervised Learning, Active Learning, Reinforcement Learning, Inference in Graphical Models, Introduction to Bayesian Learning and Inference, Healthcare Applications Case Study.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. Kevin Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012.
2. Trevor Hastie, Robert Tibshirani, Jerome Friedman, "The Elements of Statistical Learning", Springer 2009.

REFERENCES:

1. Christopher Bishop, "Pattern Recognition and Machine Learning", Springer, 2007.
2. Arvin Agah, "Medical Applications of Artificial Intelligence", CRC Press, 2017.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	3												
2			3		3									
3			3	3										
4			3	3									2	
5									3			2		2
CO (W.A)	3	3	3	3	3				3			2	2	2

22BMX24 - ARTIFICIAL INTELLIGENCE IN HEALTHCARE				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: NIL				

Course Objectives:	• To understand AI fundamentals, its future and intelligent agents, focusing on problem-solving in healthcare. • To explore various search strategies and optimization problems, including constraint satisfaction and case studies. • To infer knowledge on learning methods, rule-based systems, decision tree learning and AI applications in medical diagnosis. • To discuss first-order predicate logic, Prolog programming and reasoning systems, with relevant case studies. • To study intelligent agent architecture, communication, negotiation and biomedical applications of multi-agent systems.

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the knowledge of ethical considerations and regulatory compliance requirements related to AI applications in healthcare.	Ap	40%
CO2	Apply AI algorithms to enhance diagnostic accuracy and personalize treatment plans in healthcare settings.	Ap	40%
CO3	Analyze robotic systems and automated processes using AI techniques to assist in surgery, rehabilitation and patient care, ensuring precision and safety in medical procedures.	An	15%
CO4	Assess AI-driven Systems for Medical Imaging and Signal Processing.	E	5%
CO5	Evaluate cutting-edge AI techniques and their use in biomedical engineering through expert's perspective.	E	Internal Assessment

UNIT I – EXPLORATION OF ARTIFICIAL INTELLIGENCE	**(9)**
Overview of Artificial intelligence - Definition - Future of Artificial Intelligence - Behavioral Characteristics of Intelligent Agents - Typical Intelligent Agents - Problem Solving Approach to healthcare problems.	
UNIT II – PROBLEM SOLVING METHODS	**(9)**
Problem solving Methods - Search Strategies- Uninformed - Informed - Heuristics - Local Search Algorithms and Optimization Problems - Searching with Partial Observations - Constraint Satisfaction Problems - Constraint Propagation - Backtracking Search. Case studies.	
UNIT III – AI DECISION TREE	**(9)**
Learning methods, Rule-based systems- Decision tree learning- Reinforcement learning. AI in Medical diagnosis.	
UNIT IV – KNOWLEDGE REPRESENTATION	**(9)**

First Order Predicate Logic - Prolog Programming - Unification - Forward Chaining-Backward Chaining - Resolution - Knowledge Representation - Ontological Engineering-Categories and Objects - Events - Mental Events and Mental Objects - Reasoning Systems for Categories - Reasoning with Default Information. Case Studies.	
UNIT V – SOFTWARE AGENTS	**(9)**
Architecture for Intelligent Agents - Agent communication - Negotiation and Bargaining - Argumentation among Agents - Trust and Reputation in Multi-agent systems. Biomedical applications.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. M. Tim Jones, "Artificial Intelligence: A Systems Approach", Jones and Bartlett Publishers, Inc.; First Edition, 2015 Reprint. ISBN-13: 978-9380298139.
2. Nils J. Nilsson, "The Quest for Artificial Intelligence", Cambridge University Press, 2009. ISBN-13: 978-0521122931.

REFERENCES:

1. William F. Clocksin and Christopher S. Mellish, "Programming in Prolog: Using the ISO Standard", 5th Edition, Springer, 2012 Reprint. ISBN 978-3-642-55481-0, DOI 10.1007/978- 3-642-5548.
2. Ian Millington, John Funge, "Artificial intelligence for Games", 2nd Edition, Morgan Kaufmann Publishers, CRC Press, 2012, ISBN: 978-0-12-374731-0.
3. S. Russell and P. Norvig, "Artificial Intelligence: A Modern Approach", 3rd Edition, Prentice Hall, 2016. ISBN-1537600311, 97-81537600314.
4. David L. Poole and Alan K. Mackworth, "Artificial Intelligence: Foundations of Computational Agents", Cambridge University Press, 2010. ISBN-13: 978-0521519007.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3		3					3						
2	3	3												
3			3	3		3							3	
4		3												
5							3							3
CO (W.A)	3	3	3	3		3	3	3					3	3

22BMX25 - DEEP LEARNING TECHNIQUES				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: NIL				
Course Objectives:	• To Apply Machine Learning Algorithms to Solve Diverse Real-World Problems. • To Implement Deep Learning Architectures for Effective Data Classification. • To Analyze and Optimize Convolutional Neural Networks for Complex Tasks • To Develop Efficient Recurrent Neural Networks and Recursive Nets for Sequential Data. • To Design and Implement Autoencoders and Generative Models for Data Synthesis.			

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply Basic Machine Learning Algorithms.	Ap	40%
CO2	Apply the knowledge of Deep Learning Models for Data Analysis.	Ap	40%
CO3	Interpret Techniques for Sequential Data Analysis.	An	15%
CO4	Assess Neural Network Performance.	E	5%
CO5	Analyze complex problems through structured assignments, applying sequential data analysis techniques such as RNNs and LSTM networks.	An	Internal Assessment

UNIT I – MACHINE LEARNING BASICS	**(9)**
Learning algorithms, Maximum likelihood estimation, Building machine learning algorithm, Basic Machine Learning Algorithms: Naive Bayes, Support Vector Machine, Decision Tree, Random Forest, Neural Networks - Multilayer Perceptron, Back-propagation algorithm and its variants stochastic gradient decent, Curse of Dimensionality.	
UNIT II – DEEP LEARNING ARCHITECTURES	**(9)**
Machine Learning and Deep Learning, Representation Learning, Width and Depth of Neural Networks,Activation Functions: RELU, LRELU, ERELU, Unsupervised Training of Neural Networks, Restricted Boltzmann Machines, Auto Encoders, Deep Learning Applications.	
UNIT III – CONVOLUTIONAL NEURAL NETWORKS AND TRANSFER LEARNING	**(9)**
Architectural Overview, Motivation, Layers, Filters, Parameter sharing, Regularization, Popular CNN Architectures ResNet, AlexNet , Applications Transfer learning Techniques, Variants of CNN DenseNet, PixelNet.	
UNIT IV – SEQUENCE MODELING RECURRENT AND RECURSIVE NETS	**(9)**

Recurrent Neural Networks, Bidirectional RNNs, Encoder decoder sequence to sequence architectures BPTT for training RNN, Long Short Term Memory Networks, Neural style transfer in Keras.
UNIT V – AUTOENCODERS AND DEEP GENERATIVE MODELS **(9)**
Under complete Auto encoder, Regularized Autoencoder, stochastic Encoders and Decoders, Contractive. Encoders - Deep Belief networks, Boltzmann Machines, Deep Boltzmann Machine, Generative Adversarial Networks.
TOTAL (L:45) = 45 PERIODS

TEXT BOOKS:
1. Ian Good fellow, Yoshua Bengio and Aaron Courville, Deep Learning, MIT Press, 2017. 2. Josh Patterson, Adam Gibson Deep Learning: A Practitioner's Approach, O'Reilly Media, 2017. 3. Umberto Michelucci Applied Deep Learning. A Case-based Approach to Understanding Deep Neural Networks press, 2018.
REFERENCES:
1. Kevin P. Murphy Machine Learning: A Probabilistic Perspective, The MIT Press, 2012. 2. Ethem Alpaydin, Introduction to Machine Learning, MIT Press, Prentice Hall of India, Third Edition 2014.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2		3												
3				3										3
4	3			3										
5									3			2		
CO (W.A)	3	3		3					3			2		3

22BMX26 - MACHINE VISION				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

PRE-REQUISITE: NIL

Course Objectives:	• To understand the basics and applications of machine vision. • To apply image filtering techniques to improve image quality. • To assess the performance of various edge detection methods. • To study dynamic vision processes like motion detection and tracking. • To analyze methods for recognizing objects based on features and patterns.

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply foundational concepts of machine vision to analyze and interpret visual data effectively.	Ap	40%
CO2	Analyze comprehensive solutions for dynamic vision tasks, including motion detection, object tracking and shape reconstruction from visual data.	An	40%
CO3	Assess the performance of edge detection algorithms in various contexts, employing metrics and benchmarks to measure accuracy and robustness.	E	15%
CO4	Evaluate and select appropriate techniques for image processing and filtering to optimize image quality and enhance feature extraction.	E	5%
CO5	Develop the practical skills needed to apply the knowledge of machine vision concepts in real-world scenarios through assignments.	C	Internal Assessment

UNIT I – MACHINE VISION FUNDAMENTALS	**(9)**
Machine Vision- Relationships to Other Fields-Role of Knowledge-Image Geometry-Perspective Projection-Coordinate Systems-Levels of Computation - Thresholding, Geometric Properties, Size, Position, Orientation, Projections, Run-Length Encoding, Binary Algorithms, Morphological Operators, Optical Character Recognition.	
UNIT II – REGION AND FILTERING BASED PROCESSING	**(9)**
Regions and Edges - Region Segmentation - Region Representation - Split and Merge - Region Growing - Image Filtering - Histogram Modification - Linear Systems - Linear Filters - Median Filter – Gaussian Smoothing	
UNIT III – EDGE DETECTION	**(9)**
Gradient - Steps in Edge Detection - Comparison- Second Derivative Operators: Laplacian Operator, Second Directional Derivative, Laplacian of Gaussian, Image Approximation - Gaussian Edge Detection, Canny Edge Detector - Subpixel Location Estimation - Edge Detector Performance - Methods for Evaluating Performance - Figure of Merit - Sequential Methods - Line Detection.	
UNIT IV – DYNAMIC VISION	**(9)**
Change Detection - Change Detection - Segmentation using Motion - Motion Correspondence – Image flow - Segmentation using a Moving Camera - Tracking - Shape from Motion	

UNIT V – OBJECT RECOGNITION	(9)
System Components - Complexity of Object Recognition - Object Representation: Observer-Centered Representations, Object-Centered Representations - Feature Detection - Recognition Strategies: Classification, Matching, Feature Indexing - Verification: Template Matching, Morphological Approach, Symbolic, Analogical Methods.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. Ramesh Jain, Ramesh C Jain, Machine Vision, pp., McGraw Hill, 1995.
2. Fabio Solari, Manuela Chessa, Silvio P. Sabatini, Machine vision Applications and Systems, BoD Books on Demand, 2012.
3. J. Shi and C. Tomasi, Good Features to Track. In IEEE Conference on Computer Vision and Pattern Recognition, 1994.

REFERENCES:

1. D. G. Lowe, Distinctive Image Features from Scale-Invariant Keypoints. In International Journal of Computer Vision, 2004.
2. D. Comaniciu and P.Meer, Robust analysis of feature spaces: Color image segmentation. IEEE.
3. Conference on Computer Vision and Pattern Recognition, June 1997, 750-755.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2			3		3								2	
3		3		3										2
4			3											2
5									3			2	2	
CO (W.A)	3	3	3	3	3				3			2	2	2

22BMX27 - BIOMETRIC SYSTEM				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: NIL				

Course Objectives:	• To understand the general principles of design of biometric systems and the underlying trade-offs. • To study the technologies of fingerprint. • To study the technologies of face recognition and hand geometry. • To study the technologies of iris. • To study the technologies of speech recognition and evaluation of biometrics systems.

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Explain Various Biometric Technologies and their Applications.	Ap	40%
CO2	Apply biometric recognition techniques to recognize and classify biometric features.	An	40%
CO3	Analyze biometric system performance.	An	15%
CO4	Infer integration strategies and security considerations in combining biometric modalities for enhanced authentication.	An	5%
CO5	Articulate emerging trends in biometrics, including multimodal systems and security implications, through guest lectures.	C	Internal Assessment

UNIT I – INTRODUCTION TO BIOMETRICS	**(9)**
Introduction and back ground – biometric technologies – passive biometrics – active biometrics – Biometric characteristics, Biometric applications – Biometric Authentication systems- Taxonomy of Application Environment, Accuracy in Biometric Systems- False match rate- False non match rate- Failure to enroll rate- Derived metrics-Biometrics and Privacy.	
UNIT II – FINGERPRINT TECHNOLOGY	**(9)**
History of fingerprint pattern recognition - General description of fingerprints- fingerprint sensors, fingerprint enhancement, Feature Extraction- Ridge orientation, ridge frequency, fingerprint matching techniques- correlation based, Minutiae based, Ridge feature based, fingerprint classification, Applications of fingerprints, Finger scan- strengths and weaknesses, Evaluation of fingerprint verification algorithms.	
UNIT III – FACE RECOGNITION AND HAND GEOMETRY	**(9)**
Introduction to face recognition, face recognition using PCA, LDA, face recognition using shape and texture, face detection in color images, 3D model based face recognition in video images, Neural networks for face recognition, Hand geometry – scanning – Feature Extraction – classification.	
UNIT IV – IRIS RECOGNITION	**(9)**
Introduction, Anatomical and Physiological underpinnings, Iris sensor, Iris representation and localization- Daugman and Wilde's approach, Iris matching, Iris scan strengths and Weaknesses, System performance, future directions.	

UNIT V – VOICE SCAN AND MULTIMODAL BIOMETRICS	(9)
Voice scan, speaker features, short term spectral feature extraction, Mel frequency cepstral coefficients, speaker matching, Gaussian mixture model, NIST speaker Recognition Evaluation Program, Introduction to multimodal biometric system – Integration strategies – Architecture – level of fusion – combination strategy, examples of multimodal biometric systems, Securing and trusting a biometric transaction – matching location – local host - authentication server – match on card (MOC).	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. James Wayman& Anil Jain, "Biometric Systems- Technology Design and Performance Evaluation", SPRINGER (SIE), 1st Edition, 2011.
2. Paul Reid, "Biometrics for Network Security", Pearson Education, 2004.
3. S.Y. Kung, S.H. Lin, M.W., "Biometric Authentication: A Machine Learning Approach", Prentice Hall, 2004.

REFERENCES:

1. Nalini K Ratha, Ruud Bolle, "Automatic fingerprint recognition system", Springer, 2003.
2. L C Jain, I Hayashi, S B Lee, U Halici, "Intelligent Biometric Techniques in Fingerprint and Face Recognition", CRC Press, 1st Edition, 1999.
3. John Chirillo, Scott Blaul, "Implementing Biometric Security", John Wiley & Sons, 2003.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2		3												
3				3										
4						3								
5					3							2		3
CO (W.A)	3	3		3	3	3						2		3

22BMX28 - BRAIN COMPUTER INTERFACE AND APPLICATIONS				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: NIL				

Course Objectives:	• To understand the basics of BCI systems, including their structure, types, and EEG signal processing. • To gain knowledge on various brain signals and neural activities relevant to BCIs. • To analyze different techniques for extracting features from brain signals for BCI applications. • To apply various methods for translating brain signal features into control commands. • To explore practical applications of BCIs in neuroprosthetics, device control and specific case studies.

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the fundamental principles, structures and classification of BCI systems.	Ap	40%
CO2	Analyze and preprocess EEG signals effectively, including artifact removal and signal enhancement techniques.	An	40%
CO3	Interpret BCI applications for external device control and functional restoration.	An	15%
CO4	Assess advanced feature extraction and translation methods such as wavelets, PCA and neural networks for BCI data analysis.	E	5%
CO5	Report real-world applications of BCI technology, including neuroprosthetics and mobile robot control, through case studies to evaluate the implementation challenges and successes of BCI systems.	E	Internal Assessment

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 (L:45) : 45 PERIODS	

TEXT BOOKS:

1. Bernhard Graimann, Brendan Allison and Gert Pfurtscheller, "Brain-Computer Interfaces: Revolutionizing Human-Computer Interaction", Springer, 2010.

REFERENCES:

1. R. Spehlmann, "EEG Primer", Elsevier Biomedical Press, 1981.
2. Fred A Mettler, Milton J Guiberteau, "Essentials of Nuclear Medicine and Molecular Imaging" 7th Edition, Elseiver, 2018.
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.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2			3	3										
3		3												
4					3									3
5						3		3				2		
CO (W.A)	3	3	3	3	3	3		3				2		3

22BMX31 - BIOMECHANICS				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE: NIL

Course Objectives:	• To understand the fundamentals of fluid properties and classification, stress, and strain in fluids and non-fluids. • To analyze different types of fluid flows and measure viscosity in various flow conditions. • To explore the development and behavior of the boundary layer and the nature of turbulence. • To evaluate friction loss, velocity distribution, and blood flow dynamics in the human circulatory system. • To apply control theory and mechanical analysis to circulatory systems, focusing on myocardial mechanics and fluid dynamics of heart valves.

Course Outcomes The student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the knowledge of the mechanical properties and behaviors of biological materials such as bones, muscles and soft tissues.	Ap	30%
CO2	Analyze human motion dynamics and kinematics using biomechanical principles.	An	30%
CO3	Interpret biomechanical analysis techniques in practical applications.	An	20%
CO4	Assess joint mechanics and their implications for human movement.	E	20%
CO5	Apply biomechanical principles through detailed case studies, analyzing real-world scenarios to deepen understanding and problem-solving skills.	Ap	Internal Assessment

UNIT I – INTRODUCTION	**(9)**
Definition and perspective of biomechanics, Kinematic concept for analysing human motion, Kinetic concepts for analyzing human motion, Linear kinetics of human movement, Equilibrium, Angular kinetics of human movement, Anthropometry.	
UNIT II – BIOMECHANICS OF SOLIDS AND FLUIDS	**(9)**
Constitutive Equation, Stress, strain, viscoelasticity, models of viscoelasticity, Flow properties of blood, dynamics of fluid flow in cardiovascular system, Rheology of blood in micro vessels, Bio viscoelastic solids, Lubrication of joints.	
UNIT III – BIOMECHANICS OF HARD AND SOFT TISSUES	**(9)**
Bone: structure, composition, mechanical properties, anisotropy, fracture mechanisms – pseudo elasticity, Structure, function, mechanical properties of: skin, ligaments, skeletal muscles and tendons, Constitutive equations for soft tissues.	
UNIT IV – BIOMECHANICS OF JOINTS	**(9)**

Kinetics and kinematics of joints, Skeletal joints, mechanics of the elbow, mechanics of shoulder, mechanics of spinal column, mechanics of hip, mechanics of knee, mechanics of ankle.	
UNIT V – ORTHOPAEDIC APPLICATIONS	**(9)**
Gait analysis, Qualitative biomechanical analysis to: improve technique, understand injury development, Amputations and prosthetics, prosthetic components, Introduction to 3D printing, Introduction to accelerometer.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. Y.C.Fung, Bio-Mechanics, Mechanical Properties of Tissues, Springer-Verilog, 1993.
2. C. Ross Ether and Craig A. Simmons, Introductory Biomechanics from cells to organisms, Cambridge University Press, New Delhi, 2007.
3. Susan J Hall, Basics of Biomechanics, McGraw Hill Publishing.co. New York, 8th Edition, 2019.

REFERENCES:

1. Dhanjoo N. Ghista, Orthopaedic Mechanics, Academic Press, 1990.
2. Joseph D.Bronzino, Biomedical Engineering Fundamentals, Taylor& Francis, Fourth edition, 2015.
3. John Enderle, Susanblanchard, Joseph Bronzino, Introduction to Biomedical Engineering, Elsevier, Third edition, 2011.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	3						3						
2	3													
3				3										
4			3											
5							3					2		2
CO (W.A)	3	3	3	3			3	3				2		2

22BMX32 - ERGONOMICS				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE: NIL

Course Objectives:	• To get exposed to principles of visual capabilities. • To learn the mechanics of muscle physiology and significance of rest cycle. • To learn spatial compatibility and the relation between control orders and control response. • To know about the measurements and proportions of the human body. • To be familiar with the mathematical models, analysis and design of biomedical devices using case studies.

Course Outcomes The student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply ergonomic principles to optimize workplace environments and interfaces.	Ap	40%
CO2	Analyze physiological responses and ergonomic factors influencing workplace efficiency.	An	40%
CO3	Evaluate the impact of ergonomic design on human performance and safety.	E	15%
CO4	Assess ergonomic solutions integrating human factors and ergonomic principles.	E	5%
CO5	Discover interdisciplinary perspectives on ergonomic principles and their applications through group discussions, enhancing their understanding and application in real-world contexts.	C	Internal Assessment

UNIT I - VISUAL AND AUDITORY ERGONOMICS	**(9)**
Process of seeing – visual capabilities – factors affecting visual acuity and contrast sensitivity – human factor aspects of hard copy text and computer screen text, factors in selecting graphic representations symbols, qualitative visual display – process of hearing – principles of auditory display. Measures for monitoring control & mitigation.	
UNIT II - MUSCLE PHYSIOLOGY	**(9)**
Muscle physiology – muscle metabolism – respiratory response – joint motion study – measure of physiological in-efficiency and energy consumption – work rest cycles – aspects of manual and posture study, material handling (MMH) Bio-mechanical recommended limits of MMH.	
UNIT III - CONTROLS AND DISPLAYS	**(9)**
Spatial compatibility and physical arrangement of displays and controls - Design of displays and controls – movement capability – rotary controls and rotor displays movement of displays orientation of the operator and movement relationships control orders and control responses – human limitations in tracking task.	
UNIT IV - ANTHROPOMETRY	**(9)**
Anthropometry – anthropometric design principles – Physical work load and energy expenditure - work space envelope – factors in design of work space surfaces – principles of seat design – principles of control panel. ergonomic implications. Organization classification of human errors theories of accident causation-reducing accidents by altering behavior.	

UNIT V - CASE STUDIES	(9)
Biomedical Application, Design optimization of Medical Equipment, Ergonomic Keyboard Design for Carpal Tunnel Syndrome, Standing Desk Implementation for Workplace Ergonomics.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. Pascale Carayon, "Handbook of Human Factors and Engineering", 2nd Edition, CRC Press, 2011.
2. Martin Helander, "Guide to Human Factors and Ergonomics", 2nd Edition, CRC Press,2005
3. Benjamin W.Niebel, "Motion and Time Study", Richard, D. Irwin Inc., 7th Edition, 2002.

REFERENCES:

1. Shrawan Kumar, "Biomechanics in Ergonomics", 2nd Edition, CRC Press2007.
2. George Kanawaty, "Introduction to work study", ILO, 3rd Edition, Oxford & IBH Publishing, 2001
3. Stephen Pheasant, Christine M. Haslegrave, Bodyspace: Anthropometry, Ergonomics and the Design of Work, CRC Press, 2005.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	3												
2				3										
3			3			2		2						
4			3										2	
5									3	3				
CO (W.A)	3	3	3	3		2		2	3	3			2	

22BMX33 - FINITE ELEMENT ANALYSIS				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: NIL				
Course Objectives:	• To analyze and model engineering field problems using finite element methods. • To formulate and solve beam and 2D scalar problems using finite element methods. • To develop and apply higher-order and isoparametric elements to plane stress problems. • To evaluate elasticity equations and implement finite element solutions for plane stress, plane strain, and fluid mechanics. • To solve non-linear finite element problems in biomechanical research applications.			

Course Outcomes The student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply mathematical models to analyze how engineering structures behave.	Ap	30%
CO2	Analyze and enhance biomechanical systems using computer models.	An	30%
CO3	Analyze the effects of different conditions on structures and check the accuracy of simulations.	An	20%
CO4	Assess models for engineering applications to enhance product design.	E	20%
CO5	Develop communication skills and critically analyze finite element analysis concepts through researching and presenting seminar topics.	An	Internal Assessment

UNIT I - INTRODUCTION TO MODELLING	**(9)**
Historical Background, Mathematical Modelling of field problems in Engineering, Governing Equations, Natural and Essential Boundary conditions - Basic concepts of the Finite Element Method. One Dimensional Second Order Equations, Discretization, element types- Linear and Higher order Elements Derivation of Shape functions and Stiffness matrices and force vectors.	
UNIT II - BEAM ELEMENTS AND SCALAR PROBLEM IN TWO DIMENSION	**(9)**
Fourth Order Beam Equation Transverse deflections, Natural frequencies of beams and longitudinal vibration. Second Order 2D Equations involving Scalar Variable Variation Formulation Finite Element Formulation Triangular Elements Shape functions and element matrices and vectors. Application to Field Problems in Bio mechanics, Quadrilateral elements.	
UNIT III - APPLICATIONS TO FIELD PROBLEMS	**(9)**
Higher order elements. Natural co-ordinate systems Iso parametric elements Shape functions for isoparametric elements One, two and three dimensions Serendipity elements Numerical integration and application to plane stress problems transformation in coordinates- Jacobian of transformation order of convergence- numerical integration example problems- shape functions in natural coordinates rectangular elements- Lagrange family.	

UNIT IV - NON-LINEAR ANALYSIS	(9)
Introduction to Nonlinear problems, some solution methods, computational procedure, simple material nonlinearity, stress stiffening, contact interfaces, problems of gaps and contact, geometric nonlinearity, modelling considerations.	
UNIT V - IMPACT ANALYSIS	**(9)**
Mechanical properties of biological and commonly used biomedical engineering materials, Critical reviews of finite element analysis in biomechanical research. Modelling and force analysis of musculoskeletal systems, Stress calculations.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. King-Hay Yang, Basic Finite Element Method as Applied to Injury Biomechanics, Elsevier Academic Press. 2017.
2. Connie McGuire, Finite Element Analysis: Biomedical Aspects, NY Research press, 2015.
3. Moratal D., Finite Element Analysis from Biomedical Applications to Industrial Developments, InTech Publisher, 2014.

REFERENCES:

1. J N Reddy, Finite element methods, Tata Mc Graw Hill, 2003.
2. Seshu, Text Book of finite element analysis, Prentice Hall, New Delhi, 2003.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2		3												
3				3										
4			3										3	
5									2	3		2		
CO (W.A)	3	3	3	3					2	3		2	3	

22BMX34 - PHYSIOLOGICAL MODELLING				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE: NIL

Course Objectives:	• To explain the application of Physiological models and vital organs. • To formulate the methods and techniques for analysis and synthesis of dynamic models • To describe the dynamic models, simulate and visualize, dynamic responses of physiological models using software • To describe nonlinear models of physiological systems. • 5. To compute the Simulation of physiological systems.

Course Outcomes The student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Illustrate the application of mathematical models to represent diverse physiological systems, including dynamic, nonlinear and compartmental models.	Ap	40%
CO2	Apply software tools like Open CV and MATLAB to simulate and analyze physiological processes, enhancing understanding and practical application in biomedical research and healthcare.	Ap	5%
CO3	Analyze physiological systems using advanced techniques such as block diagram analysis, Volterra models and compartmental modeling.	An	40%
CO4	Assess the dynamics and control mechanisms of physiological systems, including their responses in both open and closed loop configurations.	E	15%
CO5	Illustrate the Simulation of physiological systems.	Ap	Internal Assessment

UNIT I - INTRODUCTION TO PHYSIOLOGICAL MODELING	**(9)**
Approaches to modelling: The technique of mathematical modelling, classification of models, characteristics of models. Time invariant and time varying systems for physiological modelling. Introduction to physiology (homeostasis, cell biology) Modelling physical systems, linear models of physiological systems, the Laplace transform, Transfer functions and block diagram analysis Physiology.	
UNIT II - MODELING OF DYNAMIC PHYSIOLOGICAL SYSTEM	**(9)**
Dynamic systems and their control, modelling and block diagrams, the pupil control systems(Human Eye), general structure of control systems, the dynamic response characteristics of the pupil control system, open &close loop systems instability, automatic aperture control.	
UNIT III - NONLINEAR MODELS OF PHYSIOLOGICAL SYSTEMS	**(9)**
Nonparametric Modelling-Volterra Models. Wiener Models. Efficient Volterra Kernel Estimation. Parametric Modelling - Basic Parametric Model Forms and Estimation Procedures- Volterra Kernels of Nonlinear Differential Equations. Discrete-Time Volterra Kernels of NARMAX Models.	
UNIT IV - COMPARTMENTENTAL PHYSIOLOGICAL MODEL	**(9)**

Modeling the body as compartments, behaviour in simple compartmental system, pharmacokinetic model, and multi compartmental system. Physiological modelling: Electrical analogy of blood vessels, model of systematic blood flow and model of coronary circulation. Mathematical modelling of the system: Thermo regulation, Thermoregulation of cold bloodedness& warm bloodedness, the anatomy of thermo regulation, lumping & partial differential equations, heat transfer examples, mathematical model of the controlled process of the body.	
UNIT V - SIMULATION OF PHYSIOLOGICALSYSTEMS	**(9)**
Simulation of physiological systems using Open CV / MATLAB software. Biological receptors: - Introduction, receptor characteristics, transfer function models of receptors, receptor and perceived intensity. Neuromuscular model, Renal System, Drug Delivery Model.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. Michel C Khoo, "Physiological Control Systems -Analysis, simulation and estimation", Prentice Hall of India, 2001.
2. Marmarelis, "Nonlinear Dynamic Modeling of Physiological Systems", Wiley-IEEE Press,2004.

REFERENCES:

1. Benjamin C Kuo, "Automatic control systems", Tenth Edition, McGraw-Hill Education, 2017.
2. MinruiFei, Shiwei Ma, Xin Li, Xin Sun, Li Jia and Zhou Su,"Advanced Computational Methods in Life System Modeling and Simulation", Springer,2017.
3. DavidTWestwick, Robert E. Kearney, Identification of Nonlinear PhysiologicalSystems, Wiley-IEEE Press, 2003.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2		3												
3				3										
4					3		2							3
5					3									3
CO (W.A)	3	3		3	3		2							3

22BMX35 - CARDIOVASCULAR ENGINEERING				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

PRE-REQUISITE: NIL

Course Objectives:	• To Understand Cardiovascular Functions. • To Analyze Cardiac Events and Cycles. • To infer knowledge on Cardiac Excitation and Regulation. • To Assess Cardiac Output Methods. • To Evaluate Hemodynamics Principles.

Course Outcomes The student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply knowledge of cardiac physiology and hemodynamics to assess and monitor patients' cardiovascular health, aiding in the diagnosis and treatment of cardiac conditions.	Ap	40%
CO2	Compare new treatments and interventions using cardiovascular physiology principles.	An	40%
CO3	Interpret clinical data and use it to inform medical decisions.	An	15%
CO4	Assess medical devices by using principles of cardiac excitation, contraction and hemodynamics.	E	5%
CO5	Articulate a research-based report, analyzing medical device testing to comprehend the causes of heart diseases and their connection to suitable treatments.	An	Internal Assessment

UNIT I – OVERVIEW OF THE CARDIOVASCULAR SYSTEM	**(9)**
Functions of the cardiovascular system, Circulation of blood, Central control of the cardiovascular system.	
UNIT II – CARDIAC CYCLE	**(9)**
Mechanical events, Arterial cycle and central venous pressure cycle, Clinical aspects of human cardiac cycle.	
UNIT III – CARDIAC EXCITATION AND CONTRACTION	**(9)**
Mechanism of contraction, Sinoatrial node function, cardiac conduction system, Atrioventricular node function, Autonomic regulation of the heart rate.	
UNIT IV – ASSESSMENT OF CARDIAC OUTPUT	**(9)**
Fick principle, Thermodilution and indicator dilution methods, Pulse Doppler methods, miscellaneous methods.	
UNIT V – HEMODYNAMICS	**(9)**

Relationship between pressure, flow and resistance, Frank-Starling law, Preload, after load and contractility, Control of stroke volume and cardiac output
TOTAL(L:45) = 45 PERIODS

TEXT BOOKS:
1. Susan J Hall, Basics of Biomechanics, McGraw Hill Publishing.co. New York, 8th Edition, 2018. 2. Dhanjoo N.Ghista, Orthopaedic Mechanics, Academic Press, 2014.
REFERENCES:
1. Joseph D.Bronzino, Biomedical Engineering Fundamentals, Taylor& Francis, 2006. 2. John Enderle, Susanblanchard, Joseph Bronzino, Introduction to Biomedical Engineering, Elsevier, 2005.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	3				2								
2			3					2					2	
3				3										
4				3										
5				3			3					2		
CO (W.A)	3	3	3	3		2	3	2				2	2	

22BMX36 - REHABILITATION ENGINEERING				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE: NIL

Course Objectives:	• To explain the need for medical aids. • To understand the sensory rehabilitation systems. • To learn the use of orthopedic prosthetics and orthotics in rehabilitation. • To understand virtual reality in rehabilitation. • To have an understanding of rehabilitation medicine and advocacy.

Course Outcomes The student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply the knowledge of roles and functions of the rehabilitation team and the principles of community-based rehabilitation to enhance proper delivery of care.	Ap	40%
CO2	Analyze engineering concepts in sensory augmentation and substitution, including visual, auditory and tactual systems to develop effective sensory aids.	An	40%
CO3	Analyze modern tools such as virtual reality and robotics to develop innovative rehabilitation systems and enhance mobility recovery.	An	15%
CO4	Assess orthopedic prosthetics, orthotics and functional electrical stimulation systems for motor rehabilitation using engineering principles.	E	5%
CO5	Develop insights into rehabilitation engineering advancements by engaging with industry experts, integrating academic knowledge with real-world practices.	C	Internal Assessment

UNIT I - INTRODUCTION TO REHABILITATION	**(9)**
Definition - Impairments, disabilities and handicaps, Primary and secondary disabilities, Activities of daily living, Appropriate Technology, Residual function. Rehabilitation. Rehabilitation team – members and their functions. Rehabilitation care –Need for proper delivery of rehabilitation care, Community based rehabilitation and its aspects.	
UNIT II - ENGINEERING CONCEPTS IN SENSORY AUGMENTATION AND SUBSTITUTION	**(9)**
Sensory augmentation and substitution- Visual system: Visual augmentation, Tactual vision substitution, and Auditory vision substitution. Auditory system- Auditory augmentation, Hearing aids, cochlear implants, visual auditory substitution, tactual auditory substitution. Tactual system - Tactual augmentation, Tactual substitution.	
UNIT III - ORTHOPEDIC PROSTHETICS AND ORTHOTICS	**(9)**
Engineering concepts in motor rehabilitation, Artificial limbs- body powered, externally powered and controlled orthotics and prosthetics, Myoelectric hand and arm prosthetics. Functional Electrical Stimulation Systems-Restoration of hand function, restoration of standing and walking, Hybrid Assistive Systems (HAS).	
UNIT IV - VIRTUAL REALITY	**(9)**

Introduction to virtual reality, Virtual reality-based rehabilitation, Hand motor recovery systems with Phantom haptics, Robotics and Virtual Reality Applications in Mobility Rehabilitation.	
UNIT V - REHABILITATION MEDICINE AND ADVOCACY	**(9)**
Physiological aspects of Function recovery, psychological aspects of Rehabilitation therapy, Legal aspect available in choosing the device and provision available in education, job and in day-to-day life.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. Joseph D Bronzino, "The Biomedical Engineering Handbook". 2nd edition, CRC Press, 2000.
2. Robinson C.J, "Rehabilitation Engineering", CRC Press, 2006.

REFERENCES:

1. Sashi S Kommu, "Rehabilitation Robotics", 1st edition, CRC Press, 2007.
2. Sunder, "Textbooks of Rehabilitation", Jaypee Brothers Medical Publishers Pvt. Ltd, New Delhi, 2nd Edition, Reprint 2007.
3. Horia- Nocholai Teodorecu, L.C.Jain, "Intelligent systems and technologies in rehabilitation Engineering", CRC; December 2000.
4. Etienne Grandjean, Harold Oldroyd, "Fitting the task to the man", Taylor & Francis, 1988.
5. Keswick. J., "What is Rehabilitation Engineering, Annual Reviews of Rehabilitation", Springer Verlag, New York, 1982.
6. Warren E. Finn, Peter G. Lopressor, "Handbook of Neuroprosthetic Methods",CRC, 2002.
7. Roy A Cooper (Editor), Hisaichi Ohnabe (Editor), Douglas A. Hobson (Editor), "An Introduction to Rehabilitation Engineering (Series in Medical Physics and Biomedical Engineering" CRC Press, 2000.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2		3												
3			3	3										
4					3									3
5							3					3		
CO (W.A)	3	3	3	3	3		3					3		3

22BMX37 - PROSTHETIC AND ORTHOTIC DEVICES				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE: NIL

Course Objectives:	• To apply suitable assistive technology (AT) for human mobility. • To analyze sensory impairment of vision and hearing and suggest suitable aiding devices. • To explore recent advancements in assistive technology for vital organs. • To evaluate an assistive device for a given organ impairment. • To assess the performance of an implant design based on its performance parameters.

Course Outcomes The student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the knowledge of the advanced control systems and virtual reality applications in the context of assistive technologies and healthcare innovations.	Ap	40%
CO2	Apply the knowledge on advanced assistive devices to enhance healthcare outcomes and patient quality of life.	An	40%
CO3	Analyze clinical challenges through the integration of innovative assistive technologies and effective implant solutions.	An	15%
CO4	Assess proficient implant design principles and methodologies to address complex healthcare needs.	E	5%
CO5	Correlate industry insights, analyze diverse perspectives and enhance communication skills to evaluate societal, health, safety, legal, and cultural issues in professional engineering practice.	E	Internal Assessment

UNIT I – ASSISTIVE TECHNOLOGY FOR MOBILITY	**(9)**
Basic assessment and evaluation for mobility, Control systems, navigation in virtual space by wheelchairs, Wheel chair seating and pressure ulcers, Fuzzy logic expert system for automatic tuning of myoelectric prostheses, Intelligent prosthesis.	
UNIT II – ASSISTIVE TECHNOLOGY AND SENSORY IMPAIRMENTS	**(9)**
Visual and auditory impairment, assessment methods, Libraille, GRAB, mathematical Braille, Augmentative and alternative methods for hearing impairment, Use of multimedia technology to help hard of hearing children, Haptic as a substitute for vision.	
UNIT III – ASSIST DEVICES FOR VITAL ORGANS AND ADVANCEMENTS IN TECHNOLOGY	**(9)**
Cardiac assist devices, Intra-Aortic Balloon Pump (IABP), auxiliary ventricles, Dialysis for kidneys, Intermittent positive pressure breathing (IPPB) type assistance for lungs, Latest use of assistive technology for chronic heart diseases and healthcare, Information technology, telecommunications, new media in assisting healthcare, Future trends in assistive technology, virtual reality based training system for disabled children.	
UNIT IV – PRINCIPLES OF IMPLANT DESIGN	**(9)**

Principles of implant design, cardiac implants, Clinical problems requiring implants for solution, Permanent versus absorbable devices, the missing organ and its replacement, Tissue engineering, scaffolds, cells and regulators criteria for materials selection, Case study of organ regeneration.	
UNIT V – IMPLANT DESIGN PARAMETERS AND ITS SOLUTION	**(9)**
Biocompatibility, local and systemic effects of implants, Design specifications for tissue bonding and modulus matching, Degradation of devices, natural and synthetic polymers, corrosion, wear and tear, Implants for Bone, Devices for nerve regeneration, dental and otologic implants.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. Yadin David, Wolf W. von Maltzahn, Michael R. Neuman, Joseph.D, Bronzino, Clinical Engineering, CRC Press, 1st edition, 2010.
2. Kenneth J. Turner, Advances in Home Care Technologies: Results of the match Project, Springer, 1st edition, 2012.

REFERENCES:

1. Gerr, M. Craddock, Assistive Technology-Shaping the future, IOS Press, 1st edition, 2003.
2. Marion. A. Hersh, Michael A. Johnson, Assistive Technology for visually impaired and blind, Springer Science & Business Media, 1st edition, 2010.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2				3									2	
3		3		3										
4			3			3								
5						3	3	3						
CO (W.A)	3	3	3	3		3	3	3					2	

22BMX38 - HAPTICS				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE: NIL

Course Objectives:	• To comprehend the fundamentals of human haptics including the somatosensory system, motor system, and muscle physiology. • To design and evaluate haptic devices with a focus on human factors. • To understand and assess haptic sensors and actuators, addressing ergonomic barriers. • To implement and analyze computational haptics for various applications, focusing on rendering and stability. • 5. To explore and apply haptic technology in medical applications such as telemedicine, rehabilitation, and educational simulations.

Course Outcomes The student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the knowledge on the fundamentals of human haptic perception and its application in interface design.	Ap	40%
CO2	Analyze haptic systems using various sensor and actuator technologies.	An	40%
CO3	Assess advanced haptic rendering techniques and control methodologies in virtual environments.	E	15%
CO4	Evaluate applications of haptics in medical simulation, rehabilitation, virtual reality and other emerging fields.	E	5%
CO5	Articulate seminars effectively on haptics, demonstrating deep understanding and critical analysis of current advancements and applications.	E	Internal Assessment

UNIT I - INTRODUCTION	**(9)**
Touch, Sense of Touch, Perception of world through touch, Haptics, Tactile system, Tactile receptors, Sensory and Motor specialization of Hand, Haptic perception, Haptic Illusion, Tactile and Haptic Displays, Haptic exploration, Concepts and terminologies.	
UNIT II - HUMAN HAPTIC PERCEPTION	**(9)**
Introduction, Touch and cognition, Human Haptic system: Mechanical structure of Arm, Hand haptics system, Human sensory system, The motor system, Haptic cognition, Haptic exploration, Concept of Illusion, Human perceptual parameters for Haptics: Interface development, Perception Thresholds.	
UNIT III - MACHINE HAPTICS	**(9)**
Introduction, Haptic Interfaces: Robotic perspective, Haptic interface system, HAVE sensor: Electromechanic sensors, Optical sensors, Capacitive sensor, Resistive sensor, Force sensors, strain gauge sensors, Magnetic sensor, HAVE actuators: Magnetic Levitation Devices, Nonholonomic devices, Magnetic sensors and parallel mechanisms, performance specifications: physical attributes, special attributes and temporal attributes.	

UNIT IV - COMPUTER HAPTICS	(9)
Introduction, Haptic rendering subsystems, Polygon, based representation and scene graph, collision detection techniques and bounding volumes, control methods for Haptic systems: Impedance control architecture, Feed, forward impedance control architecture, positive feedback Impedance control architecture, Hybrid compensation Impedance control architecture, Admittance control architecture.	
UNIT V - HAPTICS APPLICATIONS	**(9)**
Introduction, Haptics for Medical Applications: Surgical simulation, stoke based rehabilitation, support of the visually impaired, Tele, surgery, Media: Haptic broadcasting. E, commerce, Video games, other application: Mobile Haptics, Haptics and VR, Introduction to Wearable Haptic devices.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. Lynette Jones, Haptics, The MIT Press, 2018.
2. Abdulmotaleb El Saddik, Mauricio Orozco, Mohamad Eid, Jongeun Cha, Haptics Technologies: Bringing Touch to Multimedia, Springer Science & Business Media, 2011.
3. Tom Bruno, Wearable Technology: Smart Watches to Google Glass for Libraries, Rowman & Littlefield Publishers, Lanham, Maryland, 2015.

REFERENCES:

1. Hiroyuki Kajimoto, Masashi Konyo, Shoichi Hasegawa, Takuya Nojima, Ki-Uk Kyung, Haptic Interaction: Science, Engineering and Design. (2017). Switzerland: Springer Nature Singapore.
2. Abdulmotaleb El Saddik, Mauricio Orozco, Mohamad Eid, Jongeun Cha, Haptics. Technologies Bringing Touch to Multimedia, Springer, 2011.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2		3												
3				3										
4					3									3
5									3	2				
CO (W.A)	3	3		3	3				3	2				3

22BMX41 - HOSPITAL PLANNING, ORGANIZATION AND MANAGEMENT				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: NIL				

Course Objectives:	• To learn about the sole proprietorship and partnership to the principles of management and evolution. • To know about the importance of hospital management and the process of forecasting techniques and decision-making process. • To understand the pattern of staffing, selection and recruiting process to the training of organizational and career development. • To infer knowledge on the basic marketing in health sector with a principle to social marketing. • To know about system development of life cycle and main categories of information systems in hospital.

Course Outcomes The student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Explain how the hospital environment contributes to the delivery of quality patient care and overall patient experience.	Ap	40%
CO2	Analyze the essential elements required for effective hospital planning and management.	An	40%
CO3	Illustrate key considerations in the planning and designing of hospital services to ensure efficient and effective operations.	An	15%
CO4	Articulate the functional requirements necessary for delivering high-quality patient care within a hospital setting.	An	5%
CO5	Develop communication skills and critically analyze hospital management concepts through seminars.	An	Internal Assessment

UNIT I – FORMS OF ORGANISATION	**(9)**
Sole Proprietorship, Partnership, Company - Public and Private Sector Enterprises, Principles of Management, Evolution of Management.	
UNIT II - PRINCIPLE OF HOSPITAL MANAGEMENT	**(9)**
Importance of Management and Hospital, Management Control Systems. Forecasting Techniques Decision-making Process.	
UNIT III – STAFFING	**(9)**
Staffing Pattern in Hospitals, Selection, Recruiting Process, Training of Staff, Organizational Structures, Career Development.	
UNIT IV – MARKETING AND MANAGEMENT	**(9)**
Basic Concepts Marketing, Principles of Social Marketing, Social Marketing in Health Sector, Consumer Behavior and Research Health, Advertising in Health Sector, Relevance of e-marketing of Health Care Services.	

UNIT V – COMPUTER IN HOSPITAL	(9)
System Development Life Cycle, Reasons to use Computers in Hospital, Main Categories of Information Systems in Hospitals.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. G. D. Kunders, "Hospitals: Facilities Planning and Management", Tata Mc Graw Hill Education, New Delhi, 2004.
2. Goyal R.C., "Human Resource Management in Hospital", Prentice Hall of India Pvt. Ltd., New Delhi, 2000.

REFERENCES:

1. Nauhria R.N. and Rajnish Prakash, "Management & Systems", New Delhi Wheeler Publishing, 1995.
2. Syed Amin Tabish, "Hospitals & Nursing Homes: Planning, Organisations & Management", Jaypee Brothers Medical Publishers (P) Limited, 2003.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1		3												
2	3			3										
3			3											
4			3										3	
5									3	3				
CO (W.A)	3	3	3	3					3	3			3	

22BMX42 - HOSPITAL ARCHITECTURE				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE: NIL

Course Objectives:	• To gain knowledge on various framework and structure of health care system. • To know all the facets of hospital planning • To learn the newest findings in the area of hospital planning. • To implement the perspectives in constructing hospital standards. • To be studious in hospital planning activities covering every department.

Course Outcomes The student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply principles of healthcare facility planning to optimize design and functionality of hospital environments.	Ap	40%
CO2	Illustrate best practices in hospital facility management, including waste management and infrastructure maintenance, to support quality patient care.	An	40%
CO3	Explain about healthcare service planning to enhance operational effectiveness across administrative, medical, and support services.	An	15%
CO4	Evaluate and implement standards and norms in hospital design and construction to ensure safety and efficiency.	E	5%
CO5	Deduce advanced strategies and methodologies in hospital planning and management from seminar discussions.	An	Internal Assessment

UNIT I – INTRODUCTION TO HEALTH CARE SYSTEM	**(9)**
International and National Level Policy Framework for Healthcare Facilities – Types of Healthcare Facilities based on Public and Private Ownership, Bed Size and Type of Health Care Services based on Outpatient, Inpatient and Diagnostic Care - Organizational, Function and Structure of the Hospital.	
UNIT II – HOSPITAL PLANNING	**(9)**
Principles of Planning, Regionalization, Hospital Planning Team, Planning Process, Size of the Hospital, Site Selection, Hospital Architect, Architect Report, Equipping a Hospital, Interiors & Graphics, Construction & Commissioning, Planning for Preventing Injuries, Electrical Safety.	
UNIT III – PLANNING & DESIGNING OF DIFFERENT SERVICES IN HOSPITALS	**(9)**
Planning and Designing of Administrative Services, Medical and Ancillary Services, Nursing Services, Supportive Services, Public Areas and Staff Services, Hospital Services of Training Methods and their Benefits - Executive Development Programme – Common Practices - Benefits, Self-development - Knowledge Management.	

UNIT IV – STANDARDS AND NORMS FOR HOSPITALS	(9)
Design and Construction Standards for the Hospitals namely BIS – India and JCAHO, AIA and NHS – General Guidelines and Standard for Out-patient Area, In-patient Area and Diagnostic Area in the Hospitals. Voluntary & Mandatory Standards, General Standards, Mechanical Standards, Electrical Standards, Standard for Centralized Medical Gas System, Standards for Biomedical Waste.	
UNIT V – FACILITIES FOR SUPPORTIVE SERVICES	**(9)**
Transport, Information System, Communication, Food Services, Mortuary, Heating Ventilation and Air Conditioning, Medical Gases, House Keeping, Laundry.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. G.Kunders, "Hospitals - Facilities Planning & Management", Tata McGraw - Hill Education, 2004.
2. Purnima Sharma, Sangeet Sharma, Nerendra Malhotra, Jaideep Malhotra, "Step by Step Hospital Designing and Planning", 2nd Edition, Jaypee Brothers-Medical Publishers, New Delhi, 2010.

REFERENCES:

1. S.K.Gupta, S.kant, R.Chandrashekhar, S.Satpathy, "Modern trends in Planning and Designing of Hospitals: Principles and Practice", Jaypee Brothers-Medical publishers, New Delhi, 2007.
2. Sa Tabish, "Hospital and Nursing Homes Planning, Organisation and Management", Jaypee Brothers-Medical Publishers, New Delhi, 2003.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												2	
2				3										2
3		3				3								
4		3												
5									3	3		2		
CO (W.A)	3	3		3		3			3	3		2	2	2

22BMX43 - FINANCE MANAGEMENT IN HOSPITALS				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE: NIL

Course Objectives:	• To learn the scope and goal of financial management. • To infer knowledge on the basic principles and processes involved in the accounting.. • To develop skills in analyzing various technical and analytical tools for accounting. • To understand the basic budgetary control in cost and volume with profit analysis • To enhance skills in decision-making in a hospital setting and practice the preparation of final accounts.

Course Outcomes The student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply financial management principles to optimize resource allocation in healthcare organizations.	Ap	40%
CO2	Analyze financial statements to evaluate healthcare facility performance and support decision-making.	An	40%
CO3	Interpret cost accounting techniques to control operational expenses and enhance efficiency in healthcare settings.	An	15%
CO4	Evaluate strategic financing decisions to promote financial stability and growth in healthcare contexts.	E	5%
CO5	Appraise expert insights to innovate healthcare management practices, integrating strategies for optimizing operational efficiency and enhancing patient care outcomes.	E	Internal Assessment

UNIT I – INTRODUCTION	**(9)**
Finance Function – Meaning – Definition - Scope of Finance Function- Executive Functions & Incidental Functions - Scope and Goal of Financial Management in Hospitals – Profit Maximization & Wealth Maximization.	
UNIT II – ACCOUNTING TECHNIQUES	**(9)**
Types of Accounting, Hospital Accounting - Financial Book Keeping, Book Keeping Obligations. Accounting Concepts & Conventions – Final Accounts: Trading – Profit & Loss Accounts - Balance Sheet.	
UNIT III – COSTING IN HOSPITALS	**(9)**
Nature & Scope of Cost Accounting – Cost Analysis & Classification - Cost Calculation, Significance of Internal Billing in Hospital - Necessary for Internal & External Controlling Cost, Cost Unit Calculation.	

UNIT IV – MANAGEMENT ACCOUNTING	(9)
Budgeting & Budgetary control – Cost – Volume – Profit Analysis.	
UNIT V – FINANCING DECISIONS	**(9)**
Cost of Capital & Capital Structure – Sources of Short Term Finance: Management of Working Capital – Sources of Long Term Finance: Share Capital, Debentures - Corporate Debit Capacity.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. G R Kulkarni, P Satyashankar, Libert Anil Gomes, "Financial Management for Hospital", 2009.
2. I M Pandey Vikas, "Financial Management", Publishing Co., 1999.
3. Jaypee Brothers "Administration", Medical Publishers Pvt. Limited, 01-Jul-2009.

REFERENCES:

1. James C.Vanhorne, "Financial Management and Policy", 9th Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 1995.
2. Michael Nowicki, "The Financial Management of Hospitals and Healthcare Organizations", Health Administration Press, 2008.
3. Prasanna Chandra, "Financial Management", 1st Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3										3			
2		3									3			
3				3							3		3	
4			3								3			
5						3	3				3			
CO (W.A)	3	3	3	3		3	3				3			

22BMX44 - HUMAN RESOURCES MANAGEMENT IN HOSPITAL				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE: NIL

Course Objectives:	• To know about the evolution of human resource management. • To infer knowledge on the organizational job design and the forecasting of human resource requirements. • To be studious on the type of training method in the executive development programme. • To encompass the strategy of employee sustainability. • To acquaint various methods involved in performance appraisal.

Course Outcomes The student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply legal frameworks to ensure compliance with labor laws in healthcare HRM practices.	Ap	40%
CO2	Interpret diverse recruitment strategies to align workforce capabilities with organizational goals.	An	40%
CO3	Analyze the comprehensive appraisal systems to assess employee performance effectively.	An	15%
CO4	Evaluate strategic HRM theories to optimize organizational effectiveness in healthcare.	E	5%
CO5	Articulate contemporary HRM strategies through seminars to enhance organizational efficiency and employee engagement.	U	Internal Assessment

UNIT I – PERSPECTIVES OF HUMAN RESOURCE MANAGEMENT	**(9)**
Evolution of Human Resource Management - Importance of Human Factor, Objectives of Human Resource Management - Human Resource Policies - Need for HRD/HRM in Healthcare Organization - Computer Applications in Human Resource Management.	
UNIT II – THE CONCEPT OF BEST FIT EMPLOYEE	**(9)**
Organizational Job Design - Job Description - Job Analysis - Job Rotation-job Evaluation- Man-power Planning- Importance of Human Resource Planning, Forecasting of Human Resource Requirements - Selection Procedures - Test, Validation, Interviews, Recruitment, Medical Examination.	
UNIT III – TRAINING & EXECUTIVE DEVELOPMENT	**(9)**
Types of Training Methods and their Benefits - Executive Development Programme – Common Practices - Benefits, Self-development - Knowledge Management.	
UNIT IV – SUSTAINING EMPLOYEE INTEREST	**(9)**

Wage and Salary Administration – Concept of Incentives and its Operational Implications – Participative Decision making – Concept of Collective Bargaining – Compensation Plans – Rewards – Motivation – Theories of Motivation - Grievances and Redressal Methods.

UNIT V – PERFORMANCE APPRAISAL **(9)**

Importance of Performance Appraisal - Methods of Performance Evaluation - Traditional Methods – Modern Methods – Feedback – Promotion – Demotion – Transfer. Implications of Job Change. The Control Process, Methods and Requirements of Effective Control System.

TOTAL(L:45) = 45 PERIODS

TEXT BOOKS:

1. D. K. Sharma, R. C. Goyal, "Hospital Administration and Human Resource Management", PHI Learning Pvt. Ltd., 2013.
2. Decenzo and Robbins, "Human Resource Management", Wiley & Sons, Singapore, 1999.

REFERENCES:

1. Mamoria C.B. and Mamoria S., "Personnel Management", Himalaya Publishing Company, 1997.
2. R.C.Goyal, "Human Resource Management in Hospitals", Prentice Hall of India, 2000.
3. Walter J. Flynn, Robert L. Mathis, John H. Jackson, "Healthcare Human Resource Management", 2006.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3			3		3								
2	3	2												
3				3				3						
4			3											2
5									3	3		2		
CO (W.A)	3	2	3	3		3		3	3	3		2		2

22BMX45 - HEALTH POLICY AND EQUIPMENT MANAGEMENT				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE: NIL

Course Objectives:	• To learn about the various health care systems. • To infer knowledge on various health policies. • To introduce the equipment maintenance management skills. • To enlighten students on logistics support and reliability required for hospitals. • To protect equipment from electromagnetic interferences.

Course Outcomes The student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply principles of Electromagnetic Interference (EMI) management to safeguard hospital equipment and ensure operational integrity.	Ap	40%
CO2	Explain effective equipment maintenance strategies in healthcare settings using systematic approaches.	An	40%
CO3	Analyze logistic support systems to ensure reliability and availability of hospital equipment.	An	15%
CO4	Evaluate national health policies and their impact on healthcare delivery systems.	E	5%
CO5	Deduce strategic decision-making in healthcare management through insights from health policy seminars.	An	Internal Assessment

UNIT I – HEALTH SYSTEM	**(9)**
Health Organization of the Country, the State and Cities, Health Financial System, Teaching cum Research Hospitals, General Hospital, PHC Reference System, Ambulatory Care.	
UNIT II – NATIONAL HEALTH POLICY	**(9)**
Need for Evaluating a Health Policy, Need for providing Primary Health Care, Health Education, Health Insurance, Health Legislation, Inter Sectoral Co-operation.	
UNIT III – EQUIPMENT MAINTENANCE MANAGEMENT	**(9)**
Organizing the Maintenance Operation, Biomedical Equipment Procurement Procedure, Proper Selection, Compatibility, Testing and Installation, Purchase and Contract Procedure, Trained Medical Staff, Proper use of Equipment and Operating Instructions. Maintenance Job Planning, Preventive Maintenance, Maintenance Budgeting, Contract Maintenance.	
UNIT IV – LOGISTIC SUPPORT & RELIABILITY	**(9)**

Maintenance Equipment and Tools, Failure Analysis, Spare Parts and Maintenance Materials. Reliability Fundamentals.

UNIT V – EMI IN HOSPITAL EQUIPMENT	**(9)**

Principles of EMI, Computation of EMI, Method of Suppressing and Isolating the Unit from Interference.

TOTAL(L:45) = 45 PERIODS

TEXT BOOKS:

1. Antony Kelly, "Maintenance Planning & Control", Butterworth, London 1984.
2. Binseng Wang, "Medical Equipment Maintenance: Management and Oversight", Morgan & Claypool Publishers, 2012

REFERENCES:

1. Hans Pleiff Veradammann, "Hospital Engineering in Developing Countries", First edition, GTZ Report Eschborn, 1986.
2. Keith Willson, Keith Ison, Slavik Tabakov, "Medical Equipment Management", CRC Press, 2013.
3. R. C. Goyal, "Human Resource Management in Hospitals", Prentice Hall of India, New Delhi, 2000.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3						3							
2		3		3										
3				3					3					2
4	3					3								2
5									3	3				
CO (W.A)	3	3		3		3	3		3	3				2

22BMX46 - HOSPITAL WASTE MANAGEMENT				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE : NIL

Course Objective:	To provide students with a comprehensive understanding of hospital waste management, including types of hospital waste, regulatory frameworks, best practices for waste segregation, handling, treatment, and disposal, as well as the environmental and public health impacts of improper waste management.

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the knowledge to categorize and segregate hospital waste including biomedical waste, human waste and sewage waste.	Ap	30%
CO2	Develop and implement effective management strategies for biomedical waste, human waste and sewage waste.	Ap	30%
CO3	Analyze the various types of infections, and assess the role of infection control committees in managing these infections.	An	20%
CO4	Analyze safety measures for healthcare personnel in waste management and infection control settings.	An	20%
CO5	Evaluate biomedical waste management practices through the analysis of case studies and demonstrate understanding by creating an informative poster presentation.	E	Internal Assessment

UNIT I - HOSPITAL WASTE	**(9)**
Definition. Classification, Categories, Sources, Routes, Associated Diseases, Risks, Control of Hazards, Associated Problems in India; Need, Objective and Importance of Bio Medical Waste Management Programme in Health Care Facilities; Steps in Management of BMW.	
UNIT II - 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 Control of Cross-Infection; Staff Health.	
UNIT III - BIOMEDICAL WASTE MANAGEMENT	**(9)**
Meaning, Categories of Biomedical Wastes; Disposal of Biomedical Waste Products; Incineration and its Importance; Standards for Waste Autoclaving, Micro Waving and Deep Burial; Segregation, Packaging, Transportation and Storage.	
UNIT IV - HUMAN WASTE DISPOSAL AND SEWAGE DISPOSAL	**(9)**
Diseases carried from Excreta; Sanitation Barrier; Methods of Excreta Disposal; Sewage Wastes: Meaning, Composition; Aims of Sewage Disposal; Decomposition of Organic Matter; Modern Sewage Treatment; Drawbacks of Improper Disposal of Wastes; Solid and Liquid Waste Disposal.	

UNIT V - SAFETY AND PROTECTIVE MEASURE	(9)
Principles of Safe Handling; Personal Protective Devices and other Protective Measures; Occupational Safety; Training for Doctors, Nurses, Nodal Officers and Waste Management Analyzers.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. Anantpreet Singh & Kaur Sukhjit, "Bio-medical Waste Disposal", Jaypee Brothers Medical Publishers Pvt. Ltd, 2012.
2. James T. Tweedy, "Healthcare Hazard Control and Safety Management", 3rd Edition, CRC Press, 2014.

REFERENCES:

1. Bahera. P.K, "Sustainable Bio-medical Waste Management", Dominant Publishers & Distributors, 2009.
2. Sharma, "Holistic Approach to Hospital Waste Management", Department of Hospital Administration – AIIMS, New Delhi, 2006.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												2	
2			3										2	
3		3												2
4		3												2
5				3		3			3	3				2
CO (W.A)	3	3	3	3		3			3	3			2	2

22BMX47 - PATIENT SAFETY AND STANDARDS				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: NIL				

Course Objectives:	• To apply safety procedures in healthcare organizations. • To apply safety norms in different departments in healthcare sector according to their working environments.. • To analyze the Health care organization structure and the responsibilities of different levels to implement safety. • To analyze the regulatory standards for medical device maintenance. • To outline the accreditation protocols for a hospital and its safety standards.

Course Outcomes The student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Illustrate preparedness and response strategies for managing healthcare crises.	Ap	40%
CO2	Interpret complexity science principles to manage healthcare workflows effectively, improving quality and safety in clinical settings.	An	40%
CO3	Assess patient safety protocols across diverse healthcare departments.	E	15%
CO4	Evaluate and adhere to international regulatory standards for medical device maintenance and safety, ensuring compliance with ISO and national health directives.	E	5%
CO5	Analyze case study findings to evaluate and enhance healthcare practices and policies.	An	Internal Assessment

UNIT I – INTRODUCTION	**(9)**
Guidelines and safety practices for improving patient safety, Human error and patient safety, safer care, patients for patient safety, Human factors, patient safety from the perspective of medical residents, patient safety in the world, Infection prevention and control, Adverse event investigation and Risk assessment.	
UNIT II – PATIENT SAFETY IN DIFFERENT HEALTHCARE DEPARTMENTS	**(9)**
Patient safety in Intensive care and Anaesthesiology, Safe surgery, Emergency department clinical risk, obstetric safety patient, patient safety in internal medicine, risks in oncology and radiation therapy, patient safety in orthopaedics and Traumatology, patient safety in paediatrics, patient safety in paediatrics and ophthalmology.	
UNIT III – HEALTH ORGANIZATION	**(9)**
Community and Primary Care, Complexity Science as a Frame for Understanding the Management and Delivery of High Quality and Safer Care, Measuring Clinical Workflow to Improve Quality and Safety, shift work Organization, Non-technical Skills in Healthcare, Medication Safety, Digital Technology and Usability, Coping with the COVID-19 Pandemic: Roles and Responsibilities for Preparedness.	

UNIT IV – REGULATORY STANDARDS FOR MEDICAL DEVICE MAINTENANCE	(9)
International Standards, Medical Device Directive 93/42/EEC, Medical Electrical Equipment ISO 60601, Safety Testing of Medical Devices ISO 62353, Medical Device Inspection ISO17020. Indian Standards, National Health Mission, Biomedical Equipment Management and Maintenance Program (BMMP), ISO 9001-2008, AERB Compliance, Radiation protection.AE(RP)R-2004, Safety Code AE/RF-MED/SC-3.	
UNIT V – HOSPITAL ACCREDITATION AND SAFETY STANDARDS	**(9)**
Accreditation, JCI Accreditation & its Policies. Life Safety Standards- Protecting Occupants, Protecting the Hospital and Individuals from Fire, Smoke, and Heat. Managing Hazardous Medical Material and Waste, Laboratory and Radiation safety, Health and safety hazards of shift work. Patient Safety, Human factors, Reliability, Evidence based Medicine, Root cause Analysis.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. Donaldson L, Ricciardi W, Sheridan S, Tartaglia R, editors. Textbook of Patient Safety and Clinical Risk Management [Internet].
2. Cham (CH): Springer; 2021. PMID: 36315660.

REFERENCES:

1. William Charney, Handbook of Modern Hospital Safety, CRC Press, 2nd Edition, 2009.
2. Almira Badnjevic, Mario Cifrek, Ratko Magjarevic, Zijad Dzemic, Inspection of Medical Devices: For Regulatory Purposes, Springer Nature, 2018.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1		3						3						
2				3		3								
3	3					3								
4		3		3			3							
5									3			3		2
CO (W.A)	3	3		3		3	3	3	3			3		2

22BMX48 - MEDICAL DEVICE REGULATIONS				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE: NIL

Course Objectives:	• To understand the basic concepts of medical device regulations. • To apply the global policies on medical device regulations. • To analyze implications of the regulations. • To analyze the Standards and Regulations used for medical devices. • To analyze the software and Quality system regulation.

Course Outcomes The student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply principles of reliability engineering to enhance the performance of medical devices.	Ap	40%
CO2	Explain regulatory frameworks and compliance requirements in global medical device manufacturing.	An	40%
CO3	Illustrate quality management systems for medical device manufacturing adhering to international standards.	An	15%
CO4	Assess the impact of software regulations on medical device development and compliance.	E	5%
CO5	Correlate expert insights to enhance comprehension and application of global medical device regulations and standards.	An	Internal Assessment

UNIT I – INTRODUCTION	**(9)**
Defining the device, Overview of quality function deployment, Business proposal Reliability: Definition, Quality Vs Reliability Vs Unreliability, Types of Reliability, Optimizing reliability, Reliability's effects on medical devices. Concept of Failure: Causes of Failure, Practical aspects of failure, Failure rates, Hardware failure, Software Failure. Safety and Risk Management: Medical device safety and risk management, Effectiveness/performance of medical devices, Phases in the life span of a medical device.	
UNIT II – DRUG MANUFACTURING PRACTICES	**(9)**
Global Harmonization Task Force (GHTF): Objectives, Scope of the four GHTF study groups, Benefits of the GHTF, Global Medical Device Nomenclature (GMDN) The Food and Drug Administration: Device classification, Registration and listing, The 510 (k) Process, Declaration of conformity, The PMA application, Investigational Device Exemptions (IDEs), Good Manufacturing Practices (GMPs).	
UNIT III – MEDICAL DEVICE DIRECTIVES	**(9)**
The European Union: European Directives, European Standardization Bodies, European Standards Development Process, Other European Standards Considerations, Conformity Assessment and Testing, European Organization for Testing and Certification. The Medical Devices Directives: Process, Choosing the appropriate directive, Identifying the applicable essential requirements.	
UNIT IV – STANDARDS AND REGULATIONS	**(9)**
Standards and Regulation: Voluntary and mandatory standards, Standards development process, Conformity assessment with standards, National and international standards systems, Identification of standards, Current trends in the use of standards in medical device regulations. The ISO 9000 Series of	

Standards.	
UNIT V – SOFTWARES AND QUALITY SYSTEM REGULATIONS	**(9)**
Software and Quality system regulation: Software as a Technology, Domestic and International Software Regulations and Standards. Design controls, Document controls, Purchasing controls, Identification and traceability, Production and process controls, Acceptance activities, Non-conforming product, Corrective and preventive action.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. Michael Cheng, Medical Device Regulations Global Overview and Guiding Principles, World Health Organization, 2003.
2. Des O'Brien, Medical Device Regulations Roadmap A Beginners Guide, Create Space Independent Publishing Platform, 2017.
3. Aakash Deep, Medical Device Regulations A Complete Guide, Elsevier Science, 2022.

REFERENCES:

1. Jack Wong, Raymond Tong, Jenny Stanford Publishing Handbook of Medical Device Regulatory Affairs in Asia, Second Edition, 2018.
2. G.R Higson, Medical Device Safety, The Regulation of Medical Devices for Public Health and Safety, 2001.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2		3												
3				3		3								
4		3			3									2
5												3		
CO (W.A)	3	3		3	3	3						3		2

22BMX51 - BIO-MEMS TECHNOLOGY				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE: NIL

Course Objectives:	• To explore the principles and applications of MEMS and Microsystems in the healthcare industry. • To understand the fundamental principles of Micro-Opto Electromechanical Systems (MOEMS) and their applications. • To analyze the properties and applications of microfluidic systems. • To investigate BioMEMS technologies for clinical monitoring, lab-on-a-chip applications, and emerging technologies. • To comprehend the micromachining processes and technologies involved in microsystem fabrication.

Course Outcomes The student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply advanced microsystem technologies to solve healthcare challenges effectively.	Ap	40%
CO2	Explain the micromachining techniques to fabricate and enhance microsystems tailored for healthcare needs.	An	40%
CO3	Assess microfluidic systems and BioMEMS devices for clinical use.	E	15%
CO4	Evaluate and select appropriate MEMS/Microsystems for biomedical applications.	E	5%
CO5	Report their understanding and application among participants by fostering interactive discussions.	Ap	Internal Assessment

UNIT I – MEMS IN HEALTHCARE	**(9)**
MEMS and Microsystems- Introduction - Typical MEMS and Microsystem Products - Application of Micro-System in Healthcare Industry – Working Principles of Microsystems Micro-Sensors – Micro-Actuation - MEMS with Micro Actuation– Micro Accelerators.	
UNIT II – FUNDAMENTALS OF MOEMS	**(9)**
Micro-Opto Electromechanical Systems: Fundamental Principle of MOEMS Technology, Advantages - Light Modulators, Beam Splitter – Micro-Lens, Micro-Mirrors - Digital Micro-Mirror Device, Grating Light Valve, Optical Switch, Waveguide and Tuning.	
UNIT III – MICROFLUIDIC SYSTEMS	**(9)**
Microfluidics- Introduction and Fluid Properties, Applications of MFS- Fluid Actuation Methods- Electrophoresis, Dielectrophoresis, Electrowetting, Optoelectrowetting, Electroosmosis Flow, Electrothermal Flow, Thermocapillary Effect- Microfluidic Channel- Microdispenser- Microneedle-	

Microfilter	
UNIT IV – BioMEMS	**(9)**
Introduction to Biomems, Biomems for Clinical Monitoring, Lab on A Chip, DNA Sensors, E-Nose, E-Tongue. Microsystem Approaches to PCR, MEMS Based Implantable Drug Delivery System, Emerging Biomems Technology.	
UNIT V – MICROMACHINING	**(9)**
Micro System Technology-Photolithography-X-Ray Lithography-Etching-Deposition-Material Properties-Thin Film Process-Clean Room-Laser Deposition-Thin Film Diode-Transistor- FET-ISFET. Software Tools for Design, Analysis and Testing.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. Tai-Ran Hsu, "MEMS & Microsystems- Design, Manufacture and Nanoscale Engineering", 2nd Edition John Wiley & Sons, 2008.
2. Nitaigour Premchand Mahalik, "MEMS", 2 nd Reprint Tata McGraw Hill, 2008.

REFERENCES:

1. Albert Folch, "Introduction to Bio mems", 1st Edition, CRC Press, 2012.
2. N.P.Mahalik, "Micro Manufacturing & Nanotechnology", Springer, 2006.
3. Sergey Edward Lysherski, "Nano and Micro-electromechanical systems". CRCPress.2005.
4. Wanjun Wang, Steven A. Soper, "BioMEMS Technologies and Applications", CRC Press. 2006.
5. Abraham P. Lee, James L. Lee, "BioMEMS and Biomedical Nano technology", Vol.I, Springer, 2006.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												2	
2			2											
3		3		3										2
4			3	3										
5							2					3		
CO (W.A)	3	3	2.5	3			2					3	2	2

22BMX52 - NANOTECHNOLOGY IN MEDICINE				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE: NIL

Course Objectives:	• To introduce fundamental principles and characterization methods of nanotechnology. • To explore the intersection between biology and nanotechnology. • To familiarize with emerging areas in biotechnology and nanomedicine. • To infer knowledge in diagnostic characteristics of nanoparticles. • To apply nanotechnology appropriately in medical applications.

Course Outcomes The student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the knowledge of fundamental principles and techniques involved in nanotechnology.	Ap	40%
CO2	Analyze nanotechnology based solutions for biomedical applications, focusing on drug delivery, imaging and surgical interventions.	An	40%
CO3	Deduce the effectiveness of nanotechnology in cancer therapy, including drug delivery mechanisms and diagnostic techniques.	An	15%
CO4	Assess the safety, toxicity and environmental impact of nanomaterials to develop strategies for their safe and effective use.	E	5%
CO5	Connect through expert talks' perspective on the societal and environmental impacts of nanotechnology.	U	Internal Assessment

UNIT I – NANOSTRUCTURES	**(9)**
Preparation, Properties and Characterization - Self-Assembling Nanostructure - Vesicular and Micellar Polymerization-Nanofilms - Metal Nanoparticles - Lipid Nanoparticles - Nanoemulsion - Molecular Nanomaterials: Dendrimers.	
UNIT II – NANOTECHNOLOGY IN BIOMEDICAL INDUSTRY	**(9)**
Reconstructive Intervention and Surgery- Nanomaterials in Bone Substitutes and Dentistry – Implants and Prosthesis -in Vivo Imaging- Genetic Defects and Other Disease States — Nanorobotics in Surgery – Nanocarriers: Sustained, Controlled, Targeted Drug Delivery Systems.	
UNIT III – NANOTECHNOLOGY IN CANCER THERAPY	**(9)**
Cancer Cell Targeting and Detection- Polymeric Nanoparticles for Cancer Treatment – Mechanism of Drug Delivery to Tumors -Advantages and Limitations - Multifunctional Agents - Cancer Imaging – Magnetic Resonance Imaging- Cancer Immunotherapy.	
UNIT IV – NANOTECHNOLOGY IN COSMETICS	**(9)**
Polymers in Cosmetics: Film Formers – Thickeners – Hair Colouring – Conditioning Polymers: Conditioning, Cleansing – Silicons – Emulsions – Stimuli Responsive Polymeric Systems - Formulation of Nano Gels, Shampoos, Hair-Conditioners -Micellar Self-Assembly Sun-Screen Dispersions for UV Protection – Color Cosmetics.	

UNIT V – NANOTOXICITY	(9)
Nanotoxicology- Introduction, Dose Relationship- Hazard Classification-Risk Assessment and Management - Factors Affecting Nano Toxicity- Dermal Effects of Nanomaterials, Pulmonary, Neuro and Cardiovascular Effects of Nanoparticles - Gene–Cellular and Molecular Interactions of Nanomaterials.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. Springer Handbook of Nanotechnology- Ed. by, Springer-Verlag 2004.
2. Nanobiotechnology: Concepts, Applications and Perspectives, CM. Niemeyer C A. Mirkin, (Eds), Wiley, 2004.
3. Jo Anne Shatkin, "Nanotechnology: Health and Environmental Risks", 2nd Edition, CRC Press, 2013.
4. Sarah E. Morgan, Kathleen O. Havelka, Robert Y. Lochhead "Cosmetic Nanotechnology: Polymers and Colloids in Cosmetics", American Chemical Society, 2006.

REFERENCES:

1. Tuan VoDinh , "Nanotechnology in Biology and Medicine: Methods, Devices and Applications", CRC Press, 2007.
2. C.N.R. Rao, A. Muller, A. K. Cheetham (Eds), "The Chemistry of Nanomaterials: Synthesis, Properties and Applications", Wiley-VCH Verlag 2004.
3. Matthew Hull and Diana Bowman, "Nanotechnology: Environmental Health and safety, Risks, Regulation and Management", Elsevier, 2010.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2			3											
3				3									2	
4		3				3								
5							3					3		
CO (W.A)	3	3	3	3		3	3					3	2	

22BMX53 - ROBOTICS IN HEALTHCARE				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: NIL				
Course Objectives:	• To understand the foundational principles, programming modes, and kinematic analysis of robots for determining positions. • To explore the mechanics of parallel robots, apply Jacobian matrices for differential motions, and analyze forces in multi-degree-of-freedom (DOF) robots. • To design trajectory plans in joint and Cartesian spaces, implement motion control systems using controllers. • To analyze sensor characteristics, apply image processing techniques. • To examine applications in biomedical engineering.			

Course Outcomes The student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the knowledge of robotic technologies, including design, control, and kinematics, to address engineering problems.	Ap	40%
CO2	Analyze the role and functioning of sensors, actuators and vision systems in robotic applications.	An	40%
CO3	Explain the robotic solutions for biomedical engineering challenges, such as rehabilitation and surgical applications.	An	15%
CO4	Compare findings on robotic applications in biomedical engineering.	An	5%
CO5	Report on comprehensive understanding and application of robotic systems, incorporating principles of design, control, and practical applications.	Ap	Internal Assessment

UNIT I – BASIC CONCEPTS	**(9)**
Brief history - Types of Robot–Technology-Robot classifications and specifications- Design and Control issues- Various manipulators – Sensors - work cell - Programming languages.	
UNIT II – DIRECT AND INVERSE KINEMATICS	**(9)**
Mathematical representation of Robots - Position and orientation – Homogeneous transformation - Various joints - Representation using the Denavit Hattenberg parameters - Degrees of Freedom - Direct kinematics - Inverse kinematics - SCARA robots- Solvability – Solution methods - Closed form solution.	
UNIT III – PATH PLANNING, MANIPULATOR DIFFERENTIAL MOTION AND STATICS	**(9)**
Definition-Joint space technique of p-degree polynomial-Cubic polynomial-Cartesian space technique - Parametric descriptions - Straight line and circular paths - Position and orientation planning - Linear and angular velocities-Manipulator Jacobian-Prismatic and rotary joints–Inverse -Wrist and arm singularity - Static analysis - Force and moment Balance.	

UNIT IV – SENSORS, IMAGE PROCESSING AND ANALYSIS WITH VISION SYSTEMS	(9)
Sensor Characteristics, Position, Velocity, Acceleration, Force, Pressure and Torque, Microswitches, Visible and IR, Touch, Proximity, Range Finders, Sniff, Vision, Transforms – Fourier, Hough, Resolution, Quantization, Sampling, Image Processing, Segmentation, Region Growing and Splitting, Operations, Object Recognition, Depth, Specialized Lighting, Compression, Colour Images, Heuristics.	
UNIT V – APPLICATIONS	**(9)**
Applications in Biomedical Engineering – Bio Engineering Biologically Inspired Robots, Neural Engineering, Application in Rehabilitation – Interactive Therapy, Bionic Arm, Clinical and Surgical – Gynaecology, Orthopaedics, Neurosurgery.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. S. B. Niku, "Introduction to Robotics, Analysis, Control, Applications", Pearson Education, 2020
2. Robert Schilling, "Fundamentals of Robotics-Analysis and control", Prentice Hall of India, 2003.
3. Fu Gonzales and Lee, "Robotics", McGraw Hill, 1987.
4. J Craig, "Introduction to Robotics", Pearson Education, 2005.

REFERENCES:

1. Grover, Wiess, Nagel and Oderey, "Industrial Robotics", McGraw Hill, 2012.
2. Klafter, Chmielewski and Negin, "Robot Engineering", Prentice Hall Of India, 1989.
3. Mittal, Nagrath, "Robotics and Control, Tata McGraw Hill publications, 2003.
4. Bijay K. Ghosh, Ning Xi, T.J. Tarn, "Control in Robotics and Automation Sensor – Based integration", Academic Press, 1999.
5. Mikell P. Groover, Mitchell Weiss, "Industrial robotics, technology, Programming and Applications", McGraw Hill International Editions, 1986.
6. Richard D. Klafter, Thomas A. Chmielewski and Michael Negin, "Robotic engineering - An Integrated Approach", Prentice Hall Inc, Englewoods Cliffs, NJ, USA, 1989.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2		3											2	
3			3											
4				3										
5							3					3		
CO (W.A)	3	3	3	3			3					3	2	

22BMX54 - ADVANCED HEALTHCARE SYSTEM DESIGN				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: NIL				

Course Objectives:	• To analyze wearable devices and mobile health care technologies. • To evaluate digital radiology systems and medical image management. • To investigate health care networking and tele-consultation in medicine. • To critique the requirements, regulations, and ethical issues in digital health. • To assess standards and interoperability in e-health projects, emphasizing security and privacy.

Course Outcomes The student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply digital health technologies for effective healthcare solutions.	Ap	40%
CO2	Explain the integration of mobile health and digital radiology for enhanced patient care.	An	40%
CO3	Analyze e-health networking and interoperability standards' impact on healthcare delivery.	An	15%
CO4	Assess the strategies for overcoming barriers to digital health innovation and ensuring security and privacy.	E	5%
CO5	Report on digital health technologies, emphasizing integration, standards, ethical considerations and innovation strategies in healthcare through seminars.	E	Internal Assessment

UNIT I – WEARABLE DEVICES AND M-HEALTH CARE	**(9)**
Introduction to Mobile Health Care-Devices-Economy-Average Length of Stay in Hospital, Outpatient Care, Health Care Costs, Mobile Phones, 4G, Smart Devices, Wearable Devices, Uptake of E-Health and M-Health Technologies. Standards, System Design and Case Study.	
UNIT II – DIGITAL RADIOLOGY	**(9)**
Digital Radiology for Digital Hospital, Picture Archiving and Communication, System Integration, Digital History of Radiology, Medical Image Archives, Storage and Networks.	
UNIT III – E-HEALTH	**(9)**
Health Care Networking, Medical Reporting using Speech Recognition, Physiological Tests and Functional Diagnosis with Digital Methods, Tele-Consultation in Medicine and Radiology.	
UNIT IV – DIGITAL HEALTH	**(9)**
Requirements and Best Practices, Laws and Regulations in Digital Health, Ethical Issues, Barriers and Strategies for Innovation.	

UNIT V – STANDARDS FOR INTER OPERABILITY	(9)
Selection and Implementation in E-Health Project, Design of Medical Equipments Based on User Needs. Security and Privacy in Digital Health Care.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. Wlater Hruby, "Digital Revolution in Radiology – Bridging the future of health care", 2nd Edition, Springer, New York. 2006.
2. Christoph Thuemmler, Chunxue Bai, "Health 4.0: How Virtualization and Big Data are Revolutionizing Healthcare", 1st Edition, Springer, 2017.
3. Samuel A. Fricker, Christoph Thümmler , Anastasius Gavras, "Requirements Engineering For Digital Health", Springer, 2015.

REFERENCES:

1. Rick Krohn (Editor), David Metcalf, Patricia Salber, "Health-e Everything: Wearables and The Internet of Things for Health, ebook. 2013.
2. Khandpur.R.S., "Handbook of Biomedical Instrumentation ", 2nd Edition, Tata Mc Graw Hill Pub. Co., Ltd. 2003
3. John, G. Webster. Medical Instrumentation: Application and Design. Second Edition. Wiley Publisher, New Delhi. 2013.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2	3													
3				3										3
4			3											
5									3	3		2		
CO (W.A)	**3**		**3**	**3**					**3**	**3**		**2**		**3**

22BMX55 - CRITICAL CARE EQUIPMENT				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

PRE-REQUISITE: NIL

Course Objectives:	• To gain a comprehensive understanding of various intensive care unit (ICU) equipment. • To explore the necessity and functionality of operation theatre equipment. • To study assistive critical care equipment. • To evaluate centralized systems essential for critical care environments. • To analyze patient safety considerations associated with electrical hazards, grounding inspections, and safety protocols in intensive care and operation rooms.

Course Outcomes The student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Demonstrate the functionality and efficiency of hospital departments, equipment and patient care systems.	Ap	40%
CO2	Analyze how healthcare professionals interact with patients and manage medical emergencies in a hospital setting.	An	40%
CO3	Devise strategies for installing and maintaining centralized systems for healthcare facilities to ensure operational efficiency and patient comfort.	An	15%
CO4	Assess and enforce patient safety protocols.	E	5%
CO5	Evaluate hospital operations, analyze healthcare delivery systems, assess management practices and appraise patient care quality after completing hospital visit.	E	Internal Assessment

UNIT I – INTENSIVE CARE UNIT EQUIPMENT	**(9)**
Suction apparatus, Different types; Sterilizers, Chemical, Radiation, Steam for small and large units. ICU ventilators. Automated drug delivery systems, Infusion pumps, components of drug infusion system, closed loop control infusion system, implantable infusion system. BMD Measurements – SXA - DXA - Quantitative ultrasound bone densitometer.	
UNIT II – OPERATION THEATRE EQUIPMENT	**(9)**
Craniotomy, Electrosurgical Machines (ESU), electrosurgical analysers, surgical aspirator, Instruments for operation. Anaesthesia Machine, Humidification, Sterilization aspects, Boyles apparatus. Endoscopy - Laparoscopy - Cryogenic Equipment - Anaesthesia gas, Anaesthesia gas monitor – surgical Microscope.	
UNIT III – ASSISTIVE CRITICAL CARE EQUIPMENT	**(9)**
Defibrillators, Haemodialysis Machine, Different types of Dialyzers, Membranes, Machine controls and measurements. Heart Lung Machine, different types of oxygenators, peristaltic pumps, Incubators.	
UNIT IV – CENTRALISED SYSTEMS	**(9)**

Centralized Oxygen, Nitrogen, Air supply & Suction. Centralized Air Conditioning, Operation Theatre table & Lighting. C Arm.
UNIT V – PATIENT SAFETY **(9)**
Patient electrical safety, Types of hazards, Natural protective mechanisms against electricity, Leakage current, Inspection of grounding and patient isolation, Hazards in operation rooms, ICCU and IMCUs, Opto couplers and Pulse transformers.
TOTAL(L:45) = 45 PERIODS

TEXT BOOKS:

1. John G. Webster, " Medical Instrumentation Application and Design", 4th edition, Wiley India Pvt. Ltd, New Delhi, 2015
2. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", Pearson education, 2012.
3. Khandpur. R.S.,"Handbook of Biomedical Instrumentation", 2nd Edition. Tata McGrawHill Pub. Co., Ltd., 2003

REFERENCES:

1. L. A Geddes and L. E. Baker, "Principles of Applied Biomedical Instrumentation", 3rd Edition, 2008.
2. Antony Y.K. Chan, "Biomedical Device Technology, Principles and Design", Charles Thomas Publisher Ltd, Illinois, USA, 2008.
3. Leslie Cromwell, "Biomedical Instrumentation and Measurement", Pearson Education, New Delhi, 2007.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2		3												
3			3										2	
4						3		3						
5							3					3		
CO (W.A)	3	3	3			3	3	3				3	2	

22BMX56 - HUMAN ASSIST DEVICES				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE: NIL

Course Objectives:	• To study the role and importance of machines that takes over the functions of the heart and lungs. • To study various mechanical techniques that helps a non-functioning heart. • To learn the functioning of the unit that does the clearance of urea from the blood. • To understand the tests to assess the hearing loss and development of electronic devices to compensate for the loss. • To study about recent techniques used in modern clinical applications.

Course Outcomes The student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply safety standards and protocols in the operation and maintenance of critical care equipment with regulatory guidelines.	Ap	40%
CO2	Analyze the functionality and operational requirements of diverse medical devices.	An	40%
CO3	Evaluate recent advancements in medical technology to enhance diagnostic accuracy and patient management strategies.	E	15%
CO4	Assess the efficacy of medical interventions to optimize patient care.	E	5%
CO5	Interpret real-world case studies to evaluate the application, efficacy and safety of various medical devices in clinical settings.	E	Internal Assessment

UNIT I – HEART LUNG MACHINE AND ARTIFICIAL HEART	**(9)**
Condition to be satisfied by the H/L System. Different types of Oxygenators, Pumps, Pulsatile and Continuous Types, Monitoring Process, Shunting, The Indication for Cardiac Transplant, Driving Mechanism, Blood Handling System, Functioning and different types of Artificial Heart, Schematic for temporary bypass of left ventricle.	
UNIT II – CARDIAC ASSIST DEVICES	**(9)**
Assisted through Respiration, Right and left Ventricular Bypass Pump, Auxiliary ventricle, Open Chest and Closed Chest type, Intra Aortic Balloon Pumping, Prosthetic Cardiac valves, Principle of External Counter pulsation techniques.	
UNIT III – ARTIFICIAL KIDNEY	**(9)**
Indication and Principle of Haemodialysis, Membrane, Dialysate, types of filter and membranes, Different types of hemodialyzers, Monitoring Systems, Wearable Artificial Kidney, Implanting Type.	
UNIT IV – RESPIRATORY AND HEARING AIDS	**(9)**

Ventilator and its types-Intermittent positive pressure, Breathing Apparatus Operating Sequence, Electronic IPPB unit with monitoring for all respiratory parameters. Types of Deafness, Hearing Aids, SISI, masking techniques, wearable devices for hearing correction.	
UNIT V – RECENT TRENDS	**(9)**
Transcutaneous electrical nerve stimulator, bio-feedback, Diagnostic and point-of-care platforms.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. Gray E Wnek, Gray L Browlin, "Encyclopedia of Biomaterials and Biomedical Engineering", Marcel Dekker Inc New York, 2004.
2. John. G. Webster, "Bioinstrumentation" John Wiley & Sons (Asia) Pvt. Ltd., 2004.
3. Joseph D. Bronzino, "The Biomedical Engineering Handbook" 3rd Edition: Three Volume Set, CRC Press, 2006.

REFERENCES:

1. Andreas. F. Von racum, "Hand Book of Bio Material Evaluation", Mc-Millan Publishers, 1980.
2. Gray E Wnek, Gray L Browlin, "Encyclopedia of Biomaterials and Biomedical Engineering" Marcel Dekker Inc New York 2004.
3. D.S. Sunder, "Rehabilitation Medicine", 3rd Edition, Jaypee Medical Publication, 2010.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	3				3								
2	3	3												
3			3											
4				3									2	
5							3					3		
CO (W.A)	3	3	3	3		3	3					3	2	

22BMX57 - AMBULATORY SERVICES				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE: NIL

Course Objectives:	• To analyze artifacts and apply denoising techniques in patient monitoring systems • To design ambulance vehicles and comply with regulations for patient transportation. • To design efficient lift mechanisms for patient transport in ambulances. • To assess the design and regulatory aspects of mobile diagnostic equipment in ambulances. • To evaluate smart safety systems and automated alert systems in accident care.

Course Outcomes The student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Demonstrate advanced medical devices and systems for patient monitoring, diagnosis, and emergency care.	Ap	40%
CO2	Apply principles of biomedical engineering to create innovative solutions for patient transportation and care.	Ap	40%
CO3	Analyze safety and regulatory standards for medical devices and healthcare systems.	An	15%
CO4	Evaluate the efficiency and effectiveness of healthcare equipment and technology in clinical settings.	E	5%
CO5	Deduce insights from seminar presentations to improve the design and functionality of patient monitoring and emergency care systems.	An	Internal Assessment

UNIT I – PATIENT MONITORING SYSTEMS	**(9)**
Artifacts - Denoising techniques - Advancements in Wireless patient Monitoring system - Case study.	
UNIT II – DESIGN OF AMBULANCE	**(9)**
Vehicle Design - Ambulance Train - Disaster Relief Squad - Regulation for Patient Transportation - Case Study.	
UNIT III – LIFT MECHANISM	**(9)**
Design of Lift Mechanism for Patient - Design of Lift in Ambulance - Computer Based Systems - Case Study.	
UNIT IV – DESIGN OF MOBILE DIAGNOSTIC EQUIPMENT	**(9)**
Devices with Battery Backup - Mobile X-Ray Unit - Nursing - Medical Gas Handling – Regulations - GPS In Ambulance Networked Services - Case Study.	

UNIT V – ACCIDENT CARE SYSTEMS	(9)
Automated Alert System - Smart Safety Systems - Fire Protection - Maintenance And Regulation - Accreditation for Ambulance Services - Case Study.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. David Tse and Pramod Viswanath, "Fundamentals of Wireless Communication", Cambridge University Press, 2005.
2. Andreas F. Molisch, "Wireless Communications", 2nd Edition, John Wiley & sons, USA, 2010.

REFERENCES:

1. Jochen Schiller, "Mobile Communications", Addison Wesley Publishers, 2000.
2. Yi-Bing Lin and Imrich Chlamtac, "Wireless and Mobile Network Architecture", 2nd Edition, John Wiley and Sons, New Delhi, 2001.
3. Feher K., "Wireless Digital Communications", Prentice Hall of India, New Delhi, 1995.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												2	
2			3										2	
3				3										2
4		3		3										2
5									3	3		2		
CO (W.A)	3	3	3	3					3	3		2	2	2

22BMX58 - HOME MEDICARE TECHNOLOGY				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: NIL				
Course Objectives:	• To analyze the historical development and ethical issues in home health care • To apply homecare strategies tailored to diverse client needs. • To demonstrate proficiency in operating and managing medical devices commonly used in home healthcare settings.. • To identify and discuss recent advancements in medical health technologies relevant to home care. • To infer the impact and utilization of wireless technology in improving healthcare delivery at home.			

Course Outcomes The student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply effective strategies for infection control, patient education, and home care management.	Ap	40%
CO2	Analyze the advancements in health care technologies to enhance patient care, emergency response and remote monitoring capabilities.	An	40%
CO3	Deduce personalized care plans for elderly, children and mobility-impaired patients, including mobility transfers and comfort measures.	An	15%
CO4	Assess the functionality and impact of various medical devices and recommend suitable devices based on patient needs.	E	5%
CO5	Develop critical thinking and problem-solving skills in addressing complex issues related to home health care systems, patient management, medical device utilization and advancements in healthcare technology through case studies.	C	Internal Assessment

UNIT I – INTRODUCTION TO HOME HEALTH NURSING	**(9)**
Home Health Care – Purpose - Organization of Homecare System - Historical Development of Home Care - Environmental Influences of Home Care -Home Care Organization - Legal and Ethical Issues in Home Care - Case Management and Leadership Strategies - Organisation of Home Care System - Role of Home Care Nurse and Orientation Strategies - Environmental Influences on Home Care - Infection Control in Home - Patient Education in Home.	
UNIT II – WORKING WITH CLIENTS	**(9)**
Basic Human Needs - Communication and Interpersonal Skills - Caregiver Observation - Recording and Reporting, Confidentiality. Working with Elderly – Aging and Body Systems. Working with Children - Need for Home Care - Mobility Transfers and Ambulation - Range of Motion Exercises - Skin Care and Comfort Measures.	

UNIT III – MEDICAL DEVICES AT HOME	(9)
Medical Devices at Home - ECG Monitors - Smart Watch - Wireless Infant Monitoring System - PCG Monitors, Medical Alert Services. Activity Monitors - Automatic Wireless Healthcare Monitoring System - The Ventilator Dependent Patient - Device For Patient with Congestive Heart Failure - Device for Patient with Chronic Obstructive Pulmonary Disease - Device for Patient with Diabetic.	
UNIT IV – ADVANCEMENT IN MEDICAL TECHNOLOGIES	**(9)**
Advances and Trends in Health Care Technologies - Driver Impacting the Growth of Medical Technologies - Impact of Moore's Law of Medical Imaging - E-Health and Personal Healthcare - Defining the Future of Health Technology - Inventing the Future -Tools for Self-Health - Future of Nano Fabrication Molecular Scale Devices - Future of Telemedicine - Future of Medical Computing.	
UNIT V – WIRELESS TECHNOLOGY	**(9)**
Wireless Communication Basics - Types of Wireless Network - Body Area Network - Emergency Rescue - Remote Recovery - Personalized Ambient Monitoring - Future Trends in Healthcare Technology. Multi Model Interaction and Technologies for Care at Home - Cost of Home Healthcare - Direction for Emerging Technology.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:

1. Robyn Rice, "Home care nursing practice: Concepts and Application", 4th Edition, Elsevier, 2006.
2. LodewijkBos, "Handbook of Digital Homecare: Successes and Failures", Springer, 2011.

REFERENCES:

1. Yadin David, Wolf W. von Maltzahn, Michael R. Neuman, Joseph. D. Bronzino, "Clinical Engineering", CRC Press, 2010.
2. Kenneth J. Turner, "Advances in Home Care Technologies: Results of the match Project", Springer, 2011.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2			3	3									2	
3		3												
4				3		3								2
5									3			3		2
CO (W.A)	3	3	3	3		3			3			3	2	2

22GEA02 - PRINCIPLES OF MANAGEMENT				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: NIL				
Course Objectives:	• To provide with a foundational understanding of management concepts and practices. • To equip students with the knowledge and skills necessary to manage and lead organizations effectively, understanding both theoretical frameworks and practical applications in management. • To learn about various planning tools and decision-making processes crucial for organizational success. • To gain insights into human resource management functions. • To study effective communication strategies and the impact of information technology on communication and how effective control can lead to improved productivity and organizational performance.			

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply key management theories and practices to real-world business scenarios, demonstrating the ability to implement management functions.	Ap	20%
CO2	Analyze human resource management practices, evaluating how recruitment, training, performance appraisal, and employee relations contribute to organizational success.	An	30%
CO3	Evaluate strategic decisions and their impacts on organizational performance, the effectiveness of communication strategies and the use of information technology in facilitating efficient and effective communication within organizations.	E	30%
CO4	Create comprehensive strategic plans and organizational policies and design control systems to ensure continuous improvement in productivity and organizational performance.	C	20%
CO5	Engage in independent study as a member of a team and develop higher-order thinking skills that are crucial for effective management and leadership in complex organizational settings with assignments or case studies.	Ap	Internal Assessment

UNIT I - INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS	**(9)**
Definition of Management - Science or Art - Manager Vs Entrepreneur - types of managers -managerial roles and skills - Evolution of Management - Scientific, human relations, system and contingency approaches - Types of Business organization- Organization culture and Environment - Current trends and issues in Management.	
UNIT II - PLANNING	**(9)**
Nature and purpose of planning - planning process - types of planning - objectives - setting objectives - policies - Planning premises - Strategic Management - Planning Tools and Techniques - Decision making steps and process.	

UNIT III - ORGANISING	(9)
Nature and purpose - Formal and informal organization - organization chart - organization structure - types - Line and staff authority - departmentalization -delegation of authority - centralization and decentralization -Job Design - Human Resource Management - HR Planning, Recruitment, selection, Training and Development, Performance Management, Career planning and management	
UNIT IV - DIRECTING	**(9)**
Foundations of individual and group behaviour - motivation -motivation theories - motivational techniques - job satisfaction - job enrichment - leadership - types and theories of leadership -communication - process of communication - barrier in communication - effective communication -communication and IT.	
UNIT V - CONTROLLING	**(9)**
System and process of controlling - budgetary and non-budgetary control techniques - use of computers and IT in Management control - Productivity problems and management - control and performance -direct and preventive control -reporting.	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

1. Harold Koontz, Heinz Weihrich and Mark V. Cannice "Essentials of Management: An International, Innovation, and Leadership Perspective", 11th Edition, Tata McGraw-Hill Education, 2021.
2. J.A.F. Stoner, R.E. Freeman, and Daniel R. Gilbert "Management", 6th Edition, Pearson Education, 2018.

REFERENCES:

1. JAF Stoner, Freeman R.E and Daniel R Gilbert "Management", 6th Edition, Pearson Education, 2004.
2. Robert Kreitner & Mamata Mohapatra, "Management", Biztantra, 2008.
3. Stephen A. Robbins & David A. Decenzo & Mary Coulter, "Fundamentals of Management", 7th Edition, Pearson Education, 2011.
4. Tripathy PC & Reddy PN, "Principles of Management", Tata Mcgraw Hill, 1999.

Mapping of COs with POs / PSOs

	POs												PSOs	
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3										3			
2		3									3			
3										3				
4			3							3				
5											3	3		
CO (W.A)	**3**	**3**	**3**							**3**	**3**	**3**		

22GEA03- TOTAL QUALITY MANAGEMENT				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE : NIL				

Course Objective:	• To recognize the importance of quality councils and strategic planning in TQM. • To explore the elements and historical development of TQM. • To Foster employee involvement through motivation, empowerment, teamwork, and recognition. • To implement continuous process improvement methods like Juran's Trilogy, PDSA Cycle, 5S, and Kaizen. • To Conduct quality audits and understand the introduction to other ISO standards like ISO 14000, IATF 16949, TL 9000, IEC 17025, ISO 18000, ISO 20000, ISO 22000, and ISO 21001.

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Describe the elements and principles of Total Quality Management (TQM).	Ap	30%
CO2	Apply continuous process improvement methodologies such as Juran's Trilogy, PDSA Cycle, 5S, and Kaizen.	Ap	20%
CO3	Apply various quality tools and techniques in both manufacturing and service industry.	Ap	20%
CO4	Develop strong supplier partnerships and understand supplier selection, rating and relationship development.	An	20%
CO5	Choose appropriate quality standards and implement them in the respective industry App.	E	10%

UNIT – I QUALITY CONCEPTS AND PRINCIPLES	**(9)**
Definition of Quality - Dimensions of Quality - Quality Planning - Quality Assurance and Control - Quality Costs with Case Studies - Elements / Principles of TQM - Historical Review – Leadership – Qualities / Habits - Quality Council - Quality Statements, Strategic Planning – Importance - Case Studies - Deming Philosophy - Barriers to TQM Implementation – Cases with TQM Success and Failures.	
UNIT – II TQM-PRINCIPLES AND STRATEGIES	**(9)**
Customer Satisfaction - Customer Perception of Quality - Customer Complaints - Customer Retention, Employee Involvement – Motivation - Empowerment - Teams - Recognition and Reward - Performance Appraisal, Continuous Process Improvement - Juran's Trilogy - PDSA Cycle - 5S - Kaizen, Supplier Partnership - Partnering - Sourcing - Supplier Selection - Supplier Rating - Relationship Development, Performance Measures – Purpose – Methods - Cases.	
UNIT – III CONTROL CHARTS FOR PROCESS CONTROL	**(9)**
Basic Seven Tools of Quality and its Role in Quality Control, Statistical Fundamentals - Measures of Central Tendency and Dispersion, Population and Sample - Normal Curve - Control Charts for Variables and Attributes - Process Capability - Case Study- Introduction to Six Sigma.	
UNIT – IV TQM-MODERN TOOLS	**(9)**
New Seven Tools of Quality, Benchmarking - Need - Types and Process, Quality Function Deployment - House of Quality (HOQ) Construction - Case Studies, Introduction to Taguchi's Robust Design - Quality	

Loss Function - Design of Experiments (DOE), Total Productive Maintenance (TPM) - Uptime Enhancement, Failure Mode and Effect Analysis (FMEA) - Risk Priority Number (RPN) – Process - Case Studies.	
UNIT – V QUALITY SYSTEMS	**(9)**
Need for ISO 9000 and Other Quality Systems - ISO 9000: 2015 Quality System – Elements - Implementation of Quality System - Documentation - Quality Auditing, Introduction to ISO 14000 - IATF 16949 - TL 9000-IEC 17025 - ISO 18000 - ISO20000 - ISO 22000 - ISO21001. Process of Implementing ISO - Barriers in ISO Implementation.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOK:

1. Besterfield Dale H., Besterfield Carol, Besterfield Glen H., Besterfield Mary, Urdhwareshe Hemant, Urdhwareshe Rashmi "Total Quality Management", 5th Edition, Pearson Education, Noida, 2018.

REFERENCES:

1. Subburaj Ramasamy, "Total Quality Management", McGraw Hill Education, New Delhi, 2017.
2. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th Edition, Cengage Learning, 2012.
3. David Goetsch & Stanley Davis, "Quality Management for Organizational Excellence: Introduction to Total Quality", 8th Edition, Pearson, 2017.

Mapping of COs with POs / PSOs

	POs												PSOs	
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3													
2	3													
3	3													
4		3												
5	3				2									
CO (W.A)	**3**	**3**			**2**									

22GEA04- PROFESSIONAL ETHICS				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE : NIL

Course Objective:	• To develop students' ability to identify, analyse, and resolve ethical dilemmas in engineering contexts, fostering a commitment to professional responsibility, integrity, and ethical decision-making. • To provide engineering students with a comprehensive understanding of ethical principles and practices in the engineering profession. • To familiarize students with key ethical theories, principles, and frameworks that guide ethical decision-making in professional practice. • To Foster the ability to communicate ethical concerns and collaborate effectively with diverse stakeholders, including colleagues, clients, and the public. • To encourage students to uphold integrity, honesty, and accountability in their professional activities, fostering a culture of trust and reliability.

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply ethical reasoning to evaluate and resolve these issues.	Ap	30%
CO2	Apply ethical principles and reasoning to analyze real-world case studies in engineering.	Ap	30%
CO3	Analyze the importance of ethics in professional practice.	An	20%
CO4	Develop the ability to make informed and ethical decisions in engineering practice.	An	10%
CO5	Recognize the importance of continuous learning and professional development in maintaining ethical standards.	E	10%

UNIT I - INTRODUCTION TO PROFESSIONAL ETHICS	**(9)**
Definition and Importance of Ethics, Ethical Theories and Principles, Ethics vs. Morals vs. Values, Role of Ethics in Engineering.	
UNIT II - PROFESSIONAL RESPONSIBILITY AND CODES OF CONDUCT	**(9)**
Professional Responsibility and Accountability, Codes of Conduct in Engineering (e.g., IEEE, NSPE), Conflicts of Interest and Whistleblowing, Case Studies.	
UNIT III - ETHICAL DECISION-MAKING AND PROBLEM-SOLVING	**(9)**
Ethical Decision-Making Models, Tools and Frameworks for Ethical Analysis, Resolving Ethical Dilemmas, Case Studies	
UNIT IV - LEGAL AND REGULATORY ASPECTS	**(9)**
Legal Frameworks Governing Engineering Practice, Intellectual Property Rights, Health, Safety, and Environmental Regulations, Case Studies.	

UNIT V - SOCIAL AND ENVIRONMENTAL RESPONSIBILITY	(9)
Social Responsibility of Engineers, Sustainable Engineering Practices, Impact of Engineering on Society and Environment, Case Studies.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. Charles E. Harris Jr., Michael S. Pritchard, and Michael J. Rabins, "Engineering Ethics: Concepts and Cases" 6th Edition, 2018.
2. Mike W. Martin and Roland Schinzinger, "Ethics in Engineering" 5th Edition 2010.
3. M. Govindarajan, S. Natarajan, and V. S. Senthil Kumar,"Professional Ethics and Human Values", Ist Edition 2006.

REFERENCES:

1. Stephen H. Unger, "Engineering Ethics: Real-World Case Studies"
2. Online Ethics Center for Engineering and Science - www.onlineethics.org
3. National Society of Professional Engineers (NSPE) - www.nspe.org

Mapping of COs with POs / PSOs

	POs												PSOs	
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3													
2	3													
3		3												
4		3												
5								3						
CO (W.A)	**3**	**3**						**3**						

22GEZ01- Entrepreneurship Development				
	L	T	P	C
	2	0	2	3

PRE-REQUISITE : NIL

Course Objective:	• Learn basic concepts in entrepreneurship, develop mind-set and skills necessary to explore entrepreneurship • Apply process of problem –opportunity identification and validation through human centred approach to design thinking in building solutions as part of engineering projects. • Analyze market types, conduct market estimation, identify customers, create customer persona, develop the skills to create a compelling value proposition and build a Minimum Viable Product. • Explore business models, create business plan, conduct financial analysis and feasibility analysis to assess the financial viability of a venture ideas & solutions built with domain expertise. • Prepare and present an investible pitch deck of their practice venture to attract stakeholders.

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Analyze different types of entrepreneurs and their impact on emerging economies through case studies of successful and failed engineering entrepreneurs	An	20%
CO2	Apply concepts related to societal problems, generate and validate ideas, and assess business opportunities by studying emerging markets and their potential	Ap	20%
CO3	Develop prototypes using various methods and tools, understand their importance in the entrepreneurial process, and iterate based on feedback to enhance their designs	C	20%
CO4	Apply the Lean Canvas to develop business models and craft effective pitches that engage investors and customers	Ap	20%
CO5	Analyze the entrepreneurial ecosystem, including its components, financing models, and stakeholder networks through interactive activities such as visits and interactions with startup founders	Ap	20%

MODULE–I: ENTREPRENEURIAL MINDSET	**(6+6)**
Introduction to Entrepreneurship: Definition – Types of Entrepreneurs – Emerging Economics–Developing and Understanding an Entrepreneurial Mindset– Importance of Technology Entrepreneurship – Benefits to the Society. Case Analysis: Study cases of successful & failed engineering entrepreneurs - Foster Creative Thinking: Engage in a series of Problem-Identification and Problem-Solving tasks.	

MODULE– II: OPPORTUNITIES	**(6+6)**
Problems and Opportunities–Ideas and Opportunities–Identifying problems in society– Creation of opportunities – Exploring Market Types – Estimating the Market Size, - Knowing the Customer and Consumer - Customer Segmentation - Identifying niche markets – Customer discovery and validation; Market research techniques, tools for validation of ideas and opportunities. Activity Session: Identify emerging sectors / potential opportunities in existing markets - Customer Interviews: Conduct preliminary interviews with potential customers for Opportunity Validation – Analyse feedback to refine the opportunity.	
MODULE–III: PROTOTYPING & ITERATION	**(6+6)**
Prototyping – Importance in entrepreneurial process – Types of Prototypes - Different methods – Tools & Techniques. Hands-on sessions on prototyping tools (3D printing, electronics, software), Develop a prototype based on identified opportunities; Receive feedback and iterate on the prototypes.	
MODULE– IV: BUSINESS MODELS & PITCHING	**(6+6)**
Business Model and Types - Lean Approach - 9 block Lean Canvas Model - Riskiest assumptions to Business Models – Using Business Model Canvas as a Tool – Pitching Techniques :Importance of pitching-Types of pitches-crafting a compelling pitch –pitch presentation skills - using storytelling to gain investor/customer attention. Activity Session: Develop a business model canvas for the prototype; present and receive feedback from peers and mentors - Prepare and practice pitching the business ideas- Participate in a Pitching Competition and present to a panel of judges - receive & reflect feedback.	
MODULE–V: ENTREPRENEURIAL ECOSYSTEM	**(6+6)**
Understanding the Entrepreneurial Ecosystem – Components: Angels, Venture Capitalists, Maker Spaces, Incubators, Accelerators, Investors. Financing models–equity, debt, crowd funding, etc, Support from the government and corporate. Navigating Ecosystem Support: Searching & Identifying the Right Ecosystem Partner – Leveraging the Ecosystem - Building the right stakeholder network. Activity Session: Arrangement of Guest Speaker Sessions by successful entrepreneurs and entrepreneurial ecosystem leaders (incubation managers; angels; etc), Visit one or two entrepreneurial ecosystem players (Travel and visit a research park or incubator or maker space or interact with startup founders).	
TOTAL(L:30,P:30) = 60 PERIODS	

REFERENCES:

1. Robert D. Hisrich, Michael P. Peters, Dean A. Shepherd, Sabyasachi Sinha (2020). Entrepreneurship, McGraw Hill, 11 th Edition. 2. Ries,E.(2011).
2. The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses. Crown Business. 3.Blank, S.G.,& Dorf,B.(2012).
3. The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company. K&S Ranch. 4. Roy, R.(2017).
4. Indian Entrepreneurship: Theory and Practice New Delhi: Oxford University Press. 5. Osterwalder,A.,& Pigneur, Y.(2010).
5. Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers. John Wiley & Sons.

Mapping of COs with POs / PSOs														
	POs												PSOs	
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1		3							3	3		3		
2		3	3				2		3	3		3		
3			3		3				3	3		3		
4									3	3	3	3		
5									3	3	3	3		
CO (W.A)		**3**	**3**		**3**		**2**		**3**	**3**	**3**	**3**		

*Approved by Thirteenth Academic Council

22BMZ01 - CELLULAR BIOLOGY				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE: NIL

Course Objectives:	• To equip students with knowledge of cell biology concepts for understanding cellular functions and their real-world applications.

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply knowledge of cell biology to describe the structural and functional aspects of cells in biological systems.	Ap	30%
CO2	Illustrate cellular mechanisms, including transport and signaling, in maintaining homeostasis and communication.	Ap	30%
CO3	Use cell biology techniques and principles to address real-world biological or interdisciplinary challenges.	Ap	30%
CO4	Analyze the processes of cellular signaling and transport to differentiate their roles in maintaining cellular integrity and function.	An	10%
CO5	Analyze advanced concepts in cell biology by interpreting insights from interactive discussions and real-world observations during field visits.	An	Internal Assessment

UNIT I – CELL STRUCTURE	**(9)**
Definition of cells - differences between eukaryotic and prokaryotic cells - key organelles, General structure of plant and animal cells – tissues - extracellular matrix, cytoskeletal proteins. Case Study: Designing Bio-Inspired Robotics Using Cytoskeletal Proteins for Movement and Flexibility.	
UNIT II – CELL ORGANELLES	**(9)**
Overview of cell organelles structure, importance and their functions: nucleus, cytoplasm, endoplasmic reticulum, Golgi complex, lysosomes, cell membrane, mitochondria. Case Study: Lysosomal Storage Diseases and Enzyme Replacement Therapy.	
UNIT III – CELLULAR TRANSPORT	**(9)**
Basic transport mechanisms: active and passive transport, examples of Na+ K+ ATPase pump, endocytosis and exocytosis, entry of viruses and toxins. Case Study: Ion Channel Function and its Application in Designing Targeted Drug Delivery Systems.	
UNIT IV – CELL SIGNALING AND SIGNAL TRANSDUCTION	**(9)**
Introduction to cell signaling, receptors and ligands, basic signal transduction mechanisms and roles of second messengers like Ca ions and cAMP. Case Study: Signal Transduction Pathways in Cancer Cells and Development of Cancer Immunotherapies.	
UNIT V – CELL CULTURE	**(9)**

Definition, media preparation basics, propagation of cells, primary cultures and contamination prevention. Case Study: Application of Cell Culture in Developing Organoids for Drug Testing and Disease Modeling.
TOTAL (L:45) = 45 PERIODS
TEXT BOOKS:
1. James E Darnell, Harvey F Lodish, David Baltimore, "Molecular Biology of the Cell", W.H. Freeman publishers, 2012. 2. Geoffrey Cooper, "The Cell: A molecular approach", OUP USA; 8th edition, 2019. 3. Verma and Aggarval, "Cytology", S. Chand Publications, 2003.
REFERENCES:
1. Bruce Alberts, Alexander Johnson, Julian Lewis and Martin Raff, "Molecular Biology of the Cell", fifth edition, Taylor and Francis group, 2012. 2. De Robertis, E.D.P and DeRobertis, E.M.F. (2010), "Cell and Molecular Biology", (8th edition) Lippincott Williams and Wilkins, Philadelphia. 3. Gerald Karp," Cell and Molecular Biology", John Wiley and sons Inc, 2013.
WEB LINK:
1. https://onlinecourses.nptel.ac.in/noc20_ee42/preview

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2		3												
3				3										
4					3									3
5									3		2		3	
CO (W.A)	3	3		3	3				3		2		3	3

22BMZ02 – BIOMEDICAL PHOTONICS AND LASER APPLICATIONS				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE: NIL

Course Objectives:	• To provide students with a foundational understanding of photonics instrumentation, optical properties, and their applications in medicine and biology.

	Course Outcomes. The Student will be able to	**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply fundamental principles of photonics and light interactions to biomedical applications.	Ap	30%
CO2	Apply appropriate Laser for surgical applications.	Ap	30%
CO3	Apply optics concept for Non-thermal diagnostic and therapeutic applications.	Ap	20%
CO4	Analyze the optical properties of tissues for visualizing its structure.	An	20%
CO5	Present and document the case study on usage of Diagnostic and Therapeutic equipments.	An	Internal Assessment

UNIT I – FUNDAMENTALS OF PHOTONICS	**(9)**
Introduction to the basic properties of light – reflection, refraction, scattering, fluorescence and phosphorescence. Overview of light sources (arc lamps, LEDs, lasers) and detectors used in medical instrumentation. Basic principles of optical filters and optical tweezers in biomedical applications.	
UNIT II – OPTICAL PROPERTIES OF THE TISSUES	**(9)**
Understanding light transport in tissues and the optical properties of biological tissues. Introduction to laser characteristics applied to medicine, including laser-tissue interactions such as chemical, thermal and photodynamic effects. Basic principles of photoablative processes.	
UNIT III – MEDICAL APPLICATIONS OF LASERS	**(9)**
Overview of laser applications in various medical fields - ophthalmology, dermatology, dentistry and urology. Lasers in tissue welding and other non-invasive surgical procedures.	
UNIT IV – NON-THERMAL DIAGNOSTIC APPLICATIONS	**(9)**
Introduction to non-thermal diagnostic techniques: Optical Coherence Tomography (OCT), Laser Induced Fluorescence (LIF), Raman Spectroscopy, and Fluorescence Lifetime Imaging (FLIM).	
UNIT V – THERAPEUTIC APPLICATIONS	**(9)**
Introduction to phototherapy and Photodynamic Therapy (PDT). Overview of PDT principles and its applications in oncology and other medical fields. Biostimulation effects of lasers and safety procedures in laser therapy.	
TOTAL(L:45) = 45 PERIODS	

TEXTBOOKS:

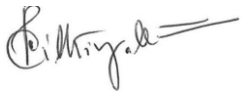
1. Markolf H. Niemz, "Laser-Tissue Interaction Fundamentals and Applications", Springer, 2007.
2. Paras N. Prasad, "Introduction to Bio photonics", A. John Wiley and sons, Inc. Publications, 2003.

REFERENCES:

1. Helena Jelinkova, "Lasers for Medical Applications: Diagnostics, Therapy and Surgery", 1st Edition, Woodhead Publishing, 2013.
2. Mark E. Brezinski, "Optical Coherence Tomography: Principles and Applications", Academic Press, 2006.
3. R. Splinter and B.A. Hooper, "An Introduction to Biomedical Optics", Taylor and Francis, 2007.
4. Tuan Vo Dinh, "Biomedical Photonics – Handbook", CRC Press LLC, 2014.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												2	
2		3											2	
3		3				2								2
4		3				2							2	
5				3					3			2	2	
CO (W.A)	**3**	**3**		**3**		**2**			**3**			**2**	**2**	**2**



22BMZ03 – WEARABLE SENSOR TECHNOLOGIES				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE: NIL

Course Objectives:	• To equip students with knowledge of wearable systems and their healthcare applications, focusing on sensors, signal processing, and wireless monitoring.

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the knowledge of various sensors to measure and analyze physiological systems.	Ap	30%
CO2	Apply bio signal acquisition methods and signal processing techniques for efficient health monitoring.	Ap	30%
CO3	Apply optimized energy techniques to enhance the performance of wearable devices.	Ap	20%
CO4	Analyze the wireless communication and BAN in Tele health technology.	An	20%
CO5	Function effectively to communicate as an individual to present case study on wireless health systems.	Ap	Internal Assessment

UNIT I – SENSORS	**(9)**
Overview of Wearable Technologies – Types of Sensors - Inertial Movement Sensors, Respiration and Activity Sensors, Thermal and Skin Response (GSR) Sensors, Wearable Motion Sensors. Biocompatibility. Case Study: Wearable Inertial Movement Sensors in Sports Medicine.	
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. Case Study: Neurotechnology Wearables for Brain-Computer Interface (BCI).

TOTAL(L:45)=45 PERIODS

TEXTBOOKS:

1. Edward Sazonov and Michael R Neuman, "Wearable Sensors: Fundamentals, Implementation and Applications", Academic Press, USA, 2014.
2. Annalisa Bonfiglio and Danilo De Rossi, "Wearable Monitoring Systems", Springer, 2011.

REFERENCES:

1. Sandeep K.S. Gupta, Tridib Mukherjee and Krishna Kumar Venkatasubramanian, "Body Area Networks Safety, Security, and Sustainability," Cambridge University Press, 2013.
2. Andreas Lymberis and Danilo de Rossi, "Wearable eHealth Systems for Personalized Health Management – State of the Art and Future Challenges", IOS press, The Netherlands, 2004.
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-ZhongYang, "Body Sensor Networks", 2nd Edition, Springer, 2014.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2											2	
2		3											2	
3			3											2
4		2		3									2	
5									3	3		2	2	
CO (W.A)	**3**	**2.3**	**3**	**3**					**3**	**3**		**2**	**2**	**2**

22BMZ04 - HOME HEALTHCARE SYSTEMS				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE: NIL

Course Objectives:	• To familiarize students with home health nursing, covering patient care, medical devices, healthcare technologies and wireless communication in home care.

	Course Outcomes The student will be able to	Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply strategies for infection control, patient education and home care management.	Ap	30%
CO2	Apply personalized care plans for elderly and mobility-impaired patients.	Ap	30%
CO3	Apply appropriate medical devices based on patient needs.	Ap	20%
CO4	Analyze advancements in healthcare technologies for improving patient care and remote monitoring.	An	20%
CO5	Analyze complex issues in home health care, patient management and medical technologies through case studies.	An	Internal Assessment

UNIT I – INTRODUCTION TO HOME HEALTH AID	**(9)**
Home Health Care – Purpose - Organization of Homecare System - Legal and Ethical Issues in Home Care - Role of Home Care Nurse and Orientation Strategies - Patient Education and Infection Control.	
UNIT II – WORKING WITH CLIENTS	**(9)**
Basic Human Needs - Communication and Interpersonal Skills - Caregiver Observation - Recording and Reporting, Confidentiality. Working with Elderly – Aging and Body Systems. Mobility Transfers and Ambulation - Range of Motion Exercises - Skin Care and Comfort Measures.	
UNIT III – MEDICAL DEVICES AT HOME	**(9)**
Medical Devices at Home - ECG Monitors - Smart Watch - Wireless Infant Monitoring System - PCG Monitors, Medical Alert Services. Activity Monitors - Automatic Wireless Healthcare Monitoring System - The Ventilator Dependent Patient - Device For Patient with Congestive Heart Failure - Device for Patient with Chronic Obstructive Pulmonary Disease - Device for Patient with Diabetic.	
UNIT IV – ADVANCEMENT IN MEDICAL TECHNOLOGIES	**(9)**
Advances and Trends in Health Care Technologies - E-Health and Personal Healthcare - Defining the Future of Health Technology - Tools for Self-Health - Future of Nano Fabrication Molecular Scale Devices - Future of Telemedicine - Future of Medical Computing.	
UNIT V – WIRELESS TECHNOLOGY	**(9)**
Wireless Communication Basics - Types of Wireless Network - Body Area Network - Emergency Rescue - Remote Recovery - Personalized Ambient Monitoring - Future Trends in Healthcare Technology.	
TOTAL(L:45) = 45 PERIODS	

TEXT BOOKS:
1. Robyn Rice, "Home care nursing practice: Concepts and Application", 4th Edition, Elsevier, 2006. 2. LodewijkBos, "Handbook of Digital Homecare: Successes and Failures", Springer, 2011.
REFERENCES:
1. Yadin David, Wolf W. von Maltzahn, Michael R. Neuman, Joseph. D. Bronzino, "Clinical Engineering", CRC Press, 2010. 2. Kenneth J. Turner, "Advances in Home Care Technologies: Results of the match Project", Springer, 2011.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2			3	3									2	
3		3												
4				3		3								2
5									3			3		2
CO (W.A)	3	3	3	3		3			3			3	2	2

22BMM01 – INTRODUCTION TO BIOMEDICAL ENGINEERING				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE: NIL

Course Objectives:	• To provide students with foundational knowledge of biomedical engineering concepts, medical instrumentation, diagnostic imaging and safety standards relevant to healthcare systems.

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply knowledge of biomedical engineering concepts to understand and analyze various biomedical devices and systems used in healthcare.	Ap	30%
CO2	Apply principles of medical instrumentation and diagnostic techniques to interpret physiological data for clinical applications.	Ap	30%
CO3	Apply critical thinking to assess the design, functionality, and operation of biomedical equipment and healthcare technologies.	Ap	30%
CO4	Apply safety standards, regulations, and ethical considerations in the operation and maintenance of biomedical devices in healthcare settings.	Ap	10%
CO5	Engage in assignments to explore real-world applications of biomedical engineering and suggest solutions for current healthcare challenges.	Ap	Internal Assessment

UNIT I – INTRODUCTION	**(9)**
Historical Perspective - Evolution of Modern Healthcare System - Modern Healthcare System - Role of Biomedical Engineers in various Domain - Recent Advances in Biomedical Engineering - Professional Status of Biomedical Engineering - Professional Societies for Biomedical Engineering.	
UNIT II – FUNDAMENTALS OF MEDICAL INSTRUMENTATION	**(9)**
Anatomy and Physiology – Sources of Biomedical Signals- Basic Medical Instrumentation System - Performance Requirements – Intelligent Medical Instrumentation Systems - PC based Medical Instruments - General Constraints in Design of Medical Instruments.	
UNIT III – DIAGNOSTIC IMAGING	**(9)**
X-rays, Nuclear Medical Imaging - Positron Emission Tomography - Magnetic Resonance Imaging Scanners -Diagnostic Ultrasound - Thermal Imaging Systems.	
UNIT IV – INTRODUCTION TO BIOMEDICAL EQUIPMENT	**(9)**
ECG - EEG - Cardiac Pacemakers - Cardiac Defibrillators – Haemodialysis Machines - Artificial Kidney – Dialyzers – Ventilators - Humidifiers, Nebulizers and Aspirators - Anaesthesia Machine.	

UNIT V – MEDICAL SAFETY STANDARDS	(9)
Medical Standards and Regulations – Institutional Review Boards – Good Laboratory Practices - Good Manufacturing Practices - Human Factors.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. Enderle, John D, Bronzino, Joseph D, Blanchard, Susan M, "Introduction to Biomedical Engineering", 2nd Edition, Elsevier Inc, 2005.
2. R. S. Khandpur, "Handbook of Biomedical Instrumentation", 2nd Edition, McGraw-Hill Publishing Company Limited, 2003.
3. Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, "Biomedical Instrumentation and Measurement", 2nd Edition, Prentice Hall of India, New Delhi, 2002.

REFERENCES:

1. John G Webster, "Medical Instrumentation: Application and Design", 4th Edition, John Wiley and Sons, New York, 2010.
2. Daniel A Vallero, "Biomedical Ethics for Engineers", 1st Edition, Elsevier Publication, 2007
3. Joseph. J Carr, John M Brown, "Introduction to Biomedical Equipment Technology", 4th Edition, John Wiley & Sons, New York, 2008.
4. Norbert Leitgeb, "Safety of Electro-medical Devices - Risks Opportunities", Springer-Verlag/Wein, 2010.
5. Michael Domach "Introduction to Biomedical Engineering", Pearson, 2004.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	3	3	3	2								3	
2		3	3										3	
3		3	3		3	3							3	
4			3	3	2								3	
5					3	2								3
CO (W.A)	3	3	3	3	2.5	2.5							3	3

22BMM02 – BIO PHYSICS				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE: NIL

Course Objectives:	• To understand the principles and applications of non-ionizing radiation, sound and radioactive materials in medical diagnostics and treatment.

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply fundamental principles of non-ionizing radiation, sound, and radioactive materials to solve problems in medical diagnostics and treatment.	Ap	30%
CO2	Analyze data obtained from biomedical instruments and apply it to interpret clinical conditions and enhance patient care.	Ap	30%
CO3	Discuss effective solutions to complex biomedical engineering problems using medical technologies such as ultrasound, radiation and sound waves.	Ap	30%
CO4	Apply established safety and effectiveness standards to ensure the reliability and accuracy of medical technologies for diagnostic and therapeutic purposes.	Ap	10%
CO5	Investigate the practical applications of medical technologies through hands-on assignments and present findings to demonstrate real-world applications.	Ap	Internal Assessment

UNIT I – NON IONIZING RADIATION	**(9)**
Non-ionizing Electromagnetic Radiation: Overview of Non-ionizing Radiation Effects - Electromagnetic Spectrum - Low Frequency Effects - Higher Frequency Effects. Physics of Light, Measurement of Light and its Unit - Limits of Vision and Color Vision, Thermography – Fundamentals of Near Infrared Spectroscopy.	
UNIT II – SOUND IN MEDICINE	**(9)**
Physics of Sound, Normal Sound Levels – Ultrasound Fundamentals – Generation of Ultrasound (Ultrasound Transducer) - Scanning Systems – Artifacts – Ultrasound - Doppler Shift.	
UNIT III – PRINCIPLES OF RADIOACTIVE NUCLIDES	**(9)**
Radioactive Decay – Spontaneous Emission – Isometric Transition – Gamma Ray Emission, Alpha, Beta, Positron Decay, Sources of Radioisotopes Natural and Artificial Radioactivity, Production of Radionuclides – Cyclotron produced Radionuclide - Reactor produced Radionuclide - Radionuclide Generator -Technetium Generator.	
UNIT IV – INTERACTION OF RADIATION WITH MATTER	**(9)**

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	**(9)**

Thermography Applications - Clinical Applications of Doppler – Applications of Gamma radiation in Medicine - Radionuclide used in Medicine and Technology.

TOTAL (L:45) = 45 PERIODS

TEXT BOOKS:

1. John R Cameran, James G Skofronick, "Medical Physics", John-Wiley & Sons Publications, 2002.
2. W.J. Meredith and J.B. Massey, "Fundamental Physics of Radiology", Varghese Publishing House, 2011.

REFERENCES:

1. S. Webb, "The Physics of Medical Imaging", Taylor and Francis, 2013.
2. J. P. Woodcock, "Ultrasonic Medical Physics Handbook Series", Adam Hilger, Bristol, 2002.
3. Hylton B. Meire and Pat Farrant, "Basic Ultrasound", John Wiley & Sons, 1994.

Mapping of COs with POs / PSOs

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3		2										3	
2		3			2									2
3			3		3								2	
4			2	3										3
5						2								3
CO (W.A)	**3**	**3**	**2.3**	**3**	**2.5**	**2**							**2.5**	**2.7**

22BMM03 – BIOMEDICAL SENSORS					
		L	T	P	C
		3	0	0	3
PRE-REQUISITE: NIL					
Course Objectives:	• To understand the fundamental principles of biomedical measurement systems, including transduction mechanisms, biosensors, biochemical sensors and biopotential electrodes used in clinical diagnostics.				

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply principles of biomedical measurement systems, including transduction mechanisms, to solve medical diagnostics and treatment problems.	Ap	30%
CO2	Apply transduction principles and measurement characteristics to interpret data from biomedical instruments and assess clinical conditions.	Ap	30%
CO3	Discuss biomedical sensors, transducers and systems for accurate measurement of physiological parameters and clinical monitoring.	Ap	30%
CO4	Apply evaluation techniques to assess the safety, functionality, and effectiveness of biosensors and measurement devices in clinical settings.	Ap	10%
CO5	Investigate practical applications of bio-potential electrodes/sensors and analyze their role in monitoring patient health through assignments or expert lectures.	Ap	Internal Assessment

UNIT I – SCIENCE OF MEASUREMENT	**(9)**
Generalized Instrumentation System, General Properties of Input Transducer. Static Characteristics: Accuracy, Precision, Resolution, Reproducibility, Sensitivity, Drift, Hysteresis, Linearity, Input Impedance and Output Impedance. Dynamic Characteristics: First Order and Second Order Characteristics, Time Delay, Transfer Function – First and Second Order Systems.	
UNIT II – DIFFERENT TRANSDUCTION PRINCIPLE	**(9)**
Transducers in Medical Applications, Temperature Transducers- Thermo Resistive and Thermoelectric, Displacement Transducers - Resistive Strain Gauges, Potentiometric, and Capacitive, Pressure Transducers - Blood Pressure Measurement and Piezoelectric Types, Case Study: Blood Pressure Monitoring with Sphygmomanometers	
UNIT III – BIO SENSORS	**(9)**
Sensors and Biosensors in Healthcare, Electrolytic Sensors, Optical Sensor, Fiber Optic Sensors. Biosensors in Clinical Chemistry, Wearable Biosensors for Real-Time Health Monitoring, Regulatory and Ethical Considerations in Biosensor Development	

UNIT IV – BIO CHEMICAL SENSORS	(9)
Introduction, Advantages and Limitations, Various Components of Biosensors, Biocatalysts based Biosensors, Bio-affinity based Biosensors & Microorganisms based Biosensors, Types of Membranes used in Biosensor Constructions.	
UNIT V – BIO POTENTIAL ELECTRODES	**(9)**
Electrodes Electrolyte Interface, Half Cell Potential, Polarization, Polarizable and Non Polarizable, Electrodes, Calomel Electrode, Electrode Circuit Model, Electrode Skin-Interface and Motion Artifact. Body Surface Electrodes. Ion Exchange Membrane Electrodes, Oxygen Electrodes, CO2 Electrodes Enzyme Electrode, ISFET for Glucose, Urea.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. John G. Webster, "Medical Instrumentation-Application and Design", 2013.
2. Richard S.C. Cobbold, "Transducers for Biomedical Measurements: Principles and Applications", John Wiley & Sons, 2004.

REFERENCES:

1. Nandini K. Jog, "Electronics in Medicine and Biomedical Instrumentation", 2nd Edition, PHI 2013.
2. Hermann K P. Neubert, "Instrument Transducer – An Introduction to their Performance and Design", 1975.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	3			3								3	
2		3	2										3	
3			3		3								2	
4			2	3									3	
5						3								3
CO (W.A)	3	3	2.3	3	3	3							2.8	3

22BMM04 – ANALYTICAL INSTRUMENTATION					
		L	T	P	C
		3	0	0	3
PRE-REQUISITE: NIL					
Course Objectives:	• To understand and apply the principles, working mechanisms and applications of advanced analytical instrumentation techniques used in biomedical diagnostics and clinical analysis.				

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply fundamental principles of analytical instrumentation techniques like colorimetry, spectrophotometry and chromatography to solve biomedical diagnostics and treatment problems.	Ap	30%
CO2	Analyze data obtained from different biomedical instruments such as gas analyzers and pH meters and apply this data to interpret clinical conditions.	Ap	30%
CO3	Suggest solutions to biomedical engineering problems using advanced technologies such as spectroscopy, chromatography and gas analysis methods to improve diagnostic accuracy.	Ap	30%
CO4	Interpret the safety and effectiveness of biomedical instrumentation systems, ensuring their proper functioning and application in clinical diagnostics.	Ap	10%
CO5	Investigate the practical applications of biomedical instrumentation through hands-on assignments and presentations, demonstrating real-world problem-solving in clinical settings.	Ap	Internal Assessment

UNIT I – COLORIMETRY AND SPECTROPHOTOMETRY	**(9)**
Significance of Invitro Diagnostics - Special Methods of Analysis – Beer-Lambert Law – Colorimeters – UV-Visible Spectrophotometers – Single and Double Beam Instruments – Sources and Detectors –Atomic Absorption Spectrophotometers – Sources and Detectors – Flame Photometers.	
UNIT II – CHROMATOGRAPHY	**(9)**
Different techniques – Gas chromatography – Detectors – Liquid chromatographs – Applications – High-pressure liquid chromatographs – Applications.	
UNIT III – GAS ANALYZERS	**(9)**
Types of Gas Analyzers – Oxygen, NO2 and H2S Types, IR Analyzers, Thermal Conductivity Analyzers, Analysis based on Ionization of Gases.	
UNIT IV – pH METERS AND DISSOLVED COMPONENT ANALYZERS	**(9)**

Principle of pH Measurement, Glass Electrodes, Hydrogen Electrodes, Reference Electrodes, Selective Ion Electrodes, Ammonia Electrodes, Cyclic Voltametry, Biosensors, Dissolved Oxygen Analyzer – Sodium Analyzer – Silicon Analyzer.

UNIT V – ELECTRO MAGNETIC RESONANCE	**(9)**

NMR – Basic Principles – NMR Spectrometer - Applications. Electron Spin Resonance Spectroscopy – Basic Principles, Instrumentation and Applications.

TOTAL (L:45) = 45 PERIODS

TEXT BOOKS:

1. R.S. Khandpur, "Handbook of Analytical Instruments", Tata McGraw Hill publishing Co. Ltd., 2007.
2. Sivasankar, "Instrumental Methods of Analysis", Oxford University Press India, 2012.

REFERENCES:

1. Robert D. Braun, "Introduction to Instrumental Analysis", McGraw Hill, Singapore, 1987.
2. Liptak, B.G, "Process Measurement and Analysis", Chilton Book Company, 1995.
3. G.W. Ewing, "Instrumental Methods of Analysis", McGraw Hill, 1992.
4. R.K.Jain, "Mechanical and Industrial Measurements", Khanna Publishers, New Delhi, 1999.
5. H.H. Willard, L.L. Merritt, J.A. Dean, F.A. Settle, "Instrumental Methods of Analysis", CBS Publishing & Distribution, 1995.

Mapping of COs with POs / PSOs

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	3									3	
2		3			3									3
3			3		3								3	
4			3	3										3
5									2	2				3
CO (W.A)	**3**	**3**	**3**	**3**	**3**				**2**	**2**			**3**	**3**

22BMM05 – RADIATION AND NUCLEAR MEDICINE				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE: NIL

Course Objectives:	• To apply the principles and technologies of radiation, nuclear medicine and imaging systems for medical diagnostics, treatment and clinical decision-making, while ensuring safety and effective application in healthcare.

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply principles of radiation, nuclear medicine and imaging systems to solve complex medical diagnostic and treatment problems.	Ap	30%
CO2	Interpret clinical data obtained from radiation therapy, imaging systems and nuclear medicine technologies for informed medical decision-making.	Ap	30%
CO3	Assess radiation therapy, imaging systems and nuclear medicine technologies for effective healthcare applications.	Ap	30%
CO4	Apply safety protocols, biological effects and effectiveness of radiation technologies in healthcare applications.	Ap	10%
CO5	Investigate and present practical applications of radiation and imaging technologies through hands-on assignments and case studies.	Ap	Internal Assessment

UNIT I – ACTION OF RADIATION IN LIVING CELLS	**(9)**
Various Theories related to Radiation at Cellular Level - DNA and Chromosomal Damages - Somatic Application of Radiation - Radio Sensitivity Protocols of different Tissues of Human - Ld50/30 Effective Radiation on Skin, Bone Marrow, Eye, Endocrine Glands, and Basis of Radio Therapy.	
UNIT II – NUCLEAR MEDICINE	**(9)**
Basic Characteristic and Units of Radioactivity, Ionization Chamber, GM Tubes, Gas Filled Detectors, Scintillation Detectors, Semiconductor Detectors, Liquid Scintillation Counter, Statistical Aspects of Nuclear Medicine.	
UNIT III – NUCLEAR MEDICINE IMAGING SYSTEMS	**(9)**
Rectilinear Scanners, Scintillation Camera, Principle of Operation, Collimator, Photomultiplier Tube, Pulse Height Analyser, Computerized Multi Crystal Gamma Camera, Principles of PET and SPECT. Radiation Safety Protocols in Nuclear Medicine Imaging Systems.	
UNIT IV – RADIATION THERAPY	**(9)**
Principles of Radiation Therapy, Radio Therapy Treatment Planning Dose in Radiotherapy, Mega Voltage	

Therapy, Intensity Modulated Radiation Therapy, Brachy-therapy, Radiotherapy using Radio Isotopes.

UNIT V – RADIOBIOLOGY AND RADIOLOGICAL PROTECTION **(9)**

Radiation Sensitivity of Biological Materials, Evidence on Radiobiological Damage from Cell Survival Curve, Radiation Effects on Humans, Maximum Permissible Dose Equivalent Limits, Hazard from Ingested Radioactivity substances, ICRP Regulations, Quality Factor and Sievert, Principles of Radiological Protection, Personnel Dosimetry.

TOTAL (L:45) = 45 PERIODS

TEXT BOOKS:

1. Mary Alice S, Paula J Visconti, E Russell Ritenour, Kelli Haynes,"Radiation Protection In Medical Radiography", Elsevier Health Sciences, 2014.
2. Glasser O., "Medical Physics", Volume I, II, III, The Year Book Publishers Inc, Chicago, 1980.

REFERENCES:

1. Moselly H., "Non Ionizing Radiation", Adam-Hilgar, Bristol, 1988.
2. Khan,F.M, "Physics for Radiation Therapy", Williams & Wilkins, 2009.
3. Gopal B.Saha, "Physics and Radiation biology of Nuclear Medicine", 2006.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3		3		2								3	
2		3		2										3
3			3		2								3	
4			3			2								3
5									2	3				3
CO (W.A)	3	3	3	2	2	2			2	3			3	3

22BMM06 – RADIOLOGICAL IMAGING TECHNIQUES				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE: NIL

Course Objectives:	• To apply principles and technologies of advanced imaging systems, including X-ray, CT, PET, MRI, ultrasound and infrared imaging for medical diagnostics and treatment applications.

	Course Outcomes The Student will be able to	**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply principles of X-ray, CT, PET, MRI, ultrasound, and infrared imaging to solve medical diagnostic and treatment problems.	Ap	30%
CO2	Analyze data obtained from various imaging systems to interpret clinical conditions and guide medical decisions.	Ap	30%
CO3	Interpret advanced imaging technologies and techniques for clinical healthcare applications.	Ap	30%
CO4	Assess safety, efficiency and effectiveness of different medical imaging technologies for diagnostic and therapeutic purposes.	Ap	10%
CO5	Investigate real-world applications of imaging technologies through hands-on assignments and case studies and present findings.	Ap	Internal Assessment

UNIT I – X-RAY AND CT IMAGING	**(9)**

Principles and Production of Soft X-rays and Hard X-rays - Details of Radiographic and Fluoroscopic Images in X-Ray Systems - Screen-film and Image Intensifier Systems - Evolution of CT Machines - CT Image Formation- Conversion of X-ray Data into Scan Image, Mathematical details of various Algorithms - Spiral CT, Transverse Tomography - CT Angiography.

UNIT II – PET AND SPECT IMAGING	**(9)**

Introduction to Emission Tomography, Basic Physics of Radioisotope Imaging Compton Cameras for Nuclear Imaging, PET Scanner Principles, SPECT, Computer Techniques in Fast Acquisition Analytic Image Reconstruction Techniques, Attenuation, Scatter Compensation in SPECT Spatial Compensation in SPECT.

UNIT III – MAGNETIC RESONANCE IMAGING	**(9)**

Principles of MRI Pulse Sequence – Image Acquisition and Reconstruction Techniques – MRI Instrumentation Magnetic Gradient System RF Coils – Receiver System Functional MRI – MRI Artifacts- Various Types of Pulse Sequences for Fast Acquisition of Imaging, NMR Spectroscopy - Application of MRI.

UNIT IV – ULTRASOUND IMAGING	**(9)**

Production of Ultrasound – Properties and Principles of Image Formation, Capture and Display – Principles of A-mode, B-mode and M-mode Display – Doppler Ultra Sound and Color Flow Mapping – Applications of Diagnostic Ultra Sound.

UNIT V – INFRA-RED IMAGING	**(9)**

Physics of Thermography – Imaging Systems – Pyroelectric Videocon Camera Clinical Thermography – Liquid Crystal Thermography.

TOTAL (L:45) = 45 PERIODS

TEXT BOOKS:

1. John Ball and Tony Price Chesney's, "Radiographic Imaging", Blackwell Science Limited, U.K., 2006.
2. Farr, "The Physics of Medical Imaging", Adem Hilger, Bristol & Philadelphia, 2007.
3. S Webb, "The Physics of Medical Imaging", Adam Highler, Bristol Published by CRC Press, first edition 1988.

REFERENCES:

1. M. Analoui, J.D. Bronzino, D.R.Peterson, "Medical Imaging: Principles and Practices", CRC Press, 2012.
2. S. Webb, "Physics of Medical Imaging", Taylor & Francis, 2010.
3. T. Farncombe, K. Iniewski, "Medical Imaging: Technology & Applications", CRC Press, 2013.

Mapping of COs with POs / PSOs

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3		3		2								3	
2		3		2										3
3			3		2								3	
4			3			2								3
5									2	3				3
CO (W.A)	**3**	**3**	**3**	**2**	**2**	**2**			**2**	**3**			**3**	**3**

22BMM07 – ICU AND OPERATION THEATRE EQUIPMENT				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE: NIL

Course Objectives:	• To apply principles of biomedical equipment, critical care systems and patient safety measures to enhance the functionality and safety of healthcare technologies in clinical settings.

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply principles of biomedical equipment such as infusion pumps, hemodialysis machines and surgical diathermy to improve healthcare delivery.	Ap	30%
CO2	Interpret data from critical care equipment to optimize treatment and care in emergency and intensive care settings.	Ap	30%
CO3	Evaluate medical technologies, including automated drug delivery systems and centralized systems, for practical healthcare applications.	Ap	30%
CO4	Apply safety standards for patient care through the use of electrical safety measures and equipment inspection in clinical settings.	Ap	10%
CO5	Investigate real-world applications of medical equipment and safety protocols through hands-on assignments, analyzing their effectiveness in improving patient care.	Ap	Internal Assessment

UNIT I – ICU EQUIPMENT	**(9)**
Suction Apparatus, Different types; Sterilizers, Chemical, Radiation, Steam for Small and Larger Units. Automated Drug Delivery Systems, Infusion Pumps, Closed Loop Control Infusion System, Implantable Infusion System.	
UNIT II – CRITICAL CARE EQUIPMENT	**(9)**
Hemodialysis Machine, Different types of Dialyzers, Membranes, Machine Controls and Measurements. Heart Lung Machine, Different Types of Oxygenators, Peristaltic Pumps, Incubators. Case Study: Heart-Lung Machines and Oxygenators in Cardiac Surgeries.	
UNIT III – OPERATION THEATRE EQUIPMENT	**(9)**
Surgical Diathermy, Instruments for Operation. Anesthesia Equipment, Humidification, Sterilization Aspects, Boyles Apparatus.	
UNIT IV – CENTRALISED SYSTEMS	**(9)**
Centralized Oxygen, Nitrogen, Air Supply & Suction. Centralized Air Conditioning, Operation Theatre	

Table & Lighting.

UNIT V – PATIENT SAFETY **(9)**

Patient Electrical Safety, Types of Hazards, Natural Protective Mechanisms against Electricity, Leakage Current, Inspection of Grounding and Patient Isolation, Hazards in Operation Rooms, ICCU and IMCUs, Opto couplers and Pulse Transformers.
Case Study: Electrical Safety in ICU and the Use of Patient Isolation Transformers.

TOTAL (L:45) = 45 PERIODS

TEXT BOOKS:

1. John G. Webster, " Medical Instrumentation Application and Design", 4th edition, Wiley India Pvt. Ltd, New Delhi, 2015
2. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", Pearson education, 2012.
3. Khandpur. R.S.,"Handbook of Biomedical Instrumentation", 2nd Edition. Tata McGrawHill Pub. Co., Ltd., 2003.

REFERENCES:

1. L. A Geddes and L. E. Baker, "Principles of Applied Biomedical Instrumentation", 3rd Edition, 2008.
2. Antony Y.K. Chan, "Biomedical Device Technology, Principles and Design", Charles Thomas Publisher Ltd, Illinois, USA, 2008.
   Leslie Cromwell, "Biomedical Instrumentation and Measurement", Pearson Education, New Delhi, 2007.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3		3		2								3	
2		3		2										3
3			3		2								2	
4			3			2								3
5									2	3				
CO (W.A)	**3**	**3**	**3**	**2**	**2**	**2**			**2**	**3**			**2.5**	**3**

22BMM08 – BIOMATERIALS				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE: NIL

Course Objectives:	• To apply principles of biomaterials science and engineering to design, evaluate and test materials for biomedical applications in tissue replacement, implants and medical devices.

Course Outcomes The Student will be able to		Cognitive Level	Weightage of COs in End Semester Examination
CO1	Apply knowledge of biomaterial properties, including mechanical and viscoelastic properties, to design and evaluate biomedical implants.	Ap	30%
CO2	Illustrate the performance and biocompatibility of metallic, ceramic, and polymeric materials for medical implant applications.	Ap	30%
CO3	Interpret tissue replacement implants using advanced biomaterials and nanotechnology for medical applications.	Ap	30%
CO4	Assess the biocompatibility, toxicity and sterilization of biomaterials through in vitro and in vivo testing methods.	Ap	10%
CO5	Investigate the practical applications of biomaterials and present findings through hands-on assignments, focusing on real-world biomedical challenges.	Ap	Internal Assessment

UNIT I – INTRODUCTION TO BIO-MATERIALS	**(9)**
Definition and classification of bio-materials, mechanical properties, visco elasticity, biomaterial performance, body response to implants, wound healing, blood compatibility, Nano scale phenomena.	
UNIT II – METALLIC AND CERAMIC MATERIALS	**(9)**
Metallic implants - Stainless steels, co-based alloys, Ti-based alloys, shape memory alloy, nanostructured metallic implants, degradation and corrosion, ceramic implant – bio inert, biodegradable or bioresorbable, bioactive ceramics, nanostructured bio ceramics.	
UNIT III – POLYMERIC IMPLANT MATERIALS	**(9)**
Polymerization, factors influencing the properties of polymers, polymers as biomaterials, biodegradable polymers, Bio polymers: Collagen, Elastin and chitin. Medical Textiles, Materials for ophthalmology: contact lens, intraocular lens. Membranes for plasma separation and Blood oxygenation, electro spinning: a new approach.	
UNIT IV – TISSUE REPLACEMENT IMPLANTS	**(9)**
Small intestinal sub mucosa and other decullarized matrix biomaterials for tissue repair: Extra cellular Matrix. Soft tissue replacements, sutures, surgical tapes, adhesive, Percutaneous and skin implants,	

maxillofacial augmentation, Vascular grafts, hard tissue replacement Implants, joint replacements, tissue scaffolding and engineering using Nano biomaterials.

UNIT V – TESTING OF BIOMATERIALS **(9)**

Biocompatibility, blood compatibility and tissue compatibility tests, Toxicity tests, sensitization, carcinogenicity, mutagenicity and special tests, Invitro and Invivo testing; Sterilization of implants and devices: ETO, gamma radiation, autoclaving. Effects of sterilization.

TOTAL (L:45) = 45 PERIODS

TEXT BOOKS:

1. Sujata V. Bhatt, "Biomaterials", 7th Edition, Narosa Publishing House, 2005.
2. Michael Lysaght, Thomas J Webster, "Biomaterials for Artificial Organs", Elsevier Science, 2018.

REFERENCES:

1. Park Joseph D.Bronzino, "Biomaterials-Principles and Applications", CRC Press, 2003.
2. J. Park, "Biomaterials: An Introduction", Springer Science & Business Media, 2012.
3. Myer Kutz, "Standard Handbook of Biomedical Engineering & Design", McGraw-Hill, 2003.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3		3		2								3	
2		3		2										3
3			3		3								3	
4			3			2								3
5									3	2				3
CO (W.A)	3	3	3	2	2.5	2			3	2			3	3