SRI MANAKULA VINAYAGAR
ENGINEERING COLLEGE
(An Autonomous Institution)

Puducherry

B.TECH.

BIOMEDICAL ENGINEERING

ACADEMIC REGULATIONS 2023
(R-2023)

CURRICULUM AND SYLLABI

COLLEGE VISION AND MISSION

Vision

To be globally recognized for excellence in quality education, innovation and research for the transformation of lives to serve the society

Mission

M1: Quality Education

To provide comprehensive academic system that amalgamates the cutting edge technologies with best practices.

M2: Research and Innovation

To foster value-based research and innovation in collaboration with industries and institutions globally for creating intellectuals with new avenues.

M3: Employability and Entrepreneurship

To inculcate the employability and entrepreneurial skills through value and skill based training.

M4: Ethical Values

To instill deep sense of human values by blending societal righteousness with academic professionalism for the growth of society.

DEPARTMENT VISION AND MISSION

Vision

To provide quality education in Biomedical Engineering focused on promoting continuous enrichment in the relevant research field and innovations in medical diagnosis for human health care.

Mission

M1: Medical science Engineering

To provide quality Biomedical Engineering education that integrates engineering principles with biomedical sciences.

M2: Research and Development

To develop Biomedical engineers to apply innovative strategies for the design and development of medical equipment.

M3: Industrial Intelligence

To incorporate novel technologies towards the healthcare industrial needs for medical applications and to become an entrepreneur.

M4: Ethical Responsibilities

To impart the desirable skill sets to become globally competent ethical professional.

PROGRAM OUTCOMES (POs)

PO1: Engineering knowledge:

Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: Problem analysis:

Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/development of solutions:

Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: Conduct investigations of complex problems:

Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of the information to provide valid conclusions.

PO5: **Modern tool usage:**

Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6: The engineer and society:

Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: Environment and sustainability:

Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of and need for sustainable development.

PO8: Ethics:

Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: Individual and team work:

Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: Communication:

Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: Project management and finance:

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.

PO12: Life-long learning:

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.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO1: Professional Skills

To become outstanding professionals to demonstrate their skills in solving challenges for healthcare diagnosis.

PEO2: Higher Education and Research

To work successfully in multi-disciplinary environments or pursue higher studies.

PEO3: Entrepreneurial Competencies

To address the challenges in biomedical engineering that supports employment and entrepreneurship to serve the society.

PEO4: Leadership Quality

To enable the graduates to exhibit leadership, make decisions with ethical responsibilities.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1: Knowledge in Biomedical Engineering

Comprehending fundamental concepts in Biomedical Engineering to meet the emerging trends.

PSO2: Problem Solving in Medical Diagnosis

Apply Bio Signal and Image processing techniques to solve real time problems in medical field.

PSO3: Troubleshooting of Medical Equipment

Troubleshoot the faulty medical Equipment used in health care industry.

STRUCTURE FOR UNDERGRADUATE ENGINEERING PROGRAM

Sl.No.	Course Category	Breakdown of Credits
1	Humanities and Social Sciences including Management courses (HS)	15
2	Basic Science Courses (BS)	24
3	Engineering Science including workshop, drawing, basics of electrical / mechanical / computer etc. (ES)	25
4	Professional Core Courses (PC)	65
5	Professional Electives Courses (PE)	18
6	Open Electives Courses (OE)	9
7	Project Work and Internship (PA)	13
8	Ability Enhancement Courses (AEC*)	-
9	Mandatory Courses (MC*)	-
Total		169

SCHEME OF CREDIT DISTRIBUTION – SUMMARY

Sl.No.	Course Category	Credits per Semester								Total Credits
		I	II	III	IV	V	VI	VII	VIII	
1	Humanities and Social Sciences including Management courses (HS)	3	5	1	1	2	-	-	3	15
2	Basic Sciences(BS)	11	4	5	4	-	-	-	-	24
3	Engineering Sciences (ES)	8	5	4	4	4				25
4	Professional Core (PC)	-	8	13	10	8	15	11	-	65
5	Professional Electives (PE)	-	-	-	3	3	3	3	6	18
6	Open Electives (OE)	-	-	-	-	3	3	3	-	9
7	Project Work (PA)	-	-	-	-	1	1	2	8	12
8	Internship (PA)	-	-	-	-	-	-	1	-	1
9	Ability Enhancement Courses (AEC*)	-	-	-	-	-	-	-	-	-
10	Mandatory courses (MC*)	-	-	-	-	-	-	-	-	-
Total		**22**	**22**	**23**	**22**	**21**	**22**	**20**	**17**	**169**

**** AEC and MC credits are not included for CGPA calculation***

HONOURS / MINOR DEGREE PROGRAMME:

The student is permitted to opt for earning an honours / Minor degree in the same discipline of engineering in addition to the degree in his/her own discipline. To earn an honours / Minor degree the student is required to earn an additional 18 - 20 credits (over and above the total 169 credits prescribed in the curriculum) starting from fourth semester onwards by completing 5 additional courses offered in respective

semesters. A student is eligible to exercise this option if he/she has passed all the courses offered upto third semester in the first attempt itself and has earned a CGPA / GPA* (*for lateral entry) of not less than 8.0.The prescribed courses offered for Honours / Minor degree are given in **Annexure – V**

SEMESTER – I										
Sl. No.	Course Code	Course Title	Category	Periods			Credits	Max. Marks		
				L	T	P		CAM	ESM	Total
Theory										
1	U23MATC01	Engineering Mathematics – I	BS	3	1	0	4	25	75	100
2	U23BSTC01	Physical Science for Engineers	BS	3	0	0	3	25	75	100
3	U23BMT101	Human Anatomy and Physiology	BS	3	0	0	3	25	75	100
4	U23BMT102	Basic Electrical Circuits	ES	3	0	0	3	25	75	100
5	U23ESTC01	Basics of Civil and Mechanical Engineering	ES	3	0	0	3	25	75	100
Theory cum Practical										
6	U23ENBC01	Communicative English - I	HS	2	0	2	3	50	50	100
Practical										
7	U23BMP101	Physiology Laboratory	BS	0	0	2	1	50	50	100
8	U23BMP102	Basic Electrical Circuits Laboratory	ES	0	0	2	1	50	50	100
9	U23ESPC02	Design Thinking and IDEA Lab	ES	0	0	2	1	50	50	100
Ability Enhancement Course										
10	U23BMC1XX	Certification Course - I**	AEC	0	0	4	-	100	-	100
Mandatory Course										
11	U23BMM101	Induction Programme	MC	2 weeks			-	-	-	-
							22	425	575	1000

SEMESTER – II										
Sl. No.	Course Code	Course Title	Category	Periods			Credits	Max. Marks		
				L	T	P		CAM	ESM	Total
Theory										
1	U23MATC02	Engineering Mathematics – II	BS	3	1	0	4	25	75	100
2	U23CSTC01	Programming in C	ES	3	0	0	3	25	75	100
3	U23BMTC01	Electron Devices and Circuits	PC	3	0	0	3	25	75	100
4	U23BMT203	Biosensors and Transducers	PC	3	0	0	3	25	75	100
5	U23HSTC01	Universal Human Values II	HS	2	0	0	2	25	75	100
Theory cum Practical										
6	U23ENBC02	Communicative English - II	HS	2	0	2	3	50	50	100
Practical										
7	U23ESPC03	Engineering Graphics using AutoCAD	ES	0	0	2	1	50	50	100

8	U23CSPC01	Programming in C Laboratory	ES	0	0	2	1	50	50	100
9	U23BMPC01	Electron Devices and Circuits Laboratory	PC	0	0	2	1	50	50	100
10	U23BMP203	Biosensors and Transducers Laboratory	PC	0	0	2	1	50	50	100
Ability Enhancement Course										
11	U23BMC2XX	Certification Course - II**	AEC	0	0	4	-	100	-	100
Mandatory Course										
12	U23BMM202	Sports Yoga and NSS	MC	0	0	2	-	100	-	100
							22	575	625	1200

***** Certification courses are to be selected from the list given in Annexure III***

SEMESTER – III										
Sl. No.	**Course Code**	**Course Title**	**Category**	**Periods**			**Credits**	**Max. Marks**		
				L	**T**	**P**		**CAM**	**ESM**	**Total**
Theory										
1	U23MATC03	Probability and Statistics	BS	3	1	0	4	25	75	100
2	U23ADTC01	Programming in Python	ES	3	0	0	3	25	75	100
3	U23BMT304	Biosignals and Systems	PC	2	1	0	3	25	75	100
4	U23ICTC01	Linear Integrated Circuits	PC	3	0	0	3	25	75	100
5	U23ICTC02	Digital Logic Circuits	PC	2	1	0	3	25	75	100
Theory cum Practical										
6	U23BMB301	Pathology and Microbiology	PC	2	0	2	3	50	50	100
Practical										
7	U23ENPC01	General Proficiency - I	HS	0	0	2	1	50	50	100
8	U23MAPC01	Engineering Mathematics Laboratory	BS	0	0	2	1	50	50	100
9	U23ADPC01	Programming in Python Laboratory	ES	0	0	2	1	50	50	100
10	U23ICPC01	Linear and Digital Integrated Circuits Laboratory	PC	0	0	2	1	50	50	100
Ability Enhancement Course										
11	U23BMC3XX	Certification Course – III**	AEC	0	0	4	-	100	-	100
12	U23BMS301	Skill Enhancement Course-1*	AEC	0	0	2	-	100	-	100
Mandatory Course										
13	U23BMM303	Climate Change	MC	2	0	0	-	100	-	100
							23	675	625	1300

SEMESTER – IV										
Sl. No.	**Course Code**	**Course Title**	**Category**	**Periods**			**Credits**	**Max. Marks**		
				L	**T**	**P**		**CAM**	**ESM**	**Total**
Theory										
1	U23MATC04	Numerical Methods and Optimization	BS	3	1	0	4	25	75	100
2	U23CSTC03	Data Structures	ES	3	0	0	3	25	75	100
3	U23BMT405	Biomechanics	PC	3	0	0	3	25	75	100
4	U23BMT406	Biomedical Instrumentation	PC	3	0	0	3	25	75	100

5	U23BME4XX	Professional Elective – I#	PE	3	0	0	3	25	75	100
Theory cum Practical										
6	U23BMB401	Biosignal Processing	PC	2	0	2	3	50	50	100
Practical										
7	U23ENPC02	General Proficiency - II	HS	0	0	2	1	50	50	100
8	U23CSPC02	Data Structures Laboratory	ES	0	0	2	1	50	50	100
9	U23BMP404	Biomedical Instrumentation Laboratory	PC	0	0	2	1	50	50	100
Ability Enhancement Course										
10	U23BMC4XX	Certification Course - IV**	AEC	0	0	4	-	100	-	100
11	U23BMS402	Skill Enhancement Course-2*	AEC	0	0	2	-	100	-	100
Mandatory Course										
12	U23BMM404	Right to Information and Good Governance	MC	2	0	0	-	100	-	100
							22	625	575	1200

 # Professional Electives are to be selected from the list given in Annexure I
**** Skill Enhancement Courses (1 and 2) are to be selected from the list given in Annexure IV***

SEMESTER – V										
Sl. No.	**Course Code**	**Course Title**	**Category**	**Periods**			**Credits**	**Max. Marks**		
				L	**T**	**P**		**CAM**	**ESM**	**Total**
Theory										
1	U23HSTC02	Research Methodology	HS	2	0	0	2	25	75	100
2	U23ITTC02	Programming in Java	ES	3	0	0	3	25	75	100
3	U23BMT507	Microcontroller and its Medical Applications	PC	3	0	0	3	25	75	100
4	U23BME5XX	Professional Elective – II#	PE	3	0	0	3	25	75	100
5	U23XX05XX	Open Elective – I$	OE	3	0	0	3	25	75	100
Theory cum Practical										
6	U23BMB502	Biocontrol Systems	PC	2	0	2	3	50	50	100
Practical										
7	U23ITPC02	Programming in Java Laboratory	ES	0	0	2	1	50	50	100
8	U23BMP505	Microcontroller and its Medical Applications Laboratory	PC	0	0	2	1	50	50	100
9	U23BMP506	Hospital Training	PC	0	0	2	1	50	50	100
Project Work										
10	U23BMW501	Micro Project	PA	0	0	2	1	100	-	100
Ability Enhancement Course										
11	U23BMC5XX	Certification Course – V**	AEC	0	0	4	-	100	-	100
Mandatory Course										
12	U23BMM505	Essence of Indian Traditional Knowledge	MC	2	0	0	-	100	-	100
							21	625	575	1200

SEMESTER – VI										
Sl. No.	Course Code	Course Title	Category	Periods			Credits	Max. Marks		
				L	T	P		CAM	ESM	Total
Theory										
1	U23BMT608	Diagnostic and Therapeutic Equipment	PC	3	0	0	3	25	75	100
2	U23BMT609	Embedded Systems for Healthcare	PC	3	0	0	3	25	75	100
3	U23BMT610	Medical Internet of Things	PC	3	0	0	3	25	75	100
4	U23BMT611	Artificial Intelligence and Machine learning in Healthcare	PC	3	0	0	3	25	75	100
5	U23BME6XX	Professional Elective – III#	PE	3	0	0	3	25	75	100
6	U23XX06XX	Open Elective – II$	OE	3	0	0	3	25	75	100
Practical										
7	U23BMP607	Diagnostic and Therapeutic Equipment Laboratory	PC	0	0	2	1	50	50	100
8	U23BMP608	Embedded Systems for Healthcare Laboratory	PC	0	0	2	1	50	50	100
9	U23BMP609	Medical Internet of Things Laboratory	PC	0	0	2	1	50	50	100
Project Work										
10	U23BMW602	Mini Project	PA	0	0	2	1	100	-	100
Ability Enhancement Course										
11	U23BMC6XX	Certification Course – VI**	AEC	0	0	4	-	100	-	100
Mandatory Course										
12	U23BMM606	Gender Equality	MC	2	0	0	-	100	-	100
							22	600	600	1200

$ Open electives are to be selected from the list given in Annexure II

SEMESTER – VII										
Sl. No.	Course Code	Course Title	Category	Periods			Credits	Max. Marks		
				L	T	P		CAM	ESM	Total
Theory										
1	U23BMT712	Biomaterials and Artificial Organs	PC	3	0	0	3	25	75	100
2	U23BMT713	Rehabilitation Engineering	PC	3	0	0	3	25	75	100
3	U23BMT714	Medical image processing	PC	3	0	0	3	25	75	100
4	U23BME7XX	Professional Elective – IV#	PE	3	0	0	3	25	75	100
5	U23XXO7XX	Open Elective III	OE	3	0	0	3	25	75	100
Practical										
6	U23BMP710	3D Printing in Biomedical Applications Laboratory	PC	0	0	2	1	50	50	100
7	U23BMP711	Medical Image Processing Laboratory	PC	0	0	2	1	50	50	100
Project Work										
8	U23BMW703	Project Phase – I	PA	0	0	4	2	50	50	100
9	U23BMW704	Internship/Inplant Training	PA	0	0	2	1	100	-	100
							20	375	525	900

SEMESTER – VIII										
Sl. No.	Course Code	Course Title	Category	Periods			Credits	Max. Marks		
				L	T	P		CAM	ESM	Total
Theory										
1	U23HSTC03	Entrepreneurship and Business Management	HS	3	0	0	3	25	75	100
2	U23BME8XX	Professional Elective – V#	PE	3	0	0	3	25	75	100
3	U23BME8XX	Professional Elective – VI#	PE	3	0	0	3	25	75	100
Project Work										
4	U23BMW805	Project Phase - II	PA	0	0	16	8	50	100	150
							17	125	325	450

Annexure – I

PROFESSIONAL ELECTIVE COURSES

Professional Elective – I (Offered in Semester IV)		
Sl. No.	**Course Code**	**Course Title**
1	U23BME401	Medical Physics
2	U23BME402	Environmental Biotechnology
3	U23BME403	Biometric Recognition Systems
4	U23BME404	Hospital Equipment Safety and Management
5	U23BMEC01	Communication Systems
Professional Elective – II (Offered in Semester V)		
Sl. No.	**Course Code**	**Course Title**
1	U23BME505	Laser and Fiber Optics in Medicine
2	U23BME506	Computers in Medicine
3	U23BME507	Transportation in Living Systems
4	U23BME508	Medical Informatics
5	U23BME509	VLSI Systems
Professional Elective – III (Offered in Semester VI)		
Sl. No.	**Course Code**	**Course Title**
1	U23BME610	Troubleshooting and Quality Control in Medical Equipment
2	U23ICEC02	Soft Computing Techniques
3	U23BME611	Physiological System Modeling
4	U23BME612	Hospital Engineering and Information Systems
5	U23BME613	Biotelemetry and Telemedicine
Professional Elective – IV (Offered in Semester VII)		
Sl. No.	**Course Code**	**Course Title**
1	U23BME714	Virtual Bioinstrumentation
2	U23BME715	Nanotechnology in Medicine
3	U23BME716	Dynamics of Biofluids
4	U23BME717	Medical Safety and Standards
5	U23BME718	Cryptography and Network Security

Professional Elective – V (Offered in Semester VIII)		
Sl. No.	**Course Code**	**Course Title**
1	U23BME819	Modeling and Designing of implants
2	U23BMEC02	Wearable Technology
3	U23BME820	Tissue Engineering
4	U23BME821	Pattern Recognition and Expert System in Medicine
5	U23BME822	Bio MEMS
Professional Elective – VI (Offered in Semester VIII)		
Sl. No.	**Course Code**	**Course Title**
1	U23BME823	Clinical Engineering
2	U23BME824	Virtual Reality in Medicine
3	U23BME825	Brain Computer Interface and Applications
4	U23BME826	Medical Ethics and Intellectual Property rights
5	U23BME827	Acoustics and Optical Imaging

Annexure – II

OPEN ELECTIVE COURSES

S.No	Course Code	Course Title	Offering Department	Permitted Departments
Open Elective – I/ Open Elective – II (Offered in Semester V for **CSE, IT, MECH, Mechatronics, AI&DS**) (Offered in Semester VI for **EEE, ECE, ICE, CIVIL, CCE, CSBS/CSEBS**)				
1	U23BMOC01	Medical Electronics	BME	EEE, ECE, CSE, IT, ICE, MECH, CIVIL, Mechatronics, AI&DS, CCE, CSBS/CSEBS
2	U23BMOC02	Biometric Systems	BME	EEE, ECE, CSE, IT, ICE, MECH, CIVIL, Mechatronics, AI&DS, CCE, CSBS/CSEBS
Open Elective – III (Offered in Semester VII)				
3	U23BMOC03	Medical Robotics	BME	EEE, ECE, CSE, IT, ICE, CIVIL, AI&DS, CCE, CSBS/CSEBS
4	U23BMOC04	Telehealth Technology	BME	EEE, ECE, CSE, IT, ICE, CIVIL, AI&DS, CCE, CSBS/CSEBS

Annexure – III
ABILITY ENHANCEMENT COURSES – (A) CERTIFICATION COURSES

S. No.	Course Code	Course Title	Certified By
1	U23XXCX01	Adobe Photoshop	Adobe
2	U23XXCX02	Adobe Animate	Adobe
3	U23XXCX03	Adobe Dreamweaver	Adobe
4	U23XXCX04	Adobe After Effects	Adobe
5	U23XXCX05	Adobe Illustrator	Adobe
6	U23XXCX06	Adobe InDesign	Adobe
7	U23XXCX07	Autodesk AutoCAD -ACU	Autodesk
8	U23XXCX08	Autodesk Inventor - ACU	Autodesk
9	U23XXCX09	Autodesk Revit - ACU	Autodesk
10	U23XXCX10	Autodesk Fusion 360 - ACU	Autodesk
11	U23XXCX11	Autodesk 3ds Max - ACU	Autodesk
12	U23XXCX12	Autodesk Maya - ACU	Autodesk
13	U23XXCX13	Cloud Security Foundations	AWS
14	U23XXCX14	Cloud Computing Architecture	AWS
15	U23XXCX15	Cloud Foundation	AWS
16	U23XXCX16	Cloud Practitioner	AWS
17	U23XXCX17	Cloud Solution Architect	AWS
18	U23XXCX18	Data Engineering	AWS
19	U23XXCX19	Machine Learning Foundation	AWS
20	U23XXCX20	Robotic Process Automation / Medical Robotics	Blue Prism
21	U23XXCX21	Advance Programming Using C	CISCO
22	U23XXCX22	Advance Programming Using C ++	CISCO
23	U23XXCX23	C Programming	CISCO
24	U23XXCX24	C++ Programming	CISCO
25	U23XXCX25	CCNP Enterprise: Advanced Routing	CISCO
26	U23XXCX26	CCNP Enterprise: Core Networking	CISCO
27	U23XXCX27	Cisco Certified Network Associate - Level 2	CISCO
28	U23XXCX28	Cisco Certified Network Associate- Level 1	CISCO
29	U23XXCX29	Cisco Certified Network Associate- Level 3	CISCO
30	U23XXCX30	Fundamentals of Internet of Things	CISCO
31	U23XXCX31	Internet of Things / Solar and Smart Energy System with IoT	CISCO
32	U23XXCX32	Java Script Programming	CISCO
33	U23XXCX33	NGD Linux Essentials	CISCO
34	U23XXCX34	NGD Linux I	CISCO
35	U23XXCX35	NGD Linux II	CISCO
36	U23XXCX36	Advance Java Programming	Ethnotech
37	U23XXCX37	Android Programming / Android Medical App Development	Ethnotech
38	U23XXCX38	Angular JS	Ethnotech

39	U23XXCX39	Catia	Ethnotech
40	U23XXCX40	Communication Skills for Business	Ethnotech
41	U23XXCX41	Coral Draw	Ethnotech
42	U23XXCX42	Data Science Using R	Ethnotech
43	U23XXCX43	Digital Marketing	Ethnotech
44	U23XXCX44	Embedded System Using C	Ethnotech
45	U23XXCX45	Embedded System with IOT / Arduino	Ethnotech
46	U23XXCX46	English For IT	Ethnotech
47	U23XXCX47	Plaxis	Ethnotech
48	U23XXCX48	Sketch Up	Ethnotech
49	U23XXCX49	Financial Planning, Banking and Investment Management	Ethnotech
50	U23XXCX50	Foundation Of Stock Market Investing	Ethnotech
51	U23XXCX51	Machine Learning / Machine Learning for Medical Diagnosis	Ethnotech
52	U23XXCX52	IOT Using Python	Ethnotech
53	U23XXCX53	Creo (Modelling & Simulation)	Ethnotech
54	U23XXCX54	Soft Skills, Verbal, Aptitude	Ethnotech
55	U23XXCX55	Software Testing	Ethnotech
56	U23XXCX56	MX-Road	Ethnotech
57	U23XXCX57	CLO 3D	Ethnotech
58	U23XXCX58	Solid works	Ethnotech
59	U23XXCX59	Staad Pro	Ethnotech
60	U23XXCX60	Total Station	Ethnotech
61	U23XXCX61	Hydraulic Automation	Festo
62	U23XXCX62	Industrial Automation	Festo
63	U23XXCX63	Pneumatics Automation	Festo
64	U23XXCX64	Agile Methodologies	IBM
65	U23XXCX65	Block Chain	IBM
66	U23XXCX66	Devops	IBM
67	U23XXCX67	Artificial Intelligence	ITS
68	U23XXCX68	Cloud Computing	ITS
69	U23XXCX69	Computational Thinking	ITS
70	U23XXCX70	Cyber Security	ITS
71	U23XXCX71	Data Analytics	ITS
72	U23XXCX72	Databases	ITS
73	U23XXCX73	Java Programming	ITS
74	U23XXCX74	Networking	ITS
75	U23XXCX75	Python Programming	ITS
76	U23XXCX76	Web Application Development (HTML, CSS, JS)	ITS
77	U23XXCX77	Network Security	ITS & Palo alto
78	U23XXCX78	MATLAB	MathWorks
79	U23XXCX79	Azure Fundamentals	Microsoft
80	U23XXCX80	Azure AI (AI-900)	Microsoft
81	U23XXCX81	Azure Data (DP -900)	Microsoft
82	U23XXCX82	Microsoft 365 Fundamentals (SS-900)	Microsoft

83	U23XXCX83	Microsoft Security, Compliance and Identity (SC-900)	Microsoft
84	U23XXCX84	Microsoft Power Platform (PI-900)	Microsoft
85	U23XXCX85	Microsoft Dynamics Fundamentals 365 – CRM	Microsoft
86	U23XXCX86	Microsoft Excel	Microsoft
87	U23XXCX87	Microsoft Excel Expert	Microsoft
88	U23XXCX88	Securities Market Foundation	NISM
89	U23XXCX89	Derivatives Equinity	NISM
90	U23XXCX90	Research Analyst	NISM
91	U23XXCX91	Portfolio Management Services	NISM
92	U23XXCX92	Cyber Security	Palo alto
93	U23XXCX93	Cloud Security	Palo alto
94	U23XXCX94	PMI – Ready	PMI
95	U23XXCX95	Tally – GST & TDS	Tally
96	U23XXCX96	Advance Tally	Tally
97	U23XXCX97	Associate Artist	Unity
98	U23XXCX98	Certified Unity Programming	Unity
99	U23XXCX99	VR Development	Unity

Annexure – IV

ABILITY ENHANCEMENT COURSES – (B) SKILL ENHANCEMENT COURSES

Sl. No.	Course Code	Course Title
1	U23BMS301	Skill Enhancement Course 1*
		1) Testing and Troubleshooting of Medical Equipment
		2) Masters in Microsoft Excel
		3) Power Point Presentation Design and Animation
2	U23BMS402	Skill Enhancement Course 2*
		1) Testing of Electronic and Medical Devices
		2) PCB Board Designing
		3) Presentation Skills using ICT

**** Choose any one Skill Enhancement Course in the list for SEC 1 and SEC 2***

Annexure – V

HONOURS / MINOR PROGRAMME - SENSORS TECHNOLOGY

COURSE DETAILS											
Sl. No.	Semester	Course Code	Course Title	Category	Periods			Credits	Max. Marks		
					L	T	P		CAM	ESM	Total
Theory											
1	IV	U23SXB401	Smart Sensors	PC	3	0	2	4	50	50	100
2	V	U23SXT502	Nano Biosensors*	PC	3	0	0	3	25	75	100
3	VI	U23SXB603	Embedded Sensing Technologies	PC	3	0	2	4	50	50	100
4	VII	U23SXT704	IoT and Sensor Networks*	PC	3	0	0	3	25	75	100
5	VIII	U23SXT805	Wearable Devices and its Applications*	PC	3	0	0	3	25	75	100
6	VIII	U23SXW806	Project / Model Making	PA	0	0	4	2	50	50	100
	Total							**19**	**225**	**375**	**600**
Equivalent NPTEL courses##											
1	IV to VII Semester	U23XXXN01	Sensors Technology Equivalent NPTEL Courses					3	12 Week Course		

The student shall be given an option to earn 3 credits through one equivalent 12 week NPTEL course instead of any one course listed for honours / minor degree programme that should be completed before the commencement of eighth semester. The equivalent courses are subject to change based on its availability as per NPTEL course list.

List of NPTEL Courses

1. Sensors and Actuators
2. Biophotonics
3. Embedded Systems Design
4. Introduction to Industry 4.0 and Industrial Internet of Things
5. Microsensors, Implantable Devices and Rodent Surgeries for Biomedical Applications

SEMESTER – I

Department	**Mathematics**	Programme: **B.Tech.**						
Semester	**I**	Course Category: **BS**			End Semester Exam Type: **TE**			
Course Code	**U23MATC01**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Engineering Mathematics – I**	**3**	**1**	**0**	**4**	**25**	**75**	**100**

(Common to ALL Branches Except CSBS)

Prerequisite: Basic Mathematics

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
CO1	Understand the concept of Eigen values and Eigen vectors, Diagonalization of a Matrix	**K3**
CO2	Solve higher order differential equations	**K3**
CO3	Understand the different types of partial differential equations	**K3**
CO4	Know about the Applications of double and triple integrals	**K3**
CO5	Gain the knowledge about Vector Calculus and its Applications	**K3**

UNIT – I	**Matrices**	**Periods:12**	
Rank of a Matrix – Systems of Linear Equations – Characteristic equation – Cayley Hamilton Theorem – Eigen values and Eigen vectors of a real Matrix – Diagonalization of Matrices.			**CO1**
UNIT – II	**Differential Equations (Higher Order)**	**Periods:12**	
Linear Differential equations of higher order with constant coefficients – Euler's linear equation of higher order with variable coefficients – Method of Variation of parameters.			**CO2**
UNIT – III	**Functions of Several Variables**	**Periods:12**	
Partial derivatives – Total derivatives – Maxima and Minima of two variables – Lagrange's Method of multipliers.			**CO3**
UNIT – IV	**Multiple Integrals**	**Periods:12**	
Multiple Integrals – Change of order of integration (Cartesian form). Applications: Area as a double integral (Cartesian form) – Volume as a triple integral (Cartesian form).			**CO4**
UNIT – V	**Vector Calculus**	**Periods:12**	
Gradient – Divergence and Curl – Directional derivatives – Irrotational and Solenoidal vector fields – Properties (Statement only) – Gauss Divergence Theorem and Stoke's Theorem (without proofs).			**CO5**

Lecture Periods: 45	**Tutorial Periods: 15**	**Practical Periods: -**	**Total Periods: 60**

Text Books

1. M.K. Venkataraman, "Engineering Mathematics", The National Publishing Company, 2nd Edition, 2016.
2. N. P Bali and Manish Goyal, "A Text Book of Engineering Mathematics", Lakshmi Publications, New Delhi, 9th Edition, 2018.
3. S.Narayanan and T.K. Manickavasagam Pillay," Differential Equations and Its Applications", Viswanathan. S, Printers & Publishers Pvt Ltd, 2009.

Reference Books

1. G. Balaji, "Matrices and Calculus (Engineering Mathematics – I)" Balaji Publications, 9th Edition June 2023
2. A. Singaravelu, "Engineering Mathematics – I", Meenakshi publications, 1998.
3. Erwin Kreyszig, "Advanced Engineering Mathematics ", Wiley, 10th Edition, 2019.
4. B.V. Ramana," Higher Engineering Mathematics", Tata McGraw – Hill, New Delhi, 6th Edition, 2018.
5. C W. Evans, "Engineering Mathematics", A Programmed Approach, 3rd Edition, 2019.

Web References

1. http://www.yorku.ca/yaoguo/math1025/slides/chapter/kuttler-linearalgebra –slides- systems of equation-handout.pdf

2.	http://www.math.cum.edu/~wn0g/2ch6a.pdf
3.	https://nptel.ac.in/courses/122/104/122104017/
4.	https://nptel.ac.in/courses/111/106/111106051/
5.	https://nptel.ac.in/courses/111/108/111108081/

* TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	2	1	-	2	1	-	-	-	-	1	3	-	-
2	3	2	1	1	-	1	-	-	-	-	1	3	-	-
3	3	2	1	1	-	1	-	-	-	-	1	3	-	-
4	3	2	1	1	-	1	-	-	-	-	1	3	-	-
5	2	2	1	-	-	-	-	-	-	-	1	3	-	-

Correlation Level: 1 - Low, 2 - Medium, 3 – High

Evaluation Methods

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	CAT 1	CAT 2	Model Exam	Assignment*	Attendance		
Marks	5	5	5	5	5	75	100

* Application oriented / Problem solving / Design / Analytical in content beyond the syllabus

Department	**Physics and Chemistry**	Programme: **B.Tech.**						
Semester	**I / II**	Course Category: **BS**				End Semester Exam Type: **TE**		
Course Code	**U23BSTC01**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Physical Science for Engineers**	**3**	**0**	**0**	**3**	**25**	**75**	**100**
(Common to all Branches)								
Prerequisite	Physics of 12th standard or equivalent / Chemistry of 12th standard or equivalent.							

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Understand the basic of properties of magnetic, dielectric and superconductors.	**K2**
	CO2 Identify the wave nature of the particles, physical significance of wave functions	**K3**
	CO3 Understand the basic principles of laser and fiber optics communication	**K2**
	CO4 Understand and familiar with the water treatment.	**K2**
	CO5 Understand the electrode potential for its feasibility in electrochemical reaction and uses of various batteries.	**K2**
	CO6 Understand the specific operating condition under which corrosion occurs and suggest a method to control corrosion.	**K2**

SECTION A – PHYSICS

UNIT-I	**Magnetic, Dielectric and Superconducting Materials**	**Periods: 8**
Introduction to magnetic materials, Ferromagnetism- Domain Theory-Types of energy-Hysteresis-Hard and Soft magnetic materials-ferrites-Dielectric materials-Types of polarization – Langevin-Debye equation-Frequency effects on polarization-Dielectric breakdown- Ferroelectric materials-Superconducting materials and their properties.		**CO1**

UNIT-II	**Quantum Mechanics**	**Periods: 7**
Matter Waves - de Broglie Wavelength - Uncertainty Principle –Physical Significance of wave functions - Schrodinger wave Equation - Time Dependent - Time Independent - Application to Particle in a One Dimensional Box - Tunnel Diode.		**CO2**

UNIT-III	**Laser And Fiber Optics**	**Periods: 7**
Lasers - Principles of Laser - Spontaneous and Stimulated Emissions - Einstein's Coefficients - Population Inversion and Laser Action –components of laser - Types of Lasers - NdYAG, CO_2 laser, GaAs Laser Fiber Optics - Principle and Propagation of light in optical fiber - Numerical aperture and acceptance angle - Types of optical fibers (material, refractive index, mode)		**CO3**

SECTION B – CHEMISTRY

UNIT-IV	**Water And Its Treatment**	**Periods: 8**
Water: Sources and impurities, Water quality parameters: Definition and significance of-color, odour, turbidity, pH, hardness, alkalinity, TDS, COD and BOD. Desalination of brackish water: Reverse osmosis-disadvantages of using hard water in boiler - Treatment of boiler feed water: Internal treatment (phosphate, colloidal, sodium aluminate and Calgon conditioning) and External treatment–Ion exchange demineralization and zeolite process.		**CO4**

UNIT-V	**Electrochemical Cells and Storage Devices**	**Periods: 8**
Galvanic cells, single electrode potential, standard electrode potential, electrochemical series. EMF of a cell and its measurement. Nernst equation. Electrolyte concentration cell. Reference electrodes-hydrogen, calomel and Ag/AgCl. Batteries and fuel cells: Types of batteries- alkaline battery-lead storage battery- nickel-cadmium battery- fuel cell H_2 -O_2 fuel cell-applications.		**CO5**

UNIT-VI	**Corrosion**	**Periods: 7**
Corrosion –Introduction - factors – types – chemical, electrochemical corrosion (galvanic, differential aeration), corrosion control – material selection and design aspects – electrochemical protection – sacrificial anode method and impressed current cathodic method. Uses of inhibitors, metallic coating – anodic coating, cathodic coating. Metal cladding, Electroplating of Copper and electroless plating of nickel.		**CO6**

Lecture Periods: 45	Tutorial Periods: -	Practical Periods: -	Total Periods: 45

Text Books

1. V Rajendran, "Engineering Physics", TMH, New Delhi , 2nd Edition ,2011.
2. S.S Dara – "A text book of Engineering Chemistry" -. S.Chand Publications, 15th Edition, 2021
3. C.Jain, Monica Jain"Engineering Chemistry. Dhanpat Rai Pub. Co., New Delhi, 17th Edition (2015).

Reference Books

1. R.Murugeshan, "Modern Physics", S. Chand &Co, New Delhi,2006.
2. William D Callister Jr., "Material Science and Engineering", John Wiley and sons, 6th Edition, 2009.
3. Jain & Jain "Engineering chemistry", DhanpatRai Publishing Company. 23rd Edition, 2022
4. Mars Fontana "Corrosion Engineering", July 2017
5. JinaRedlin, "Handbook of Electrochemistry", March 2005

Web References

1. https://www.sciencedaily.com/terms/materials_science.htm.
2. https://www.acs.org/content/acs/en/careers/college-to-career/chemistry-careers/materials science.html.
3. https://study.com/academy/lesson/semiconductors-superconductors-definition-properties.html
4. https://mechanicalc.com/reference/engineering-materials
5. http://ndl.ethernet.edu.et/bitstream/123456789/89589/1/%5BPerez_N.%5D_Electrochemistry_and_corrosion%28BookZZ.org%29.pdf

* TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	2	2	2	-	-	-	-	-	-	-	2	-	-
2	3	2	3	2	-	-	-	-	-	-	-	2	-	-
3	3	2	3	2	-	-	-	-	-	-	-	2	2	-
4	3	1	-	-	-	-	-	-	-	-	-	2	-	-
5	3	1	-	-	-	-	-	-	-	-	-	2	-	-
6	3	1	-	-	-	-	-	-	-	-	-	2	-	-

Correlation Level: 1 - Low, 2 - Medium, 3 – High

Evaluation Methods

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	CAT 1	CAT 2	Model Exam	Assignment*	Attendance		
Marks	5	5	5	5	5	75	100

* Application oriented / Problem solving / Design / Analytical in content beyond the syllabus

Department	**Biomedical Engineering**	Programme:**B.Tech.**						
Semester	**I**	Course Category:**BS**			*End Semester Exam Type:**TE**			
Course Code	**U23BMT101**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Human Anatomy and Physiology**	**3**	**0**	**0**	**3**	**25**	**75**	**100**
Prerequisite								

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Describe basic structural and functional elements of human body.	**K2**
	CO2 Explain the function of heart and its conduction and knowledge on nervous systems.	**K3**
	CO3 Illustrate the Physiological function of Eye, Ear and Excretory systems	**K3**
	CO4 Distinguish the types of skeletal systems and functions of respiration	**K3**
	CO5 Elucidate the classification, Metabolism of Macromolecules and its Measurement	**K3**

UNIT-I	**Basic Elements of Human Body**	**Periods:9**	
Structure and function of Cell and cellular components, Membrane Potential, Action Potential, Generation and Conduction, Blood Cell: Composition, Fluid and electrolytic balance, Blood Groups - ABO and Rh System, Estimation of RBC and WBC.			**CO1**
UNIT-II	**Cardiovascular and Nervous System**	**Periods:9**	
Cardiovascular system - Heart and vascular system, ECG, Blood Pressure, Homeostasis, Cardiac Cycle, Basics of Cardiac Output and Heart Sounds, PCG. **Nervous System** - Structure and functions of Neurons, Synapse, Reflex action and Receptors, Velocity of Conduction of Nerve Impulses, Nerve conduction Test, Nervous control of Heart.			**CO2**
UNIT-III	**Urinary and Visual -Auditory System**	**Periods:9**	
Gastro Urinal system, Structure and function of kidneys and Nephron, Mechanism of Urine formation, Urine Reflex. Optics of Eye: Retina, Photochemistry of Vision, Accommodation, Neurophysiology of Vision, Structure and functions of Internal Ear, Mechanism of Hearing, Auditory pathway, Hearing Tests.			**CO3**
UNIT-IV	**Musculo Skeletal and Respiratory System**	**Periods:9**	
Musculo Skeletal System: Muscle Tissue, Structure of Skeletal Muscle, Types of Muscle, Types of Joints, Major Muscles of Limbs and their actions. **Respiratory system:** Physiological aspects of respiration, Exchange of gases, Regulation of Respiration, Pulmonary function test, Artificial respiration.			**CO4**
UNIT-V	**Macromolecules and Measurement**	**Periods:9**	
Carbohydrates: Classification, Metabolism of carbohydrate and its dysfunction. Lipids: Classification, Metabolism of lipids and dysfunction, Protein: Classification of Amino acids, architecture of protein molecules. Measurement: Principles of Photometry, Spectrophotometry, Flurometry, Flame Photometry, Densitometry, Calorimetry,			**CO5**

LecturePeriods:45	**Tutorial Periods:-**	**Practical Periods:-**	**TotalPeriods:45**

Text Books

1. Guyton, “Text book of Medical Physiology”, WB Jaunder company Philadelphia, 10th Edition, 2010
2. Elaine.N. Marieb, “Essential of human Anatomy and Physiology”, Pearson Education New Delhi, 8th Edition, 2010
3. C.L.Ghai, “A textbook of Practical physiology”, Jaypee Medical Publishers, 5th Edition, 2013

Reference Books

1. Frederic H. Martini, Judi L. Nath, Edwin F. Bartholomew, “Fundamentals of Anatomy and Physiology”, Pearson Publishers, 5th Edition, 2014
2. Gillian Pocock, Christopher D. Richards, “The Human Body – An introduction for Biomedical and Health Sciences”, Oxford University Press, USA, 8thEdition, 2013
3. William F.Ganong, “Review of Medical Physiology”, McGraw Hill, New Delhi, 22nd Edition, 2010
4. Eldra Pearl Solomon, “Introduction to Human Anatomy and Physiology”, W.B. Saunders Company, 2015
5. Guyton & Hall, “Medical Physiology”, Elsevier Saunders, 13th Edition ,2015

Web References

1. https://byjus.com/biology/human-body-anatomy/
2. https://www.khanacademy.org/
3. https://www.youtube.com/channel/UCJayvjGvKEblkA3KYK1BQQw
4. https://www.britannica.com/browse/Anatomy-Physiology

* TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	-	-	-	-	2	-	-	-	2	3	-	-	3
2	3	2	-	-	-	2	-	-	-	2	3	2	-	3
3	3	2	-	-	-	2	-	-	-	2	3	2	2	3
4	3	2	-	-	-	2	-	-	-	2	3	2	-	3
5	3	2	-	-	2	2	-	-	-	2	3	2	-	3

Correlation Level: 1 - Low, 2 - Medium, 3 – High

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	CAT 1	CAT 2	Model Exam	Assignment*	Attendance		
Marks	5	5	5	5	5	75	100

* Application oriented / Problem solving / Design / Analytical in content beyond the syllabu

Department	**Biomedical Engineering**	Programme :**B.Tech.**						
Semester	**I**	Course Category:**ES**			*End Semester Exam Type:**TE**			
Course Code	**U23BMT102**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Basic Electrical Circuits**	**3**	**0**	**0**	**3**	**25**	**75**	**100**
Prerequisite								

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Gain knowledge in fundamentals of electrical circuits	**K2**
	CO2 Analyze the electrical parameters of the circuits using basic theorems	**K3**
	CO3 Compare frequency response of resonant circuits	**K3**
	CO4 Determine the steady state and transient response of RL, RC and RLC circuits	**K4**
	CO5 Analyze the working principle and application of electrical machines	**K3**

UNIT-I	**Introduction to Electrical Circuits**	**Periods:12**
Basic Components of electric Circuits, Ohms Law, Kirchhoff's Law, series and Parallel Connected Independent Sources, Resistors in Series and Parallel, voltage and current division, Star-Delta conversion Concepts of AC circuits: RMS value, Average Value, Form Factor, Peak Factor, study of RL, RC, RLC series and parallel circuit, phasor representation in Polar and rectangular form, concept of impedance, admittance, active, reactive, apparent and complex power, power factor.		**CO1**
UNIT-II	**Network Theorems**	**Periods:12**
Mesh analysis, Nodal analysis, Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Reciprocity Theorem, Compensation Theorem, Maximum Power Transfer Theorem, Millman's Theorem.		**CO2**
UNIT-III	**Resonance And Coupled Circuits**	**Periods:12**
Resonance: Series and Parallel resonance, Variation of Impedance, Current and Voltage with frequency in series and parallel resonant circuits, Bandwidth, Q factor and Selectivity. **Coupled Circuits**: Self-inductance, Mutual inductance, Dot rule, Coefficient of coupling - Series and Parallel connection of coupled inductors - Single tuned coupled circuit.		**CO3**
UNIT-IV	**Transient Response Analysis**	**Periods:12**
Steady State and Transient Response, Source free, Step, Impulse, Sinusoidal and exponential response for RL, RC and RLC circuits.		**CO4**
UNIT-V	**Electrical Machines and Safety**	**Periods:12**
Working principle of DC generator, motor-EMF and Torque equation – Types: Shunt, Series and Compound, Applications. Working principle of transformer-EMF equation-Operating principles of three phase and single- phase induction motor-Applications. Operating principles of Synchronous motor, stepper motor-Applications. Safety measures in electrical system-Electrical tools and accessories–wiring standards.		**CO5**

LecturePeriods:45	**TutorialPeriods:15**	**Practical Periods: -**	**TotalPeriods:60**

Text Books

1. Charles K. Alexander, Matthew N. O. Sadiku" Fundamentals of Electric Circuits", McGraw Hill May, 7th Edition ,2022.
2..ChakrabatiA,"CircuitTheoryAnalysisandSynthesis", Dhanpath Rai and Sons,New Delhi, 7th edition, 2018
3.WilliamH.Hayt,Jr.JackE.KemmerlyandStevenM.Durbin,"EngineeringCircuitAnalysis", McGraw Hill Science Engineering, 8th Edition, 11th Reprint 2016.

Reference Books

1. William Haystack, E Kemmerly and Steven M Durbin, "Engineering Circuits Analysis", Tata McGraw-Hill, 8thEdition 2013,
2. John Bird, "Electrical Circuit theory and technology", Routledge, 5th Edition2013.
3. KothariDPandI.JNagrath,"BasicElectricalandElectronicsEngineering", McGrawHillEducation,7thEdition2014.
4. Joseph Edminister and Mahmood Nahvi, "Electric Circuits", Schaum"s Outline Series, , Tata McGraw Hill

5. Publishing Company, New Delhi, 5th Edition Reprint 2016.
6. Charles K. Alexander, Mathew N.O. Sadiku, "Fundamentals of Electric Circuits", 5th Edition, McGraw Hill, 9th Edition Reprint 2015.

Web References

1. https://www.khanacademy.org/science/electrical-engineering/ee-circuit-analysis-topic
2. https://www.thelearningpoint.net/home/electrical-science-andengineering/circuit-theory
3. https://www.classcentral.com/course/edx-circuits-and-electronics-1-basic-circuit-analysis-444
4. https://swayam.gov.in/nd1_noc19_ee36/preview
5. https://nptel.ac.in/courses/117/106/117106108/

* TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

Cos	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	2	1	1	2	1	1	1	1	2	3	2	2	3
2	3	3	2	2	2	1	1	1	1	2	3	3	2	3
3	2	3	2	2	2	1	1	1	1	2	2	3	2	2
4	3	3	2	3	2	1	1	1	1	2	3	3	2	3
5	3	3	3	2	3	2	2	2	2	3	3	2	3	3

Correlation Level: 1 - Low, 2 - Medium, 3 – High

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	CAT 1	CAT 2	Model Exam	Assignment*	Attendance		
Marks	5	5	5	5	5	75	100

* Application oriented / Problem solving / Design / Analytical in content beyond the syllabus

Department	**Civil and Mechanical**	Programme:**B.Tech.**						
Semester	**I / II**	Course Category:**ES**			*End Semester Exam Type:**TE**			
Course Code	**U23ESTC01**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Basics of Civil and Mechanical Engineering**	**3**	**0**	**0**	**3**	**25**	**75**	**100**
(Common to ECE, EEE, ICE, MECH, CIVIL,MCTR,BME Branches)								
Prerequisite	**Basic Science**							

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Understand the types of buildings and materials.	**K2**
	CO2 Summarize on the various components of buildings and surveying concepts	**K2**
	CO3 Identify the various infrastructure facilities	**K2**
	CO4 To familiarize the working principles of IC engines and automobile systems	**K2**
	CO5 To understand about the power generation systems and its components	**K1**
	CO6 To acquire knowledge about the various machining process.	**K2**

SECTION A - CIVIL ENGINEERING

UNIT - I	**Buildings And Buildings Materials**	**Periods: 08**
Buildings – Definition – Classification according to NBC-plinth area, Floor area, carpet area, floor space index - Development of Smart cities - Green building, Benefits from green building. Building Materials - stone, brick, cement, cement mortar, concrete, steel, Timber - their properties and uses		**CO1**
UNIT - II	**Buildings Components and Surveying**	**Periods: 08**
Various Buildings Components and their functions. Foundation: function and types - Brick masonry, Stone Masonry and its types – Floors, Roofs and its types. Surveying: Objects – Classification – Principles – Measurements of Distances and areas – Leveling		**CO2**
UNIT - III	**Basic Infrastructure**	**Periods: 07**
Roads and Bridges – types, components advantage and disadvantages. Railways - Permanent way and its elements. Sources of Water - Quality of Water- Domestic sewage Treatment – Rain Water harvesting – Dams - site selection for dam construction, types of dams.		**CO3**

SECTION B – MECHANICAL ENGINEERING

UNIT- IV	**Internal And External Combustion Systems**	**Periods: 08**
IC engines – Classification – Working principles – Diesel and Petrol Engines: Two stroke and four stroke engines – merits and demerits.Steam generators (Boilers) – Classification – Constructional features (of only low-pressure boilers) – Boiler mountings and accessories – Merits and demerits – Applications.		**CO4**
UNIT- V	**Power Generation Systems, Refrigeration and Air Conditioning System**	**Periods: 07**
Power plants: Thermal – Nuclear, Hydraulic, Solar, Wind, Geothermal, Wave, Tidal and Ocean Thermal Energy Conversion systems - Functions, Applications - Schemes and layouts (Description only) Refrigeration and Air Conditioning System: Terminology of Refrigeration and Air Conditioning. Principle of vapour compression and absorption system – Layout of typical domestic refrigerator – Window and Split type room Air conditioner.		**CO5**
UNIT- VI	**Manufacturing Process**	**Periods: 07**
Lathe - types, Specifications, Operations of a centre lathe. Casting - Pattern making, Allowances, Green sand and dry sand moulding, casting defects. Welding - Arc and Gas welding process, brazing and soldering (process description only).		**CO6**
Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 45**

Text Books
1. Dr. S. Jayakumar, “Basic Civil Engineering”, Aagash Nekaa Publications, 2011
2. G Shanmugam, MS Palanichamy, Basic Civil and Mechanical Engineering, McGraw Hill Education, 1st Edition, 2018.
3. Palanikumar, K. Basic Mechanical Engineering, ARS Publications, 2010.
Reference Books
1. M.P. Poonia, S.C. Sharma and T.R. Banga, Basic Mechanical Engineering, Khanna Publishing House 2018.
2. S.S.Bhavikatti, Basic Civil engineering, New Age International Ltd. 2018.
3. V. Rameshbabu, Basic Civil & Mechanical Engineering, VRB Publishers Private Limited, January 2017.
4. Serope Kalpakjian, Steven Schmid, Manufacturing Engineering and Technology, Pearson Publication, 7th Edition, 2014.
5. Gopi Satheesh, Basic Civil engineering, Pearson Publications, 3rd Edition, 2015.
Web References
1. https://nptel.ac.in/courses/112107291/
2. https://nptel.ac.in/courses/112/103/112103262/
3. https://ocw.mit.edu/courses/mechanical-engineering/2-61-internal-combustion-engines-spring-2017/ lecture-notes/
4. https://nptel.ac.in/courses/105102088/
5. https://nptel.ac.in/courses/105104101/

* TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	1	1	-	1	-	-	-	-	-	1	-	-	-
2	3	1	1	-	1	-	-	-	-	-	1	-	-	-
3	3	1	1	-	1	-	-	-	-	-	1	-	-	-
4	3	1	-	-	-	-	-	-	-	-	1	-	-	-
5	3	1	-	-	-	-	-	-	-	-	1	-	-	-

Correlation Level: 1 - Low, 2 - Medium, 3 – High

Evaluation Methods

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	CAT 1	CAT 2	Model Exam	Assignment*	Attendance		
Marks	5	5	5	5	5	75	100

* Application oriented / Problem solving / Design / Analytical in content beyond the syllabus

Department	**English**	Programme: **B.Tech.**						
Semester	**I**	Course Category : HS				End Semester Exam Type:**TE**		
Course Code	U23ENBC01	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Communicative English - I**	**2**	**-**	**2**	**3**	**50**	**50**	**100**

(Common to ALL Branches except CSBS)

Prerequisite	Basics of English Language	
Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Understand the communication flow in organization and its objectives	**K2**
	CO2 Write the technical contents with grammatically precise sentences	**K2**
	CO3 Articulate with correct pronunciation and overcome vernacular impact in speaking	**K3**
	CO4 Express opinions confidently in formal and informal communicative contexts	**K2**
	CO5 Attend interview with assertiveness	**K3**

UNIT- I	**Workstead Communication**	**Periods:10**	
Communication, Definition, Process, Channels, Barriers, Strategies for Effective Communication, Verbal and Nonverbal Communication - Listening, Types, Barriers, Enhancing Listening Skills - Bibliography: Book, Journal and Internet References			**CO1**
UNIT- II	**Common Errors In Writing And Comprehension Strategies**	**Periods:10**	
Subject Verb Agreement, Misplaced Modifiers, Squinting Modifiers, Dangling Modifier, Fused Sentence, Comma Splice, Sentence Fragment - Reading Comprehension: Technical passage, Strategies: Skimming, Scanning, Intensive and Extensive Reading, Prediction, and Contextual Meaning			**CO2**
UNIT- III	**Phonetics**	**Periods:10**	
Pronunciation Guidelines to consonants and vowels, Sounds Mispronounced, Silent and Non-silent Letters, Intonation, Spelling Rules and Words often misspelled, Mother Tongue Influence (MTI), Various Techniques for Neutralization of Mother Tongue			**CO3**
UNIT- IV	**Communication Practice-I**	**Periods:15**	
List of Exercises **Listening**: Self Introduction videos **Speaking**: Self-Introduction, Extempore, and Role Play **Reading**: Non-Technical Comprehension Passage **Writing:** Common Errors in Writing			**CO4**
UNIT-V	**Interpersonal Communication-I**	**Periods:15**	
List of Exercises **Listening:** Speech Sounds, Interview Videos **Speaking**: Debate, Structured Group Discussion, and Conversation **Reading**: Commonly Confused Words **Writing:** Transcription			**CO5**

Lecture Periods:30	**Tutorial Periods:-**	**Practical Periods:30**	**Total Periods:60**

Text Books

1. Richa Mishra , Ratna Rao, “A textbook of English Language Communication Skills”, Macmillan Publishers India Private Ltd., Revised Edition 2021.
2. Rizvi M. Ashraf, “Effective Technical Communication”, New Delhi: Tata-McGraw-Hill Publishing Company Limited, 4th Edition, 2010.
3. Balasubramanian T, “English Phonetics for Indian students workbook”, 2nd Edition, Trinity Press, 2016.

Reference Books

1. N.P.Sudharshana, C. Savitha," English for Engineers", Cambridge University Press, 2018.
2. Raman, Meenakshi, and Sharma, Sangeetha, "Technical Communication - Principles and Practice", 3rd Edition, Oxford University Press, 2017.
3. Comfort, Jeremy,etal., "Speaking Effectively: Developing Speaking Skills for Business English", Cambridge University Press, Cambridge, Reprint 2011.
4. Wren & Martin, "High School English Grammar and Composition", S Chandh &Co. Ltd, 2015.
5. Boove, Courtland L, "Business Communication Today", Pearson Education, New Delhi,2002.

Web References

1. https://lemongrad.com/subject-verb-agreement-rules/
2. https://opentextbc.ca/advancedenglish/chapter/misplaced-and-dangling-modifiers/
3. https://www.hitbullseye.com/Reading-Comprehension-Tricks.php
4. https://www.softwaretestinghelp.com/how-to-crack-the-gd/
5. https://worldscholarshipvault.com/neutralize-mother-tongue-interference/

* TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	1	-	-	-	-	-	-	-	3	-	1	-	-	-
2	1	-	-	-	-	-	-	-	3	-	1	-	-	-
3	1	-	-	-	-	-	-	-	3	-	1	-	-	-
4	1	-	-	-	-	-	-	-	3	-	1	-	-	-
5	1	-	-	-	-	-	-	1	3	-	1	-	-	-

Correlation Level: 1 - Low, 2 - Medium, 3 – High

Evaluation Methods

Theory						
Assessment	Continuous Assessment Marks (CAM)				End Semester Examination (ESE) Marks	Total Marks
	CAT 1	CAT 2	Model Exam	Attendance		
Marks	5	5	5	5	75	60
	20(to be weighted for 10 marks)				(to be weighted for 50 marks)	

Practical				
Continuous Assessment Internal Evaluation		End Semester Internal Evaluation		Total Marks
30(to be weighted for 10 marks)		30 marks		40
Listening (L)*	10	Listening (L)*	10	
Speaking(S)	5	Speaking(S)	5	
Reading(R)*	10	Reading(R)*	10	
Writing(W)*	5	Writing(W)*	5	

- **LRW components of Practical can be evaluated through Language Lab Software**

Department	**Biomedical Engineering**	Programme:**B.Tech.**						
Semester	**I**	Course Category:**BS**			*End Semester Exam Type:**LE**			
Course Code	**U23BMP101**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Physiology Laboratory**	**0**	**0**	**2**	**1**	**50**	**50**	**100**
Prerequisite								

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Evaluate and Analysis the practice of Physiology	**K4**
	CO2 Identify the General Tests of carbohydrates, Proteins and lipids	**K4**
	CO3 Apply the principles and preparation of serum and plasma from blood	**K3**
	CO4 Identify the Quantitative Estimation present in the slide	**K3**
	CO5 Measurement of pH level in the body fluids	**K3**

List of Experiments:

1. Blood Group Test
2. Estimation of RBC count
3. Estimation of WBC count
4. General tests for Carbohydrates
5. General tests for Proteins
6. General tests for Lipids
7. Preparation of Serum from blood.
8. Preparation of Plasma from blood.
9. Quantitative estimation of Blood Glucose
10. Quantitative estimation of Creatinine
11. Quantitative estimation of Cholesterol
12. Quantitative estimation of Urea
13. Study of Measurement of pH and conductivity of body fluids

Lecture Periods: -0	**Tutorial Periods: -0**	**PracticalPeriods:30**	**TotalPeriods:30**

Reference Books

1. Mohammad A, “Practical Examination Manual of Pathology”, CBS, January 2011.
2.Kanika Sharma Ane’s student edition, “Manual of Microbiology tools and techniques”, March 2010.
3. Sabitri Sanyal Aparna Bhattacharrya, “Clinical Pathology: A Practical Manual”,Elsevier India, 3rd Edition, 2014
4. McPherson Henry's “Clinical Diagnosis and Management by Laboratory Methods”, Elsevier, 24e”, South Asia Edition January 2021
5. Rajbala Yadav, Nidhi Verma, Meeta Singh, “Essentials of Practical Pathology for Undergraduates”, Elsevier India1st Updated Edition Paperback – October 2019.

Web References

1. https://ocw.mit.edu/courses/biology/7-012-introduction-to-biology-fall-2004/videolectures
2. https://ocw.mit.edu/courses/biology/8-012-introduction-to-biology-fall-2004/videolectures
3. nptel.ac.in/courses/102105034/

* TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

Cos	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	3	2	2	2	2	1	2	1	3	3	2	2	3
2	3	2	2	2	2	1	1	1	1	3	3	2	2	3
3	3	2	2	2	2	2	1	1	1	3	3	3	3	3
4	3	3	2	3	2	1	1	1	1	2	3	3	2	3
5	3	2	2	2	3	2	1	1	1	2	3	3	3	3

Correlation Level: 1 - Low, 2 - Medium, 3 – High

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	Performance in practical classes			Model Practical Examination	Attendance		
	Conduction of practical	Record work	viva				
Marks	15	5	5	15	10	50	100

Department	**Biomedical Engineering**	Programme: **B.Tech.**						
Semester	**I**	Course Category:**ES**			*End Exam Type:**LE**			
Course Code	**U23BMP102**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Basic Electrical Circuits Laboratory**	**0**	**0**	**2**	**1**	**50**	**50**	**100**
Prerequisite								

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Construct electrical circuits to analyze the basic laws	**K4**
	CO2 Observe and analyze the theorems in electrical circuits	**K4**
	CO3 Analyze the electrical characteristics of RL, RC and RLC circuits	**K4**
	CO4 Classify the operation of types of lamps	**K3**
	CO5 Understand the wiring concepts and trouble shooting of electrical equipment	**K3**

List of Experiments:

1. Verification of ohms law and Kirchhoff law
2. Verification of mesh and nodal analysis
3. Verification of superposition theorem
4. Verification of Thevenin's and Norton's Theorem
5. Verification of maximum power transfer theorem and reciprocity theorem
6. Demonstration of CRO (Measurement of Amplitude, Time and Frequency)
7. Measurement of electrical quantities–voltage, current, power & power factor in RL, RC and RLC circuits.
8. Study of types of wiring (fluorescent lamp wiring, staircase wiring, etc.)
9. Study of types of lamps
10. Measurement of resistance to earth of an electrical equipment
11. Study of troubleshooting of electrical equipment (fan, iron box, mixer-grinder, etc.)

Lecture Periods: -	**Tutorial Periods: -**	**PracticalPeriods:30**	**TotalPeriods:30**

Reference Books

1. Brian Kelly, "Introduction to Electrical Circuits", Lab manual, OUP Canada, 8th Edition, August 2008
2. Karen Craigs, Lauren Fuentes, "Introduction to Electric Circuits: Lab Manual",OUP Canada., 10th Edition August 2019.
3. K.A. Navas ," Electronics Lab Manual Volume-1",, PHI Learning,5th Edition, November 2015.
4. David A. Bell "Fundamentals of Electric Circuits: Lab Manual, OUP Canada," 7thEdition, September 2009.
5. Robert Boylestad , Louis Nashelsky, Franz Monssen ," Lab Manual for Electronic Devices and Circuit Theory", Pearson, 11th Edition ,August 2012.

Web References

1. https://www.classcentral.com/course/edx-circuits-and-electronics-1-basic-circuit-analysis-444

* TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

Cos	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	3	2	2	2	1	-	1	-	2	2	1	2	3
2	3	3	2	2	2	1	-	1	-	2	2	2	2	3
3	3	3	2	2	2	1	-	1	-	2	2	2	2	3
4	2	2	2	1	2	1	-	1	-	2	2	1	2	2
5	2	2	2	1	3	2	-	1	1	2	2	1	3	2

Correlation Level: 1 - Low, 2 - Medium, 3 – High

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	Performance in practical classes			Model Practical Examination	Attendance		
	Conduction of practical	Record work	viva				
Marks	15	5	5	15	10	50	100

Department	**Mechanical Engineering**	Programme: **B.Tech.**						
Semester	**I / II**	Course Category : **ES**			*End Semester Exam Type: **LE**			
Course Code	**U23ESPC02**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Design Thinking and IDEA Lab**	**0**	**0**	**2**	**1**	**50**	**50**	**100**
(Common to ALL Branches)								
Prerequisite	**Basic Knowledge of Science**							

		On completion of the course, the students will be able to	BT Mapping (Highest Level)
Course Outcomes	**CO1**	Demonstrate a comprehensive understanding of the tools and inventory associated with the IDEA Lab.	**K2**
	CO2	Develop proficiency in ideation techniques to generate creative and innovative solutions for various design and problems challenges	**K3**
	CO3	Acquire practical knowledge of mechanical and electronic fabrication processes, including hands-on experience with machinery, tools, and techniques used in the manufacturing and assembly of physical components.	**K3**
	CO4	Cultivate the skills necessary for developing innovative and desirable products, including the ability to integrate user needs, market trends, and technological advancements into the design process.	**K4**
	CO5	Apply iterative design methodologies to refine and improve solutions based on feedback, user testing, and evaluation of functional, aesthetic, and usability aspects	**K4**

Design process: Traditional design, Design thinking, Existing sample design projects, Study on designs around us, Compositions/structure of a design, Innovative design: Breaking of patterns, Reframe existing design problems, Principles of creativity Empathy: Customer Needs, Insight-leaving from the lives of others/standing on the shoes of others, Observation

Design team-Team formation, Conceptualization: Visual thinking, Drawing/sketching, New concept thinking, Patents and Intellectual Property, Concept Generation Methodologies, Concept Selection, Concept Testing, Opportunity identification Prototyping: Principles of prototyping, Prototyping technologies, Prototype using simple things, Wooden model, Clay model, 3D printing; Experimenting/testing.

Sustainable product design, Ergonomics, Semantics, Entrepreneurship/business ideas, Product Data Specification, establishing target specifications, Setting the final specifications. Design projects for teams.

List of Lab Activities and Experiments

1. Schematic and PCB layout design of a suitable circuit, fabrication and testing of the circuit.
2. Machining of 3D geometry on soft material such as softwood or modelling wax.
3. 3D scanning of computer mouse geometry surface. 3D printing of scanned geometry using FDM or SLA printer.
4. 2D profile cutting of press fit box/casing in acrylic (3 or 6 mm thickness)/cardboard, MDF (2 mm) board using laser cutter & engraver.
5. 2D profile cutting on plywood /MDF (6-12 mm) for press fit designs.
6. Familiarity and use of welding equipment.
7. Familiarity and use of normal and wood lathe.
8. Embedded programming using Arduino and/or Raspberry Pi.

9. Design and implementation of a capstone project involving embedded hardware, software and machined or 3D printed enclosure.
10. Discussion and implementation of a mini project.
11. Documentation of the mini project (Report and video).

Lecture Periods: -	Tutorial Periods: -	Practical Periods: 30	Total Periods: 30

Text Books

1. Tim Brown, Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation, HarperCollins Publishers Ltd
2. Workshop / Manufacturing Practices (with Lab Manual), Khanna Book Publishing.

Reference Books

1. Ulrich and Eppinger, Product Design and Development, McGraw Hill, 3rd Edition, 2004
2. The Big Book of Maker Skills: Tools & Techniques for Building Great Tech Projects. Chris Hackett. Weldon Owen; 2018.
3. The Total Inventors Manual (Popular Science): Transform Your Idea into a Top-Selling Product. Sean Michael Ragan, Weldon Owen; 2017.
4. . Paul Horowitz and Winfield Hill " The Art of Electronics" Cambridge University Press. 3rd edition.
5. Paul Sherz and Simon Monk "Practical Electronics for Inventors". .. McGraw Hill. 4th edition
6. Make Your Own PCBs with EAGLE: From Schematic Designs to Finished Boards. Simon Monk and Duncan Amos. McGraw Hill Education.
7. Programming Arduino: Getting Started with Sketches. 2nd edition. Simon Monk. McGraw Hill.
8. Venuvinod, PK., MA. W., Rapid Prototyping – Laser Based and Other Technologies, Kluwer
9. Chapman W.A.J, "Workshop Technology", Volume I, II, III, CBS Publishers and Distributors, 5th Edition,2002.

Web References

1. https://onlinecourses.nptel.ac.in/noc23_mg72

* TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	2	2	2	2	2	-	2	-	3	2	-	-	-
2	3	3	3	2	2	2	-	2	-	3	2	-	-	-
3	3	3	3	2	3	2	-	2	-	3	2	-	-	-
4	3	3	3	2	3	2	-	2	-	3	2	-	-	-
5	3	3	3	2	3	2	-	2	-	3	2	-	-	-

Correlation Level: 1 - Low, 2 - Medium, 3 – High

Evaluation Methods

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	Performance in practical classes			Model Practical Examination	Attendance		
	Conduction of practical	Record work	Viva				
Marks	15	5	5	15	10	50	100

Department	**Biomedical Engineering**	Programme: **B.Tech.**						
Semester	**I**	Course Category: **AEC**			*End Semester Exam Type:**LE**			
Course Code	**U23BMC1XX**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Certification Course – I**	**0**	**0**	**4**	**-**	**100**	**-**	**100**

Students shall choose an international certification course offered by the reputed organizations like Google, Microsoft, IBM, Texas Instruments, Bentley, Autodesk, Eplan and CISCO, etc. The duration of the course is 40-50 hours specified in the curriculum, which will be offered through Centre of Excellence.

Pass /Fail will be determined on the basis of participation, attendance, performance and completion of the course. If a candidate Fails, he/she has to repeat the course in the subsequent years. Pass in this course is mandatory for the award of degree.

Lecture Periods:-	**Tutorial Periods: -**	**Practical Periods: 50**	**Total Periods:50**

Evaluation methods

Assessment	**Continuous Assessment Marks (CAM)**		**Total Marks**
	Attendance	**MCQ Test**	
Marks	10	90	100

Department	**Biomedical Engineering**	Programme: **B.Tech.**					
Semester	**I**	Course Category: **MC**			End Semester Exam Type: -		
Course Code	**U23BMM101**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Induction Programme**	**2 weeks**			Non-Credit	-	-	-
Prerequisite	**-**							

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Develop holistic attitude and harmony in the individual, family, and Society	**K2**
	CO2 Acquire grammar skills and capable to write and speak English confidently	**K2**
	CO3 Understand the basic concepts in Mathematics and Programming	**K2**
	CO4 Know about the art and culture, language and literature of this vastsecularnation	**K2**
	CO5 Identify the inherent talent and develop it professionally	**K3**

UNIT-I	**Universal Human Values**	**Periods:12**
Welcome and Introductions - Getting to know each other, Aspirations and Concerns - Individual Academic and Career, Expectations of Family, Peers, Society, Nation, Fixing one's Goals, Self-Management - Self-confidence, Peer Pressure, Time Management, Anger, Stress Personality Development, Self-improvement, Health - Health issues, Healthy diet, Healthy lifestyle, Hostel life, Relationships - Home sickness, Gratitude towards Parents, Teachers and others Ragging and interaction, Competition and Cooperation, Peer Pressure, Society - Participation in Society, Natural Environment - Participation in Nature, Sum Up - Role of Education, Need for a Holistic Perspective, Self-evaluation and Closure - Sharing and feedback.		**CO1**

UNIT-II	**Proficiency in English**	**Periods:12**
Communication skills – Prognostic test on Grammar - Synonyms, Antonyms, Tenses, Sentence Completion, Idioms and Phrases, One- word Substitution, Homophones, Homonyms, Use of Prepositions, Subject-verb Agreement - Writing –Paragraph writing, Letter writing, Essay writing, Story Development.		**CO2**

UNIT-III	**Bridge Course in Mathematics and C Programming**	**Periods:12**
Mathematics: Fundamentals of differential and integral calculus: Theory and Practice, Limit of function - Fundamental results on limits - Continuity of a function - Concept of differentiation - Concept of derivative - Slope of a curve -Differentiation Techniques - Derivatives of elementary functions from first principle –Derivatives of inverse functions – Logarithmic differentiation – Method of substitution – Differentiation of parametric functions – Differentiation of implicit functions –Higher order derivatives. Integrals of functions containing linear functions -Method of integration (Decomposition method, method of substitution, integration by parts) – Definite integrals. Simple definite integrals – Properties of Definite integrals –Reduction formulae - Area and volume –Length of curve –surface area of a solid. **C Programming:** Features of C and its basic Structure - Keywords - constants - variables - operators - Data types - Formatted input and output statements - Control and Looping statement - Arrays - Functions - Strings - writing simple C programs.		**CO3**

UNIT-IV	**Literary Activities**	**Periods:12**
Team building activities - Quiz - Oral Exercises - Group discussion, Debate, Extempore, Role play, *சிறப்பு சொற்பொழிவு – தமிழர்மரபு மற்றும் தமிழர் தொழில் நுட்பம்.*		**CO4**

UNIT-V	**Creative Arts**	**Periods:12**
Introduction to painting and renowned artworks - Documentary and Short films - Music - Vocal, Instrumental - Dance - Classical, Cinematic -Mimicry -Mime.		**CO5**

Lecture Periods:60	**Tutorial Periods:-**	**Practical Periods:-**	**Lecture Periods:60**

Reference Books

1. R.R Gaur, R. Asthana, G.P. Bagaria," A Foundation Course in Human Values and Professional Ethics", Excel Books, New Delhi, 2nd Revised Edition, 2019.

2. Kumar Mohan R, “English Grammar for all (Functional and Applied Grammar)”, Unicare Academy, 2022.
3. Seely, John,” Oxford A-Z of Grammar and Punctuation, Oxford Publication, 2013.
4. B.V. Ramana,” Higher Engineering Mathematics”, Tata McGraw – Hill, New Delhi, 6th Edition, 2018.
5. Dr. A. Singaravelu, “Engineering Mathematics - I”, Meenakshi publications, Tamil Nadu, 2019.
6. E. Balagurusamy, "PROGRAMMING IN ANSI C", Mc Graw Hill, 8th Edition, 2019.
7. Dr.K.K.Pillay,”Social Life of Tamils”, A joint publication of TNTB & ESC and RMRL
8. R.Balakrishnan, “Journey of Civilization”, Roja muthiah research publishers, 1st Edition 2019
9. *தமிழகவரலாறு - மக்களும்பண்பாடும், பிள்ளை, கே. கே. , சென்னை : உலகத்தமிழாராய்ச்சிநிறுவனம் , 2002.*
10. *கணினித்தமிழ் - முனைவர்இல.சுந்தரம், விகடன்பிரசுரம்.*
11. *கீழடி – வைகை நதிக்கரையில் சங்ககால நகரநாகரிகம், தமிழக தொல்லியல் துறை*

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1. http://www.newsociety.com/Books/S/Slow-isBeautiful
2. https://www.aplustopper.com/formal-letter/
3. https://www.javatpoint.com/c-programming-language-tutorial
4. http://www.math.cum.edu/~wn0g/2ch6a.pdf
5. https://education.nsw.gov.au/teaching-and-learning/curriculum/creative-arts

SEMESTER – II

Department	**Mathematics**	Programme : **B.Tech.**						
Semester	**II**	Course Category: **BS**				*End Semester Exam Type: TE		
Course Code	**U23MATC02**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Engineering Mathematics – II**	**3**	**1**	**0**	**4**	**25**	**75**	**100**

(Common to ALL Branches Except CSBS, FT)

Prerequisite	Basic Mathematics		
Course Outcomes	**On completion of the course, the students will be able to**		BT Mapping (Highest Level)
	CO1	Convert a periodic function into series form.	**K2**
	CO2	Compute Fourier transforms of various functions.	**K3**
	CO3	Solve Differential Equations using Laplace transforms.	**K3**
	CO4	Apply inverse Laplace transform of simple functions.	**K3**
	CO5	Solve difference equations using Z – transforms.	**K3**

UNIT – I	**Fourier Series**	**Periods:12**	
Dirichlet's conditions – General Fourier series – Odd and Even functions – Half-Range sine series and cosine series – Change of intervals – Parseval's Identity.			**CO1**
UNIT – II	**Fourier Transforms**	**Periods:12**	
Fourier Transforms and its inverse – Properties of Fourier Transform (without proof) – Fourier sine and cosine Transforms and their properties (excluding proof).			**CO2**
UNIT – III	**Laplace Transforms**	**Periods:12**	
Laplace transforms of elementary functions and Periodic functions – Basic properties (excluding proof) – Laplace transforms of derivatives and integrals – Initial and final value theorems.			**CO3**
UNIT – IV	**Inverse Laplace Transforms**	**Periods:12**	
Definition of inverse Laplace Transforms – Convolution theorem (excluding proof) – Solutions of Linear Ordinary Differential Equations of second order with constant coefficients.			**CO4**
UNIT – V	**Z – Transforms**	**Periods:12**	
Z-transforms – Elementary Properties – Inverse Z-transforms (using partial fraction and Residues) – Solution of difference equations using Z - transform.			**CO5**

Lecture Periods: 45	**Tutorial Periods: 15**	**Practical Periods: -**	**Total Periods: 60**

Text Books

1. T. Veerarajan, "Engineering Mathematics", Tata McGraw Hill, New Delhi, 3rd Edition, 2011.
2. C. P. Gupta, Shree Ram Singh. M. Kumar, "Engineering Mathematics for semester I & II", Tata McGraw Hill, New Delhi, 2nd Edition, 2016.
3. H.K. Dass, "Advanced Engineering Mathematics", S. Chand, New Delhi, 22nd Edition2019.

Reference Books

1. N.P. Bali and Dr. Manish Goyal, "A Textbook of Engineering Mathematics", University Science Press, India, 8th Edition, 2016.
2. P. Sivaramakrishna Das and C. Vijayakumari, "Engineering Mathematics", Pearson India Education services Pvt. Ltd, India 1st 2017.
3. Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons, New Delhi, 10th Edition, 2019.

4. G. Balaji, “Engineering Mathematics - Transforms and Partial Differential Equations”, G. Balaji Publishers, 18th Edition, 2022.
5. B.V. Ramana, “Higher Engineering Mathematics”, Tata McGraw Hill, New Delhi, 2017.

Web References

1. https://nptel.ac.in/courses/111105121/
2. https://nptel.ac.in/courses/111105035/
3. https://nptel.ac.in/courses/11110711
4. https://swayam.gov.in/nd1_noc20_ma17/preview
5. https://nptel.ac.in/courses/111/103/111103021/

* TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	2	2	-	-	1	-	-	-	-	1	1	-	-
2	3	2	1	1	-	1	-	-	-	-	1	3	-	-
3	3	2	1	1	-	1	-	-	-	-	1	3	-	-
4	3	2	1	1	-	1	-	-	-	-	1	3	-	-
5	3	2	1	1	-	1	-	-	-	-	1	3	-	-

Correlation Level: 1 - Low, 2 - Medium, 3 – High

Evaluation Methods

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	CAT 1	CAT 2	Model Exam	Assignment*	Attendance		
Marks	5	5	5	5	5	75	100

* Application oriented / Problem solving / Design / Analytical in content beyond the syllabus

Department	**Computer Science and Engineering**	Programme: **B.Tech.**						
Semester	**I / II**	Course Category: **ES**			*End Semester Exam Type: **TE**			
Course Code	**U23CSTC01**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Programming in C**	**3**	**0**	**0**	**3**	**25**	**75**	**100**

(Common to All Branches)

Prerequisite	-	
Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Comprehend the basics of Computers.	**K2**
	CO2 Illustrate the concepts of control structures and looping.	**K2**
	CO3 Implement programs using arrays and functions.	**K3**
	CO4 Demonstrate programs using Structure and Pointers.	**K3**
	CO5 Build the programs using Union and File management Operations.	**K3**

UNIT-I	**Introduction**	**Periods:09**	
Generation and Classification of Computers - Block Diagram of a Computer –Categories of Software – Network Structure - Number System – Binary – Decimal – Conversion – Algorithm – Pseudo code – Flow Chart.			**CO1**
UNIT-II	**C Programming Basics**	**Periods:09**	
Introduction to ' C' Programming – Basic structure of a 'C' program – compilation and linking processes – Constants, Variables – Data Types – Expressions using operators in 'C' – Managing Input and Output operations – Decision Making and Branching – Looping statements.			**CO2**
UNIT-III	**Arrays and Functions**	**Periods:09**	
Arrays – Initialization – Declaration – One dimensional and Two dimensional arrays. String- String operations – String Arrays. Simple programs- sorting- searching – matrix operations- Function – definition of function – Declaration of function – Pass by value – Pass by reference – Recursion			**CO3**
UNIT-IV	**Structure and Pointers**	**Periods:09**	
Structure Introduction – Structure definition – Structure declaration – Structure within a structure –Self Referential Structure. Pointers - Definition – Initialization – Pointers arithmetic – Pointers and arrays -Pointer to Function –Pointer and Structure- Simple programs.			**CO4**
UNIT-V	**Unions and Files**	**Periods:09**	
Union Introduction - Programs Using Structures and Unions – Introduction to File - File Operations - File Input and Output Functions - Random Access to Files - File System Functions - Command Line Arguments- Storage Classes - Pre-Processor Directives- Dynamic Memory Functions.			**CO5**

LecturePeriods:45	**Tutorial Periods:**	**Practical Periods:-**	**TotalPeriods:45**

Text Books

1. Balagurusamy. E, "Programming in ANSI C", Tata McGraw Hill, 8thEdition,2019.
2. YashvantKanetkar, "Let us C", BPB Publications, 16th Edition, 2017
3. Herbert Schildt," C: The Complete Reference", McGraw Hill, FourthEdition,2014

ReferenceBooks

1. Vikas B. Agarwal Jyoti P. Mirani, "Computer Fundamentals , Nirali Prakashan Aug-2019,
2. Ashok N Kamthane, "Computer Programming", Pearson education, 2nd Impression,2012.
3. VikasVerma, "A Workbook on C ", Cengage Learning, 2nd Edition,2012.
4. P.Visu, R.Srinivasan and S.Koteeswaran, "Fundamentals of Computing and Programming", Sri Krishna Publications, 4th Edition, 2012.
5. PradipDev, ManasGhoush, "Programming in C", Oxford University Press,2nd Edition, 2011.

Web References

1. https://www.programiz.com/c-programming
2. https://www.geeksforgeeks.org/c-language-set-1-introduction/
3. https://www.tutorialspoint.com/cprogramming
4. https://www.assignment2do.wordpress.com/.../solution-programming-in-ansi-c
5. https://nptel.ac.in/courses/106/104/106104128/

* TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	2	1	-	-	3	-	-	-	-	-	-	3	-	3
2	2	1	-	-	3	-	-	-	-	-	-	3	-	3
3	3	2	1	1	3	-	-	-	-	-	-	3	-	3
4	3	2	1	1	3	-	-	-	-	-	-	3	-	3
5	3	2	1	1	3	-	-	-	-	-	-	3	-	3

Correlation Level: 1 - Low, 2 - Medium, 3 – High

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	CAT 1	CAT 2	Model Exam	Assignment*	Attendance		
Marks	5	5	5	5	5	75	100

*Application oriented / Problem solving / Design / Analytical in content beyond the syllabus

Department	**Biomedical Engineering**	Programme:**B.Tech.**						
Semester	**II**	Course Category:**PC**			*End Semester Exam Type:**TE**			
Course Code	**U23BMTC01**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Electron Devices and Circuits**	**3**	**0**	**0**	**3**	**25**	**75**	**100**

(Common to BME and ICE Branches)

Prerequisite: **Physics**

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Explain the operation of basic semiconductor diodes and its applications	**K2**
	CO2 Classify the transistors configuration and analyze its characteristics	**K3**
	CO3 Distinguish the special semiconductor devices and its applications	**K3**
	CO4 Analyze the transistor using small signal model and understand the operation of different categories of amplifiers	**K4**
	CO5 Investigate the operation of different types of feedback amplifiers and oscillators	**K3**

UNIT-I	**Diodes and their Applications**	**Periods:9**
Formation of P-N junction diode- forward and reverse biased P-N junction, V-I characteristics, diffusion and transient capacitance, Zener diode and its reverse characteristics, Zener breakdown, Avalanche breakdown, Rectifiers-half wave rectifier, full wave rectifier with and without filters, Clippers, Clampers, Voltage Regulator – Zener diode as Voltage regulator.		**CO1**
UNIT-II	**Bipolar Junction Transistor and Field Effect Transistor**	**Periods:9**
Bipolar Junction Transistor: Principle of operation –Current components, CE, CB, and CC Configurations, Input and output characteristics – Cut-off, active and saturation region, Transistor as a switch, Transistor as an amplifier. **Field Effect Transistor:** Classification - JFET and its characteristics – JFET parameters, MOSFET – principle of operation-Depletion and enhancement modes.		**CO2**
UNIT-III	**Special Semiconductor Devices**	**Periods:9**
Unijunction Transistor (UJT), Tunnel diode, Varactor diode, Schottky diode, Gunn diode, Light Emitting Diode (LED), Laser, PIN diode, Photo diode, Liquid Crystal Display (LCD), Silicon Control Rectifier (SCR), DIAC, TRIAC, Applications of SCR, DIAC, TRIAC.		**CO3**
UNIT-IV	**Amplifiers**	**Periods:9**
BJT small signal low frequency model using h parameter – Analysis of CE, CB and CC amplifiers, RC coupled amplifiers, Cascade amplifier, Power amplifiers –Class A, Class B, Class AB, Push Pull, Class C amplifiers.		**CO4**
UNIT-V	**Feedback Amplifiers and Oscillators**	**Periods:9**
Feedback amplifiers-Properties of negative feedback-voltage and current, Series and Shunt feedback, Positive feedback, Barkhausen Condition for oscillations, Classification of Oscillators, RC phase shift, Wien bridge, Hartley, Colpitts and Crystal oscillators.		**CO5**

Lecture Periods:45	**Tutorial Periods:-**	**Practical Periods:-**	**TotalPeriods:45**

Text Books

1. S.Salivahanan, N. Suresh Kumar, A. Vallavaraj, “Electronic Devices and Circuits”, Tata Mcgraw-Hill, 2nd Edition, 2017
2. Jacob Millman,Chritos CHalkias,“Electronic Devices and Circuits”,McGrawHill, 4th edition, 2015
3. R S Sedha “A Textbook of Applied Electronics”S.Chand Publications, 2008

Reference Books

1. Robert L. Boylestad and Louis Nashelsky, Electronic Devices and Circuits Theory, Pearson, 9th Edition, 2013.
2. ThomasL.Floyd,“Electronicdevices”PrenticeHall”,10th Edition,2018

3. Kumar and Jain, “Electronic devices and Circuits” PHI learning, 2016
4. Bakshi, U. A., &Godse, A. P.,“Electronic Devices and Circuits”, Technical Publications,2008
5. Anil Kumar Maini.,Varsha Agrawal, “Electronic devices and circuits”, Wiley,2019

Web References

1. https://nptel.ac.in/courses/117/103/117103063/
2. https://nptel.ac.in/courses/108108122/
3. https://www.electronics-tutorials.ws/

* TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	2	1	1	2	1	1	1	1	2	3	2	1	3
2	3	3	2	2	2	1	1	1	1	2	3	3	1	3
3	3	2	2	1	2	1	1	1	1	2	3	2	2	3
4	3	3	3	2	3	1	1	2	2	3	3	3	2	3
5	3	3	3	2	3	1	1	2	2	3	3	3	3	3

Correlation Level: 1 - Low, 2 - Medium, 3 – High

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	CAT 1	CAT 2	Model Exam	Assignment*	Attendance		
Marks	5	5	5	5	5	75	100

* Application oriented / Problem solving / Design / Analytical in content beyond the syllabus

Department	**Biomedical Engineering**	Programme: **B.Tech.**						
Semester	**II**	Course Category: **PC**			*End Semester Exam Type: **TE**			
Course Code	**U23BMT203**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Biosensors and Transducers**	**3**	**0**	**0**	**3**	**25**	**75**	**100**
Prerequisite	**-**							

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Understand various measurements and instruments	**K2**
	CO2 Apply fundamental transduction and photo sensing principles using various sensors	**K3**
	CO3 Distinguish transducers and electric sensors its application	**K3**
	CO4 Analyze different types of electrodes in biological measurements	**K3**
	CO5 Interpret various biochemical sensors used in physiological measurement	**K3**

UNIT-I	**Introduction To Measurements**	**Periods:09**	
Measurement System–Instrumentation–Classification and Characteristics of Transducers– Static and Dynamic–Errors in Measurements– Calibration–Primary and secondary standards. Measurements using AC & DC Bridges			**CO1**
UNIT-II	**Displacement, Pressure and Temperature Sensors**	**Periods:09**	
Strain Gauge: Gauge factor, sensing elements, configuration, unbounded strain gauge, biomedical applications; strain gauge as displacement & pressure transducers: Capacitive transducer, Inductive transducer, LVDT, Passive types: RTD materials range, relative resistances. temperature characteristics, thermistor characteristics, biomedical applications of Temperature sensors. Active type: Thermocouple–Characteristics.			**CO2**
UNIT-III	**Transducers And Photoelectric Sensors**	**Periods:09**	
Introduction to Transducers, Piezoelectric active transducer and biomedical applications as pressure& Ultrasound transducer comparison of photoelectric transducers, Spectro photometric applications of photoelectric transducers. Ionizing & Non-Ionizing radiation and its effects. Phototube, scintillation counter, Photo Multiplier Tube (PMT), photovoltaic, Photoconductive cells, photo diodes, phototransistor.			**CO3**
UNIT- IV	**Electrodes**	**Periods:09**	
Recording Electrodes– Half cell potential and action potential, Electrode-tissue interface, polarization, skin contact impedance, motion artifacts, Silver-Silver Chloride electrodes, Surface Electrodes– Needle electrodes– Microelectrodes-Electrical conductivity of electrode. Measurement of Skin Resistance			**CO4**
UNIT-V	**Biochemical Transducers**	**Periods:09**	
Biosensors– Chemoreceptor, hot and cold receptors, Baro receptors, sensors for smell, sound, vision, osmolality and taste. Transducers for the measurement of ions and dissolved gases. Ion exchange membrane electrodes– Measurement of pH–Glass pH electrodes. Measurement of pO2, Measurement of pCO2.ISFET for glucose.			**CO5**

Lecture Periods: -	**Tutorial Periods: -**	**Practical Periods: -**	**TotalPeriods:45**

Text Books

1.A.K. Sawhney, “A Course in Electrical and Electronic measurements and Instruments”, Dhanpat Rai and Sons,2012.
2.Prof.PingWang and Dr. Qingjun Liu, “Biomedical Sensors and Measurement “,Springer Publications”, 1st Edition,2011.
3.Tatsuo Tagawa, Toshio Tamura and Ake Oberg, “Biomedical Sensors and Instruments”, CRC Press Taylor and Francis Group, 2nd Edition, 2011.

Reference Books

1.R. Anandanatarajan, “Biomedical Instrumentation nad measurements”, PHI Learning, 2nd Edition,December20
2.Ernest O Doebelin and Dhanesh N Manik, “Measurement Systems, Applications and Design”, MCGraw-Hill, 5th edition 2007.
3.MichaelJ.McGrath, Cliodhna Ní Scanaill,“Sensor Technologies: Healthcare, Wellness and Environmental Applications, Apress,8th Edition 2013.

4.RichardS.C.Cobbold, "Transducers for Biomedical Measurements: Principles and Applications ", John Wiley and Sons, 7th Edition ,2004.
5, NandiniK.Jog,"ElectronicsinMedicineandBiomedicalInstrumentation",,PHI, 2nd Edition ,2013.

Web References

1. http://www.gvpcew.ac.in/unit%202.pdf
2. http://www.123seminarsonly.com/Seminar-Reports/018/31005914-Notes-on-Transducers.pdf
3. https://nptel.ac.in/courses/108/108/108108147/
4. https://nptel.ac.in/content/storage2/courses/112103174/pdf/mod2.pdf
5. https://www.uvpce.ac.in/content/biomedical-transducers-and-biosensors-laboratory

* TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes(PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	2	1	1	2	1	1	1	1	2	3	2	2	3
2	3	3	2	2	3	1	1	1	1	2	3	3	2	3
3	3	3	2	2	3	1	1	1	1	2	3	3	3	3
4	3	3	2	2	2	2	1	1	1	2	3	3	2	3
5	3	3	2	2	2	2	1	1	1	3	3	3	2	3

Correlation Level: 1 - Low, 2 - Medium, 3 – High

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	CAT 1	CAT 2	Model Exam	Assignment*	Attendance		
Marks	5	5	5	5	5	75	100

* Application oriented / Problem solving / Design / Analytical in content beyond the syllabus

Department	**Biomedical Engineering**	Programme:**B.Tech.**						
Semester	**II**	Course Category:**HS**			End Semester Exam Type: -			
Course Code	**U23HSTC01**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Universal Human Values –II**	**2**	**0**	**0**	**2**	**25**	**75**	**100**
Prerequisite	UHV-I: Universal Human Values-Introduction							

Course Outcomes	**The course will enable the student to**	BT Mapping (Highest Level)
	CO1 Aware of themselves, and their family, society and nature.	**K2**
	CO2 Be responsible in life, and in handling problems while keeping human relationships and human nature in mind.	**K2**
	CO3 Apply creativity in their education and develop holistic model.	**K2**
	CO4 Apply what they have learnt to their real life.	**K2**
	CO5 Be proficient to provide sustainable solutions to the problems in society and nature.	**K2**

UNIT-I	**Introduction to Value Education**	**Periods:09**
Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education) - Understanding Value Education - Self-exploration as the Process for Value Education -Continuous Happiness and Prosperity – the Basic Human Aspirations - Happiness and Prosperity – Current Scenario- Method to Fulfil the Basic Human Aspirations		**CO1**
UNIT-II	**Harmony in the Human Being**	**Periods:09**
Understanding Human being as the Co-existence of the Self and the Body-Distinguishing between the Needs of the Self and the Body-The Body as an Instrument of the Self-Understanding Harmony in the Self-Harmony of the Self with the Body-Programme to ensure self-regulation and Health		**CO2**
UNIT-III	**Harmony in the Family and Society**	**Periods:09**
Harmony in the Family – the Basic Unit of Human Interaction- 'trust' – the Foundational Value in Relationship- 'Respect' – as the Right Evaluation-Other Feelings, Justice in Human-to-Human Relationship-Understanding Harmony in the Society-Vision for the Universal Human Order.		**CO3**
UNIT-IV	**Harmony in the Nature/Existence**	**Periods:09**
Understanding Harmony in the Nature-Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature-Realizing Existence as Co-existence at All Levels-The Holistic Perception of Harmony in Existence		**CO4**
UNIT-V	**Implications of the Holistic Understanding – a Look at Professional Ethics**	**Periods:09**
Natural Acceptance of Human Values-Definitiveness of (Ethical) Human Conduct-: A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order-Competence in Professional Ethics-Holistic Technologies, Production Systems and Management Models-Typical Case Studies-Strategies for Transition towards Value-based Life and Profession		**CO5**

LecturePeriods:45	**Tutorial Periods: -**	**Practical Periods: -**	**TotalPeriods:45**

Text Books

A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019.

Reference Books

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
5. Small is Beautiful - E. F Schumacher
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa

8. Bharat Mein Angreji Raj – Pandit Sunderlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)
13. Gandhi - Romain Rolland (English)

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	CAT 1	CAT 2	Model Exam	Assignment*	Attendance		
Marks	5	5	5	5	5	75	100

* Application oriented / Problem solving / Design / Analytical in content beyond the syllabus

Department	**English**	Programme: **B.Tech.**						
Semester	**II**	Course Category : HS			End Semester Exam Type:**TE**			
Course Code	U23ENBC02	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Communicative English - II**	**2**	**-**	**2**	**3**	**50**	**50**	**100**

(Common to ALL Branches except CSBS)

Prerequisite	Basics of English Language		
Course Outcomes	**On completion of the course, the students will be able to**		BT Mapping (Highest Level)
	CO1	Draft effective written communication in professional environment	**K2**
	CO2	Apply the mechanics of creative writing with precision and clarity	**K3**
	CO3	Acquire language skills professionally to groom the overall personality through sensitizing various etiquettes in real time situation	**K2**
	CO4	Develop language fluency and gain self-confidence	**K3**
	CO5	Express thoughts and ideas with clarity and focus	**K2**

UNIT-I	**Business Correspondence**	**Periods:10**	
Business Writing: Circular, Agenda, Memoranda, Notice, Instruction, Minutes, Email Writing ,Report Writing- Official and Demi Official Letters : Applying for Educational / Car / Home Loans / Joining Report, Leave Letter, Industrial Visit, In plant Training, Letter to the Editor, Calling for a quotation, Placing Order, Letter of Complaints, Letter seeking Clarification, Resume', Job Application Letter, Bio-data, CV			**CO1**
UNIT-II	**Functional Writing Skills**	**Periods:10**	
Four Modes of Writing, Sentence Structure , Art of condensation: Summary Writing and Note Making, Use of phrase and clause in sentence, Principles of paragraph writing, Techniques of Essay Writing, Jumbled Sentence, Paraphrasing			**CO2**
UNIT-III	**Etiquettes**	**Periods:10**	
Etiquette: Meaning, Kinds: Corporate Etiquette, Meeting Etiquette, Telephone Etiquette, Email Etiquette, Social Media Etiquette, Dining Etiquette, Communication Etiquette			**CO3**
UNIT-IV	**Communication Practice-II**	**Periods:15**	
List of Exercises **Listening:** Letter writing tips **Speaking:** Just a Minute, Impromptu Speech, Contemporary Issues **Reading:** Variety of examples for Modes of Writing **Writing:** Different types of letters			**CO4**
UNIT-V	**Interpersonal Communication-II**	**Periods:15**	
List of Exercises **Listening:** Videos on different types of Etiquettes **Speaking:** Team Presentation, Negotiation Skills **Reading:** Phrases and Clauses **Writing:** Free writing on any given topic, Paraphrasing Practice			**CO5**

LecturePeriods:30	**Tutorial Periods: -**	**Practical Periods:30**	**Total Periods:60**

Text Books

1. PC Das, "Letter Writing including Official and Business Letters", New Central Book Agency, 2020.
2. Kumar, Sanjay, Pushpalatha," Communication Skills". Oxford University Press, 2018.
3. Raman, Meenakshi&Sangeetha Sharma," Communication Skills", New Delhi: OUP,2018.

Reference Books

1. Sahukar, Nimeran , Bhalla, Prem,, "The book of Etiquettes and Manners".PustakMahal Publisher, New Delhi; 1st Edition 2009.

2. Gerson Sharon J, Steven M. Gerson, “Technical Writing Process and Product”, Pearson Education Pvt. Ltd. 3rd Edition, 2009.
3. Grussendorf, Marion, “English for Presentations”. Oxford University Press, Oxford, 2007.
4. Seely John, “The Oxford Guide to Writing and Speaking”, Oxford University Press, 2006.
5. R.C. Sharma, Krishna Mohan, “Business Correspondence and Report Writing”, Tata McGraw Hill &Co.Ltd., New Delhi, 2001.

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1. https://www.indeed.com/career-advice/finding-a-job/how-to-write-an-application-letter
2. https://owlcation.com/humanities/Four-Types-of-Writing
3. https://targetstudy.com/languages/english/paragraph-writing.html
4. https://www.businessnewsdaily.com/8262-email-etiquette-tips.html
5. https://www.youtube.com/watch?v=UOceysteljo

* TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	1	-	-	-	-	-	-	-	3	-	1	-	-	-
2	1	-	-	-	-	-	-	-	3	-	1	-	-	-
3	1	-	-	-	-	-	-	-	3	-	1	-	-	-
4	1	-	-	-	-	-	-	-	3	-	1	-	-	-
5	1	-	-	-	-	-	-	-	3	-	1	-	-	-

Correlation Level: 1 - Low, 2 - Medium, 3 – High

Evaluation Methods

Theory						
Assessment	Continuous Assessment Marks (CAM)				End Semester Examination (ESE) Marks	Total Marks
	CAT 1	CAT 2	Model Exam	Attendance		
Marks	5	5	5	5	75	60
	20(to be weighted for 10 marks)				(to be weighted for 50 marks)	

Practical				
Continuous Assessment Internal Evaluation		End Semester Internal Evaluation		Total Marks
30(to be weighted for 10 marks)		30 marks		
Listening (L)*	10	Listening (L)*	10	40
Speaking(S)	5	Speaking(S)	5	
Reading(R)*	10	Reading(R)*	10	
Writing(W)*	5	Writing(W)*	5	

- **LRW components of Practical can be evaluated through Language Lab Software**

Department	**Mechanical Engineering**	Programme : **B.Tech.**						
Semester	**I / II**	Course Category: **ES**			*End Semester Exam Type: **LE**			
Course Code	**U23ESPC03**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Engineering Graphics Using AutoCAD**	**0**	**0**	**2**	**1**	**50**	**50**	**100**

(Common to all Branches)

Prerequisite	-	
Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Familiarize with the fundamentals and standards of engineering graphics.	**K3**
	CO2 Perform drawing of basic geometrical constructions and multiple views of objects.	**K2**
	CO3 Visualize the isometric and perspective sections of simple solids.	**K3**
	CO4 Connect side view associate on front view.	**K4**
	CO5 Correlate sectional views and lateral surface developments of various solids.	**K4**

List of Experiments

1. Study of capabilities of software for Drafting and Modeling – Coordinate systems (absolute, relative, polar, etc.) – Creation of simple figures like polygon and general multi-line figures.
2. Drawing a Title Block with necessary text and projection symbol.
3. Drawing 2D sketch by applying modify tools like fillet, mirror, array, etc.,
4. Drawing front view and top view of simple solids like prism, pyramid, cylinder, cone, etc., and Dimensioning.
5. Drawing front view, top view and side view of objects from the given pictorial views (eg. Simple stool, V-block, Mixie Base).
6. Drawing a plan of residential building (Two bed rooms, kitchen, hall, etc.)
7. Drawing sectional views of prism, pyramid, cylinder, cone, etc,
8. Drawing lateral surface development of prism, pyramid, cylinder, cone, etc,
9. Drawing isometric projection of simple objects.
10. Creating 3D model of simple object and obtaining 2D multi-view drawings.
11. Note: Plotting of drawings must be made for each exercise and attached to the records written by Students.

Lecture Periods: -	**Tutorial Periods: -**	**Practical Periods: 30**	**Total Periods: 30**

Reference Books

1. James D. Bethune, Engineering Graphics with AutoCAD A Spectrum book 1st Edition, Macromedia Press, Pearson, 2020.
2. NS Parthasarathy and Vela Murali, Engineering Drawing, Oxford university press, 2015.
3. M.B Shah, Engineering Graphics, ITL Education Solutions Limited, Pearson **Education** Publication, 2011.
4. Bhatt N.D and Panchal V.M, Engineering Drawing: Plane and Solid Geometry, Charotar Publishing House, 2017.
5. Jeyapoovan T, Engineering Drawing and Graphics Using AutoCAD, Vikas Publishing House Pvt Ltd., 7th Edition, New Delhi, 2016.
6. C M Agrawal, Basant Agrawal, Engineering Graphics, McGraw Hill, 2012.
7. Dhananjay A. Jolhe, Engineering Drawing: With An Introduction To CAD McGraw Hill, 2016.
8. James Leach, AutoCAD 2017 Instructor, SDC Publications, 2016.

Web References

1. http://vlabs.iitb.ac.in/vlabs-dev/labs/mit_bootcamp/egraphics_lab/labs/index.php

2. http://www.nptelvideos.in/2012/12/computer-aided-design.html
3. https://mech.iitm.ac.in/meiitm/course/cad-in-manufacturing/
4. https://autocadtutorials.com
5. https://dwgmodels.com

* TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	1	-	-	3	-	-	3	-	-	2	3	3	3
2	3	1	-	-	3	-	-	3	-	-	3	3	3	3
3	3	1	-	-	3	-	-	3	-	-	3	3	3	3
4	3	1	-	-	3	-	-	3	-	-	2	3	3	3
5	3	1	-	-	3	-	-	3	-	-	3	3	3	3

Correlation Level: 1 - Low, 2 - Medium, 3 – High

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	Performance in practical classes			Model Practical Examination	Attendance		
	Conduction of practical	Record work	viva				
Marks	15	5	5	15	10	50	100

Department	**Computer Science and Engineering**	Programme:**B.Tech.**						
Semester	**I / II**	Course Category:**ES**			*End Semester ExamType:**LE**			
Course Code	**U23CSPC01**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Programming In C Laboratory**	**0**	**0**	**2**	**1**	**50**	**50**	**100**

(Common to all Branches)

Prerequisite	-	
Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Implement logical formulations to solve simple problems leading to specific applications.	**K3**
	CO2 Execute C programs for simple applications making use of basic constructs, arrays and strings.	**K3**
	CO3 Experiment C programs involving functions, recursion, pointers, and structures.	**K3**
	CO4 Demonstrate applications using sequential and random access file processing.	**K3**
	CO5 Build solutions for online coding challenges.	**K3**

List of Exercises **Periods:09**

1. Create a C program to find the Area of the triangle.
2. Develop a C program to read a three digit number and produce output like
   1 hundreds
   7 tens
   2 units
   For an input of 172.
3. Write a C program to check whether a given character is vowel or not using Switch – Case statement.
4. Print the numbers from 1 to 10 along with their squares using C program.
5. Demonstrate do—While loop in C to find the sum of ‘n’ numbers.
6. Find the factorial of a given number using Functions in C.
7. Write a C program to check whether a given string is palindrome or not?
8. Write a C program to check whether a value is prime or not?
9. Develop a C program to swap two numbers using call by value and call by reference.
10. Construct a C program to find the smallest and largest element in an array.
11. Implement matrix multiplication using C program.
12. Create a C program to perform various string handling functions like strlen, strcpy, strcat, strcmp.
13. Develop a C program to remove all characters in a string except alphabets.
14. Create a C program to find the sum of an integer array using pointers.
15. Write a C program to find the Maximum element in an integer array using pointers.
16. Construct a C program to display Employee details using Structures
17. Write a C program to display the contents of a file on the monitor screen.
18. Create a File by getting the input from the keyboard and retrieve the contents of the file using file operation commands.
19. Write a C program to create two files with a set of values. Merge the two file contents to form a single file
20. Create a C program to pass the parameter using command line arguments.

Lecture Periods:	**Tutorial Periods:**	**PracticalPeriods:30**	**TotalPeriods:30**

Reference Books

1. Zed A Shaw, “Learn C the Hard Way: Practical Exercises on the Computational Subjects You Keep Avoiding (Like C)”, Addison Wesley,2016.
2. Anita Goel and Ajay Mittal,” Computer Fundamentals and programming in C”, Pearson Education, First edition, 2011.
3. Maureen Sprinkle Hubbard,” Problem Solving and Programming Concepts,” Pearson,9th Edition, 2011.
4. Yashwanth Kanethkar, “Let us C”, BPB Publications,13th Edition,2008.
5. B.W.Kernighan and D.M. Ritchie, “The C Programming Language”, Pearson Education, 2nd Edition, 2006.

Web References

1. https://alison.com/course/introduction-to-c-programming
2. https://www.geeksforgeeks.org/c-programming-language/
3. http://cad-lab.github.io/cadlab_data/files/1993_prog_in_c.pdf
4. https://www.tenouk.com/clabworksheet/clabworksheet.html
5. https://fresh2refresh.com/c-programming/

* TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	2	1	-	-	3	-	-	-	-	-	-	3	-	3
2	2	1	-	-	3	-	-	-	-	-	-	3	-	3
3	3	2	1	1	3	-	-	-	-	-	-	3	-	3
4	3	2	1	1	3	-	-	-	-	-	-	3	-	3
5	3	2	1	1	3	-	-	-	-	-	-	3	-	3

Correlation Level: 1 - Low, 2 - Medium, 3 – High

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	Performance in practical classes			Model Practical Examination	Attendance		
	Conduction of practical	Record work	viva				
Marks	15	5	5	15	10	50	100

Department	**Biomedical Engineering**	Programme:**B.Tech.**						
Semester	**II**	Course Category:**PC**			*End Semester Exam Type:**LE**			
Course Code	**U23BMPC01**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Electron Devices and Circuits Laboratory**	**0**	**0**	**2**	**1**	**50**	**50**	**100**

(Common to ICE and BME Branches)

Prerequisite	-	
Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Demonstrate the characteristic of PN Junction diode and Zener diode	**K3**
	CO2 Construct and analyze the applications of diodes	**K4**
	CO3 Analyze the characteristics of different types of transistors and special diodes.	**K4**
	CO4 Design the LC oscillators and analyze the frequency response of CE amplifier.	**K4**
	CO5 Simulate the power amplifiers and feedback amplifiers.	**K3**

List of Experiments:

1. Characteristics of PN Junction Diode and Zener Diode.
2. Analysis of Half wave and Full wave Rectifiers.
3. Analysis of wave shaping circuits (Clippers and Clampers).
4. Characteristics of LED and Photo diode.
5. Characteristics of BJT in CB configuration
6. Characteristics of BJT in CE configuration
7. Characteristics of JFET
8. Negative resistance characteristics of UJT
9. Characteristics of Thyristors
10. Study the frequency response of CE Amplifier.
11. Design and Testing of LC Oscillators.
12. Simulation of Power Amplifiers and Feedback Amplifiers.

Lecture Periods: -	**Tutorial Periods: -**	**Practical Periods: 30**	**Total Periods:30**

Reference Books

1. Srinivasa Murthy, “Electronic Devices and Circuits Laboratory Manual”, 4th Edition, October 2015
2. David A.Bell,” Lab Manual For Electronic Devices & Circuits”, Fourth edition, PHI learning private limited, January 2004
3. Robert Boylestad , Louis Nashelsky, Franz Monssen ,“ Lab Manual for Electronic Devices and Circuit Theory”, Pearson, 11th Edition, August 2012.
4. Maheswari. L.K and Anand.M.M.S, “Laboratory Manual for Introductory Electronic Experiments”, New Age, 2010.
5. Muhammad H. Rashid “Introduction to PSpice using OrCAD for circuits and electronics,Pearson, 3rd Edition , 2004.

Web References

1. www.allaboutcircuits.com
2. www.circuitstoday.com
3. www.tutorialspoint.com

* TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	2	2	1	2	1	1	1	1	2	3	2	2	3
2	3	3	2	2	2	1	1	1	1	2	3	3	2	3
3	3	3	2	2	3	1	1	1	1	2	3	3	2	3
4	3	3	3	2	3	1	1	2	1	2	3	3	2	3
5	3	2	2	2	3	1	1	2	1	2	3	3	3	3

Correlation Level: 1 - Low, 2 - Medium, 3 – High

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	Performance in practical classes			Model Practical Examination	Attendance		
	Conduction of practical	Record work	viva				
Marks	15	5	5	15	10	50	100

Department	**Biomedical Engineering**	Programme:**B.Tech.**					
Semester	**II**	Course Category:**PC**			*End Semester Exam Type:**LE**		
Course Code	**U23BMP203**	Periods/Week			Credit	Maximum Marks	
		L	T	P	C	CAM	ESE	TM
Course Name	**Biosensors and Transducers Laboratory**	**0**	**0**	**2**	**1**	**50**	**50**	**100**
Prerequisite								

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Study the characteristics of instruments and measurements	**K3**
	CO2 Performance measurements of AC and DC bridges	**K3**
	CO3 Perform the displacement, temperature and pressure measurement using appropriate sensors / transducers	**K4**
	CO4 Study the characteristics of an LVDT, load cell and pH Electrodes	**K4**
	CO5 Perform torque measurement with strain gauge and bio transducers and bioelectrodes	**K4**

List of Experiments:

1. Study of Instruments and Measurements.
2. Measurement of resistance using DC Bridges.
3. Measurement of Inductance using AC Bridges.
4. Measurement of Capacitance using AC Bridges
5. Temperature measurement using AD590IC sensor
6. Displacement measurement by using a capacitive transducer
7. Torque measurement Strain gauge transducer
8. Study and characterize Bio transducers–Pressure, Temperature, Humidity
9. Pressure and displacement measurement by using LVDT
10. Study and characterize Bioelectrodes–ECG, EMG, EEG
11. Study and Characterize pH electrodes
12. Measurement of change in temperature using thermocouple, thermistor and RTD
13. Measurement of optical variables with the aid of photo diodes and photo transistors.

Lecture Periods:-	**Tutorial Periods:-**	**Practical Periods: 30**	**TotalPeriods:30**

Reference Books

1. A.E.G. Cass, “Biosensors: A Practical Approach “, Oxford University Press, 2nd Edition,July 1990.
2. Jonathan Cooper, Anthony Cass, “Biosensors: Practical Approach”, OUP Oxford, 2ndEdition, March 2004.
3. Robert S. Marks (Editor), Christopher R. Lowe, David C. Cullen, Howard H. Weetall, Isao Karube, “Handbook of Biosensors and Biochips”, Wiley, 1st Edition,October 2007.
4. R. P. Areny and T. G. Webster, “Sensors and Signal Conditioning”, Wiley- Interscience, 2015
5. Albert D. Helfrick and William D.Cooper. “Modern Electronic Instrumentation and Measurement Techniques”, Prentice Hall of India, 2007

Web References

1. uspas.fnal.gov/materials/04UW/Instrumentation.pdf
2. www.scilab.in/textbook_companion/generate_book/174
3. https://nptel.ac.in/courses/108/105/108105153/
4. https://nptel.ac.in/courses/108/108/108108147/
5. https://nptel.ac.in/content/storage2/courses/112103174/pdf/mod2.pdf

* TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

Cos	Program Outcomes (POs)											Program Specific Outcomes(PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	2	2	2	3	1	1	2	1	2	3	2	2	3
2	3	2	2	2	3	1	1	2	1	2	2	3	2	3
3	3	3	3	3	3	2	1	2	2	2	3	3	3	3
4	3	2	2	2	3	2	1	2	2	2	3	3	2	3
5	3	3	3	3	3	2	1	2	2	3	3	3	3	3

Correlation Level: 1 - Low, 2 - Medium, 3 – High

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	Performance in practical classes			Model Practical Examination	Attendance		
	Conduction of practical	Record work	viva				
Marks	15	5	5	15	10	50	100

Department	**Biomedical Engineering**	Programme: **B.Tech.**						
Semester	**II**	Course Category: **AEC**			*End Semester Exam Type:**LE**			
Course Code	**U23BMC2XX**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Certification Course - II**	**0**	**0**	**4**	**-**	**100**	**-**	**100**

Students shall choose an International certification course offered by the reputed organizations like Google, Microsoft, IBM, Texas Instruments, Bentley, Autodesk, Eplan and CISCO, etc. The duration of the course is 40-50 hours specified in the curriculum, which will be offered through Centre of Excellence.

Pass /Fail will be determined on the basis of participation, attendance, performance and completion of the course. If a candidate Fails, he/she has to repeat the course in the subsequent years. Pass in this course is mandatory for the award of degree.

Lecture Periods:-	**Tutorial Periods:-**	**Practical Periods: 50**	**Total Periods:50**

* TE – Theory Exam, LE – Lab Exam

Evaluation methods

Assessment	**Continuous Assessment Marks (CAM)**		**Total Marks**
	Attendance	**MCQ Test**	
Marks	10	90	100

Department	**Biomedical Engineering**	Programme:**B.Tech.**						
Semester	**II**	Course Category:**MC**			End Semester Exam Type:-			
Course Code	**U23BMM202**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Sports Yoga and NSS**	0	0	2	Non-Credit	100	-	100
Prerequisite	**-**							

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Practice Physical activities and Hatha Yoga focusing on yoga for strength, flexibility and relaxation.	**K2**
	CO2 Understand basic skills associated with yoga and physical activities including strength and flexibility, balance and coordination.	**K2**
	CO3 Develop understanding of psychological problems associated with age and lifestyle.	**K2**
	CO4 Recognize the importance of national service in community development.	**K2**
	CO5 Convert existing skills into socially relevant life skills.	**K2**

UNIT-I	**Introduction To Physical Education**	**Periods: 06**
Definition, Aims and Objectives of Physical Education - Changing trends in Physical Education **Physical Fitness, Wellness and Lifestyle:** Importance of Physical Fitness and Wellness - Components of Physical fitness - Components of Health related fitness - Components of wellness - Preventing Health Threats through Lifestyle Change - Concept of Positive Lifestyle.		**CO1**
UNIT-II	**Yoga And Lifestyle**	**Periods: 06**
Importance of Yoga - Elements of Yoga - Introduction - Asanas, Pranayama, Meditation and Yogic Kriyas - Yoga for concentration and related Asanas (Sukhasana, Tadasana, Padmasana and Shashankasana) - Relaxation Techniques for improving concentration - Yog-nidra. Asanas as preventive measures – Hypertension – Obesity - Back Pain-Diabetes - Asthema.		**CO2**
UNIT-III	**Training And Planning In Sports**	**Periods: 06**
Training - Warming up and limbering down-Skill, Technique and Style - Objectives of Planning – Tournament - Knock-Out, League/Round Robin and Combination. **Psychology and Sports** - Important of Psychology in Physical Education and Sports - Differentiate Between Growth and Development - Adolescent problems and their Management - Emotion: Concept, Type and Controlling of emotions - Concepts and Types of Aggressions in Sports - Psychological benefits of exercise - Anxiety and Fear and its effects on Sports Performance - Motivation, its type and techniques - Understanding Stress and Coping strategies		**CO3**
UNIT-IV	**Introduction To National Service Scheme**	**Periods: 06**
Orientation of NSS volunteers: History, motto, symbol, awards, structure and activities of NSS - Days of National and International Importance - Sensitizing about the thrust areas and awareness activities - Importance of tree plantation and voluntary blood donation - The role of SHGs and NGOs in community development – CSR - Life skills and youth development-extension activities in HEIs - various clubs and schemes like RRC, ELC, YRC, UBA, SBA, etc.,		**CO4**
UNIT-V	**Community Issues And The Use Of Technology**	**Periods: 06**
Common Problems of rural India - Technology development and its suitability – Sustainability - Value addition to agricultural products - Service learning and youth volunteering – Shramdaan - Campus cleaning - Field visit to nearby communities - village survey - Initiatives to clean and green environment - preservation of water bodies in adopted villages.		**CO5**

Lecture Periods:-	**Tutorial Periods:-**	**Practical Periods:30**	**Total Periods: 30**

1. Brar Ajmer Singh, Gill Jagtar Singh, Bains Jagdish, “Modern Textbook of Physical Education Health and Sports- I”, Kalyani i. Publishers , 6th Edition, 2014
2. B.K.S. Iyengar, “Light on Yoga: The Definitive Guide to Yoga Practice”,Thorsons Publishers, Thorsons Classics edition, 2015
3. Joseph, Siby K, Mahodaya, “Bharat Essays on Conflict Resolution”, Institute of Gandhian Studies Publishers, 2007
4. Barman Prateeti , Goswami, “Document on Peace Education”, Triveni Akansha Publishing House, New Delhi, 2009
5. Prof R.B.S. Verma, “Field Work Practicum in Social Work-Emerging Concerns”,Rapid Publisher, Lucknow, 2020

6. Sibereisen, K , Richard M, “Lerner Approaches to Positive Youth Development”, Sage Publications, New Delhi, 2007
7. Hoshiar Singh, “Administration of Rural Development in India”, Sterling Publisher, the University of Michigan, 2009

Web References

1. http://www.thebetterindia.com/140/national-service-scheme-nss
2. http://en.wikipedia.org/wiki/national-service-scheme 19=http://nss.nic.in/adminstruct
3. http://nss.nic. In
4. http://socialworknss.org/about.html
5. Young Journal on Youth published by SAGE: http://you.sagepub.com

Evaluation methods

Assessment	Continuous Assessment Marks (CAM)			Total Marks
	Attendance	MCQ Test	Presentation / Activity / Assignment	
Marks	10	30	60	100

Department	**Mathematics**	Programme: **B.Tech.**						
Semester	**III**	Course Category Code:**BS**				*End Semester Exam Type:**TE**		
Course Code	**U23MATC03**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Probability and Statistics**	**3**	**1**	**-**	**4**	**25**	**75**	**100**

(Common to All Branches Except CSBS)

Prerequisite	Basic Probability	
Course Outcome	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Apply the concept of probability.	**K3**
	CO2 Solve the problem on Random variables.	**K3**
	CO3 Evaluate the correlation and Regression.	**K3**
	CO4 Find Correlation between variables.	**K3**
	CO5 Analyze the problems in small samples.	**K3**

UNIT – I	**Theory of Probability**	**Periods:12**
Random Experiments - Sample Space - Exhaustive events- Axioms of probability – Conditional probability – Total probability – Bayes theorem.		**CO1**
UNIT – II	**Random Variables**	**Periods:12**
Moments–Moment generating functions and their properties. Binomial distribution – Poisson distribution – Exponential distribution – Normal distribution (Excluding Derivation of Mean, Variance and MGF)		**CO2**
UNIT – III	**Design of Experiments**	**Periods:12**
Analysis of variance: One way and two-way classifications. Correlation – Rank correlation and Regression.		**CO3**
UNIT – IV	**Large Samples**	**Periods:12**
Large Samples: Single Propositions – Difference of Proportions – Single Mean – Difference of Mean – Difference of Standard Deviations		**CO4**
UNIT – V	**Small Samples**	**Periods:12**
Test for Mean – Test for Ratio of Variances – Chi-Square test for Goodness of Fit and Independence of Attributes.		**CO5**

Lecture Periods:45	**Tutorial Periods:15**	**Practical Periods:-**	**Total Periods:60**

Text Books

B.S. Grewal, “Higher Engineering Mathematics”, Khanna publishers, 3rd Edition,2017.

T. Veerarajan, “Probability, Statistics and Random Processes”, Tata McGraw-Hill, 3rd Edition, 2008.

A. Singaravelu, “Probability and Statistics”, Meenakshi Agency, 2019.

Reference Books

1. Ravish R. Singh, Mukul Bhatt “Engineering Mathematics”, McGraw-Hill, 1stEdition, 2017.
2. William Mendenhall, Robert J. Beaver and Barbara M. Beaver: “Introduction to Probability & Statistics”, Cengage Learning, 15thEdition, 2019.
3. Richard. A. Johnson, Irwin Miller and John E. Freund,” Probability and Statistics for Engineers”, Pearson Education, Asia, 9th Edition, 2018.
4. Vijay K. Rohatgi and A.K. Md. Ehsanes Saleh, “An Introduction to Probability and Statistics”, Wiley, 3rd Edition 2008.

Web References

1. www.stat110.net
2. http://www.nptel.ac.in/courses/111105035 (R.V)
3. http:// www.probabilitycourse.com.

4. www.edx.org/Probability
5. http://www2.aueb.gr/users/demos/pro-stat.pdf

* TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	2	1	1	-	-	-	-	-	-	1	1	1	1
2	3	2	1	1	-	-	-	-	-	-	1	1	1	1
3	2	2	-	-	-	1	-	-	-	-	1	1	1	1
4	3	2	1	1	-	1	-	-	-	-	1	1	1	1
5	3	2	1	1	-	1	-	-	-	-	1	1	1	1

Correlation Level: 1 - Low, 2 - Medium, 3 – High

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	CAT 1	CAT 2	Model Exam	Assignment*	Attendance		
Marks	5	5	5	5	5	75	100

* Application oriented / Problem solving / Design / Analytical in content beyond the syllabus

Department	**Artificial Intelligence and Data Science**	Programme: **B.Tech**						
Semester	**III**	Course Category : **ES**				End Semester Exam Type: **TE**		
Course Code	**U23ADTC01**	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Programming in Python**	**3**	**0**	**0**	**3**	**25**	**75**	**100**

(Common to All Branches)

Prerequisite	-

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Interpret the basic concepts of Python programs.	**K2**
	CO2 Articulate the concepts of Sets, Dictionaries and Object-Oriented concepts.	**K2**
	CO3 Experiment with Numpy package.	**K3**
	CO4 Apply and analyze Data Manipulation with Pandas.	**K3**
	CO5 Illustrate programming concept for Visualization with Matplotlib.	**K3**

UNIT-I	**Introduction to Python**	**Periods: 09**
Structure of Python Program – Underlying mechanism of Module Execution – Branching and Looping – Problem Solving Using Branches and Loops – Functions – Lambda Functions – Lists and Mutability – Problem Solving Using Lists and Functions.		**CO1**
UNIT-II	**Sequence Datatypes and Object-Oriented Programming**	**Periods: 09**
Sequences – Mapping and Sets – Dictionaries. Classes: Classes and Instances – Inheritance – Exception Handling – Introduction to Regular Expressions using “re” module.		**CO2**
UNIT-III	**Using Numpy**	**Periods: 09**
Basics of NumPy – Computation on NumPy – Aggregations – Computation on Arrays – Comparisons – Masks and Boolean Arrays – Fancy Indexing – Sorting Arrays – Structured Data: NumPy’s Structured Array.		**CO3**
UNIT-IV	**Data Manipulation with Pandas**	**Periods: 09**
Introduction to Pandas Objects – Data indexing and Selection – Operating on Data in Pandas – Handling Missing Data – Hierarchical Indexing – Combining Data Sets. Aggregation and Grouping – Pivot Tables –Vectorized String Operations – Working with Time Series – High Performance Pandas – eval() and query().		**CO4**
UNIT-V	**Visualization With Matplotlib**	**Periods: 09**
Basic functions of Matplotlib – Simple Line Plot – Scatter Plot – Density and Contour Plots – Histograms – Binnings and Density – Customizing Plot Legends – Colour Bars – Three-Dimensional Plotting in Matplotlib.		**CO5**

Lecture Periods: 45	**Tutorial Periods:**	**Practical Periods:**	**Total Periods: 45**

Text Books

1. Jake VanderPlas, “Python Data Science Handbook - Essential Tools for Working with Data”, O’Reily Media Inc, 2016.
2. Zhang.Y, “An Introduction to Python and Computer Programming”, Springer Publications, 2016.
3. Wesley J Chun, “Core Python Programming”, Pearson Education, 2nd Edition, 2006.

Reference Books

1. John Paul Mueller, Luca Massaron, “Python for Data Science for Dummies”, 2nd Edition, John Wiley& Sons, 2019.
2. Jesus Rogel-Salazar, “Data Science and Analytics with Python”, CRC Press Taylor and Francis Group, 2017.
3. Brian Draper, “Python Programming A Complete Guide for Beginners to Master and Become an Expert in Python Programming Language”, CreateSpace Independent Publishing Platform, 2016.
4. Mark Lutz, Laura Lewin, Frank Willison, “Programming Python”, O'Reilly Media, 3rd Edition, 2006.
5. Gowrishankar S, Veena A, “Introduction to Python Programming”, CRC Press, 2018.

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1. https://nptel.ac.in/courses/106/106/106106212/
2. https://www.geeksforgeeks.org/data-analysis-visualization-python/
3. https://www.coursera.org/learn/python-data-analysis

4. https://www.python.org/
5. https://www.programiz.com/python-programming

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	2	1	-	-	3	-	-	-	-	-	-	3	-	3
2	2	2	1	3	-	-	-	-	-	-	2	2	2	3
3	3	2	2	3	-	-	-	-	-	-	2	3	2	3
4	3	3	2	3	-	-	-	-	-	-	3	3	3	3
5	3	3	2	3	-	-	-	-	-	-	2	3	3	3

Correlation Level: 1 - Low, 2 - Medium, 3 – High

Evaluation Methods

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	CAT 1	CAT 2	Model Exam	Assignment*	Attendance		
Marks	5	5	5	5	5	75	100

* Application oriented / Problem solving / Design / Analytical in content beyond the syllabus

Department	**Biomedical Engineering**	Programme: **B.Tech.**						
Semester	**III**	Course Category Code: **PC**			*End Semester Exam Type: **TE**			
Course Code	**U23BMT304**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Biosignals and Systems**	**2**	**1**	**-**	**3**	**25**	**75**	**100**

Prerequisite	-	
Course Outcome	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Distinguish the continuous and discrete-time signals and systems	**K2**
	CO2 Capable of characterizing LTI-CT systems in the Transform domain	**K3**
	CO3 Analyse the concepts of Z-transform and discrete Fourier transform	**K4**
	CO4 Capable of characterizing LTI-DT systems in the Transform domain	**K4**
	CO5 Apply DFT for the analysis of digital signals and systems	**K4**

UNIT – I	**Basics of Discrete and Continuous Time Signals and Systems**	**Periods:12**
Generation, Representation of discrete time signals and continuous time signals - Standard discrete time signals, Standard continuous time signals - Classification of signals: Continuous time (CT) Discrete time (DT) signals, Basic bio signals, Mathematical operations on CTS and DTS - Scaling, folding, time shifting, addition and multiplication. Classification of systems: static and dynamic systems - time invariant and time variant - linear and nonlinear systems - causal and non-causal systems, stable and unstable systems.		**CO1**
UNIT – II	**Linear Time Invariant Continuous Time Systems**	**Periods:12**
Impulse response - Convolution integrals- Differential Equation- Fourier and Laplace transforms in analysis of CT systems - Systems connected in series / parallel.		**CO2**
UNIT – III	**Transforms of Discrete Time Signals**	**Periods:12**
Z transform-properties-Region of convergence - Representation of poles and zeros in z transform, Inverse z transform - Power series expansion, Partial Fraction method, Discrete time Fourier transform - Properties, Relation between Z transform and DTFT		**CO3**
UNIT – IV	**Linear Time Invariant-Discrete Time Systems**	**Periods:12**
Impulse response – Difference equations-Convolution sum- Discrete Fourier Transform and Z Transform Analysis of Recursive & Non-Recursive systems-DT systems connected in series and parallel.		**CO4**
UNIT – V	**Discrete Fourier Transforms**	**Periods:12**
Discrete Fourier transforms (DFT) - Properties of DFT - Periodicity, Symmetry, Circular convolution. Linear filtering using DFT. Filtering long data sequences - Overlap save and overlap add method. Fast computation of DFT - Radix-2 Decimation-in-time (DIT) Fast Fourier transform (FFT), Decimation-in-frequency (DIF) Fast Fourier transform (FFT). Linear filtering using FFT.		**CO5**

Lecture Periods:45	**Tutorial Periods:15**	**Practical Periods:**	**Total Periods:60**

Text Books

1. P. Ramesh Babu, “Signals and Systems”, Fifth Edition, Scitech Publishers, 2014.
2. Allan V. Oppenheim, Allan S.Willsky and S.HamidNawab, “Signals and Systems”, Second Edition, PHI Learning, New Delhi, 2010.
3. B. P. Lathi, “Principles of Linear Systems and Signals”, Third Edition, Oxford University Press, 2012.

Reference Books

1. A. Anand Kumar, “Signals and systems”, Third edition PHI learning Pvt. Ltd., 2015.
2. M.J. Roberts, “Signals and Systems: Analysis using transform methods and MATLAB”, Second edition, Tata McGraw Hill, 2012.
3. Suresh R, Devashayam, “Signals and Systems in Biomedical Engineering”, Second edition, Springer US, 2013.
4. Dr Chitode ”Signals and system”, Technical Publications 2014.

5. A.Nagoor Kani,"Digital Signal Processing", 2nd edition, McGraw Hill Education, 2016.

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1. http://www.nptelvideos.in/2012/12/signals-and-system.html
2. http://freevideolectures.com/Course/3177/Signals-and-Systems
3. https://nptel.ac.in/courses/117/101/117101055/
4. http://www.cdeep.iitb.ac.in/webpage_data/nptel/Electrical%20&%20Comm%20Engg/Signals%20and%20System/Course_home2.20.html
5. http://www.cdeep.iitb.ac.in/webpage_data/nptel/Electrical%20&%20Comm%20Engg/Signals%20and%20System/Course_home4.30.html

* TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	3	3	-	-	-	1	-	-	-	-	2	2	-
2	3	3	3	2	-	-	1	-	-	-	-	2	2	-
3	3	3	3	2	-	-	1	-	-	-	-	2	2	-
4	3	3	3	2	-	-	1	-	-	-	-	2	2	-
5	3	3	3	2	-	-	1	-	-	-	-	2	2	-

Correlation Level: 1 - Low, 2 - Medium, 3 – High

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	CAT 1	CAT 2	Model Exam	Assignment*	Attendance		
Marks	5	5	5	5	5	75	100

* Application oriented / Problem solving / Design / Analytical in content beyond the syllabus

Department	**Instrumentation and Control Engineering**	Programme: **B.Tech.**						
Semester	**III**	Course Category: PC			End Semester Exam Type: **TE**			
Course Code	**U23ICTC01**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Linear Integrated Circuits**	**3**	**0**	**0**	**3**	**25**	**75**	**100**
(Common to ICE & BME Branches)								
Prerequisite	**Knowledge of electronic circuits**							

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
CO1	Acquire knowledge on basic operation of op-amp	**K2**
CO2	Understand the different applications of Operational Amplifier and their design	**K3**
CO3	Gain knowledge on the comparators and waveform generators	**K3**
CO4	Demonstrate the basic concepts and design of active filters and data converters	**K4**
CO5	Gain knowledge on operation, applications of timers and describe the basic concepts of PLL and Voltage regulators.	**K3**

UNIT – I	**Op-Amp and its Characteristics**	**Periods:09**
Basics of operational amplifier (op amp) and its ideal characteristics, Internal Building Block, Inverting and non-inverting amplifier, Voltage follower, Differential Amplifier, DC characteristics and AC characteristics.		**CO1**
UNIT – II	**Op-Amp Applications**	**Periods:09**
Basic Op Amp Applications- Summing Amplifier, Subtractor, Differentiator and Integrator, Half wave rectifier and Full wave rectifier, Peak detector, Clipper and Clamper, Sample and hold circuit, log amplifier, Instrumentation amplifier, V-I and I-V converter.		**CO2**
UNIT – III	**Comparators and Waveform Generators**	**Periods:09**
Comparator and its applications - Schmitt trigger, Astable multivibrator, Monostable multivibrator, Triangular wave generator, Sawtooth wave generator, RC Phase shift oscillator, Wien bridge oscillator.		**CO3**
UNIT – IV	**Active Filters and Data Converters**	**Periods:09**
Active Filters: First order low pass and high pass filter, Band Pass Filter, Band Stop Filter. Digital to Analog converters (DAC): Weighted Resistor DAC, R-2R ladder DAC, Inverted R-2R DAC. Analog to Digital converters (ADC): Flash type ADC, Successive approximation ADC, Dual slope ADC.		**CO4**
UNIT – V	**Timer, PLL and Voltage Regulators**	**Periods:09**
555 timer IC pin diagram and functional diagram, 555 timer in monostable mode and its application as pulse width modulation, 555 timer in astable mode and its application as frequency shift keying (FSK), Phase Lock Loop IC 565. Voltage Regulators: Series op-amp regulator, LM78XX, 79XX fixed voltage regulator, 723 General Purpose Regulator, Switched Mode Power Supply.		**CO5**

Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 45**

Text Books

1. D Roy Choudhury and Shail Jain, “Linear integrated circuits”, New Age Science Limited, Fourth edition, 2018
2. Ramakant A. Gayakwad, “OP-AMP and Linear ICs”, Fourth Edition, Prentice Hall / Pearson Education, 2015
3. S.Salivahanan & V.S. Kanchana Bhaskaran, “Linear Integrated Circuits”, TMH, 2010.

Reference Books

1. Sergio Franco, “Design with Operational Amplifiers and Analog Integrated Circuits”, Fourth Edition,Tata Mc Graw-Hill, 2016.
2. S.Salivahanan& V.S. Kanchana Bhaskaran, “Linear Integrated Circuits”, Second Edition, TMH, 4th Reprint, 2016.

3. Robert F.Coughlin, Frederick F.Driscoll, “Operational Amplifiers and Linear Integrated Circuits”, Sixth Edition, PHI, 2008.
4. B.S.Sonde, “System design using Integrated Circuits”, Second Edition, New Age Pub, 2010
5. Gray and Meyer, “Analysis and Design of Analog Integrated Circuits”, Wiley International, 2009.

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1. http://www.ti.com/applications/industrial/medical/technical-documents.html
2. https://e-box.co.in/linear-integrated-circuits.shtml
3. https://www.tutorialspoint.com/linear_integrated_circuits_applications/index.html

* TE – Theory Exam, LE – Lab Exam

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	-	2	-	-	-	-	-	-	-	2	3	1	-
2	3	2	2	-	-	-	-	-	-	-	1	3	1	-
3	3	3	3	-	-	-	-	-	-	-	1	3	1	1
4	3	2	2	-	-	-	-	-	-	-	2	3	1	-
5	3	3	3	1	2	-	-	-	-	-	2	3	1	-

Correlation Level: 1 - Low, 2 - Medium, 3 – High

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	CAT 1	CAT 2	Model Exam	Assignment*	Attendance		
Marks	5	5	5	5	5	75	100

Department	**Instrumentation and Control Engineering**	Programme: **B.Tech.**						
Semester	**III**	Course Category: **PC**			End Semester Exam Type: **TE**			
Course Code	**U23ICTC02**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Digital Logic Circuits**	**2**	**1**	**0**	**3**	**25**	**75**	**100**

(Common to ICE & BME Branches)

Prerequisite: **-**

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
CO1	Interpret the concepts of number systems and binary codes.	**K2**
CO2	Analyze the operations of Boolean algebra and logic gates.	**K3**
CO3	Design and implement combinational logic circuits	**K3**
CO4	Design and implement sequential logic circuits	**K3**
CO5	Understand the memory devices, programmable logic devices and Logic families	**K3**

UNIT – I	**Number Systems and Binary Codes**	**Periods:12**
Number Systems-Binary, Octal, Decimal, Hexadecimal. Number system conversions, Binary Arithmetic, Representation of signed binary numbers, 1s and 2s Complements. **Binary Codes -** Classification, Binary coded decimal (BCD), Weighted, non-weighted, Reflective, sequential, Alphanumeric codes. Error detection codes. Error correction codes.		**CO1**
UNIT – II	**Boolean Algebra and Logic Gates**	**Periods:12**
Boolean Algebra: Basic Theorems and Properties, Standard Forms of Boolean Expression-Sum of Product (SOP), Product of Sum(POS), Canonical and Standard forms, Simplification of Boolean expressions - Algebraic simplification, Karnaugh-Map simplification, Quine McClusky simplification. **Logic gates:** Basic logic gates; Universal gates; Implementation of Boolean function using gates		**CO2**
UNIT – III	**Combinational Logic Circuits**	**Periods:12**
Binary adders- Half adder, Full adder, Parallel Adder, Look ahead carry adder, Binary Subtractors - Half subtractor, Full subtractor, 1bit and 2bit Magnitude comparators, Code converters, Decoders and encoders, Multiplexers and Demultiplexers, Parity bit generator and checker.		**CO3**
UNIT – IV	**Sequential Logic Circuits**	**Periods:12**
Types of sequential circuits, Comparison between combinational and sequential circuits, Latches-RS latch; Flip flops (FF) – RS,D, JK, and T, JK Master/Slave FF, triggering of flip flops, Excitation tables, Flip flop conversions. Design of Counters- Asynchronous (Ripple) Counters, synchronous counters, Shift registers, Classification of shift registers, Universal Shift Register, Ring Counter, Johnson counter.		**CO4**
UNIT – V	**Memory, Programmable Logic Circuits and Logic Families**	**Periods:12**
Memory Classification- Random Access Memory (RAM), Static RAM, Dynamic RAM, Read Only Memory (ROM); PROM, EPROM, EEPROM. **Programmable Logic Devices**: Programmable ROM (PROM), Programmable Array Logic (PAL), Programmable Logic Array (PLA), Implementation of combinational circuits using PROM, PAL, PLA. **Logic families**: Characteristics - propagation delay, power dissipation, fan-in, fan-out, noise margin, TTL, ECL, CMOS.		**CO5**

Lecture Periods: 60	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 60**

Text Books

1. M. Morris Mano, Digital Design, Fourth Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2008.
2. Anand Kumar, Fundamentals of Digital Circuits Prentice Hall of India, Pvt Ltd, New Delhi, Second Edition, 2014.
3. R.P. Jain, Modern Digital Electronics, Fourth edition, Tata McGraw Hill, 2010.

Reference Books

1. Donald P. Leach and Albert Paul Malvino, Digital Principles and Applications, 6th Edition, TMH, 2003.
2. Charles H. Roth, Larry L. Kinney, Raghunandan G.H. Fundamentals of Logic Design, Cengage Learning India Pvt. Ltd.; 1st edition, 1 September 2019
3. William H. Gothmann, Digital Electronics Prentice Hall, 2001
4. John M. Yarbrough, Digital logic: Applications and Design Thomas Vikas Publishing House, 2002.
5. Ananda Natarajan R, Digital Design, Second edition, Eastern Economy Editions, PHI Learning Pvt. Ltd., 2015.

Web References

1. https://nptel.ac.in/courses/117106086/
2. https://learn.ni.com/teach/resources/1104/digital-electronics
3. http://nptel.ac.in/courses/117/106/117106086/

* TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	2	2	-	-	-	-	-	-	-	-	3	1	1
2	3	2	2	-	-	-	-	-	-	-	-	3	1	1
3	3	2	2	-	-	-	-	-	-	-	-	3	1	1
4	3	-	1	-	-	-	-	-	-	-	-	3	1	1
5	3	2	1	-	-	-	-	-	-	-	-	3	1	1

Correlation Level: 1 - Low, 2 - Medium, 3 – High

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	CAT 1	CAT 2	Model Exam	Assignment*	Attendance		
Marks	5	5	5	5	5	75	100

* Application oriented / Problem solving / Design / Analytical in content beyond the syllabus

Department	**Biomedical Engineering**	Programme: **B.Tech**					
Semester	**III**	Course Category: **PC**			End Semester Exam Type: **TE & LE**		
Course Code	**U23BMB301**	Periods / Week			Credit	Maximum Marks	
		L	T	P	C	CAM	ESE	TM
Course Name	**Pathology and Microbiology**	**2**	**0**	**2**	**3**	**50**	**50**	**100**

Prerequisite	-	
Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Understand the structural and functional aspects of living organisms	**K2**
	CO2 Understand the importance of Fluid related disorders	**K2**
	CO3 Describe the structure of Bacteria and virus	**K3**
	CO4 Knowledge about the function of microscope	**K3**
	CO5 Define methods involved in easing the pathological diseases	**K3**

UNIT-I	**Cell Degeneration, Repair and Neoplasia**	**Periods: 10**
Cell injury and Necrosis, Apoptosis – Intracellular accumulations – Pathological calcification, cellular adaptations of growth and differentiation – Inflammation and Repair including fracture healing, Neoplasia – Classification, Benign and Malignant tumours – carcinogenesis, spread of tumours – Autopsy and biopsy.		**CO1**
UNIT-II	**Fluid and Hemodynamic Derrangements And Microscopes**	**Periods: 10**
Edema, normal hemostasis, thrombosis – disseminated intravascular coagulation – embolism, infarction, shock. Hematological disorders – Bleeding disorders, Leukaemias, Lymphomas. **Microscopes**: Light microscope – bright field, dark field, phase contrast, fluorescence – Electron microscope (TEM & SEM). – Preparation of samples for electron microscope – Staining methods – simple, gram staining and AFB staining.		**CO2**
UNIT-III	**Microbial Cultures and Immunology**	**Periods: 10**
Morphological features and structural organization of bacteria – growth curve, identification of bacteria – culture media and its types – culture techniques and observation of culture. **Immunology:** Natural and artificial immunity – opsonization, phagocytosis, inflammation – Immune deficiency syndrome – antibodies and its types – antigen and antibody reactions – immunological techniques: immune diffusion, immuno electrophoresis – RIA and ELISA – monoclonal antibodies.		**CO3**
UNIT-IV	**Pathology Lab Experiments**	**Periods: 15**
1. Sterilization techniques. 2. Preparation of culture media for micro-organisms. 3. ABO blood grouping and Cross matching of blood. 4. Hemoglobin estimation. 5. Bleeding time and clotting time. 6. Manual paraffin tissue processing and section cutting (Demonstration)		**CO4**
UNIT-V	**Microbiology Lab Experiments**	**Periods: 15**
1. Study and handling of light microscope. 2. Total RBC count. 3. Peripheral smear study (i) Morphology (ii) WBC differential count. 4. Urine physical and chemical examination. 5. Identification of Bacterial morphology by phase contrast Microscopy/Live and dead bacterial cells by Fluorescence Microscopy (Demonstration) 6. Identification of bacteria using 16s-rRNA sequencing (Demonstration)		**CO5**

Lecture Periods: 30	**Tutorial Periods:**	**Practical Periods: 3 0**	**Total Periods: 60**

Text Books

1. Ramzi S Cotran, Vinay Kumar & Stanley L Robbins, “Pathologic Basis of Diseases”, 10th edition, WB Saunders Co. 2020.
2. Prescott, Harley and Klein, “Microbiology”, 10th edition, McGraw Hill, 2021
3. Harsh Mohan: Text book of Pathology. Jaypee publishers. 9th edition. 2023

Reference Books

1. Underwood JCE: General and Systematic Pathology Churchill Livingstone, 5th edition, 2010.
2. Ananthanarayanan & Panicker, “Microbiology” Orientblackswan, 12/E ,2022.
3. Dubey RC and Maheswari DK. “A Textbook of Microbiology” Chand & Company Ltd, 5th edition ,2022
4. Vinay Kumar, Abul K. Abbas” Robbins Essential Pathology” Elsevier, 2020
5. Apurba S Sastry, Sandhya Bhat “Review of Microbiology & Immunology“J aypee Brothers Medical Publishers Pvt. Limited, 2 Jun 2020

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2. http://www.rkmyat.in/up1/34/1629.pdf
3. http://moscmm.org/pdf/Ananthanarayan%20microbio.pdf

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	3	3	1	3	-	1	-	-	-	1	2	-	-
2	3	3	3	1	-	-	1	-	-	-	1	2	-	-
3	3	3	3	1	-	-	1	-	2	-	1	2	-	-
4	2	2	2	2	-	-	-	1	2	-	-	1	2	2
5	1	-	-	-	3	1	-	1	1	3	2	-	-	2

Correlation Level: 1 - Low, 2 - Medium, 3 – High

Evaluation Methods

Theory						
Assessment	Continuous Assessment Marks (CAM)				End Semester Examination (ESE) Marks	Total Marks
	CAT 1	CAT 2	Model Exam	Attendance		
Marks	5	5	5	5	75	60
	20 (to be weighted for 10 marks)				(to be weighted for 50 marks)	

Practical				
Continuous Assessment Internal Evaluation		End Semester Internal Evaluation		Total Marks
30(to be weighted for 10 marks)		30 marks		40
Conduction of Practical	15 marks	Procedure / Algorithms	5 marks	
Report	10 marks	Experiment / Program Execution	10 marks	
Viva-Voce	5 marks	Result / Output	10 marks	
Total	30 marks	Viva-Voce	5 marks	

Department	**English**	Programme: **B.Tech.**						
Semester	**III**	Course Category Code:**HS**			*End Semester Exam Type:**LE**			
Course Code	**U23ENP301**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**General Proficiency- I**	**0**	**0**	**2**	**1**	**50**	**50**	**100**

(Common to ALL Branches except CSBS)

Prerequisite	**Basics of English Language**	
Course Outcome	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Interpret meaning and apply reading strategies in technical and non-technical context	**K3**
	CO2 Develop interpersonal communication skills professionally	**K4**
	CO3 Demonstrate various forms of formal writing	**K3**
	CO4 Decode graphical data coherently	**K2**
	CO5 Apply the techniques of verbal aptitude in competitive exams	**K3**

UNIT- I	**Comprehension Analysis**	**Periods:6**
Listening: Dialogue based on social contexts (IELTS based) - Speaking: Break the iceberg (IELTS based) Submitting Video Recording - Reading: Reading technical passage (IELTS based) - Writing: Writing Task: 2 (IELTS Academic) - Vocabulary: Synonyms (IELTS)		**CO1**
UNIT- II	**Personality Development**	**Periods:6**
Listening: Monologue about the everyday social issues (IELTS based) - Interview Videos - Speaking: Speak about the topic in the Flash Card (IELTS based) - Reading: British & American Vocabulary - Writing: SWOT Analysis - Vocabulary: Idioms and Phrases (IELTS)		**CO2**
UNIT- III	**Inferential Learning**	**Periods:6**
Listening: Conversation between 4 people regarding education (IELTS based), Anecdotes - Speaking: Structure Discussion (IELTS based) - Reading: Distinguish between facts & opinions (IELTS based), - Writing: Writing Conversation to different context - Vocabulary: Phrasal Verbs (IELTS)		**CO3**
UNIT- IV	**Interpretation And Functional Writing**	**Periods:6**
Listening: Monologue on an academic subject (IELTS based), Group Discussion videos - Speaking: Group Discussion Practice - Reading: Read and review (Books, Magazines) - Writing: Writing Task 1: (IELTS Academic: Graph/ chart/tables description) - Vocabulary: Collocations (IELTS)		**CO4**
UNIT-V	**Verbal Aptitude - I**	**Periods:6**
Language Enhancement: Articles, Preposition, Conjunction **Verbal Ability Enhancement:** Ordering of sentences, Blood Relation, Completing Statements- Cloze test, Spotting Errors - Sentence Improvement, Word Analogy, Word Groups **(GATE)**		**CO5**

Lecture Periods: -	**Tutorial Periods: -**	**Practical Periods:30**	**Total Periods:30**

Reference Books

1.Lewis, Norman, “Word Power Made Easy”.Goyal Publishers and Distributors Pvt.Ltd., Latest Edition, 2020.
2.Patterson, Kerry, Joseph Grenny,Ron McMillan, Al Switzler, “Crucial Conversation Tools for talking when Stakes are High”, Kindle Publication,2nd Edition, 2011.
3.Comfort, Jeremy,et.al. “Speaking Effectively: Developing Speaking Skills for Business English”, Cambridge University Press, Cambridge: Reprint 2011.
4.Agarwal, R. S. “A Modern Approach to Verbal & Non-Verbal Reasoning”. S. Chand, 2010.
5.Wren, Percival Christopher, and Wren Martin. “High School English Grammar and Composition”. S Chand, 2005.

Web References

1.https://www.ielts-exam.net/grammar/
2.https://ieltsfocus.com/2017/08/02/collocations-ielts/
3.https://www.fresherslive.com/online-test/blood-relations-questions-and-answers
4.https://www.toppr.com/guides/english-language/reading-comprehension/cloze-test/
5.https://www.examsbook.com/word-analogy-test-questions-with-answers

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	1	-	-	-	-	-	1	-	3	-	2	1	1	1
2	1	-	-	-	-	-	1	-	3	-	2	1	1	1
3	1	-	-	-	-	-	1	-	3	-	2	1	1	1
4	1	-	-	-	-	-	1	-	3	-	2	1	1	1
5	1	-	-	-	-	-	1	-	3	-	2	1	1	1

Correlation Level: 1-Low, 2-Medium, 3-High

Evaluation Methods

Practical				
Continuous Assessment Internal Evaluation		**End Semester External Evaluation**		**Total Marks**
50 marks		**50 marks**		
Conduction of Practical (Assignment 1&2 -10 Marks Performance in practical classes - 5 Marks)	15	Listening (L)	20	100
Record	5	Speaking(S)	10	
Viva	5	Reading(R)	10	
Model Practical Examination (Model Exam is conducted for 50 Marks that will be converted to 15 Marks)	15	Writing(W)	10	
Attendance	10			

Department	**Mathematics**	Programme: **B.Tech.**						
Semester	**III**	Course Category Code: **CC**			*End Semester Exam Type: **LE**			
Course Code	**U23MAPC01**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Engineering Mathematics Laboratory**	**0**	**0**	**2**	**1**	**50**	**50**	**100**
(Common to all Branches Except CSBS)								
Prerequisite	Matrices, Fourier Transforms, Laplace Transforms							

Course Outcome	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Perform and evaluate Matrix Operations	**K3**
	CO2 Solve Differential and Integral Equations	**K3**
	CO3 Construct Fourier series and Fourier Transforms of the given function	**K3**
	CO4 Find the Measures of Central tendency	**K3**
	CO5 Analyze Correlation and Regression lines	**K3**

List of Experiments:

1. Find the Inverse, Rank, Eigen values and Eigen Vectors of the matrix.
2. Solve the first order differential equation.
3. Find the integration of $\int_a^b f(x)dx$.
4. Find the Fourier series of f(x).
5. Find the Fourier Transform of f(x).
6. Find the Laplace Transform of f(x).
7. Find the Mean, Median and Mode.
8. Construct the Pie and Bar Diagram.
9. Find the Correlation coefficient.
10. Find the Regression lines.

Lecture Periods:- Nil	**Tutorial Periods:- Nil**	**Practical Periods: 3 0**	**Total Periods :30**

Reference Books

1. T. Veerarajan, “Engineering Mathematics, Tata McGraw Hill Education (India) Private Limited Chennai 2nd Edition Paperback – 1 January 2018.

2. M.K. Venkataraman, “Engineering Mathematics, The National Publishing Company, Madras, 2016.

3. Dr. A. Singaravelu, “Probability and Statistics”, Meenakshi Agency, Paperback – 1, 2019.

Web References

1. https://www.mccormick.northwestern.edu/documents/students/undergraduate/introduction-to-matlab.pdf
2. https://www.nrigroupindia.com/niist/wp-content/uploads/sites/6/2022/02/lab-manual-it406matlab.pdf
3. https://www.studocu.com/row/document/comsats-university-islamabad/signals-and-systems/lab-lab-manual/38332410

* TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	2	1	1	1	-	1	-	-	-	-	1	1	1	1
2	3	2	1	1	-	1	-	-	-	-	1	1	1	1
3	2	1	-	-	-	1	-	-	-	-	1	1	1	1
4	2	1	-	-	-	1	-	-	-	-	1	1	1	1
5	3	2	1	1	-	1	-	-	-	-	1	1	1	1

Correlation Level: 1 - Low, 2 - Medium, 3 – High

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	Performance in practical classes			Model Practical Examination	Attendance		
	Conduction of practical	Record work	viva				
Marks	15	5	5	15	10	50	100

Department	**Artificial Intelligence and Data Science**	Programme: **B.Tech**						
Semester	**III**	Course Category : **ES**			End Semester Exam Type:**LE**			
Course Code	**U23ADPC01**	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Programming in Python Laboratory**	**0**	**0**	**2**	**1**	**50**	**50**	**100**
	(Common to All Branches)							

Prerequisite	NIL	
Course Outcome	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Describe common Python functionality and features used for data science.	**K2**
	CO2 Query Data Frame structures for cleaning and processing.	**K2**
	CO3 Configure your programming environment	**K3**
	CO4 Experiment the concept using data visualization.	**K3**
	CO5 Analyze real time datasets,	**K3**

List of Exercises

1. Build a python program to implement Fibonacci series.
2. Build a python program to get a range of numbers from user and to separate even numbers and odd numbers respectively.
3. Build a function in Python to check duplicate letters. It must accept a string, i.e., a sentence. The function should return True if the sentence has any word with duplicate letters, else return False.
4. Build a program to perform arithmetic operations using lambda function.
5. Build a Python program that takes a list of numbers as input and returns a new list containing only the even numbers from the input list.
6. Build a python program to create a class called Car with attributes Company, model, and year. Implement a method that returns the age of the car in years.
7. Build a python program to create a base class called Shape that has a method called area which returns the area of the shape (set it to 0 for now). Then, create two derived classes Rectangle and Circle that inherit from the Shape class to calculate the area of derived classes.
8. Build a python program to implement aggregation using Numpy.
9. Build a python program to perform Indexing and Sorting.
10. Build a python program to perform Handling of missing data.
11. Build a python program to perform usage of Pivot table using Titanic datasets
12. Build a python program to perform use of eval () and query ()
13. Build a python program to perform Scatter Plot
14. Build a python program to perform 3D plotting
15. Implement an application to process a real time data.

Lecture Periods:	**Tutorial Periods:**	**Practical Periods: 30**	**Total Periods: 30**

Reference Books

1. Chirag Shah, “A Hands-On Introduction to Data Science”, Cambridge University Press, 2020.
2. Siddhartha Chatterjee, Michal Krystyanczuk, “Python Social Media Analytics”, Packt Publishing, 2017.
3. Jake VanderPlas, “Python Data Science Handbook - Essential Tools for Working with Data”, O’Reily Media Inc, 2016.
4. Zhang.Y, “An Introduction to Python and Computer Programming”, Springer Publications, 2016.
5. Wesley J Chun, “Core Python Programming”, Pearson Education, 2nd Edition, 2006.

Web References

1. https://nptel.ac.in/courses/106/106/106106212/
2. https://www.geeksforgeeks.org/data-analysis-visualization-python/
3. https://www.coursera.org/learn/python-data-analysis

4. https://www.python.org/
5. https://www.programiz.com/python-programming

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	2	2	2	1	3	-	-	-	-	-	-	2	2	2
2	2	3	2	2	3	-	-	-	-	-	-	2	3	2
3	3	3	3	2	3	-	-	-	-	-	-	3	3	3
4	3	3	3	3	3	-	-	-	-	-	-	3	3	3
5	3	3	3	3	3	-	-	-	-	-	-	3	3	3

Correlation Level: 1 - Low, 2 - Medium, 3 – High

Evaluation Methods

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	Performance in practical classes			Model Practical Examination	Attendance		
	Conduction of practical	Record work	viva				
Marks	15	5	5	15	10	50	100

Department	**Biomedical Engineering**	Programme: **B. Tech.**						
Semester	**III**	Course Category: **PC**			*End Semester Exam Type: **LE**			
Course Code	**U23ICPC01**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Linear and Digital Integrated Circuits Lab**	**0**	**0**	**2**	**1**	**50**	**50**	**100**
(Common to ICE & BME Branches)								
Prerequisite	-							

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Design various applications of op-amp.	**K4**
	CO2 Able to design signal conditioning circuits necessary for instrumentation.	**K3**
	CO3 Design various sequential digital circuits like shift registers, counters.	**K3**
	CO4 Design asynchronous sequential circuits.	**K3**
	CO5 Implement Multiplexer and demultiplexer	**K2**

PART –A

1. Design and Testing of Inverting amplifier, Noninverting amplifier and Voltage Follower.
2. Design and Testing of Summer and Subtractor circuits.
3. Design and Testing of Differentiator and Integrator.
4. Design and Testing of Instrumentation amplifier.
5. Design and Testing of First order active filters (LPF, HPF).
6. Implementation of 4-bit DAC using OP AMP, ADC using op-amp.
7. Design and Testing of Astable and monostable multivibrators using 555 Timer.

PART –B

8. Study of Logic Gates.
9. Design and implementation of Half Adder, Full Adder, Half Subtractor and Full Subtractor circuits.
10. Implementation of Code converters.
11. Implementation of Encoders and Decoders.
12. Verification of multiplexer and demultiplexer.
13. Implementation of Flip flops.
14. Design and implementation of counters.
15. Design and implementation of 4-bit shift registers.

Lecture Periods:	**Tutorial Periods:-**	**Practical Periods: 30**	**Total Periods: 30**

Reference Books

1. D Roy Choudhury and Shail Jain, “Linear integrated circuits”, New Age Science Limited, Fourth edition, 2018.
2. Ramakant A. Gayakwad, “OP-AMP and Linear ICs”, Fourth Edition, Prentice Hall / Pearson Education, 2015.
3. M. Morris Mano and Michael D. Cilette, Digital Designǁ, Prentice Hall, Fifth Edition,2012
4. Thomas L Floyd, “Digital Fundamentals", Prentice Hall, 11th Edition, 2014.
5. Anand Kumar, Fundamentals of Digital Circuitsǁ, Prentice Hall of India, Pvt Ltd, New Delhi, 4th Edition, 2016.

Web References

1. https://www.electronics-lab.com/
2. http://vlabs.iitkgp.ernet.in/be/#
3. https://nptel.ac.in/courses/122/106/122106025/

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	2	2	1	2	-	-	-	-	-	1	3	1	1
2	3	1	-	1	2	-	-	-	-	-	1	3	1	1
3	3	1	-	-	2	-	-	-	-	-	1	3	1	1
4	3	2	3	3	2	-	-	-	-	-	1	3	1	1
5	3	2	3	3	2	-	-	-	-	-	1	3	1	1

Correlation Level: 1 - Low, 2 - Medium, 3 – High

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	Performance in practical classes			Model Practical Examination	Attendance		
	Conduction of practical	Record work	viva				
Marks	15	5	5	15	10	50	100

Department	**Biomedical Engineering**	Programme: **B.Tech.**						
Semester	**III**	Course Category: **AE**			*End Semester Exam Type:**LE**			
Course Code	**U23BMC3XX**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Certification Course – III**	**0**	**0**	**4**	**-**	**100**	**-**	**100**

Students shall choose an international certification course offered by the reputed organizations like Google, Microsoft, IBM, Texas Instruments, Bentley, Autodesk, Eplan and CISCO, etc. The duration of the course is 40-50 hours specified in the curriculum, which will be offered through Centre of Excellence.

Pass /Fail will be determined on the basis of participation, attendance, performance and completion of the course. If a candidate Fails, he/she has to repeat the course in the subsequent years. Pass in this course is mandatory for the award of degree.

Lecture Periods:-	**Tutorial Periods: -**	**Practical Periods: 50**	**Total Periods:50**

Evaluation methods

Assessment	**Continuous Assessment Marks (CAM)**		**Total Marks**
	Attendance	**MCQ Test**	
Marks	10	90	100

Department	**Biomedical Engineering**	Programme: **B.Tech.**						
Semester	**III**	Course Category: **AE**			*End Semester Exam Type: **LE**			
Course Code	**U23BMS301**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Skill Enhancement Course 1***	**0**	**0**	**2**	**-**	**100**		**100**
Prerequisite								

Course Outcome	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Apply safety protocols in medical equipment troubleshooting.	**K3**
	CO2 Execute preventive maintenance for optimal blood pressure monitors.	**K3**
	CO3 Learn about the Shortcut keys, Formulae etc.	**K3**
	CO4 Explore about power p[joint Presentation	**K3**
	CO5 Learn various methods to design in power point presentation	**K3**

Course Content:

Testing and Troubleshooting of Medical Equipment

1. Rules of Engagements
   a. Look at the device/procedure/process.
   b. Listen to the user/device/procedure/process.
   c. Applications for the device/procedure/process
2. Blood Pressure Monitor Equipment (Manual)
   a. Preventive Maintenance
   b. Dissembling a Mercury Manometer
   c. Mercury handling protocol
3. Centrifuge Equipment
   a. Preventive Maintenance
   b. Checking Motor Functions
   c. RPM Measurements
   d. Bypassing Interlock
4. Microscope
   a. Preventive Maintenance
   b. Checking Light Source
   c. Adjustments of Knobs
   d. Ensuring the amount of Lubricants
5. Sphygmomanometer
   a. Preventive Maintenance
   b. Mercury leakage
   c. Pressure check.
   d. Aneroid instrument pressure check.
6. Stethoscopes
   a. Earpiece sound check.
   b. Tube connector check in headpiece.
   c. Parts damaged or faulty.

Lecture Periods:	**Tutorial Periods:**	**Practical Periods:30**	**Total Periods: 30**

Reference Books

1. Justin Cooper and Alex Dahinten, “Medical Equipment Troubleshooting Flowchart Handbook” Published by: Engineering world health, Vesion- 6, 2013

Web References

1. https://www.youtube.com/watch?v=whp2pnCBs6s
2. https://www.youtube.com/watch?v=EJJVrCm3YT4
3. https://www.youtube.com/watch?v=T0QmUe0bwL8
4. https://www.youtube.com/watch?v=3kXnL0AQhYA
5. https://www.usms.biz/preventive-maintenance-for-medical-devices/

Masters in Microsoft Excel

Module I: Excel Basics **(6 Hrs)**

About Excel, The Excel environment, The Title Bar – The Ribbon – Scroll Bars – The MS Office Button – The Quick Access Toolbar – The Formula Bar – The Workbook Window – The Status bar – The Workbook View Buttons – The Zoom Slider – the Mini toolbar – Keyboard Shortcuts.

Module II: Data handling **(6 Hrs)**

Sorting & Filtering: Techniques for sorting and filtering data, including controlling the order of precedence in a sort, advanced filters, and an introduction to PivotTables. Using sorting and filtering to check and 'clean' data. Controlling user input: Controlling the way users can enter data into a spreadsheet to reduce risk of error and increase efficiency. Covers Data Validation and using IS- functions to trap errors. Working with Text: Entering and formatting text, extracting or combining parts of text. 'Cleaning' data for typos and bugs. Lookup & Reference: Looking up information in a basic table, and more flexibly. VLOOKUP() and the more flexible INDEX()/MATCH() combination. Advanced lookups.

Module III: Formatting **(6 Hrs)**

Cell Formatting - Basic font formatting, alignment – Including horizontal and vertical alignment, wrapping, merging, orientation, Alt-Return; consistent, sensible row heights & column. Number Formatting - Types of number (E.g., currency, %, decimal, negative numbers) – and Excel formats best employed. Custom number formats and how to maximise impact and clarity. Conditional Formatting - Changing the format of cells depending on their value. Graphical conditional formats. Writing conditional format formulas.

Module IV: Presentation **(6 Hrs)**

Graphs and Charts - Creating simple charts and editing them to control and improve formatting. Choosing the right chart Principles and guidelines for communicating well with charts. Sparkline's and Maps (when and how to use). Page & Print Setup - Displaying spreadsheets as pages. Page layout view, page breaks, print area, Printing from multiple Worksheets (and that default will be to print only from active Worksheet). Headers and footers. Adjusting page setup. Printing very large sheets of data and finally printing!

Module V: Advanced Excel Capabilities **(6 Hrs)**

Conditional formatting, importing data and text to columns, Functions – Mathematical, String, IF, AND, OR, Searching: match, search, vlookup, Dates, Misc, Pivot tables, Recording and editing Macros.

Lecture Periods:	Tutorial Periods:	Practical Periods:30	Total Periods: 30

Text Books

1. Michael Alexander, "Excel 2007 Dashboards and Reports for Dummies", John Wiley & Sons, 2011
2. Ellen Monk, Spring Davidson, Joseph Brady, "Problem Solving Cases in Microsoft Access and Excel", Cengage Learning, 2009
3. Colleen Conmy, Bill Hazlett, Bill Jelen, Adrienne Soucy, "Excel for Teachers", Tickling Keys, 2010

Reference Books

1. Noreen Brown, Barbara Lave, Julie Romey, "Beginning Excel 2019", Open Oregon Educational Resources, 2017
2. Greg Harvey, "Excel 2019 All-in-One For Dummies", John Wiley & Sons, 2018
3. John Walkenbach, "Excel 2007 Bible", John Wiley & Sons, 2011
4. Matthew MacDonald, "Excel 2010: The Missing Manual", O'Reilly Media, Inc., 2010
5. Rob Bovey, Stephen Bullen, Dennis Wallentin, John Green, "Professional Excel Development: The Definitive Guide to Developing Applications Using Microsoft Excel, VBA, and .NET", Addison-Wesley Professional, 2009

Web References

1. https://www.google.com/search?q=ms+excel+working&oq=MS+Excel+working&aqs=chrome.0.0i457j0l3j0i22i30l4.9421j0j4&sourceid=chrome&ie=UTF-8
2. https://www.investintech.com/resources/blog/archives/5430-excel-data-tips.html
3. https://edu.gcfglobal.org/en/excel2010/working-with-basic-functions/1/
4. https://www.online-tech-tips.com/ms-office-tips/microsoft-excel-basics-tutorial-learning-how-to-use-excel/
5. https://spreadsheeto.com/how-to-use-excel/

Power Point Presentation Design and Animation

Module I: Getting acquainted with PowerPoint (6 Hrs)

Understanding and working with the PowerPoint interface including: the Outline and Slides pane, the Ribbon, Quick Access toolbar, notes pane and the Status Bar.

Module II: Objects and Formatting (6 Hrs)

Working with objects in PowerPoint. Copying and moving objects. Formatting including the format painter. Fonts and effects. Inserting new slides. Slide layout. Selecting multiple objects. Grouping objects. The different objects that you can include on a slide. Six slides that demonstrate the six content types: Table, Chart, Graphic, Picture, Clip art, Media clip (movie).

Module III: Slide Design (6 Hrs)

Templates and Slide Masters, How to use themes, masters and templates to make slide design quick and consistent. Layouts and footers. Principles of slide design - Principles to guide good, clean design and formatting of slides. Making your slides clearer. Creating professional-looking slides with real impact.

Module IV: Making an Impact (6 Hrs)

When and why to use images. How to insert and edit images. Cropping, resizing and manipulating images. Screenshots and videos. Removing picture backgrounds. Applying artistic effects.

Module V: Animation (6 Hrs)

Adding and controlling transition effects between slides. Detailed animation and transition options. Animating individual elements of text boxes, charts and diagrams. Presenter tools and features. Custom slide shows. Annotating your slide during a talk. Navigating a presentation. Self-running presentations.

Lecture Periods:	Tutorial Periods:	Practical Periods:30	Total Periods: 30

Text Books

1. Joan Lambert, “Microsoft PowerPoint step by step 2016”, Microsoft Press, 2016
2. Curtis Frye, Joan Preppernau, and Joyce Cox, “Microsoft® Office PowerPoint® 2007 Step by Step”, Microsoft Press, 2015
3. John Walkenbach, Michael R. Groh, Herb Tyson, Faithe Wempen, “Office 2010 Library: Excel 2010 Bible, Access 2010 Bible, PowerPoint 2010 Bible, Word 2010 Bible”, John Wiley & Sons, 2010

Reference Books

1. Joan Lambert, “Microsoft PowerPoint step by step 2019”, Microsoft Press, 2019
2. David W. Beskeen, “Illustrated Course Guide: Microsoft PowerPoint 2013 Advanced” Cengage Learning, 2014
3. Joan Preppernau and Joyce Cox, “PowerPoint 2010”, Microsoft Press, 2010
4. “Microsoft PowerPoint 2013”, John Wiley and Sons, 2013
5. Ann Shaffer and Katherine T. Pinard, “New Perspectives Microsoft Office 365 & PowerPoint 2016: Intermediate”, Course Technology, 2016

Web References

1. https://smallbusiness.chron.com/bibliography-powerpoint-40572.html
2. https://bookboon.com/en/powerpoint-ebooks
3. https://penandthepad.com/cite-book-powerpoint-8344519.html
4. https://www.bookdepository.com/category/1931/PowerPoint

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)			Total Marks
	Attendance	Report	Presentation / Demo / Skill Test	
Marks	10	40	50	100

Department	**Biomedical Engineering**	Programme: **B.Tech.**					
Semester	**III**	Course Category: **MC**			*End Semester Exam Type:-		
Course Code	**U23BMM303**	Periods/Week			Credit	Maximum Marks	
		L	T	P	C	CAM	ESE	TM
Course Name	**Climate Change**	**0**	**2**	**0**	**-**	**100**	**-**	**100**

UNIT- I	**Atmosphere and its Components**	**Periods:6**

Importance of Atmosphere-Physical Chemical Characteristics of Atmosphere- Vertical structure of the atmosphere-Composition of the atmosphere-Atmospheric stability-Temperature profile of the atmosphere-Lapse rates-Temperature inversion-effects of inversion on pollution dispersion.

UNIT- II	**Global Climate**	**Periods:6**

Account of past climate Environmental indicators and instrumental records Human Footprints on global warming- Predicting future climates- Temperature regime - Extreme climate events

UNIT- III	**Impacts of Climate Change**	**Periods:6**

Causes of Climate change: Change of Temperature in the environment-Melting of ice Pole-sea level rise-Impacts of Climate Change on various sectors Agriculture, Forestry and Ecosystem - Water Resources Human Health Industry, Settlement and Society Methods and Scenarios - Projected Impacts for Different Regions- Uncertainties in the Projected Impacts of Climate Change - Risk of Irreversible Changes.

UNIT- IV	**Observed Changes and its Causes**	**Periods:6**

Climate change and Carbon credits- Initiatives in India-Kyoto Protocol-Intergovernmental Panel on Climate change- Climate Sensitivity and Feedbacks-The Montreal Protocol UNFCCC - IPCC Evidences of Changes in Climate and Environment on a Global Scale and in India.

UNIT-V	**Climate Change and Mitigation Measures**	**Periods:6**

Clean Development Mechanism -Carbon Trading- examples of future Clean Technology - Biodiesel Natural Compost Eco Friendly Plastic Alternate Energy Hydrogen Bio-fuels-Mitigation Efforts in India and Adaptation funding. Key Mitigation Technologies and Practices-Carbon sequestration - Carbon capture and storage (CCS) - International and Regional cooperation- Remedial measures.

Lecture Periods: 30	**Tutorial Periods: -**	**Practical Periods:**	**Total Periods:30**

Text Books

1. Joan Fitzgerald "Greenovation: Urban Leadership on Climate Change, Oxford University Press 2020.
2. J. David Neelin" Climate change and climate modelling" Cambridge University press (2011).
3. Robin Moilveen "Fundamentals of weather and climate" Oxford University Press (2nd Edition) (2010),
4. Andrew Dessler and Edward A. Parson "The Science and Politics of Global Climate Change" 2009
5. Dash Sushil Kumar, "Climate Change An Indian Perspective", Cambridge University Press India Pvt. Ltd, 2007.

Reference Books

1. Bill McKibben (2012), The Global Warming Reader: A Century of Writing About Climate Change,Penguin.
2. Jason Smerdon(2009) Climate Change: The Science of Global Warming and Our Energy Future, Columbia University
3. Adaptation (2006) and mitigation of climate change-Scientific Technical Analysis. Cambridge University Press, Cambridge.
4. J.M. Wallace and P.V. Hobbs (2006) Atmospheric Science, Elsevier / Academic Press.
5. Jan C. van Dam, (2003) Impacts of "Climate Change and Climate Variability on Hydrological Regimes", Cambridge University Press

Web References

1. https://nptel.ac.in/courses/105102089/
2. https://www.warmheartworldwide
3. https://nptel.ac.in/content/storage

Evaluation methods

Assessment	Continuous Assessment Marks (CAM)			Total Marks
	Attendance	MCQ Test	Presentation / Activity / Assignment	
Marks	10	30	60	100

Department	**Mathematics**	Programme : **B.Tech.**						
Semester	**IV**	Course Category Code: **BS**			End Semester Exam Type: **TE**			
Course Code	**U23MATC04**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Numerical Methods and Optimization**	**3**	**1**	**-**	**4**	**25**	**75**	**100**

(Common to EEE, ECE, ICE, BME, MECH, CIVIL & MECHATRONICS)

Prerequisite	Basic Mathematics	
Course Outcome	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Solve Algebraic and Transcendental equations	**K2**
	CO2 Solve Simultaneous Equations by various Numerical Techniques.	**K3**
	CO3 Apply the Numerical Techniques of interpolation in various Intervals.	**K3**
	CO4 Solve Linear programming problems by using Optimization Techniques.	**K3**
	CO5 Find the solution of Transportation and Assignment Problems.	**K3**

UNIT – I	**Solution of algebraic and transcendental equations**	**Periods:12**
Solution of Algebraic and Transcendental equations – Bisection method - Method of False position – Newton Raphson method (single only) – Eigen value and Eigen vector by Power method.		**CO1**
UNIT – II	**Linear system of equations**	**Periods:12**
Solutions of Linear system of equations and Matrix Inversion – Gauss Elimination and Gauss - Jordan methods. Iterative methods – Gauss Jacobi – Gauss Seidel.		**CO2**
UNIT – III	**Interpolation and solution of ordinary differential equations**	**Periods:12**
Interpolation by Newton's Forward and Backward Difference formula for equal intervals – Lagrange's method for unequal intervals. Integration by Trapezoidal and Simpson's rules (Single integration only). Fourth order Runge-Kutta method for solving first order Differential Equations.		**CO3**
UNIT – IV	**Linear programming problems**	**Periods:12**
Linear Programming Problems – Graphical Method – Simplex Method: Big M method – Two phase method.		**CO4**
UNIT – V	**Transportation and assignment problems**	**Periods:12**
Transportation Problems – Initial basic feasible solution using North-West Corner rule, Least Cost Method, Vogel's Approximation Method – Optimality in Transportation Problem by Modified Distribution (MODI) Method. Assignment Problems – Solutions of Assignment Problems by Hungarian Method – Unbalanced Assignment Problems.		**CO5**

Lecture Periods:45	**Tutorial Periods:15**	**Practical Periods: -**	**Total Periods:60**

Text Books

1. P. Kandasamy, K. Thilagavathy, K. Gunavathi, "Numerical Methods", S. Chand Limited, 2008.
2. R. Panneerselvam "Operations Research" Prentice Hall of India, 2nd Edition,2004.
3. P.K. Gupta, D.S. Hira, "Operations Research", S. Chand, 5th Edition, 2018.

Reference Books

1. Atul Goyal, Madhuchanda Rakshit Suchet Kumar, "Numerical Methods", New India publishing Agency, 1st Edition, 2019.

2. Rajesh Kumar Gupta, “Numerical Methods - Fundamental and Applications”, Cambridge University Press, 1st Edition, 2019.
3. S.Kalavathy, “Operation Research” ,Vikas Publishing house,4th Edition,2012.
4. Kevin J. Hastings, “Introduction to the Mathematics of Operations Research with Mathematica”, Taylor and Francis, 2nd Edition, 2019.
5. T. Veerarajan, “Operations Research”, McGraw Hill, 1st Edition, 2018.

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1. https://nptel.ac.in/courses/111106101/
2. https://www.geektonight.com/operation-research-notes-pdf/#.XrXzoP8za00
3. https://freecomputerbooks.com/Numerical-Methods-with-Applications.html
4. https://www.pphmj.com/journals/IJNMA.htm
5. https://nptel.ac.in/courses/106/108/106108056/

* TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	3	2	2	2	-	-	-	1	1	2	2	2	1
2	3	3	2	2	2	-	-	-	1	1	2	2	2	1
3	3	3	2	2	2	-	-	-	1	1	2	2	2	1
4	3	3	3	2	3	-	-	-	1	2	2	2	3	2
5	3	3	3	2	3	-	-	-	1	2	2	2	3	2

Correlation Level: 1 - Low, 2 - Medium, 3 – High

Evaluation Methods

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	CAT 1	CAT 2	Model Exam	Assignment*	Attendance		
Marks	5	5	5	5	5	75	100

* Application oriented / Problem solving / Design / Analytical in content beyond the syllabus

Department	**Computer Science Engineering**	Programme : B.Tech						
Semester	**IV**	Course Category: **ES**			End Semester Exam Type: **TE**			
Course Code	**U23CSTC03**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Data Structures**	**3**	**0**	**0**	**3**	**25**	**75**	**100**

(Common to All Branches except CSBS and FT)

Prerequisite	Any Programming Knowledge	
Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Compute time and space complexity for given problems	**K2**
	CO2 Demonstrate stack, queue and its operation.	**K2**
	CO3 Illustrate the various operations of linked list.	**K3**
	CO4 Use the concepts of tree for various applications.	**K3**
	CO5 Outline the various Tables, Graphs and Sets techniques.	**K3**

UNIT - I	**Basic Terminologies of Data Structures**	**Periods:09**
Introduction: Basic Terminologies – Asymptotic Notations: Complexity analysis. Array and its operations - Searching: Linear Search and Binary Search Techniques. Sorting: Bubble Sort – Selection Sort – Insertion Sort – Heap Sort – Shell Sort. Performance and Comparison among the sorting methods.		**CO1**
UNIT - II	**Stack and Queue Operations**	**Periods:09**
Stacks and Queues: ADT Stack and its operations. Applications of Stacks: Expression Conversion and evaluation. ADT Queue and its operations. Types of Queue: Simple Queue – Circular Queue – Priority Queue – Deque.		**CO2**
UNIT - III	**Linked List Operations**	**Periods:09**
Linked Lists: Singly linked list: Representation in memory. Algorithms of several operations: Traversing – Searching – Insertion – Deletion. Linked representation of Stack and Queue. Doubly linked list: operations. Circular Linked Lists: operations.		**CO3**
UNIT - IV	**Trees**	**Periods:09**
Trees: Basic Tree Terminologies. Different types of Trees: Binary Tree – Threaded Binary Tree – Binary Search Tree – Binary Tree Traversals – AVL Tree- Red Black Tree.		**CO4**
UNIT - V	**Graphs, Tables and Sets**	**Periods:09**
Graph: Basic Terminologies and Representations – Graph traversal algorithms. Tables: Different types of tables – Hash Table and its operations - Applications. Sets: Representation of Sets- Operations and its applications.		**CO5**

Lecture Periods:45	**Tutorial Periods:**	**Practical Periods:-**	**Total Periods:45**

Text Books

1. Ellis Horowitz, Sartaj Sahni," Fundamentals of Data Structures", Illustrated Edition, Computer Science Press, 2018.
2. Thomas H. Coreman, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, "Introduction to Algorithms", PHI, Third Edition, 2010.
3. Alfred V. Aho, Jeffrey D. Ullman, John E. Hopcroft, "Data Structures and Algorithms", 4th Edition, 2009.

Reference Books

1. D. Samanta, "Classic Data Structures", Prentice-Hall of India, Second Edition, 2012.
2. Robert Kruse, C.L. Tondo and Bruce Leung, "Data Structures and Program Design in c" . Prentice-Hall of India, Second Edition, 2007.
3. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C", Pearson Education, Second. Edition,2006.
4. Mark Allen Weiss," Algorithms, Data Structures and Problem Solving with C++", Illustrated Edition, Addison-Wesley

Publishing Company, 1995.
5. Mark Allen Weiss," Algorithms, Data Structures and Problem Solving with C++", Addison- Wesley Publishing Company, IllustratedEdition, 1995.

Web References

1. https://www.geeksforgeeks.org/data-structures/
2. https://www.javatpoint.com/data-structure-tutorial/
3. https://www.studytonight.com/data-structures/
4. https://www.tutorialspoint.com/data_structures_algorithms/
5. https://www.w3schools.in/data-structures-tutorial/intro/

* TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	3	2	2	3	-	-	-	1	1	2	2	2	1
2	3	2	2	1	3	-	-	-	1	1	2	2	2	2
3	3	2	2	2	3	-	-	-	1	1	2	2	2	2
4	3	2	2	2	3	-	-	-	1	2	2	2	3	2
5	3	3	2	2	3	-	--		1	2	2	2	3	2

Correlation Level: 1 - Low, 2 - Medium, 3 – High

Evaluation Methods

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	CAT 1	CAT 2	Model Exam	Assignment*	Attendance		
Marks	5	5	5	5	5	75	100

* Application oriented / Problem solving / Design / Analytical in content beyond the syllabu

Department	**Biomedical Engineering**	Programme: **B.Tech.**						
Semester	**IV**	Course Category: **PC**			End Semester Exam Type: **TE**			
Course Code	**U23BMT405**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Biomechanics**	**3**	**0**	**0**	**3**	**25**	**75**	**100**
Prerequisite								

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Understand the fundamental principles of biomechanics	**K2**
	CO2 Analyse the deformability, strength of bone, modes of loading and failure	**K3**
	CO3 Analyse the elasticity and deformation properties of soft tissues	**K3**
	CO4 Explain the types and mechanics of skeletal joints	**K2**
	CO5 Know the locomotion principles of human body	**K2**

UNIT-I	**Introduction to biomechanics**	**Periods: 9**	
Scope of mechanics in medicine, mechanics of bone structure, determination of in-vivo elastic modulus. Biofluid mechanics, flow properties of blood.			**CO1**
UNIT-II	**Hard tissue biomechanics**	**Periods: 9**	
Hard Tissues: Bone structure and composition mechanical properties of bone, cortical and cancellous bones,viscoelastic properties, Maxwell and Voight models — anisotropy. Electrical properties of bone, type of fractures, biomechanics of fracture healing.			**CO2**
UNIT-III	**Soft tissue biomechanics**	**Periods: 9**	
Soft Tissues: Structure and functions of Soft Tissues: Cartilage, Tendon, Ligament, and Muscle; Material Properties: Cartilage, Tendon, Ligament, and Muscle; Modelling: Cartilage, Tendon, Ligament, and Muscle.			**CO3**
UNIT-IV	**Joints biomechanics**	**Periods: 9**	
Skeletal joints, forces and stresses in human joints, Analysis of rigid bodies in equilibrium, free body diagrams, types of joint, biomechanical analysis of elbow, shoulder, hip, knee and ankle.			**CO4**
UNIT-V	**Movement biomechanics**	**Periods: 9**	
Gait analysis, body and limbs- mass and motion characteristics actions, forces transmitted by joints. Joints forces results in the normal and disable human body, normal and fast gait on the level. Patterns: Push/Throw Continuum Biomechanics of push - like motions, Biomechanics of throw - like motions			**CO5**

Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 45**

Text Books

1. Gerhard A. Holzapfel, Ray W. Ogden, “Mechanics of Biological Tissue”, Springer, 2010.
2. Sean P. Flanagan and Flanagan, “Biomechanics: A case-based Approach”, Jones and Bartlett Publishers,2018.
3. Carol A. Oatis, “The Mechanics and Pathomechanics of Human Movement”, Lippincott Williams and Wilkins, 2010.

Reference Books

1. Ozkaya, N, Leger, D, Goldsheyder, D, Nordin, M, “Fundamentals of Biomechanics: Equilibrium, Motion,and

Deformation", 4th edition. Springer International Publishing, 2017.
2. Donald R. Peterson and Joseph D. Bronzino," Biomechanics: principles and applications", third edition.CRC Press, 2011.
3. Ray W. Ogden, "Biomechanics of Soft Tissue in Cardiovascular Systems", Springer Vienna, 2014.
4. Subrata Pal, "Text book of Biomechanics", Viva education Private limited, New Delhi. 2009
5. Susan J.Hall, "Basics Bio Mechanics" 5th Edition, McGraw-Hill Publishing Co, Newyork, 2007.

Web References

1. https://tinyurl.com/y9bm4f9q
2. https://tinyurl.com/y8osnq6d
3. https://tinyurl.com/y78y4cvy

* TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	2	2	2	2	2	-	-	1	1	2	3	2	1
2	3	3	3	2	3	2	-	-	1	2	2	3	3	2
3	3	3	3	2	3	2	-	-	1	2	2	3	3	2
4	3	2	2	2	2	2	-	-	1	1	2	3	2	1
5	3	2	2	1	2	2	-	-	1	1	2	3	2	1

Correlation Level: 1 - Low, 2 - Medium, 3 – High

Evaluation Methods

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	CAT 1	CAT 2	Model Exam	Assignment*	Attendance		
Marks	5	5	5	5	5	75	100

***** Application oriented / Problem solving / Design / Analytical in content beyond the syllabus

Department	**Biomedical Engineering**	Program: **B.Tech.**						
Semester	**IV**	Course Category: **PC**				End Semester Exam Type: **TE**		
Course Code	**U23BMT406**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Biomedical Instrumentation**	**3**	**0**	**0**	**3**	**25**	**75**	**100**
Prerequisite								

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Gain knowledge in electrodes and its functions.	**K2**
	CO2 Understand the different types of electrodes and its placement for various recordings.	**K3**
	CO3 Analyse bio amplifier and signal conditioning circuits.	**K4**
	CO4 Explain various techniques for non-electrical physiological measurements.	**K3**
	CO5 Investigate various assist and respiratory devices.	**K3**

UNIT – I	**BIOPOTENTIAL ELECTRODES**	**Periods:9**
Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Electrooculogram (EOG), Electroretinogram (ERG), Recording Electrodes – Electrode-tissue interface, polarization, skin contact impedance, motion artifacts, Silver-Silver Chloride electrodes, Electrodes for ECG, Electrodes for EEG, Electrodes of EMG, Electrical conductivity of electrode jellies and creams, microelectrodes, Needle electrodes		**CO1**

UNIT – II	**BIOPOTENTIAL MEASUREMENTS**	**Periods:9**
Bio signals characteristics – frequency and amplitude ranges. ECG – Einthoven „s triangle, standard 12 lead system, Principles of vector cardiography. EEG – 10-20 electrode system, unipolar, bipolar and average mode. EMG– unipolar and bipolar mode. Recording of ERG, EOG and EGG		**CO2**

UNIT – III	**SIGNAL CONDITIONING CIRCUITS**	**Periods:9**
Need for bio-amplifier - single ended bio-amplifier, differential bio-amplifier, Impedance matching circuit, isolation amplifiers – transformer and optical isolation - isolated DC amplifier and AC carrier amplifier., Power line interference, Right leg driven ECG amplifier, Band pass filtering		**CO3**

UNIT – IV	**MEASUREMENT OF NON-ELECTRICAL PARAMETERS**	**Periods:9**
Temperature, respiration rate and pulse rate measurements. Blood Pressure: indirect methods -Auscultatory method, oscillometric method, direct methods: electronic manometer, Pressure amplifiers, Systolic, diastolic, mean detector circuit. Blood flow and cardiac output measurement: Indicator dilution, thermal dilution and dye dilution method, Electromagnetic and ultrasound blood flow measurement.		**CO4**

UNIT – V	**ASSIST DEVICES AND RESPIRATORY DEVICES**	**Periods:9**
Pacemakers - Defibrillators – Audiometry – Hearing aid, Ventilators, Spirometer, Lung Volume and capacities, Pneumo tachometers: different types		**CO5**

Lecture Periods: 45	**Tutorial Periods:**	**Practical Periods: -**	**Total Periods: 45**

Text Books

1. R. S. Khandpur, “Biomedical Instrumentation Technology and Applications”, McGraw-Hill Professional, 2014.
2. Leshie Cromwell, Fred. J. Weibell and Erich. A. Pfeiffer, “Biomedical Instrumentation and Measurements”, 2nd edition. PHI, 2008.
3. Raja Rao, C and Guha S.K, “Principles of Medical Electronics and Biomedical Instrumentation”, Orient Longman Publishers, 2001

Reference Books

1. R. Anandanatarajan, “Biomedical Instrumentation”, 2nd edition, PHI Learning, 2016.
2. Andrew G. Webb, “Principles of Biomedical Instrumentation”, Cambridge University Press, 2018.
3. John G. Webster, “Medical Instrumentation: Application and Design”, 4th edition. John Wiley and Sons, New York, 2010.

4. A.K. Sawhney, “A Course in Electrical and Electronic measurements and Instruments”, DhanpatRai and Sons, 2015
5. M. Arumugam, “Biomedical Instrumentation”,Anuradha Agencies Publishers, 2002.

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1. https://apm.iitm.ac.in/biomedical/sai/
2. https://www.youtube.com/watch?v=iK-6q4nnmtA
3. https://www.youtube.com/watch?v=8m8yNSaCMpg

* TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	2	2	1	2	2	2		1	1	2	3	2	1
2	3	2	2	1	2	2	2		1	1	2	3	2	1
3	3	3	3	2	3		2		1	1	2	3	3	2
4	3	3	3	2	3	2	2		1	2	2	3	3	2
5	3	3	3	2	3	2	2		1	2	2	3	3	3

Correlation Level: 1 - Low, 2 - Medium, 3 – High

Evaluation Methods

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	CAT 1	CAT 2	Model Exam	Assignment*	Attendance		
Marks	5	5	5	5	5	75	100

* Application oriented / Problem solving / Design / Analytical in content beyond the syllabus

Department	**Biomedical Engineering**	Programme: **B.Tech.**						
Semester	**IV**	Course Category Code: **PC**			*End Semester Exam Type: **TE**			
Course Code	**U23BMB401**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Biosignal Processing**	**2**	**-**	**2**	**3**	**50**	**50**	**100**
Prerequisite								

Course Outcome	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Design and implement IIR digital filters	**K4**
	CO2 Design and implement FIR digital filters	**K4**
	CO3 Identify the process of analyzing ECG & EEG Signals	**K3**
	CO4 Implement the FIR and IIR filters in various applications	**K3**
	CO5 Simulates and analyses Bio signals	**K3**

UNIT-I	**Infinite impulse response filters**	**Periods:10**
Characteristics of commonly used analog filters - Butterworth filters, Chebyshev filters. Design of IIR filters from analog filters (LPF, HPF, BPF, BRF) - Approximation of derivatives, Impulse invariance method, Bilinear transformation. Frequency transformation in the analog domain. Structure of IIR filter - direct form I, direct form II, Cascade, parallel realizations.		**CO1**
UNIT-II	**Finite impulse response filters**	**Periods:10**
Design of FIR filters - symmetric and Anti-symmetric FIR filters - design of linear phase FIR filters using Fourier series method - FIR filter design using windows (Rectangular, Hamming and Hanning window), Frequency sampling method. FIR filter structures - linear phase structure, direct form realizations.		**CO2**
UNIT-III	**Biological signal processing**	**Periods:10**
Preprocessing of ECG signal, QRS detection Methods-Differentiation-based and template-based. Rhythm analysis and Arrhythmia detection algorithms, Automated ECG analysis, Correlation. Detection of EEG Rhythms, Template matching for EEG spike and wave detection, Sleep EEG classification and epilepsy. Medical Applications of Adaptive Noise Cancellation, Speech signal analysis.		**CO3**
UNIT- IV	**Impulse response filters**	**Periods:15**
List of Experiments 1.Generation of Discrete and Continuous time signals 2.Linear and Circular Convolution 3.Frequency analysis using DFT 4. IIR Filter Design 5. FIR Filter Design 6. Spectrum analysis and noise removal of biomedical signals		**CO4**
UNIT-V	**ECG Signal Processing**	**Periods:15**
List of Experiments 1. ECG Data Compression techniques 2. Detection of QRS Component from ECG signal 3. Analysis of PCG Signal 4. Analysis of EEG Signal 5. Speech signal analysis 6. Down sampling and up-sampling of ECG signals		**CO5**

Lecture Periods:30	Tutorial Periods:-	Practical Periods:30	Total Periods:60

Text Books

1. Rangayyan, R.M."Biomedical signal analysis (Vol. 33)", John Wiley & Sons,2015.
2. Reddy, D.C."Biomedical signal processing: principles and techniques". McGraw-Hill,2005
3. Willis J. Tompkins , "Biomedical Digital Signal Processing", Prentice-Hall of India Pvt. Ltd., 2012

Reference Books

1. Jonathan Wolpaw and Elizabeth Winter Wolpaw, "Brain-Computer Interfaces: Principles and Practice",Oxford University Press, 2012.
2. Monson H.Hayes, "Statistical Digital Signal Processing and Modeling", Wiley-India, 2010.
3. StephaneMallat, "Wavelet Tour of Signal Processing: The Sparse Way", Third edition. Academic Press, 2011.
4. Kayvan Najarian Robert Splinter "Biomedical Signal and Image Processing" by Taylor & Francis Group,LLC, Second edition. 2012
5. Li Tan , Jean Jiang "Digital Signal Processing fundamentals and Applications", Second edition,Academic Press, 2013

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1. https://www.youtube.com/watch?v=S_U-s27nPLE
2. https://www.youtube.com/watch?v=bFeYjFtSsrg
3. https://www.journals.elsevier.com/biomedical-signal-processing-and-control/recent-articles
4. https://www.classcentral.com/course/swayam-biomedical-signal-processing-10069
5. https://nptel.ac.in/content/syllabus_pdf/108105101.pdf

* TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	2	3	2	3	-	-	-	1	1	2	2	3	1
2	3	2	3	2	3	-	-	-	1	1	2	2	3	1
3	3	3	2	2	2	2	-	-	1	1	2	2	3	2
4	3	2	3	2	3	-	-	-	1	1	2	2	3	2
5	3	3	2	2	2	2	-	-	1	1	2	2	3	2

Correlation Level: 1 - Low, 2 - Medium, 3 – High

Evaluation Methods

Theory						
Assessment	Continuous Assessment Marks (CAM)				End Semester Examination (ESE) Marks	Total Marks
	CAT 1	CAT 2	Model Exam	Attendance		
Marks	5	5	5	5	75	60
	20 (to be weighted for 10 marks)				(to be weighted for 50 marks)	

Practical				
Continuous Assessment Internal Evaluation		**End Semester Internal Evaluation**		**Total Marks**
30(to be weighted for 10 marks)		**30 marks**		40
Conduction of Practical	15 marks	Procedure / Algorithms	5 marks	
Report	10 marks	Experiment / Program Execution	10 marks	
Viva-Voce	5 marks	Result / Output	10 marks	
Total	30 marks	Viva-Voce	5 marks	

Department	**English**	Programme: **B.Tech.**						
Semester	**IV**	Course Category: **HS**			*End Exam Type :**LE**			
Course Code	**U23ENPC02**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**General Proficiency- II**	**0**	**0**	**2**	**1**	**50**	**50**	**100**
Prerequisite	Basics of English Language							

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Infer ideas to attend international standardized test by broadening receptive and productive skills	**K2**
	CO2 Interpret the types of writing in different state of affairs	**K3**
	CO3 Acquire meticulous exposure in speaking and get rid of performance anxiety	**K2**
	CO4 Articulate the ideas and opinions effectively and coherently	**K2**
	CO5 Progress the skills to compete in various competitive exams like GATE, GRE, UPSC, etc.	**K4**

UNIT- I	**Career Skills**	**Periods:6**
Listening: Listening at specific contexts - Speaking: Demonstrative speaking practice using visual aids (charts, graphs, maps) - Reading: Read and Review -Newspaper, Advertisement, Company Handbooks, and Guidelines (IELTS based) - Writing: Integrated Writing Task (TOEFL) - Vocabulary: Synonyms and Antonyms (IELTS)		**CO1**
UNIT- II	**Corporate Skills**	**Periods:6**
Listening: Listening English news and reproducing in own words - Speaking: Team Presentation - Reading: Short texts and Longer Passages (cloze reading) - Writing: Analytical Writing: Analyzing an issue and Argument task (GRE based) - Vocabulary: Prefix and Suffix		**CO2**
UNIT- III	**Functional Skills**	**Periods:6**
Listening: Listening TED Talks - Speaking: Brainstorming & Individual Presentation - Reading: Text Completion (GRE Based) - Writing: Picture Inference - Vocabulary: Word Formation		**CO3**
UNIT- IV	**Transferrable Skills**	**Periods:6**
Listening: Listening Documentaries and making notes - Speaking: Mock Interview - Reading: Read texts on emerging trends - Writing: Agreeing & Disagreeing Essay (IELTS) - Vocabulary: Euphemism, Redundancy, Clichés and Intensifier.		**CO4**
UNIT-V	**Verbal Aptitude - Ii**	**Periods:6**
Transformational Grammar: Tenses, Change of Voice, Concord **Verbal Ability Enhancement:** Letter Series, Coding &Decoding, Sentence Equivalence (GRE)Analytical Reasoning and Logical Reasoning (GATE), Syllogism, One-word Substitution, Jumbled Sentences		**CO5**

Lecture Periods: -	**Tutorial Periods: -**	**Practical Periods:30**	**Total Periods:30**

Reference Books

1. Cullen, Pauline, Amanda French, and Vanessa Jakeman**.** “The official Cambridge guide to IELTS for academic & general training”.Cambridge, 2014.
2. Prasad, Hari Mohan, Sinha, Uma Rani, “Objective English for Competitive Examinations”, Tata Mc Graw Hill: Noida,2010.
3. Lougheed, Lin. “Barron's Writing for the TOEFL IBT: With Audio CD”. Barron's Educational series, 2008.
4. Grussendorf, Marion, “English for Presentations”, Oxford University Press, Oxford, 2007.
5. Murphy, Raymond English Grammar in Use with answers: Reference and Practice for Intermediate students, Cambridge: CUP,2004.

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1. https://www.englishclub.com/grammar/nouns-compound.htm
2. https://lofoya.com/Verbal-Test-Questions-and-Answers/Sentence-Completion/l3p1
3. https://www.grammarwiz.com/phrases-and-clauses-quiz.html
4. https://www.clarkandmiller.com/25-english-euphemisms-for-delicate-situations/
5. http://www.englishvocabularyexercises.com/general-vocabulary/

***** TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	2	-	2	2	-	-	1	2	-	3	2	2	-
2	2	3	-	2	1	-	-	-	3	-	2	2	2	-
3	1	2	-	1	-	-	2	3	3	2	2	-	-	-
4	2	2	-	2	-	-	2	2	3	2	2	-	-	-
5	3	3	-	3	2	-	-	1	2	2	3	3	3	-

Correlation Level: 1 - Low, 2 - Medium, 3 – High

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	Performance in practical classes			Model Practical Examination	Attendance		
	Conduction of practical	Record work	viva				
Marks	15	5	5	15	10	50	100

Department	**Computer Science Engineering**	Programme: **B.Tech.**						
Semester	**IV**	Course Category: **ES**			*End Semester Exam Type: **LE**			
Course Code	**U23CSPC02**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Data Structures Laboratory**	**0**	**0**	**2**	**1**	**50**	**50**	**100**

(Common to all Branches Except CSBS and FT)

Prerequisite	Basic Programming Knowledge	
Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Analyse the algorithm's / program's efficiency in terms of time and space complexity.	**K3**
	CO2 Solve the given problem by identifying the appropriate Data Structure.	**K3**
	CO3 Solve the problems of searching and sorting techniques.	**K3**
	CO4 Solve problems in linear Data Structures.	**K4**
	CO5 Solve problems in non-linear Data Structures.	**K4**

List of Exercises:

1. Write a C program to implement recursive and non-recursive i) Linear search ii) Binary Search.
2. Write a C program to implement i) Bubble sort ii) Selection sort iii) Insertion sort iv) Shell sort v) Heap sort.
3. Write a C program to implement the following using an array. a) Stack ADT b) Queue ADT
4. Write a C program to implement list ADT to perform following operations a) Insert an element into a list.
   a) Delete an elementfrom list b) Search for a key element in list c) count number of nodes in list.
5. Write a C program to implement the following using a singly linked list. a) Stack ADT b) Queue ADT.
6. Write a C program to implement the dequeue (double ended queue) ADT using a doubly linked list and an array.
7. Write a C program to perform the following operations:
   a) Insert an element into a binary search tree.
   b) Delete an element from a binary search tree.
   c) Search for a key element in a binary search tree.
8. Write a C program that use recursive functions to traverse the given binary tree in
   a) Preorder b) Inorder c) Postorder.
9. Write a C program to perform the AVL tree operations.
10. Write a C program to implement Graph Traversal Techniques.
11. Write a C program to implement the Set operations.

Union b) Intersection c) Difference.

Lecture Periods: -	**Tutorial Periods: -**	**Practical Periods: 30**	**Total Periods: 30**

Reference Books

1. Yashavant Kanetkar, "Data Structures through C", BPB Publications, 3rd Edition, 2019.
2. Tenebaum Aaron M, "Data Structures using C', Pearson Publisher, 1st Edition, 2019.
3. Manjunath Aradhya M and Srinivas Subramiam, "C Programming and Data Structures", Cengage India 1st Edition, 2017.
4. Reema Thareja, "Data structures using C", Oxford University, 2nd Edition, 2014.

Gav.pai, “Data Structures and Algorithms”, McGraw-Hill India, 1st Edition, 2013.

Web References

1. https://www.tutorialspoint.com/data_structures_algorithms/
2. https://www.w3schools.in/data-structures-tutorial/intro/
3. https://nptel.ac.in/courses/106103069/
4. https://swayam.gov.in/nd1_noc20_cs70/preview
5. https://nptel.ac.in/courses/106103069

* TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	3	-	2	3	-	-	-	1	-	2	2	3	-
2	3	3	2	2	3	-	-	-	1	-	2	3	3	-
3	3	3	2	2	3	-	-	-	1	-	2	3	2	-
4	3	3	2	2	3	-	-	-	1	-	2	3	2	-
5	3	3	2	2	3	-	-	-	1	-	2	3	3	2

Correlation Level: 1 - Low, 2 - Medium, 3 – High

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	Performance in practicalclasses			Model Practical Examination	Attendance		
	Conduction of practical	Record work	viva				
Marks	15	5	5	15	10	50	100

Department	**Biomedical Engineering**	Programme : **B.Tech.**					
Semester	**IV**	Course Category: **PC**			*End Semester Exam Type: **LE**		
Course Code	**U23BMP404**	Periods/Week			Credit	Maximum Marks	
		L	T	P	C	CAM	ESE
Course Name	**Biomedical Instrumentation Laboratory**	**0**	**0**	**2**	**1**	**50**	**50**

Prerequisite

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
CO1	Determine the heart axis in different leads and analyse the heart rate	**K4**
CO2	Examine the blood pressure using sphygmomanometer	**K4**
CO3	Investigate cardiac efficiency test, tuning fork tests for hearing	**K4**
CO4	Explain the stimulation of eye, near point and near response	**K3**
CO5	Demonstrate Artificial respiration and Cardio Pulmonary Resuscitation	**K4**

LIST OF EXPERIMENTS

1. Determination of Heart Axis by measuring QRS amplitude in the different leads (Lead I, Lead II and Lead III) and Plotting Einthoven Triangle
2. Recording of blood pressure using sphygmomanometer and stethoscope
3. Measurement of Blood pressure using photo-plethysmography
4. Measurements of various time intervals between each segment of ECG, Measurement of R-R interval and calculation of Heart Rate
5. Cardiac Efficiency Test
6. Measurement of Visually Evoked Potential
7. Galvanic Skin Resistance (GSR) Measurement
8. Peripheral pulse signal in different physical posture
9. EMG Signal for different stress on the muscle
10. Recording and interpretation of Heart sounds
11. Demonstration of Artificial respiration and Cardiopulmonary Resuscitation
12. Determination of Nerve conduction velocity

Lecture Periods: -	**Tutorial Periods: -**	**Practical Periods: 30**	**Total Periods: 30**

Textbooks

1. A.K.Sawhney ,"A Course in Electrical and Electronic measurements and Instruments" Dhanpat Rai and Sons, 2000.
2. Leshie Cromwell, Fred. J. Weibell and Erich. A. Pfeiffer, "Biomedical Instrumentation and Measurements", 2nd edition. PHI, 2018.
3. Raja Rao, C and Guha S.K, "Principles of Medical Electronics and Biomedical Instrumentation", Orient Longman Publishers, 2001

Reference Books

1. R. Anandanatarajan, Biomedical Instrumentation. PHI Learning, 2009.
2. Andrew G. Webb, Principles of Biomedical Instrumentation. Cambridge University Press, 2018.
3. John G. Webster, "Medical Instrumentation: Application and Design", 4th edition. John Wiley and Sons, New York, 2010.

4. A.K. Sawhney, “A Course in Electrical and Electronic measurements and Instruments”, Dhanpat Rai and Sons, 2015
5. M. Arumugam, “Biomedical Instrumentation”, Anuradha Agencies Publishers, 2002.

Web References

1. https://www.uvpce.ac.in/content/biomedical-transducers-and-biosensors-laboratory
2. https://apm.iitm.ac.in/biomedical/sai/
3. https://www.electrical4u.com/introduction-to-biomedical-instrumentation/

* TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	3	2	2	2	-	-	-	2	-	2	3	3	-
2	3	3	2	2	2	2	-	-	2	-	2	3	2	-
3	3	3	2	3	2	-	-	-	2	-	2	3	3	-
4	3	2	2	2	2	-	-	-	2	-	2	3	2	-
5	3	2	3	2	2	3	2	2	3	2	2	3	2	3

Correlation Level: 1 - Low, 2 - Medium, 3 – High

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	Performance in practical classes			Model Practical Examination	Attendance		
	Conduction of practical	Record work	viva				
Marks	15	5	5	15	10	50	100

Department	**Biomedical Engineering**	Programme: **B.Tech.**						
Semester	**IV**	Course Category: **AEC**			*End Semester Exam Type:**LE**			
Course Code	**U23BMC4XX**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Certification Course – IV**	**0**	**0**	**4**	**-**	**100**	**-**	**100**

Students shall choose an international certification course offered by the reputed organizations like Google, Microsoft, IBM, Texas Instruments, Bentley, Autodesk, Eplan and CISCO, etc. The duration of the course is 40-50 hours specified in the curriculum, which will be offered through Centre of Excellence.

Pass /Fail will be determined on the basis of participation, attendance, performance and completion of the course. If a candidate Fails, he/she has to repeat the course in the subsequent years. Pass in this course is mandatory for the award of degree.

Lecture Periods:-	**Tutorial Periods: -**	**Practical Periods: 50**	**Total Periods:50**

Evaluation methods

Assessment	**Continuous Assessment Marks (CAM)**		**Total Marks**
	Attendance	**MCQ Test**	
Marks	10	90	100

Department	**Biomedical Engineering**	Programme: **B.Tech.**						
Semester	**IV**	Course Category: **AEC**			*End Semester Exam Type:			
Course Code	**U23BMS402**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Skill Enhancement Course 2***	**0**	**0**	**2**	**-**			**100**
Prerequisite								

Course Outcome	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Knowledge about electrical equipment that realize specified testing functions	**K2**
	CO2 Analyze the different types of testing in medical equipment	**K3**
	CO3 Understand the concept of PCB	**K2**
	CO4 Gain adequate knowledge of PCB designing	**K3**
	CO5 Acquire presentation skills using ICT	**K2**

Course Content:

Testing of Electronic and Medical Devices

MODULE 1: Testing of Electrical Equipment **(6 Hrs)**

AC, DC power supply, Grounding, shielding, Guarding, insulation testing, insulation resistance measurement, Types of Circuit Breakers, Rating – Testing of circuit breakers –Transformer testing- Earthing –Earth wires - Earthing of appliances –contactor, relay testing–CT and PT, Panel wiring- Megger-Testing equipment and instruments.

MODULE 2: Testing of Electronic Components **(6 Hrs)**

Troubleshooting of PCB boards, Calibration of analog and digital sensor probe, Display interface, DC Power supply design, testing, Safe electrical practice, Cables and standard, Fuse

MODULE 3: Testing of Surgical Equipment (Coursera) **(6 Hrs)**

Functions and operating procedure-Testing and maintenance of Heart lung machine, surgical lights, ventilator, patient monitor, anesthesia machine, dialyzer, surgical tools.

MODULE 4: Testing of ICU Equipment (Coursera) **(6 Hrs)**

X-ray machines, Testing of ECG recorders, incubator, baby warmer, infusion pumps, annual maintenance, contract requirements, vendor services, quality and safety standards.

MODULE 5: Life Cycle Management of Medical Equipment **(6 Hrs)**

Cost of the medical equipment, maintenance cost, replacement analysis, managing equipment service, decision making, extracting optimal benefit from medical equipment over its life cycle, Case study.

Lecture Periods:	**Tutorial Periods:**	**Practical Periods: 30**	**Total Periods:**

Reference Books

1. Joseph. J Carr, John M Brown, Introduction to Biomedical Equipment Technology, John Wiley& Sons, New York, 4th edition, 2008.
2. Keith Willson, Keith Ison, Slavik Tabakov, “Medical equipment management”, CRC Press, UK, 2014.
3. Jenny Dooley,John Lehnert Virginia Evans, “Career Paths: Medical Equipment Repair”, Express Publishing, UK,2018
4. Shakti Chatterjee, Aubert Miller, “Biomedical Instrumentation systems”, Cengage Learning Technology & Engineering, 2010.
5. David Herres, “Troubleshooting and Repairing Commercial Electrical Equipment”, McGraw Hill Professional edition, 2013.

Web References

1. https://www.element.com/connected-technologies/electronics-test-methods
2. https://www.electronics-notes.com/articles/test-method
3. https://www.element.com/more-sectors/medical-device
4. https://www.metlabs.com/industries/medical-device-testing/
5. https://www.intertek.com/medical/

PCB Board Designing:

MODULE 1: Introduction to PCB Designing Concepts (6 Hrs)

Introduction & Brief History - What is PCB, Difference between PWB and PCB, Types of PCBs: Single Sided (Single Layer), Multi-Layer (Double Layer), PCB Materials? Introduction to Electronic design Automation (EDA) - Brief History of EDA, Latest Trends in Market, How it helps and why it requires, Different EDA tools, Introduction to SPICE and PSPICE Environment, Introduction and Working of PROTEUS.

MODULE 2: Component Introduction and their Categories (6 Hrs)

Types of Components - Active Components, Passive Components, Component Package Types - Through Hole Packages: Axial lead o Radial Lead, Single Inline Package (SIP), Dual Inline Package (DIP), Transistor Outline (TO), Pin Grid Array(PGA), Through Hole Packages: Metal Electrode Face(MELF), Leadless Chip Carrier(LCC), Small Outline Integrated Circuit(SOIC), Quad Flat Pack(QPF) and Thin QFP (TQFP), Ball Grid Array(BGA), Plastic Leaded Chip Carrier(PLCC)

MODULE 3: Introduction to Development Tools (6 Hrs)

Introduction to PCB Design using OrCAD tool, Introduction to PCB Design using PROTEUS tool

MODULE 4: Detailed Description and Practical of PCB Designing (6 Hrs)

PCB Designing Flow Chart - Schematic Entry, Net listing, PCB Layout Designing, Prototype Designing - Design Rule Check (DRC), Design for Manufacturing (DFM), PCB Making - Printing, Etching, Drilling, Assembly of components. Description of PCB Layers - Electrical Layers, Mechanical Layers, Documentation Layers, PCB Materials, Rules for Track, Study of IPC Standards

MODULE 5: Designing and Fabrication Process (6 Hrs)

Starting the PCB designing, Understanding the schematic Entry, Creating Library & Components, Drawing a Schematic, Flat Design / hierarchical Design, Setting up Environment for PCB, Design a Board Auto routing - Introduction to Auto routing, Setting up Rules, Defining Constraints, Auto router Setup, PCB Designing Practice, Post Designing & PCB Fabrication Process.

Lecture Periods:	Tutorial Periods:	Practical Periods: 30	Total Periods:

Reference Books

1. Christopher T Robertson, Printed Circuit Board Designer's Reference; Basics, Prentice Hall Modern Semiconductor Design, 2003
2. Bosshart, Printed Circuit Boards: Design and Technology, Tata McGraw-Hill Education, 1983
3. R. S. Khandpur, Printed Circuit Boards, McGraw-Hills, 2005.
4. Charles A. Harper, High Performance Printed Circuit Boards, McGraw Hill Professional, 2000
5. Jon Varteresian, Fabricating Printed Circuit Boards, Newnes, 2002

Web References

1.https://www.electronics-notes.com/articles/analogue_circuits/pcb-design/how-to-design-pcb-board-basics.php
2.https://www.circuitbasics.com/make-custom-pcb/
3.https://learn.sparkfun.com/tutorials/pcb-basics/all
4.https://www.pcbpower.com/
5.https://www.build-electronic-circuits.com/pcb-design/

Presentation Skills using ICT:

The methodology used is “learning by doing”, a hands-on approach, enabling the students to follow their own pace. The teacher, after explaining the project, became a tutor, answering questions and helping students on their learning experience.

CT skills

- Understand ICT work flow in cloud computing.
- Manage multitasking.
- Deal with main issues using technology in class.
- Record, edit and deliver audio and video.
- Automate assessments and results.

Teaching tools

- Different ways to create audio visual activities.
- Handle audio visual editors.
- Collaborative working.
- Individualize learning experience.
- Get instant feedback from students.

Each one of the students will be assigned an ICT Topic and the student has to conduct detailed study and have to prepare a report, running to15 or 20 pages for which a demo to be performed followed by a brief question and answer session. The demo will be evaluated by the internal assessment committee for a total of100marks. The marks attained or this course is not considered for CGPA calculation.

Evaluation methods

Assessment	Continuous Assessment Marks (CAM)			Total Marks
	Attendance	MCQ Test	Presentation / Activity / Assignment	
Marks	10	30	60	100

Department	**Biomedical Engineering**	Programme: **B.Tech.**					
Semester	**IV**	Course Category: **MC**			*End Semester Exam Type:-		
Course Code	**U23BMM404**	Periods/Week			Credit	Maximum Marks	
		L	T	P	C	CAM	ESE	TM
Course Name	**Right To Information and Good Governance**	**2**	**0**	**-**	**-**	**100**	**-**	**100**

UNIT- I	**Introduction**	**Periods:6**

Conceptual background - Right to know - Open Government - Transparency in governance and accountability - Right to information under the Indian Constitution - Article 19 (1)(a) and Article 21 of the Constitution - Role of NGOs and movement for right to information - Right to Information Act, 2005 - Scope and objectives.

UNIT- II	**Obligation of Public Authorities**	**Periods:6**

Obligations of public authorities: Section 4
Designation of Public Information Officers: Section 5
Disposal of request: Section 7
Exemption from disclosure of information: Section 8
Grounds for rejection to access in certain cases: Section 9
Severability: Section 10
Third party information: Section 11

UNIT- III	**Central and State Information Commission**	**Periods:6**

Constitution of Central and State Information Commissions
Terms of office and conditions of service
Removal of Chief Information Commissioner or Information Commissioner.
Powers and functions of Information Commissions.

UNIT- IV	**Judiciary and Right to Information Act**	**Periods:6**

Protection of right to access the information - Role of the Supreme Court and High Courts Recent attempts of dilution of the right to information Law

UNIT-V	**Right to Information Act, 2005 and its relevance to other laws**	**Periods:6**

Public Records Act, 1993
Whistle Blowers Protection Act, 2014
Official Secrets Act, 1923

Lecture Periods:-	**Tutorial Periods: -**	**Practical Periods:50**	**Total Periods:50**

* TE – Theory Exam, LE – Lab Exam

Evaluation methods

Assessment	**Continuous Assessment Marks (CAM)**		**Total Marks**
	Attendance	**MCQ Test**	
Marks	10	90	100

Dr. A.Vijayalakshmi B.Tech. Biomedical Engineering

PROFESSIONAL ELECTIVE - I

Department	**Biomedical Engineering**	Programme: **B.Tech**						
Semester	**IV**	Course Category: **PE**			End Semester Exam Type:- **TE**			
Course Code	**U23BME401**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Medical Physics**	**3**	**0**	**0**	**3**	**25**	**75**	**100**
Prerequisite	**-**							

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Comprehend the significance and role of non-ionizing radiation in Medical Applications	**K2**
	CO2 Understand radioactive decay and production of radio nuclides.	**K2**
	CO3 Understand the concepts of different interaction of radiation with matter	**K2**
	CO4 Discuss the measurement of ionizing radiation	**K3**
	CO5 Enumerate the effect of ionizing radiation in human body	**K3**

UNIT-I	**Nonionizing Radiation and its Medical Application**	**Periods: 09**
Light- Physics of light, Intensity of light color vision and limits of vision sound - Normal sound levels – Ultrasound fundamentals- Generation of ultrasound (Ultrasound Transducer) Interaction of Ultrasound with Materials- Reflection and Refraction – Absorption and Scattering Nonionizing Electromagnetic Radiation, Tissue as a leaky dielectric — Relaxation process- overview of non-ionizing radiation effects- low frequency effect- high frequencyeffect.		**CO1**
UNIT-II	**Principles of Radioactive Nuclides**	**Periods: 09**
Radioactive Decay – Spontaneous Emission – Isometric Transition – Gamma ray emission, alpha, beta, Positrondecay, electron capture, Sources of Radioisotopes Natural and Artificial radioactivity, Radionuclide used in Medicine and Technology, Decay series, Production of radionuclides – Cyclotron produced Radionuclide- Reactor produced Radionuclide- fission and electron Capture reaction, radionuclide Generator-Milking process – Linearaccelerator.		**CO2**
UNIT-III	**Interaction of Radiation with Matter**	**Periods: 09**
Interaction of charged particles with matter –Specific ionization, Linear energy transfer range, Bremsstrahlung, Annihilation, Interaction of Gamma radiation with matter- Photoelectric effect, Compton Scattering, Pair production, Attenuation of Gamma Radiation, Interaction of neutron with matter and their clinical significance.		**CO3**
UNIT-IV	**Principles of Radiation Detection and Dosimeters**	**Periods: 09**
Principles of radiation detection, Properties of dosimeters, Theory of gas filled detectors, Ionization Chamber, Proportional chamber, G.M. Counter, Film dosimetry, luminescence dosimetry, scintillation detectors, Radiation detection instruments, Area survey meters, Personal Radiation monitoring device, Film badge.		**CO4**
UNIT-V	**Radiation Effects**	**Periods: 09**
Acute Radiation Effects - The concept of LD 50 – Radiation syndromes- Central nervous system syndrome - Gastro intestinal syndrome –Bone Marrow syndrome Delayed Effects of Radiation -Stochastic and Deterministic effects Late Deterministic effect in different organs and tissues.		**CO5**

Lecture Periods: -45	**Tutorial Periods: -**	**Practical Periods:**	**Total Periods: 45**

Text Books

1. Gopal B. Saha "Physics and Radiobiology of Nuclear Medicine", Fourth Edition, Springer, 2013.
2. ThayalanKuppusamy, "Basic Radiological Physics" Second Edition, Jaypee Brothers Medical Publishers, 2017.
3. Kwan Hoong Ng, "Problem and solutions in Medical Physics: Diagnostic imaging Physics", Third volume, CRC press, 2011.

Reference Books

1. Muhammad Maqbool," An Introduction to Medical Physics", Springer, 2018.
2. SlavikTabakov, "Encyclopedia of Medical Physics", volume 1, CRC press, 2012.
3. Andrew Webb, Nadrine Barrie Smith, "Introduction to Medical Imaging:Physics, Engineering and ClinicalApplications, Cambridge University press, 2010.
4. Faiz M Khan,"Khan"s Lecture: Handbook of the Physics of Radiation Therapy", 2011.
5. Faiz M Khan, John P Gibbons, "Khan"s the physics of Radiation Therapy" Fifth Edition, 2014.

Web References

1. https://g.co/kgs/CBBKUU
   https://en.m.wikipedia.org/wiki/Medical_physics
2. https://www.medphys.org/
3. https://physicsworld.com/c/medical-physics/
4. https://www.classcentral.com/course/medical-applications-particle-accelerato-12557

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	2	-	-	2	2	-	-	-	-	2	3	2	-
2	3	2	-	-	2	2	-	-	-	-	2	3	2	-
3	3	3	-	2	2	1	-	-	-	-	2	3	3	-
4	3	2	2	3	3	2	2	-	1	-	2	3	3	2
5	3	2	-	2	1	3	3	-	-	-	2	3	2	1

Evaluation Methods

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	CAT 1	CAT 2	Model Exam	Assignment*	Attendance		
Marks	5	5	5	5	5	75	100

Department	**Biomedical Engineering**	Programme: **B.Tech.**						
Semester	**IV**	Course Category: **PE**			End Semester Exam Type: **TE**			
Course Code	**U23BME402**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Environmental Biotechnology**	**3**	**1**	**0**	**3**	**25**	**75**	**100**
Prerequisite								

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Gain knowledge in the basic concepts of environmental biotechnology	**K2**
	CO2 Familiarize with the biodegrading and bioremediation modules and its functions	**K2**
	CO3 Describe the principles of microbiological treatment technologies to clean up contaminated environments.	**K3**
	CO4 Explain the replacement of conventional treatment methodologies by using biocatalyst and bioreactors	**K2**
	CO5 Understand the various bioproducts production and composting technology	**K3**

UNIT – I	**Introduction**	**Periods:9**
Biotechnology in the reduction of carbon dioxide emission- Microbial flora of soil - Microbial treatment of heavy Metal — bioleaching, bioaccumulation, biosorption and bioprecipitation Understand the various bioproducts production and composting technology of heavy metals - Soil, water and air - sources and effects - Removal of Pollutants.		**CO1**
UNIT – II	**Biodegradation and Bioremediation**	**Periods:9**
Aerobic degradation of aliphatic and aromatics compounds - Anaerobic degradation of aromatic compounds - Biodegradation of herbicides and pesticides - Remediation Technologies - Bioventing, bio sparging and bio slurping, phytoremediation – Bio desulphurization of coal and oil - microbial treatment of oil pollution.		**CO2**
UNIT – III	**Microbial Treatment of Waste and Waste Water**	**Periods:9**
Biological treatment of anaerobic and aerobic- methanogenesis, methanogenic, acetogenic- Use of genetically engineered organisms - Biotechnological Processes in waste - water treatment; Applications include treatment of municipal and industrial wastewaters.		**CO3**
UNIT – IV	**Biocatalysts and Bioreactors**	**Periods:9**
Enzymes isolation, whole cell systems - Biocatalytic Application - Advantages & Disadvantages- Design of activatedsludge process and anaerobic digestion system - Trickling Filter - Rotating biological contactors - Fluidized bed reactor - Up-flow anaerobic sludge blanket reactor (UASB) - High-rate anaerobic waste water treatment.		**CO4**
UNIT – V	**Bioproducts and Renewable Sources**	**Periods:9**
Biofertilizers – Biopesticides - Biofuel production – Bioethanol – Biohydrogen – Biodiesel - Bioplastics and biopolymers - Composting technologies, composting systems, compost quality.		**CO5**

Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 45**

Text Books

1. Bhattacharya B. C. and Banerjee R, " Environmental Biotechnology", Oxford University Press, 2017.
2. Jordening H. J. and Winter J., "Environmental Biotechnology: Concepts and Application", Wiley ,2015.
3. Bruce Rittmann and Perry McCarty," Environmental Biotechnology", McGraw-Hill, 2011.

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1. W.D. Grant & P.E. Long, Blakie, Environmental Microbiology, Springer, 2019.
2. H. Polasa, Microbial Gene Technology, South Asian Publishers, 2011.
3. D. L. Wise, Biotreatment Systems. CRC Press, 2010.

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1. https://en.wikipedia.org/wiki/Environmental_biotechnology
2. http://dbtindia.gov.in/schemes-programmes/research-development/energy-environment-and-bio- resource-based-applications-0
3. https://www.hindawi.com/journals/scientifica/si/269412/

* TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	2	-	-	-	2	-	-	1	-	2	3	2	-
2	3	3	-	2	2	3	-	-	1	-	2	3	3	-
3	3	3	2	3	2	2	-	-	1	-	2	3	3	2
4	3	3	3	3	3	2	-	-	1	-	2	3	3	2
5	3	2	3	2	2	3	1	-	2	1	3	3	2	2

Correlation Level: 1 - Low, 2 - Medium, 3 – High

Evaluation Methods

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	CAT 1	CAT 2	Model Exam	Assignment*	Attendance		
Marks	5	5	5	5	5	75	100

Department	**Biomedical Engineering**	Programme: **B.Tech.**						
Semester	**IV**	Course Category: **PE**			End Semester Exam Type: **TE**			
Course Code	**U23BME403**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Biometric Recognition Systems**	**3**	**0**	**0**	**3**	**25**	**75**	**100**
Prerequisite								

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Understand the knowledge of engineering principles underlying biometric systems	**K2**
	CO2 Apply algorithms to model finger print	**K3**
	CO3 Classify different face recognition and hand geometry pattern	**K3**
	CO4 Analyze the design and performance of biometrics	**K3**
	CO5 Explain various computations of authentication methods	**K2**

UNIT – I	**Introduction to Biometrics**	**Periods:9**
Introduction and background – biometric technologies – passive biometrics – active biometrics - Biometric systems — Enrollment — templates — algorithm — verification — Biometric applications — biometric characteristics- Authentication technologies –Need for strong authentication - Protecting privacy and biometrics and policy – Biometric applications — biometric characteristics.		**CO1**
UNIT – II	**Fingerprint Technology**	**Periods:9**
History of fingerprint pattern recognition - General description of fingerprints - Finger print feature processing techniques - fingerprint sensors using RF imaging techniques – fingerprint quality assessment – computer enhancement and modeling of fingerprint images – fingerprint enhancement – Feature extraction – fingerprint classification — fingerprint matching		**CO2**
UNIT – III	**Face Recognition and Hand Geometry**	**Periods:9**
Introduction to face recognition, Neural networks for face recognition – face recognition from correspondence maps Hand geometry – scanning – Feature Extraction - Adaptive Classifiers - Visual-Based Feature Extraction and Pattern Classification - feature extraction – types of algorithms – Biometric fusion.		**CO3**
UNIT – IV	**Multimodal Biometrics and Performance Evaluation**	**Periods:9**
Voice Scan – physiological biometrics –Behavioral Biometrics - Introduction to multimodal biometric system – Integration strategies – Architecture – level of fusion – combination strategy – training and adaptability – examplesof multimodal biometric systems – Performance Evaluation-Statistical Measures of Biometrics – FAR – FRR – FTE EER – Memory requirement and allocation.		**CO4**
UNIT – V	**Biometric Authentication**	**Periods:9**
Introduction - Biometric Authentication Methods - Biometric Authentication Systems – Biometric authentication by fingerprint - Biometric Authentication by Face Recognition. Expectation-Maximization theory - Support Vector Machines. Biometric authentication by fingerprint – biometric authentication by hand geometry- Securing and trusting a biometric transaction – matching location – local host - authentication server – match on card (MOC) – Multibiometrics and Two-Factor Authentication. Voice and Gait authentication.		**CO5**

Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 45**

Textbooks

1. Joseph N. Pato, Lynette I. Millette, “Biometric Recognition: Challenges and Opportunities”, 2010.
2. Zhenan Sun, Jianhuang Lai, Xilin Chen, Tieniu Tan, “ Biometric Recognition” Sixth Chinese conference, 2011.
3. Anil Kumar Jain, Arun A Ross, KarthikNandakumar, “Introduction to Biometrics”, Springer, 2011.

Reference Books

1. Ravi Das, “Biometric Technology: Authentication, Biocryptography and cloud based architecture”, CRC Press, 2014.
2. Sebastien Marcel, Mark S Nixon, Stan Z. Li, “Handbook of Biometric Anti- spoofing”, Springer, 2014.
3. Mohammad S Obaidat, IssaTraoreIssacWoungang, “Biometric- Based Physical and cybersecurity systems”, Springer, 2018.

4. Amine Nait-ali, “Hidden Biometrics when biometric security meets Biomedical Engineering”, Springer, 2019.
5. Ted Dunstone, “Biometric system and Data Analysis”, Springer, 2010.

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1. https://www.mooc-list.com/tags/biometric
2. https://www.coursera.org/lecture/usable-security/biometric-authentication-RXVog
3. https://www.udemy.com/course/biometrics/
4. https://nptel.ac.in/courses/106/104/106104119/
5. http://www.scholarpedia.org/article/Biometric_authentication

* TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	2	-	-	2	-	-	-	1	-	2	3	2	-
2	3	3	2	2	3	-	-	-	1	-	2	3	3	2
3	2	3	2	2	3	-	-	-	1	-	2	3	3	2
4	2	3	3	3	3	-	-	-	1	-	2	3	3	2
5	2	3	2	3	3	2	1	-	2	1	3	2	3	2

Correlation Level: 1 - Low, 2 - Medium, 3 – High

Evaluation Methods

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	CAT 1	CAT 2	Model Exam	Assignment*	Attendance		
Marks	5	5	5	5	5	75	100

Department	**Biomedical Engineering**	Programme: **B.Tech.**						
Semester	**IV**	Course Category: **PE**			End Semester Exam Type: **TE**			
Course Code	**U23BME404**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Hospital Equipment Safety and Management**	**3**	**0**	**0**	**3**	**25**	**75**	**100**
Prerequisite								

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Assess practice-based learning and improvement in quality and health policies for patients	**K2**
	CO2 Increase the trend for developing educational interventions in patient safety	**K2**
	CO3 Know the necessity of improving standard and quality of the hospital	**K2**
	CO4 Gain the roles and responsibilities of hospital staffs in various functions of hospital	**K3**
	CO5 Able to reach the hospital management standard for the patient safety	**K4**

UNIT – I	**Clinical Engineering**	**Periods:9**
Clinical engineering program, Educational responsibilities, Role to be performed by them in hospital, Staff structure in hospital — HIS. Need for evolving health policy, Health organization in state, Health financing system, Health education, Health insurance, Health legislation.		**CO1**
UNIT – II	**Hospital and Industrial Organization**	**Periods:9**
Difference between hospital and industrial organization, Levels of training, Steps of training, Developing training program, Evaluation of training, Wages and salary, Employee appraisal method.		**CO2**
UNIT – III	**Standardization**	**Periods:9**
Necessity for standardization, Indian Standards, FDA, AERB, Joint Commission of Accreditation of hospitals, ICRP and other standard organization, methods to monitor the standards.		**CO3**
UNIT – IV	**Strategic Management in Hospitals**	**Periods:9**
Nature and value of strategic management in hospitals - Awareness on the application of IT in Various functions of Hospital. Application of statistical tools in the areas of Health services. Introduction to support services — Disaster management, Ambulance services, Laundry services, Civil Assets.		**CO4**
UNIT – V	**Safety Measures**	**Periods:9**
Elements of Safety - Safety Publications and Standards Organizations - Orientation to Laboratory Safety - Types of risks in the hospitals - factors of environment - Safety showers and Eye Washes — Radiation hazards — radiationdetection — safety measures — standards. Ergonomics - Flammables and Explosives — Formaldehydes - PEL Standards and Calculations - Material Safety - Organization of Safety in the hospitals.		**CO5**

Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 45**

Textbooks

1. Joydeep Das Gupta, “Hospital Administration and Management: A Comprehensive Guide”, Jaypee Brothers Medical Publishers, 2015.
2. Saxena.M, “Hospital Management”, CBS Publishing, First edition, 2016.
3. Girdhar J Gyani and Alexander Thomas, “Handbook of Healthcare quality and patient safety” Second edition,Jaypeebrothers medical publisher, 2019.

Reference Books

1. Sonu Dr. Goel, “Textbook of Hospital Administration”, Elsevier, 2014.
2. William Charney,”Handbook of Modern Hospital Safety”, CRC press, Second edition, 2010.
3. Ramani. K. V, “Hospital Management”, Pearson, 2011.
4. Arnold D. Kalcizony& Stephen M. Shortell, “Health Care Managementll”, Sixth Edition,Cengage Learning, 2011.
5. Cindy Taylor, “The Hospital Safety Professional"s Handbook”, Fifth Edition, 2015.

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1.	https://en.wikipedia.org/wiki/Medical_equipment_management
2.	http://www.who.int/hac/techguidance/preparedness/hospital_safety_index_forms.pdf
3.	https://www.who.int/news-room/fact-sheets/detail/patient-safety
4.	https://www.coursera.org/browse/health/healthcare-management
5.	https://www.who.int/management/newitems/en/index1.html

* TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	2	-	2	-	3	2	1	2	2	3	2	-	-
2	2	2	-	-	-	3	2	1	2	1	3	2	-	-
3	2	3	2	2	1	3	2	1	2	2	3	3	1	-
4	2	2	2	2	2	2	1	3	3	3	3	2	-	2
5	2	2	3	2	1	3	2	2	3	3	3	2	1	2

Correlation Level: 1 - Low, 2 - Medium, 3 – High

Evaluation Methods

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	CAT 1	CAT 2	Model Exam	Assignment*	Attendance		
Marks	5	5	5	5	5	75	100

Department	**Biomedical Engineering**	Programme: **B.Tech.**						
Semester	**IV**	Course Category: **PE**			End Semester Exam Type: **TE**			
Course Code	**U23BMECO1**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Communication Systems**	**3**	**0**	**0**	**3**	**25**	**75**	**100**
Prerequisite								

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
CO1	Understand the various Analog modulation techniques	**K2**
CO2	Gain knowledge in Digital modulation techniques	**K2**
CO3	Knowledge about fiber optic and satellite communication systems	**K2**
CO4	Analyse spread spectrum and multiple access techniques	**K3**
CO5	Realize the importance of radio communication	**K2**

UNIT – I	**Analog Modulation**	**Periods:9**
Need for modulation - Amplitude modulation – Frequency spectrum of AM wave – Representation of AM –Power relation – Frequency modulation – Frequency spectrum of FM wave –AM transmitter – FM transmitter – Super heterodyne AM receiver –FM receivers.		**CO1**
UNIT – II	**Digital Modulation**	**Periods:9**
Principles of pulse modulation – sampling theorem, PAM, PWM, PPM, Conversion of PWM wave to PPM wave – Generation of PAM, PPM and PWM waves – Demodulation of PAM, PWM, PPM – An introduction todigital modulation systems – PCM, DPCM, Delta Modulation, ADM, ASK, FSK and PSK.		**CO2**
UNIT – III	**Fiber Optic and Satellite Communication**	**Periods:9**
Need for fiber optics- principle of light transmission through a fiber- fiber classification-fiber losses- Light sources and photo detectors- Block diagram of a fiber optic system - Power budget analysis for an optical link- Recent medical application of fiber optics. Block diagram of a satellite communication system, Satellite Orbits, satellite parameters, satellite link model, GPS services.		**CO3**
UNIT – IV	**Spread Spectrum and Multiple Access Techniques**	**Periods:9**
Pseudo-noise sequence, DS spread spectrum, FH spread spectrum, multiple access techniques –TDMA andFDMA, source coding of speech for wireless communication.		**CO4**
UNIT – V	**Radio Communication**	**Periods:9**
Advanced Mobile Phone System (AMPS) - Global System for Mobile Communications (GSM) – Code division multiple access (CDMA) – Cellular Concept and Frequency Reuse – Channel Assignment and Hand off- Introduction to 4G & 5G technologies		**CO5**

Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 45**

Text Books

1. Wayne Tomasi, “Advanced Electronic Communication Systems”, Sixth Edition, Pearson Education, 2010.
2. Kennedy Davis, “Electronic Communication Systems”, Fifth Edition,Tata McGraw Hill Publishing CompanyLimited, New Delhi, 2011.
3. William C.Y. Lee, “Mobile Cellular Telecommunication Systems”, McGraw Hill International Edition, Third edition, 2008.

Reference Books

1. Simon Haykin, “Communication Systems”, Fourth Edition, John Wiley and Sons, 2009.
2. Rappaport T.S, "Wireless Communications: Principles and Practice", Second Edition, PearsonEducation, 2010
3. H.Taub, D L Schilling and G Saha, “Principles of Communication”, Third Edition, Pearson Education,2010
4. B. P.Lathi, “Modern Analog and Digital Communication Systems”, Third Edition, Oxford University Press,2009
5. Martin S.Roden, “Analog and Digital Communication System”, Fifth Edition, Prentice Hall of India, 2012.

Web References	
1.	https://nptel.ac.in/courses/108104091/
2.	https://www.docsity.com/en/lecture-notes-of-intro-to-communication-systems/4580827/
3.	https://nptel.ac.in/courses/117/105/117105143/
4.	https://nptel.ac.in/courses/108104091/
5.	https://www.docsity.com/en/lecture-notes-of-intro-to-communication-systems/4580827/

* TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	2	-	-	2	-	-	-	1	-	2	3	-	-
2	3	2	-	-	2	-	-	-	1	-	2	3	2	-
3	3	2	2	2	3	1	-	-	1	-	2	3	2	2
4	3	3	2	3	3	-	-	-	1	-	2	3	3	2
5	3	2	-	-	2	2	-	1	2	1	2	3	3	2

Correlation Level: 1 - Low, 2 - Medium, 3 – High

Evaluation Methods

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	CAT 1	CAT 2	Model Exam	Assignment*	Attendance		
Marks	5	5	5	5	5	75	100

Department	**Management Studies**	Programme : **B.Tech.**						
Semester	**V**	Course Category Code: HS			*End Semester Exam Type: TE			
Course Code	**U23HSTC02**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Research Methodology**	**2**	**0**	**0**	**2**	**25**	**75**	**100**

(Common to All Branches)

Prerequisite	**Nil**	
Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Interpret the different types of research and explain how research methods can be used to address engineering problems.	**K2**
	CO2 Discuss the research problems, conduct comprehensive literature reviews, and utilize tools and services for effective information retrieval.	**K2**
	CO3 Apply appropriate methods to design experiments, analyze data, and interpret results using both numerical and graphical techniques.	**K3**
	CO4 Analyze and apply ethical guidelines to structure and write research papers and dissertations, ensuring academic integrity and avoiding plagiarism.	**K4**
	CO5 Examine the fundamentals of intellectual property rights to protect and enforce them, with emphasis on their role in fostering innovation and entrepreneurship in engineering.	**K3**

UNIT-I	**Introduction to Research**	**Periods: 6**
Meaning and Importance of Research, Types of Research: Overview of Basic, Applied, and Developmental Research, Overview of the Research Process, Defining a Research Problem: Key Considerations, Setting Research Objectives and Research Questions, Introduction to Research Design: Basic Concepts, Approaches to Research: Quantitative vs. Qualitative.		**CO1**
UNIT-II	**Problem Formulation and Literature Review**	**Periods: 6**
Identifying and Formulating Research Problems, conducting a Literature Review: Essential Steps, Referencing and Citation Methods: Basic Techniques. Sources of Information: Overview of Libraries and Online Databases.		**CO2**
UNIT-III	**Research Methods and Data Analysis**	**Periods: 6**
Introduction to Experimental Research, Developing Hypotheses: Basic Approach. Data Collection Methods:Sampling and Surveys, Basics of Data Analysis: Numerical and Graphical Analysis, Introduction to Inferential Statistics.		**CO3**
UNIT-IV	**Writing and Presenting Research**	**Periods: 6**
Preparing a Research Report: Key Sections (Abstract, Introduction, Methodology, Results, Discussion, Conclusion). Referencing and Citation: Brief Overview.		**CO4**
UNIT-V	**Ethics and Legal aspects in research**	**Periods: 6**
Ethical Considerations in Research: Introduction to Scientific Misconduct. Basics of Intellectual Property Rights - Introduction to Patents, Copyrights, and Trademarks – Case studies on ethical dilemmas in research.		**CO5**

Lecture Periods: 30	**Tutorial Periods:**	**Practical Periods:**	**Total Periods: 30**

Text Books

1. Kumar, R. “Research Methodology: A Step-by-Step Guide for Beginners”, SAGE Publications, 5th Edition 2019.
2. Ram Ahuja,” Research methods “. Rawat Publications. 2nd Edition ,2022
3. Creswell, J. W., and Creswell, J. D. “Research Design: Qualitative, Quantitative, and Mixed Methods Approaches”, SAGE Publications, 5th Edition, 2018.

Reference Books

1. Thiel, D. V. “Research methods for engineer”, Cambridge University Press”. 2014
2. Ganesan,.R. “Research methodology for engineers”, MJP Publishers. 2024.
3. Agarwal.C. & Sharma.V. ”Research methodology in sociology” ,Common wealth Publishers,2012
4. Thody, A.“Writing and presenting research SAGE Study Skills Series”, SAGE Publications,2006
5. Kothari CR. Research methodology – methods and techniques. 5th Edition, New Delhi: New Age International Publishers; 2023.

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1.	https://conjointly.com/kb/
2.	https://owl.purdue.edu/owl/research_and_citation/conducting_research/writing_a_literature_review.html
3.	https://files.eric.ed.gov/fulltext/ED536788.pdf
4.	https://researcheracademy.elsevier.com/
5.	https://www.wipo.int/
6.	https://www.scholastic.com /7-steps-to-successful-research-report.html
7.	https://www.futurelearn.com/info/courses/business-research-methods- investigation.
8.	https://articles.manupatra.com/article-details/Patent-Types-Laws-related-to-them-in-India

* TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	3	-	2	-	-	-	-	-	-	2	3	-	-
2	3	3	-	3	2	-	-	-	-	-	2	3	2	-
3	3	3	2	3	3	-	-	-	-	-	2	2	3	2
4	-	-	-	-	-	-	3	-	2	-	-	-	-	-
5	-	-	-	-	-	2	-	-	-	3	3	2	2	3

Correlation Level: 1 - Low, 2 - Medium, 3 – High

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	CAT 1	CAT 2	Model Exam	Assignment*	Attendance		
Marks	5	5	5	5	5	75	100

* Application oriented / Problem solving / Design / Analytical in content beyond the syllabus

Department	**Information Technology**	Programme: **B.Tech.**						
Semester	**V**	Course Category Code: **ES**			*End Semester Exam Type: **TE**			
Course Code	**U23ITTC02**	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Programming in Java**	**3**	**0**	**0**	**3**	**25**	**75**	**100**

(Common to All Branches)

Prerequisite	**Basic knowledge of Object-Oriented Programming Principles**	
Course Outcome	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Articulate the concept of Java fundamentals, OOPs and Strings	**K2**
	CO2 Demonstrate the principles of inheritance, packages and interfaces with real time applications	**K2**
	CO3 Create real time applications using exception handling and thread programming.	**K3**
	CO4 Build distributed applications using Collections and IO streams	**K3**
	CO5 Design and build simple GUI programs using AWT, Swings and build database applications	**K3**

Unit- I	**Introduction**	**Periods: 09**

Introduction: Java: History – Features – JVM - JRE – JDK – Java Compilation and Execution – Data Types - Variables, Types, Expressions, Assignment Statements, Input/Output Statements: Scanner/System class, Type Casting (Primitives to Primitives), Conditional and Iterative Control Structures - Arrays

OOPs with Java: Introduction to OOPs Concepts - Class – Objects – Methods - Access Modifiers – Creating Class and Objects, Object Life-Cycle - Garbage Collection-Constructors - this – static – Array of Objects – Nested Classes.

String: String Class– Built-in Methods – String Builder - String Buffer

CO1

Unit- II	**Inheritance, Interfaces and Packages**	**Periods: 09**

Inheritance: Types of Inheritance – is-a Relationship, has-a Relationship – super keyword – final keyword – Polymorphism - Method overloading and Method overriding – Abstract Class

Interfaces: Define – Extend – Implement – Access - Interfaces vs Abstract classes, Type Conversions (Primitives to Objects vice-versa): Autoboxing and Auto unboxing

Packages: Define – Create – Access – Import

CO2

Unit- III	**Exception Handling and Multithreading**	**Periods: 09**

Exception Handling: Exception Hierarchy – Checked and Unchecked Exceptions – try, catch, throws, throw and finally – User Defined Exceptions.

Multithreading: Thread – Life cycle – Defining and Running – Implementation Types – Thread Priorities – Thread Synchronization - Inter-Thread Communication

CO3

Unit- IV	**Collections and I/O Streams**	**Periods: 09**

Collections: List: Array List and Linked List. Set: Hash Set and Tree Set. Map: HashMap – Stack – Queue. Lambda Expressions.

I/O Streams: Streams – Byte Streams and Character Streams – File Input Stream and File Output Stream – File Reader and File Writer. Object Serialization : Object Input Stream and Object Output Stream

CO4

Unit- V	**GUI and JDBC**	**Periods: 09**

AWT: Components – Controls – Event Handling

SWING: Swing Components – Layout Management.

JDBC: JDBC Architecture – JDBC Driver Types – Implementation of JDBC.

CO5

Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 45**

Text Books

1. Allen B. Downey and Chris Mayeld, “Think Java - How to Think Like a Computer Scientist”, 2nd Edition, Green Tea Press, 2020
2. Herbert Schildt, “Java: The Complete Reference”, TMH Publishing Company Ltd, 11th Edition, 2018.
3. H.M.Dietel and P.J.Dietel, “Java How to Program”, 11th Edition, Pearson Education/PHI, 2017
4. Cay S. Horstmann, Gary Cornell, “Core Java Volume - I Fundamentals”, 9th Edition, Prentice Hall, 2013.

Reference Books

1. Sagayaraj, Denis, Karthik, Gajalakshmi, “JAVA Programming for core and advanced learners”, Universities Press Private Limited, 2018.
2. Poaul Deitel, Harvey Deitel, “Java SE 8 for programmers”, 3rd Edition, Pearson, 2015.
3. P.J. Dietel and H.M Dietel, “Java for Programmers”, Pearson Education, 9th Edition, 2011.
4. Steven Holzner, “Java 2 Black book”, Dreamtech Press, 2011.

Web References

1. https://www.javatpoint.com/java-tutorial
2. https://docs.oracle.com/en/java/
3. https://www.studytonight.com/java/
4. https://onlinecourses.nptel.ac.in/

* TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

Correlation Level: 1 - Low, 2 - Medium, 3 – High

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	2	-	-	2	-	-	-	2	-	2	3	-	-
2	3	2	2	-	2	-	-	-	2	-	2	3	2	-
3	3	2	3	2	3	-	-	-	2	-	2	3	3	2
4	3	2	2	3	3	-	-	-	2	-	2	3	3	2
5	3	2	3	2	3	2	-	-	3	3	2	3	3	3

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	CAT 1	CAT 2	Model Exam	Assignment*	Attendance		
Marks	5	5	5	5	5	75	100

*Application oriented / Problem solving / Design / Analytical in content beyond the syllabus

Department	**Biomedical Engineering**	Program: **B.Tech.**						
Semester	**V**	Course Category: **PC**			End Semester Exam Type: **TE**			
Course Code	**U23BMT507**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Microcontroller and its Medical Applications**	**3**	**0**	**0**	**3**	**25**	**75**	**100**
Prerequisite	**Digital Logic Circuits**							

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Understand the fundamental concepts of 8051 microprocessors	**K2**
	CO2 Apply knowledge in programming and interfacing of devices with Microcontroller	**K3**
	CO3 Interpret PIC Microcontroller based system design	**K3**
	CO4 Elucidate about peripheral devices and interfacing for data communication	**K4**
	CO5 Illustrate the applications of microcontroller in biomedical systems	**K3**

UNIT – I	**8051 Microcontroller**	**Periods:9**	
Architecture of 8051 – Pin diagram – Special Function Registers (SFRs) – I/O Pins Ports and Circuits – Addressing modes – Instruction set – Assembly language programming.			**CO1**
UNIT – II	**Interfacing microcontroller**	**Periods:9**	
Programming 8051 Timers – Serial Port Programming – Interrupts Programming – LCD and Keyboard Interfacing – ADC, DAC and Sensor Interfacing – External Memory Interface- Stepper Motor and Waveform generation.			**CO2**
UNIT – III	**PIC Microcontroller**	**Periods:9**	
General Introduction – PIC 18F4X2 architecture – Von Neumann Architecture and Harvard Architecture – Memory Organization – Addressing Modes – Instruction Set.			**CO3**
UNIT – IV	**Peripherals and Interfacing**	**Periods:9**	
GPIO programming – Timers Programming – Serial Communication – PWM programming– ADC, DAC and Sensor Interfacing - Stepper Motor			**CO4**
UNIT – V	**Medical Applications**	**Periods:9**	
Physiological monitoring: Microcontroller based ECG Machine - Pulse oximeter circuit using microcontroller – Design of EOG based home automation – **Design of Multipara monitoring system:** Temperature - Blood Pressure and Respiration rate.			**CO5**

Lecture Periods: 45	**Tutorial Periods:**	**Practical Periods: -**	**Total Periods: 45**

Text Books

1. A.K.Ray, K. M. Bhurchandi, “Advanced Microprocessor and Peripherals”, Tata McGraw Hill, 3rd Edition, 2013
2. Mohamed Ali Mazidi, Janice Gillispie Mazidi, Rolin McKinlay, “The 8051 Microcontroller and Embedded Systems: Using Assembly and C”, 2nd Edition, Pearson education, 2013
3. Muhammad Ali Mazidi, Rolin D. Mckinlay, Danny Causey ,” PIC Microcontroller and Embedded Systems using Assembly and C for PIC18", Pearson Education 2016

Reference Books

1. Krishna Kant, “Microprocessor and Microcontroller Architecture, programming and system design using 8085, 8086, 8051 and 8096”, PHI, 2013
2. DoughlasV.Hall, Microprocessors and Interfacing, Programming and Hardware”, TMH,2012
3. Peatman J., “Embedded system Design using PIC18Fxxx”, Prentice Hall, 2013.
4. Raj Kamal,” Microcontrollers: Architecture, Programming, Interfacing and System Design” Pearson,2011
5. Martin P. Bates,” Programming 8-bit PIC Microcontrollers in C" Newnes,2008

Web References

1. https://www.youtube.com/watch?v=S1QCZW92fU4
2. https://swayam.gov.in/nd1_noc20_ee42/microprocessors-and-microcontrollers/

3.	https://www.classcentral.com/course/swayam
4.	https://freevideolectures.com/course/3018/microprocessors
5.	https://www.elprocus.com/peripherals-interfacing-to-the-microcontroller-8051-in-electronics

* TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	2	-	-	2	-	-	-	-	-	2	3	-	-
2	3	3	3	2	3	-	-	2	2	2	2	3	3	3
3	3	3	3	2	3	-	-	-	2	2	2	3	3	3
4	3	3	2	3	3	-	-	-	2	2	2	3	3	3
5	3	3	2	2	3	2	-	-	2	2	2	3	3	3

Correlation level: 1 - Low 2 - Medium 3 - High

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	CAT 1	CAT 2	Model Exam	Assignment*	Attendance		
Marks	5	5	5	5	5	75	100

*Application oriented / Problem solving / Design / Analytical in content beyond the syllabus

Department	**Biomedical Engineering**	Programme: **B.Tech**						
Semester	**V**	Course Category: **PC**			*End Semester Exam Type: **TE & LE**			
Course Code	**U23BMB502**	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Biocontrol Systems**	2	0	2	3	**50**	**50**	**100**
Prerequisite	**Biosignals and Systems**							

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Explain the concepts of different modelling systems.	**K3**
	CO2 Analyse the time response of different order systems, steady state error and frequency response using various plots	**K4**
	CO3 Determine the stability and root locus concepts and Investigate the biomedical applications	**K4**
	CO4 Demonstrate Transient analysis of signals	**K4**
	CO5 Simulate the model of Biological Control System	**K4**

UNIT-I	**Modelling of Systems**	**Periods: 10**
Classification of control systems - Open loop and closed loop control systems - advantages and disadvantages, Transfer function, Modelling of electrical systems, Modelling of translational and rotational mechanical systems, Analogous systems, Block diagram reduction technique, Signal flow graph, conversion of block diagram to signal flow graph.		**CO1**
UNIT-II	**Time and Frequency Response Analysis**	**Periods: 10**
Standard test signals - step, ramp, parabolic and impulse type and order of a system, Time response of first order systems, Time response of second order systems, Transfer function-Time constant form and pole zero form, time domain specifications, Steady state error. **Frequency Response Analysis:** Frequency response - Frequency domain specifications, Polar plot, Bode plot.		**CO2**
UNIT-III	**Stability Analysis and Biological Control Systems**	**Periods: 10**
Stability criterion- necessary conditions for stability, Determining the stability by Routh and Hurwitz criterion, Root locus concepts, Rules for the construction of root locus. Effect of adding poles and zeros to a system. **Biological control Systems** - Cardiovascular Control System, Skeletal Muscle Servomechanism, Oculo - motor system, sugar level Control Mechanism, Lung mechanics model with proportional control		**CO3**
UNIT-IV	**Simulation of Transient and Stability Analysis**	**Periods: 15**
1. Generation of Periodic, Exponential, Sinusoidal, Step, Impulse, Ramp signals 2. Transient Analysis of Impulse Response 3. Transient Analysis of Step Response 4. Determine the Time response of Second Order system 5. Frequency Domain Analysis of Signals 6. Stability analysis (Bode, Root Locus) of Linear Time Invariant system.		**CO4**
UNIT-V	**Simulation of Biological Control Systems Modelling**	**Periods: 15**
1. State space model for classical transfer function 2. Pole Zero Configuration in S-plane for the given transfer function 3. ECG Signal Generation 4. Simple Lung Mechanics using Transfer Function 5. Blood Glucose Regulation using Simulink 6. Neuromuscular Regulation using Simulink		**CO5**

Lecture Periods: 30	**Tutorial Periods:-**	**Practical Periods:30**	**Total Periods: 60**

Textbooks

1. Nagrath J and Gopal M, “Control system engineering”, 5th Edition, New Age International Publishers, 2011.
2. Rajeev Gupta, ”Control systems engineering”, 1st Edition. Wiley India Pvt Ltd, 2011.
3. Michael C K Khoo, Physiological control systems-Analysis, simulation and estimation”, Second Edition, India, 2018.

Reference Books

1. Norman S Nice, “Control system engineering”, 7th Edition, Wiley India Pvt Ltd, 2015.
2. K R Varmah, “Control systems”, 1st Edition. Tata McGraw Hill, 2010.
3. Salivahanan,” Control systems Engineering”, Pearson Education India, 2015
4. K. Padmanabhan,”Control systems”, Wiley India Pvt Ltd, 2020
5. A. Anand Kumar, “Control systems”, 2nd Edition. PHI Learning Pvt Ltd, 2015.

Web References

1. https://nptel.ac.in/courses/107106081/
2. https://www.youtube.com/watch?v=QY9NTVh-Awo&list=PLDK4cGT3XCf3GovuGIqmp-mgfm8pXIPH6
3. https://www.youtube.com/watch?v=RJIeGwXorUk

* TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	2	-	-	2	-	-	-	-	-	2	3	-	-
2	3	3	2	2	3	-	-	-	-	-	2	3	3	-
3	3	3	2	3	2	-	-	-	2	2	2	3	3	2
4	3	2	-	2	3	-	-	-	-	-	2	3	3	-
5	3	3	3	3	3	-	-	-	2	2	2	3	3	3

Correlation Level: 1 - Low, 2 -Medium, 3 – High

Evaluation Methods

Theory						
Assessment	Continuous Assessment Marks (CAM)				End Semester Examination (ESE) Marks	Total Marks
	CAT 1	CAT 2	Model Exam	Attendance		
Marks	5	5	5	5	75	60
	20 (to be weighted for 10 marks)				(to be weighted for 50 marks)	

Practical				
Continuous Assessment Internal Evaluation		End Semester Internal Evaluation		Total Marks
30(to be weighted for 10 marks)		30 marks		40
Conduction of Practical	15 marks	Procedure / Algorithms	5 marks	
Report	10 marks	Experiment / Program Execution	10 marks	
Viva-Voce	5 marks	Result / Output	10 marks	
Total	30 marks	Viva-Voce	5 marks	

Department	**Information Technology**	Programme: **B.Tech**						
Semester	**V**	Course Category Code: **ES**			*End Semester Exam Type: **LE**			
Course Code	**U23ITPC02**	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Programming in Java Laboratory**	**0**	**0**	**2**	**1**	**50**	**50**	**100**

(Common to All Branches)

Prerequisite	Basic concepts of Object-Oriented Programming Principles	
Course Outcome	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Apply and practice logical formulations to solve simple problems leading to specific applications.	**K3**
	CO2 Demonstrate the use of inheritance, interface and package in relevant applications	**K3**
	CO3 Implement robust application programs in Java using exception handling and multithreading	**K3**
	CO4 Build java distributed applications using Collections and IO streams.	**K3**
	CO5 Implement Graphical User Interface based application programs by utilizing event handling features and Swing in Java.	**K3**

LIST OF EXERCISES

1. Develop simple programs using java
2. Develop a java program that implements class and object.
3. Write a java program to find the frequency of a given character in a string
4. Write a java program to demonstrate inheritance and interfaces.
5. Develop a java program that implements the Packages.
6. Create java applications using Exception Handling for error handling.
7. Develop a simple real life application program to illustrate the use of Multi-Threads.
8. Implement simple applications using Collections.
9. Develop application using the concept of I/O Streams
10. Write a Java Program to demonstrate AWT and Swing Components
11. Develop a simple application and use JDBC to connect to a back-end database.

Lecture Periods: -	**Tutorial Periods: -**	**Practical Periods: 30**	**Total Periods: 30**

Reference Books

1. Allen B. Downey and Chris Mayeld, “Think Java - How to Think Like a Computer Scientist”, Green Tea Press, 2nd Edition, 2020
2. Sagayaraj, Denis, Karthik, Gajalakshmi, “JAVA Programming for core and advanced learners”, Universities Press Private Limited, 2018
3. Cay.S.Horstmann and Gary Cornell, “Core Java 2”, Vol 2, Advanced Features, Pearson Education, 7th Edition, 2010

Web References

1. http://www.ibm.com/developerworks/java/
2. http://docs.oracle.com/javase/tutorial/rmi/.
3. IBM’s tutorials on Swings, AWT controls and JDBC.
4. https://www.edureka.co/blog.
5. https://www.geeksforgeeks.org.

* TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	2	2	-	2	-	-	-	2	-	2	3	2	-
2	3	2	3	-	3	-	-	-	2	-	2	3	3	-
3	3	2	3	2	3	-	-	-	2	2	2	3	3	2
4	3	2	2	2	3	-	-	-	2	2	2	3	3	2
5	3	2	3	-	3	-	-	-	3	3	2	3	3	2

Correlation Level: 1 - Low, 2 - Medium, 3 – High

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	Performance in practical classes			Model Practical Examination	Attendance		
	Conduction of practical	Record work	viva				
Marks	15	5	5	15	10	50	100

Department	**Biomedical Engineering**	Programme : **B.Tech.**					
Semester	**V**	Course Category: **PC**			End Semester Exam Type: **LE**		
Course Code	**U23BMP505**	Periods/Week			Credit	Maximum Marks	
		L	T	P	C	CAM	ESE
Course Name	**Microcontroller and its Medical Applications Laboratory**	**0**	**0**	**2**	**1**	**50**	**50**
Prerequisite							

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Develop Proficiency in Microcontroller Assembly Language Programming	**K3**
	CO2 Execute Assembly Language Programming for arithmetic operations	**K4**
	CO3 Analyze controller interfacing with external devices.	**K4**
	CO4 Implement Interfacing devices using Keil / Proteus Software	**K4**
	CO5 Interface memory and I/O device with controller**.**	**K4**

LIST OF EXPERIMENTS

Part A: Experiments using 8051 Microcontroller

1. Study of 8051 Microcontroller trainer kit.
2. Assembly Language Program for addition of 8-bit numbers stored in an array.
3. Assembly Language Program for Multiplication by successive addition of two 8-bit numbers.
4. Assembly Language Program for finding largest no. from a given array of 8-bit numbers.
5. Assembly Language program to arrange 8-bit numbers stored in an array in ascending order.
6. Stepper motor control by 8051 Microcontroller.
7. Interfacing of 8-bit ADC 0809 with 8051 Microcontroller.
8. Interfacing of 8-bit DAC 0800 with 8051 Microcontroller and Waveform generation.

Part B: Experiments with PIC microcontroller using Keil / Proteus Software

9. Implementation of GPIO
10. Implementation of ADC
11. Interfacing of Stepper motor
12. Interfacing of 7 Segment display
13. Design of heart rate monitoring circuit using PIC microcontroller

Reference Books

1. A.K .Ray, K. M. Bhurchandi, “Advanced Microprocessor and Peripherals”, Tata McGraw Hill, 3rd Edition, 2013
2. Mohamed Ali Mazidi, Janice Gillispie Mazidi, Rolin McKinlay, “The 8051 Microcontroller and Embedded Systems: Using Assembly and C”, 2nd Edition, Pearson education, 2013
3. Muhammad Ali Mazidi, Rolin D. Mckinlay, Danny Causey ,” PIC Microcontroller and Embedded Systems using Assembly and C for PIC18", Pearson Education 2016
4. Krishna Kant, “Microprocessor and Microcontroller Architecture, programming and system design using 8085, 8086, 8051 and 8096”, PHI, 2013
5. Doughlas V.Hall, Microprocessors and Interfacing, Programming and Hardware”, TMH,2012

Web References

1. https://www.youtube.com/watch?v=S1QCZW92fU4
2. https://swayam.gov.in/nd1_noc20_ee42/microprocessors-and-microcontrollers/
3. https://www.classcentral.com/course/swayam
4. https://freevideolectures.com/course/3018/microprocessors
5. https://www.elprocus.com/peripherals-interfacing-to-the-microcontroller-8051-in-electronics

* TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	2	-	-	3	-	-	-	-	-	2	3	2	2
2	3	2	-	-	3	-	-	-	-	-	2	3	2	2
3	3	3	2	2	3	-	-	-	2	2	2	3	3	3
4	3	2	3	2	3	-	-	-	2	2	2	3	3	3
5	3	3	3	2	3	-	-	-	2	2	2	3	3	3

Correlation level: 1 - Low 2 - Medium 3 - High

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	Performance in practical classes			Model Practical Examination	Attendance		
	Conduction of practical	Record work	viva				
Marks	15	5	5	15	10	50	100

Department	**Biomedical Engineering**	Programme : **B.Tech.**					
Semester	**V**	Course Category: **PC**			*End Semester Exam Type: **LE**		
Course Code	**U23BMP506**	Periods/Week			Credit	Maximum Marks	
		L	T	P	C	CAM	ESE
Course Name	**Hospital Training**	**0**	**0**	**2**	**1**	**50**	**50**
Prerequisite							

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Apply principles of medical instrumentation to patient care.	**K3**
	CO2 Analyze healthcare challenges using biomedical engineering techniques.	**K3**
	CO3 Gain hands-on experience of radiological techniques in diagnosing orthopedic and neurological disorders.	**K4**
	CO4 Evaluate effectiveness of biomedical engineering solutions in critical care units.	**K5**
	CO5 Recognize the importance of inter-professional collaboration in healthcare.	**K5**

Department Visit

1. Cardiology
2. Ophthalmology
3. ENT
4. Orthopaedic and Physiotherapy
5. ICU/CCU
6. Operation Theatre
7. Neurology
8. Nephrology
9. Radiology
10. Nuclear Medicine
11. Pulmonology
12. Urology
13. Obstetrics and Gynaecology
14. Emergency Medicine
15. Biomedical Engineering Department
16. Histo Pathology
17. Biochemistry
18. Pediatric and Neonatal
19. Dental
20. Oncology
21. Medical records/Telemetry

Text Books

1. Girdhar J Gyani and Alexander Thomas, “Handbook of Healthcare quality and patient safety”, Jaypee brothers medical publisher, 2nd Edition, 2019.
2. Shakti Kumar Gupta,Sunil Kant, R Chandrashekhar and Sidharth Satpathy,“Modern Trends in Planning & Designing of Hospitals: Principles and Practice”, Jaypee, 2007.
3. Dr Malhotra"s series, “Step by Step Hospital designing & planning”, Jaypee, 2007.

Reference Books

1. Sonu Dr. Goel, “Textbook of Hospital Administration”, Elsevier, 2014.
2. William Charney,” Handbook of Modern Hospital Safety”, CRC press, 2nd Edition, 2010.
3. Cindy Taylor, “The Hospital Safety Professional‟s Handbook”, HCPro, BLR, 5th Edition. 2015.

Web References

1. https://en.wikipedia.org/wiki/Medical_equipment_management
2. http://www.who.int/hac/techguidance/preparedness/hospital_safety_index_forms.pdf
3. https://www.who.int/news-room/fact-sheets/detail/patient-safety
4. https://www.coursera.org/browse/health/healthcare-management
5. https://www.who.int/management/newitems/en/index1.html

* TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	2	3	2	2	3	3	-	2	2	2	3	2	3
2	3	3	2	3	2	2	2	-	2	2	2	3	3	3
3	2	2	-	3	3	2	-	-	2	-	2	3	3	3
4	3	3	3	3	2	3	3	2	2	2	2	3	3	3
5	2	-	-	-	-	3	3	3	3	2	3	2	2	2

Correlation level: 1 - Low 2 - Medium 3 - High

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	Performance in practical classes			Model Practical Examination	Attendance		
	Conduction of practical	Record work	viva				
Marks	15	5	5	15	10	50	100

Department	**Biomedical Engineering**	Programme: **B. Tech.**						
Semester	**V**	Course Category Code: **PA**				*End Semester Exam Type: **-**		
Course Code	**U23BMW501**	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Micro Project**	**0**	**0**	**2**	**1**	**100**	**-**	**100**
Prerequisite	**Biomedical Instrumentation, Electronics**							

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
CO1	Identify the problem statement for the micro project work through the literature survey	**K2**
CO2	Choose the proper components as per the requirements of the design/ system**.**	**K2**
CO3	Apply the acquainted skills to develop final model/system	**K3**

There shall be a Micro Project, which the student shall pursue as a team consists of maximum 4 students during the third year, fifth semester. The aim of the micro project is that the student has to understand the real time hardware / software applications. The student should gain a thorough knowledge in the problem he/she has selected and in the hardware / software he/she using in the Project. The Micro-project is an application that should be formally initiated and should be developed and also to be implemented by the respective team.

The Micro Project shall be submitted in a report form along with the hardware model / software developed, duly approved by the department internal evaluation committee. It shall be evaluated for 100 marks as Continuous Assessment. The department internal evaluation committee shall consist of faculty coordinator, supervisor of the project and a senior faculty member of the department. There shall be two reviews that will be considered for assessing a Micro Project work with weightage as indicated evaluation Methods.

Lecture Periods: -	**Tutorial Periods: -**	**Practical Periods: 30**	**Total Periods: 30**

COs/POs/PSOs Mapping

COs	**Program Outcomes (POs)**											**Program Specific Outcomes (PSOs)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
1	3	3	2	2	2	2	2	-	2	2	2	3	2	2
2	2	2	3	2	3	2	-	2	2	2	2	3	3	3
3	3	3	3	3	3	2	2	3	2	3	3	3	3	3

Correlation Level: 1 – Low, 2 – Medium, 3 - High

Evaluation Method

Assessment	Review 1			Review 2				Total Marks
	Novelty	Presentation	Viva	Presentation	Demonstration	Viva	Report	
Marks	10	20	10	20	20	10	10	100

Department	**Biomedical Engineering**	Programme: **B.Tech.**						
Semester	**V**	Course Category: **AEC**			*End Semester Exam Type:			
Course Code	**U23BMC5XX**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Certification Course – V**	**0**	**0**	**4**	**-**	**100**	**-**	**100**
Prerequisite								

of six courses) which will be offered through the Centre of Excellence. These courses have no credit and will not be considered for CGPA calculation.

(i) Certification Courses are required to be completed to fulfil the degree requirements. All Certification courses are assessed internally for 100 marks.

(ii) The Course coordinator handling the course will assess the student through attendance and MCQ test, and declare the student as “pass” on satisfactory completion. A letter grade “P” is awarded to declare pass.

(iii) The marks scored in these courses will not be taken into consideration for the SGPA / CGPA calculations in the grade sheet.

Lecture Periods:-	**Tutorial Periods: -**	**Practical Periods: 50**	**Total Periods:50**

Evaluation methods

Assessment	**Continuous Assessment Marks (CAM)**		**Total Marks**
	Attendance	**MCQ Test**	
Marks	10	90	100

Department	**Biomedical Engineering**	Programme: **B.Tech.**						
Semester	**V**	Course Category Code: **MC**			*End Semester Exam Type: **-**			
Course Code	**U23BMM505**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Essence of Indian Traditional Knowledge**	**2**	**0**	**0**	**-**	**100**	**-**	**100**

Common to ALL Branches

Prerequisite	**-**	
Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Familiarize with the philosophy of Indian culture	**K2**
	CO2 Distinguish the Indian languages and literature	**K2**
	CO3 Describe the philosophy of ancient, medieval and modern India	**K2**
	CO4 Illustrate the information about the fine arts in India	**K2**
	CO5 Describe the contribution of scientists of different eras	**K2**

UNIT- I	**Introduction To Culture**	**Periods:06**
Culture, civilization, culture and heritage, general characteristics of culture, importance of culture in human literature, Indian Culture, Ancient India, Medieval India, Modern India		**CO1**
UNIT- II	**Indian Languages, Culture and Literature**	**Periods:06**
Indian Languages and Literature - I: the role of Sanskrit, significance of scriptures to current society, Indian philosophies, other Sanskrit literature, literature of south India Indian Languages and Literature-II: Northern Indian languages & literature		**CO2**
UNIT- III	**Religion and Philosophy**	**Periods:06**
Religion and Philosophy in ancient India, Religion and Philosophy in Medieval India, Religious Reform Movements in Modern India (selected movements only)		**CO3**
UNIT- IV	**Fine Arts in India (Art, Technology and Engineering)**	**Periods:06**
Indian Painting, Indian handicrafts, Music, divisions of Indian classical music, modern Indian music, Dance and Drama, Indian Architecture (ancient, medieval and modern), Science and Technology in India, development of science in ancient, medieval and modern India		**CO4**
UNIT-V	**Education System in India**	**Periods:06**
Education in ancient, medieval and modern India, aims of education, subjects, languages, Science and Scientists of Ancient India, Science and Scientists of Medieval India, Scientists of Modern India		**CO5**

Lecture Periods:30	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods:30**

Reference Books

1. KapilKapoor,"Text and Interpretation:The India Tradition",ISBN:81246033375,2005
2. "Science in Samskrit",Samskrita Bharti Publisher,ISBN13:978-8187276333,2007
3. NCERT,"Position paper on Arts,Music,Dance and Theatre",ISBN 81-7450494-X,200
4. S.Narain,"Examinations in ancient India",Arya Book Depot,1993
5. M. Hiriyanna, "Essentials of Indian Philosophy", Motilal Banarsidass Publishers, ISBN 13: 978 - 8120810990, 2014

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1. https://nptel.ac.in/courses/109/104/109104102/
2. https://nptel.ac.in/courses/101/104/101104065/
3. https://nptel.ac.in/courses/109/108/109108158/
4. https://nptel.ac.in/courses/109/106/109106059/
5. https://nptel.ac.in/noc/courses/noc17/SEM1/noc17-ae01/

COs/POs/PSOs Mapping

A.

Dr. A.Vijayalakshmi B.Tech. Biomedical Engineering

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	2	-	-	-	-	3	2	2	2	1	2	2	-	-
2	2	-	-	-	-	2	2	2	3	1	2	2	-	-
3	3	-	-	-	-	3	3	-	2	-	2	2	-	-
4	2	-	-	-	-	2	2	2	3	-	2	2	-	-
5	3	1	-	-	-	2	-	-	2	1	2	2	-	-

Correlation Level: 1 - Low, 2 - Medium, 3 – High

Evaluation Methods

Assessment	Continuous Assessment Marks (CAM)			Total Marks
	Attendance	MCQ Test	Presentation / Activity / Assignment	
Marks	10	30	60	100

PROFESSIONAL ELECTIVE – V

Department	**Biomedical Engineering**			Programme: **B.Tech**				
Semester	**V**			Course Category: **PE**		*End Semester Exam Type: **TE**		
Course Code	**U23BME505**			Periods / Week		Credit	Maximum Marks	
				L	T	P	C	CAM	ESE	TM
Course Name	**Laser and Fiber Optics in Medicine**			**3**	**0**	**0**	**3**	**50**	**50**	**100**
Prerequisite	-									
Course Outcomes	**On completion of the course, the students will be able to**							BT Mapping (Highest Level)		
	CO1	Understand the basic principles of optical fibers						**K2**		
	CO2	Analyse the characteristics and configurations of different laser types.						**K4**		
	CO3	Elucidate the use of laser systems in medicine						**K4**		
	CO4	Evaluate optical fiber techniques for measurements and applications.						**K5**		
	CO5	Analyse the applications of laser in medicine						**K4**		
UNIT-I	**Optical Fibers and their Properties**						**Periods: 09**			
Introduction to optical fiber - fiber characteristics - principles of light propagation through a fiber - Different types of fibers and their properties - Losses in the optical fiber - Dispersion - advantages and disadvantages of optical fibers								**CO1**		
UNIT-II	**Laser Fundamentals**						**Periods: 09**			
Laser Fundamentals: Introduction to lasers - Laser characteristics – Laser configuration – Three level and four level lasers – Q-switching – Mode locking – Types of lasers: Gas lasers, Solid lasers, Liquid lasers and Semiconductorlasers.								**CO2**		
UNIT-III	**Laser Systems**						**Periods: 09**			
Lasers used in medical practice: Ruby laser, CO2 laser, Nd-Y AG laser and related solid-state laser. Laser - issue Interaction: Terminology, spectral band designations, energy & power, irradiant & radiant exposure.								**CO3**		
UNIT-IV	**Applications of Optical Fibers**						**Periods: 09**			
Interferometer method of measurement of length – Moire fringes – Measurement of pressure, Temperature, Current, Voltage, Liquid level and strain - fiber optic Gyroscope – Polarization maintaining fibers - Applications.								**CO4**		
UNIT-V	**Laser Applications in Medicine**						**Periods: 09**			
Application in general surgery-Dermatology, Ophthalmology, Cardiovascular &chest surgery, Dentistry, Neuro surgery, Otolaryngology & head and neck surgery, Laser Oncology, Gynecologic laser, Endoscopy, Laparoscopy.								**CO5**		
Lecture Periods: 45	**Tutorial Periods:-**			**Practical Periods:-**			**Total Periods: 45**			

Textbooks

1. Abraham Katzir, “Lasers and Optical Fibers in Medicine”, Academic press Inc, 2012.
2. Helena Jelinkova, “Lasers for medical Applications”, Woodhead Publishing, 2013.
3. David A Boas, “Handbook of Biomedical Optics”, CRC Press, 2011.

Reference Books

1. Tuan Vo-Dinh, “Biomedical Photonics Handbook”, 3 volume set, 2018.
2. Tosi Daniele, “Fiber optics Sensor for Biomedical Applications”, 2010.
3. KeyvanNouri, “Laser in Dermatology and Medicine”, Springer, 2011.
4. Nagabhushana, “Laser and Optical Instrumentation”, I.K International House Pvt Ltd. 2010.

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1. https://en.wikipedia.org/wiki/Fiber_laser
2. https://en.wikipedia.org/wiki/Optical_fiber
3. https://ethw.org/Fiber_Optics
4. https://www.classcentral.com/course/swayam-fiber-optics-7913
5. https://ocw.mit.edu/resources/res-6-005-understanding-lasers-and-fiberoptics-spring-2008/

* TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	2	-	-	2	-	-	-	-	-	2	3	2	2
2	3	3	2	2	3	-	-	-	2	2	2	3	3	3
3	3	2	2	2	2	3	3	-	2	2	2	3	3	3
4	3	3	3	2	3	-	-	-	2	2	2	3	3	3
5	3	3	2	2	2	3	2	1	2	2	2	3	3	3

Correlation Level: 1 - Low, 2 -Medium, 3 – High

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	CAT 1	CAT 2	Model Exam	Assignment*	Attendance		
Marks	5	5	5	5	5	75	100

*Application oriented / Problem solving / Design / Analytical in content beyond the syllabus

Department	**Biomedical Engineering**	Program: **B.Tech.**						
Semester	**V**	Course Category: **PE**			*End Semester Exam Type: **TE**			
Course Code	**U23BME506**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Computers In Medicine**	**3**	**0**	**0**	**3**	**25**	**75**	**100**
Prerequisite	**Biomedical Instrumentation**							

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Understand the fundamental principles of computer systems and their applications in healthcare	**K2**
	CO2 Analyze the Biosignals and medical imaging data	**K4**
	CO3 Gain the knowledge about patient monitoring using computers	**K3**
	CO4 Evaluate the benefits and limitations of various medical computing technologies.	**K3**
	CO5 Explore diverse applications of computational tools in healthcare solutions.	**K4**

UNIT – I	**Introduction to Computers in Medicine**	**Periods:9**
Introduction -Overview of computer systems-Medical computing history and evolution-Healthcare information systems-Medical informatics principles-Ethical considerations.		**CO1**
UNIT – II	**Medical Imaging and Data Analysis**	**Periods:9**
Multichannel computerized ECG, EMG and EEG-Medical imaging modalities -MRI, CT, PET-Image processing and analysis-Medical image informatics-Picture Archiving and Communication Systems (PACS)- Image-based diagnosis and decision support.		**CO2**
UNIT – III	**Computers in Patient Monitoring**	**Periods:9**
Physiological monitoring, automated ICU, computerized arrhythmia monitoring, information flow in a clinical lab, computer interfacing to HIS.		**CO3**
UNIT – IV	**Computers In Medical Systems Modeling**	**Periods:9**
Radiotherapy-types- drug design, drug delivery system, physiological system modeling and simulation.		**CO4**
UNIT – V	**Application of Computers in Medicine**	**Periods:9**
AI-driven diagnostics and predictive analytics-Applications of ML in personalized medicine, Applications in securing medical records and improving transparency		**CO5**

Lecture Periods: 45	**Tutorial Periods:**	**Practical Periods: -**	**Total Periods: 45**

Text Books

1. R.D.Lee, " Computers in Medicine: Progress in Medical Informatics ", Tata McGraw-Hill, New Delhi, 2010
2. J. G. L. Garcia Computers in Medicine" Tata McGraw-Hill, January 2006
3. Dhiya Al-Jumeily Abir Hussain Conor Mallucci Carol Oliver, "Applied computing in medicine and health", 1st Edition, 2015.

Reference Books

1. David J. Brailer, David B. Kibbe "Computers In Medicine", Springer-Verlag,1991
2. Edward H. Shortliffe, James J. Cimino , " Biomedical Informatics: Computer Applications in Health Care and Biomedicine ", Springer, 2014
3. Naval Kishore, "Computer in medicine", S.Chand (G/L) & Company Ltd, 2003.

Web References

1. https://www.techwalla.com/articles/10-ways-computers-are-used-in-medicine
2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2233671/
3. https://www.online-sciences.com/computer/computers-in-medicine-uses-advantages-and-disadvantages/

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	2	2	-	2	2	-	-	2	2	2	3	2	2
2	3	3	3	3	3	2	-	-	2	2	2	3	3	3
3	3	2	2	2	2	3	2	-	2	2	2	3	3	3
4	3	3	2	2	3	3	3	2	2	2	3	3	3	3
5	3	3	2	2	3	2	2	2	2	2	3	3	3	3

Correlation Level: 1-Low, 2-Medium, 3- High

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	CAT 1	CAT 2	Model Exam	Assignment*	Attendance		
Marks	5	5	5	5	5	75	100

*Application oriented / Problem solving / Design / Analytical in content beyond the syllabus

Department	**Biomedical Engineering**	Programme: **B.Tech.**						
Semester	**V**	Course Category Code: **PE**			*End Semester Exam Type: **TE**			
Course Code	**U23BME507**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Transportation in living Systems**	**3**	**0**	**0**	**3**	**25**	**75**	**100**
Prerequisite	Human Anatomy and Physiology							

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
CO1	Develop and solve models of living system as a microvascular network	**K2**
CO2	Analyse how the living system characteristics depend on the underlying network structure	**K4**
CO3	Evaluate fluid transport systems through natural membranes.	**K5**
CO4	Apply concepts of lymph transportation in human systems.	**K3**
CO5	Provides clear idea about human system along with artificial organ	**K2**

UNIT – I	**Introduction**	**Periods:09**
Organization of the human body, cells, tissues, different organs, natural membrane system. Transport of momentum, heat and mass by molecular motion- Newton"s law of viscosity, Fourier"s law of heat conduction and Fick"s law of diffusion. Transport properties – Viscosity, Thermal conductivity and Mass diffusivity.		**CO1**
UNIT – II	**Heat Transport**	**Periods:09**
Body temperature regulation based on thermostate principle and its operation, transportation in tissues, muscle, skin and other organs in different environmental temperature.		**CO2**
UNIT – III	**Transportation of Fluids**	**Periods:09**
Blood transport through internal organs, urogenitary system, cardio pulmonary system, central nervous system, gastro intestine system, diffusion, osmosis, electroosmosis, ultrafiltration, reverse osmosis through natural membrane systems, reverse osmosis through artificial synthetic membranes.		**CO3**
UNIT – IV	**Transportation of Lymph**	**Periods:09**
Transportation of lymph through internal organs, urogenitary system, cardio pulmonary system, central nervous system, gastro intestine system, problems on lymph transfer in human body.		**CO4**
UNIT – V	**Mass Transfer**	**Periods:09**
Constituents of blood, urine, mass transfer in kidney, skeletal, nervous, gastro intestine system, cardio pulmonary system,comparison with artificial organs.		**CO5**

Lecture Periods:45	**Tutorial Periods:**	**Practical Periods: -**	**Total Periods:45**

Textbooks

1. David O.Cooney, “An introduction to fluid, heat & mass transport process-Principles”, Marcel Dekker Inc., Vol.1, 2nd Edition, 2007
2. Richard P. Menninger, “Best and Taylor's Physiological Basis of Medical Practice”, LippinCott Williams and Wilkins, 2008
3. RB Bird, WE Stewart and EN Lightfoot,” Transport Phenomena”, Second Edition, John Wiley and Sons, 2007.

Reference Books

1. Kim Barrett, Susan Barman, Jason Yuan, Heddwen Brooks, “Ganong's Review of Medical Physiology”, McGraw-Hill Education, 2019.
2. SujitK.Chaudhuri, “Concise Medical Physilogy” New Central Book agency, 6th Edition, 2011.
3. Patrick Tabeling, “Introduction to Microfluidics”, Oxford University Press, 2005.
4. Edwin N Lightfoot, “Transport phenomena and living systems; Biomedical aspects of momentum and mass transport”, Wiley; 1st Edition,1974.
5. Truskey and Yuan and Katz, “Transport Phenomena in Biological Systems “, Pearson Prentice Hall 2009.

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1. https://www.toppr.com/ask/question/transportation-in-the-living-organisms-is-necessary-because-of-the following-reasons/
2. https://link.springer.com/content/pdf/10.1007/978-1-349-14068-8_6.pdf
3. https://secondarytwojyssscience.weebly.com/transport-system-in-living-things.html

* TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	3	2	2	2	-	-	-	1	1	2	3	2	2
2	3	3	2	2	2	2	-	-	1	1	2	3	2	2
3	3	3	2	2	2	-	-	-	2	2	2	3	3	3
4	3	2	2	2	2	2	2	-	2	2	2	3	3	3
5	3	3	3	2	3	3	3	2	2	2	3	3	3	3

Correlation Level: 1 - Low, 2 - Medium, 3 – High

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	CAT 1	CAT 2	Model Exam	Assignment*	Attendance		
Marks	5	5	5	5	5	75	100

* Application oriented / Problem solving / Design / Analytical in content beyond the syllabus

Department	**Biomedical Engineering**	Program: **B.Tech.**						
Semester	**V**	Course Category: **PE**			*End Semester Exam Type: **TE**			
Course Code	**U23BME508**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Medical Informatics**	**3**	**0**	**0**	**3**	**25**	**75**	**100**
Prerequisite	**-**							

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Discuss about health informatics and the function of Hospital Information Systems	**K2**
	CO2 Analyze medical standards	**K4**
	CO3 Explain about storage of medical data	**K2**
	CO4 Understand the basic concepts of bioinformatics	**K2**
	CO5 Discuss about the application of medical informatics	**K3**

UNIT – I	**Medical Informatics**	**Periods: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 taking by computer, Dialogue with the computer		**CO1**
UNIT – II	**Medical Standards**	**Periods: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.		**CO2**
UNIT – III	**Medical Data Storage and Automation**	**Periods:9**
Plug in Data Acquisition and Control Boards, Data Acquisition using Serial Interface, Medical Data formats, Signal, Image and Video Formats, Medical Databases, Automation in clinical laboratories, Intelligent Laboratory Information System, PACS, Data mining.		**CO3**
UNIT – IV	**Health Informatics**	**Periods:9**
Bioinformatics Databases, Bio, information technologies, Semantic web and Bioinformatics, Genome projects, Clinical informatics, Nursing informatics, Public health informatics, Education and Training		**CO4**
UNIT – V	**Recent Trends in Medical Informatics**	**Periods:9**
Medical Expert Systems, Virtual reality applications in medicine, Virtual Environment, Surgical simulation, Radiation therapy and planning , Telemedicine , virtual Hospitals , Smart Medical Homes , Personalized ehealth services , Biometrics , GRID and Cloud Computing in Medicine		**CO5**

Lecture Periods: 45	**Tutorial Periods:**	**Practical Periods: -**	**Total Periods: 45**

Text Books

1. R.D.Lele, —Computers in medicine progress in medical informatics, Tata McGraw Hill Publishing computers Ltd, New Delhi,2005
2. H. K. Huang , “PACS and Imaging Informatics: Basic Principles and Applications”, 2010
3. Oleg S. Pianykh, “Digital Image Quality in Medicine”, Springer. 2014

Reference Books

1. Mohan Bansal, —Medical informatics, Tata McGraw Hill Publishing Computers Ltd, New Delhi,2003
2. N.Mathivanan, —PC-Based Instrumentation, Prentice Hall of India Pvt Ltd , New Delhi , 2007
3. Orpita Bosu and Simminder KaurThukral, —Bioinformatics Databases, Tools and Algorithms, Oxford University press, , New Delhi,2007
4. Yi , Ping Phoebe Chen, —Bioinformatics Technologies, Springer International Edition, New Delhi,2007
5. Wager, K. A., Lee, F. W., & Glaser, J. P, “Health care information systems: A practical approach for health care management”,4th Edition, 2017

Web References

1. https://www.springer.com/series/1114/books?srsltid=AfmBOopn8yFsNpXa7zA9Vl1RiO62iZvVTroR29Sn-VsktB5wjCYnYtK

2. https://researchguides.uic.edu/c.php?g=252330&p=1683330
3. https://elearn.nptel.ac.in/shop/nptel/data-integration-interoperability-in-healthcare/?v=c86ee0d9d7ed

* TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	2	2	1	2	3	2	1	2	2	2	3	2	2
2	3	3	2	2	3	3	2	-	2	2	2	3	3	3
3	3	2	2	1	3	2	-	-	2	2	2	3	2	3
4	3	2	2	2	2	2	-	-	1	2	3	3	2	2
5	3	3	2	2	2	2	2	1	2	2	3	3	3	3

Correlation Level: 1-Low, 2-Medium, 3- High

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	CAT 1	CAT 2	Model Exam	Assignment*	Attendance		
Marks	5	5	5	5	5	75	100

* Application oriented / Problem solving / Design / Analytical in content beyond the syllabus

Department	**Biomedical Engineering**	Programme: **B.Tech.**						
Semester	**V**	Course Category: **PE**			*End Semester Exam Type: **TE**			
Course Code	**U23BME509**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**VLSI Systems**	**3**	**0**	**0**	**3**	**25**	**75**	**100**
Prerequisite	**Digital Electronics**							

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Understand the analysis of CMOS digital electronics circuits	**K2**
	CO2 Knowledge about moderately sized CMOS circuits that realize specified digital functions	**K2**
	CO3 Apply CMOS technology in sequential circuit design	**K3**
	CO4 Apply the concepts of CMOS in designing Memory structures	**K3**
	CO5 Implement different design approach of programmable logic devices	**K4**

UNIT – I	**Introduction TO VLSI Design Styles and CMOS Logic**	**Periods:9**
Introduction to VLSI Design, Different types of VLSI design styles Full custom, VLSI Design flow. operation of MOS transistors, CMOS logic: PMOS, NMOS and CMOS, Electrical characteristics, stick diagram		**CO1**
UNIT – II	**Combinational MOS Logic Design**	**Periods:9**
Static MOS design; Complementary MOS, Rationed logic, Pass Transistor logic, complex logic circuits, Dynamic MOS Design, Dynamic Logic Families and Performances.		**CO2**
UNIT – III	**CMOS Sequential Circuit Design**	**Periods:9**
CMOS Sequential circuits**:** Static latches and Registers, Dynamic latches and Registers, Sense Amplifier Based Register Pipelining, Schmitt Trigger, Monostable Sequential Circuits, A stable Sequential Circuits.		**CO3**
UNIT – IV	**Design of Arithmetic Building Blocks**	**Periods:9**
Arithmetic Building Blocks: Data Paths, Adders, Multipliers, Shifters, ALUs, power and speed tradeoffs, Static and Dynamic Adder circuits - The Array Multiplier - Multiplier structures-Baugh-Wooly – Booth Multiplier - Barrel shifter.		**CO4**
UNIT – V	**Design Approach of Programmable Logic Devices**	**Periods:9**
Design approach of Programmable logic devices - PLA, PAL and FPGA. FPGA Building Block Architectures, FPGA Interconnect Routing Procedures, ASIC – Types of ASICs, Programmable ASICs.		**CO5**

Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 45**

Text Books

1. Jan Rabaey, Anantha Chandrakasan, B.Nikolic, "Digital Integrated Circuits: A Design Perspective",, Pearson, 2 nd Edition,2016.
2. Wayne wolf, “Modern VLSI Design: System on Chip Design”, Prentice Hall of India, 2012.
3. N.Weste, K.Eshraghian, “Principles of CMOS VLSI Design”, A system Perspective, Addision Wesley, McGraw-Hil, 4th Edition, 2010.

Reference Books

1. Neil H. E. Weste, Kamran Eshraghian, "CMOS Digital Integrated Circuits Analysis and Design", 4th Edition,2011,
2. E.Eshranghian, D.A.Pucknelland S.Eshraghian, “Essentials of VLSI circuits and systems”, PHI, 2009.
3. A.Pucknell, Kamran Eshraghian, “BASIC VLSI DESIGN”, Prentice Hall of India, 3rd Edition, 2007.
4. R.Jacob Baker, Harry W.LI., David E.Boyee, “CMOS Circuit Design, Layout and Simulation”, Prentice Hall of India, 2019
5. Deba Prasad Das, “VLSI Design”, Oxford University Press, 2012.

Web References

1. www.cmosvlsi.com
2. www.vlsi-world.com

TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	3	2	2	2	-	-	-	1	1	2	3	2	2
2	3	3	3	2	3	-	-	-	1	2	2	3	3	2
3	3	3	3	2	3	-	-	1	1	2	2	3	3	3
4	3	3	3	2	3	-	-	1	1	2	2	3	3	3
5	3	3	3	2	3	-	-	1	1	2	2	3	3	3

Correlation Level: 1 - Low, 2 - Medium, 3 – High

Evaluation Methods

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	CAT 1	CAT 2	Model Exam	Assignment*	Attendance		
Marks	5	5	5	5	5	75	100

***** Application oriented / Problem solving / Design / Analytical in content beyond the syllabus

Department	**Biomedical Engineering**	Program: **B.Tech.**						
Semester	**VI**	Course Category: **PC**			*End Semester Exam Type: **TE**			
Course Code	**U23BMT608**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Diagnostic and Therapeutic Equipment**	**3**	**0**	**0**	**3**	**25**	**75**	**100**
Prerequisite	Biomedical Instrumentation							

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Understand Ultrasonic Techniques	**K2**
	CO2 Describe the patient monitoring and Biotelemetry	**K3**
	CO3 Understand the classification of Diathermy	**K3**
	CO4 Interpret special diagnostic techniques	**K4**
	CO5 Acquire knowledge in patient's safety	**K3**

UNIT – I	**Ultrasonic Techniques**	**Periods:9**
Diagnosis-Basic principles of Echo technique - display techniques A, B and M mode - Application of ultrasound technique- Echocardiogram, abdomen - obstetrics and gynecology, contrast-enhanced ultrasound,3D and 4D ultrasound imaging.		**CO1**
UNIT – II	**Patient Monitoring System**	**Periods:9**
ICU/CCU Equipment - Infusion pumps - bed side monitors - wearable health monitoring - Central consoling controls - Radio Telemetry (single, multi) - Portable and Landline Telemetry unit, - Applications in ECG and EEG Transmission.		**CO2**
UNIT – III	**Diathermy**	**Periods:9**
IR and UV lamp and its application - Thermography - Recording and clinical application - short wave diathermy -ultrasonic diathermy - Microwave diathermy - Electro surgery machine - Current waveforms, Tissue Responses -Electro surgical current level, Radiofrequency Ablation.		**CO3**
UNIT – IV	**Special Diagnostic and Therapeutic Techniques**	**Periods:9**
Endoscopy, Laparoscopy, Optical Coherence Tomography (OCT), CT-700,EECP(Enhanced External Counter pulsation) -Need for heart lung machine - functioning of bubble - disc type and membrane type oxygenators - finger pump - roller pump - electronic monitoring of functional parameter – Haemo Dialyzer unit – Lithotripsy- Principles of Cryogenic technique and application		**CO4**
UNIT – V	**Patient Safety**	**Periods:9**
Physiological effects of electricity - important susceptibility parameters -Macro shock – Micro shock hazards – Patient's electrical environment - Isolated Power system – Conductive surfaces - Electrical safety codes and standards- Basic Approaches to protection against shock - Protection equipment design - Electrical safety analyzer - Testing the Electric system		**CO5**

Lecture Periods: 45	**Tutorial Periods:**	**Practical Periods: -**	**Total Periods: 45**

Text Books

1. Leslie Cromwell," Biomedical Instrumentation and Measurement", 2nd Edition, Prentice Hall, 2015.
2. John G. Webster, "Medical Instrumentation Application and Design", 5th Edition, John Willey and sons,2020.
3. Joseph J. Carr and John M. Brown, "Introduction to Biomedical equipment technology",3rd Edition, John Willey and sons, New York, 2003

Reference Books

1. Khandpur,R.S,"Handbook of Biomedical Instrumentation ",2nd Edition. Tata Mc Graw Hill, 2003
2. Rick Krohn, David Metcalf, Patricia Salber, "Health-e Everything: Wearables and The Internet of Things for Health, 2013
3. Principles of Applied Biomedical Instrumentation L. A Geddas and L.E.Baker – 2004.

4. John G. Webster, “Medical Instrumentation: Application and Design”, 4th Edition. John Wiley and Sons, New York, 2010.
5. Samuel A. Fricker, Christoph Thümmler , Anastasius Gavras, “Requirements Engineering For Digital Health”, Springer, 2015

Web References

1. https://www.nap.edu/read/21794/chapter/7
2. https://www.embs.org/about-biomedical-engineering/our-areas-of-research/diagnostic-therapeutic-systems
3. https://www.wsh.nhs.uk/CMS-Documents/Trust-policies/201-250/PP19206 Diagnostic and Therapeutic EquipmentTraining.pdf

* TE - Theory Exam, LE - Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	2	2	2	3	1	1	1	1	2	1	3	3	1
2	3	2	2	2	3	2	1	1	2	2	1	2	3	2
3	3	2	3	2	3	2	1	2	2	2	2	3	3	2
4	3	2	3	3	3	2	2	2	2	2	2	3	3	2
5	3	3	2	2	3	3	2	3	1	2	2	2	2	3

Correlation Level: 1 - Low, 2 - Medium, 3-High

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	CAT 1	CAT 2	Model Exam	Assignment*	Attendance		
Marks	5	5	5	5	5	75	100

* Application oriented / Problem solving / Design / Analytical in content beyond the syllabus

Department	**Biomedical Engineering**	Program: **B.Tech.**						
Semester	**VI**	Course Category: **PC**			*End Semester Exam Type: **TE**			
Course Code	**U23BMT609**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Embedded Systems for Healthcare**	**3**	**0**	**0**	**3**	**25**	**75**	**100**
Prerequisite	Microcontroller							

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Gain in-depth knowledge about embedded processor, its hardware and Instruction set	**K2**
	CO2 Analyze memory management and debugging tools for embedded processors.	**K4**
	CO3 Familiarize with various Embedded networking protocols	**K3**
	CO4 Design embedded systems using EDLC models and hardware-software co-design	**K4**
	CO5 Design a Real time embedded system for biomedical applications	**K5**

UNIT – I	**Introduction to Embedded System and ARM Architecture**	**Periods:9**
Introduction to Embedded Systems – Embedded system design process. Embedded processors – ARM processor – Architecture, ARM and Thumb Instruction sets		**CO1**

UNIT – II	**Embedded Computing Platform Design**	**Periods:9**
Structural units in Embedded processor Structural unit of embedded system - DMA – Memory management methods - Timer and Counting devices, Watchdog Timer - Real Time Clock - In circuit emulator - Target Hardware Debugging.		**CO2**

UNIT – III	**Embedded Networking**	**Periods:9**
Embedded Networking: Introduction, I/O Device Ports and Buses– Serial Bus communication protocols –RS232 standard – RS422 – RS485 – CAN Bus -Serial Peripheral Interface (SPI) – Inter Integrated Circuits (I2C) –need for device drivers		**CO3**

UNIT – IV	**Embedded Firmware Development Environment**	**Periods:9**
Embedded Product Development Life Cycle- objectives - different phases of EDLC - Modelling of EDLC - issues in Hardware-software Co-design - Data Flow Graph - state machine model - Sequential Program Model - concurrent Model - object oriented Model.		**CO4**

UNIT – V	**Real Time Health Care applications**	**Periods:9**
Biomedical application- Pulmonary, Patient monitoring system, Body temperature measurement, Mobile phone based bio signal recording		**CO5**

Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 45**

Text Books

1. RajKamal, “Embedded Systems Architecture, Programming and Design”, Tata McGrawHill ,Second Edition, 2014
2. Marilyn Wolf, “Computers as Components - Principles of Embedded Computing System Design”, Third Edition “Morgan Kaufmann Publisher (An imprint from Elsevier), 2012.
3. C.M. Krishna, Kang G. Shin, “Real-Time Systems”, International Editions, Mc Graw Hill 1997

Reference Books

1. Jonathan W.Valvano, “Embedded Microcomputer Systems Real Time Interfacing”, Third Edition Cengage Learning, 2012.
2. Tim Wilhurst, “An Introduction to the Design of Small Scale Embedded Systems,Palgrave, 2004
3. Tammy Noergaard, “Embedded Systems Architecture”, Elsevier, 2005.
4. Jonathan Valvano, ”Embedded Systems: Real-Time Interfacing to Arm Cortex-M3”,CreateSpace Independent Publishing Platform,2011
5. David Simon,”Embedded Systems: A Contemporary Design Tool",Wiley,2009

Web References	
1.	https://www.youtube.com/watch?v=uFhDGagZzjs
2.	https://nptel.ac.in/courses/108102045
3.	https://www.amoriabond.com/en/insights/blog/real-time-applications-of-embedded-systems/
4.	https://www.youtube.com/watch?v=S-daLDfkoyY
5.	https://www.youtube.com/watch?v=7LqPJGnBPMM

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COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	2	2	2	3	1	-	1	-	1	-	3	2	1
2	3	2	2	2	3	3	-	-	-	-	-	3	3	-
3	3	3	2	3	1	2	-	1	1	1	1	3	3	2
4	3	3	2	2	2	2	-	-	-	-	1	3	2	1
5	3	3	2	2	2	2	-	-	-	-	1	2	3	3

Correlation Level: 1 - Low, 2 - Medium, 3 -High

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	CAT 1	CAT 2	Model Exam	Assignment*	Attendance		
Marks	5	5	5	5	5	75	100

* Application oriented / Problem solving / Design / Analytical in content beyond the syllabus

Department	**Biomedical Engineering**	Program: **B.Tech.**						
Semester	**VI**	Course Category: **PC**			*End Semester Exam Type: **TE**			
Course Code	**U23BMT610**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Medical Internet of Things**	**3**	**0**	**0**	**3**	**25**	**75**	**100**
Prerequisite	Biomedical Instrumentation							

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Understand the architecture of IoT and its associated protocols	**K2**
	CO2 Apply cloud service models in networked IoT systems	**K3**
	CO3 Analyze the impact of IoT in healthcare and focusing on patient monitoring	**K3**
	CO4 Evaluate IoT integration in surgical equipment monitoring.	**K4**
	CO5 Describe wearable technologies and applications of M-IOT	**K4**

UNIT-I	**Introduction to IoT**	**Periods: 09**
Brief History of IoT – Architectural Layers of IoT – Bluetooth – Zigbee - Wi-Fi - IP-Based Protocols – UPnP – CoAP – MQTT – XMPP – SCADA - Authentication protocols - IEEE 802.15.4.60.		**CO1**
UNIT-II	**Cloud Integration**	**Periods: 09**
Network layer – Cloud - Network Technologies - Types of Networks – BAN - Cloudterminologies - Types of Cloud - Service Models - Fog and edge customization - BigData		**CO2**
UNIT-III	**IoT in Healthcare**	**Periods: 09**
Introduction to Raspberry Pi – Implementation of IoT with Raspberry Pi – Wearable Technologies and IOT - Electronic tattoos - Smart lenses for diabetics - Bio-monitoring drugs - Baby Monitoring system- Aging in place - Wireless patient Monitoring		**CO3**
UNIT-IV	**IoT in Surgery**	**Periods: 09**
Perception Layer – RFIDs – cameras – Sensors - Introduction to ASICs - pulse oximeters, instrumentation amplifiers - Surgical equipment and dependencies - Surgery and its types - role of IOT in surgery.		**CO4**
UNIT-V	**Applications of IoT**	**Periods: 09**
Ventilators - Wearable Technologies - Smart watches - Remote patient monitoring systems- Smart Care technology Systems		**CO5**

Lecture Periods: 45	**Tutorial Periods:**	**Practical Periods: -**	**Total Periods: 45**

Text Books

1. Aboul Ella Hassanien, Nilanjan Dey, Surekha Borra “Medical Big Data and Internet of Medical Things”, CRC Press, 1st Edition, 2018
2. P. B. Pankajavalli, G. S. Karthick“Incorporating the Internet of Things in Healthcare Applications and Wearable Devices,Advances in Medical Technologies and Clinical Practice(AMTCP)”, IGI Global, 1st Edition, 2019
3. Peter Waher, “Learning Internet of Things”, Packt Publishing, 2015

Reference Books

1. Valentia E.Balas, Le Hoang Son, Sudan Jha, Manju Khari, Raghvendra Kumar “Internet of Things in Biomedical Engineering”, Academic Press, 2019
2. Dr. Guillaume Girardin , Antoine Bonnabel, Dr. Eric Mounier, 'Technologies Sensors for the Internet of Things Businesses & Market Trends 2014 -2024',Yole Development Copyrights ,2014
3. Vijender Kumar Solanki, Raghvendra Kumar, Md. Atiqur Rahman Ahad “A Handbook of Internet of Things in Biomedical and Cyber Physical System” Springer International Publishing,2019
4. Amit Banerjee, Lalit Garg, Joel J. P. C. Rodrigues “Internet of Medical Things for Smart Healthcare” Springer Singapore,2019

Web References

1. https://nptel.ac.in/noc/courses/noc19/SEM1/noc19-cs31/

2.	https://www.digimat.in/nptel/courses/video/108105091/L01.html
3.	https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=7113786

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COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	3	2	2	2	2	-	-	-	-	1	3	1	1
2	3	3	2	2	2	2	-	-	-	-	1	3	2	1
3	3	3	2	2	2	2	-	-	-	-	1	3	2	1
4	3	3	2	2	2	2	-	-	-	-	1	3	2	1
5	3	3	2	2	2	2	-	-	-	-	1	3	2	1

Correlation Level: 1 - Low, 2 - Medium, 3-High

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	CAT 1	CAT 2	Model Exam	Assignment*	Attendance		
Marks	5	5	5	5	5	75	100

* Application oriented / Problem solving / Design / Analytical in content beyond the syllabus

Department	**Biomedical Engineering**	Program: **B.Tech.**						
Semester	**VI**	Course Category: **PC**			*End Semester Exam Type: **TE**			
Course Code	**U23BMT611**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Artificial Intelligence and Machine Learning in Healthcare**	**3**	**0**	**0**	**3**	**25**	**75**	**100**
Prerequisite	**-**							

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Define the various characteristics of intelligent agents	**K2**
	CO2 Describe the different search strategies in AI	**K3**
	CO3 Apply the particular agent strategy to solve a given problem	**K3**
	CO4 Classify the different machine learning techniques	**K3**
	CO5 Acquire knowledge on applications of AIML in biomedical applications	**K4**

UNIT – I	**Introduction**	**Periods:9**	
Introduction–Future of Artificial Intelligence – Characteristics of Intelligent Agents–Typical Intelligent Agents – Problem Solving Approach, Artificial Intelligence in Medicine.			**CO1**
UNIT – II	**Problem Solving Methods**	**Periods:9**	
Problem solving Methods - Search Strategies- Uninformed - Informed - Heuristics - Local Search Algorithms and Optimization Problems - Searching with Partial Observations – Constraint Satisfaction Problems – Constraint Propagation.			**CO2**
UNIT – III	**Knowledge Representation**	**Periods:9**	
First Order Predicate Logic – Prolog Programming – Unification – Forward Chaining-Backward Chaining,Data Preprocessing-Data cleaning, handling missing values, normalization, data augmentation			**CO3**
UNIT – IV	**Machine Learning for Healthcare**	**Periods:9**	
Supervised learning algorithms for healthcare prediction - Unsupervised learning techniques in healthcare - Evaluation and validation of machine learning models in healthcare			**CO4**
UNIT – V	**Healthcare Applications**	**Periods:9**	
Predictive modelling for disease diagnosis and prognosis - Healthcare resource allocation and optimization - Fraud detection and anomaly detection in healthcare data. - Case studies in cancer treatment, neurodegenerative diseases			**CO5**

Lecture Periods: 45	**Tutorial Periods:**	**Practical Periods: -**	**Total Periods: 45**

Text Books

1. Lei Xing, Maryellen L. Giger, James K. Min “Artificial Intelligence in Medicine Technical Basis and Clinical Applications” Elsevier Science 2020.
2. Bratko, “PrologProgramming for Artificial Intelligence”, Fourth Edition, Addison-Wesley Educational Publishers,2011.
3. S. Russell and P. Norvig, "Artificial Intelligence: A Modern Approach”, 3rd Edition, Prentice Hall,2009,

Reference Books

1. Gerhard Weiss, “Multi Agent Systems”, 2nd Edition, 2013, MIT Press.
2. David L. Poole and Alan K. Mackworth, “Artificial Intelligence: Foundations of Computational Agents”, 4th Edition, Cambridge University Press, 2010
3. Richard Szeliski, “Computer Vision: Algorithms and Applications”, 1st Edition, 2010, Springer
4. Simon J.D. Prince, “Computer vision: models, learning and inference”, 1st Edition, Cambridge University Press,2012

Web References

1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6616181/
2. https://sigmoidal.io/artificial-intelligence-and-machine-learning-for-healthcare/
3. https://link.springer.com/book/10.1007/978-981-16-0811-7

* TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	2	1	1	1	1	-	-	-	-	-	2	1	1	1
2	3	3	2	3	1	-	-	-	-	-	2	1	1	1
3	2	3	2	3	-	1	-	-	-	-	2	1	1	1
4	2	3	2	2	-	1	-	-	-	-	2	1	1	1
5	2	2	1	1	-	1	-	-	-	-	2	1	1	1

Correlation Level: 1 - Low, 2 - Medium, 3 -High

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	CAT 1	CAT 2	Model Exam	Assignment*	Attendance		
Marks	5	5	5	5	5	75	100

***** Application oriented / Problem solving / Design / Analytical in content beyond the syllabus

Department	**Biomedical Engineering**	Programme : **B.Tech.**					
Semester	**VI**	Course Category: **PC**			*End Semester Exam Type: **LE**		
Course Code	**U23BMP607**	Periods/Week			Credit	Maximum Marks	
		L	T	P	C	CAM	ESE
Course Name	**Diagnostic and Therapeutic Equipment Laboratory**	**0**	**0**	**2**	**1**	**50**	**50**
Prerequisite							

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Experiment the analysis of ECG, EEG and EMG signals.	**K3**
	CO2 Simulate ECG signals and Pacemaker.	**K4**
	CO3 Conduct investigation using Defibrillator simulator.	**K3**
	CO4 Describe shortwave and ultrasonic diathermy.	**K3**
	CO5 Demonstrate the protection equipment's for electrical safety measures.	**K3**

LIST OF EXPERIMENTS

1. Recording and analysis of ECG signals
2. Recording and analysis of EEG signals
3. Recording - Fatigue test of EMG signals
4. Simulation of ECG – detection of QRS complex and heart rate
5. Operation and analysis of a Pacemaker and Defibrillator simulator
6. Analyze the functioning and safety aspects of surgical diathermy, shortwave and ultrasonic diathermy
7. Transmission and Reception of biological signal using a telemetry system
8. Study of Endoscopy and Laparoscopy equipment's
9. Electrical safety measurements
10. Auditory system checkup using Audiometer
11. Measurement of Oxygen Saturation and Heart Rate using Pulse-oximeter
12. Study of heart lung machine model.

Reference Books

1. Richard Aston, "Principles of Biomedical Instrumentation and Measurement", Merril Publishing Company, 2007.
2. Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw Hill, 3rd Edition, New Delhi, 2003.
3. Myer Kutz, "Standard Handbook of Biomedical Engineering and Design", Mc Graw Hill, 2003.
4. L.A Geddes and L.E.Baker, "Principles of Applied Biomedical Instrumentation", 3rd Edition, 2008.
5. Antony Y.K.Chan, "Biomedical Device Technology, Principles and design", Charles Thomas Publisher Ltd, Illinois, USA, 2008.

Web References

1. https://www.nap.edu/read/21794/chapter/7
2. https://www.embs.org/about-biomedical-engineering/our-areas-of-research/diagnostic-therapeutic-systems.
3. https://www.wsh.nhs.uk/CMS-Documents/Trust-policies/201-250/PP19206

* TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	3	2	2	2	2	-	-	-	-	1	3	1	1
2	3	3	2	2	2	2	-	-	-	-	1	3	2	1
3	3	3	2	2	2	2	-	-	-	-	1	3	2	1
4	3	3	2	2	2	2	-	-	-	-	1	3	2	1
5	3	3	2	2	2	2	-	-	-	-	1	3	2	1

Correlation Level: 1 - Low, 2 - Medium, 3 -High

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	Performance in practical classes			Model Practical Examination	Attendance		
	Conduction of practical	Record work	viva				
Marks	15	5	5	15	10	50	100

Department	**Biomedical Engineering**	Programme : **B.Tech.**					
Semester	**VI**	Course Category: **PC**			*End Semester Exam Type: **LE**		
Course Code	**U23BMP608**	Periods/Week			Credit	Maximum Marks	
		L	T	P	C	CAM	ESE
Course Name	**Embedded Systems for Healthcare Laboratory**	**0**	**0**	**2**	**1**	**50**	**50**
Prerequisite							

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Write programs in ARM for a specific Application	**K2**
	CO2 Interface memory, A/D and D/A convertors with ARM system	**K3**
	CO3 Write program for interfacing keyboard, display, motor and sensor.	**K3**
	CO4 Generate PWM signals for motor control applications	**K3**
	CO5 Formulate a mini project using embedded system	**K4**

LIST OF EXPERIMENTS

1. Study of ARM evaluation system
2. Flashing of LEDS
3. Interfacing Buzzer
4. Interfacing ADC
5. Interfacing DAC
6. Interfacing Seven segment display
7. Interfacing real time clock
8. Interlinking Keyboard and LCD
9. Interfacing of stepper motor
10. Interfacing DC motor
11. Interfacing of PWM based LED lighting board
12. Interfacing Temperature sensor

Text Books

1. 1. RajKamal, “Embedded Systems Architecture, Programming and Design”, Tata McGrawHill ,2nd Edition, 2008
2. Marilyn Wolf, “Computers as Components - Principles of Embedded Computing System Design”, 3rd Edition “Morgan Kaufmann Publisher (An imprint from Elsevier), 2012.
3. C.M. Krishna, Kang G. Shin, “Real-Time Systems”, International Editions, Mc Graw Hill 1997
4. Jonathan W.Valvano, “Embedded Microcomputer Systems Real Time Interfacing”, 3rd Edition Cengage Learning, 2012.
5. Jonathan Valvano, ”Embedded Systems: Real-Time Interfacing to Arm Cortex-M3”,CreateSpace Independent Publishing Platform,2011
6. David Simon,”Embedded Systems: A Contemporary Design Tool",Wiley,2009

Web References

1. https://www.youtube.com/watch?v=uFhDGagZzjs
2. https://nptel.ac.in/courses/108102045
3. https://www.amoriabond.com/en/insights/blog/real-time-applications-of-embedded-systems/
4. https://www.youtube.com/watch?v=S-daLDfkoyY
5. https://www.youtube.com/watch?v=7LqPJGnBPMM
6. https://www.youtube.com/watch?v=uFhDGagZzjs

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COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	3	2	2	2	2	-	-	-	-	1	3	1	1
2	3	3	2	2	2	2	-	-	-	-	1	3	2	1
3	3	3	2	2	2	2	-	-	-	-	1	3	2	1
4	3	3	2	2	2	2	-	-	-	-	1	3	2	1
5	3	3	2	2	2	2	-	-	-	-	1	3	2	1

Correlation Level: 1 - Low, 2 - Medium, 3 -High

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	Performance in practical classes			Model Practical Examination	Attendance		
	Conduction of practical	Record work	viva				
Marks	15	5	5	15	10	50	100

Department	**Biomedical Engineering**	Programme : **B.Tech.**					
Semester	**VI**	Course Category: **PC**			*End Semester Exam Type: **LE**		
Course Code	**U23BMP609**	Periods/Week			Credit	Maximum Marks	
		L	T	P	C	CAM	ESE
Course Name	**Medical Internet of Things Laboratory**	**0**	**0**	**2**	**1**	**50**	**50**

Prerequisite

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
CO1	Gain knowledge in Programming for embedded applications.	**K3**
CO2	Realize human fall detection, ECG system, and surgical system.	**K4**
CO3	Familiarize with ThingSpeak cloud.	**K3**
CO4	Integrate Raspberry pi and ThingSpeak.	**K3**
CO5	Analyze smart systems	**K4**

LIST OF EXPERIMENTS

Conduct the Experiments using Arduino / Raspberry pi

1. Study of Raspberry pi, UART Communication
2. To interface LED/Buzzer and write a program to 'turn ON' LED for 1 sec after every 2 seconds.
3. To interface Push button/Digital sensor (IR/LDR) and write a program to 'turn ON' LED when push button is pressed or at sensor detection.
4. Study of REST and HTTP protocols, PUSH, PUT and GET commands, Linux CLI, Raspberry OS
5. Human Fall detection system using an Accelerometer sensor
6. Study of ECG system, which gets Heart beat sensor reading from different modes
7. Surgical automation system, which runs 2 motor using a Servo Motor based inputs given on console in pc and operates the motor operation.
8. Baby Monitoring system, to prevent sudden infant death syndrome
9. Clinical Management system consisting of RFIDs tags and cards which constantly uploads inpatient and outpatient details to ThingSpeak. Server
10. Smart Ventilator system to control through various modes of ventilator connected to ThingSpeak. server,and remotely operated.
11. Waste Management system consisting of moisture and Gas sensor connected to server and remotely indicating the recycle process of medical waste
12. Smart watch system, to indicate and alert users of their routine works and also monitor the pulse and temperature readings.

Reference Books

1. Aboul Ella Hassanien, Nilanjan Dey, Surekha Borra "Medical Big Data and Internet of Medical Things", CRC Press, 1st Edition, 2018
2. P. B. Pankajavalli, G. S. Karthick"Incorporating the Internet of Things in Healthcare Applications and Wearable Devices,Advances in Medical Technologies and Clinical Practice(AMTCP)", IGI Global, 1st Edition, 2019
3. Valentia E.Balas, Le Hoang Son, Sudan Jha, Manju Khari, Raghvendra Kumar "Internet of Things in Biomedical Engineering", , Academic Press, 2019
4. Vijender Kumar Solanki, Raghvendra Kumar, Md. Atiqur Rahman Ahad "A Handbook of Internet of Things in Biomedical and Cyber Physical System" Springer International Publishing,2019
5. Amit Banerjee, Lalit Garg, Joel J. P. C. Rodrigues "Internet of Medical Things for Smart Healthcare"

Springer Singapore,2019

Web References

1. https://nptel.ac.in/noc/courses/noc19/SEM1/noc19-cs31/
2. https://www.digimat.in/nptel/courses/video/108105091/L01.html
3. https://www.jmir.org/2020/11/e20135/

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COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	3	3	3	3	2	-	2	2	-	3	3	1	1
2	3	3	3	3	3	2	-	2	2	-	3	3	1	1
3	3	3	3	3	3	2	-	2	2	-	3	3	1	1
4	3	3	3	3	3	2	-	2	2	-	3	3	1	1
5	3	3	3	3	3	2	-	2	2	-	3	3	3	3

Correlation Level: 1 - Low, 2 - Medium, 3 -High

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	Performance in practical classes			Model Practical Examination	Attendance		
	Conduction of practical	Record work	viva				
Marks	15	5	5	15	10	50	100

Department	**Biomedical Engineering**	Programme: **B. Tech.**					
Semester	**VI**	Course Category Code: **PA**			*End Semester Exam Type: **-**		
Course Code	**U23BMW602**	Periods / Week			Credit	Maximum Marks	
		L	T	P	C	CAM	ESE	TM
Course Name	**MINI PROJECT**	**0**	**0**	**2**	**1**	**100**	**-**	**100**

Prerequisite	Biomedical Instrumentation, Electronics, C Programming	
Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Identify the problem statement for the mini project work through the literature survey	**K2**
	CO2 Choose the proper components as per the requirements of the design/ system**.**	**K2**
	CO3 Apply the acquainted skills to develop final model/system	**K3**

There shall be a Mini Project, which the student shall pursue as a team consists of maximum 4 students during the third year, fifth semester. The aim of the mini project is that the student has to understand the real time hardware / software applications. The student should gain a thorough knowledge in the problem he/she has selected and in the hardware / software he/she using in the Project. The Mini-project is an application that should be formally initiated and should be developed and also to be implemented by the respective team.

The Mini Project shall be submitted in a report form along with the hardware model / software developed, duly approved by the department internal evaluation committee. It shall be evaluated for 100 marks as Continuous Assessment. The department internal evaluation committee shall consist of faculty coordinator, supervisor of the project and a senior faculty member of the department. There shall be two reviews that will be considered for assessing a Mini Project work with weightage as indicated evaluation Methods.

Lecture Periods: -	**Tutorial Periods: -**	**Practical Periods: 30**	**Total Periods: 30**

COs/POs/PSOs Mapping

COs	**Program Outcomes (POs)**											**Program Specific Outcomes (PSOs)**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
1	3	2	2	2	-	-	-	3	3	-	1	1	1	1
2	3	3	3	2	2	2	2	3	3	3	1	2	2	2
3	3	2	2	1	-	2	-	3	3	3	1	2	2	2

Correlation Level: 1 – Low, 2 – Medium, 3 – High

Evaluation Method

Assessment	Review 1			Review 2				Total Marks
	Novelty	Presentation	Viva	Presentation	Demonstration	Viva	Report	
Marks	10	20	10	20	20	10	10	100

Department	**Biomedical Engineering**	Programme: **B. Tech.**						
Semester	**VI**	Course Category: **AEC**			End Semester Exam Type: **-**			
Course Code	**U23BMC6XX**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**CERTIFICATION COURSE - VI**	**0**	**0**	**4**	**-**	**100**	**-**	**100**
Prerequisite	**-**							

Students shall choose an International / Reputed organization certification course of 40-50 hours duration specified in the curriculum (It is mandatory to do a minimum of six courses) which will be offered through the Centre of Excellence. These courses have no credit and will not be considered for CGPA calculation.

(i) Certification Courses are required to be completed to fulfil the degree requirements. All Certification courses are assessed internally for 100 marks.

(ii) The Course coordinator handling the course will assess the student through attendance and MCQ test, and declare the student as “pass” on satisfactory completion. A letter grade “P” is awarded to declare pass.

(iii) The marks scored in these courses will not be taken into consideration for the SGPA / CGPA calculations in the grade sheet.

Evaluation Method

Assessment	**Continuous Assessment Marks (CAM)**		**Total Marks**
	Attendance	**MCQ Test**	
Marks	**10**	**90**	**100**

Department	**Biomedical Engineering**	Programme: **B. Tech.**						
Semester	**VI**	Course Category: **MC**			End Semester Exam Type :			
Course Code	**U23BMM606**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Gender Equality**	**2**	**0**	**0**	**-**	**100**	**-**	**100**

Prerequisite	**-**	
Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Describe the general identity, social construction of gender roles.	**K2**
	CO2 Illustrate the causes and issues of gender discrimination in Indian society.	**K2**
	CO3 Describe the workplace discrimination, media influences on gender and culture.	**K2**
	CO4 Familiarize with international and Indian frameworks on gender equality.	**K2**
	CO5 Illustrate the current challenges in gender equality, including the glass ceiling and the role of technology.	**K2**

UNIT – I	**Introduction to Gender Equality**	**Periods:06**
Gender equality – exploring gender identity and expression, Understanding the social construction of general roles and norms, historical perspectives on gender roles, Analyzing key milestones in the fight for gender equality.		**CO1**
UNIT – II	**Gender Inequality and Its Manifestations**	**Periods:06**
Gender discrimination in Indian society – causes of gender inequality – Illiteracy, patriarchal set up, lack of awareness, social beliefs, practice and custom – Issues of gender discrimination – Child marriage, child domestic work, poor education and health, violence and exploitation in workplace.		**CO2**
UNIT – III	**Gender and Culture**	**Periods:06**
Workplace discrimination, Media influences on gender and culture, Gender and power dynamics in society. Strategies for promoting gender equality and cultural understanding.		**CO3**
UNIT – IV	**Promoting Gender Equality**	**Periods:06**
Gender Equality and Human Rights – International frameworks and Conventions on Gender Equality – Equality under the Indian Constitution – Policies and initiatives for gender mainstreaming – Strategies for promoting Gender Equality in various contexts.		**CO4**
UNIT – V	**Contemporary Challenges and Future Directions**	**Periods:06**
Current challenges and emerging issues in gender equality – Glass ceiling – role of technology in continuing or challenging gender inequality – Exploring possibilities for transformative change and envisioning a gender-equal future.		**CO5**

Lecture Periods: 30	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 30**

Text Books

1. "Gender and Society" by Raewyn Connell – This book provides a comprehensive overview of gender roles, power dynamics, and the social construction of gender.
2. "The Second Sex" by Simone de Beauvoir – A historical and philosophical examination of women's oppression and gender inequality.
3. "Women and Gender in the Indian Society" by Neera Desai and Usha Thakkar – Focuses on the context of gender roles, inequality, and feminist movements in India.

Reference Books

1. Woman in early Indian societies, New Delhi: Manohar Publications. Sita A. Raman (2009).
2. A social and Cultural history, Volume1. Connecticut: Oxford: Praeger. Sita Raman (2009).
3. A social and Cultural history, Volume2. Connecticut: Oxford: Praeger.
4. Iftikhar R. (2016). Indian Feminism: Class, Gender and Identity in Medieval Ages. Chennai: Notion Press. Iftikhar, R. (2012).

Web References

1. https://www.unwomen.org
2. https://ncw.nic.in
3. https://en.unesco.org/themes/gender-equality
4. https://www.weforum.org/reports
5. https://wcd.nic.in

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	1	-	-	-	-	-	-	-	3	-	1	1	-	1
2	1	-	-	-	-	-	-	-	3	-	1	1	-	1
3	1	-	-	-	-	-	-	-	3	-	1	1	-	1
4	1	-	-	-	-	-	-	-	3	-	1	1	-	1
5	1	-	-	-	-	-	-	-	3	-	1	1	-	1

Correlation Level: 1 - Low, 2 - Medium, 3 – High

Evaluation Methods

Assessment	Continuous Assessment Marks (CAM)			Total Marks
	Attendance	MCQ Test	Presentation / Activity / Assignment	
Marks	10	30	60	100

PROFESSIONAL ELECTIVE-VI

Department	**Biomedical Engineering**	Program: **B.Tech.**						
Semester	**VI**	Course Category: P**E**			*End Semester Exam Type: **TE**			
Course Code	**U23BME610**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Troubleshooting and Quality Control in Medical Equipment**	**3**	**0**	**0**	**3**	**25**	**75**	**100**
Prerequisite								

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Apply troubleshooting techniques to identify equipment failures.	**K3**
	CO2 Describe the testing procedures of active and passive components.	**K3**
	CO3 Analyze the fault diagnosis in analog circuits and digital ICs.	**K4**
	CO4 Identify the problems in common biomedical equipment in hospitals when it is not working and provide a suitable solution.	**K4**
	CO5 Describe the various quality measures & standards adapted for medical systems	**K3**

UNIT – I	**Fundamental Troubleshooting Testing Procedures**	**Periods:9**
Equipment failure and its cause-Functional block diagram of a troubleshooting system-Troubleshooting process & fault-finding aids-Troubleshooting techniques and their correction action-Testing of active and passive components: resistor, capacitor, inductor, BJT, JFET, & MOSFET		**CO1**
UNIT – II	**Fault Diagnosis in Analog & Digital Integrated Circuits**	**Periods:9**
Characteristics of ideal op-amps, typical op-amp based medical circuits-Fault diagnosis in op-amp circuits-Digital troubleshooting methods-Digital IC Troubleshooters, logic clip, logic probe, logic pulser, logic current tracer, logic comparator-Circuit board Troubleshooting.		**CO2**
UNIT – III	**Biomedical Equipment Troubleshooting**	**Periods:9**
Troubleshooting- ECG Machine, EEG Machine- defibrillator, electrosurgical unit Troubleshooting- anesthesia machine, autoclaves & sterilizers- endoscope, incubators, nebulizer- oxygen concentrators, sphygmomanometers, suction machine- X-ray machine.		**CO3**
UNIT – IV	**Medical Device Design Quality**	**Periods:9**
Definition of quality, essence of quality-Quality operating system and the device life cycle-Evolution of quality Business excellence: a value proposition-Health care quality.		**CO4**
UNIT – V	**Design For Six Sigma and Medical Device Regulation**	**Periods:9**
Global Perspective on medical device regulations, medical device classification (USA, Europe & GHTF-Medical device safety, medical device quality management systems requirements-Medical device regulation throughout the product development life cycle-Purpose of ISO 9001:2001&ISO 13485.		**CO5**

Lecture Periods: 45	**Tutorial Periods:**	**Practical Periods: -**	**Total Periods: 45**

Textbooks

1. Khandpur R S, “Troubleshooting Electronic Equipment- Includes Repair & Maintenance”, 2nd Edition, Tata McGrawHill, 2009.
2. Basem S EL-Haik& Khalid S Mekki, “Medical Device Design for Six Sigma: A Road Map for Safety and Effectiveness”, 1st Edition, John Wiley & Sons 2008.
3. Gopalakrishna, P. Purchasing and Materials Management, Tata MC.Graw Hill, New Delhi, 2017.

Reference Books

1. Nicholas Cram & Selby Holder, “Basic Electronic Troubleshooting for Biomedical Technicians”, 2nd Edition, 2010, TSTC Publishing.
2. Dan Tomal& Neal Widmer, “Electronic Troubleshooting”, 3rd Edition, McGraw Hill ,2004,.
3. Richard Fries, “Reliable Design of Medical Devices”, 2nd Edition, CRC Press., 2006

4. Joseph J Panichello, "X-Ray Repair: A Comprehensive Guide to the Installation & Servicing of Radiographic Equipment", 2nd Edition, Charles C Thomas Publisher Ltd. , 2005
5. Gopalakrishna, P., Materials Management, Prentice Hall, New Delhi, 2015.

Web References

1. https://www.who.int/medical_devices/publications/en/MD_Regulations.pdf
2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2924127/
3. https://www.ncbi.nlm.nih.gov/pubmed/7613571

* TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	2	1	1	2	1	-	-	-	-	1	2	2	3
2	3	2	1	1	2	1	-	-	-	-	1	2	2	3
3	3	3	2	1	2	1	-	-	-	-	1	2	2	3
4	3	3	2	1	2	1	-	-	-	-	1	2	1	1
5	3	3	2	1	2	1	-	-	-	-	1	2	1	1

Correlation Level: 1 - Low, 2 - Medium, 3 – High

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	CAT 1	CAT 2	Model Exam	Assignment*	Attendance		
Marks	5	5	5	5	5	75	100

* Application oriented / Problem solving / Design / Analytical in content beyond the syllabus

Department	**Instrumentation and Control Engineering**	Programme: **B.Tech.**						
Semester	**VI**	Course Category Code: **PE**			*End Semester Exam Type: **TE**			
Course Code	**U23ICEC02**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Soft Computing Techniques**	**3**	**0**	**0**	**3**	25	75	100

(Common to ICE, ECE and BME Branches)

Prerequisite		
Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Familiarize in the neural network architecture.	**K2**
	CO2 Impart knowledge on various training algorithm of neural network and its application	**K3**
	CO3 Illustrate the fuzzy sets and the properties of fuzzy logic	**K2**
	CO4 Comprehend fuzzy logic controllers and its applications.	**K2**
	CO5 Understand the concepts of optimization algorithms.	**K2**

UNIT – I	**Introduction to Neural Network**	**Periods:9**
Introduction to neural networks – Biological neural networks, Artificial Neural network: Single and Multi-layer feed forward network- Activation function, types (step and sigmoid function), threshold function- Classification of learning: Supervised, Unsupervised and Reinforced. McCulloh Pitts neuron: architecture, algorithm and applications.		**CO 1**
UNIT – II	**Neural Networks Control**	**Periods:9**
Back propagation neural net: standard architecture, algorithm -Hopfield net: architecture and algorithm- Kohonnen's Self Organizing map- Adaptive Resonance Theory ART 1: Architecture and operation- Neural networks for control: Schemes of neuro control - Applications of neuro controller.		**CO2**
UNIT – III	**Introduction to Fuzzy Logic**	**Periods:9**
Classical sets - Fuzzy sets – properties of fuzzy sets – operations on fuzzy sets, Cartesian Product, Fuzzy relations linguistic variables – Linguistic approximation. Fuzzy statements: Assignments, Conditional and Unconditional statements.		**CO3**
UNIT – IV	**Fuzzy Logic Control System**	**Periods:9**
Introduction to Fuzzy logic controller: Architecture – Fuzzification, Membership functions: Triangular, Trapezoidal, Gaussian. Inference Mechanism, knowledge base, fuzzy rule base, Inference method: Mamdani, Sugeno and TSK models, Defuzzification - Applications of Fuzzy logic controller.		**CO4**
UNIT – V	**Optimization**	**Periods:9**
Optimization - Derivative-based Optimization – Descent Methods – The Method of Steepest Descent – Classical Newton"s Method – Step Size Determination – Derivative-free Optimization – Genetic Algorithm Search – Downhill Simplex Search.		**CO5**

Lecture Periods:45	**Tutorial Periods:45**	**Practical Periods:-**	**Total Periods:45**

Text Books

1. Timothy J. Ross, "Fuzzy Logic with Engineering Applications", McGraw- Hill International Editions,2010
2. Laurene Fausett, "Fundamentals of Neural Networks" Pearson Education, 2008
3. George J. Klir and Bo Yuan, "Fuzzy sets and Fuzzy Logic ". Prentice Hall, USA .2015

Reference Books

1. David E. Goldberg, "Genetic Algorithms in Search, Optimization and Machine Learning", Addison Wesley, 2019
2. Rajasekaran. S, Pai. G.A.V. "Neural Networks, Fuzzy Logic and Genetic Algorithms", Prentice-Hall
3. Jang J.S.R., Sun C.T. and Mizutani E, "Neuro-Fuzzy and soft computing", Pearson Education 2007
4. W.T.Miller, R.S.Sutton and P.J.Webrose, Neural Networks for Control, MIT Press, 2001.
5. S. N. Sivanandam, S. Sumathi, S. N. Deepa, "Introduction to Neural Networks using MATLAB 6.0", Tata McGraw Hill Education, 1st Edition, 2017.

Web References
1. https://lecturenotes.in/subject/922.
2. https://www.ifi.uzh.ch/dam/jcr:00000000-2826-155d-0000-00005e4763e3/fuzzylogicscript.pdf.
3. https://nptel.ac.in/courses/106/105/106105173/.

* TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	3	-	-	-	2	-	-	-	-	-	3	2	1
2	3	3	-	3	3	2	-	-	-	-	-	2	2	1
3	3	3	2	3	3	2	-	-	-	-	-	2	2	1
4	3	2	3	3	3	2	-	-	-	-	-	2	2	1
5	3	3	3	2	2	2	-	-	-	-	-	2	2	1

Correlation Level: 1 - Low, 2 - Medium, 3 – High

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	CAT 1	CAT 2	Model Exam	Assignment*	Attendance		
Marks	5	5	5	5	5	75	100

* Application oriented / Problem solving / Design / Analytical in content beyond the syllabus

Department	**Biomedical Engineering**	Programme: B.Tech.						
Semester	**VI**	Course Category: **PE**			*End Semester Exam Type: **TE**			
Course Code	**U23BME611**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Physiological System Modeling**	**3**	**0**	**0**	**3**	**25**	**75**	**100**
Prerequisite	Human Anatomy and Physiology							

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Explain the application of Physiological models and vital organs	**K2**
	CO2 Formulate the methods and techniques for analysis and synthesis of dynamic models	**K3**
	CO3 Describe the dynamic models, simulate and visualize, dynamic responses of physiological models using software	**K2**
	CO4 Describe nonlinear models of physiological systems	**K2**
	CO5 Compute the Simulation of physiological systems	**K3**

UNIT – I	**Introduction to Physiological Modeling**	**Periods:9**
Approaches to modelling: The technique of mathematical modelling, classification of models, characteristics of models. Time invariant and time varying systems for physiological modelling.		**CO1**

UNIT – II	**Modeling of Dynamic Physiological System**	**Periods:9**
Dynamic systems and their control, modelling and block diagrams, The Circulatory System -Blood flow, circulation, arterial pulse. The Endocrine System - Pituitary gland, insulin and glucose. The pupil control systems (Human Eye), the dynamic response characteristics of the pupil control system, The Inner Ear - Frequency tuning, models of the cochlea, resonance in hair cells.		**CO2**

UNIT – III	**Nonlinear Models of Physiological Systems**	**Periods: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.		**CO3**

UNIT – IV	**Compartmental Physiological Model**	**Periods:9**
Modelling 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.		**CO4**

UNIT – V	**Simulation of Physiological Systems**	**Periods: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.		**CO5**

Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 45**

Textbooks

1. Michel C Khoo, “Physiological Control Systems -Analysis, simulation and estimation”, Prentice Hall of India, 2021.
2. Marmarelis, “Nonlinear Dynamic Modelling of Physiological Systems”, Wiley-IEEE Press, 2004.

Reference Books

1. Benjamin C Kuo, “Automatic control systems”, Tenth Edition, McGraw-Hill Education, 2017.
2. David.T Westwick, Robert E. Kearney, Identification of Nonlinear Physiological Systems, Wiley-IEEE Press, 2003.
3. MinruiFei, Shiwei Ma, Xin Li, Xin Sun, Li Jia and Zhou Su,“ Advanced Computational Methods in Life System Modelling and Simulation*”,* Springer,*2017*
4. Mathematical Modeling in Systems Biology, by Brian Ingalls (ISBN: p780262315623)

Web References

1. https://nsec.lab.uconn.edu/home/courses-2/bme-3100-physiological-modeling/
2. https://lcp.mit.edu/pdf/HeldtLNM10Ch2.pdf

3. https://www.sciencedirect.com/topics/engineering/physiological-models

TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	-	-	-	-	-	-	-	-	-	1	1	1	-
2	3	1	1	-	-	-	-	-	-	1	1	1	1	-
3	3	-	1	-	-	-	-	-	-	-	1	1	1	-
4	3	3	3	2	1	-	-	-	-	-	1	1	1	-
5	3	2	3	2	3	-	-	-	-	-	1	1	1	-

Correlation Level: 1 - Low, 2 - Medium, 3 -High

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	CAT 1	CAT 2	Model Exam	Assignment*	Attendance		
Marks	5	5	5	5	5	75	100

* Application oriented / Problem solving / Design / Analytical in content beyond the syllab

Department	**Biomedical Engineering**	Program: **B.Tech.**						
Semester	**VI**	Course Category: **PE**			*End Semester Exam Type: **TE**			
Course Code	**U23BME612**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Hospital Engineering and Information Systems**	**3**	**0**	**0**	**3**	**25**	**75**	**100**
Prerequisite								

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Provide good academic ambience by adopting best information system	**K2**
	CO2 Achieve the best possible support from patient and administration	**K3**
	CO3 Deliver efficient delivery of high-quality health services	**K2**
	CO4 Develop decision support systems, health information standards and information systems acquisitions	**K3**
	CO5 Identify problems and alternate solutions related to records management in the healthcare environment	**K3**

UNIT – I	**Health System**	**Periods:9**	
Concept of Hospital Management - Roles and Responsibilities of Administrator - Hospital Design - Health organization of the country, state, and cities, Health Financing System, Health policies and regulations			**CO1**
UNIT – II	**Hospital Organisation**	**Periods:9**	
Organization of Out-Patient Services - Problems encountered in functioning of O.P Department – Organization of In- Patient Services - Casualty & Emergency Services - Organization and management of Operation theatres, Medical Records Department			**CO2**
UNIT – III	**Hospital Services**	**Periods:9**	
Engineering department - maintenance management- clinical engineering- electrical system- air conditioning system- water supply and sanitary system- centralized medical gas system-communication system, Biomedical Waste Management			**CO3**
UNIT – IV	**Infection Control and Waste Management**	**Periods:9**	
Importance of infection control-hand hygiene-clinical laboratory standards to infection control-health care workers safety-solid waste management and transportation, Sterilization Techniques			**CO4**
UNIT – V	**Integrated Medical Information System**	**Periods:9**	
Integration of inter and intra hospital information system. Role of expert systems-web based Multimedia information system- introduction of a computerized HIS Automation of medical record-cost and Benefits of HIS Modems and Networking in Hospitals, Electronic Health Records (EHRs).			**CO5**

Lecture Periods: 45	**Tutorial Periods:**	**Practical Periods: -**	**Total Periods: 45**

Text Books

1. Dr. L.L. Rao, “Hospital Management”, Annamalai University Press, 2nd Edition, 2013 2 3.
2. R. D. Lele, “Computers in Medicine”, Tata McGraw Hill, 3rd Edition, 2005
3. Mohan Bansal, “Medical informatics”, Tata McGraw Hill. 2nd Edition, 2005.

Reference Books

1. Gupta, Kant, Chandrashekhar, Satpathy,” Modern Trends in Planning and Designing of Hospitals Principles and Practice with CD-ROM”, JaySpee Medical publishers, 1st Edition,2007.
2. Sharma, “Essentials for Hospital Support Services and Physical Infrastructure”, Jaypee Medical Publishers, 1 st Edition, 2003
3. Ramani.K.V.,”Hospital Management”, Pearson, 2011.
4. Sakharkar, “Principles of Hospital Administration and Planning”, Jaypee Medical, 1st Edition, 2004.
5. Harold E. Smalley, “Hospital Management Engineering – A guide to the improvement of hospital management system “, PHI, 1st Edition, 1982.

Web References	
1.	https://en.wikipedia.org/wiki/Hospital_information_system
2.	https://www.ncbi.nlm.nih.gov/books/NBK22862
3.	https://en.wikipedia.org/wiki/Healthcare_engineering

* TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	2	1	-	1	3	-	-	-	-	1	3	1	1
2	3	2	1	-	1	3	-	-	-	-	1	3	1	1
3	3	2	1	-	1	3	-	-	-	-	1	3	1	1
4	2	2	1	-	1	3	-	-	-	-	1	3	1	1
5	3	2	1	-	1	3	-	-	-	-	1	3	1	1

Correlation Level: 1 - Low, 2 -Medium, 3 – High

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	CAT 1	CAT 2	Model Exam	Assignment*	Attendance		
Marks	5	5	5	5	5	75	100

***** Application oriented / Problem solving / Design / Analytical in content beyond the syllabus

Department	**Biomedical Engineering**	Program: **B.Tech.**						
Semester	**VI**	Course Category: **PE**			*End Semester Exam Type: **TE**			
Course Code	**U23BME613**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Biotelemetry and Telemedicine**	**3**	**0**	**0**	**3**	**25**	**75**	**100**
Prerequisite								

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Understand telemetry basics and its classification	**K2**
	CO2 Gain knowledge about telemetry and telemedicine applications	**K2**
	CO3 Describe the applications of Biotelemetry	**K3**
	CO4 Acquire clear idea about the fundamentals of telemedicine	**K2**
	CO5 Explain the Applications of telemedicine in various fields	**K3**

UNIT – I	**Introduction to Telemetry**	**Periods:9**	
Basic system - Classification - Nonelectrical telemetry systems - Mechanical and Pneumatic type, Voltage and Current telemetry systems - Local transmitters and Converters - Frequency telemetry system - Power Line carrier communication (PLCC).			**CO1**
UNIT – II	**Biotelemetry Systems and Components**	**Periods:9**	
Sensors and Transducers: Types and functions. Signal Acquisition: Methods for collecting physiological signals.Data Transmission: Wireless technologies and protocols.			**CO2**
UNIT – III	**Application of Biotelemetry**	**Periods:9**	
Wireless Telemetry - Single Channel and Multi-channel Telemetry systems - Multi Patient Telemetry – Implantable Telemetry Systems - Ambulatory patient monitoring. .			**CO3**
UNIT – IV	**Fundamentals of Telemedicine**	**Periods:9**	
History and advancements in telemedicine - Benefits of telemedicine – Functional Block of a telemedicine system - Use of computers in distance mode of healthcare delivery - Familiarizing with technology of telemedicine – scanner, electro stethoscope - data reception equipment - Scope for telemedicine - Limitations of telemedicine.			**CO4**
UNIT – V	**Applications of Telemedicine**	**Periods:9**	
Tele radiology: Basic parts of Teleradiology system -Telemedicine in Neuroscience - Telecardiology – Telepathology –- Telepediatrics – Telepharmacy – Telepsychiatry and mental health – Veterinary.			**CO5**

Lecture Periods: 45	**Tutorial Periods:**	**Practical Periods: -**	**Total Periods: 45**

Text Books

1. Konstantina S.Nikita, “Handbook of Biomedical Telemetry”, 1st Edition, 2014
2. Charles J.Amlaner and David W. Macdonald, “A Handbook on biotelemetry and Radio Tracking”, 1st Edition,2013
3. Wootton, R., Craig, J., Patterson, V. (Eds.), “Introduction to Telemedicine”, 5th Edition, 2006, Royal Society of Medicine Press Ltd.

Reference Books

1. Bemmel, J.H. van, Musen, M.A. (Eds.), “Handbook of Medical Informatics”, 2nd Edition, 2002, Springer.
2. Olga (EDT), Ferre Roca, M. Sosa (EDT, “Handbook of Telemedicine”, 3rd Edition, 1998, IOS press
3. Ferrer-Roca, O., Sosa-Iudicissa, , “Handbook of Telemedicine”, 12th Edition, 2002, IOS Press
4. Norris, A.C, “Essentials of Telemedicine and Telecare”, 8th Edition, 2002, Wiley.
5. Bashshur , R. L. , Sanders, J. H and Shannon, G, “Telemedicine: Theory and Practice”, 6th Edition, 1999, Springer.

Web References

1. https://en.wikipedia.org/wiki/Biotelemetry
2. https://www.who.int/goe/publications/goe_telemedicine_2010.pdf

3.. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5927731/

* TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	2	-	-	-	1	2	1	2	1	1	2	-	-
2	3	2	1	-	1	2	2	1	2	1	1	2	-	-
3	3	2	2	-	2	2	2	1	2	2	1	3	1	-
4	3	1	-	-	1	1	1	1	2	1	1	3	-	-
5	3	1	1	-	1	2	1	1	2	1	1	3	1	1

Correlation Level: 1 - Low, 2 - Medium, 3 – High

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	CAT 1	CAT 2	Model Exam	Assignment*	Attendance		
Marks	5	5	5	5	5	75	100

* Application oriented / Problem solving / Design / Analytical in content beyond the syllabus

Open Elective – I / Open Elective – II

Department	**Biomedical Engineering**	Programme: **B.Tech.**						
Semester	**V / VI**	Course Category Code: **OE**			*End Semester Exam Type: **TE**			
Course Code	**U23BMOC01**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**MEDICAL ELECTRONICS**	**3**	**-**	**-**	**3**	**25**	**75**	**100**
Prerequisite	-							
Common to EEE, ECE, CSE, IT, ICE, CCE, MECH, CIVIL, MCTR, AI&DS,CSBS/CSEBS								

Course Outcomes		**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1	Know the human body electro- physiological parameters and recording of bio-potentials	**K2**
	CO2	Comprehend the non-electrical physiological parameters and their measurement – body temperature, blood pressure, pulse, blood cell count, blood flow meter etc.	**K3**
	CO3	Interpret the various assist devices used in the hospitals viz. pacemakers, defibrillators, dialyzers and ventilators	**K3**
	CO4	Comprehend physical medicine methods eg. ultrasonic, shortwave, microwave surgical diathermies, and bio-telemetry principles and methods	**K4**
	CO5	Know about recent trends in medical instrumentation	**K4**

UNIT – I	**Electro-Physiology and Bio-Potential Recording**	**Periods:9**
Sources of bio medical signals, Bio-potentials, Biopotential electrodes, biological amplifiers, ECG, EEG, EMG, PCG, typical waveforms and signal characteristics.		**CO1**
UNIT – II	**Bio-Chemical and Non-Electrical Parameter Measurement**	**Periods:9**
pH, PO2, PCO2, Colorimeter, Blood flow meter, Cardiac output, respiratory, blood pressure, temperature and pulse measurement, Blood Cell Counters.		**CO2**
UNIT – III	**Assist Devices**	**Periods:9**
Cardiac pacemakers, DC Defibrillator, Dialyser, Ventilators, Magnetic Resonance Imaging Systems, Ultrasonic Imaging Systems.		**CO3**
UNIT – IV	**Physical Medicine and Biotelemetry**	**Periods:9**
Diathermies- Shortwave, ultrasonic and microwave type and their applications, Surgical Diathermy, Biotelemetry.		**CO4**
UNIT – V	**Recent Trends in Medical Instrumentation**	**Periods:9**
Telemedicine, Insulin Pumps, Radio pill, Endomicroscopy, Brain machine interface, Lab on a chip.		**CO5**

Lecture Periods:45	**Tutorial Periods:-**	**Practical Periods: -**	**Total Periods:45**

Textbooks

1. Leslie Cromwell, “Biomedical Instrumentation and Measurement”, Prentice Hall of India, New Delhi, 2007
2. M. Arumugam, “Biomedical Instrumentation”,Anuradha Agencies Publishers, 2002.
3. **Andrew Webb, “***Introduction to Biomedical Imaging”,* 2nd Edition, Cambridge University Press, United Kingdom, 2018

Reference Books

1. Khandpur, R.S., “Handbook of Biomedical Instrumentation”, TATA Mc Graw-Hill, New Delhi, 2003.
2. Joseph J.Carr and John M.Brown, “Introduction to Biomedical Equipment Technology”, John Wiley and Sons, New York, 2004.
3. Onkar N. Pandey, Rakesh Kumar, “Bio-Medical Electronics and Instrumentation”, 3rd Edition, Katson Books, 2002.
4. **Michael R. Neuman, “***Biomedical Sensors and Instruments*”, 3rd Edition, CRC Press, Boca Raton, 2023.

5. **Barbara Christe**, *"Introduction to Biomedical Instrumentation: The Technology of Patient Care"*, 2nd Edition, Cambridge University Press, 2022.

Web References

1. https://www.sciencedirect.com/topics/engineering/medical-electronics
2. https://en.wikipedia.org/wiki/Electronics_for_Medicine
3. https://www.scribd.com/document/378058078/Medical-Electronics-Lecture-Notes-Study-Material-and-Important-Questions-Answers

* TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	2	-	-	-	1	2	1	2	1	1	3	2	3
2	3	2	1	-	1	2	2	1	2	1	1	3	3	2
3	3	2	2	-	2	2	2	1	2	2	1	3	3	3
4	3	1	-	-	1	1	1	1	2	1	1	3	3	3
5	3	1	1	-	1	2	1	1	2	1	1	3	3	3

Correlation Level: 1 - Low, 2 - Medium, 3 – High

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	CAT 1	CAT 2	Model Exam	Assignment*	Attendance		
Marks	5	5	5	5	5	75	100

***** Application oriented / Problem solving / Design / Analytical in content beyond the syllabus

Department	**Biomedical Engineering**	Programme: **B.Tech.**						
Semester	**V / VI**	Course Category: **OE**			Course Category: **TE**			
Course Code	**U23BMOC02**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**BIOMETRIC SYSTEMS**	**3**	**0**	**0**	**3**	**25**	**75**	**100**
Prerequisite	-							

Common to EEE, ECE, CSE, IT, ICE, CCE, MECH, CIVIL, MCTR, AI&DS, CSBS/CSEBS

Course Outcomes	**On completion of the course, the students will be able to**		BT Mapping (Highest Level)
	CO1	Explain the fundamentals of biometric systems	**K2**
	CO2	Describe the various fingerprint technologies	**K3**
	CO3	Distinguish different face recognition and hand geometry pattern	**K3**
	CO4	Analyze the multimodal biometrics and performance evaluation of biometrics	**K4**
	CO5	Recognize various Biometric authentication methods	**K3**

UNIT – I	**Introduction to Biometrics**	**Periods:9**
Introduction– biometric technologies – passive biometrics – active biometrics - Biometric systems – Enrolment – templates – algorithm – verification –Need for strong authentication - Protecting privacy and biometrics policy – Biometric applications – biometric characteristics.		**CO1**
UNIT – II	**Fingerprint Technology**	**Periods:9**
History of fingerprint pattern recognition - General description of fingerprints - Finger print feature processing techniques - fingerprint sensors using RF imaging techniques – fingerprint quality assessment – fingerprint enhancement – Feature extraction – fingerprint classification – fingerprint matching- Hand geometry.		**CO2**
UNIT – III	**Face Recognition**	**Periods:9**
Introduction to face recognition - face recognition from correspondence maps - scanning - feature extraction - Adaptive Classifiers - Visual Based feature extraction and Pattern Classification -types of algorithm - Retina scan -Iris scan - Biometric fusion.		**CO3**
UNIT – IV	**Multimodal Biometrics and Performance Evaluation**	**Periods:9**
Introduction to multimodal biometric system: Physiological biometrics –Behavioral biometrics - Voice scan - Integration strategies - Architecture -level of fusion - combination strategy – training and adaptability - examples of multimodal biometric systems - Performance evaluation - Statistical Measures of Biometrics- FAR - FRR - FTE - EER -Memory requirement and allocation.		**CO4**
UNIT – V	**Biometric Authentication**	**Periods:9**
Introduction - Biometric Authentication Methods - Authentication technologies- Biometric authentication by fingerprint - Biometric Authentication by Face Recognition. Expectation-Maximization theory - Support Vector Machines- Biometric authentication by hand geometry- Securing and trusting a biometric transaction – matching location – local host - authentication server – match on card (MOC) – Multibiometrics and Two-Factor Authentication.		**CO5**
Lecture Periods:45	**Tutorial Periods:-**	**Practical Periods: -**	**Total Periods:45**

Textbooks

1.Anil K. Jain, Arun Ross, and KarthikNandakumar “Introduction to Biometrics”, Springer,2011

2. Richard O. Duda, David G.Stork,Peter E. Hart “Pattern Classification”, Wiley 2007

3. S.Y.Kung, S.H. Lin, M.W.Mak, “Biometric Authentication: A Machine Learning Approach”, Prentice Hardcover September 2004

Reference Books

1. Anil K. Jain, Patrick Flynn, and Arun A. Ross,” Handbook of Biometrics” Springer, 2008

2. John Chirillo, Scott Blaul, “Implementing Biometric Security”:John Wiley, 2003.
3. John R. Vacca, “Biometric Technologies and Verification System”, Elsevier Inc, 2007
4. James Wayman, Anil Jain, DavideMaltoni, Dario Maio, “Biometric Systems “Technology Design and Performance EvaluationSpringer,2005
5. Nikolaos V. Boulgouris,Konstantinos N. Plataniotis ,Evangelia Micheli-Tzanakou, “Biometrics” Theory, Methods, and Applications, Wiley 2009

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1.http://www.findbiometrics.com/Pages/glossary.html
2.http://www.biometrics.gov/Documents/privacy.pdf
3.http://zing.ncsl.nist.gov/biousa/docs/Usability_and_Biometrics_final2.pdf
4.User Interface, System Design
5. http://www.cesg.gov.uk/site/ast/biometrics/media/BEM_10.pdf

* TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	2	-	-	-	1	-	-	-	-	1	2	2	-
2	3	2	2	1	1	2	-	-	-	-	1	3	3	-
3	3	2	2	1	2	2	-	-	-	-	1	3	3	-
4	3	1	1	1	1	1	-	-	-	-	1	3	3	-
5	3	1	2	1	2	2	-	-	-	-	1	3	3	-

Correlation Level: 1 - Low, 2 - Medium, 3 – High

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	CAT 1	CAT 2	Model Exam	Assignment*	Attendance		
Marks	5	5	5	5	5	75	100

* Application oriented / Problem solving / Design / Analytical in content beyond the syllabus

Department	**Biomedical Engineering**	Programme: **B.Tech**						
Semester	**VII**	Course Category: **PC**			End Semester Exam Type: **TE**			
Course Code	**U23BMT712**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course name	**BIOMATERIALS AND ARTIFICIAL ORGANS**	**3**	**0**	**0**	**3**	**25**	**75**	**100**
Prerequisite	**Human Anatomy and Physiology**							

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Understand the basic knowledge about the biomaterials.	**K2**
	CO2 Distinguish the types of Biomaterials	**K2**
	CO3 Analyze the tissue implant materials used in the medical applications.	**K4**
	CO4 Gain adequate knowledge of artificial organs	**K3**
	CO5 Explain the artificial organs implanted in the human body.	**K3**

UNIT-I	**Overview of Biomaterials**	**Periods:9**	
Introduction to biomaterials – uses of biomaterials – biomaterials in organ and body systems – materials used in the body – performance of biomaterials. Metallic biomaterials – Introduction – stainless steel – Cobalt – chromium alloy - Titanium alloy – Titanium nickel alloy - dental metals – Corrosion of metallic implant, manufacturing of implant.			**CO1**

UNIT-II	**Types of Biomaterials**	**Periods:9**	
Biomaterials types – Ceramic - non absorbable/relatively bioinert, bio ceramics, biodegradable, bio reactive ceramic – deterioration of ceramics, **Polymeric** –basic structure, polymers used as biomaterials, sterilization, **Composite** – Structure - bounds on properties an isotropy of composites - particulate composites - fibrous composites, porous materials and biocompatibility, biodegradable polymer materials.			**CO2**

UNIT-III	**Tissue Materials and Tissue Replacement**	**Periods:9**	
Structure and properties of collagen and collagen rich tissue, Resorbable collagen based medical implant, Types of transplants by stem cell, sutures, surgical tapes, Tissue adhesive/glue, effect of materials selection – effect of surface properties. Preservation techniques –non-freezing storage – freeze thaw technology – freeze drying.			**CO3**

UNIT-IV	**Artificial Organs**	**Periods:9**	
Introduction – Outlook of organ replacement – Design, consideration and evaluation process – overview – immunological consideration – blood transfusion – individual organs – kidney, liver, heart, lungs, bone marrow, cornea.			**CO4**

UNIT-V	**Artificial Organ Implants**	**Periods:9**	
Neural and neuromuscular implants – heart valves implant – heart and lungs assist devices – artificial heart, cardiac pacemakers – artificial kidney – dialysis membrane and artificial blood - gastrointestinal system – dentistry – maxillofacial and craniofacial replacement – soft tissue replacement and augmentation.			**CO5**

Lecture Periods:45	**Tutorial Periods:**	**Practical Periods:**	**Total Periods: 45**

Textbooks

1. Lysaght M, Webster T J., “Biomaterials for artificial organs”, Woodhead Publishing Limited, 1st edition, 2011
2. Hench L, Jones J., “Biomaterials, artificial organs and tissue engineering”, Woodhead Publishing Limited, 1st edition, 200S5.
3. Monika Saini, Yashpal Singh, Pooja Arora, Vipin Arora, and Krati Jain., “Implant biomaterials: A comprehensive review”, World Journal of Clinical Cases, 2015

Reference Books

1. Joseph D. Bronzino, Donald R. Peterson., "Biomedical engineering fundamentals", CRC Press, 4th edition, 2014.
2. R S Khandpur, "Handbook of Biomedical Instrumentation", Tata McGraw Hill, 2003
3. David Williams, "Essential biomaterials science", Cambridge University Press, 1st edition, 2014
4. Yannas, I. V, "Tissue and Organ Regeneration in Adults", New York, NY: Springer, 2001.
5. Donatella Duraccio , Federico Mussano, Maria Giulia Faga., "Biomaterials for dental implants: current and future trends", Journal of Materials Science, 2015.

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1. https://youtu.be/jVj1xE5FUMI
2. https://youtu.be/XqFSlG6WKO0
3. https://youtu.be/DsAvyyykwB8
4. https://nptel.ac.in/courses/106/105/106105077/
5. https://nptel.ac.in/courses/102/101/102101068/

*TE –Theory Exam, LE–Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	-	-	-	-	-	-	-	-	-	3	2	1	-
2	3	2	2	-	-	-	-	-	-	2	3	3	2	-
3	3	1	1	-	-	-	-	-	-	1	3	3	1	-
4	3	1	2	-	-	-	-	-	-	1	3	3	3	2
5	3	1	1	-	-	-	2	-	-	2	2	3	1	2

CorrelationLevel:1-Low,2-Medium,3–High

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	CAT1	CAT2	Model Exam	Assignment*	Attendance		
Marks	5	5	5	5	5	75	100

*Application oriented/Problem solving /Design/Analytical in content beyond the syllabus

Department	**Biomedical Engineering**	Program: **B.Tech.**						
Semester	**VII**	Course Category: **PC**			*End Semester Exam Type: **TE**			
Course Code	**U23BMT713**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**REHABILITATION ENGINEERING**	**3**	**0**	**0**	**3**	**25**	**75**	**100**
Prerequisite								

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Understand the quality and safety standards in design of devices for user needs	**K2**
	CO2 Describe the applications of different orthosis and prosthesis for various disabilities	**K3**
	CO3 Compare the different therapeutic exercises and design an orthopedic wheelchair	**K2**
	CO4 Interpret the techniques and aids for impairments related to sensory and motor functions.	**K4**
	CO5 Explore the use of Robots and Virtual Reality tool in rehabilitative curative care.	**K4**

UNIT – I	**Fundamentals of Rehabilitation**	**Periods:9**
Introduction to Rehabilitation Engineering - Epidemiology of Rehabilitation, Health, Levels of Prevention, Preventive Rehabilitation, Impairment disability handicap, Primary & secondary Disabilities-Rehabilitation team, Classification of members-The human component, Principles of Assistive Technology Assessment, Principles of Rehabilitation Engineering- Key Engineering Principles, Key Ergonomic Principles.		**CO1**

UNIT – II	**Prosthetic and Orthotics Devices**	**Periods:9**
Prosthetics: Hand and Arm replacement, body-powered prosthetics, externally powered limb prosthetics, Myoelectric hand and arm prosthetics - FES System: Restoration of hand function; restoration of standing and walking. **Orthotics:** General orthotics, Classification of orthotics-functional & regional, General principles of Orthosis, Calipers- FO, AFO, KAFO, HKAFO.		**CO2**

UNIT – III	**Therapeutic Devices and Wheelchairs**	**Periods:9**
Therapeutic exercise: Co-ordination exercises, Frenkel's exercises, Gait -Pathological Gaits, Gait Training, Relaxation exercises, Methods for training Relaxation, Strengthening exercises - Strength training, Types of Contraction, Mobilization exercises, Endurance exercises. **Wheelchair:** History and Categories of Wheelchairs, Seating Assessment, Wheelchair Structure and Component Design, Ergonomics of wheel chair propulsion, Power Wheelchair Electrical System- Wheel chair transportation.		**CO3**

UNIT – IV	**Management of Communication Impairments**	**Periods:9**
Speech Impairment: Introduction to communication, Aphasia, Types of aphasia, Treatment of aphasic patient, Speech Augmentative Devices and Text-to-Speech (TTS) Systems. **Visual impairment:** Categories of visual impairment - Cortical & retinal implants - Auditory Information Display, Blind mobility aids, reading writing & graphics access, Braille Reader, Tactile devices for visually challenged. **Auditory impairment:** Hearing functional assessment, Types of deafness - Surgical and non-surgical hearing aids, Cochlear implants		**CO4**

UNIT – V	**Recent trends in Rehabilitation**	**Periods:9**
Rehabilitation Robots- Automated gait training devices, Automated training devices for the upper extremities**,** Therapeutic and Learning Support Virtual Reality Applications- virtual environments in the treatment of motor skills impairments- VR based tele-rehabilitation.		**CO5**

Lecture Periods: 45	**Tutorial Periods:**	**Practical Periods: -**	**Total Periods: 45**

Text Books

1. Dr. S. Sunder, "Textbook of Rehabilitation", 4th Edition, Jaypee Medical Publications, New Delhi. 2019.
2. Joseph D.Bronzino,"The Biomedical Engineering Handbook", 3rd Edition, CRC Press, 2006.
3. Rory A Cooper, An Introduction to Rehabilitation Engineering, Taylor & Francis, CRC press, 2006.

Reference Books

1. Marion A Hersh, Michael A, Johnson, "Assistive Technology for Visually impaired and blind people", Springer Publications, First edition, 2008.
2. Sashi S Kommu; Rehabilitation Robotics,1 edition, CRC Press, 2007.
3. Suzanne Robitaille, "The illustrated guide to Assistive technology and devices–Tools and gadgets for living independently", Demos Health New York, First edition, 2010.
4. Patrice L. (Tamar) Weiss, Emily A. Keshner, Mindy F. Levin, "Virtual Reality for Physical and Motor Rehabilitation", 2014.
5. Susan B O'Sullivan, Thomas J Schmitz, Physical Rehabilitation. 5th Edition, Davis publications, 2007

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1. https://en.wikipedia.org/wiki/Rehabilitation_engineering
2. https://www.embs.org/about-biomedical-engineering/our-areas-of-research/rehabilitation-engineering/
3. https://bme.unc.edu/rehabilitation-engineering/
4. https://youtu.be/-y2jDL-diz0
5. https://youtu.be/s3rEAIwLEXM?t=2

*TE –Theory Exam, LE–Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	1	1	2	1	-	2	1	1	1	-	-	-	-	1
2	3	3	3	2	2	2	2	2	1	1	1	3	3	3
3	3	3	3	2	2	2	2	2	1	1	-	1	2	1
4	3	3	3	3	2	2	2	2	2	2	1	1	3	2
5	2	2	2	2	3	2	2	2	2	2	-	1	2	2

Correlation Level: 1 - Low, 2 - Medium, 3 -High

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	CAT 1	CAT 2	Model Exam	Assignment*	Attendance		
Marks	5	5	5	5	5	75	100

* Application oriented / Problem solving / Design / Analytical in content beyond the syllabus

Dr. A.Vijayalakshmi B.Tech. Biomedical Engineering

Department	**Biomedical Engineering**	Programme: **B.Tech**						
Semester	**VII**	Course Category Code: **PC**			*End Semester Exam Type: **TE**			
Course Code	**U23BMT714**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**MEDICAL IMAGE PROCESSING**	**3**	**0**	**0**	**3**	**25**	**75**	**100**
Prerequisite								

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Gain knowledge in fundamentals of digital image processing.	**K2**
	CO2 Examine image enhancement techniques in medical images.	**K3**
	CO3 Execute restoration and segmentation techniques in medical images	**K3**
	CO4 Apply the compression Techniques in medical images	**K3**
	CO5 Describe the representations of features and recognize the images	**K2**

UNIT–I	**Fundamental of Digital Image Processing**	**Periods:09**	
Introduction, Steps in Digital Image Processing -Components –Elements of Visual Perception - Image Sensing and Acquisition - Image Sampling and Quantization -Relationships between pixels - colour models. Basics of Spatial Filtering– Smoothing and Sharpening Spatial Filtering.			**CO1**
UNIT–II	**Frequency domain Enhancement**	**Periods:09**	
Introduction to Fourier Transform — Smoothing and Sharpening frequency domain filters — Ideal, Butterworth andGaussian filters, Wavelets -Sub band coding, Wavelets based image processing.			**CO2**
UNITIII	**Medical Image Restoration And Segmentation**	**Periods:09**	
Image Restoration: Noise Model – Notch Filters– Inverse Filtering – Wiener filtering. **Image Segmentation:** Detection of Discontinuities–Edge Linking and Boundary detection – Region based segmentation- Region Growing, Region Splitting, Morphological processing- erosion and dilation – Watershed algorithm.			**CO3**
UNIT –IV	**Medical Image Compression**	**Periods:09**	
Image Compression models–Error Free Compression–Variable Length Coding–Bit-Plane Coding–Lossless Predictive Coding – Lossy Compression – Lossy Predictive Coding –Discrete wavelet transform for image compression-Compression Standards-JPEG, Image Registration (Multimodal Image Registration)			**CO4**
UNIT– V	**Medical Image Representation and Recognition**	**Periods:09**	
Boundary representation- Chain Code-Polygonal approximation, signature, boundary segments-Boundary description – Shape number - Regional Descriptors – Topological feature, Texture –Patterns and Pattern classes. **Image Recognition**: Digital Imaging and Communication (DICOM) in Medicine, Various modalities of Medical Imaging-CT, MRI, PET, Thermography, Angiography.			**CO5**
LecturePeriods:45	**Tutorial Periods:**	**Practical Periods: -**	**TotalPeriods:45**

Text Books

1 G.R. Sinha, Bhagwati Charen Patel, “Medical Image Processing: Concepts and Applications”, PHI Learningprivatelimited.2014

2 Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, “Digital Image Processing Using MATLAB”, Third Edition Tata McGraw HillPvt.Ltd.,2011

3 Kayvan Najarian and Robert Splinter, “Biomedical Signal and Image Processing",2nd Edition, CRC Press,2005.

Reference Books

1 Anil JainK.“Fundamentals of Digital Image Processing”,PHI Learning Pvt.Ltd.,2011.

2 E.R.Davies, “Computer & Machine Vision”, Fourth Edition, Academic Press,2012.

3 MalayK.Pakhira,“Digital Image Processing and Pattern Recognition”,1st Edition, PHI Learning Pvt.Ltd.,2011.

4 Geoff Dougherty, “Medical Image Processing: Techniques and Applications”, Springer Science & BusinessMedia,2011

5 IsaacN.Bankman,“Hand book of Medical Image Processing and Analysis”,Science Direct,2nd Edition,2009.

Web References	
1	https://youtu.be/xUCsfKA8bi0
2	https://youtu.be/0SIPA8TvCbU
3	https://youtu.be/8fBZFjiHw3I
4	https://youtu.be/PqBS3tFZYI8
5	https://m.youtube.com/watch?v=i8a2LdyenoY

*TE –Theory Exam, LE–Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	2	-	-	2	-	-	-	-	-	-	3	2	-
2	3	3	2	-	3	-	-	-	-	1	-	3	3	2
3	2	3	3	3	3	-	-	-	-	2	-	2	3	3
4	3	3	2	2	3	-	-	-	-	1	-	3	3	2
5	2	3	2	2	3	-	-	1	1	3	1	3	3	2

CorrelationLevel:1-Low,2-Medium,3– High

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE)Marks	Total Marks
	CAT1	CAT2	Model Exam	Assignment*	Attendance		
Marks	10		5	5	5	75	100

*Application oriented/Problem solving/Design/Analytical in content beyond the syllabus

Department	**Biomedical Engineering**	Programme: **B.Tech.**						
Semester	**VII**	Course Category Code: **PC** *End Semester Exam Type: **LE**						
Course Code	**U23BMP710**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**3D PRINTING IN BIOMEDICAL APPLICATIONS LABORATORY**	**0**	**0**	**2**	**1**	**50**	**50**	**100**
Prerequisite	**-**							

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Understand 3D printing principles, techniques, and biomedical applications.	**K2**
	CO2 Operate and calibrate FDM/SLA printers for biomedical model production.	**K3**
	CO3 Analyze print parameters' effects on mechanical properties and accuracy.	**K4**
	CO4 Design patient-specific biomedical models using 3D scanning and modeling.	**K5**
	CO5 Evaluate surface quality and enhance prints with post-processing techniques.	**K6**

List of Experiments:

1. Study of FDM 3D Printer Operation and Calibration
2. 3D Scanning of Biomedical Model of ear and finger Using a Handheld Scanner
3. Scanning and Reconstruction of an artificial Dental Model Using an Intraoral Scanner
4. Conversion of DICOM Images to 3D Printable STL Files
5. Design and Printing of a Patient-Specific Skull Model
6. Study of Layer Thickness and Print Orientation on Mechanical Properties
7. Fabrication of a Dental Crown Using SLA Printing
8. 3D Printing of a Custom Prosthetic Finger Using Flexible Filament
9. Development of a 3D-Printed Microfluidic Device for Biofluid Analysis
10. Evaluation of Surface Roughness in SLA vs. FDM Printing
11. Design and Printing of a Patient-Specific Surgical Guide for nose Placement
12. Fabrication of a 3D-Printed Rehabilitative Orthopedic Cast with Ventilation

Lecture Periods: -0	**Tutorial Periods: -0**	**Practical Periods:30**	**TotalPeriods:30**

Textbook

1. Prosenjit Saha, “3D Bioprinting from Lab to Industry” , Wiley , 2023.
2. Mohamad Zaki Hassan and Ilyas Aufa, “Handbook of 3D Printing in Biomedical Applications”, CRC Press , 2022.
3. Neeta Raj Sharma, Karupppasamy Subburaj, Kamalpreet Sandhu, and Vivek Sharma , “Applications of 3D Printing in Biomedical Engineering”,Springer , 2021.

Reference Books

1. Mohanan, P. V., editor. Compendium of 3D Bioprinting Technology. CRC Press, 2025.
2. BioCraft: Unleashing the Future of Bioprinting. Independently published, 2024.
3. Narayan, Roger J., editor. Advances in 3D Bioprinting. CRC Press, 2024.
4. Crook, Jeremy M., editor. 3D Bioprinting: Principles and Protocols. Humana Press, 2020.
5. Guvendiren, Murat, editor. 3D Bioprinting in Medicine: Technologies, Bioinks, and Applications. Springer

Web References

1. https://link.springer.com/book/10.1007/978-1-0716-0520-2
2. https://en.wikipedia.org/wiki/3D_bioprinting
3. https://www.iipseries.org/assets/docupload/rsl2024F767C1609A33C6E.pdf
4. https://youtu.be/yLaXBQgMdR8

*TE –Theory Exam, LE–Lab Exam

COs/POs/PSOs Mapping

Cos	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	2	-	-	2	-	1	-	-	-	-	3	2	2
2	2	2	2	2	3	-	-	-	2	2	2	3	3	3
3	2	3	2	2	3	-	-	-	2	2	1	3	3	3
4	3	3	3	3	3	1	1	-	3	3	3	3	3	2
5	3	2	2	2	3	-	1	2	3	3	2	3	3	3

CorrelationLevel:1-Low,2- Medium,3 –High

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE)Marks	Total Marks
	Performance in practical classes			Model Practical Examination	Attendance		
	Conduction of practical	Record work	viva				
Marks	15	5	5	15	10	50	100

Department	**BIOMEDICAL ENGINEERING**	Programme: **B.Tech.**						
Semester	**VII**	Course Category: **PC**			*End Semester Exam Type: **LE**			
Course Code	**U23BMP711**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**MEDICAL IMAGE PROCESSING LABORATORY**	**0**	**0**	**2**	**1**	**50**	**50**	**100**

Prerequisite	MATLAB Basics, Image Processing, Mathematics, Signal Processing, Computer Vision.	
Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Describe digital image fundamentals	**K3**
	CO2 Examine image enhancement techniques in medical images	**K4**
	CO3 Execute restoration and segmentation techniques in medical images	**K4**
	CO4 Apply various transforms to the images	**K3**
	CO5 Describe the representations of features and recognize the images	**K3**

List of Exercises:

1. Image sampling and quantization.
2. Analysis of spatial and intensity resolution of images.
3. Intensity transformation of images
4. DFT analysis of images
5. Transforms (Walsh, Hadamard, DCT, Haar).
6. Histogram Processing.
7. Image Enhancement-Spatial filtering.
8. Image Enhancement- Filtering in frequency domain
9. Image segmentation – Edge detection, line detection and point detection
10. Basic Morphological operations
11. Basic Thresholding functions
12. Analysis of images with different color models
13. Watershed Algorithm for Image Segmentation.

Lecture Periods: -	**Tutorial Periods: -**	**Practical Periods:30**	**TotalPeriods:30**

Text Books

1. G.R. Sinha, Bhagwati Charen Patel, “Medical Image Processing: Concepts and Applications”, PHI Learning private limited,2014.
2. Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, “Digital Image Processing Using MATLAB”, 3rdEdition, Tata McGraw Hill Pvt.Ltd., 2011.Manjunath Aradhya M and Srinivas Subramiam, “C Programming and Data Structures”, CengageIndia1st Edition, 2017.
3. Kayvan Najarian and Robert Splinter,"Biomedical Signal and Image Processing",2nd Edition, CRC Press,2005.

Reference Books

1. AnilJainK.“Fundamentals of Digital Image Processing”,PHI Learning Pvt Ltd,2011.
2. E.R. Davies,“Computer& Machine Vision”, 4th Edition, Academic Press,2012.
3. MalayK.Pakhira,“Digital Image Processing and Pattern Recognition”,1st Edition,PHI Learning Pvt Ltd,2011.
4. Geoff Dougherty, “Medical Image Processing: Techniques and Applications”, Springer Science & BusinessMedia,2011.
5. Isaac N. Bankman, “Handbook of Medical Image Processing and Analysis”, Science Direct, 2nd Edition,2009.

Web References

1. https://youtu.be/0UPoSdBFD48
2. https://youtu.be/6mXXN1-vHQQ
3. https://youtu.be/8fBZFjiHw3I
4. https://youtu.be/PqBS3tFZYI8
5. https://m.youtube.com/watch?v=i8a2LdyenoY

*TE–Theory Exam, LE–Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	2	-	-	3	-	-	-	-	-	-	3	2	-
2	2	3	2	-	3	-	-	-	-	2	-	3	3	2
3	2	3	3	3	3	-	-	-	-	2	-	3	3	3
4	3	2	2	2	3	-	-	-	-	2	-	3	3	2
5	3	2	2	2	3	-	-	2	2	3	1	3	3	2

CorrelationLevel:1-Low,2-Medium,3–High

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE)Marks	Total Marks
	Performance in practical classes			Model Practical Examination	Attendance		
	Conduction of practical	Record work	Viva				
Marks	15	5	5	15	10	50	100

Department	**BIOMEDICAL ENGINEERING**	Programme: **B.Tech.**						
Semester	**VII**	Course Category: **PA**			*End Semester Exam Type: **LE**			
Course Code	**U23BMW703**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**PROJECT PHASE - I**	**0**	**0**	**4**	**2**	**50**	**50**	**100**
Prerequisite								

Each batch of 2 or 3 students will be assigned an experimental or a theoretical project to be carried out under the supervision of a guide. The project work has to be carried out in the 7th and 8th semesters and has to be completed by the end of the 8th semester.

In the phase I of the project work, the progress of the work carried out in the 7th semester will be monitored and assessed. A committee of departmental faculty members comprising the project guide, the Head of the Department and one more faculty member will conduct the internal assessment. The project work and the report will be evaluated by the internal assessment committee by conducting three reviews for a total of 50 marks. The end semester examination which carries a total of 50 marks will have report evaluation and viva voce examination conducted by a committee of one external examiner and one internal examiner

CAM and ESM break-up for Project Phase-I

Sl. No	Description			Weightage
1	**Continuous Assessment Marks**			
a	Review1	Review Committee	10	15
		Supervisor	5	
b	Review2	Review Committee	10	15
		Supervisor	5	
c	Review3	Review Committee	15	20
		Supervisor	5	
	Total CAM			50

2	**End Semester Marks**			
	Evaluation of Phase I Report and Viva-voce	Report	15	50
		Presentation and Viva	20	
		Demonstration	15	
	Total ESM			50
Total Marks				100

Department	**BIOMEDICAL ENGINEERING**	Programme: **B.Tech.**						
Semester	**VII**	Course Category: **PA**			*End Semester Exam Type: **LE**			
Course Code	**U23BMW704**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**INTERNSHIP/ INPLANT TRAINING**	**0**	**0**	**2**	**1**	**100**	**-**	**100**
Prerequisite								

Students may undergo Inplant training or internship during summer / winter vacation at Industry/ Research organization for a period of two weeks to four weeks. Students are also permitted to undergo internships during their seventh semester after the theory classes are over. Each student has to submit a detailed report on In-Plant Training which He / She have undergone. The department committee will assess the progress of the student and recommend the grade (100% Continuous Assessment pattern) based on the completion of Inplant training or internship.

Assessment method for Industrial Training/Internship

Assessment	**Continuous Assessment Marks (CAM)**		Total Marks
	Report	Presentation	
Marks	50	50	100

PROFESSIONAL ELECTIVE –IV
(Offered in Semester VII)

Department	**Biomedical Engineering**	Program: **B.Tech.**						
Semester	**VII**	Course Category: **PE**			*End Semester Exam Type: **TE**			
Course Code	**U23BME714**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**VIRTUAL BIOINSTRUMENTATION**	**3**	**0**	**0**	**3**	**25**	**75**	**100**
Prerequisite								

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Understand the basic concepts of Virtual instrumentation	**K2**
	CO2 Realize the programming language used in VI	**K3**
	CO3 Analyze the concept of data acquisition using VI	**K3**
	CO4 Interpret the interfacing concept used in LabVIEW	**K3**
	CO5 Apply the concept of VI for medical applications	**K4**

UNIT – I	**Introduction**	**Periods:9**
History of Virtual Instrumentation, advantages, block diagram and architecture of a virtual instrument, data-flow techniques, LabVIEW basics – graphical programming, LabVIEW environment		**CO1**
UNIT – II	**Programming Techniques**	**Periods:9**
VIS and sub-VIS, loops and charts, arrays, clusters, graphs, case and sequence structures, formula modes, local and global variable, string and file input. Publishing measurement data in the web.		**CO2**
UNIT – III	**Data Acquisition**	**Periods:9**
Data acquisition basics: Introduction to data acquisition on PC, Sampling fundamentals, Input / Output techniques and buses. ADC, DAC, Digital I/O, counters and timers, DMA, Software and hardware installation, Calibration, Resolution, Data acquisition interface requirements		**CO3**
UNIT – IV	**Instrument Interfaces**	**Periods:9**
Current loop, GPIB, System basics, interface basics: USB, PCMCIA, networking basics for office and industrial application VISA and IVI, image acquisition and processing, Motion Control, waveform generator.		**CO4**
UNIT – V	**Biomedical Applications**	**Periods:9**
Biofeedback systems and its components, Virtual applications for ECG, EEG, EMG signals, Air Flow and Lung Volume, Non-invasive Blood Pressure Measurement, Virtual Reality and 3D graphical modelling, Virtual Prototyping.		**CO5**

Lecture Periods: 45	**Tutorial Periods:**	**Practical Periods: -**	**Total Periods: 45**

Text Books

1. Jon B. Olansen, Eric Rosow, “Virtual Bio-Instrumentation: Biomedical, Clinical, and Healthcare Applications in LabVIEW” Prentice Hall PTR, 2001
2. Gary Johnson, “LABVIEW Graphical Programming”, 4th Edition, McGraw Hill, 2006.
3. Ronald W. Larsen, “LabVIEW for Engineers”, Pearson , 1st Edition, 2010

Reference Books

1. Robert H. Bishop,” Learning with LabVIEW” , Pearson, First edition, 2014
2. Jerome, “Virtual Instrumentation Using LabView”, PHI, 2010.
3. Sanjay Gupta and Joseph John, ” Virtual Instrumentation using LabVIEW”, Tata Mc Graw – Hill Publishing Company Limited, New Delhi, 1st Edition, 2005.
4. John Essick,” Hands-on Introduction to LabVIEW for Scientists and Engineers “,Oxford University Press, 4th Edition,2018
5. Kevin James, “PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control”, Newnes, 2000.

Web References

1. https://youtu.be/_2IZVC902kg
2. https://youtu.be/78dZ8IjJ52M
3. https://youtu.be/fIy6XT3CdPQ
4. https://youtu.be/U0bQBOEiBQY
5. https://youtu.be/Q8rFSpaa84Q

*TE–Theory Exam, LE–Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	2	-	-	3	-	-	-	-	1	-	3	2	-
2	3	2	-	-	3	-	-	-	-	2	-	3	2	1
3	3	3	2	2	3	-	-	-	-	2	-	3	3	3
4	3	3	2	2	3	-	-	-	-	2	1	3	3	3
5	3	3	3	3	3	1	1	2	2	3	2	3	3	3

Correlation Level: 1 - Low, 2 - Medium, 3 -High

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	CAT 1	CAT 2	Model Exam	Assignment*	Attendance		
Marks	5	5	5	5	5	75	100

* Application oriented / Problem solving / Design / Analytical in content beyond the syllabus

Department	**Biomedical Engineering**	Program: **B.Tech.**						
Semester	**VII**	Course Category: **PE**			*End Semester Exam Type: **TE**			
Course Code	**U23BME715**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**NANOTECHNOLOGY IN MEDICINE**	**3**	**0**	**0**	**3**	**25**	**75**	**100**
Prerequisite								

Course Outcomes	On completion of the course, the students will be able to	BT Mapping (Highest Level)
	CO1 Understand the basic concept of nanomaterial synthesis	**K2**
	CO2 Analyze the mechanisms involved in biological nanoparticle formation.	**K3**
	CO3 Evaluate blood-biomaterial interactions, including heparin effects	**K3**
	CO4 Explain the characterization techniques used in nanomaterials	**K3**
	CO5 Assess vascular and lymphatic targeting strategies for nanoparticle drug delivery.	**K4**

UNIT – I	**Physical and Chemical Process**	**Periods:9**
Chemical processes: Chemical precipitation and co-precipitation, Sol-Gel synthesis; Microemulsions synthesis, Hydrothermal, Microwave assisted synthesis, Core-Shell nanostructure, Physical Methods: Inert gas condensation, Arc discharge, RF- plasma, Plasma arc technique, Laser ablation, Molecular beam epitaxy (MBE), Chemical vapour deposition (CVD) method.		**CO1**
UNIT – II	**Biological Methods of Synthesis**	**Periods:9**
Use of bacteria, fungi, Actinomycetes for nanoparticle synthesis, Magneto tactic bacteria for natural synthesis of magnetic nanoparticles; Mechanism of formation; Viruses as components for the nanostructured materials; synthesis process and application, Role of plants in nanoparticle synthesis.		**CO2**
UNIT – III	**Biological Interactions with Materials**	**Periods:9**
Introduction, Biocompatibility, Toxicity, Cytotoxicity, Hypersensitivity, Carcinogenicity, Interaction of Materials with Soft Tissues, Inflammation, Granulation Tissue Formation, Foreign Body Reaction, Fibrosis, Modification of Blood-Biomaterial Interactions, Interaction with Blood by Heparin, Interactions with Proteins, Cell Adhesion, Interactions with Hard Tissues, The Vroman Effect, Adhesion of Osteoblasts, Osseointegration, Fibrous Capsule Formation,		**CO3**
UNIT – IV	**Characterization Techniques**	**Periods:9**
Nanostructured materials Characterization Techniques X-ray diffraction (XRD), SEM, EDAX, TEM, Elemental mapping, FTIR, UV-Visible spectrophotometer, Nanomechanical Characterization using Nanoindentation, Differential Scanning Calorimeter (DSC), Differential Thermal Analyzer (DTA), Thermo gravimetric Analysis (TGA), TEM, X-ray Photoelectron Spectroscopy (XPS), ICP-AES chemical analysis.		**CO4**
UNIT – V	**Biological Transport for Targeted Drug Delivery**	**Periods:9**
Drug transport mechanisms – Passive and active targeting – Nanocarriers (liposomes, dendrimers, polymeric nanoparticles) – Nanobots for precision medicine – Stimuli-responsive drug delivery – Controlled release systems – Tumor-targeted therapy – Blood-brain barrier penetration – Real-time tracking and monitoring of drug delivery.		**CO5**

Lecture Periods: 45	**Tutorial Periods:**	**Practical Periods: -**	**Total Periods: 45**

Text Books

1. Harry F. Tibbals, “Medical Nanotechnology and Nanomedicine”, 1st Edition, CRC Press, 2011.
2. Hossein Hossein Khani, “Nanomaterials in Advanced Medicine”, Wiley, 2019.
3. Kirthi, A. Vishnu, Karthik, L., Janarthanan, Pushpamalar, “Nanotechnology in Medicine”, Springer, 2021.

Reference Books

1. BIOMEDICAL NANOSTRUCTURES. Edited by Kenneth E. Gonsalves, Craig R. Halberstadt, Cato T. Laurencin, Lakshmi S. Nair, WILEY-INTERSCIENCE A JOHN WILEY & SONS, INC., PUBLICATION, 2008
2. Z.L Wang ,” Characterization of Nanophase materials”, 1st Edition, Wiley-VCH, 2000.
3. G. Schmidt, “Nanoparticles: From theory to applications”, 2nd Edition, Wiley Weinheim, 2004.
4. Zoraida Aguilar, “Nanomaterials for Medical Applications”, 1st Edition,Elsevier, 2012.
5. Nanomaterials, Nanotechnologies and Design: an Introduction to Engineers and Architects, D. Michael Ashby, Paulo Ferreira, Daniel L. Schodek, Butterworth-Heinema 2009.

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1.	https://en.wikipedia.org/wiki/Nanomedicine
2.	https://www.medicalnewstoday.com/articles/244972
3.	https://www.azonano.com/article.aspx?ArticleID=4840
4.	https://youtu.be/ZS1QPndpD2w
5.	https://youtu.be/iiT_KJJ1Uhs

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	2	-	-	2	-	1	-	-	1	-	3	2	-
2	3	3	2	2	2	-	-	-	-	2	-	3	3	-
3	3	3	2	3	2	3	2	2	-	2	-	3	3	2
4	3	3	2	2	3	-	-	-	-	2	-	3	2	2
5	3	3	3	2	3	2	2	2	1	3	2	3	3	2

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

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	CAT1	CAT2	Model Exam	Assignment*	Attendance		
Marks	5	5	5	5	5	75	100

*Application oriented/Problem solving/Design/Analytical in content beyond the syllabus

Department	**Biomedical Engineering**	Programme: **B.Tech**						
Semester	**VII**	Course Category Code: **PE**			*End Semester Exam Type: **TE**			
Course Code	**U23BME716**	Periods/Week			Credit	Maximum Marks		
		L	T	**P**	C	CAM	ESE	TM
Course Name	**DYNAMICS OF BIOFLUID**	**3**	**0**	**0**	**3**	**25**	**75**	**100**
Prerequisite								

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Understand to apply the fluid mechanics principles in bio fluid studies	**K2**
	CO2 Gain adequate knowledge about the Vascular Mechanics	**K2**
	CO3 Comprehend the physical, chemical and rheological properties of blood	**K2**
	CO4 Analyze cardiovascular dynamics, fluid flow, pressure, compliance, elastance, and modeling.	**K4**
	CO5 Comprehend dynamics of cerebrospinal fluid, alveolar mechanics, and synovial fluid.	**K3**

UNIT–I	**Fundamentals of Biofluid Mechanics**	**Periods:09**	
Intrinsic Fluid Properties: Density, Viscosity, Compressibility, Surface Tension, Hydrostatics -Macroscopic Balances of Mass and Momentum - Microscopic Balance of Mass and Momentum – The Bernoulli Equation - Dimensional Analysis - Fluid Mechanics in a Straight Tube - Flow Stability and Related Characteristics - Effect of Flow Pulsatility - Boundary Layer Separation.			**CO1**
UNIT–II	**Vascular Mechanics**	**Periods:09**	
Anatomical Organization of the Vasculature, Mechanical Properties of Blood Vessels, Functional Properties of Blood, Control Aspects of the Vascular System, Hemodynamic of Large Arteries, Heart Valves, Ventricular Outflow and the Aorta, Pressure-Flow Relations and Vascular Impedance, Wave Propagation Phenomena- Wave Reflection Phenomena.			**CO2**
UNIT–III	**Rheology of Blood**	**Periods:09**	
Physical Properties of Blood - Viscous Behavior of Blood - Pressure–Flow Relationship for Non-Newtonian Fluids- Viscometry and Theory for Capillary - Capillary Viscometer - Coaxial Cylinder Viscometer - Cone and Plate Viscometer - Hemolysis and Platelet Activation with Fluid – Structural Components of the Blood Vessel - Material Behavior of Blood Vessels.			**CO3**
UNIT –IV	**Computation Fluid Dynamics**	**Periods:09**	
Cardiovascular system – Ventricular pressure -volume diagram, Blood flow in arteries-blood vessel bifurcation-Uniform shear hypothesis -Two-element – Electric analogy model for two, three and four element model-Wave Propagation-Review concepts of compliance and Elastance- in arterial circulation-pressure changes in different distance from heart.			**CO4**
UNIT– V	**Bio-fluid Dynamic of Human Brain, Respiratory and Orthopedic**	**Periods:09**	
Cerebro Spinal Fluid – Cerebral blood flow – Blood brain barrier – Brain diseases. Alveoli mechanics – Interaction of Blood and Lung P-V curve of Lung – Breathing mechanism – Airway resistance – Physics of Lung diseases, Pleural Fever. Synovial joint – Synovial fluid – Diseases affecting synovium.			**CO5**

Lecture Periods:45	**Tutorial Periods:**	**Practical Periods: -**	**Total Periods:45**

Text Books

1. Goyal, M.R., Bhowmik, A., & Chauhan, A. (Eds.). (2025). Biofluid Dynamics of Human Body Systems: Expanded and Revised Edition (1st ed.). Apple Academic Press.
2. Goyal, Megh R., et al. "Introduction and Properties of Biofluids in the Human Body Systems." Biofluid Dynamics of Human Body Systems. Apple Academic Press 1-52.
3. Nithiarasu, P. "Biofluid Dynamics." Chapter 2 (2022): 20-21.
4. Lauga, Eric. The fluid dynamics of cell motility. Vol. 62. Cambridge University Press, 2020.
5. David A. Rubenstein, Weiyin, Mary D. Frame, “Biofluid Mechanics- An Introduction to fluid Mechanics, Macrocirculation and Microcirculation”, 2015, 1st Edition, Academic Press, Massachusetts, New York.

Reference Books

1. Taylor, R. L., and P. Nithiarasu. The finite element method for fluid dynamics. Elsevier, 2024.
2. Chin, Wilson C., and Jamie A. Chin, eds. Biofluids Modeling: Methods, Perspectives, and Solutions.
3. Grotberg, James B. Biofluid mechanics: analysis and applications. Cambridge University Press, 2021.

*TE –Theory Exam, LE–Lab Exam

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3. https://www.maths.gla.ac.uk/~xl/Arasu-biofluid.pdf
4. https://www.youtube.com/watch?v=6ABq269ALFk
5. https://youtu.be/L4eZ0lOafvc
6. https://youtu.be/emmf2JYAD-0
7. https://youtu.be/NlLy-u61yyk

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	2	-	2	2	-	1	-	-	1	-	3	2	-
2	3	2	2	2	2	2	-	-	-	1	-	3	3	-
3	3	3	-	2	3	1	-	2	-	1	-	3	3	2
4	3	3	3	3	3	1	-	-	-	2	-	3	3	2
5	3	2	2	2	2	2	2	1	-	2	-	3	3	2

CorrelationLevel:1-Low,2-Medium,3– High

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE)Marks	Total Marks
	CAT1	CAT2	Model Exam	Assignment*	Attendance		
Marks	10		5	5	5	75	100

*Application oriented/Problem solving/Design/Analytical in content beyond the syllabus

Department	**Biomedical Engineering**	Programme: **B.Tech.**						
Semester	**VII**	Course Category Code: **PE**			*End Semester Exam Type: **TE**			
Course Code	**U23BME717**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**MEDICAL SAFETY AND STANDARDS**	**3**	**0**	**0**	**3**	**25**	**75**	**100**
Prerequisite	-							

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Gain knowledge about hospital safety devices necessary for health care system	**K2**
	CO2 Understand the techniques to shield patient from electrical hazards	**K3**
	CO3 Gain knowledge in radiation safety and control measures	**K2**
	CO4 Apply the various methods to monitor and assess quality in healthcare	**K3**
	CO5 Apply the guidelines for medical standards in hospitals	**K3**

UNIT–I	**Hospital Safety**	**Periods:09**
Security and Safety of Hospital -Property, Staff & Patients, Safety precautions, Safe medical devices - device requirements - devices for varying age – initial inspection –maintenance-Safe handling and operation Reporting- Bed rails- Flawed mechanics- removable parts and packaging. Personal protective Equipment.		**CO1**
UNIT–II	**Electrical Safety**	**Periods:09**
Physiological effects of electricity - Electrical faults in medical devices - Leakage Current-Electrical isolation - Grounding system -Emergency power system - Uninterrupted power supply. IEC Standards for Electrical Safety.		**CO2**
UNIT–III	**Radiological Safety**	**Periods:09**
Fundamentals of radiation detection-Classification of radiation - Biological effects of Ionizing and Non-Ionizing radiation - Hazards associated with UV radiation - UV monitor and control measures, LASER - radiation hazards - control measures, Guidelines for CT installations, MRI safety guidelines.		**CO3**
UNIT–IV	**Quality Assessment in Healthcare**	**Periods:09**
Quality management-risk management- types of responsibilities – CSR, Individual and institutional Responsibility-MDRA and medical device standards - ICRP regulations for radiation safety- Methods Adopted to monitor the standards, Evaluation of hospital services – Quality Assurance in Hospitals Sop's -TQM in Health care organization-Quality assurance methods.		**CO4**
UNIT–V	**Hospital Accreditation and Standards**	**Periods:09**
Accreditation- JCI Accreditation & its Policies, Patient centered standards, ISO standards and CDSCO Standards for medical safety. Healthcare Organization management standards, Life Safety Standards- Protecting Occupants, Protecting the Hospital from Fire, Smoke, and Heat, Providing and Maintaining Fire Alarm Systems, Minimizing EC Risks, Smoking Prohibitions, Managing Hazardous Material and Waste.		**CO5**

Lecture Periods:45	**Tutorial Periods:**	**Practical Periods: -**	**Total Periods:45**

Textbooks

1. Barbara J. Youngberg," Patient Safety Handbook "Jones& Bartlett Learning, 2nd Edition, 2013
2. Peter Lachman, Moira Stewart, and Siobhan McQuillan," Safety and Improvement in Primary Care: The Essential Guide", Radcliffe Publishing, 1st Edition,2012.
3. Hani H. Abujudeh, "Quality and Safety in Radiology", Oxford University Press, 1st Edition, 2010.
4. Ronda Hughe, "Patient Safety and Quality: An Evidence-Based Handbook for Nurses" , Agency for Healthcare Research and Quality, 1st Edition, 2008.

Reference Books

1. Peter Lachman, Moira Stewart, and Siobhan McQuillan, "Safety and Improvement in Primary Care: The Essential Guide" , Radcliffe Publishing, 1st Edition , 2012.
2. Lucian L. Leape," Making Healthcare Safe: The Story of the Patient Safety Movement", Springer,1st Edition, 2021
3. Pascale Carayon , " Handbook of Human Factors and Ergonomics in Health Care and Patient Safety" , CRC Press , 2nd Edition, 2011.
4. Robert Wachter and Kiran Gupta, "Understanding Patient Safety", McGraw-Hill Education,3rd Edition, 2017

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1. www.wma.net/what-we-do/education
2. www.medvarsity.com/courses/certificationcourse
3. www.medscape.com/courses/business
4. www.onlinecourses.swayam2.ac.in
5. www.healthcentral.com/healthcare

*TE–Theory Exam, LE– Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	2	2	1	2	3	2	2	1	2	1	3	2	3
2	3	3	2	2	3	3	2	2	1	2	1	3	2	3
3	3	2	2	2	3	3	3	3	-	2	1	3	3	2
4	3	3	3	2	2	2	2	2	1	3	2	3	2	2
5	3	3	3	2	2	3	3	3	2	3	2	3	2	2

CorrelationLevel:1-Low,2-Medium,3–High Evaluation

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE)Marks	Total Marks
	CAT1	CAT2	Model Exam	Assignment	Attendance		
Marks	5	5	5	5	5	75	100

*Application oriented/Problem solving/Design/Analytical in content beyond the syllabus

Department	**Biomedical Engineering**	Program: **B.Tech.**						
Semester	**VII**	Course Category: **PE**			*End Semester Exam Type: **TE**			
Course Code	**U23BME718**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**CRYPTOGRAPHY AND NETWORK SECURITY**	**3**	**0**	**0**	**3**	**25**	**75**	**100**
Prerequisite	**Network Essential**							

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Explain the fundamentals of cryptography, including security attacks, encryption techniques, and steganography, to understand data protection principles.	**K3**
	CO2 Compare and analyze symmetric and asymmetric cryptographic algorithms	**K4**
	CO3 Demonstrate knowledge of authentication techniques and their applications in secure communication	**K3**
	CO4 Describe IP security principles and key management strategies for secure networks	**K2**
	CO5 Implement various network security protocols to mitigate security threats.	**K4**

UNIT – I	**Introduction**	**Periods:9**
Introduction To Cryptography - Security Attacks - Services And Mechanism - Conventional Encryption -Classical Encryption Techniques - Substitution Ciphers And Transposition Ciphers – Cryptanalysis – Steganography.		**CO1**
UNIT – II	**Symmetric and Asymmetric Cryptography**	**Periods:9**
Symmetric key Ciphers: Block ciphers principles - Data Encryption Standard (DES) - strength of DES - triple DES – Advanced Encryption Standard (AES) **Asymmetric key Ciphers:** Principles of public key crypto systems - RSA algorithm - security of RSA - key management – Diffle-Hellman key exchange algorithm - Elliptic curve cryptography		**CO2**
UNIT – III	**Message Authentication and Integrity**	**Periods:9**
Message Authentication and Hash Function: Authentication requirements - authentication functions - message authentication code - hash functions **Integrity:** Message Digest Algorithm (MD5) - Secure Hash Algorithm (SHA) Digital Signatures: Digital Signatures - authentication protocols - Digital Signature Standards (DSS)		**CO3**
UNIT – IV	**Ip Security and Authentication Algorithms**	**Periods:9**
IP Security: Architecture - Authentication header - Encapsulating security payloads - combining security associations - key management. Authentication Applications: Kerberos and X.509.		**CO4**
UNIT – V	**Web and System Security**	**Periods:9**
Web Security: Secure socket layer and transport layer security - secure electronic transaction (SET) - electronic mail security-pretty good privacy (PGP). **System Security:** Intruders - Viruses and related threads - firewall design principals – trusted systems		**CO5**

Lecture Periods: 45	**Tutorial Periods:**	**Practical Periods: -**	**Total Periods: 45**

Text Books

1. William Stallings: “Cryptography and Network Security”- Principles and Practice, 5th Edition, Pearson/PHI, 2011.
2. Behrouz A. Ferouzan, "Cryptography & Network Security", 5th Edition, Tata McGraw-Hill,2017
3. Wenbo Mao, —”Modern Cryptography-Theory and Practise”, First Edition Pearson Education 2004

Reference Books

1. William Stallings, “Network Security Essentials (Applications and Standards)”, 4th Edition, Pearson Education. ,2012
2. Atul Kahate, “Cryptography and Network Security”, 4th edition, Tata Mc Grawhill, 2019
3. V.S. Bagad and I.A Dhotre, “Cryptography & Network Security”, 1st edition, 2020.
4. Charles Pfleeger, Shari Pfleeger, Jonathan Margulies, “Security in Computing”, Fifth Edition, Prentice Hall, New Delhi, 2015.
5. Buchmann: “Introduction to Cryptography”, 2nd Edition, Springer, 2004

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1. https://www.geeksforgeeks.org/cryptography-introduction/
2. http://uru.ac.in/uruonlinelibrary/Cyber_Security/Cryptography_and_Network_Security.pdf
3. https://nptel.ac.in/courses/106105031

* TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	3	2	2	2	2	1	3	1	2	1	3	2	1
2	3	3	2	2	2	-	-	3	-	2	-	3	2	-
3	3	3	2	2	2	2	1	3	2	2	2	3	2	1
4	3	3	2	2	3	2	1	3	-	2	2	3	2	1
5	3	3	2	2	3	2	2	3	1	3	2	3	3	2

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

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	CAT1	CAT2	Model Exam	Assignment*	Attendance		
Marks	5	5	5	5	5	75	100

*Application oriented/Problem solving/Design/Analytical in content beyond the syllabus

OPEN ELECTIVE –III
(Offered in Semester VII)

Department	**BIOMEDICAL ENGINEERING**	Programme: **B.Tech.**						
Semester	**VII**	Course Category: **OE**				End Semester Exam Type: **TE**		
Course Code	**U23BMOC03**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**MEDICAL ROBOTICS**	**3**	**0**	**0**	**3**	**25**	**75**	**100**

Common to EEE, ECE, CSE, IT, ICE, CCE, CIVIL, AI&DS, CSBS / CSEBS

Course Outcomes	**On completion of the course, the students will be able to**		BT Mapping (Highest Level)
	CO1	Understand the basics of robotic systems.	**K2**
	CO2	Explore workspace and related motion of the Robots	**K3**
	CO3	Analyse and extract information from the image using Robots	**K3**
	CO4	Design of task planning and simulating the task.	**K4**
	CO5	Construct Robots for Medical applications	**K4**

UNIT-I	**INTRODUCTION**	**Periods: 9**	
Introduction- Automation and Robots – Classification - Applications- Specifications – Direct Kinematics Dot and cross products – Coordinate frames – Rotations – Homogeneous coordinates Link coordination arm equation – Four-axis robot -Five-axis robot - Six-axis robot.			**CO1**
UNIT-II	**KINEMATICS**	**Periods: 9**	
Inverse Kinematics – General properties of solutions tool configuration – Workspace analysis and trajectory planning work envelope - examples- workspace fixtures – Pick and place operations-Robotic Manipulator – Continuous path motion – Interpolated motion – Straight-line motion.			**CO2**
UNIT-III	**ROBOT VISION**	**Periods: 9**	
Robot Vision- Image representation – Template matching – Polyhedral objects – Shane analysis – Segmentation – Thresholding – region labelling – Shrink operators – Swell operators – Euler numbers – Perspective transformation – Structured illumination – Camera calibration.			**CO3**
UNIT-IV	**PLANNING**	**Periods: 9**	
Task Planning – Task level programming – Uncertainty – Configuration – Space, Gross motion – Planning – Grasp Planning – Fine-motion planning – Simulation of planar motion – Source and Goal scenes – Task Planner simulation.			**CO4**
UNIT-V	**MEDICAL APPLICATIONS**	**Periods: 9**	
Applications in Biomedical Engineering – Biologically Inspired Robots – Application in Rehabilitation – Interactive Therapy – Bionic Arm – Clinical and Surgical – Gynaecology – Orthopaedics – Neurosurgery.			**CO5**

Lecture Periods: 45	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods: 45**

Text Books

1. Robert Schilling, “Fundamentals of Robotics-Analysis and control”, Prentice Hall, January 2019.
2. Paula Gomes,“Biomedical Instrument and Robotic Surgery System: Design and Development for Biomedical Applications”,Woodhead Publishing,2012.
3. Klafter, Chmielewski and Negin, “Robotic Engineering - An Integrated approach”,, PHI, first edition, 2009.

Reference Books

1. J.J.Craig, “Introduction to Robotics”, Pearson Education, 2019.
2. Fu, Lee and Gonzalez., “Robotics, control vision and intelligence”, McGraw Hill International, 2nd edition, 2007
3. John J. Craig, “Introduction to Robotics”, Addison Wesley Publishing, 3rd edition, 2010.
4. Saeed B. Niku, “Introduction to Robotics: Analysis, Systems, Applications”, Prentice Hall, 2001.
5. K. S. Fu, R. C. Gonzales and C. S. G. Lee, “Robotics”, McGraw Hill, 2008.

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2.https://www.intechopen.com/books/medical_robotics/motion_tracking_for_minimally_invasive_robotic_surgery

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3.https://www.intechopen.com/books/medical_robotics/robotic_applications_in_neurosurgery
4.https://www.intechopen.com/books/medical_robotics/medical_robotics_in_cardiac_surgery
5.https://www.worldscientific.com/worldscinet/jmrr

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	2	-	-	-	1	-	-	-	-	1	2	1	-
2	3	2	-	1	1	1	-	-	-	-	1	2	1	-
3	3	2	-	1	1	1	-	-	-	-	1	2	1	-
4	3	1	1	1	1	1	-	-	-	-	1	2	1	-
5	2	1	1	-	1	1	-	-	-	-	1	3	1	-

Correlation Level: 1 - Low, 2 - Medium, 3 – High

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	CAT 1	CAT 2	Model Exam	Assignment*	Attendance		
Marks	5	5	5	5	5	75	100

* Application oriented / Problem solving / Design / Analytical in content beyond the syllabus

Department	**BIOMEDICAL ENGINEERING**	Programme: **B.Tech.**					
Semester	**VII**	Course Category:**OE**			End Semester Exam Type: **TE**		
Course Code	**U23BMOC04**	Periods/Week			Credit	Maximum Marks	
		L	T	P	C	CAM	ESE	TM
Course Name	**TELEHEALTH TECHNOLOGY**	**3**	**0**	**0**	**3**	**25**	**75**	**100**
Prerequisite								

Common to EEE, ECE, CSE, IT, ICE, CCE, CIVIL, AI&DS, CSBS / CSEBS

Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Understand the history and evolution of telemedicine.	**K2**
	CO2 Understand the principles of multimedia communication, including text, audio, video, and data.	**K2**
	CO3 Learn about medical information storage and management in telemedicine, including patient information, medical history, test reports, and medical images.	**K3**
	CO4 Analyze the security and confidentiality concerns regarding medical records in telemedicine and understand the relevant cyber laws.	**K2**
	CO5 Focusing on the applications of telemedicine in specialized areas like telecardiology, tele oncology, and neurosciences.	**K3**

UNIT–I	**Telemedicine and Health**	**Periods:9**
History and Evolution of telemedicine, Organs of telemedicine, Global and Indian scenario, Ethical and legal aspects of Telemedicine - Confidentiality, Social and legal issues, Safety and regulatory issues, Advances in Telemedicine.		**CO1**
UNIT –II	**Telemedical Technology**	**Periods:9**
Principles of Multimedia - Text, Audio, Video, data, Data communications and networks, P0STN, POTS, ANT, ISDN, Internet, Air/ wireless communications Communication infrastructure for telemedicine – LAN and WAN technology. Satellite communication, Mobile communication.		**CO2**
UNIT –III	**Mobile Telemedicine**	**Periods:9**
Tele radiology: Image Acquisition system Display system, Tele pathology, Medical information storage and management for telemedicine- patient information, medical history, test reports, medical images, Hospital information system		**CO3**
UNIT –IV	**Telemedical Standards**	**Periods:9**
Data Security and Standards: Encryption, Cryptography, Mechanisms of encryption, phases of Encryption. Protocols: TCP/IP, ISO-OSI, Standards to followed DICOM, HL7, H. 320 series Video Conferencing, Security and confidentiality of medical records, Cyber laws related to telemedicine		**CO4**
UNIT–V	**Telemedical Applications**	**Periods:9**
Telemedicine – health education and self-care. · Introduction to robotics surgery, Telesurgery. Telecardiology, Teleoncology, Telemedicine in neurosciences, Business aspects - Project planning and costing, Usage of telemedicine.		**CO5**

Lecture Periods:45	**Tutorial Periods: -**	**Practical Periods: -**	**Total Periods:45**

TextBooks

1. Haux, R., Heidrich, J.P., & Schleyer, T. "Introduction to Telemedicine", Springer, 2017
2. Krishna, S., & Liss, A. "Telemedicine: A Practical Guide for Professionals", Springer, 2005
3. Norris, A.C. “Essentials of Telemedicine and Telecare”, Wiley, 2002

Reference Books

1. Goetz, S.K. "Telemedicine: The Electronic Practice of Medicine", Springer, 2011
2. Krupinski, C. & Rhoads, J.M. "Telemedicine: Technology and Applications", CRC Press, 2019
3. Ramakrishnan, S. & Chaturvedi, A. "Telemedicine: A Guide to Assessing Telecommunications for Healthcare", Wiley, 2006
4. Gajendra, J.A. & Williams, A.J. "Telemedicine Technologies: Principles and Applications", Wiley, 2008
5. McGonigle, D. & Mastrian, K.G. "Health Informatics: An Interprofessional Approach", Elsevier, 2020

Web References

1. https://www.who.int/health-topics/telemedicine

2. https://www.telemedicine.org
3. https://www.youtube.com/watch?v=TaOu0NB2dsc

*TE–Theory Exam, LE–Lab Exam

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)											Program Specific Outcomes(PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	1	-	-	1	1	1	-	-	-	-	1	3	1	1
2	3	2	-	1	1	1	-	-	-	-	1	2	1	1
3	3	2	2	2	1	1	-	-	-	-	1	3	1	1
4	3	3	2	2	2	1	-	-	-	-	1	3	1	2
5	2	3	3	3	2	1	-	-	-	-	2	3	1	2

Correlation Level: 1- Low,2- Medium,3 –High

Evaluation Method

Assessment	Continuous Assessment Marks (CAM)					End Semester Examination (ESE) Marks	Total Marks
	CAT1	CAT2	Model Exam	Assignment*	Attendance		
Marks	5	5	5	5	5	75	100

* Application oriented / Problem solving / Design / Analytical in content beyond the syllabus