SRI MANAKULA VINAYAGAR
ENGINEERING COLLEGE
(AN AUTONOMOUS INSTITUTION)

8th Board of Studies Meeting in the department of
Biomedical Engineering

for the Programme
B.Tech – Biomedical Engineering

Venue
Seminar Hall, Department of BME
Sri Manakula Vinayagar Engineering College
Madagadipet, Puducherry – 605 107

Date & Time
4.09.2024 & 10.30 a.m

Minutes of Eighth Board of Studies

The Eighth Board of Studies meeting for B.Tech. Biomedical Engineering was held on 4th September 2024 at 10.30 A.M in the Seminar Hall, Department of BME, Sri Manakula Vinayagar Engineering College with the Head of the Department in the Chair.

The following members were present for the BoS meeting

Sl. No.	Name of the Member	Designation
1. Head of the Department concerned (Chairperson)		
1	**Dr. A.Vijayalakshmi,** Professor and Head Specialization: Wireless Sensor Networks, Signal Processing Email: hodbme@smvec.ac.in Mobile: 9486985430	Chairperson
2. All faculty members of the Department		
2	Dr.A.V.Srinath, Assistant Professor Specialization: Electronics and Instrumentation, Biomedical Engineering	Member
3	Mr.P.M.Bharath, Assistant Professor Specialization: Embedded System Technologies	Member
4	Mrs. N.Radha, Assistant Professor Specialization: Wireless Communication	Member
5	Mrs. S.Suguna, Assistant Professor Specialization: Digital Signal Processing	Member
6	Mrs.T. Logasundari, Assistant Professor Specialization: Biomedical Engineering	Member
7	Mr.A.Aravind, Assistant Professor Specialization: Nanoscience and Technology	Member
8	Mr.M.Vadivelan, Assistant Professor Specialization: VLSI Design	Member
9	Mr.K.Babu, Assistant Professor Specialization: Communication and Networks	Member
10	Dr.T.Poovaragavan, Assistant Professor Specialization: Mathematics	Member
11	Dr.K.Samuvel, Assistant Professor Specialization: Physics	Member
12	Dr.A.Balamurugan, Assistant Professor Specialization: Chemistry	Member
13	Dr.D.Jaichithra, Professor Specialization: English	Member

2.A.9.1

Agenda of the Meeting

Item No.	Particulars
BoS/2024/UG/BME/8.1	To Welcome the BoS members and introduction of external experts to all the members.
BoS/2024/UG/BME/8.2	To review and confirm the minutes of Seventh Board of Studies meeting.
BoS/2024/UG/BME/8.3	To discuss and approve the Curriculum and Syllabi of V Semester and VI Semester courses for B.Tech – Biomedical Engineering under Regulations R-2023.
BoS/2024/UG/BME/8.4	To discuss and approve the Professional Elective and Open Elective courses syllabi offered for V and VI semester B.Tech – Biomedical Engineering under Regulations R-2023.
BoS/2024/UG/BME/8.5	To discuss and approve the syllabi of all the courses of Honours / Minor degree programme offered by BME department under Regulations R-2023.
BoS/2024/UG/BME/8.6	To discuss and approve the Ability Enhancement courses and Mandatory courses offered for V and VI semesters under Autonomous Regulations 2023.
BoS/2024/UG/BME/8.7	To apprise and approve the Professional elective and open elective courses, Employability enhancement and Mandatory courses, NPTEL/MOOC courses offered for V and VII semester students under Regulations 2020.
BoS/2024/UG/BME/8.8	To apprise and approve the Ability Enhancement courses and Mandatory courses offered for I and III semester students under Regulations 2023.
BoS/2024/UG/BME/8.9	To apprise the academic calendar for the odd semester of the Academic Year 2024-25 and department activities.
BoS/2024/UG/BME/8.10	To apprise and approve the End Semester Examinations July 2024 Results and Graduation details of the second Batch 2020-2024 students under Autonomous Regulations R-2020.
BoS/2024/UG/BME/8.11	To discuss and recommend the panel of examiners to the Academic Council.
BoS/2024/UG/BME/8.12	Any other item with the permission of the chair.

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Dr.A.Vijayalakshmi
Chairperson-BoS/BME

2.A.9.2

3. Two subject experts from outside the Parent University nominated by the Academic Council.		
14	**Dr. Anima Nanda** Dean, IQAC Sathyabama Institute of Science and Technology, Jeppiaar Nagar, Chennai - 600 119. Email: dean.iqac@sathyabama.ac.in Mobile: 9443786840	Subject Expert
15	**Dr. S. Pravin Kumar** Associate Professor Department of Biomedical Engineering, SSN College of Engineering, Chennai. Email : pravinkumars@ssn.edu.in Mobile: 9994246503	Subject Expert
4. One expert nominated by the Vice-Chancellor from a panel of six recommended by the Autonomous College Principal as a University Nominee.		
16	**Dr. Varshini Karthik** Professor and Head, Department of BioMedical Engineering, SRM Institute of Science and Technology, Kattankulathur-603 203 Email : varshink@srmist.edu.in Mobile: 9841582226	University Nominee
5. One representative from industry/corporate sector/allied areas nominated by the Principal as an Industry Nominee.		
17	**Dr. S.Atheena Milagi Pandian** Founder and Chief Executive Officer Atheenapandian Private Limited, Courtallam,Tamilnadu. Email : atheenapandian@gmail.com Mobile: 7502599891	Industry Expert
6. One member of the College alumni nominated by the Principal.		
18	**S.Rosy** Associate Analyst Zifo RnD Solutions,Chennai Email : rosyymaryy200@gmail.com Mobile: 8870890106	Alumni
19	**S.Khiruba Lakshmi** Final Year Student	Member
7. Experts from outside the Autonomous College, whenever special courses of studies are to be formulated, nominated by the Principal.		
20	**Dr. B.Hema Kumar** Associate Dean, Department of Electronics and Instrumentation Engineering, Puducherry Technological University, Puducherry Email: hemakumarb@pec.edu Mobile: 9994196804	Member

2.A.9.3

Minutes of the Meeting

Dr.A.Vijayalakshmi, BoS Chairperson started the meeting by a warm welcome and thanked the members for accepting the invitation to conduct Eighth Board of Studies meeting on 4th September 2024.

The Chairperson proceeded the meeting with the presentation on the agenda items:

BoS/2024/UG/BME/8.1 — The BoS Chairperson greeted the BoS members and introduced the external experts to all the members.

BoS/2024/UG/BME/8.2 — Reviewed the minutes of Seventh Board of Studies meeting with the members and confirmed the incorporation of minor modifications in III and IV semester courses syllabi of B.Tech BME Curriculum under Regulations 2023.

BOS/2024/UG/BME/8.3 — Discussed the Curriculum and Syllabi of V and VI Semester courses for B.Tech – Biomedical Engineering under Regulations 2023 and the BoS members suggested the following modifications.

S.No.	Semester	Course Title with Code	Unit	Suggestions
1.	V	Microcontroller and its Medical Applications (U23BMT507)	5	To include Multipara monitoring system.
2.	V	Microcontroller and its Medical Applications Laboratory (U23BMP505)	-	Suggested to include PIC Microcontroller based heart rate monitoring circuit.
3.	VI	Diagnostic and Therapeutic Equipment (U23BMT608)	4	Suggested to include more Therapeutic equipment.
4.	VI	Medical Internet of Things (U23BMT610)	3	Suggested to modify unit 3 as IoT in Healthcare
5.	VI	Artificial Intelligence & Machine Learning in Healthcare (U23BMT611)	5	Suggested to include AIML Healthcare applications

The Suggestions are incorporated, and the Syllabi is given in Annexure I and approved by BoS members

BoS/2024/UG/BME/8.4 — The Professional Elective and Open Elective courses syllabi offered for V semester and VI semester B.Tech – Biomedical Engineering under Regulations R-2023 are discussed and the BoS members suggested the following modifications in the course content:

S.No	Semester	Course title with Code	Unit	Suggestions
1	V	Computers in Medicine (U20BME506)	1	Suggested to modify the content as an Introduction to computer systems

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	2. | VI | Physiological System Modelling (U23BME611) | 4 | Suggested to modify the content relevant to Compartmental Physiological Model **The Suggestions are incorporated, and the Syllabi is given in Annexure I and approved by BoS members**
BoS/2024/UG/BME/8.5	The Curriculum and syllabi of Honours / Minor degree in Sensors Technology and its equivalent NPTEL courses under Regulations R-2023 are discussed and approved by BoS members. **The Curriculum and Syllabi approved by BoS members is given in Annexure II**
BoS/2024/UG/BME/8.6	The Ability Enhancement and Mandatory courses offered for V and VI semesters under Autonomous Regulations 2023 are discussed and approved by BoS members
BoS/2024/UG/BME/8.7	Apprised the Professional Electives and Open Elective courses, Employability Enhancement and Mandatory courses, NPTEL/MOOC courses offered for V semester and VII semester students under Regulations 2020 and approved by the BoS members.
BoS/2024/UG/BME/8.8	The Ability Enhancement and Mandatory courses offered for V and VII semesters under Autonomous Regulations 2020 are discussed and approved by BoS members.
BoS/2024/UG/BME/8.9	The academic calendar for the odd semester of the Academic Year 2024-25 and department activities are discussed with the BoS members.
BoS/2024/UG/BME/8.10	End Semester Examinations July 2024 Results and Graduation details of the second Batch 2020-2024 students under Autonomous Regulations R-2020 are discussed with BoS members.
BoS/2024/UG/BME/8.11	The revised list for panel of examiners and question paper setters for the end semester examinations are discussed and confirmed with the members. **(Annexure - III)**
BoS/2024/UG/BME/8.12	B.Tech. Biomedical Engineering Equivalent Degree for pursing higher studies is discussed with BoS members and they approved that students can do Higher Degree in any discipline.

Dr. A.Vijayalakshmi, Chairperson-BoS and Head of the Department, Biomedical Engineering concluded the meeting with vote of thanks.

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Dr. A.Vijayalakshmi
Chairperson-BoS/BME

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SRI MANAKULA VINAYAGAR
ENGINEERING COLLEGE
(AN AUTONOMOUS INSTITUTION)

DEPARTMENT OF BIOMEDICAL ENGINEERING

EIGHTH BOS MEETING ATTENDANCE

Board of Studies Members:

S.No.	Name of the Member with Designation and official Address	Responsibility in the BoS	Signature
1	**Dr.A.Vijayalakshmi** Professor and Head Department of Biomedical Engineering Sri Manakula Vinayagar Engineering College, Puducherry	Chairperson	
2	**Dr. Anima Nanda** Dean, IQAC Sathyabama Institute of Science and Technology, Chennai - 600 119.	Academic Expert	
3	**Dr. S. Pravin Kumar** Associate Professor Department of Biomedical Engineering, SSN College of Engineering, Chennai.	Academic Expert	
4	**Dr. Varshini Karthik** Professor and Head, Department of Biomedical Engineering, SRM Institute of Science and Technology, Kattankulathur-603 203	University Nominee	
5	**Dr. S.Atheena Milagi Pandian** Founder and Chief Executive Officer Atheenapandian Private Limited,Courtallam, Tamilnadu.	Industry Expert	
6	**S.Rosy** Associate Analyst Zifo RnD Solutions, Chennai	Alumni Member	
7	**Dr. B.Hema Kumar** Associate Dean, Department of Electronics and Instrumentation **Engineering,** Puducherry Technological University, Puducherry	Subject Expert	

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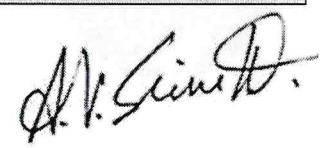
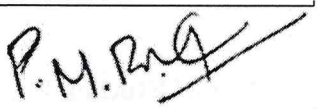
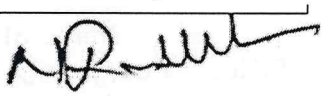
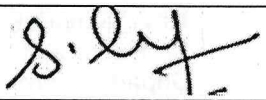
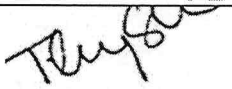
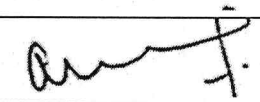
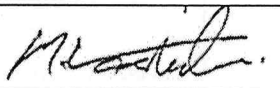
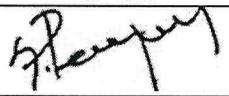
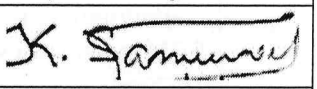
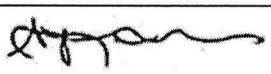
Sl.No	Name of the Member with Designation and official Address	Responsibility in the BoS	Signature
8	**Dr.A.V.Srinath**, Assistant Professor Specialization: Electronics and Instrumentation, Biomedical Engineering	Internal Member	
9	**Mr.P.M.Bharath**, Assistant Professor Specialization: Embedded System Technologies	Internal Member	
10	**Mrs. N.Radha**, Assistant Professor Specialization: Wireless Communication	Internal Member	
11	**Mrs.S.Suguna**, Assistant Professor Specialization: Digital Signal Processing	Internal Member	
12	**Mrs.T.Logasundari**, Assistant Professor Specialization: Biomedical Engineering	Internal Member	
13	**Mr.A.Aravind**, Assistant Professor Specialization: Nanoscience and Technology	Internal Member	
14	**Mr.M.Vadivelan**, Assistant Professor Specialization: VLSI Design	Internal Member	
15	**Mr.K.Babu**, Assistant Professor Specialization: Communication and Networks	Internal Member	
16	**Dr.T.Poovaragavan**, Assistant Professor Specialization: Mathematics	Internal Member	
17	**Dr.K.Samuvel**, Assistant Professor Specialization: Physics	Internal Member	
18	**Dr.A.Balamurugan**, Assistant Professor Specialization: Chemistry	Internal Member	
19	**Dr.D.Jaichithra**, Professor Specialization: English	Internal Member	
20	**S.Khiruba Lakshmi** Final Year Student	Member	

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SRI MANAKULA VINAYAGAR
ENGINEERING COLLEGE
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Puducherry

B.TECH.

BIOMEDICAL ENGINEERING

ACADEMIC REGULATIONS 2023
(R-2023)

CURRICULUM AND SYLLABI

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2.A.9.9.

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.

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Dr. A.Vijayalakshmi

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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.

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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.

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Dr. A.Vijayalakshmi

B.Tech. Biomedical Engineering

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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

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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

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Dr. A.Vijayalakshmi

B.Tech. Biomedical Engineering

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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

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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	U23XX0CXX	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

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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	U23BMCCXX	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	U23XXOCXX	Open Elective III	OE	3	0	0	3	25	75	100
Practical										
6	U23BMP710	Bioprinting Research 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

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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

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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

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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,BME,CCE,CSE&BS**)				
1	U23BMOC01	Medical Electronics	BME	EEE, ECE, CSE, IT, ICE, CCE, MECH, CIVIL, Mechatronics, AI&DS CSE&BS
2	U23BMOC02	Biometric Systems	BME	EEE, ECE, CSE, IT, ICE, CCE, MECH, CIVIL, Mechatronics, AI&DS CSE&BS
Open Elective – III (Offered in Semester VII)				
3	U23BMOC03	Medical Robotics	BME	EEE, ECE, CSE, IT, ICE, CCE,AI&DS, CIVIL,CSE&BS
4	U23BMOC04	Telehealth Technology	BME	EEE, ECE, CSE, IT, ICE, CCE,AI&DS, CIVIL, CSE&BS

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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

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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

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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 of Electronic and Medical Devices
		2) Masters in Microsoft Excel
		3) Power Point Presentation Design and Animation
2	U23BMS402	Skill Enhancement Course 2*
		1) Testing and Troubleshooting of Medical Equipment
		2) PCB Board Designing
		3) Presentation Skills using ICT

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

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Annexure – V

Honours / Minor Programme – Sensors Technology

Sl. No.	Semester	Course Code	Course Title	Category	Periods			Credits	Max. Marks		
					L	T	P		CAM	ESM	Total
1	IV	U23ICX401	Smart Sensors	PC	3	1	0	4	25	75	100
2	V	U23BMX502	Nano Biosensors	PC	3	1	0	4	25	75	100
3	VI	U23ICX603	Embedded Sensing Technologies	PC	3	1	0	4	25	75	100
4	VII	U23ICX704	IoT and Sensor Networks	PC	3	1	0	4	25	75	100
5	VIII	U23BMX805	Wearable Devices and its Applications	PC	3	1	0	4	25	75	100
								20	125	375	500

Equivalent NPTEL courses[##]

1	**Course Code** U23XXXN01	Sensors and Actuators	**3**	**12 Weeks Course**
2		Biophotonics	**3**	
3		Embedded Systems Design	**3**	
4		Design for Internet of Things	**3**	
5		Sensor Technologies: Physics, Fabrication, and Circuits	**3**	

[##]The student shall be given an option to earn 3 credits through one equivalent 12 weeks NPTEL course instead of any one course listed for honours / minors 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.

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Annexure – I

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	U23XX0CXX	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	U23XX0CXX	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

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PROFESSIONAL ELECTIVE COURSES

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

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, BME, CCE, CSE&BS**)				
1	U23BMOC01	Medical Electronics	BME	EEE, ECE, CSE, IT, ICE, CCE, MECH, CIVIL, Mechatronics, AI&DS CSE&BS
2	U23BMOC02	Biometric Systems	BME	EEE, ECE, CSE, IT, ICE, CCE, MECH, CIVIL, Mechatronics, AI&DS CSE&BS

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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 Edition2019.
2. Ram Ahuja," Research methods ". Rawat Publications. 2nd edition ,2022
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2. Ganesan, R. "Research methodology for engineers". MJP Publishers. 2024.
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* TE – Theory Exam, LE – Lab Exam

COs/POs/PSOs Mapping

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

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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

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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.

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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.

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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

COs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	1	1	-	1	-	-	-	-	-	-	2	3	2	1
2	3	3	3	-	3	-	-	-	-	-	-	2	3	2	1
3	3	3	3	1	3	-	-	-	-	-	-	2	3	2	1
4	3	3	3	1	3	-	-	-	-	-	-	2	3	2	1
5	3	3	3	1	3	-	-	-	-	-	-	2	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	10		5	5	5	75	100

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

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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", Second 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

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1. https://www.youtube.com/watch?v=S1QCZW92fU4

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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	PO12	PSO1	P1SO2	PSO3
1	2	2	3	2	2	2	-	-	-	-	-	2	1	1	1
2	2	2	3	2	2	2	-	-	-	-	-	2	1	1	1
3	2	1	3	2	1	1	-	-	-	-	-	2	1	1	-
4	2	1	3	2	1	1	-	-	-	-	-	2	1	1	-
5	2	1	3	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	10		5	5	5	75	100

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

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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**

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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, Prentice Hall of India, 2018.

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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.

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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	PO12	PSO1	PSO2	PSO3
1	3	3	2	2	2	2	1	3	-	-	-	3	3	2	-
2	3	3	2	2	2	2	1	3	-	-	-	3	3	2	-
3	3	3	2	2	2	2	1	3	-	-	-	3	3	2	-
4	3	3	2	2	2	2	1	3	-	-	-	3	3	2	-
5	3	3	2	2	2	2	1	3	-	-	-	3	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	

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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

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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	PO12	PSO1	PSO2	PSO3
1	3	2	1	1	3	-	-	-	-	-	-	-	3	2	1
2	3	2	1	1	3	-	-	-	-	-	-	-	3	2	1
3	3	2	1	1	3	-	-	-	-	-	-	-	3	2	1
4	3	2	1	1	3	-	-	-	-	-	-	-	3	2	1
5	3	2	1	1	3	-	-	-	-	-	-	-	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

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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", Second 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. DoughlasV.Hall, Microprocessors and Interfacing, Programming and Hardware", TMH,2012

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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

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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	PO12	PSO1	PSO2	PSO3
1	3	2	1	1	3	-	-	-	-	-	-	-	3	2	1
2	3	2	1	1	3	-	-	-	-	-	-	-	3	2	1
3	3	2	1	1	3	-	-	-	-	-	-	-	3	2	1
4	3	2	1	1	3	-	-	-	-	-	-	-	3	2	1
5	3	2	1	1	3	-	-	-	-	-	-	-	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

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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 Learn a patient-centered approach in healthcare.	K3
	CO2 Apply radiological techniques in diagnosing orthopedic and neurological disorders.	K3
	CO3 Recognize the importance of inter-professional collaboration in healthcare.	K4
	CO4 Evaluate effectiveness of biomedical engineering solutions in critical care units.	K4
	CO5 Design a workflow for integrating telemetry with medical record systems.	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.

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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.

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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	PO12	PSO1	PSO2	PSO3
1	3	3	3	2	3	2	-	-	-	-	-	2	2	3	3
2	3	3	3	2	3	2	-	-	-	-	-	2	2	3	3
3	3	3	3	2	3	2	-	-	-	-	-	2	1	3	3
4	3	3	3	2	3	2	-	-	-	-	-	2	1	3	3
5	3	3	3	2	3	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
	Performance in practical classes			Model Practical Examination	Attendance		
	Conduction of practical	Record work	viva				
Marks	15	5	5	15	10	50	100

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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	PO12	PSO1	PSO2	PSO3
1	3	2	2	2	-	-	-	-	3	3	-	1	1	1	1
2	3	3	3	2	2	2	2	2	3	3	3	1	2	2	2
3	3	2	2	1	-	2	-	-	3	3	3	1	3	3	3

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

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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

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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								

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.

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

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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/

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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	PO12	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

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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.

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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	PO12	PSO1	PSO2	PSO3
1	3	1	1	-	-	1	-	-	-	-	-	1	2	-	1
2	3	1	2	-	1	1	-	-	-	-	-	1	2	1	1
3	3	2	2	-	1	1	-	-	-	-	-	1	2	2	1
4	3	2	2	2	2	1	-	-	-	-	-	1	2	2	1
5	3	2	2	2	2	1	-	-	-	-	-	1	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	10		5	5	5	75	100

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

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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								

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.

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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/

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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	PO12	PSO1	PSO2	PSO3
1	3	1	1	-	-	-	-	1	-	1	-	-	3	1	1
2	3	1	1	--	-	-	-	1	-	1	-	-	3	1	1
3	3	1	1	-	-	-	-	2	-	1	-	-	3	1	2
4	3	1	1	-	-	-	-	2	-	2	-	-	3	1	2
5	3	1	1	-	-	-	-	2	-	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
	CAT 1	CAT 2	Model Exam	Assignment*	Attendance		
Marks	10		5	5	5	75	100

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

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B.Tech. Biomedical Engineering

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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.

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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; First 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	PO12	PSO1	PSO2	PSO3
1	3	2	1	-	-	1	-	-	-	-	-	1	2	1	1
2	3	2	1	-	-	1	-	-	-	-	-	1	2	1	1
3	3	2	1	-	-	1	-	-	-	-	-	1	2	1	1
4	3	2	1	-	-	1	-	-	-	-	-	1	2	1	1
5	3	2	1	-	-	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	10		5	5	5	75	100

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

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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

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* 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	PO12	PSO1	PSO2	PSO3
1	3	1	-	-	-	-	1	1	-	-	-	-	3	1	1
2	3	1	-	-	-	-	1	1	-	-	-	-	3	1	1
3	3	1	-	-	2	-	2	3	-	-	-	1	3	1	1
4	3	1	1	-	2	-	2	2	-	-	-	2	3	2	2
5	3	1	1	-	2	-	2	2	-	-	-	2	3	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

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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, Astable 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, SecondEdition,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,Fourth Edition, 2010.

Reference Books

1. Neil H. E. Weste, Kamran Eshraghian, "CMOS Digital Integrated Circuits Analysis and Design", Fourth 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, Third 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.

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4.	www.btechbunks.com/2011/03/vlsi-design-study-material

* 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	PO12	PSO1	PSO2	PSO3
1	3	2	-	1	2	-	-	1	-	-	-	-	3	-	-
2	3	2	-	1	2	-	-	1	-	-	-	-	3	-	-
3	3	2	-	1	2	-	-	1	-	-	-	-	3	-	-
4	3	2	3	2	2	-	-	1	-	-	-	-	3	-	-
5	3	2	3	1	2	-	-	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

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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", Second edition. Prentice Hall, 2015.
2. John G. Webster, "Medical Instrumentation Application and Design", Fifth edition, John Willey and sons,2020.
3. Joseph J. Carr and John M. Brown, "Introduction to Biomedical equipment technology", Third edition, John Willey and sons, New York, 2003

Reference Books

1. Khandpur,R.S,"Handbook of Biomedical Instrumentation ",Second 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.

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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
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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	PO12	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

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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

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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

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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

* 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	PO12	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

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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

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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

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2.	https://www.digimat.in/nptel/courses/video/108105091/L01.html
3.	https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=7113786

* 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	PO12	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

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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", Third Edition, Prentice Hall,2009,

Reference Books

1. Gerhard Weiss, "Multi Agent Systems", Second Edition, 2013, MIT Press.
2. David L. Poole and Alan K. Mackworth, "Artificial Intelligence: Foundations of Computational Agents", Fourth Edition, Cambridge University Press, 2010
3. Richard Szeliski, "Computer Vision: Algorithms and Applications", First Edition, 2010, Springer
4. Simon J.D. Prince, "Computer vision: models, learning and inference", First edition, Cambridge University Press,2012

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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

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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	PO12	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

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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, Third 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", Third edition, 2008.
5. Antony Y.K.Chan, "Biomedical Device Technology, Principles and design", Charles Thomas Publisher Ltd, Illinois, USA, 2008.

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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

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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	PO12	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

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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 ,Second Edition, 2008
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
4. Jonathan W.Valvano, "Embedded Microcomputer Systems Real Time Interfacing", Third 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

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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

* TE – Theory Exam, LE – Lab Exam

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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	PO12	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

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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

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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/

* 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	PO12	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

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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	PO12	PSO1	PSO2	PSO3
1	3	2	2	2	-	-	-	-	3	3	-	1	1	1	1
2	3	3	3	2	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

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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

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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

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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.

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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	PO12	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

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PROFESSIONAL ELECTIVE-VI

Department	Biomedical Engineering	Program: B.Tech.						
Semester	VI	Course Category: PE			*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.

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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	PO12	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

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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 – Simulated Annealing – Random 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

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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.

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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	PO12	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

Correlaion 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

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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								

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)

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

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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	PO12	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

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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.

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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	PO12	PSO1	PSO2	PSO3
1	3	2	1	-	1	3	2	-	-	-	-	1	3	1	1
2	3	2	1	-	1	3	2	-	-	-	-	1	3	1	1
3	3	2	1	-	1	3	2	-	-	-	-	1	3	1	1
4	2	2	1	-	1	3	2	-	-	-	-	1	3	1	1
5	3	2	1	-	1	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

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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.

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4. https://en.wikipedia.org/wiki/Biotelemetry
5. https://www.who.int/goe/publications/goe_telemedicine_2010.pdf

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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	PO12	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

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OPEN ELECTIVE COURSES

Department	**Biomedical Engineering**	Programme: **B.Tech.**						
Semester	**V / VI**	Course Category Code: **OE**			*End Semester Exam Type: **TE**			
Course Code	**U23BMOCO1**	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	**Medical Electronics**	**3**	**-**	**-**	**3**	**25**	**75**	**100**
Prerequisite	-							

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.

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. Joseph J.Carr and John M.Brown, "Introduction to Biomedical Equipment Technology", John Wiley and Sons, New York, 2004.

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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	PO12	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

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Department	Biomedical Engineering	Programme: B.Tech.						
Semester	V / VI	Course Category: OE			Course Category: TE			
Course Code	U23BMOCO2	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	Biometric 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	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

Reference Books

1.Anil K. Jain, Patrick Flynn, and Arun A. Ross, —Handbook of Biometrics, Springer, 2008

2. John Chirillo, Scott Blaul, —Implementing Biometric Securityll, John Wiley, 2003.

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3. John R. Vacca, —Biometric Technologies and Verification Systemsll, 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 ,EvangeliaMicheli-Tzanakou,llBiometrics: Theory, 4 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	PO12	PSO1	PSO2	PSO3
1	3	2	-	-	-	1	-	-	-	-	-	1	1	1	-
2	3	2	2	1	1	2	-	-	-	-	-	1	1	1	-
3	3	2	2	1	2	2	-	-	-	-	-	1	1	1	-
4	3	1	1	1	1	1	-	-	-	-	-	1	1	1	-
5	3	1	2	1	2	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

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SRI MANAKULA VINAYAGAR
ENGINEERING COLLEGE
(An Autonomous Institution)

Puducherry

B.TECH.

BIOMEDICAL ENGINEERING

HONOURS / MINOR PROGRAMME – SENSORS TECHNOLOGY

ACADEMIC REGULATIONS 2023
(R-2023)

CURRICULUM AND SYLLABI

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Annexure – II

Honours / Minor Programme – Sensors Technology

Sl. No.	Semester	Course Code	Course Title	Category	Periods			Credits	Max. Marks		
					L	T	P		CAM	ESM	Total
1	IV	U23ICX401	Smart Sensors	PC	3	1	0	4	25	75	100
2	V	U23BMX502	Nano Biosensors	PC	3	1	0	4	25	75	100
3	VI	U23ICX603	Embedded Sensing Technologies	PC	3	1	0	4	25	75	100
4	VII	U23ICX704	IoT and Sensor Networks	PC	3	1	0	4	25	75	100
5	VIII	U23BMX805	Wearable Devices and its Applications	PC	3	1	0	4	25	75	100
								20	125	375	500

Equivalent NPTEL courses[##]

1	**Course Code** U23XXXN01	Sensors and Actuators	3	**12 Weeks Course**
2		Biophotonics	3	
3		Embedded Systems Design	3	
4		Design for Internet of Things	3	
5		Sensor Technologies: Physics, Fabrication, and Circuits	3	

[##]The student shall be given an option to earn 3 credits through one equivalent 12 weeks NPTEL course instead of any one course listed for honours / minors 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.

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Department	Instrumentation and Control Engineering / Biomedical Engineering	Programme: B.Tech. Honours / Minor					
Semester	IV	Course Category Code: PC			*End Semester Exam Type: TE		
Course Code	U23ICX401	Periods/Week			Credit	Maximum Marks	
		L	T	P	C	CAM	ESE	TM
Course Name	Smart Sensors	3	1	-	4	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	Attain knowledge on fundamentals of smart sensors	K2
CO2	Acquaint on the materials and technologies	K3
CO3	Gain knowledge on the characteristics of smart sensors	K2
CO4	Interpret the data transferred to the MCU	K2
CO5	Understand the standards for smart sensing	K2

UNIT – I	Introduction to smart sensors	Periods:12
Introduction, Temperature IC and Smart Sensors, Pressure IC and Smart Sensors and Accelerometers, Rotation Speed Sensors, Intelligent Opto Sensors, Humidity Frequency Output Sensors, Chemical and Gas Smart Sensors.		CO1
UNIT – II	**Materials and Technologies**	**Periods:12**
Materials: Silicon as a Sensing Material, Plastics, Metals, Ceramics, Structural Glasses, Optical Glasses, Nano-materials, Surface Processing: Spin-Casting, Vacuum Deposition, Sputtering, Chemical Vapor Deposition, Electroplating, MEMS Technologies: Photolithography, Silicon Micromachining, Micromachining of Bridges and Cantilevers, Wafer Bonding.		CO2
UNIT – III	**Characteristics of Smart Sensors**	**Periods:12**
Important Characteristics of Sensors: Determination of the Characteristics - Fractional order element: Constant Phase Impedance for sensing applications such as humidity, water quality, milk quality - Impedance Spectroscopy: Equivalent circuit of Sensors and Modelling of Sensors -Importance and Adoption of Smart Sensors		CO3
UNIT – IV	**Getting Sensor Information into the MCU**	**Periods:12**
Introduction, Amplification and Signal Conditioning: Instrumentation Amplifiers, SLEEP MODE Operational Amplifier, Rail-to-Rail Operational Simplifiers, Switched Capacitor Amplifier, 4- to 20-mA Signal Transmitter, Inherent Power-Supply Rejection, Separate Versus Integrated Signal Conditioning: Integrated Passive Elements, Integrated Active Elements, Digital Conversion: A/D Converters		CO4
UNIT – V	**Standards for Smart Sensing**	**Periods:12**
Introduction, Setting the Standards for Smart Sensors and Systems, IEEE 1451.1, IEEE 1451.2, IEEE 1451.3, IEEE 1451.4, IEEE 1451.5, IEEE 1451.6, IEEE 1451.7, Application Example.		CO5

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

Text Books

1. D Patranabis, Sensors and Transducers, PHI 2nd Edition 2013.
2. Jacob Fraden, "Hand Book of Modern Sensors: physics, Designs and Applications", 4th edition, Springer, New York, 2014.
3. Sergey Y. Yurish,"Digital Sensors and Sensor Systems: Practical Design", 1st edition, IFSA publishing, New York, 2011.

Reference Books

1. A.K. Shawney, "A Course in Electrical and Electronic Measurements and Instrumentation", Paperback – 1 January 2021.
2. Wilson Jon, "Sensor Technology Handbook", Elsevier Inc, 2005.
3. Pavel Ripka, Alois Tipek, 'Modern Sensors Handbook', ISTE LTD, 2007.
4. Simon Monk, "A Hands-On Course in Sensors Using the Arduino and Raspberry Pi", O'Reilly Media, 2019.

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1. https://www.elprocus.com/smart-sensor/
2. https://www.fourfaith.com/industry-news/smart-sensor.html

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3.	https://www.bosch-sensortec.com/products/smart-sensor-systems/
4.	https://www.fierceelectronics.com/electronics/what-are-smart-sensors

* 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	PO12	PSO1	PSO2	PSO3
1	2	3	2	3	2	-	-	-	-	-	-	-	2	1	2
2	2	3	2	3	2	-	-	-	-	-	-	-	2	1	2
3	2	3	2	3	2	-	-	-	-	-	-	-	2	1	2
4	1	3	1	3	2	-	-	-	-	-	-	-	2	1	2
5	2	3	2	3	2	-	-	-	-	-	-	-	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

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

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Department	Biomedical Engineering / Instrumentation and Control Engineering	Programme: B.Tech. Honours / Minor					
Semester	V	Course Category: PC			*End Semester Exam Type: TE		
Course Code	U23BMX502	Periods/Week			Credit	Maximum Marks	
		L	T	P	C	CAM	ESE	TM
Course Name	Nano Biosensors	3	1	0	4	25	75	100
Prerequisite	-							

Common to All Branches

Course Outcomes	On completion of the course, the students will be able to	BT Mapping (Highest Level)
CO1	Explain the principles underlying nano biosensor design and operation	K2
CO2	Familiarize with the detection mechanisms used in nano biosensors.	K3
CO3	Gain knowledge in analyzing the specificity of nano biosensors for target molecules.	K2
CO4	Gain knowledge in describing methods for fabricating nano biosensors.	K3
CO5	Gain knowledge in Integrating nano biosensors into existing technologies for enhanced functionality.	K2

UNIT-I	Introduction to Biosensors and Nanotechnology	Periods: 12	
Basics of Biosensors - - Definition and historical overview - Components of biosensors: Bioreceptor, transducer, and detector - Overview of biosensor applications. Introduction to nanomaterials and their unique properties - Role of nanotechnology in enhancing biosensor performance.			CO1
UNIT-II	**Nanomaterials in Biosensors**	**Periods: 12**	
Types of Nanomaterials - - Carbon-based nanomaterials (e.g., carbon nanotubes, graphene) - Metal nanoparticles (e.g., gold, silver) - Semiconductor nanoparticles (quantum dots) - Conducting polymers. Fabrication Techniques- Top-down and bottom-up approaches - Self-assembly and template synthesis - Surface functionalization strategies.			CO2
UNIT-III	**Design and Application of Nano Biosensors**	**Periods: 12**	
Design Principles of Nano Biosensors - Transduction mechanisms (optical, electrochemical, mechanical) - Bioreceptor immobilization techniques - Signal amplification strategies.			CO3
UNIT-IV	**Applications of Nano Biosensors**	**Periods: 12**	
Clinical diagnostics and point-of-care testing - Environmental monitoring - Food safety and quality control - Drug discovery and pharmacokinetics.			CO4
UNIT-V	**Current Trends and Future Directions**	**Periods: 12**	
Innovations in Nano Biosensor Technology- Wearable biosensors - Lab-on-a-chip devices - Single-molecule detection - Internet of Things (IoT) integration.			CO5

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

Textbooks

1. Aiguo Wu, "Nano Biosensors: From Design to Applications", Springer, 1st edition, 2016.
2. Sandro Carrara, "Nano biosensors and Nanobioanalyses", Elsevier, 1st edition, 2015.
3. Dmitry Zemlyanov,"Nano biosensors: Carbon Nanotubes and Graphene", CRC Press, 1st edition, 2013.

Reference Books

1. Alexandru Grumezescu, "Nano biosensors: Nanotechnology in the Agri-Food Industry", Academic Press, 1st edition, 2016.
2. Sandro Carrara,"Nano biosensors: Theory and Applications in Healthcare", Springer, 1st edition, 2016.
3. Abhijit Bandyopadhyay,"Nano biosensors: Carbon Nanotubes in Disease Diagnosis", CRC Press, 1st edition, 2012.

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1. https://wires.onlinelibrary.wiley.com/doi/abs/10.1002/wnan.136
2. https://www.ncbi.nlm.nih.gov/
3. https://www.nano.gov/

* TE – Theory Exam, LE – Lab Exam

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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	PO12	PSO1	PSO2	PSO3
1	2	3	2	3	2	-	-	-	-	-	-	-	2	1	2
2	2	3	2	3	2	-	-	-	-	-	-	-	2	1	2
3	2	3	2	3	2	-	-	-	-	-	-	-	2	1	2
4	1	3	1	3	2	-	-	-	-	-	-	-	2	1	2
5	2	3	2	3	2	-	-	-	-	-	-	-	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

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

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Department	Instrumentation and Control Engineering / Biomedical Engineering	Programme: B.Tech. Honours / Minor						
Semester	VI	Course Category Code: PC			*End Semester Exam Type: TE			
Course Code	U23ICX603	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	Embedded Sensing Technologies	3	1	-	4	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	Understanding Fundamental Principles of Sensing	K2
CO2	Ability to understand the Core Concepts of Embedded Systems:	K3
CO3	Ability to apply principle of sensing to select appropriate sensing techniques for various applications.	K2
CO4	Ability to integrate embedded systems into different network environments	K2
CO5	Understanding Real-Time Scheduling Algorithms	K2

UNIT –I	Introduction to Sensor Technologies	Periods:12	
Principle of Sensing- Capacitance-magnetic and electromagnetic induction-resistance-piezoelectric effect-heat transfer- light. Physical sensor, optical detectors and sensors.			CO1
UNIT –II	**Typical Embedded System**	**Periods:12**	
Core of the embedded system, Sensors and actuators, classification of embedded systems. Communication interface, Embedded firmware- Applications of embedded system - control system and industrial automation			CO2
UNIT –III	**Embedded Computing Platform**	**Periods:12**	
Embedded computing – classification, characteristics and challenges –embedded system design process- overview of processors and hardware units in an embedded system- Host and target machines- Model of programs - Assembly, Linking and Loading - Embedded application.			CO3
UNIT –IV	**Network interface for embedded system**	**Periods:12**	
Distributed Embedded Architecture- Hardware and Software Architectures, Networks for embedded systems- RS232, RS485, SPI, I2C, CAN, SHARC link supports, Ethernet, Myrinet, Internet.			CO4
UNIT –V	**Real-Time Characteristics**	**Periods:12**	
Clock driven Approach, weighted round robin Approach, Priority driven Approach, Dynamic Versus Static systems, effective release times and deadlines, Optimality of the Earliest deadline first (EDF) algorithm, challenges in validating timing constraints in priority driven systems, Off-line Versus On-line scheduling.			CO5

LecturePeriods:45	TutorialPeriods:15	PracticalPeriods:-	TotalPeriods:60

Text Books

1. Shibu K.V. "Introduction to Embedded Systems", Tata McGraw Hill, 2009.
2. Marilyn Wolf, "Computers as components: Principles of Embedded Computing System Design", 4th edition, Morgan Kaufmann publications (Elsevier), United States, 2017.
3. Jiacun Wang, "Real-Time Embedded Systems", First Edition, Wiley Publishers, United States, 2017.

Reference Books

1. Jonathan W Valvano, "Embedded Microcomputer Systems: Real Time Interfacing", CENGAGE Learning Custom Publishing, 3rd edition, 2010.
2. Lyla.B.Das, "Embedded Systems, An Integrated Approach", Pearson, 2013.
3. Raj Kamal, "Embedded systems Architecture, Programming and Design", 2017, 3rd edition, McGraw Hill Education, India
4. Hermann Kopetz, "Real-time systems: design principles for distributed embedded applications", Kluwer academic publishers, 2002.

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1. https://medium.com/@nanibrolly/embedded-systems-vs-internet-of-things-iot-navigating-the-distinctions-12f6b3afb7c9
2. https://sensorsolutions.net/home
3. https://www.geeksforgeeks.org/real-time-systems/
4. https://www.totalphase.com/blog/2019/11/what-is-importance-of-embedded-networking/
5. https://www.coursera.org/articles/embedded-systems

* 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	PO12	PSO1	PSO2	PSO3
1	3	2	1	2	2	2	-	-	-	-	-	-	2	1	2
2	3	2	2	2	2	2	-	-	-	-	-	-	2	1	2
3	3	2	2	2	2	2	-	-	-	-	-	-	2	1	2
4	3	2	2	2	2	2	-	-	-	-	-	-	2	1	2
5	3	2	2	2	2	2	-	-	-	-	-	-	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
	CAT1	CAT2	Model Exam	Assignment*	Attendance		
Marks	5	5	5	5	5	75	100

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

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Department	Instrumentation and Control Engineering / Biomedical Engineering	Programme: B.Tech. Honours / Minor						
Semester	VII	Course Category Code: PC				*End Semester Exam Type: TE		
Course Code	U23ICX704	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	IoT and Sensor Networks	3	1	-	4	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 Understand the architecture of IoT	K2
	CO2 Acquaint on fundamentals of wireless sensor networks	K2
	CO3 Interpret the protocols of WSNs	K2
	CO4 Gain knowledge on middleware and operating systems for WSNs	K2
	CO5 Impart knowledge on case studies on IoT implementations.	K3

UNIT – I	Architecture of IoT	Periods:12
The History and Reasoning Behind the IoT - The IoT Architectural Reference Model as Enabler - IoT in Practice: Examples: IoT in Logistics and Health – Elements to protect in IoT- Risk sources –Addressing performance and scalability – Addressing – Addressing Security – Addressing Privacy- Addressing Availability and Resilience		CO1
UNIT – II	**Introduction to Wireless Sensor Networks(WSN)**	**Periods:12**
IoT Reference Architecture - Interaction of all sub models – Domain Model – Information Model - Functional Model – Communication Model – Trust, Security and Privacy Background of Sensor Network Technology - Basic Sensor Network Architectural Elements- Brief Historical Survey of Sensor Networks - Challenges and Hurdle - Applications of Wireless Sensor Networks.		CO2
UNIT – III	**Protocols for WSNs**	**Periods:12**
Fundamentals of MAC Protocols - MAC Protocols for WSNs - Sensor-MAC Case Study – Routing Challenges in WSNs - Routing Strategies in WSNs - Transport Protocol Design Issues- Examples of Existing Transport Control Protocols - Performance of Transport Control Protocols		CO3
UNIT – IV	**Middleware and Operating systems for WSNs**	**Periods:12**
WSN Middleware Principles- Middleware Architecture - Existing Middleware : MiLAN - IrisNet - AMF - DSWare - CLMF - MSM – Em –Impala – Dfuse -DDS – Sensor Ware. Operating System- Examples of Operating Systems – TinyOS - Mate – MagnetOS – MANTIS – OSPM - EYES OS – SenOS – EMERALDS – PICOS		CO4
UNIT – V	**CASE STUDY – IoT Implementations**	**Periods:12**
Case study: Smart Grid &IoT, Commercial building automation using IoT, Recent trends in sensor network and Automation in Industrial aspect of IOT.		CO5

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

Text Books

1. Raj Kamal, "Internet of Things-Architecture and design principles", McGraw Hill Education.
2. Holger Karl & Andreas Willig, "Protocols And Architectures for Wireless Sensor Networks", John Wiley, 2005.
3. Feng Zhao & Leonidas J. Guibas, "Wireless Sensor Networks- An Information Processing Approach", Elsevier, 2007.

Reference Books

1. Alessandro Bassi, Martin Bauer, Martin Fiedler, Thorsten Kramp, Rob van Kranenburg, Sebastian Lange, Stefan Meissner, "Enabling things to talk – Designing IoT solutions with the IoT Architecture Reference Model", Springer Open, 2016
2. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stamatis Karnouskos, Stefan Avesand, David Boyle, "From Machine to Machine to Internet of Things", Elsevier Publications, 2014.
3. Vijay Madisetti, Arshdeep Bahga, Adrian McEwen (Author), Hakim Cassimally "Internet of Things A Hands-on-Approach" Arshdeep Bahga & Vijay Madisetti, 2014.
4. Barrie Sosinsky, "Cloud Computing Bible", Wiley-India, 2010.

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1. https://www.geeksforgeeks.org/wireless-sensor-network-wsn/
2. https://mrcet.com/downloads/digital_notes/EEE/IoT%20&%20Applications%20Digital%20Notes.pdf
3. https://www.techtarget.com/iotagenda/definition/Internet-of-Things-IoT
4. https://www.iotforall.com/wireless-sensors-for-iot
5. https://www.tutorialspoint.com/difference-between-wireless-sensor-networks-and-iot

* 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	PO12	PSO1	PSO2	PSO3
1	2	2	1	1	1	1	-	-	-	-	-	-	3	2	3
2	2	2	2	1	2	1	-	-	-	-	-	-	3	2	3
3	2	2	2	1	1	1	-	-	-	-	-	-	3	2	3
4	3	2	3	1	2	1	-	-	-	-	-	-	3	2	3
5	2	2	3	1	2	1	-	-	-	-	-	-	3	2	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

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Department	Biomedical Engineering / Instrumentation and Control Engineering	Programme: B.Tech. Honours / Minor						
Semester	VIII	Course Category: PC				*End Semester Exam Type: TE		
Course Code	U23BMX805	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	Wearable Devices and its Applications	3	1	0	4	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	Identify the need for development of wearable devices and its implications on various sectors.	K2
	CO2	Discus the applications of various wearable inertial sensors for biomedical applications. .	K3
	CO3	Comprehend the design and development of various wearable bio-electrode and physiological activity monitoring devices for use in healthcare applications.	K2
	CO4	Discuss the usage of various biochemical and gas sensors as wearable devices.	K3
	CO5	Acquaint various wearable locomotive sensors as assistive devices for tracking and navigation.	K3

UNIT-I	Unit:1 Introduction to Wearable Devices	Periods: 12	
Motivation for development of Wearable Devices, The emergence of wearable computing and wearable electronics, Types of wearable sensors: Invasive, Non-invasive; Intelligent clothing, Industry sectors' overview – sports, healthcare, Fashion and entertainment, military, environment monitoring, mining industry, public sector and safety.			CO1
UNIT-II	Wearable Inertial Sensors	Periods: 12	
Wearable Inertial Sensors - Accelerometers, Gyroscopic sensors and Magnetic sensors; Modality of Measurement-Wearable Sensors, Invisible Sensors, In-Shoe Force and Pressure Measurement; Applications: Fall Risk Assessment, Fall Detection , Gait Analysis, Quantitative Evaluation of Hemiplegic and Parkinson's Disease patients. Physical Activity monitoring: Human Kinetics, Cardiac Activity, Energy Expenditure measurement: Pedometers, Actigraphs.			CO2
UNIT-III	Wearable Devices for Healthcare	Periods: 12	
Wearable Blood Pressure (BP) Measurement: Cuff-Based Sphygmomanometer, Cuffless Blood Pressure Monitor. Wearable sensors for Body Temperature: Intermittent and Continuous temperature monitoring, Detection principles – thermistor, infrared radiation, thermopile, Modality of measurement wearable, adhesive/tattoo type. Conductive textile electrodes, Knitted Piezoresistive Fabric (KPF) sensors.			CO3
UNIT-IV	Wearable Biochemical and Gas Sensors	Periods: 12	
Wearable Biochemical Sensors: Parameters of interest, System Design –Textile based, Microneedle based; Types: Noninvasive Glucose Monitoring Devices, GlucoWatch G2 Biographer, GlucoTrackTM; Pulse oximeter, Portable Pulse Oximeters, wearable pulse oximeter; Wearable capnometer for monitoring of expired carbon dioxide. Wearable gas sensors: Metal Oxide (MOS) type, electrochemical type, new materials-CNTs, graphene, Zeolites; Detection of atmospheric pollutants.			CO4
UNIT-V	Wearable Cameras and Microphones for Navigation	Periods: 12	
Cameras in wearable devices, Applications in safety and security, navigation, Enhancing sports media, Automatic digital diary. Cameras in smart-watches; Use of Wearable Microphones: MEMS microphones, Bioacoustics, Microphones and AI for respiratory diagnostics and clinical trials. Wearable Assistive Devices for the Blind - Hearing and Touch sensation, Assistive Devices for Fingers and Hands, Assistive Devices for wrist, for arm and feet, vests and belts, head-mounted devices.			CO5

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

Text Books

1. Toshiyo Tamura and Wenxi Chen, "Seamless Healthcare Monitoring", Springer 2018.
2. Edward Sazonov and Michael R. Neuman, "Wearable Sensors -Fundamentals, Implementation and Applications", Elsevier Inc., 2014.
3. Aimé Lay-Ekuakille and Subhas Chandra Mukhopadhyay, "Wearable and Autonomous Biomedical Devices and Systems for

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Reference Books

1. Subhas Chandra Mukhopadhyay, "Wearable Electronics Sensors - For Safe and Healthy Living", Springer 2015 ECE (BSW) Page 37.
2. Shantanu Bhattacharya, A K Agarwal, NripenChanda, Ashok Pandey and Ashis Kumar Sen, "Environmental, Chemical and Medical Sensors", Springer Nature Singapore Pte Ltd. 2018.
3. M. Mardonova and Y. Choi, "Review of Wearable Device Technology and Its Applications to the Mining Industry," Energies, vol. 11, p. 547, 2018.
4. N. Luo, W. Dai, C. Li, Z. Zhou, L. Lu, C. C. Y. Poon, et al., "Flexible Piezoresistive Sensor Patch Enabling Ultralow Power Cuffless Blood Pressure Measurement," Advanced Functional Materials, vol. 26, pp. 1178-1187, 2016.

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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	PO12	PSO1	PSO2	PSO3
1	2	3	2	3	2	-	-	-	-	-	-	-	2	1	2
2	2	3	2	3	2	-	-	-	-	-	-	-	2	1	2
3	2	3	2	3	2	-	-	-	-	-	-	-	2	1	2
4	1	3	1	3	2	-	-	-	-	-	-	-	2	1	2
5	2	3	2	3	2	-	-	-	-	-	-	-	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

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

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Annexure – III

SRI MANAKULA VINAYAGAR
ENGINEERING COLLEGE
(AN AUTONOMOUS INSTITUTION)

Department of Biomedical Engineering
Panel of Examiners

SL. No.	Name of the Examiner	Highest Qualification	Specialization	Experience (in Years)	Communication Address	Email ID with Mobile Number
1.	Dr.P.Shanmugaraja	Ph.D	Medical Electronics	26	Professor, Department of Electronics and Instrumentation, Annamalai University, Chidambaram	psraja70@gmail.com 9443275120
2.	Dr. B.Hema Kumar	Ph.D	Biomedical Engineering	21	Associate Professor, Department of Electronics and Instrumentation Pondicherry Technological University, Puducherry	hemakumarb@pec.edu 9944929804
3.	Dr.K.Kala	Ph.D	Anatomy and Physiology	22	Assistant Professor Department of Biomedical Engineering, Saveetha Engineering College, Chennai-602105	Kala.harishi@gmail.com 6381089711
4.	Dr.V.Janakiraman	Ph.D	Signal processing	20	Professor Department of Electronics and Communication Engineering Dhanalakshmi Srinivasan College of Engineering and Technology, Chennai- 603104	vjramece@gmail.com 9444255029, 7358374100

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5.	Dr. V.Kamatchi Sundari	Ph.D	Image Processing	22	Professor, Departmentof Electronics and Communication Engineering, SRM Institute of Science and Technology, Chennai	vkamatchisundari@gmail.com 9952041393
6.	Dr. P. Vijayakumar	Ph.D	Wireless Communication Network Security	13	Associate Professor, Department of Electronics Engineering, Vellore Institute of Technology, Chennai.	vijayrgcet@gmail.com 9894727271
7.	Dr. Jobin Christ	Ph.D	Biomedical signal processing	24	Professor, Department of Biomedical Engineering, Rajalakshmi Engineering College, Chennai.	jobinchrist@gmail.com jobinchrist.mc@rajalakshmi.edu.in 9842666844
8.	Dr.M.Vijayakarthik	Ph.D	Electronics and Instrumentation	18	Associate Professor, Department of Electronics and Instrumentation, Madras Institute of Technology, Chennai.	vijayakarthick@yahoo.co.in 9976995692
9.	Dr. J. Mohan	Ph.D	Biomedical Signal and Image Processing	18	Valliammai Engineering college, SRM Nagar, Kattankulathur.	mohanjece@valliammai.co.in, 9840791532
10.	Dr.D.Kathirvelu	Ph.D	Physiology, Image Processing	21	Associate Professor, Department of Biomedical Engineering Kattankulathur Campus, SRM Institute of Science and Technology,Chennai.	kathir297@gmail.com 9443283639
11.	Dr.S.Sathishbabu	Ph.D	Biosignals and Systems	26	Associate Professor, Department of Electronics and Communication, Thanthai Periyar	sathish3575@gmail.com 9894235162

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					Government Institute of Technology, Vellore.	
12.	Dr.RamjiKalidoss	Ph.D	Human Anatomy and Physiology	28	Associate Professor, Department of Biomedical Engineering Bharath Institute of Higher Education and Research, Chennai.	ramji.sat@gmail.com 9840959832
13	Dr. P. Thirunavukkarasu	Ph.D	Biotechnology	16	Assistant Professor Cancer Biology &Animal tissue culture Department of Biotechnology Dr. MGR Educational and Research University Maduravoyal, Chennai.	pthirunacas@gmail.com. 9952172249
14	Dr. M. PheminaSelvi	Ph.D	ECE	26	Assistant professor, Department of Electronics and Communication Engineering, University College of Engineering, Villupuram	vm.femina@gmail.com 9994267707
15	Dr. R.Sandanalakshmi	Ph.D	ECE	22	Assistant Professor Department of Electronics and Communication Engineering, Pondicherry Engineering College, Puducherry.	sandanalakshmi@pec.edu 9790972173
16	Dr. N. M. Hariharan	Ph.D	Biotechnology	12	Professor and Head, Department of Biotechnology, SreeSastha Institute of Engineering and Technology,Chennai.	biotechhod@ssiet.in 904062599 .

17	Dr. C. Siva	Ph.D	Nano-technology	12	Assistant Professor, Department of Nano science and Technology, SRM Institute of Science and Technology Kattankulathur 603 203	chumshiva@gmail.com. 9944567367
18	Dr. Ashokan	Ph.D	Biomedical Engineering	10	Professor and Head, Department of Biomedical Engineering Kongunadu College of Engineering and Technology.	Hodbme@kongunadu.ac.in 8012505054
19	Dr.Srigitha.S.Nath	Ph.D	Applied Electronics	22	Associate Professor, Department of Electronics and Communication Engineering Saveetha Engineering college,Chennai.	hod.ece@saveetha.ac.in 9840367678
20	Dr.P.Muthu	Ph.D	Biomedical Engineering	16	Assistant Professor Department of Nano science and Technology, SRM Institute of Science and Technology Kattankulathur.	muthup@srmist.edu.in 9486338640
21	Dr. Prasath Alias Surendhar. S	Ph.D	Biomedical Engineering	10	Associate Professor Department of Biomedical Engineering Aarupadai Veedu Institute of Technology Rajiv Gandhi Salai (OMR) Paiyanoor-603 104	prasaths.bme@gmail.com 8754581937
22	Dr. A. Uma Maheswari	Ph.D	Biosignals and Systems	20	Assistant Professor, Department of ECE, University College of Engineering, Panruti.	umamaheswaritrk@gmail.com 8838553935

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23	Dr. S. Ashok	Ph.D	Communication Systems	12	Assistant Professor, Department of ECE, Veltech multitech Dr. Rangarajan Dr. Sakunthala Engineering college, Chennai.	sashok@veltechmultitech.org 9994206725
24	Dr. S. Rajalaxmi	Ph.D	Biomedical Instrumentation	15	Associate Professor & Head, Department of Biomedical Engineering Mahendra college of Engineering, Salem.	hodbiomed@mahendracollege.com 9865147730
25	Dr. S. Saranya	Ph.D	Biomechanics	8	Assistant Professor, BME, Sri Sivasubramaniya Nadar College of Engineering, Chennai.	ssaranya@ssn.edu.in 9941163265
26	Dr. E. Sathish	Ph.D	Biomechanics	7	Assistant Professor, Dept of BME, Vellore Institute of Technology, Chennai.	sathish.e@vit.ac.in 9941163265
27	Dr. T. Rajalakshmi	Ph.D	Digital Logic Circuits	13	Assistant Professor,Dept of BME, SRM Institute of Science and Technology, Chennai.	rajalakt@srmist.edu.in 9884781995
28	Dr. V. Parthasaradi	Ph.D	Biosignals and Systems	7	Assistant Professor, Department of ECE,E.G.SPillay Engineering College, Nagapattinam.	saradi.66@gmail.com 8838553935
29	Dr. D. Ashok Kumar	Ph.D	Diagnostic and Therapeutic Equipments	18	Associate Professor, Department of BME, SRM Institute of Science and Technology, Chennai.	ashok.d@ktr.srmuniv.ac.in 9442139050
30	Dr. P.Mathivanan	Ph.D	Medical Image Techniques	7	Assistant Professor, Department of ECE, Amrita Vishwa Vidyapeetham chennai campus, Chennai.	p_mathivanan@ch.amrita.edu 9840079520

31	Dr.S.Vijayanand	Ph.D	Microcontroller and Embedded Systems	10	Assistant Professor, Department of ECE, Sri Venkateswara college of engineering, Chennai.	vijayanand.s@svce.ac.in 9840079520
32	Dr. N. Prithiviraj	Ph.D	Diagnostic and Therapeutic Equipment	12	Research Scientist, Centre for Biomedical Research, Aarupadai Veedu Medical College &Hospital, Puducherry	prithivinaga@gmail.com. 6380400036
33	Dr.R.Naresh	Ph.D	Image Processing	10	Assistant Professor, School of Computing, SRM Institute of Science and Technology, Kattankulathur, Chennai	nareshcsephd@gmail.com 8056662701
34	Dr.N.Senthilkumar	Ph.D	Nanotechnoloy	5	Assistant Professor, Department of ECE, M.Kumarasamy College of Engineering, Erode,	Senthilkumarn.ece@mkce.ac.in 9894856176
35	Dr.Indhumathi	Ph.D	Biomedical Instrumentation	15	Assistant Professor, Department of BME Bharath Institute of Technology Chennai.	indhumathir.biomedical@bharathuniv.ac.in 9384565205
36	Dr.Sandhiya,	Ph.D	Medical Electronics	8	Assistant Professor/BME, Aarupadai Veedu Institute of Technology, Chennai.	sandhiya.bme@avit.ac.in 9384565205
37	Dr.A.T.Priyeshkumar	Ph.D	Biomedical Instrumentation	12	Assistant Professor/BME Mahendra College of Engineering, Salem.	priyeshmce.bme@gmail.com 8825250302

38	Dr.K.Saravanan	Ph.D	Applied Electronics	12	Associate Professor/EEE Dr.MGR Educational and Research Institute	saravanan.eee@drmgr.ac.in 9444579849
39.	Dr.M.Ravi	Ph.D	Human Genetics	11	Professor Department of Human Genetics SRM Institute of Science and Technology, Kattankulathur, Chennai	mravi@sriramachandra.edu.in 9841486363
40.	Dr. P. Baranisrinivasan	Ph.D	Biomedical Engineering	18	Professor, Department of Biomedical Engineering, Rajiv Gandhi college of Engineering and Technology, Puducherry	pbspy01l@gmail.com 8778484608
41	Dr.A.Vengadesan	Ph.D	Electrical and Electronics Engineering	16	Assist Professor, Department of Biomedical Engineering, Sri Venkateshwara college of Engineering and Technology, Puducherry	avmithrankavin@svcet.ac.in 8838263097
42	Dr. Vijayakumar P	Ph.D	Network Security	14	Professor, School of Electronic Engineering, Vellore Institute of Technology, Chennai.	vijayrgcet@gmail.com 9894727271
43	Dr.Babu Shanmugham	Ph.D	Electronics Instrumentation	16	Associate Professor, Department of Biomedical Engineering, Rajiv Gandhi college of Engineering and Technology, Puducherry	Babulakshmi2007@gmail.com 9884251898

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44	Dr.N.Kins Burk Sunil	Ph.D	Biomedical Instrumentation ,Bio Signal Image processing	17	Associate Professor / Biomedical Engineering Sethu Institute of Technology, Pulloor, Kariapatti, Virudhunagar District, Tamil Nadu - 626115	kinsburksunil@gmail.com 9994045939
45	Dr P Maran	Ph.D	Signal Processing	8	Assistant professor (sr gr) Department of ECE, Amrita Vishwa Vidyapeetham chennai campus, Chennai.	p_marab@ch.amrita.edu 9884019078
46	Dr. V. Magesh	Ph.D	ECE	20	Assistant Professor/ECE Velammal Engineering College, Chennai - 66	mahi0437@gmail.com 8124428388
47	Dr.R.Annamalai	Ph.D	Artificial Intelligence	15	Associate Professor /CSE AI Amrita Vishwa vidyapeetham Chennai	annamalaimtech@gmail.com 7449204021
48	Dr.R.Krishnaprasanna	Ph.D	Medical Electronics	13	Assignment Professor/ECE Sathyabama institute of science and technology, chennai	krishnaprasanna.ece@sathyabama.ac.in 9952489022
49	Dr. A.Aranganathan	Ph.D	Image Processing	16	Associate Professor / Dept. of. ECE Sathyabama University, OMR, Jeppiaar Nagar, Sholinganallur, Chennai- 119	aranganathan.etc@sathyabama.ac.in 9444234224

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SRI MANAKULA VINAYAGAR
ENGINEERING COLLEGE
(AN AUTONOMOUS INSTITUTION)

DEPARTMENT OF BIOMEDICAL ENGINEERING - COMMON COURSES				
Sl.No	**Offering Department**	**Course Code**	**Course Name**	**Remarks**
1	BME	U23BMTC01	Electron Devices and Circuits	Common to BME and ICE
Professional Elective				
2	BME	U23BMEC01	Communication Systems	Common to BME and ICE
3	BME	U23BMEC02	Wearable Technology	Common to BME,ECE and ICE

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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

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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	PO12	PSO1	PSO2	PSO3
1	3	2	2	-	2	2	-	-	-	-	-	-	3	-	2
2	3	2	2	1	2	2	-	-	-	-	-	-	3	-	2
3	3	2	2	1	2	2	-	-	-	-	-	-	3	-	2
4	3	3	2	1	2	2	-	-	-	-	-	-	3	-	2
5	3	3	2	1	2	2	-	-	-	-	-	-	3	-	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	10		5	5	5	75	100

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

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Dr. A.Vijayalakshmi

B.Tech. Biomedical Engineering

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Department	Biomedical Engineering	Programme: B.Tech.						
Semester	IV	Course Category: PE				End Semester Exam Type: TE		
Course Code	U20BMECO1	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	Communication Systems	3	0	0	3	25	75	100
	(Common to BME and ICE Branches)							
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 and FDMA, 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.		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

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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	PO1	PO2	PO6	PO1	PO2	PO9	PO1	PO2	PO12	PO1	PO2	PSO3
1	3	3	2	1	2	-	-	-	-	3	1	1	2	2	-
2	3	2	2	1	2	-	-	-	-	3	1	1	2	2	-
3	3	3	-	1	1	-	-	-	-	3	1	1	2	2	-
4	3	2	-	1	1	-	-	-	-	3	1	1	2	2	-
5	3	3	2	1	2	-	-	-	-	3	1	1	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

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

Dr. A.Vijayalakshmi

B.Tech. Biomedical Engineering

Department	Biomedical Engineering	Program: B.Tech.						
Semester	VI / VIII	Course Category: PE			*End Semester Exam Type: TE			
Course Code	U23BMECO2	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CAM	ESE	TM
Course Name	Wearable Technology	3	0	0	3	25	75	100

(Common to BME,ECE and ICE Branches)

Prerequisite	Electron Devices and Sensors	
Course Outcomes	**On completion of the course, the students will be able to**	BT Mapping (Highest Level)
	CO1 Acquire knowledge about sensors in wearable systems.	K2
	CO2 Gain knowledge on signal processing for wearable systems	K3
	CO3 Elucidate the usage of energy techniques for wearable devices	K3
	CO4 Gain knowledge about wireless health technology	K3
	CO5 Analyse the applications of wearable systems	K3

UNIT – I	INTRODUCTION TO WEARABLE SYSTEMS AND SENSORS	Periods:9	
Need for wearable systems, Sensors for wearable systems-Inertia movement sensors, Respiration activity sensor, Inductive plethysmography, Impedance plethysmography, pneumography, Wearable ground reaction force sensor, GSR, Radiant thermal sensor, Wearable motion sensors, E-Textiles,			CO1
UNIT – II	**SIGNAL PROCESSING**	**Periods:9**	
Wearability issues -physical shape and placement of sensor, technical challenges - sensor design, signal acquisition, Constraint on sampling frequency for reduced energy consumption, light weight signal processing, Rejection of irrelevant information,			CO2
UNIT – III	**ENERGY HARVESTING FOR WEARABLE DEVICES**	**Periods:9**	
Solar cell, Vibration based, Thermal based, Human body as a heat source for power generation, Hybrid thermoelectric photovoltaic energy harvests, Thermopiles.			CO3
UNIT – IV	**WIRELESS HEALTH TECHNOLOGY**	**Periods:9**	
Need for wireless monitoring, Definition of Body area network, BAN and Healthcare, Technical Challenges-System security and reliability, BAN Architecture, Wireless communication techniques.			CO4
UNIT – V	**APPLICATIONS OF WEARABLE SYSTEMS**	**Periods:9**	
Medical Diagnostics - Medical monitoring of patients with chronic disease, Hospital patients, Elderly patients, Multi parameter monitoring, Neural recording.			CO5

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

Text Books

1. Helena Jelinkova, "Lasers for medical applications: Diagnostics, Therapy and Surgery", 1st edition, Woodhead Publishing, 2013.
2. Markolf. H.Neimz, "Laser tissue interactions-Fundamentals and applications", 3rd edition, Springer, 2014.
3. Subhas Chandra Mukhopadhyay and Tarikul Islam, "Wearable Sensors Applications, design and implementation", IOP Publishing Ltd, 2017.

Reference Books

1. Orazio Svelto and David C. Hanna, "Principles of lasers", 5th edition, Springer, 2010.
2. William T. Silfvast, "Laser fundamentals", 2nd edition, Cambridge University Press, 2009.
3. Bonfiglio, Annalisa, De Rossi, Danilo, "Wearable Monitoring Systems", 1st Edition, Springer US, 2011.
4. Hang, Yuan-Ting, "wearable medical sensors and systems" , Springer – 2013.
5. Mehmet R. Yuce, Jamil Y. Khan, "Wireless Body Area Networks Technology, Implementation and Applications", Pan Standard Publishing, Singapore, 2012.

Web References

1. https://en.wikipedia.org/wiki/Smart_wearable_system
2. https://www.ncbi.nlm.nih.gov/pubmed/15227552
3. https://www.researchgate.net/publication/232811306_Smart_wearable_systems_Currentstatus_and_future_challenges
4. https://m.youtube.com/watch?v=Mj1aH7CkNCw
5. https://youtu.be/tpTnraEagw4

* TE – Theory Exam, LE – Lab Exam

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COs/POs Mapping

COs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	2	2	3	-	-	-	-	-	-	3	3	2	2
2	3	3	2	2	3	-	-	-	-	-	-	3	3	2	2
3	3	3	2	3	2	-	-	-	-	-	-	3	3	2	2
4	3	3	2	3	3	-	-	-	-	-	-	3	3	2	2
5	3	3	2	3	3	-	-	-	-	-	-	3	3	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	10		5	5	5	75	100

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

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