VIT Vidyalankar Institute of Technology
Accredited A+ by NAAC

Vidyalankar Institute of Technology

An Autonomous Institute affiliated to University of Mumbai

Bachelor of Technology

in

Biomedical Engineering

Third Year Scheme & Syllabus

(As per AICTE guidelines, with effect from Academic Year 2024-25)

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated, and taken forward in a systematic manner. Therefore, autonomy for Vidyalankar Institute of Technology is not merely a transition from pre-cooked syllabi to self-designed curriculum. Autonomy curriculum of the Institute offers required academic flexibility with emphasis on industry requirements and market trends, employability and problem-solving approach which leads to improving competency level of learners with diverse strengths. In line with this, the curriculum framework designed is **Choice-Based Credit and Grading System (CBCGS)**. Number of credits for each category of courses learnt by learners, internships and projects is finalized considering the scope of study and the ability that a learner should gain through the programme. The overall credits and approach of curriculum proposed is in line with AICTE model curriculum.

The curriculum comprises courses from various categories like basic sciences, humanities and social sciences, engineering sciences, general education and branch specific courses including professional electives and open electives. The curriculum has core courses of branch of engineering positioned and sequenced to achieve sequential and integral learning of the entire breadth of the specific branch. These courses are completed by third year of the engineering programme that enables learners to prepare for higher education during their final year. Professional elective courses, that begins from third year of programme, offer flexibility and diversity to learners to choose specialization from a basket of recent developments in their field of technology. The selection of unique professional elective courses based on industrial requirements and organizing them into tracks is a salient feature of this curricula ensuring employability. Open Elective courses cover multi-disciplinary, special skill development, project management and similar knowledge that make learner capable to work in industrial environment.

For holistic development of learners, apart from technical courses, Humanities and Social Science courses develop the required soft-skills and attitude amongst learners. Our curriculum also introduces Social Service Internship and Internship with institutes abroad along with courses like Design Thinking, Wellness - Body, Mind & Spirit, Indian Traditional Knowledge System under General Education category. These general education courses aim to create balance in brain hemispheres and hence improve learners' clarity in thoughts and responses.

Additionally, curriculum provides add-on minor/honours degree that involves field/ domain study. Learner can avail this degree by completing requirement of additional 18 credits. Thus, the academic plan of VIT envisages a shift from summative to formative and competency-based learning system which will enhance learner's ability towards higher education, employability and entrepreneurship.

Chairman, Board of Studies
Department of Biomedical Engineering
Vidyalankar Institute of Technology

Chairman, Academic Council
Vidyalankar Institute of Technology

Third Year B. Tech. Biomedical Engineering **Semester: V**

Course Structure and Assessment guidelines

Course		Head of Learning	Credits	Assessment guidelines (Marks)			Total marks (Passing@40% of total marks)
Code	Name			ISA	MSE	ESE	
HS04	Presentation Skills	Practical	1	25	-	25	050
BS13T	Basics of VLSI	Theory	2	15	20	40	075
BS13P	Basics of VLSI Lab	Practical	1	25	-	25	050
BM09T	Diagnostic and Monitoring Equipment	Theory	2	15	20	40	075
BM09P	Diagnostic and Monitoring Equipment Lab	Practical	1	25	-	25	050
BM10T	Microprocessors and Microcontrollers	Theory	2	15	20	40	075
BM10P	Microprocessors and Microcontrollers Lab	Practical	1	25	-	25	050
BM11T	Biomedical Digital Signal Processing	Theory	2	15	20	40	075
BM11P	Biomedical Digital Signal Processing Lab	Practical	1	25	-	25	050
BM12T	Medical Imaging Equipment	Theory	2	15	20	40	075
BM12P	Medical Imaging Equipment Lab	Practical	1	25	-	25	050
BMXXT	Prof. Elective 1	Theory	2	15	20	40	75
BMXXP	Prof. Elective 1 Lab	Practical	1	25	-	25	50
BM39P	Mini Project-1	Practical	2	25		50	75
Total Credits			**21**	**-**	**-**	**-**	**-**

ISA=In Semester Assessment, MSE= Mid Semester Examination, ESE= End Semester Examination

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Guidelines for Professional Elective Courses and Specialization Certificate – Refer Appendix-A

Important Note 1: Learners are required to go through the Appendix-A carefully before selecting the Professional Elective courses. Detailed guidelines regarding Professional Elective courses, specialization tracks and courses relevant to each track are given in Appendix-A.

Professional Elective -1 Courses (BMXX)

Code	Course Name	Specialization Track Name#
BM21T	Integrated Data Management	AI in Healthcare
BM21P	Integrated Data Management Lab	AI in Healthcare
BM22T	Modern Sensors for Internet of Things (IoT)	Internet of Things (IoT)
BM22P	Modern Sensors for Internet of Things (IoT) Lab	Internet of Things (IoT)
BM23T	Bio-Photonics	Biomedical Technology and Innovation
BM23P	Bio-Photonics Lab	Biomedical Technology and Innovation

#For details of Specialization Certificate, refer Appendix-A

Guidelines for Award of Honours/ Minor Degree – Refer Appendix-B

Important Note 2: Before the end of Semester 5, learners are required to go through the Appendix-B carefully to opt for Honours/ Minor Degree Programme. The courses of Honours/ Minor degree programme will be offered from the end of semester 5. Learners willing to opt for Honours/ Minor degree programme are required to satisfactorily complete the course named "Industry Interaction" of 1 credit during preferably during the break of the semester 5 and semester 6 which will facilitate them to select Honours/ Minor degree programme of their choice. Detailed guidelines regarding the Honours/ Minor degree programmes of all the departments, Eligibility criterion and Credit requirements are given in Appendix-B. Courses relevant to Honours/ Minor Degree Programmes offered by Department of Biomedical Engineering are given in Appendix-C.

Third Year B. Tech. Biomedical Engineering **Semester: VI**

Course Structure and Assessment guidelines

Course		Head of Learning	Credits	Assessment guidelines (Marks)			Total marks (Passing@40% of total marks)
Code	Name			ISA	MSE	ESE	
BM13T	Critical Care Equipment	Theory	2	15	20	40	075
BM13P	Critical Care Equipment Lab	Practical	1	25	-	25	050
BM14T	Digital Image Processing	Theory	2	15	20	40	075
BM14P	Digital Image Processing Lab	Practical	1	25	-	25	050
BM15T	Biomedical Microsystems	Theory	2	15	20	40	075
BM15P	Biomedical Microsystems Lab	Practical	1	25	-	25	050
BM16T	Hospital Management	Theory	2	15	20	40	075
BM16P	Hospital Management Lab	Practical	1	25	-	25	050
BMXXT	Prof. Elective 2	Theory	2	15	20	40	075
BMXXP	Prof. Elective 2 Lab	Practical	1	25	-	25	050
BMXXT	Prof. Elective 3	Theory	2	15	20	40	075
BMXXP	Prof. Elective 3 Lab	Practical	1	25	-	25	050
BM40P	Mini Project-2	Practical	2	25	-	50	075
Total Credits			**20**	**-**	**-**	**-**	**-**

ISA=In Semester Assessment, MSE= Mid Semester Examination, ESA= End Semester Examination

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Professional Elective- 2 Courses (BMXX)

Code	Name	Specialization Track Name#
BM24T	Artificial Intelligence	AI in Healthcare
BM24P	Artificial Intelligence Lab	AI in Healthcare
BM25T	Principles of Internet of Things (IoT)	Internet of Things
BM25P	Principles of Internet of Things (IoT) Lab	Internet of Things

BM26T	Robotics in Medicine	Biomedical Technology and Innovation
BM26P	Robotics in Medicine Lab	Biomedical Technology and Innovation

#For details of Specialization Certificate, refer Appendix-A

Professional Elective-3 Courses (BMXX)

Code	Name	Specialization Track Name#
BM27T	Machine Learning	AI in Healthcare
BM27P	Machine Learning Lab	AI in Healthcare
BM28T	Embedded System Design with Tiny Operating System (OS)	Internet of Things
BM28P	Embedded System Design with Tiny Operating System (OS) Lab	Internet of Things
BM29T	Point of Care Technology	Biomedical Technology and Innovation
BM29P	Point of Care Technology Lab	Biomedical Technology and Innovation

#For details of Specialization Certificate, refer Appendix-A

TE Summer Break

Course		Head of Learning	Credits	Assessment guidelines (Marks)	Total marks (Passing@40% of total marks)
Code	Name				
BM41	Industry Internship	Practical	5	As decided by Internal and External guide	

Detailed Syllabus of Third Year Semester-V

Course Name: Presentation Skills

Course Code: HS04

Category: Humanities, Social Sciences and Management

Preamble:

The course, Presentation Skills, is intended to equip students with the necessary skill-set to help them bridge the gap from the campus to the corporate world. It will help them to be industry ready in sync with the requirements of the program they are pursuing

Course Objectives:

- To help students to bridge the gap between the campus and the corporate world
- To help students to be industry ready by equipping them with the necessary soft skill-set

Pre-requisites:

NIL

Course Outcome:

The students will be able to:

CO1: Deliver Corporate Presentations, Storyboards, and Business Plan
CO2: Participate in campus placements
CO3: Build a personal brand and establish their presence as a global citizen.

Course Scheme:

Contact Hours		Credits Assigned
Theory	Practical	Practical
	02	01

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	050

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose a revised assessment methodology for his/her course. However, the revised assessment methodology shall be

approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Module Contents	No. of Hours
01	Personal Branding	Introduction to Personal Branding –Purpose, Significance, Benefits and Techniques to build a personal brand Corporate/Organisational Branding Online identity of Brand on social media Maintenance and Improvement of your Brand Factors affecting your Brand	04
02	Corporate Presentations	Business Presentation Tips Digital Presentations PAIBOC Model and Minto Pyramid Principles	04
03	Business Plan Presentations	Introduction to Business Plans Company Overview & Industry Analysis Persuasive Communication in Marketing Strategy Operations Strategy in Financial Management Implementation Plan	04
04	Storyboarding and Storytelling	Visual Story Telling Video Presentations Story Structure with images Film and Animation	04
05	Placement Readiness	Mock HR Interviews Mock GDs Aptitude Tests Placement ready resume	04
06	Global Communication	An introduction to inter-cultural communication Introduction to languages and cultures Global media in mass communication Tips to become a global citizen Respecting cultural diversity	0
Total			**24**

Guidelines to conduct practical sessions:

1. Personal Branding
2. Personal Branding
3. Corporate Presentations
4. Corporate Presentations
5. Business Plan Presentations
6. Business Plan Presentations

7. Storyboarding and Storytelling
8. Storyboarding and Storytelling
9. Placement Readiness
10. Placement Readiness
11. Global Communication
12. Global Communication

List of Assignments:

1. Personal Branding (Individual)
2. Corporate Presentations (Group)
3. Business Plan Presentations (Group)
4. Storyboarding and Storytelling (Group)
5. Global Communication (Individual)

Recommended Online Courses:

1. Introduction to Personal Branding - https://www.coursera.org/learn/personal-branding
2. Strategic Self-Marketing and Personal Branding - https://www.coursera.org/learn/self-marketing
3. Learn to Storyboard for Film or Animation - https://www.udemy.com/course/storyboard-for-film-or-animation/
4. Powerful Tools for Teaching and Learning: Digital Storytelling - https://www.coursera.org/learn/digital-storytelling
5. Presentation Skills: Speechwriting, Slides and Delivery Specialization - https://www.coursera.org/specializations/presentation-skills
6. Business English for Cross-Cultural Communication - https://www.coursera.org/learn/cross-cultural-communication-business

Reference Books / Articles

1. Murphy, Effective Business Communication, Tata McGraw Hill
2. Wallace and Masters, Personal Development for Life and Work, Thomson Learning
3. Robbins Stephens, Organizational Behaviour, Pearson Education
4. Kitty O Locker, Business Communication- "Building Critical Skills," McGraw Hill

Course Name: Basics of VLSI

Course Code: BS13T

Category: Basic Science

Preamble:

This course introduces students to Physics of CMOS, with detailed technical introduction to working of MOSFET, MOS Circuits, Fabrication, and Hardware Description Languages

Course Objectives:

- To understand the basics physics of CMOS devices and CMOS Circuits.
- To gain the knowledge of various fabrication techniques.
- To understand various HDLs

Pre-requisites:

1. Physics for Biomedical Engineering (BS20T)
2. Electronic Devices and Circuits (BM03T)
3. Digital logic design and analysis (BM01T)

Course Outcome:

The students will be able to:

CO1: Describe hardware description language used to model circuits.
CO2: Analyze the physics of MOS devices.
CO3: Compare the implementation of inverter circuits using N MOS and CMOS devices and noise in these circuits
CO4: Compare the fabrication technology used in IC fabrication and how system clocking is designed.
CO5: Apply the design rules and draw layouts for various digital gates.

Course Scheme:

Contact Hours		Credits Assigned
Theory	Practical	Theory
02	--	02

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory+ Tutorial	15	20	40	075

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose a revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Module Contents	No. of Hours
01	Hardware Description Language	Introduction to VHDL hardware description language, core features of VHDL, Combinational and Sequential Logic design using VHDL Using VHDL	06
02	Physics of MOSFET	MOSFET, threshold voltage, linear and saturated operation, FET capacitance, Scaling of MOS circuits, types of scaling and limitations of scaling-short channel and hot electron effect. MOS Transistors, MOS transistor switches, Basic MOS inverter and its working, types of MOS invertors viz active load nMOS inverter, MOSFET Inverter with E-nMOS as pull up, MOSFET Inverter with D- nMOS as pull up, MOSFET Inverter with pMOS as pull up, CMOS inverter, voltage transfer characteristics, noise immunity and noise margins,	08
03	Fabrication of CMOS	Silicon Semiconductor Technology Wafer processing, mask generation, oxidation, epitaxy growth diffusion, ion implantation, lithography, etching, metalization, basic NMOS and PMOS processes. Latch up in CMOS and CMOS using twin tub process.	06
04	MOSFET Circuits	Introduction to VLSI Clocking and System Design: Clocking: CMOS clocking styles, Clock generation, stabilization and distribution. Low Power CMOS Circuits: Various components of power dissipation in CMOS, Limits on low power design, low power design through voltage scaling.	05
05	Design Rules and Layout Diagrams	Design rules and Layout NMOS and CMOS design rules and layout, Design of NMOS and CMOS inverters, NAND and NOR gates. Interlayer contacts, butting and buried contacts, stick diagrams, layout of inverter, NAND and NOR gates. Design of basic VLSI circuits Design of circuits like multiplexer, decoder, Flip flops, using MOS circuits	05
Total			**30**

Recommended Online Courses:

1. VLSI - This is where design meets fabrication-Udemy https://www.udemy.com/course/vlsi-academy-custom-layout/
2. Build a CPU with Verilog HDL Udemy-https://www.udemy.com/topic/verilog-hdl-programming/

Reference Books / Articles

1. Kang, CMOS Digital Integrated Circuits, Tata McGraw Hill Publications, Third Edition
2. E. D. Fabricus, Introduction to VLSI design, McGraw Hill Publications, 1990
3. D.A. Pucknell and Eshraghian, Basic VLSI Design, Prentice Hall of India,2005
4. John F Wakerly, Digital Design Principles and Practices, Prentice Hall of India,Third edition
5. Volnei A. Pedroni, Circuit Design with VHDL, Prentice Hall of India, 2009
6. Examples, Douglas Perry, VHDL Programming McGraw Hill Publications, 2008
7. Neil H.E. Weste, Kamran Eshraghian Principles of CMOS VLSI Design: A Systems Perspective, Addison Wesley Publications, Second edition, 1993

Course Name: Basics of VLSI lab

Course Code: BS13P

Category: Basic Science

Preamble:

This course introduces students to Physics of CMOS, with detailed technical introduction to working of MOSFET, MOS Circuits, Fabrication, and Hardware Description Languages

Course Objectives:

- To understand the basics physics of CMOS devices and CMOS Circuits.
- To gain the knowledge of various fabrication techniques.
- To understand various HDLs

Pre-requisites:

1. Physics for Biomedical Engineering (BS20P)
2. Electronic Devices and Circuits (BM03P)
3. Digital logic design and analysis (BM01P)

Course Outcome:

The students will be able to:

CO1: Describe hardware description language used to model circuits.
CO2: Analyze the physics of MOS devices.
CO3: Compare the implementation of inverter circuits using N MOS and CMOS devices and noise in these circuits
CO4: Compare the fabrication technology used in IC fabrication and how system clocking is designed.
CO5: Apply the design rules and draw layouts for various digital gates.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
--	02	--	01

Assessment guidelines:

Head of Learning	**ISA**	**MSE**	**ESE**	**Total**
Theory+ Tutorial	25	-	25	050

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose a revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Suggested List of Experiments

1. Multiplexor using behavioral coding uses more hardware compared to data flow models
2. Design of asynchronous circuits in VHDL
3. ALU is basically a multiplexor.
4. Design a car lock opening with a password. Provision should be given to user to set password.
5. Drain current of MOSFET varies with KP, VT0, LAMBDA. Demonstrate using SPICE models of MOSFET.
6. Product kn*RL decides the Noise margin of resistive load inverter. Use SPICE models to demonstrate.
7. A resistive load inverter with R=1K has VDD=5V;VT0=1V;Kp=22;gamma=0.2. What should be W/L so that VOL=0.6V
8. Noise Margin of CMOS Inverter changes with kn and kp
9. W/L ratio of PMOS and NMOS in layout decides the propagation delay and leakage current in CMOS inverter. Use a suitable tool to prove
10. Design a pulse rate monitor on FPGA
11. Design a body temperature monitoring on FPGA
12. Design a circuit to give stock details of the medicines available in the pharmacy using pass transistors in DSCH2
13. Design a patient monitoring system using 4 input parameters and an alarm output using CMOS Logic in DSCH2
14. Develop an object detecting system for blind using NMOS logic in DSCH2
15. Develop a logic for “Biomedical Sleep Inducer” using transmission gate logic in DSCH2

Suggested List of Value-Added Assignments

1. Short Channel Effects
2. Effect Dielectric Constant on Working of inverter
3. CMOS Clocking Design
4. Problem Based Assignment

Reference Books / Articles

1. Kang, CMOS Digital Integrated Circuits, Tata McGraw Hill Publications, Third Edition.
2. E. D. Fabricus, Introduction to VLSI design, McGraw Hill Publications, 1990.
3. D.A. Pucknell and Eshraghian, Basic VLSI Design, Prentice Hall of India, 2005.
4. John F Wakerly, Digital Design Principles and Practices, Prentice Hall of India, Third edition.
5. Volnei A. Pedroni, Circuit Design with VHDL, Prentice Hall of India, 2009.

6. Examples, Douglas Perry, VHDL Programming McGraw Hill Publications, 2008.
7. Neil H.E. Weste, Kamran Eshraghian Principles of CMOS VLSI Design : A Systems Perspective, Addison Wesley Publications, Second edition, 1993.

Course Name: Diagnostic and Monitoring Equipment

Course Code: BM09T

Category: Professional Core

Preamble:

This course will introduce students to the essential Diagnostic and Monitoring Equipment used in clinical setup. The course will lay a foundation knowledge for understanding the basic working principle and technology involved in this equipment. On broader view knowledge gained by the students will make them competent to work in areas of medical device manufacture and hospitals.

Pre-requisites:

1. Human Anatomy and Physiology (BS18T)
2. Biomedical Transducers and Control Systems (BM04T)
3. Analytical and Clinical Equipment (BM05T)

Course Objectives:

- To understand the basic principle, working and design of various automated diagnostic equipment's.
- To study various medical instrumentation systems, drug delivery systems and health management systems.
- To develop skills enabling biomedical engineers to serve hospitals, national and international industries, and government agencies.

Course Outcomes:

Learner will be able to:

CO1: Have better understanding for various bioelectrical phenomenon existing in the human body and explain the instrumentation system involved in measuring theses phenomenon.
CO2: Classify different types of arrhythmias and explain the electronic system required for arrhythmia, ambulatory and cardiac stress monitoring.
CO3: Describe techniques and electronic system involved in measurement of heart rate, pulse rate, blood pressure, respiration rate and body temperature monitoring.
CO4: Classify and discuss different techniques for measurement of blood flow and cardiac output.
CO5: Describe principle and working on oximeters.
CO6: Illustrate working principle and technical specifications of physiotherapy equipments.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
3	-	2	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	75

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No. of Hours
1	Bioelectrical Signals and Recorders	Introduction to Action Potential and Cell Membrane Physiology. Principle, Measurement Techniques and Clinical Applications of ECG, EMG, EEG, ERG, EOG and Phonocardiography.	8
2	Arrhythmia and Ambulatory Monitoring Systems	Cardiac Arrhythmia: Definition and Classification. Working principle of Arrhythmia Monitors. QRS and P wave detection technique with algorithm. Introduction to Ambulatory Monitoring and Holter Cardiography. Exercise Stress Testing: Principle and Protocols involved in cardiac stress Testing.	4
3	Patient Monitoring System	Patient Monitoring System: Introduction and Features of Modern-Day Patient Monitoring Systems. Principle and Measurement Techniques for Heart Rate, Pulse Rate, Blood Pressure, Temperature, Respiration Rate and Apnea Monitors. Block Representation of Modern-Day Patient Monitor and Central Nurse Station.	6
4	Blood Flow and Cardiac Output Measurement	Introduction to Blood Flow and Cardiac Output. Techniques for Measurement of Blood Flow: Electromagnetic, Ultrasonic, NMR and Laser Doppler flowmetry. Techniques for Measurement of Cardiac Output: Indicator Dilution, Dye Dilution and Thermal Dilution Techniques.	4
5	Oximeters	Introduction to Oximetry. *In-vitro* and *In-vivo* Oximetry, Ear Oximetry, Pulse Oximetry, Skin Reflectance Oximeters, Intravascular Oximeters.	4

6	Physiotherapy Equipment	Working Principle and Technical Specifications of 1. Shortwave Diathermy 2. Ultrasonic Therapy unit 3. Microwave Therapy unit 4. Nerve and Muscle Stimulator	4
Total			**30**

Suggested list of Assignments:

1. Bioelectrical Signals and Recorders
2. Arrhythmia and Ambulatory Monitoring Systems
3. Patient Monitoring System
4. Blood Flow and Cardiac Output Measurement
5. Oximeters
6. Physiotherapy Equipment

Suggested List of Value-Added Home Assignments:

1. Design of Instructional Videos.
2. Design of Demographics and uploading on Social Media Platform.
3. Creation of a Wikipedia page.
4. Problem Based Assignment.

Suggested Online Courses:

1. Vital Signs: Understanding What the Body Is Telling Us https://www.coursera.org/learn/vital-signs?
2. The Development of Mobile Health Monitoring Systems https://www.coursera.org/learn/mobile-health-monitoring-systems
3. MedTech: Digital Health and Wearable Technology https://www.futurelearn.com/courses/medtech-digital-health
4. Nanotechnology for Health: Innovative Designs for Medical Diagnosis https://www.futurelearn.com/courses/nanotechnology-health

Reference Books:

1. R.S. Khandpur, *"Handbook of Biomedical Instrumentation"*, PHI, Third Edition.
2. J.G. Webster, *"Medical Instrumentation: Application and Design"*, TMH, Third Edition.
3. J.G. Webster, *"Encyclopedia of Medical Devices and Instrumentation. Vol. I, II, III, IV, V, VI"*, Willey, Second Edition.
4. S. Ananthi, *"A Textbook of Medical Instruments"*, New Age International Pvt. Ltd, First Edition.

Course Name: Diagnostic and Monitoring Equipment Lab

Course Code: BM09P

Category: Professional Core

Preamble:

This course will introduce students to the essential Diagnostic and Monitoring Equipment used in clinical setup. The course will lay a foundation knowledge for understanding the basic working principle and technology involved in this equipment. On broader view knowledge gained by the students will make them competent to work in areas of medical device manufacture and hospitals.

Pre-requisites:

1. Human Anatomy and Physiology (BS18T)
2. Biomedical Transducers and Control Systems (BM04T)
3. Analytical and Clinical Equipment (BM05T

Course Objectives:

- To understand the basic principle, working and design of various automated diagnostic equipment's.
- To study various medical instrumentation systems, drug delivery systems and health management systems.
- To develop skills enabling biomedical engineers to serve hospitals, national and international industries, and government agencies.

Course Outcomes:

Learner will be able to:

1. Provide a better understanding about various bioelectrical signal recorders and patient safety.
2. Demonstrate the principles of electronics used in designing various biomedical monitoring equipment.
3. Acquire in-depth knowledge about different streams in biomedical engineering with greater emphasis on health care equipment and the advanced technologies.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	50

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Suggested list of Practicals:

1. Design and implementation of design of instrumentation amplifier.
2. Design and implementation of design of notch filters.
3. Design and implementation of design of low pass filters.
4. Design and implementation of design of high pass filters.
5. Design and implementation of band pass filters.
6. Design and implementation of pulse generating circuits.
7. Demonstration and simulation of patient monitor.
8. Demonstration and simulation of ecg simulator.
9. Demonstration and simulation of arrhythmia simulator.
10. Mini project to a group of 3 students (mini project will be based on a live problem and students have to address this with a technical solution)

Guidelines to conduct practical sessions:

1. The Lab Activity will involve implementing Electronic Systems and Circuits for Different Clinical Equipment.
2. This is an individual activity to be done by every student.
3. Students will work with circuit simulation software like LTSpice, Multisim or TickerCAD and prepare circuit model.
4. This needs to be verified in Hardware Setup using Active and Passive Electronic Components.
5. Lab Activity should be documented with results and observation in the form of a lab journal.

Suggested Online Courses:

1. Vital Signs: Understanding What the Body Is Telling Us https://www.coursera.org/learn/vital-signs?
2. The Development of Mobile Health Monitoring Systems https://www.coursera.org/learn/mobile-health-monitoring-systems
3. MedTech: Digital Health and Wearable Technology https://www.futurelearn.com/courses/medtech-digital-health
4. Nanotechnology for Health: Innovative Designs for Medical Diagnosis https://www.futurelearn.com/courses/nanotechnology-health

Reference Books:

1. R.S. Khandpur, "Handbook of Biomedical Instrumentation", PHI, Third Edition.
2. J.G. Webster, "Medical Instrumentation: Application and Design", TMH, Third Edition.
3. J.G. Webster, "Encyclopedia of Medical Devices and Instrumentation. Vol. I, II, III, IV, V, VI", Willey, Second Edition.
4. S. Ananthi, "A Textbook of Medical Instruments", New Age International Pvt. Ltd, First Edition.

Course Name: Microprocessors and Microcontrollers

Course Code: BM10T

Category: Core Engineering

Preamble:

This course is to create a strong foundation by studying the basics of Microprocessors and Microcontroller interfacing to various peripherals which will lead to a well-designed Microprocessor/ Microcontroller System.

Pre-requisites:

1. Digital logic design and analysis (BM01T)
2. Structured Programming (ES04T)
3. Electronic Devices and Circuits (BM03T)

Course Objectives:

- To understand the fundamentals of microprocessors and microcontrollers.
- To program microprocessors and microcontrollers in assembly language
- To Interface microprocessors and microcontrollers with different peripherals.
- To apply microprocessors and microcontrollers to solve real-world problems.

Course Outcomes:

Learner will be able to:

CO1: Understand the basic of Microprocessor and Microcontroller based systems and their architecture.
CO2: Understand 8086 microprocessor along with its architecture and memory organization
CO3: Understand peripheral controller ICs used in interfacing.
CO4: Understand 8051 Microcontroller architecture, memory organization, Interrupt structure, Port structure, Timers/Counters.
CO5: Understand assembly language and C compilers used to program 8051.
CO6: Design simple interfaces for keyboard LCD, ADC/DAC and Stepper motors...

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	75

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module no	Module name	Content	No of Hours
1	Introduction to Microprocessor	Introduction to Microprocessor and Microcontroller, Microcomputer based system elements, Generalized block diagram of Microprocessor, Microprocessor Programming languages, Microcomputer System software, Evolution of Microprocessor, machine cycle, T states and concepts of read write cycles.	3
2	Architecture of Intel 8086 Microprocessor	Major features of 8086 processor, 8086/88, CPU Architecture and the pipelined operation, Programmer's Model and Memory Segmentation	5
3	Peripheral Controllers for 8086 family and System Design	Functional Block Diagram and description, Control Word Formats, Operating Modes and Applications of the Peripheral Controller namely 8255-PPI, , 8259- PIC and 8237-DMAC, 8279- Display and Keyboard driver, Interfacing of the above Peripheral Controllers. Keyboard and Display Interface.	5
4	MCS-51 Microcontroller	8051 architecture; its variants and comparison, comparison of microprocessor and microcontrollers, CPU timing and machine cycle, memory organisation, SFR's, integrated peripherals such as timers/counters, serial ports, parallel I/O ports, interrupt structure, memory interfacing power saving and power down modes.	6
5	8051programming	Assembly language programming process, programming tools, addressing modes, instruction set and Programming practice using assembly and C compilers	6
6	Microcontroller design and interfacing case studies	Interfacing with external memories, Interfacing with 8255, Interfacing with 7 segment display, Interfacing with keyboard, interfacing with LCD, Interfacing with ADC,DAC and Sensors, Interfacing with stepper motor Interfacing with PC using RS232	5
Total			30

Suggested Online Courses:

1. Microprocessors and Microcontrollers https://onlinecourses.nptel.ac.in/noc21_ee18/preview
2. Microcontroller https://www.edx.org/learn/microcontrollers
3. An Introduction to Programming the Internet of Things (IOT) Specialization https://www.coursera.org/specializations/iot

Reference Books:

1. "8086/8088 family: "Design, Programming an Interfacing", John Uffenbeck: Prentice Hall,
2. 2nd Edition.
3. Microcomputer systems 8086/8088 family, Architecture, Programming and Design - YuCheng Liu & Glenn A Gibson, 2nd Edition- July 2003, Prentice Hall of India.
4. "Advanced Microprocessor and Peripherals – Architecture, Programming and Interfacing",A.K.Ray & K.M Bhurchandi, Tata Mc Graw Hill , 2006.
5. The 8051 microcontrollers-Kenneth J Ayala
6. The 8051 Microcontroller and Embedded Systems Muhammad A Mazidi, , Pearson Education
7. Using MCS-51 Microcontroller Han-Way Huang,.
8. 8051 microcontroller hardware, software applications. V Udayashankara, M Mallikarjunaswamy

Course Name: Microprocessors and Microcontrollers Lab

Course Code: BM10P

Category: Core Courses

Preamble:

This course is to create a strong foundation by studying the basics of Microprocessors and Microcontroller interfacing to various peripherals which will lead to a well-designed Microprocessor/ Microcontroller System.

Pre-requisites:

1. Digital logic design and analysis (BM01P)
2. Structured Programming (ES04P)
3. Electronic Devices and Circuits (BM03P)

Course Objectives:

- To understand the fundamentals of microprocessors and microcontrollers.
- To program microprocessors and microcontrollers in assembly language
- To Interface microprocessors and microcontrollers with different peripherals.
- To apply microprocessors and microcontrollers to solve real-world problems.

Course Outcomes:

Learner will be able to:

CO1: Understand the basic of Microprocessor and Microcontroller based systems and their architecture.
CO2: Understand 8086 microprocessor along with its architecture and memory organization
CO3: Understand peripheral controller ICs used in interfacing.
CO4: Understand 8051 Microcontroller architecture, memory organization, Interrupt structure, Port structure, Timers/Counters.
CO5: Understand assembly language and C compilers used to program 8051.
CO6: Design simple interfaces for keyboard LCD, ADC/DAC and Stepper motor.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	50

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Suggested List of Practicals:

1. Basic arithmetic operations like Add, Sub, Mul, Div with 8-bit & 16-bit numbers
2. Block data transfer from Data segment to Data segment and from Data to Extra segment
3. Number conversion from HEX to ASCII & ASCII to HEX
4. To find smallest and largest number from the array
5. To arrange the array in ascending and descending order
6. To count odd/even elements of the array and to count 1's and 0's in a byte
7. To convert the number from BCD to ASCII and ASCII to BCD
8. To change the string from uppercase to lowercase and lowercase to uppercase
9. To finding frequency of given character in a string
10. To check whether the string is Palindrome?
11. To Check whether the entered digit is Odd/Even and display the message accordingly
12. To convert number from HEX to BCD and BCD to HEX

Suggested List of Mini projects:

1. The Mini project work is to be conducted by a group of three students
2. To encourage project-based learning in the curriculum, students will select one of the project topics from the list given or a topic of their choice after a review process by the subject in charge.
3. In addition to the Mini project work each student needs to perform at least 8 practicals during lab sessions
4. Out of 8 practicals at least 4 practicals should be in Mixed language (Assembly & C)
5. Practical assessment should be done on weekly basis and Mini project assessment at least twice in a semester
6. Preferably certify the practical work during the last practical session, so no submissions

Suggested Online Courses:

1. Microprocessors and Microcontrollers
   https://onlinecourses.nptel.ac.in/noc21_ee18/preview
2. Microcontroller
   https://www.edx.org/learn/microcontrollers

3. An Introduction to Programming the Internet of Things (IOT) Specialization https://www.coursera.org/specializations/iot

Reference Books:

1. "8086/8088 family: "Design, Programming an Interfacing", John Uffenbeck: Prentice Hall, 2nd Edition.
2. Microcomputer systems 8086/8088 family, Architecture, Programming and Design - YuCheng Liu & Glenn A Gibson, 2nd Edition- July 2003, Prentice Hall of India.
3. "Advanced Microprocessor and Peripherals – Architecture, Programming and Interfacing",A.K.Ray & K.M Bhurchandi, Tata Mc Graw Hill , 2006.
4. The 8051 microcontrollers-Kenneth J Ayala
5. The 8051 Microcontroller and Embedded Systems Muhammad A Mazidi, , Pearson Education
6. Using MCS-51 Microcontroller Han-Way Huang,.
7. 8051 microcontroller hardware, software applications.V Udayashankara, M Mallikarjunaswamy

Course Name: Biomedical Digital Signal Processing

Course Code: BM11T

Category: Core

Preamble:

The course will help student to understand the basic concepts related to Digital Signal Processing. The course covers fundamentals of digital signal processing and application, discrete time signals and systems; Analysis of LTI systems; Structures of discrete time systems; Filter designing techniques; DFT and FFT; Architecture of DSP Processors. The application of the concepts in real world will help students to relate well to the subject.

Course Objectives:

- To understand the basics concepts of discrete time systems.
- To gain the knowledge of various medical applications of Digital Signal Processing.

Pre-requisites:

1. Engineering Mathematics-I (BS02)
2. Engineering Mathematics-II (BS04)
3. Engineering Mathematics-III (BS06)
4. Engineering Mathematics-IV (BS08)

Course Outcome:

The students will be able to:

CO1: Describe the digital signals and perform fundamental techniques like convolution and z transform on digital signals.
CO2: Apply DFT and FFT on discrete time signals.
CO3: Design analog IIR filters by different methods.
CO4: Design FIR filters to meet arbitrary specifications and Develop algorithms for implementation by different methods.
CO5: Describe use of advanced signal processing techniques and digital signal processors in various applications.
CO6: Explain Biomedical signal processing.

Course Scheme:

Contact Hours		Credits Assigned
Theory	Practical	Theory
02	--	02

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory+ Tutorial	15	20	40	075

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose a revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Module Contents	No. of Hours
01	Introduction to discrete time signal analysis	Basic elements of Digital Signal Processing, concepts of frequency in analog and digital signals, sampling theorem, discrete time signals and systems their properties, Z-transform and properties, Linear & circular convolution, Correlation, DTFT.	08
02	Discrete Fourier transform	Introduction to DFT, Properties of DFT, DIT and DIF, FFT algorithms, use of FFT in linear filtering, discrete cosine transforms.	08
03	Design of IIR filters	Review of design of analog Butterworth and Chebyshev filters, frequency transformation in analog domain, design of IIR digital filters using impulse invariance method, design of digital filters using bilinear transformation.	06
04	Design of FIR filters	Structure of FIR filters, linear phase filters, filter design using window technique, frequency sampling techniques, finite word length effects in digital filters, realisation of FIR & IIR filters, direct, cascade and parallel forms	06
05	Introduction to DSP Processors	Introduction to digital signal processors, architecture, features, addressing formats, functional mode, introduction to commercial processors, applications	03
06	Biomedical Signal	Preliminaries, biomedical signals (ECG, EMG, EEG) origin &	08

Module No.	Module Name	Module Contents	No. of Hours
	Processing	dynamics, statistical preliminaries, time domain filtering (synchronized averaging, moving average), time domain filtering (moving average filter to integration-derivative based operator), Frequency domain filtering (notch Filter), optimal filtering: Weiner filter, adaptive filtering, selecting appropriate filter	
Total			**36**

Recommended Online Courses:

1. Digital Signal Processing 1: Basic Concepts and Algorithms offered by École Polytechnique Fédérale de Lausanne https://www.coursera.org/learn/dsp1
2. Digital Signal Processing By Prof. C. S. Ramalingam, IIT Madras https://onlinecourses.nptel.ac.in/noc19_ee50/preview

Reference Books / Articles

1. Proakis, Manolakis, "Digital Signal Processing: Principles, Algorithm & Application", 4th edition, Pearson
2. Oppeheim, Schafer, Buck, "Discrete Time Signal Processing" Pearson education publication, 2nd Edition, 2003.
3. Li Tan, Jean Jiang, "Digital Signal Processing fundamentals and Applications", Academic Press,2nd edition,2013
4. S.K. Mitra," Digital Signal Processing – A computer-based Approach", Tata McGraw Hill,3rd edition,2006,
5. Lonnie c. Ludeman," Fundamentals of digital Signal Processing", Wiley
6. Emmanuel C. Ifeachor, Barrie W. Jervis, "Digital Signal processing-A Practical Approach", Pearson Education, second edition.
7. S. Salivahanan, A. Vallavaraj, C. Gnapriya, "Digital Signal Processing", TMH
8. B. Venkatramani, M Bhaskar, "Digital Signal Processors, Architecture, programming and applications" Mc-Graw Hill

Course Name: Biomedical Digital Signal Processing Lab

Course Code: BM11P

Category: Core

Preamble:

The course will help student to understand the basic practical concepts related to Digital Signal Processing. The course covers fundamentals of digital signal processing and application, discrete time signals and systems; Analysis of LTI systems; Structures of discrete time systems; Filter designing techniques; DFT and FFT; Architecture of DSP Processors. The application of the concepts in real world will help students to relate well to the subject.

Course Objectives:

- To understand the basics practicals discrete time systems.
- To gain the knowledge of various medical applications of Digital Signal Processing.

Pre-requisites:

1. Engineering Mathematics-I (BS02)
2. Engineering Mathematics-II (BS04)
3. Engineering Mathematics-III (BS06)
4. Engineering Mathematics-IV (BS08)

Course Outcome:

The students will be able to:

CO1: Describe the digital signals and perform fundamental techniques like convolution and z transform on digital signals.
CO2: Apply DFT and FFT on discrete time signals.
CO3: Design analog IIR filters by different methods.
CO4: Design FIR filters to meet arbitrary specifications and Develop algorithms for implementation by different methods.
CO5: Describe use of advanced signal processing techniques and digital signal processors in various applications.
CO6: Explain Biomedical signal processing.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
--	02	--	01

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory+ Tutorial	25	-	25	050

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose a revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Suggested List of Experiments

1. License plate recognition.
2. Write a program for Direct form – I, II form realization of the given IIR system function.
3. Write a program to plot pole-zero of a given FIR filter.
4. Design low pass butter worth digital filter with given specification using impulse invariance method.
5. Design a high pass elliptical filter with given specification using impulse invariance method.
6. Design a band pass chebychev-2 filter.
7. Design a second-order digital bandpass Butterworth filter.
8. Program to demonstrate the time shifting and frequency shifting property of DTFT.
9. Write a program to perform circular convolution of two sequences using DFT.
10. Write a program to up sample the sinusoidal sequence by an integer factor.

Suggested List of Mini projects

1. License plate recognition.
2. Write a program for Direct form – I, II form realization of the given IIR system function.
3. Write a program to plot pole-zero of a given FIR filter.
4. Design low pass butter worth digital filter with given specification using impulse invariance method.
5. Design a high pass elliptical filter with given specification using impulse invariance method.
6. Design a band pass chebychev-2 filter.
7. Design a second-order digital bandpass Butterworth filter.

8. Program to demonstrate the time shifting and frequency shifting property of DTFT.
9. Write a program to perform circular convolution of two sequences using DFT.
10. Write a program to up sample the sinusoidal sequence by an integer factor.

Reference Books / Articles

1. Proakis, Manolakis, "Digital Signal Processing: Principles, Algorithm & Application", 4th edition, Pearson.
2. Oppeheim, Schafer, Buck, "Discrete Time Signal Processing" Pearson education publication, 2nd Edition, 2003.
3. Li Tan, Jean Jiang, "Digital Signal Processing fundamentals and Applications", Academic Press,2nd edition,2013.
4. S.K. Mitra," Digital Signal Processing – A computer-based Approach", Tata McGraw Hill,3rd edition,2006.
5. Lonnie c. Ludeman," Fundamentals of digital Signal Processing", Wiley.
6. Emmanuel C. Ifeachor, Barrie W. Jervis, "Digital Signal processing-A Practical Approach", Pearson Education, second edition.
7. S. Salivahanan, A. Vallavaraj, C. Gnapriya, "Digital Signal Processing", TMH.
8. B. Venkatramani, M Bhaskar, "Digital Signal Processors, Architecture, programming and applications" Mc-Graw Hill.

Course Name: Medical Imaging Equipment

Course Code: BM12T

Category: Basic Science

Preamble:

This course will introduce students to the essential Medical Imaging Equipment used in clinical setup. This course will lay a foundation knowledge for system configurations, working principle and clinical applications of Medical Imaging Equipment.

Pre-requisites:

Human Anatomy and Physiology (BS18T)

Electronic Devices and Circuits (BM03T)

Course Objective:

- To understand the anatomical structures of the human body and their relationship to each other.
- To understand the different physiological processes taking place inside the human body

Course Outcomes:

Learner will be able to:

CO1: Understand physical characteristics, properties of X-Rays and different systems components of X-Ray Machine.
CO2: Explore different advanced applications of X-Ray Imaging Equipment.
CO3: Describe working principle and system components of Computed Tomography (CT) machine with its clinical applications.
CO4: Discuss working principle and system components of Ultrasound machine with its clinical applications.
CO5: Discuss working principle and system components of Magnetic Resonance Imaging (MRI) with its clinical applications and classify its Biological Effects.
CO6: Describe working principle and system components of Endoscopy machine with its clinical applications.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	75

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Module Contents	No. of Hours
01	X-Ray Imaging	Properties of X rays, production of X rays, X ray interaction with matter, Total radiographic System: X –ray tubes, Rating of X ray tubes, X –ray generators, Filters, Grids, Beam Restrictors, Control Panel, X ray Film, Biological Effects of X Ray, and Clinical Applications.	8
02	Advanced X-Ray Techniques	Fluoroscopic Imaging, Digital Subtraction Angiography and Mammography	4
03	Computed Tomography	Principle of CT, Generations of CT scan, detectors, CT Acquisition, Artifacts in CT and Clinical Applications, Biological Effects of CT, and Clinical Applications.	6
04	Ultrasound Imaging	Principle of Ultrasound Imaging, Properties of Ultrasound, Modes of Ultrasound and Ultrasound Transducers, Biological Effects of Ultrasound and Clinical Applications.	4
05	Magnetic Resonance Imaging	Principle of MRI and Physics, Hardware Components of MRI: Magnets, Grids and RF Coils used in MRI, Biological Effects of MRI, and Clinical Applications.	4
06	Endoscopy	Principle of Endoscopy, Equipment Techniques and Clinical Applications.	4
Total			**30**

Suggested Online Courses:

1. Introduction to Biomedical Imaging
   https://www.edx.org/course/introduction-to-biomedical-imaging
2. Fundamentals of Biomedical Imaging: Ultrasounds, X-ray, positron emission tomography (PET) and applications
   https://www.edx.org/course/fundamentals-of-biomedical-imaging-ultrasounds-x-r
3. Fundamentals of Biomedical Imaging: Magnetic Resonance Imaging (MRI)
   https://www.edx.org/course/fundamentals-of-biomedical-imaging-magnetic-resona
4. Ultrasound Imaging: What Is Inside?
   https://www.futurelearn.com/courses/ultrasound-imaging

Textbooks:

1. Thomas S. Curry, James E. Dowdey, Robert C. Murry, Wolters Kluwer, Christensen's Physics of Diagnostic Radiology, Fourth Edition.
2. William R. Hendee, E. Russell Ritenour, Wiley, Medical Imaging Physics, Fourth Edition.

Reference Books / Articles

1. Thomas S. Curry, James E. Dowdey, Robert C. Murry, Wolters Kluwer, Christensen's Physics of Diagnostic Radiology, Fourth Edition.
2. William R. Hendee, E. Russell Ritenour, Wiley, Medical Imaging Physics, Fourth Edition.
3. David Dowsett, Patrick A Kenny, R Eugene Johnston, Physics of Diagnostic Imaging, CRC Press, Second Edition.
4. John G. Webster, Marcell Dekker, Encyclopedia of Medical Devices, and Instrumentation Vol. I, II, III, IV, Pub, Second Edition.
5. Ray H. Hashemi, William G. Bradley, Christopher J. Lisanti, Lippincott Williams & Wilkins, MRI: The Basics, Second Edition.

Course Name: Medical Imaging Equipment (MIE) Lab

Course Code: BM12P

Category: Core

Preamble:

This course will introduce students to the essential Medical Imaging Equipment used in clinical setup. This course will lay a foundation knowledge for system configurations, working principle and clinical applications of Medical Imaging Equipment.

Course Objectives:

- To familiarize the learners with the various Imaging techniques in medicine operating principles and quality control aspects of various imaging modalities.
- To keep the learners abreast with the technological developments in the field of Medical Imaging.

Pre-requisites:

Human Anatomy and Physiology (BS18T)

Electronic Devices and Circuits (BM03T)

Course Outcome:

The students will be able to:

CO1: Understand physical characteristics, properties of X-Rays and different systems components of X-Ray Machine.
CO2: Explore different advanced applications of X-Ray Imaging Equipment.
CO3: Describe working principle and system components of Computed Tomography (CT) machine with its clinical applications.
CO4: Discuss working principle and system components of Ultrasound machine with its clinical applications.
CO5: Discuss working principle and system components of Magnetic Resonance Imaging (MRI) with its clinical applications and classify its Biological Effects.
CO6: Describe working principle and system components of Endoscopy machine with its clinical applications.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	50

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose a revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Suggested List of Experiments

1. Design and Implementation of X-Ray System Component-Timing Circuit.
2. Design and Implementation of X-Ray System Component-Exposure Circuit.
3. Design and Implementation of Digital Subtraction in sample X-Ray Images.
4. Generate Sinogram of Image.
5. Perform CT Windowing on an Image.
6. Design and Implementation of Back Projection Algorithm for CT Images.
7. Case Study in Ultrasound Imaging.
8. Simulation of T1 and T2 Relaxation Process in MRI.
9. Simulation of FIDs in MRI.
10. Technical Specification Evaluation of Endoscopy Equipment.
11. Problem Based Activity on assigned topic.

Guidelines to conduct practical sessions:

1. The Laboratory work is to be conducted by a group of three-five students.
2. To encourage project-based learning in the curriculum students may either select one of the case-study topics of their choice after a review process by the subject faculty.
3. Each group along with subject faculty shall identify a potential area of case study selected, on which the study can be conducted.
4. Students should prepare power point presentations, posters etc. on the selected case study.
5. Assessment will be done at the end of the semester.

Suggested List of Mini Projects/PBL:

1. Design and Implementation of Digital Subtraction in sample X-Ray Images.
2. Case study on a given disease/abnormality which requires imaging modality for diagnosis/treatment.

Recommended Online Courses:

1. Introduction to Biomedical Imaging
   https://www.edx.org/course/introduction-to-biomedical-imaging
2. Fundamentals of Biomedical Imaging: Ultrasounds, X-ray, positron emission tomography (PET) and applications
   https://www.edx.org/course/fundamentals-of-biomedical-imaging-ultrasounds-x-r
3. Fundamentals of Biomedical Imaging: Magnetic Resonance Imaging (MRI)
   https://www.edx.org/course/fundamentals-of-biomedical-imaging-magnetic-resona
4. Ultrasound Imaging: What Is Inside?
   https://www.futurelearn.com/courses/ultrasound-imaging

Reference Books / Articles

1. Thomas S. Curry, James E. Dowdey, Robert C. Murry, Wolters Kluwer, Christensen's Physics of Diagnostic Radiology, , Fourth Edition.
2. William R. Hendee, E. Russell Ritenour, Wiley, Medical Imaging Physics, Fourth Edition.
3. David Dowsett, Patrick A Kenny, R Eugene Johnston, Physics of Diagnostic Imaging, CRC Press, Second Edition.
4. John G. Webster, Marcell Dekker, Encyclopedia of Medical Devices, and Instrumentation Vol. I, II, III, IV, Pub, Second Edition.
5. Ray H. Hashemi, William G. Bradley, Christopher J. Lisanti, Lippincott Williams & Wilkins, MRI: The Basics, Second Edition.

Course Name: Integrated Data Management

Course Code: BM21T

Category: Professional Elective (PEC)

Preamble:
In today's digital age, efficient management and manipulation of data are critical skills for professionals in various fields. This combined course on Data Structures and Database Management provides students with a comprehensive understanding of foundational data structures and relational database concepts. Through theoretical learning and hands-on exercises, students will gain proficiency in designing, implementing, and optimizing data structures and databases to address real-world challenges.

Pre-requisites:
Structure Programing (BS12)

Course Objectives:

- To Understand Fundamental Data Structures
- To Master Relational Database Management Systems (RDBMS)
- To Develop Skills in Advanced Data Structures and Optimization Techniques

Course Outcomes:

Learner will be able to:

CO1: Implement and analyze fundamental data structures like arrays, linked lists, stacks, queues, trees, and graphs to solve computational problems effectively.

CO2: Demonstrate proficiency in designing relational databases, writing SQL queries for data manipulation and retrieval, and implementing database systems adhering to normalization principles.

CO3: Demonstrate proficiency in implementing and analyzing advanced data structures such as priority queues, heaps, hash tables, and advanced tree structures.

CO4: Design and implement relational databases, including schema creation, indexing, transaction management, and concurrency control, to ensure data integrity and efficiency.

CO5: Understand the principles of query optimization, including query execution plans, cost estimation, and optimization strategies, and apply them to improve database performance.

CO6: Develop skills in optimizing data storage and retrieval, including indexing techniques, data compression, partitioning, and clustering, to enhance database performance and scalability.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	075

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours
1	Introduction to Data Structures and Databases	Overview of data structures and their importance in computer science Introduction to database management systems (DBMS) and their role in information storage and retrieval Comparison between data structures and databases: similarities, differences, and complementary roles	2
2	Fundamental Data Structures	Arrays, linked lists, stacks, and queues: implementation, operations, and applications Trees and binary trees: traversal algorithms, balancing techniques, and binary search trees Graphs: representation methods, traversal algorithms, and applications in real-world scenarios	6
3	Advanced Data Structures	Priority queues, heaps, and hash tables: implementation, operations, and applications Advanced tree structures: B-tree, Advanced graph algorithms: shortest path, minimum spanning tree, and graph traversal	6
4	Relational Database Management Systems (RDBMS)	Overview of relational database concepts: tables, rows, columns, keys, and relationships SQL (Structured Query Language): data definition, manipulation, and querying Database normalization: concepts and techniques for minimizing redundancy and maintaining data integrity	6
5	Database Design and Implementation	Database design process: requirements analysis, conceptual design, and logical design Entity-Relationship (ER) modeling: entities, attributes, relationships, and cardinality Database implementation: schema creation, transaction	6

		management, and concurrency control	
6	Data Storage and Retrieval Optimization	Indexing techniques: B-tree indexing, hash indexing, and bitmap indexing	2
		Total	**30**

Textbooks:

1. "Data Structures and Algorithms Made Easy" by Narasimha Karumanchi, Career Monk Publications, 2016
2. "Fundamentals of Database Systems" by Ramez Elmasri and Shamkant B. Navathe, 6th Edition, Addison-Wesley

Reference books:

1. “Database System Concepts” by Avi Silberschatz, Henry F. Korth, S. Sudarshan, 7th Edition, McGraw-Hill
2. " Database Management Systems”, by Johannes Gehrke and Raghu Ramakrishnan, 2nd Edition, McGraw-Hill
3. "Introduction to Algorithms" by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein, 4th Edition, MIT Press
4. "Data Structures and Algorithms in Java" by Robert Lafore, 2nd edition, Pearson.

Course Name: Integrated Data Management Lab

Course Code: BM21P

Category: Professional Elective (PEC)

Preamble:
In today's digital age, efficient management and manipulation of data are critical skills for professionals in various fields. This combined course on Data Structures and Database Management provides students with a comprehensive understanding of foundational data structures and relational database concepts. Through theoretical learning and hands-on exercises, students will gain proficiency in designing, implementing, and optimizing data structures and databases to address real-world challenges.

Pre-requisites:
Structure Programing (BS12)

Course Objectives:
- To Understand Fundamental Data Structures
- To Master Relational Database Management Systems (RDBMS)
- To Develop Skills in Advanced Data Structures and Optimization Techniques

Course Outcomes:
Learner will be able:
CO1: To demonstrate the regression and classification models
CO2: To implement ensemble learning models
CO3: To explore properties of unsupervised learning models
CO4: To identify characteristics of various activation functions used in ANN
CO5: To apply ANN learning algorithms to train model for given problem
CO6: To exhibit proficiency in identifying and implementing appropriate ML model

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	050

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Suggested List of Practicals:

Sr No.	Title of Practicals
1	Implement basic data structures such as arrays, linked lists, stacks, and queues in a programming language of your choice
2	Implement binary trees and binary search trees (BST) with operations like insertion, deletion, and traversal (in-order, pre-order, post-order).
3	Implement a graph using an adjacency list and perform depth-first search (DFS) and breadth-first search (BFS).
4	Implement a binary heap and use it to create a priority queue.
5	Implement a hash table with collision handling techniques such as chaining and open addressing.
6	Create a small database using a relational database management system (e.g., MySQL, PostgreSQL) and write basic SQL queries to insert, update, delete, and retrieve data.
7	Design ER model for selected problem statement
8	Use an RDBMS to create the tables and relationships for your designed database.
9	Write complex SQL queries involving joins, subqueries, and aggregation functions.

Course Name: Modern Sensors for Internet of Things

Course Code: BM22T

Category: Professional elective (IoT Track)

Preamble:

This course introduces students to the fundamental principles and applications of sensors in various engineering fields. It covers different types of sensors, their working mechanisms, and their integration into systems, including IoT, embedded systems, and other fields.

Pre-requisites: Nil

Course Objectives:

- Understand the basic principles and classifications of sensors.
- Learn about various types of sensors and their applications.
- Design and implement sensor systems in practical scenarios.
- Integrate sensors with IoT and embedded systems.
- Explore the use of sensors in biomedical applications

Course Outcomes:

Student will be able to:
CO1: Understand fundamentals of Sensors and their characteristics.
CO2: Use different type sensors in Embedded and IoT applications.
CO3: Apply knowledge of conditioning in the design of data acquisition system.
CO4: Create a small sensor network using knowledge of communication protocols.
CO5: Understand concept of communication protocols.
CO6: Designing small application using one or more sensor.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment Guidelines:

Head	ISA	MSA	ESA	Total
Theory	15	20	40	075

The assessment guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module no	Module name	Content	No of Hours
1	Sensors Fundamentals and Characteristics	Sensor Classification, Physical Principles of Sensors- Resistive, capacitive, inductive sensors, Optical, magnetic, and thermal sensors, Sensor Characteristics, Performance and Types, Error Analysis characteristics- Sensitivity, accuracy, precision, range, and resolution. Response time and stability, Applications in various fields and criteria to select sensor	5
2	Types of sensors	Optical Sensors- Photodetectors and phototransistors, Fiber optic sensors, Imaging sensors. Mechanical Sensors- Strain gauges and pressure sensors, Accelerometers and gyroscopes, Ultrasonic sensors. Chemical and Biological Sensors- Electrochemical sensors, gas sensors, humidity and temperature sensors, Biosensors	6
3	Data acquisition and Signal Conditioning	Analog and Digital data acquisition system, Data logger, Amplification, filtering, and Analog-to-Digital conversion, Noise reduction techniques, Calibration methods	5
4	Wireless Sensor Networks	Basics of wireless communication, Network topologies and protocols, Bluetooth, ZigBee, Ultra Wide Band (UWB), Near Field Communication (NF) and RFID, WiFi and IEEE 802.11architecture, applications in IoT.	6
5	IoT Systems Integration and communication protocols	Introduction to IoT, Integrating sensors with microcontrollers (e.g., Arduino, Raspberry Pi), Communication protocols (I2C, SPI, UART),	4
6	Sensor applications	On board automobile sensing system, Home automation and Environment monitoring system, Biomedical sensing system, Radio sensing for industrial applications,	4
Total			**30**

Textbooks:

1. Jacob Fraden, "Hand Book of Modern Sensors: physics, Designs and Applications", 2015, 3rd edition, Springer, New York.
2. Jon. S. Wilson, "Sensor Technology Hand Book", 2011, 1st edition, Elsevier, Netherland.
3. D. Patranabis – Sensor and Transducers (2e) Prentice Hall, New Delhi, 2003.
4. Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on-Approach)",1st Edition, VPT, 2014.
5. Sensors and Transducers" by Ian R. Sinclair - Comprehensive introduction to various sensors and their applications.

Reference Books:

1. Edited by Qusay F Hasan, Atta ur rehman Khan, Sajid A madani, "Internet of Things Challenges, Advances, and Application", CRC Press.
2. Triethy HL - Transducers in Electronic and Mechanical Designs, Mercel Dekker, 2003.
3. Gerd Keiser,"Optical Fiber Communications", 2017, 5th edition, McGraw-Hill Science, Delhi. 212.
4. John G Webster, Halit Eren, "Measurement, Instrumentation and sensor Handbook", 2014, 2nd edition, CRC Press, Taylor and Fransis Group, New York.
5. Adrian McEwen, "Designing the Internet of Things", Wiley Publishers, 2013, ISBN: 978-1-118-43062-0.
6. Nathan Ida, "Sensors, Actuators and their Interfaces: A Multidisciplinary Introduction", Second Edition, IET Control, Robotics and Sensors Series 127, 2020.

Course Name: Modern Sensors for Internet of Things Laboratory

Course Code: BM22P

Category: Professional elective (IoT Track)

Preamble:
This course introduces students to different types of sensors, their working mechanisms, and their integration into systems. Selection and interfacing of a sensor in the IoT and embedded systems design.

Pre-requisites: Nil

Course Objectives:

- To understand various sensors type and their characteristics.
- To understand different type of sensors and their application.
- To understand communication protocol and their use in sensor network.
- To understand various types communication protocols required in IoT applications and their characteristics.
- To learn to develop small IoT or Embedded system using sensor.

Course Outcomes:

Student will be able to:
CO1: Identify and test the characteristics of various sensors.
CO2: Select most appropriate sensor and design required signal condition for the same.
CO3: Implement communication and wireless communication protocol in IoT application.
CO4: Design and implement small IoT or Embedded system.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment Scheme:

Head	ISA	MSA	ESA	Total
Practical	25	-	25	050

Suggested List of Practical:

- Identification of sensor and their important characteristics.
- Testing and Calibration of sensor.
- Identification of Sensitivity, range, resolution, Response time parameters of sensors.
- Develop a system to record one of the physical parameter using appropriate sensor.
- Develop a system to communicate one or more physical parameters using wireless communication.
- Develop a system to communicate one or more physical parameters using communication

protocol.

- Design and develop a small IoT or system using one or more sensor and a communication procol.

Textbooks:

1. Jacob Fraden, "Hand Book of Modern Sensors: physics, Designs and Applications", 2015, 3rd edition, Springer, New York.
2. Jon. S. Wilson, "Sensor Technology Hand Book", 2011, 1st edition, Elsevier, Netherland
3. D. Patranabis – Sensor and Transducers (2e) Prentice Hall, New Delhi, 2003.
4. Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on-Approach)",1st Edition, VPT, 2014.
5. Sensors and Transducers" by Ian R. Sinclair - Comprehensive introduction to various sensors and their applications.

Reference Books:

1. Edited by Qusay F Hasan, Atta ur rehman Khan, Sajid A madani, "Internet of Things Challenges, Advances, and Application", CRC Press.
2. Triethy HL - Transducers in Electronic and Mechanical Designs, Mercel Dekker, 2003
3. Gerd Keiser,"Optical Fiber Communications", 2017, 5th edition, McGraw-Hill Science, Delhi. 212.
4. John G Webster, Halit Eren, "Measurement, Instrumentation and sensor Handbook", 2014, 2nd edition, CRC Press, Taylor and Fransis Group, New York.
5. Adrian McEwen, "Designing the Internet of Things", Wiley Publishers, 2013, ISBN: 978-1-118-43062-0.
6. Nathan Ida, "Sensors, Actuators and their Interfaces: A Multidisciplinary Introduction", Second Edition, IET Control, Robotics and Sensors Series 127, 2020.

Course Name: Biophotonics

Course Code: BM23T

Category: Professional Elective

Preamble:
This course introduces students to help the students to build up a detailed knowledge of the methods and design, fabrication and applications of biophotonic systems with lasers and optical fibers.

Pre-requisites:
- Applied Physics
- Instrumentation and Control

Course Objectives:

- To enable learners to understand basic principles of optics to design Laser systems.
- To enable learners to understand how lasers are constructed based on different properties
- To enable learners to understand how lasers are transmitted through fiber optics.
- To enable learners to apply principles of lasers and fiber optics in medical field for diagnostic and therapeutic purpose.

Course Outcomes:

Learner will be able to:

CO1: Categorize the different lasers and fiber optics principles and their application.

CO2: Compare the construction of different types of lasers and their working.

CO3: Analyze the use of fiber optic laser system in various fields of medicine.

CO4: Create appropriate hospital design considering laser safety requirements.

CO5: Correlate the knowledge of medicine and engineering for the wellness of human being.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2+1(O)	-	2	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	20	30	50	100

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be

approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No. of Hours
1	Introduction to Optical Radiation, Emission & Resonator	Spontaneous and Stimulated emission, Einstein's coefficients, gain coefficient, laser oscillation conditions, population inversion, three and four level systems, rate equations, Optical resonators and types, modes and mode stability criteria, losses in optical resonators-quality factor.	6
2	Types of Lasers	Working principle of Ruby laser, dye laser, argon ion laser, solid state lasers- fundamental and higher harmonic generation. Detailed study of semiconductor lasers, Nd: YAG laser- flash lamp pumped and diode pumped lasers, He-Ne laser, CO2 laser, excimer laser, nitrogen laser, free electron laser, Ti:Saphire laser, rare earth doped and photonic crystal fiber based lasers, soliton lasers. Chemical lasers, metal vapour lasers, Medical applications of Lasers, laser safety	8
3	Laser Safety	Practical Laser Safety requirements, Environmental safety, Equipment safety, personnel protection, Education/training for handling laser equipments, Role of Laser Safety officer, Standards of practice for the use of Laser in medicine and Surgery, Recommendation Regarding the Laser safety officer, Hospital Laser Committee .	5
4	Optic Fiber Fundamentals	Light transmission in optical fibers- principles, optical properties of optical fibers, Fiber materials ,Types of Optical fibers, Modes, Losses, Fabrication of optical fibers, Methods and Principle, Fiber Splicing, Fiber optic imaging, Biomedical Optical fibers, Invivo Applications.	8
5	Optical Sensors	MM and SM fibers for sensing, Lasers & LEDs suitable for sensing, PIN & APDs for fiber optic sensing. Principles of electro optic modulators bulk & integrated optic modulators. Optical sensor types, advantages and disadvantages of fiber optic sensors, intensity modulated sensors, interferometric sensors, rotation sensors, bio sensors.	6
6	Laser and fiber activated therapy	Photodynamic therapy, photo-sensitizers for photodynamic therapy, Tissue engineering using light, Laser system in Cardiovascular disease, Gastroenterology, Gynaecology, Neurosurgery, Oncology, Ophthalmology, Orthopaedics, Otolaryngology (ENT), Urology, lasers and fibers in skin treatment.	5
Total			**38**

Suggested list of Assignments:

Suggested List of Value-Added Home Assignments:

1. Reviewing Literature in the form of a technical paper based on the recent advancements in laser technology.
2. Problem Based Assignment.

Suggested Online Courses:

1. https://nptel.ac.in/courses/117/108/117108037/
2. https://nptel.ac.in/courses/104/104/104104085/
3. https://nptel.ac.in/courses/115/107/115107095/
4. https://nptel.ac.in/courses/104/104/104104085/

Reference Books:

1. Tu Vo Dinh, Biomedical Photonics: A Handbook- CRC Press, Boca Raton, FL 2003.
2. V N Prasad, Introduction to Biophotonics, Wiley-Interscience, 2003.
3. A.Ghatak & K. Thyagarajan, Lasers: Theory & Applications, Macmillan India LTD. 2003.
4. Orazio Svelto, Principles of Lasers, 4thEdn, Plenum Press, 1998.
5. Dakin J and Culshow B., (Ed), Optical fiber sensors, Vol I,II, III, Artech House, 1998.
6. Francis T.S Yu, Shizhuo Yin (Eds), Fiber Optic Sensors, Marcel Dekker Inc., New York, 2002.
7. Silfvast. W T., Laser Fundamentals, Cambridge University Press, New Delhi, 1998.
8. Thyagarajan .K & Ghatak A K Lasers, Theory and Applications Macmillan, 1991.

Course Name: Biophotonics Lab

Course Code: BM23P

Category: Professional Elective

This course introduces students to help the students to build up a detailed knowledge of the methods and design, fabrication and applications of biophotonic systems with lasers and optical fibers.

Pre-requisites:

- Applied Physics
- Instrumentation and Control

Course Objectives:

- To enable learners to understand basic principles of optics to design Laser systems.
- To enable learners to understand how lasers are constructed based on different properties
- To enable learners to understand how lasers are transmitted through fiber optics.
- To enable learners to apply principles of lasers and fiber optics in medical field for diagnostic and therapeutic purpose.

Course Outcomes:

Learner will be able to:

CO1: Categorize the different lasers and fiber optics principles and their application.

CO2: Compare the construction of different types of lasers and their working.

CO3: Analyze the use of fiber optic laser system in various fields of medicine.

CO4: Create appropriate hospital design considering laser safety requirements.

CO5: Correlate the knowledge of medicine and engineering for the wellness of human being.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	50	-	50	100

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be

approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Suggested list of Practicals:

1. To study basic physics of laser.
2. To study the modes of laser and laser cavity.
3. To study the interaction of laser with tissue.
4. To study different types of lasers.
5. To study laser safety.
6. To study basics of fiber optics.
7. To study physics of optical fibers and its types.
8. To set up analog optical link.
9. To set up digital optical link.

Guidelines to conduct practical sessions:

1. Photonics based 8 practical need to be conducted.
2. Students will have to complete one mini project which is based on light based detection of biological parameters.
3. Each group along with its guide/mentor shall identify a potential research area/problem domain, on which the study is to be conducted.

Suggested Online Courses:

1. https://nptel.ac.in/courses/117/108/117108037/
2. https://nptel.ac.in/courses/104/104/104104085/
3. https://nptel.ac.in/courses/115/107/115107095/
4. https://nptel.ac.in/courses/104/104/104104085/

Reference Books:

1. Tu Vo Dinh, Biomedical Photonics: A Handbook- CRC Press, Boca Raton, FL 2003.
2. V N Prasad, Introduction to Biophotonics, Wiley-Interscience, 2003.
3. A.Ghatak & K. Thyagarajan, Lasers: Theory & Applications, Macmillan India LTD. 2003.
4. Orazio Svelto, Principles of Lasers, 4thEdn, Plenum Press, 1998.
5. Dakin J and Culshow B., (Ed), Optical fiber sensors, Vol I,II, III, Artech House, 1998.
6. Francis T.S Yu, Shizhuo Yin (Eds), Fiber Optic Sensors, Marcel Dekker Inc., New York, 2002.
7. Silfvast. W T., Laser Fundamentals, Cambridge University Press, New Delhi, 1998.
8. Thyagarajan .K & Ghatak A K Lasers, Theory and Applications Macmillan, 1991.

Course Name: Mini Project-I

Course Code: BM39P

Category: Project and Internship

Preamble:

Students will be acquainted with the process of identifying the needs and converting it into the problem. Third year students will be familiarized with the process of solving the problem in a group and applying basic engineering fundamentals to attempt solutions to the problems. This will inculcate the process of self-learning and research.

Pre-requisites:
All subjects they learned till TE and beyond.

Course Objectives:

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Course Outcomes:

Learner will be able to:
CO1: Identify problems based on societal /research needs and apply Knowledge and skill to solve societal problems in a group.
CO2: Develop interpersonal skills to work as member of a group or leader and Excel in written and oral communication.
CO3: Draw the proper inferences from available results through theoretical/ experimental/simulations and analyze the impact of solutions in societal and environmental context for sustainable development.
CO4: Use standard norms of engineering practices
CO5: Demonstrate capabilities of self-learning in a group, which leads to lifelong learning.
CO6: Demonstrate project management principles during project work.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	4	-	2

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25		50	75

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall decide her/his assessment methodology based on the course's nature. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Guidelines for Mini Project:

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students' hall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A logbook to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case-by-case basis.

Internal Assessment:

The review/ progress monitoring committee shall be constituted by head of department. The progress of mini project to be evaluated on continuous basis, minimum two reviews during the semester.

Review 1: First review shall be for finalization of problem and proposed solution.
Review 2: Second review shall be for implementation and testing of solution.

- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of internal assessment marks for minor project shall be as below:
    - Marks awarded by guide/supervisor based on logbook: 10
    - Marks awarded by review committee: 10
    - Quality of Project report: 05

Minor Project shall be assessed based on following criteria:

1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness and Societal impact
6. Full functioning of working model as per stated requirements
7. Effective use of skill sets
8. Effective use of standard engineering norms
9. Contribution of an individual's as member or leader
10. Clarity in written and oral communication In case of minor project-I all criteria in generic may be considered for evaluation of performance of students in mini project.

End semester examination assessment:

- Report should be prepared as per the guidelines issued by the department.
- Minor Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Detailed Syllabus of Third Year Semester-VI

Course Name: Critical Care Equipment

Course Code: BM13T

Category: Core Engineering

Preamble:

This course introduces students to different critical care equipment which is life-saving equipment. The course covers working principles and development in this category of equipment.

Pre-requisites:

- Diagnostic and Monitoring Equipment
- Electronics Circuits and Devices
- Human Physiology & Anatomy

Course Objectives:

- To enable learners to understand the basic blocks of Pacemakers.
- To enable learners to understand the working of Defibrillators.
- To enable learners to understand the different blocks of instrumentation involved in Anaesthesia machine and Capnograph.
- To enable learners to learn fundamentals of surgical equipment.
- To enable learners to understand the working of heart-lung machine.
- To enable learners to understand the functions of different blocks of Dialysis machine**.**

Course Outcomes:

Learner will be able to:

CO1: Understand the working principle and recent developments in Cardiac Pacemakers.
CO2: Demonstrate performance of Defibrillators.
CO3: Express the importance of use of Anesthesia machine and Capnograph during Surgery.
CO4: Explain the basic principle, working and applications of surgical equipment with safety aspects.
CO5: Describe the importance and application of heart lung machine during surgery.
CO6: Summarize the basic principle of Dialysis and compare its types.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	75

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No. of Hours
1	Cardiac Pacemakers	Need for a pacemaker, modes of operation, Classification of pacemaker, Leads and electrodes, recent developments of Implantable Pacemakers.	4
2	Cardiac Defibrillator	Need for Defibrillator, DC defibrillator, Modes of operation and electrodes, Performance aspects of dc-defibrillator, Implantable defibrillator, cardioverter.	6
3	Ventilators & Anaesthesia	Pulmonary function measurement, measurement of volume Ventilators Artificial ventilation, ventilator terms and its types, modes of ventilators, classification of ventilators, Need for anaesthesia, Anesthesia machine: Gas supply, flow and delivery system Vapor delivery and humidification and patient breathing Capnography.	8
4	Surgical equipment	Surgical Diathermy machine, automated electrosurgical systems, electrodes used with surgical diathermy, safety aspects in electronic surgical units.	4
5	Heart Lung machine	Heart Lung Machine and types of oxygenators	4
6	Hemodialysis machine	Basic principle of Dialysis and its type. Different types of dialyzer membrane, various monitoring circuits	4
Total			**30**

Suggested list of Assignments:

1. Classification of pacemakers and their applications.
2. Defibrillators need and types.
3. Role of Anesthesia machine and parts.
4. Different output waveforms of Surgical Equipment.
5. Functional block diagram of HLM
6. Dialysis principle and working of blocks.

Suggested List of Value-Added Home Assignments:

1. Reviewing Literature in the form of a technical paper based on specialized equipment.
2. Novel technical paper writing based on recent advancements.
3. Problem Based Learning on Equipment

Suggested Online Courses:

1. Introduction to Biomedical Engineering
   https://www.coursera.org/learn/bioengineering
2. Foundations of Healthcare Systems Engineering
   https://www.coursera.org/learn/foundations-of-healthcare-systems-engineering

Reference Books:

1. R S. Khandpur, "Handbook of Biomedical Instrumentation", PH Publication, Third edition, 2014.
2. J G. Webster, "Medical Instrumentation, Application and Design", John Wiley Publication, 2012
3. Leislie Cromwell, Fred J. Weibell, Enrich A. Pfeiffer, "Biomedical Instrumentation and measurements". PHI Publication, 1990.

Course Name: Critical Care Equipment Lab

Course Code: BM13P

Category: Core Engineering

Preamble:

This course introduces students to different critical care equipment which are life-saving equipment. The course covers working principle and development in this category of the equipment.

Pre-requisites:

- Diagnostic and Monitoring Equipment
- Electronics Circuits and Devices
- Human Physiology & Anatomy

Course Objectives:

- To enable learners to understand the basic blocks of Pacemakers.
- To enable learners to understand the working of Defibrillators.
- To enable learners to understand the different blocks of instrumentation involved in Anesthesia machine and Capnograph.
- To enable learners to learn fundamentals of surgical equipment.
- To enable learners to understand the working of heart-lung machine.
- To enable learners to understand the functions of different blocks of Dialysis machine**.**

Course Outcomes:

Learner will be able to:

CO1: Understand the working principle and recent developments in Cardiac Pacemakers.
CO2: Demonstrate performance of Defibrillators.
CO3: Express the importance of use of Anesthesia machine and Capnograph during Surgery.
CO4: Explain the basic principle, working and applications of surgical equipment with safety aspects.
CO5: Describe the importance and application of heart lung machine during surgery.
CO6: Summarize the basic principle of Dialysis and compare its types.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	50

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Suggested list of Practicals:

1. Implementation and testing of basic circuit of pacemaker.
2. Implementation of NAND Gate Oscillator in Surgical Diathermy.
3. Implementation of RLC Over damped system.
4. Demonstration of Defibrillator.
5. Demonstration of Pacemaker.
6. Demonstration of Surgical Diathermy.
7. Industry / Hospital visits.

Guidelines to conduct practical sessions:

1. The Laboratory work is to be conducted by a group of three-five students.
2. To encourage project-based learning in the curriculum students may either select one of the commercial biosensors for a review.
3. Each group along with subject faculty shall identify a potential biosensor, on which the study can be conducted. They can perform real or virtual experiments related to the topic selected in the laboratory along with regular experiments.
4. Students should prepare working models, power point presentation, posters etc. on the selected topics.
5. The assessment will be done at the end of the semester.

Suggested Online Courses:

1. Introduction to Biomedical Engineering
   https://www.coursera.org/learn/bioengineering
2. Foundations of Healthcare Systems Engineering
   https://www.coursera.org/learn/foundations-of-healthcare-systems-engineering

Reference Books:

1. R S. Khandpur, "Handbook of Biomedical Instrumentation", PH Publication, Third edition, 2014.
2. J G. Webster, "Medical Instrumentation, Application and Design", John Wiley Publication, 2012.
3. Leislie Cromwell, Fred J. Weibell, Enrich A. Pfeiffer, "Biomedical Instrumentation and measurements". PHI Publication, 1990.

Course Name: Digital Image Processing

Course Code: BM14T

Category: Core

Preamble:

The course will help student to understand the basic concepts related to Digital Signal Processing. The course covers fundamentals of digital signal processing and application, discrete time signals and systems; Analysis of LTI systems; Structures of discrete time systems; Filter designing techniques; DFT and FFT; Architecture of DSP Processors. The application of the concepts in real world will help students to relate well to the subject.

Course Objectives:

- To understand the basics concepts of Digital Image Processing.
- To gain the knowledge of various medical applications of Digital Image Processing.

Pre-requisites:

1. Engineering Mathematics-II (BS04)
2. Engineering Mathematics-III (BS06)
3. Biomedical Digital Signal Processing (BM11T)

Course Outcome:

The students will be able to:

CO1: Explain the fundamental concepts of a digital image processing system.
CO2: Demonstrate image enhancement techniques in the spatial & frequency domain.
CO3: Apply different image segmentation algorithms.
CO4: Apply various transform techniques on the image for analysis and compression of images.
CO5: Compare morphological operation on images.
CO6: Choose image processing techniques for object recognition and classification.

Course Scheme:

Contact Hours		**Credits Assigned**
Theory	Practical	Total
02	--	02

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory+ Tutorial	15	20	40	075

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose a revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Module Contents	No. of Hours
01	Basics of Image Processing	Image acquisition, Processing, Communication, Display; Electromagnetic spectrum; Elements of visual perception - Structure of the human eye, Image formation in the eye, Brightness adaptation and discrimination, Image formation model, Sampling, Quantization, Image formats.	02
02	Image Enhancement	Spatial domain - Point processing techniques, Histogram processing, Neighbourhood processing, Frequency domain techniques, 2D-DFT, Properties of 2D-DFT, Low pass, High pass, Noise removal, Homomorphic filters, Basics of colour image processing.	08
03	Image Segmentation	Basic relationships between pixels, Neighbours, Adjacency, Connectivity, Regions, Boundaries, Distance measures; Detection of discontinuities, point, line and edges, Edge linking, Hough transform, Thresholding based segmentation, Region-based segmentation.	06
04	Image Transforms & Image Compression	DFT, FFT, DCT, DST, Hadamard, Walsh, Haar, Basis functions and basis images, Introduction to wavelet transform, Fundamentals of image compression models, Lossless compression, RLE, Huffman, LZW and Arithmetic coding techniques, Lossy compression - IGS coding, Transform coding, JPEG, JPEG 2000.	06
05	Morphology, Representation and Description	Dilation, Erosion, Open, Close, Hit-or-miss, Boundary extraction, Region filling, Thinning and thickening; Chain Codes, Polygonal approximations, Signatures; Fourier descriptors, Moments.	04
06	Feature Recognition and	Object recognition and classification, connected components labelling, Features, Statistical classification,	04

Module No.	Module Name	Module Contents	No. of Hours
	Classification	Structural/syntactic classification, Applications in medical image analysis	
Total			**30**

Suggested List of Value-Added Home Assignments:

1. Reviewing Literature in the form of a technical paper based on the project.
2. Novel technical paper writing based on the project.
3. Creation of a Wikipedia page based on the project.

Recommended Online Courses:

1. Fundamentals of Digital Image and Video Processing at Northwestern university https://www.coursera.org/learn/digital
2. Image and Video Processing: From Mars to Hollywood with a Stop at the Hospital at Duke University https://www.coursera.org/learn/image-processing

Reference Books / Articles

1. Gonzalez and Woods, Digital Image Processing, Pearson Education
2. A.K. Jain, Fundamentals of Digital Image Processing, P.H.I
3. Chanda Majumder, Digital Image Processing and Analysis, Prentice Hall India
4. Geoff Dougherty, Digital Image Processing for Medical Applications, Cambridge University Press, 2009.
5. William Pratt, Digital Image Processing, John Wiley.

Course Name Digital Image Processing Lab

Course Code: BM14P

Category: Core

Preamble:

The course will help student to understand the basic concepts related to Digital Image Processing. The course covers concepts of image enhancement, segmentation, compression and restoration. The application of the concepts in real world will help students to relate well to the subject

Course Objectives:

- To understand the basics practical of Digital Image Processing.
- To gain the knowledge of various medical applications of Digital Image Processing.

Pre-requisites:

1. Engineering Mathematics-II (BS04)
2. Engineering Mathematics-III (BS06)
3. Biomedical Digital Signal Processing Lab (BM11P)

Course Outcome:

The students will be able to:

CO1: Explain the fundamental concepts of a digital image processing system.
CO2: Demonstrate image enhancement techniques in the spatial & frequency domain.
CO3: Apply different image segmentation algorithms.
CO4: Apply various transform techniques on the image for analysis and compression of images.
CO5: Compare morphological operation on images.
CO6: Choose image processing techniques for object recognition and classification.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
--	02	--	01

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory+ Tutorial	25	-	25	050

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose a revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Suggested List of Experiments

1. Different image enhancement techniques.
2. Given an image with very low contrast. Suggest various methods for adjusting contrast and compare them. Justify with quantified outcomes.
3. Contrast Stretching demonstration using MATLAB/Python.
4. Intensity level Slicing demonstration using MATLAB/Python.
5. The given image contains Noises. Apply spatial Domain filters to denoise and improve the image. . Justify with quantified outcomes.
6. Manipulation of Histogram is an image enhancement technique. Improve the quality of the given image by histogram manipulations you know.
7. Simulation of DCT, Walsh, Hadamard, Haar and Slant transform using variable block sizes.
8. Image transforms can be used to improve and compress images. Compare different image transforms .
9. Morphological operations can change shape, size and quality of image. Illustrate through programming.
10. Zooming and Shrinking Images by Pixel Replication.

Suggested List of Project:

1. License plate recognition.
2. Face Emotion recognition.
3. Face recognition.
4. Cancer detection.
5. Object detection.
6. Pedestrian detection.
7. Lane detection for ADAS.
8. Blind assistance systems.
9. Gesture recognition
10. Drowsy driver detection

Reference Books / Articles

1. Gonzalez and Woods, Digital Image Processing, Pearson Education
2. A.K. Jain, Fundamentals of Digital Image Processing, P.H.I
3. Chanda Majumder, Digital Image Processing and Analysis, Prentice Hall India

4. Geoff Dougherty, Digital Image Processing for Medical Applications, Cambridge University Press, 2009.
5. William Pratt, Digital Image Processing, John Wiley.

Course Name: Biomedical Microsystems

Course Code: BM15T

Category: Core Engineering

Preamble:
This course introduces students to MEMS materials, microfabrication, and packaging of MEMS Devices. It also covers the applications of MEMS in Biomedical Engineering

Pre-requisites:

- Human Anatomy & Physiology
- Engineering Physics
- Engineering Chemistry

Course Objectives:

- To enable learners to learn the properties of MEMS materials.
- To enable learners to understand MEMS processes steps and procedure.
- To enable learners to learn the basics of soft-lithography technique.
- To enable learners to study fundamentals of Lab-on-Chip technology.
- To enable learners to understand the application of MEMS as drug delivery system.
- To enable learners to apply MEMS process knowledge in MEMS packaging.

Course Outcomes:

Learner will be able to:

CO1: Understand the different MEMS materials properties and their applications in MEMS.
CO2: Analyze & study different MEMS processes to make micro devices for a specific application.
CO3: Choose appropriate soft lithography technique for developing microstructures.
CO4: Differentiate different parts of the micro total analysis systems and understand the purpose of individuals.
CO5: Relate the microstructures and their applications in drug delivery systems.
CO6: Compare the MEMS packaging techniques.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	75

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No. of Hours
1	MEMS Materials	Clean room classification, MEMS, Substrates and Wafers, Properties of Silicon Compounds Polymers in MEMS	4
2	MEMS Processes	Wafer cleaning processes, Deposition process, Doping, Etching, Lithography techniques, and Surface characterization techniques	10
3	Soft lithography	SAMs, Types: Micro contact Printing, Micro molding techniques: replica molding, microtransfer molding,	4
4	Micro Total Analysis Systems (μTAS)	Flow techniques in μ-fluidics: pressure driven force, electro-osmosis, electrophoresis, Micropump, microvalves: types and fabrication, Microchannels: Types and fabrication (SU8, glass, silicon)	4
5	Drug Delivery Devices	Overview of drug delivery systems, Types of drug delivery systems, MEMS based drug delivery systems: Implantable drug delivery systems (IDDS), Micro needles and its fabrication, Micro particles for oral drug delivery	4
6	Microsystem Packaging	Packaging materials, Levels of packaging, Comparison between IC and MEMS packaging	4
Total			**30**

Suggested list of Assignments:

1. Classification of MEMS materials.
2. MEMS processes with case study
3. Overview of replica techniques.
4. Application of MEMS in Biomedical Engineering.
5. MEMS Packaging techniques.

Suggested List of Value-Added Home Assignments:

1. Reviewing MEMS products and new technologies.
2. Novel technical paper writing based on recent advancements.
3. Problem Based Learning on MEMS sensor development.

Suggested Online Courses:

1. Micro and Nanofabrication (MEMS)
   https://www.edx.org/course/micro-and-nanofabrication-mems

Reference Books:

1. Marc Madou, "Fundamentals of Microfabrication", CRC Press, 1997.
2. Steven S. Saliterman , "Fundamentals of BioMEMS and Medical Microdevices", SPIE Press Monograph Vol. PM153 by Wiley Interscience, 2012.
3. W. Menz, J. Mohr, 0. Paul, "Microsystem Technology", WILEY-VCH, 2001.
4. James J. Allen , "Electro Mechanical System Design", Taylor & Francis Group, 2005.
5. Neelina H. Malsch, "Biomedical Nanotechnology", CRC PRESS, Taylor and Francis Group, 2005.

Course Name: Biomedical Microsystems Lab

Course Code: BM15P

Category: Core Engineering

This course introduces students to MEMS materials, microfabrication, and packaging of MEMS Devices. It also covers the applications of MEMS in Biomedical Engineering

Pre-requisites:

- Human Anatomy & Physiology
- Engineering Physics
- Engineering Chemistry

Course Objectives:

- To enable learners to learn the properties of MEMS materials.
- To enable learners to understand MEMS processes steps and procedure.
- To enable learners to learn the basics of soft-lithography technique.
- To enable learners to study fundamentals of Lab-on-Chip technology.
- To enable learners to understand the application of MEMS as drug delivery system.
- To enable learners to apply MEMS process knowledge in MEMS packaging.

Course Outcomes:

Learner will be able to:

CO1: Understand the different MEMS materials properties and their applications in MEMS.
CO2: Analyze & study different MEMS processes to make micro devices for a specific application.
CO3: Choose appropriate soft lithography technique for developing microstructures.
CO4: Differentiate different parts of the micro total analysis systems and understand the purpose of individuals.
CO5: Relate the microstructures and their applications in drug delivery systems.
CO6: Compare the MEMS packaging techniques.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	50

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Suggested list of Practicals:

1. Demonstration of scaling law for miniaturized structure.
2. Materials in MEMS technology and application- Case study.
3. Nanopattern collapsing due to capillary forces: Study & suppression techniques.
4. Surface characterization techniques and applications as a case study.
5. Soft Lithography Techniques- Replication technique for polypropylene microneedles
6. Selection of separation Techniques in uTAS System for sensing application.
7. Design of Biosensor for NSA removal.
8. Packaging Techniques in MEMS for different applications.
9. Sensitivity enhancement for sensor a case study.

Guidelines to conduct practical sessions:

1. The Laboratory work is to be conducted by a group of three-five students.
2. To encourage project-based learning in the curriculum students may either select one of the commercial biosensors for a review.
3. Each group along with subject faculty shall identify a potential biosensor, on which the study can be conducted. They can perform real or virtual experiments related to the topic selected in the laboratory along with regular experiments.
4. Students should prepare working models, power point presentation, posters etc. on the selected topics.
5. The assessment will be done at the end of the semester.

Suggested Online Courses:

1. Micro and Nanofabrication (MEMS)
   https://www.edx.org/course/micro-and-nanofabrication-mems

Reference Books:

1. Marc Madou, "Fundamentals of Microfabrication", CRC Press, 1997.
2. Steven S. Saliterman , "Fundamentals of BioMEMS and Medical Microdevices", SPIE Press Monograph Vol. PM153 by Wiley Interscience, 2012.
3. W. Menz, J. Mohr, 0. Paul, "Microsystem Technology", WILEY-VCH, 2001.
4. James J. Allen , "Electro Mechanical System Design", Taylor & Francis Group, 2005.
5. Neelina H. Malsch, "Biomedical Nanotechnology", CRC PRESS, Taylor and Francis Group, 2005.

Course Name: Hospital Management

Course Code: BM16T

Category: Core

Preamble:

This course introduces students to understanding the basic principles used for designing layouts of various departments in the hospital. This course will help students to understand the role of Biomedical Engineer in hospital and to develop skills enabling them to serve the health care industry. Students will be able to apply modern engineering and management principles to provide high quality hospital care to the community.

Pre-requisites:

Analytical and Clinical Equipment (BM05T)
Diagnostic and Monitoring Equipment (BM09T)
Critical Care Equipment – (BM13T)
Human anatomy and Physiology (BS18T)

Course Objective:

- To understand the basic principles used for designing various departments in the hospital.
- To understand the role of Biomedical Engineer in hospital and basic develop skills enabling to serve hospitals.
- To understand the overall functioning of various departments in the hospital.

Course Outcomes:

Learner will be able to:

CO1: Understand the basic management principles, communicate effectively, and develop leadership skills and team building abilities.
CO2: Understand and apply resource management concepts (personnel, finance, and material resources), the processes and strategies needed in planning & building hospital facilities.
CO3: Understand the principles of designing, implementing, and commissioning of clinical services in the hospital.
CO4: Understand the principles of designing, implementing, and commissioning of clinical supportive departments in the hospital.
CO5: Understand the roles and responsibilities of Biomedical Engineer and to understand the functions of other Engineering services and axillary services in hospital.
CO6: Understand and apply materials management concept in health care industry.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	20	30	50	100

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Module Contents	No. of Hours
01	General management Principles	Principles of management, Leadership, Motivation, Time management, H.R. management in Hospital (Recruitment, Performance appraisal, Training, and development,), effective communication, Accounting - Types of Budgets.	4
02	Management structure of Hospital	Management structure, Types of hospitals, Governing body, Hospital committee and hospital functionaries, Duties, and responsibilities of various positions. Guiding principles in planning hospital facilities and services and planning the hospital building.	3
03	Clinical Services in the hospital	(Location, Layout, equipment, and personnel): Emergency, IN patient, Outpatient, Intensive care unit, Operation Theatre, Laboratory, Blood Bank, Radiology	8
04	Support Services in the hospital	(Location, Layout, equipment, and personnel): Medical Record department, Central Sterile Service Dept, Pharmacy, Laundry and Linen Medical social service Dept. Hospital security, Housekeeping, Dietary (Food services).	4
05	Engineering & Auxiliary Services in the hospital	Engineering Services: Biomedical Engineering Department: Roles and responsibilities of Biomedical Engineer in hospitals, Maintenance types: Routine(preventive) and breakdown Maintenance contracts (CMC and AMC), Electrical, Mechanical and Civil Engineering Department (Basic Functions), Hospital Ventilation and Air Conditioning, Medical Gas systems, Hospital information systems. B) Auxiliary Services: Waste management, Hospital Infection	8

Module No.	Module Name	Module Contents	No. of Hours
		control, Disaster management	
06	Material management in Hospital	Classification of Materials Purchase Management: Purchase system (Centralized, Decentralized, Local purchase), Purchase Procedures: Selection of Suppliers, tendering procedures, Analyzing bids, Price negotiations, Issue of purchase orders, Rate Contracts. Store Management: Functions of Store Manager, Materials handling, Flow of goods/FIFO. Inventory Control: Lead-time, Buffer stock, Reorder level, Two Bin System, EOQ	3
Total			**30**

Suggested list of Assignments:

1. Explain the concept of depreciation with the help of an example.
2. Design a layout (diagram with approximate dimensions) for the installation of CT scan/MRI/Cath Lab in a hospital.
3. How Biomedical Waste in Mumbai is treated?

Suggested list of Value-Added Home Assignments:

1. Prepare Technical Specifications of Key Medical Equipment.
2. Study available (selected in assignment 1) equipment and their specifications from net.
3. Prepare Purchase Proposal for the above equipment.
4. Prepare a Tender document for the purchase of the above equipment.

Suggested Online Courses:

1. Health Care Delivery in Healthcare Organizations, Rutgers University, USA
   https://www.coursera.org/programs
2. Quality Improvement in Healthcare Organizations, Rutgers University, USA
   https://www.coursera.org/programs
3. Foundations of Healthcare Systems Engineering, Johns Hopkins University, USA
   https://www.coursera.org/programs
4. Fixing Healthcare Delivery 2.0: Advanced Lean, University of Florida
   https://www.coursera.org/programs

Textbooks:

1. Dr. Pragna Pai, Effective Hospital Management, 2nd Edition.
2. Kunders G D, Gopinath, A kataka, Hospital Planning, Designing and Management: (Private Pub Bangalore), 2003, 3rd Edition.

Reference Books / Articles

1. R. D. Lele, Computers in Medicine, (TMH Pub).
2. Dr. Kalanidhi, Hospital Care & Hospital Management AICTE Journal Vol. 1,2, 3, (AICTE Pub Bangalore).
3. Shantanu Thatte, Careers in Biomedical.

Course Name: Hospital Management (HM) Lab

Course Code: BM16P

Category: Core

Preamble:

This course introduces students to understanding the basic principles used for designing layouts of various departments in the hospital. This course will help students to understand the role of Biomedical Engineer in hospital and to develop skills enabling them to serve the health care industry. Students will be able to apply modern engineering and management principles to provide high quality hospital care to the community.

Pre-requisites:

Analytical and Clinical Equipment (BM05T)
Diagnostic and Monitoring Equipment (BM09T)
Critical Care Equipment – (BM13T)
Human anatomy and Physiology (BS18T)

Course Objectives:

- To understand the basic principles used for designing various departments in the hospital.
- To understand the role of Biomedical Engineer in hospital and basic develop skills enabling to serve hospitals.
- To understand the overall functioning of various departments in the hospital.

Course Outcome:

The students will be able to:

CO1: Understand the basic management principles, communicate effectively, and develop leadership skills and team building abilities.
CO2: Understand and apply resource management concepts (personnel, finance, and material resources), the processes and strategies needed in planning & building hospital facilities.
CO3: Understand the principles of designing, implementing, and commissioning of clinical services in the hospital.
CO4: Understand the principles of designing, implementing, and commissioning of clinical supportive departments in the hospital.
CO5: Understand the roles and responsibilities of Biomedical Engineer and to understand the functions of other Engineering services and axillary services in hospital.
CO6: Understand and apply materials management concept in health care industry.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	50

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose a revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Suggested List of Experiments

1. The capstone project work - to prepare presentation on any one department of the hospital.
2. Design of Registration form of hospital.
3. Prepare budget using EXCEL sheet for purchase of hospital equipment.
4. Preparation of Comparative Statement of Equipment for purchase (Any Two)
5. Design the layout of Outpatient Department in hospital.
6. Design the layout of In-Patient Department in hospital.
7. Design the layout of Surgical Operation Theatre Complex in hospital.
8. Design the layout of Radiology Department in hospital.
9. Design the layout of Pathology Laboratory and Blood Bank Department in hospital.
10. Design the layout of Physiotherapy Department in hospital.
11. Design the layout of Central Sterile Supply Department in hospital.

Guidelines to conduct practical sessions:

1. The Laboratory work is to be conducted by a group of three-five students.
2. To encourage project-based learning in the curriculum students may either select one of the medical equipment of their choice after a review process by the subject faculty.
3. Students should prepare power point presentations, posters etc. on the selected medical equipment. Assessment will be done at the end of the semester.

Suggested List of Mini Projects/PBL (to name few):

1. Implement basic principle of inventory control (ABC) based on cost criteria and (VED) on criticality. Show with example.
2. Preparing a draft tender document for the purchase of ECG machine Technical Specs, List of dealers, GCC etc.

Recommended Online Courses:

1. Health Care Delivery in Healthcare Organizations, Rutgers University, USA
   https://www.coursera.org/programs
2. Quality Improvement in Healthcare Organizations, Rutgers University, USA
   https://www.coursera.org/programs
3. Foundations of Healthcare Systems Engineering, Johns Hopkins University, USA
   https://www.coursera.org/programs
4. Fixing Healthcare Delivery 2.0: Advanced Lean, University of Florida
   https://www.coursera.org/programs

Reference Books / Articles

1. R. D. Lele, Computers in Medicine, (TMH Pub).
2. Dr. Kalanidhi, Hospital Care & Hospital Management AICTE Journal Vol. 1,2, 3,. (AICTE Pub Bangalore).
3. Shantanu Thatte, Careers in Biomedical.

Course Name: Artificial Intelligence

Course Code: BM24T

Category: Professional Elective

Preamble:
Intelligent machines have replaced human capabilities in many areas. Artificial intelligence is the intelligence exhibited by machines or software. It emphasizes creating intelligent machines that work and react like humans.

Pre-requisites:
NIL

Course Objectives:

1. Understand Artificial Intelligence
2. Know and use various problem-solving methods
3. Acquire and use knowledge representation methods in AI
4. Understand and design Artificial intelligence Agents
5. Know and identify AI applications
6. Design and apply Artificial Intelligence in community

Course Outcomes:
Learner will be able to:
CO1: To understand the basics of Artificial Intelligence
CO2: To know and use various problem-solving methods
CO3: To acquire and use knowledge representation methods in AI
CO4: To understand and design Artificial intelligence Agent
CO5: To know and identify AI applications
CO6: To design and apply Artificial Intelligence in community

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	75

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall decide her/his assessment methodology based on the course's nature. Faculty may propose the revised assessment methodology for his/her

course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours
1	Introduction to Artificial Intelligence	• Artificial Intelligence Introduction • Future of Artificial Intelligence • Characteristics of Intelligent Agents • Typical Intelligent Agents	4
2	Problem Solving Methods	• Problem solving Methods • Search Strategies • Uninformed and Informed Search • Local Search • Heuristics • Algorithms and Optimization Problems • Searching with Partial Observations • Constraint: Satisfaction Problems, Constraint Propagation, Backtracking Search • Game Playing • Optimal Decisions in Games • Alpha-Beta Pruning • Stochastic Games	6
3	Knowledge Representation	• Knowledge Representation • First-Order Predicate Logic • Prolog Programming • Unification • Forward and Backward Chaining • Resolution • Ontological Engineering • Categories and Objects • Events • Mental Events and Mental Objects • Reasoning Systems for Categories • Reasoning with Default Information	5
4	Software Agents	• Architecture for Intelligent Agents • Agent communication • Negotiation and Bargaining • Argumentation among Agents • Trust and Reputation in Multi-agent systems	5

5	Artificial Intelligence Applications	• Artificial Intelligence applications • Language Models • Information Retrieval • Information Extraction • Natural Language Processing • Machine Translation • Speech Recognition • Robotics • Hardware and Software for Robots • Planning and Perception	5
6	Real Time USECASE	Students are supposed to study any AI Application and provide insights about the concepts used in respective application.	5
Total			**30**

Textbooks:

1. Artificial Intelligence: A Modern Approach (AIMA) is a university textbook on artificial intelligence, written by Stuart J. Russell and Peter Norvig.
2. S. Russel and P. Norvig, "Artificial Intelligence – A Modern Approach", Second Edition, Pearson Education

Reference Books:

1. David Poole, Alan Mackworth, Randy Goebel," Computational Intelligence : a logical approach", Oxford University Press.
2. G. Luger, "Artificial Intelligence: Structures and Strategies for complex problem solving", Fourth Edition, Pearson Education.
3. J. Nilsson, "Artificial Intelligence: A new Synthesis", Elsevier Publishers.

Course Name: Artificial Intelligence Lab

Course Code: BM24P

Category: Professional Elective

Preamble: Intelligent machines have replaced human capabilities in many areas. Artificial intelligence is the intelligence exhibited by machines or software. It emphasizes on creating intelligent machines that work and react like humans. AI labs will help to understand these concepts with practical experiments.

Pre-requisites:
NIL

Course Objectives:

- Understand Artificial Intelligence
- Know and use various problem-solving methods
- Acquire and use knowledge representation methods in AI
- Understand and design Artificial intelligence Agents
- Know and identify AI applications
- Design and apply Artificial Intelligence in community

Course Outcomes:
Learner will be able to:
CO1: To understand and conceptualize basic ideas and techniques in artificial Intelligence
CO2: To know and use various problem-solving methods
CO3: To acquire and choose appropriate knowledge representation methods in AI
CO4: To understand and design Artificial intelligence Agents
CO5: To know and identify AI applications
CO6: To design and develop Artificial Intelligence Applications in real world scenarios

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment guidelines:

Head of Learning	ISA (TW)	MSE	Oral / Pract	Total
Practical	25	-	25	50

Suggested List of Practicals:

Sr No.	Title of Practicals
1	One case study on AI applications published in IEEE/ACM/ Springer Journals
2	Program on uninformed search methods (BFS)
3	Program on uninformed search methods (DFS)
3	Program on informed search methods (A *)
4	Program on game playing assignments (Minmax)
5	Program on First order logic
6	Project (Develop any small AI Application)

Course Name: Principles of Internet of Things

Course Code: BM25T

Category: Professional electives

Preamble:

The world around us is becoming increasingly interconnected. Internet of Things (IoT), a rapidly evolving field that's transforming the way we live, work, and interact with the world around us. This course will be your deep dive into the foundations of IoT. Students will delve into the language of sensors and actuators, uncover the secrets of communication between devices, and understand the challenges and opportunities that come with a connected world.

By the end, students will gain a solid understanding of the fundamental building blocks of IoT and be well-equipped to navigate this exciting and ever-growing field. Students will also be able to build use cases and Mini projects

Pre-requisites:

- C Programming
- Object Oriented Programming
- Microprocessor and Microcontroller

Course Objectives:

- To Understand the core concepts of the Internet of Things (IoT) and its key components & Levels.
- To Explore different Protocols used in IoT Communication
- To Gain a foundational knowledge of common IoT Interfaces.
- To Develop critical thinking skills to analyze proper selection of Boards
- To build practical skills by programming or building a simple IoT project to solidify your understanding**.**

Course Outcomes:

Student will be able to:
CO1: Understand the concept of IoT and its key components of IoT.
CO2: Understand different IoT Communication Protocols.
CO3: Understand different hardware Communication Protocols.
CO4: Select appropriate development boards for Building IOT Applications.
CO5: Develop programs for IoT application.
CO6: Develop creative applications of IoT technology in chosen fields.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment Guidelines:

Head of learning	ISA	MSE	ESE	Total
Theory	15	20	40	75

The assessment guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No. of Hours
1	Introduction to Internet of Things	1.1 Definition and characteristics of IoT 1.2 History and evolution of IoT 1.3 Architectural layers of an IoT system (perception, network, application, data management) 1.4 Levels of IoT	5
2	Communication Protocols	2.1 IoT Edge to Cloud protocols: HTTP, REST APIs, WebSocket, MQTT, COAP, Comparison of Protocols.M2M Communication Protocols, 2.2 Bluetooth BR/EDR and Bluetooth low energy. RFID IoT System , RFID IoT Network Architecture, ZigBee IP/ZigBee SE2.0, Wifi(WLAN), 2.3 Message Communication protocols for connected devices Data exchange formats: JSON & XML	5
3	Sensor Interfaces	3.1 Digital Interfaces: UART, Serial Peripheral Interface (SPI), I2C (Inter-Integrated Circuit), Controller Area Network (CAN), Middleware Technologies, 3.2 Communication Protocols and Models. Practical Components Programming with interface in Arduino, MBed and Raspberry Pi	5
4	Hardware Fundamentals	4.1 Introduction to various sensors (temperature, humidity, pressure, motion, etc.) 4.2 Actuators and their types (solenoids, motors, relays) 4.3 Microcontrollers and development boards (e.g., Arduino, Raspberry Pi) 4.4 Interfacing sensors and actuators with	5

		microcontrollers 4.5 Introduction to embedded system design principles	
5	Software Development for IoT	5.1 Introduction to programming languages for IoT (e.g., Python, C++) 5.2 Data acquisition, processing, and visualization techniques 5.3 Introduction to IoT platforms and frameworks Security considerations in IoT applications	5
6	IOT Applications and USE Cases	Case Studies Illustrating IoT Design in Applications like Home Automation, Smart Cities, Environment, Agriculture, Healthcare.	5
Total			**30**

Text Books:

1. Arshdeep Bahga and Vijay Madisetti, "Internet of Things: A Hands-on Approach, Universities Press.
2. Raj Kamal, "Internet of Things: Architecture and Design Principles", McGraw Hill Education, First edition

Reference Books:

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry,"IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things
2. N. Ida, Sensors, Actuators and Their Interfaces, Scitech Publishers, 2014.

Course Name: Principles of Internet of Things Laboratory

Course Code: BM25T

Category: Professional electives

Preamble:

This lab will describe the market around the Internet of Things (IoT), the technology used to build these kinds of devices, how they communicate, how they store data, and the kinds of distributed systems needed to support them

Pre-requisites:

Programming Languages – II & III, Microprocessor & Microcontroller- IV.

Course Objectives:

- To Understand interfacing of Sensors & actuators
- To identify how IoT differs from traditional data collection systems.
- To explore the interconnection and integration of the physical world and able to design & develop IOT Devices.

Course Outcomes:

Student will be able to:
CO1: Adapt different techniques for data acquisition using various IoT sensors for different applications.
CO2: Demonstrate the working of actuators based on the collected data.
CO3: Use different IoT simulators and correlate working of IoT protocols.
CO4: Select appropriate development board for IoT application.
CO5: Implement IoT protocols like MQTT for communication to realize the revolution of internet in mobile devices, cloud and sensor networks.
CO6: Develop use cases for Different IoT Applications.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment Guidelines:

Head of learning	ISA	MSE	ESE	Total
Practical	25	-	25	50

The assessment guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Suggested List of Practical's:

1. To study and implement interfacing of different IoT sensors with Raspberry Pi/Arduino/NodeNCU
2. To study and implement interfacing of actuators based on the data collected using IoT sensors. (like led switch ON/OFF, stepper word)Modulation and Demodulation of Binary Frequency Shift Keying.
3. To study and demonstrate use of IoT simulators (like Beviswise) on any real time device (LED/stepper motor)
4. To study MQTT Mosquitto server and write a program on Arduino/Raspberry Pi to publish sensor data to MQTT broker.
5. Interfacing to Wireless Communication Devices like Bluetooth , LoRA
6. Install OS in Raspberry Pi
7. Predictive Maintenance in Industrial Automation Systems
8. Study different hardware Boards used in IoT applications

Mini Projects / Case Stud

Select any one case study (in a group of 2-3) and perform the experiments 5 to 10. The sample case studies can be as follows:

1. Smart home automation system
2. Healthcare management system
3. Smart traffic management system etc.

Write a program on Raspberry Pi to push and retrieve the data from cloud like thingspeak, thingsboard, AWS, Azure etc.

Text Books / Reference Books

1. Jake VanderPlas, "Python Data Science Handbook", O'Reilly publication, 2016.
2. Joakim Verona," Practical DevOps", PACKT publishing, 2016.
3. Honbo Zhou," The internet of things in the cloud", CRC press, Taylor and Francis group, 2012.
4. Perry Lea," Internet of things for architects", PACKT publishing, 2018.

Course Name: Robotics in Medicine

Course Code: BM26T

Category: Professional Elective

Preamble:

The course will help student to understand the basic concepts Robot classification, Direct Kinematics, Inverse Kinematics, Robotic Workspace, Robotic vision, motion planning and biomedical robots

Course Objectives:

- To understand the basics of Robot Kinematics, Work Envelop and Robot Motion Planning.
- To gain the knowledge of various medical applications of Robotics. .

Pre-requisites:

1. Engineering Mathematics-III (BS06)
2. Digital Image Processing Lab (BM14P)

Course Outcome:

The students will be able to:

CO1: Describe basic types and classes of robots.
CO2: Describe direct and inverse kinematics of robots.
CO3: Describe workspace envelop and trajectory planning for robots.
CO4: Apply various image processing tools for robotic manipulation.
CO5: Implement motion planning solutions using various algorithms.
CO6: Describe robotic system for medical applications

Course Scheme:

Contact Hours		Credits Assigned
Theory	Practical	Total
02	--	02

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory+ Tutorial	15	20	40	075

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his

assessment methodology based on the nature of the course. Faculty may propose a revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Module Contents	No. of Hours
01	Introduction	Automation and Robots, Classification, Application, Specification, Notations	2
02	Direct Kinematics	Dot and cross products, Coordinate frames, Rotations, Homogeneous coordinates Link coordination arm equation, (Five- axis robot, Four-axis robot, Six-axis robot)	8
03	Inverse Kinematics, Workspace analysis and trajectory planning	General properties of solutions tool configuration Five axis robots, Three-Four axis, Six axis robot (Inverse Kinematics). Workspace analysis and trajectory planning work envelope and examples, workspace fixtures, Pick and place operations, Continuous path motion, Interpolated motion, Straight-line motion.	6
04	Robot Vision	Image representation, Template matching, Polyhedral objects, Shane analysis, Segmentation (Thresholding, region labeling, Shrink operators, Swell operators, Euler numbers, Perspective transformation, Structured illumination, Camera calibration).	6
05	Task Planning	Task level programming, Uncertainty, Configuration, Space, Gross motion, Planning, Grasp Planning, Fine-motion planning, Simulation of planar motion, Source and Goal scenes, Task Planner simulation.	6
06	Applications in Biomedical Engineering	Applications in Biomedical Engineering Application in rehabilitation, Clinical and Surgery	2
Total			**30**

Suggested List of Value-Added Home Assignments:

1. Robot path planning algorithms
2. Applications in Medicine
3. Robot Vision Techniques
4. Problem Based Assignment
5. Reviewing Literature in the form of a technical paper based on the project.
6. Novel technical paper writing based on the project.
7. Creation of a Wikipedia page based on the project.

Recommended Online Courses:

1. Modern Robotics, Course 6: Capstone Project, Mobile Manipulation, Northwestern University https://www.coursera.org/learn/modernrobotics-course6
2. Modern Robotics: Mechanics, Planning, and Control Specialization Northwestern University https://www.coursera.org/specializations/modernrobotics

Reference Books / Articles

1. Robert Shilling, Fundamentals of Robotics-Analysis and control, Prentice Hall of India, 2003.
2. Fu, Gonzales and Lee, Robotics, Robotics, McGraw Hill, SecondEdition,2011.
3. John J. Craig, Introduction to Robotics–Mechanics &Control Pearson Education, India, Third Edition, ,2009.
4. Staughard, Robotics and AI, Prentice Hall of India.
5. Grover, Wiess, Nagel, Oderey Industrial Robotics, , McGraw Hill.
6. Walfram Stdder, Robotics and Mechatronics, Mc Graw Hill, New York 2008.
7. Saeed B Niku, Introduction to Robotics, Pearson Education.
8. Mittal, Nagrath, Robotics and Control, Tata McGraw Hill publications

Course Name: Machine Learning

Course Code: BM27T

Category: Professional Elective

Preamble:
Machine Learning (ML) is a fundamental area of study in modern computer science and engineering, enabling systems to automatically learn and improve from experience without being explicitly programmed. This course provides undergraduate engineering students with a comprehensive understanding of the theoretical aspects of machine learning algorithms, models, and techniques. Through a combination of theoretical lectures, practical exercises, and hands-on projects, students will gain the necessary knowledge and skills to understand, implement, and evaluate various machine learning algorithms.

Pre-requisites:
Engineering Mathematics

Course Objectives:
- To understand fundamental concepts of Machine Learning
- To learn and implement supervised learning techniques such as regression, classification
- To be able to interpret outcome of classification process and evaluate them
- To learn and implement unsupervised learning techniques such as clustering
- To understand working of artificial neural network and to implement ANN learning algorithms
- To get basic understanding of deep networks

Course Outcomes:

Learner will be able to:
CO1: To demonstrate a thorough understanding of the principles and importance of machine learning
CO2: To apply various techniques for supervised learning
CO3: To develop critical thinking skills to evaluate the performance of various classifiers
CO4: To implement various techniques for unsupervised learning
CO5: To design ANN architecture for problem solving
CO6: To understand basic concepts of deep networks

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	075

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours
1	Introduction to Machine Learning	Basic concepts and terminology in machine learning, Types of ML algorithms, Overview of ML process	2
2	Supervised Learning-I	Regression: Linear regression models, Nonlinear regression (only introduction), Classification: Decision tree (Revision), Bayesian classifier, KNN classifier, SVM classifier	6
3	Supervised Learning-II	Evaluation of classifiers: Accuracy, Precision, Recall, F1 score, TPR, TNR, Confusion matrix, ROC, Overfitting, Underfitting, Variance, Bias, Concepts of regularization and generalization, Ensemble Learning: Basic concept, Stacking, Bagging, Boosting, Random Forest, AdaBoost, GBM, XG Boost	6
4	Unsupervised Learning	Types of Clustering algorithms, Revision of basic algorithms, DBSCAN, BIRCH, Evaluating clustering tendency, Evaluation of clusters	6
5	Introduction to Neural Networks	Biological neuron and artificial neuron, MP neuron, Perceptron, Activation functions, ANN architectures: single layer, MLP, Recurrent network, ANN learning algorithms: PLR, DLR, HLR, Winner-takes-all, Gradient Descent & EBP	8
6	Introduction to Deep Networks	What is deep network? Advantages and challenges, Concepts of CNN, RNN, GRU and LSTM	2
		Total	**30**

Textbooks:

3. "Introduction to Machine Learning" by Ethem Alpaydın, 4th Edition, MIT press
4. "Machine Learning in Action" by Peter Harrington, Manning Publication

Reference books:

1. “Machine Learning for beginners” by Harsh Bhasin, BPB Publication

Course Name: Machine Learning Lab

Course Code: BM27P

Category: Professional Elective

Preamble:
Machine Learning (ML) is a fundamental area of study in modern computer science and engineering, enabling systems to automatically learn and improve from experience without being explicitly programmed. This course provides undergraduate engineering students with a comprehensive understanding of the theoretical aspects of machine learning algorithms, models, and techniques. Through a combination of theoretical lectures, practical exercises, and hands-on projects, students will gain the necessary knowledge and skills to understand, implement, and evaluate various machine learning algorithms.

Pre-requisites:
Skill Based Lab-Python

Course Objectives:
- Develop students' ability to implement supervised learning models
- Enhance students' proficiency in implementing and applying unsupervised learning methods
- Foster students' awareness of deep networks
- Provide students with opportunities to analyze performance of classifiers

Course Outcomes:
Learner will be able:
CO1: To demonstrate the ability to implement regression and classification models
CO2: To implement ensemble learning models
CO3: To explore properties of unsupervised learning models
CO4: To identify characteristics of various activation functions used in ANN
CO5: To apply ANN learning algorithms to train the NN model for given problem
CO6: To exhibit proficiency in identifying and implementing appropriate ML model to solve real world problems

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	050

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Suggested List of Practicals:

Sr No.	Title of Practicals
1	To implement linear regression models
2	To implement classification models
3	To implement ensemble learning techniques
4	To implement clustering techniques
5	To demonstrate various activation functions
6	To implement basic logic gate functions using MP neuron
7	To implement different NN learning algorithms
8	To implement hand written digit recognition using MLP
9	To implement mini project on selected problem statement

Course Name: Embedded System Design with Tiny Operating System (OS)

Course Code: BM28T

Category: Professional Elective (IoT Track)

Preamble:
Embedded System is a used for developing a dedicated task or application. Internet of Things (IoT) is an upcoming technology based on the base of embedded systems. Machine learning (ML) is also an upcoming technology and concepts of ML are used in many applications. This course blends the concepts of embedded systems with machine learning for developing smart and dedicated applications for requirements of IoT. It introduces the fundamental concepts of operating system and use of operating system in the development of embedded systems.

Pre-requisites:

- C Programming
- Object Oriented Programming
- Microprocessor and microcontroller

Course Objectives:

- To understand the fundamentals of ARM 7 family.
- To understand concepts of embedded systems.
- To understand communication interface for embedded systems.
- To understand working with Real Time Operating Systems (RTOS).
- To understand fundamental concepts of tiny machine learning.
- To use tiny machine learning for embedded systems.

Course Outcomes:

Student will be able to:

CO1: Understand fundamental concepts of advanced 32 bit micro-controllers.

CO2: Demonstrate the fundamental concepts of embedded system design

CO3: Use communication interface for design of embedded system.

CO4: Understand concept of Real Time Operating Systems (RTOS) for embedded system design.

CO5: Understand fundamental concepts of tiny machine learning.

CO6: Use concept of tiny machine learning for design of embedded systems.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
2	2	2	1

Assessment Guidelines:

Head	ISA	MSA	ESE	Total (Passing @40% of total)
Theory	15	20	40	75
Lab	25	--	25	50

The assessment guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module no	Module name	Content	No of Hours
1	ARM 7 family and Programming	Introduction, features, basic architecture, Cortex family, register organization with different registers like CPSR	6
2	Introduction to embedded systems	Introduction and different examples/applications, classification of embedded systems, design metrics of an embedded systems, embedded system design life cycle, processor technology for embedded systems, concept of modelling in embedded systems	5
3	Communication Protocols for embedded systems	UART, SPI, I2C, CAN with details like pins, working, timing diagram and common applications, introduction to other communication protocols like zig-bee and Wi-Fi.	6
4	Real Time Operating Systems	Basic concept of operating system, process management with scheduling and related issues, process synchronization with algorithms, concept of threading	6
5	Machine Learning Fundamentals	Concept of machine learning, fundamentals of tiny ML, design and challenges, Building and training machine learning model, Convolutional Neural Networks	4
6	Application Development	Building applications and deployment of model	3
Total			**30**

Textbooks:

1. Embedded System Architecture, Programming & Design (Tata McGraw Hill Publication, Third Edition)- Raj Kamal.
2. An Embedded Software Primer- David E. Simon.
3. Embedded Real Time Systems Programming- Sriram V. Iyer, Pankaj Gupta.
4. MicroC/OS-II, Indian Low price Edition 2002- Jean J. Labrose.
5. Embedded Real Time Systems: Concepts, design & Programming (Dreamtech Publication)- K. V. K. K. Prasad

Reference Books:

1. Embedded System Design: A Unified Hardware/Software Introduction (Wiley Publication)- frank Vahid, Tony Givargis
2. ARM System-on-Chip Architecture (Pearson 2005)- Steve Furber
3. Tiny Machine Learning - Pete Warden and Daniel Situnayake
4. Rajib Mall: "Real Time Systems theory and practice", Pearson 2008

Assessment:

1. **ISA (In-Semester-Assessment):** In semester assessment will carry total 15 marks. It will consist of weekly graded assignments based on modules (each carrying 10 marks). The assignments are self-study work and need to be completed by individual students separately. Every student will be submitting four completed assignments. Students are encouraged to develop their own problem statements and devise a proper method / solution. Importance will be given to the concept understanding and applying it to solve the industrial problem using coding.

2. **MSA (Mid-Semester-Assessment):** Mid Semester Assessment will consist of three mid semester internal theory test carrying 20 marks based on completion of minimum modules. This test will be common for all the students. ***Repeat examination will not be conducted.***

3. **ESE (End-Semester-Examination):** End Semester Examination will be conducted for total of 40 marks based on the completion of remaining modules post completion of mid semester examination or an entire syllabus. This test will be common for all the students.

Course Name: Embedded System Design with Tiny Operating System (OS) Laboratory

Course Code: BM28P

Category: Professional Elective (IoT Track)

Preamble: Embedded System is used for developing a dedicated task or application. Internet of Things (IoT) is an upcoming technology based on the base of embedded systems. Machine learning (ML) is also an upcoming technology and concepts of ML are used in many applications. This course enables learner to use concept of tiny machine learning and Real Time Operating System for design of embedded systems.

Pre-requisites:

- C Programming
- Object Oriented Programming
- Microprocessor and microcontroller

Course Objectives:

- To understand the fundamentals of ARM 7 family.
- To understand concepts of embedded systems.
- To understand communication interface for embedded systems.
- To understand working with Real Time Operating Systems (RTOS).
- To understand fundamental concepts of tiny machine learning.
- To use tiny machine learning for embedded systems.

Course Outcomes:

Student will be able to:

CO1: Use concepts of advanced 32 bit micro-controllers.

CO2: Apply the fundamental concepts of embedded system design.

CO3: Use communication interface for design of embedded system.

CO4: Use Real Time Operating Systems (RTOS) for embedded system design.

CO5: Use fundamental concepts of tiny machine learning.

CO6: Apply concept of tiny machine learning for design of embedded systems.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment Scheme:

Head	ISA	MSA	ESA	Total
Practical	25	-	25	25

Suggested List of Practical:

All practical will be project based with focus on following application

1. Smart population count system
2. Smart traffic light system
3. Smart temperature monitoring system
4. E notice board
5. E display
6. Smart elevator system

Textbooks:

1. Embedded System Architecture, Programming & Design (Tata McGraw Hill Publication, Third Edition)- Raj Kamal
2. An Embedded Software Primer- David E. Simon
3. Embedded Real Time Systems Programming- Sriram V. Iyer, Pankaj Gupta
4. MicroC/OS-II, Indian Low price Edition 2002- Jean J. Labrose
5. Embedded Real Time Systems: Concepts, design & Programming (Dreamtech Publication)- K. V. K. K. Prasad

Reference Books:

1. Embedded System Design: A Unified Hardware/Software Introduction (Wiley Publication)- frank Vahid, Tony Givargis
2. ARM System-on-Chip Architecture (Pearson 2005)- Steve Furber
3. Tiny Machine Learning - Pete Warden and Daniel Situnayake
4. Rajib Mall: "Real Time Systems theory and practice", Pearson 2008

Assessment: In-Semester-Assessment (25 Marks)

1. ***All the students are required (mandatory) to be present in person during the laboratory conduction session.*** The ISA will consist of awarding marks for the complete, successful and in time submission of minimum 10 dually graded experiments (project based).
2. ***Project prototype to be developed and demonstrated.***
3. ***Graded marks for 10 experiments will be converted to ISA marks of 25. Only one repeat session is allowed to cover up the missed lab session.***
4. Students will be awarded grade / or marks on each experiment based on his / her own contribution, showcasing the knowledge application skills, demonstrating measurement work, developing code / solution to the given problem and peer interaction. ***Student will lose the marks if he or she remains absent for the Laboratory Practical Session.***

Course Name: Point of Care Technology

Course Code: BM29T

Category: Professional Elective

Preamble:

The course will include the development of wearable devices and its implications on various sectors. Comprehend the design and development of various wearable inertial sensors and wearable bio-electrode and physiological activity monitoring devices for use in healthcare applications. Also, the usage of various biochemical and gas sensors as wearable devices

Pre-requisites:

1. Physics for Biomedical Engineers.
2. Biomedical Transducers and Control Systems.

Course Objectives:

- To enable learners to understand the need for the development of wearable devices in real-life healthcare applications.
- To enable learners to analyze the usage of various biochemical and gas sensors in wearable technology.
- To enable learners to describe the design and development of wearable bio-electrodes and physiological activity monitoring devices for healthcare use.
- To enable learners to explain the applications of various wearable sensors for biomedical purposes.

Course Outcomes:

Learner will be able to:
CO1: Understand the need for development of wearable devices.
CO2: Explain the applications of various wearable sensors for biomedical applications.
CO3: Describe design and development of various wearable bio-electrode and physiological activity monitoring devices for use in healthcare applications.
CO4: Analyze the usage of various biochemical and gas sensors in wearable devices.
CO5: Compare various wearable devices for detection of biochemical and physiological body signals, environmental monitoring, safety, and navigational assistive devices.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	20	30	50	100

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No. of Hours
1	Introduction to Wearable and Implantable Technologies	Wearable technology and distinguish this from non-wearable technologies, implantable technology, history of wearable technologies, key security and privacy challenges presented by wearable technology, wearable technology devices isolate or connect people	10
2	Components and Software of Wearables	Electronic components that make up nearly all wearables, Moore's law and describe how the reduction in the size of components, key sensors used in various wearable applications, Compare analog and digital sensors	4
3	Batteries in Wearables	Technological improvements in other areas help extend battery life, various battery technologies, characteristics, and limitations, liquid and solid-state batteries, wireless battery charging, lithium-ion battery, metals used in batteries	4
4	Flexible Electronics and Textiles for Wearable Technologies	Wearable Organic Sensors, Resistor-Based Sensors, Organic Field-Effect Transistor Based Sensors, Stimuli-Responsive Electronic Skins, Flexible Thermoelectric and Thermoelectric Textiles	4
5	Wearable Biochemical and Gas Sensors	Wearable Biochemical Sensors: Parameters of interest, System Design –Microneedle based; Types: Non-invasive Glucose Monitoring Devices, 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, Detection of atmospheric pollutants	4
6	Wearable Technology in Healthcare	Applications of wearable technology in healthcare, wearable technology in fitness and sports,	4

Total	30

Suggested list of Assignments:

1. Wearable and Implantable Technologies.
2. Components and Software of Wearables.
3. Batteries in Wearables.
4. Flexible Electronics and Textiles for Wearable Technologies.
5. Poster presentation on Wearable Technology in Healthcare.

Suggested List of Value-Added Home Assignments:

1. Reviewing Literature in the form of a technical paper based on the Wearable Devices.
2. Novel technical paper writing based on the recent advancements.
3. Problem Based Learning on PoC Devices.

Suggested Online Courses:

1. MedTech: Digital Health and Wearable Technology
   https://www.futurelearn.com/courses/medtech-digital-health
2. Wearable Technologies and the Internet of Things
   https://online-learning.harvard.edu/course/wearable-technologies-and-internet-things?delta=0

Reference Books:

1. "Seamless Healthcare Monitoring", Toshiyo Tamura and Wenxi Chen, Springer 2018.
2. "Wearable Sensors -Fundamentals, Implementation and Applications", by Edward Sazonov and Michael R. Neuman, Elsevier Inc., 2014.
3. "Wearable and Autonomous Biomedical Devices and Systems for Smart Environment", by Aimé Lay-Ekuakille and Subhas Chandra Mukhopadhyay, Springer 2010.
4. "Environmental, Chemical and Medical Sensors", by Shantanu Bhattacharya, A K Agarwal, Nripen Chanda, Ashok Pandey and Ashis Kumar Sen, Springer Nature Singapore Pte Ltd. 2018.

Course Name: Point of Care Technology Lab

Course Code: BM29P

Category: Professional Elective

Preamble:

The course will include the development of wearable devices and its implications on various sectors. Comprehend the design and development of various wearable inertial sensors and wearable bio-electrode and physiological activity monitoring devices for use in healthcare applications. Also, the usage of various biochemical and gas sensors as wearable devices.

Pre-requisites:

Physics for Biomedical Engineers
Biomedical Transducers and Control Systems

Course Objectives:

- This course enables students to understand the need for the development of wearable devices in real-life healthcare applications.
- This course will explain the applications of various wearable sensors for biomedical purposes.
- This course will describe the design and development of wearable bio-electrodes and physiological activity monitoring devices for healthcare use.
- This course enables learners to analyze the usage of various biochemical and gas sensors in wearable technology.
- This course will compare various wearable devices for detecting biochemical and physiological body signals, environmental monitoring, and navigational assistance.

Course Outcomes:

Learner will be able to:
CO1: Understand the need for development of wearable devices.
CO2: Explain the applications of various wearable sensors for biomedical applications.
CO3: Describe design and development of various wearable bio-electrode and physiological activity monitoring devices for use in healthcare applications.
CO4: Analyze the usage of various biochemical and gas sensors in wearable devices.
CO5: Compare various wearable devices for detection of biochemical and physiological body signals, environmental monitoring, safety, and navigational assistive devices.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
--	2	--	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	50	--	50	100

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Suggested list of Practical:

1. Review of the topic through Journals & websites.
2. Design & Simulation using freeware/ online simulators.
3. Implementation of circuits & testing.
4. Concise report covering all ten blended exercises.
5. Hospital visits for any one of the equipment.

Suggested list of Capstone Projects:

1. To study about various Transducers & Sensors.
2. To study different parts of Wearable devices
3. Introduction to various types of Wearable devices.

Guidelines to conduct practical sessions:

1. Practicals on Wearable devices must involve design, & simulation-based exercises.
2. To encourage students for research, PBL will be based on recent developments.
3. Each student should submit the concise report on opted experiments with references.
4. The ISA will be done after the completion of minimum 10 experiments.

Suggested Online Courses:

1. MedTech: Digital Health and Wearable Technology
   https://www.futurelearn.com/courses/medtech-digital-health
2. Wearable Technologies and the Internet of Things
   https://online-learning.harvard.edu/course/wearable-technologies-and-internet-things?delta=0

Reference Books:

1. "Seamless Healthcare Monitoring", Toshiyo Tamura and Wenxi Chen, Springer 2018.
2. "Wearable Sensors -Fundamentals, Implementation and Applications", by Edward Sazonov and Michael R. Neuman, Elsevier Inc., 2014.
3. "Wearable and Autonomous Biomedical Devices and Systems for Smart Environment", by Aimé Lay-Ekuakille and Subhas Chandra Mukhopadhyay, Springer 2010.

4. "Environmental, Chemical and Medical Sensors", by Shantanu Bhattacharya, A K Agarwal, Nripen Chanda, Ashok Pandey and Ashis Kumar Sen, Springer Nature Singapore Pte Ltd. 2018.

Course Name: Mini Project-II

Course Code: BM40P

Category: Project and Internship

Preamble:

Students will be acquainted with the process of identifying the needs and converting it into the problem. Third year students will be familiarized with the process of solving the problem in a group and applying basic engineering fundamentals to attempt solutions to the problems. This will inculcate the process of self-learning and research.

Pre-requisites:

All subjects they learned till TE and beyond.

Course Objectives:

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Course Outcomes:

Learner will be able to:

CO1: Identify problems based on societal /research needs and apply Knowledge and skill to solve societal problems in a group.
CO2: Develop interpersonal skills to work as member of a group or leader and Excel in written and oral communication.
CO3: Draw the proper inferences from available results through theoretical/ experimental/simulations and analyze the impact of solutions in societal and environmental context for sustainable development.
CO4: Use standard norms of engineering practices
CO5: Demonstrate capabilities of self-learning in a group, which leads to lifelong learning.
CO6: Demonstrate project management principles during project work.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	4	-	2

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25		50	75

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall decide her/his assessment methodology based on the course's nature. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Guidelines for Mini Project:

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students hall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Internal Assessment:

- The review/ progress monitoring committee shall be constituted by head of department. The progress of mini project to be evaluated on continuous basis, minimum two reviews during the semester.
    1. Review 1: First review shall be for finalization of problem and proposed solution
    2. Review 2: Second review shall be for implementation and testing of solution.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of internal assessment marks for minor project shall be as below:
    1. Marks awarded by guide/supervisor based on log book: 10
    2. Marks awarded by review committee: 10
    3. Quality of Project report: 05

Minor Project shall be assessed based on following criteria:

1. Quality of survey/ need identification.
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions.
4. Feasibility of proposed problem solutions and selection of best solution.
5. Cost effectiveness and Societal impact.
6. Full functioning of working model as per stated requirements.
7. Effective use of skill sets.
8. Effective use of standard engineering norms.
9. Contribution of an individual as member or leader.
10. Clarity in written and oral communication In case of minor project-I all criteria in generic may be considered for evaluation of performance of students in mini project.

End semester examination assessment:

- Report should be prepared as per the guidelines issued by the department.
- Minor Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Scheme and Syllabus for Honours/Minor Degree

Syllabus Scheme Template

Sr. No.	Course			Preferred Semester	Credits	Assessment guidelines (Marks)			Total marks (Passing@40% of total marks)
	Code	Head of Learning	Name			ISA	MSE	ESE	
1	XXXX	Theory	Industry Interaction	Break of Sem5 and Sem6	1	25	-	-	025
2	XXXX	Theory	Honours / Minor Degree Course 1	6	2	15	20	40	075
3	XXXX	Practical	Honours / Minor Degree Course 1 Lab	6	1	25	-	25	050
4	XXXX	Theory	Survey Paper	Break of Sem6 and Sem7	2	25	-	25	050
5	XXXX	Theory	Honours / Minor Degree Course 2	7	2	15	20	40	075
6	XXXX	Practical	Honours / Minor Degree Course 2 Lab	7	1	25	-	25	050
7	XXXX	Theory	Seminar	Break of Sem7 and Sem8	2	25	-	25	050
8	XXXX	Theory	Honours / Minor Degree Course 3	8	2	15	20	40	075
9	XXXX	Practical	Honours / Minor Degree Course 3 Lab	8	1	25	-	25	050
10	XXXX	Practical	Specialized Project	8	4	75	-	50	125
Total					**18**				

Honours / Minor Degree Programmes offered by Department of Biomedical Engineering

Department of Biomedical Engineering offers the below listed Honours degree programme for learners of Biomedical Engineering these programmes can be availed as Minor degree programme by learners of other departments.

1. Advanced AIML
2. Advanced Internet of Things (AIoT)
3. Medical Imaging Technology
4. UIUX
5. Blockchain

Courses to be successfully completed as a part of Honours / Minor Degree Programme

1. Advanced AIML

Semester	Course Code	Course Name
VI	BM53T	Ethics, Privacy, & Security in AI Driven Healthcare
VI	BM53P	Ethics, Privacy, & Security in AI Driven Healthcare Lab
VII	BM59T	Applied Machine Learning for Biomedical Signals
VII	BM59P	Applied Machine Learning for Biomedical Signals Lab
VIII	BM65T	Application of ML in Healthcare
VIII	BM65P	Application of ML in Healthcare Lab

2. Advanced Internet of Things (AIoT)

Semester	Course Code	Course Name
VI	BM54T	Embedded Linux System
VI	BM54P	Embedded Linux System Lab
VII	BM60T	IoT and Data Analytics
VII	BM60P	IoT and Data Analytics Lab
VIII	BM66T	IoT Applications and Web Development
VIII	BM66P	IoT Applications and Web Development Lab

3. Medical Imaging Technology

Semester	Course Code	Course Name
VI	BM55T	Structural Imaging Technology
VI	BM55P	Structural Imaging Technology Lab
VII	BM61T	Functional Imaging Technology
VII	BM61P	Functional Imaging Technology Lab
VIII	BM67T	Nuclear Imaging Techniques
VIII	BM67P	Nuclear Imaging Techniques Lab

4. UIUX

Semester	Course Code	Course Name
VI	BM56T	Foundations of UI and UX
VI	BM56P	Foundations of UI and UX Lab
VII	BM62T	Design and Evaluation
VII	BM62P	Design and Evaluation Lab
VIII	BM68T	Applied UI UX with capstone project
VIII	BM68P	Applied UI UX with capstone project Lab

5. Blockchain

Semester	Course Code	Course Name
VI	BM57T	Blockchain Technology
VI	BM57P	Blockchain Technology Lab
VII	BM63T	Solidity Programing
VII	BM63P	Solidity Programing Lab
VIII	BM69T	Blockchain Architecture
VIII	BM69P	Blockchain Architecture Lab

Course Name: Ethics, Privacy, & Security in AI Driven Healthcare

Course Code: BM53T

Category: Honour Course

Preamble:
This course, "Ethics, Privacy, & Security in AI-Driven Healthcare," is conceived with the vision of empowering healthcare professionals, AI developers, policymakers, and researchers with the knowledge and tools necessary to responsibly harness the power of AI. It provides a comprehensive framework to understand and address the ethical dilemmas, privacy concerns, and security risks associated with AI in healthcare.

Pre-requisites:
AI and ML

Course Objectives:
- To develop a Comprehensive Understanding of AI Technologies in Healthcare
- To analyze and Address Ethical, Privacy, and Security Challenges
- To integrate Ethical, Legal, and Social Considerations into AI Development

Course Outcomes:
Learner will be able to:
CO1: Demonstrate a comprehensive understanding of the basic principles of AI, including machine learning and deep learning, and their specific applications in healthcare.
CO2: Articulate the foundational ethical principles relevant to AI in healthcare, including beneficence, non-maleficence, autonomy, and justice.
CO3: Identify privacy risks and concerns associated with AI-driven healthcare, including common breaches and vulnerabilities.
CO4: Identify specific vulnerabilities and threats to AI systems in healthcare, including adversarial attacks.
CO5: Evaluate the impact of AI on the healthcare workforce and societal and cultural considerations.
CO6: Integrate ethical, privacy, and security considerations into the development and deployment of AI technologies in healthcare.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	075

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours
1	Introduction	Foundational Ethical Principles, Beneficence, non-maleficence, autonomy, and justice, Applying these principles to AI Ethical Challenges in AI	4
2	Ethics in AI-Driven Healthcare	Bias and fairness in AI algorithms Transparency and explainability, Accountability and responsibility, Case Studies and Ethical Dilemmas, Real-world scenarios, Group analysis and discussion, Regulations and Guidelines	4
3	Privacy Concerns in AI-Driven Healthcare	Understanding Healthcare Data, Types of data used in AI Data lifecycle in healthcare, Privacy Risks and Concerns, Identifying and assessing privacy risks, Common privacy breaches in healthcare, Data Anonymization and De-identification, Techniques for protecting patient privacy Balancing data utility and privacy Regulatory Frameworks, HIPAA, GDPR, and other relevant regulations, Compliance requirements and best practices, Case Studies and Best Practices, Analyzing privacy breaches, Developing privacy-preserving strategies	6
4	Security in AI-Driven Healthcare	Cybersecurity Basics in Healthcare, Key security concepts and threats, Importance of cybersecurity in healthcare Threats to AI Systems, Specific vulnerabilities of AI systems Adversarial attacks on AI models Security Measures and Protocols, Encryption, access controls, and monitoring Implementing robust security frameworks Incident Response and Management, Developing an incident response plan, Case studies of security breaches	6
5	Ethical, Legal, and Social Implications (ELSI) of AI in Healthcare	Introduction to ELSI, Framework for understanding ELSI, Importance of ELSI in AI development, Legal Issues and Intellectual Property, Understanding legal challenges Intellectual property rights in AI, Social Implications, Impact on healthcare workforce, Societal and cultural considerations Patient Consent and Autonomy, Informed consent in AI applications, Respecting patient autonomy, Policy and Advocacy, Role of policy in shaping AI ethics, Advocacy for ethical AI practices	6
6	Practical Applications and Future Directions	Integrating Ethics, Privacy, and Security into AI Development, Best practices for developers, Interdisciplinary approaches Building Ethical AI Models, Techniques for bias mitigation Ensuring fairness and transparency, Privacy-Preserving AI Techniques, Differential privacy, federated learning, Emerging	4

		privacy-preserving technologies, Interactive Workshop:	
		Total	**30**

Textbooks:

1. "Data Structures and Algorithms Made Easy" by Narasimha Karumanchi, CareerMonk Publications, 2016.
2. "Artificial Intelligence in Healthcare", by Adam Bohr and Kaveh Memarzadeh, Edition 1st , Academic Press.
3. "Ethics of Artificial Intelligence and Robotics", by Vincent C. Müller, Edition 1st, Publisher: Springer.
4. "Healthcare Privacy and Security: Regulatory Compliance and Data Security in the Age of Electronic Health Records", by Bernard Peter Robichau, Edition 1st, Auerbach Publications

Reference books:

1. "Machine Learning and AI for Healthcare: Big Data for Improved Health Outcomes", by Arjun Panesar, Edition 1st, Apress.
2. "AI in Healthcare: Ethical and Legal Challenges", by Stefan Felder and Claus Wendt, Edition: 1st, Springer.
3. "Security and Privacy in Cyber-Physical Systems: Foundations, Principles, and Applications", by Houbing Song, Glenn A. Fink, and Sabina Jeschke, Edition 1st, Wiley-IEEE Press

Course Name: Ethics, Privacy, & Security in AI Driven Healthcare Lab

Course Code: BM53P

Category: Honour Course

Preamble:
"Hands-On Practice in Ethics, Privacy, & Security for AI-Driven Healthcare," is designed to provide participants with practical experience and technical expertise in addressing these critical issues. Through a series of hands-on lab sessions, participants will gain proficiency in implementing ethical, privacy-preserving, and secure AI solutions in healthcare settings.

Pre-requisites:
AI-ML

Course Objectives:

- To introduce AI Tools in Healthcare
- To study risks associated with AI-driven healthcare systems, apply data anonymization and de-identification techniques,
- To understand relevant legal and regulatory frameworks (HIPAA, GDPR), conduct compliance assessments for AI systems in healthcare

Course Outcomes:
Learner will be able:
CO1: Setup AI development environments and using fundamental AI tools (TensorFlow, PyTorch) to build and run basic AI models on healthcare datasets.
CO2: Understand basic machine learning algorithms, evaluate model performance, and perform feature selection and data preprocessing in the context of healthcare.
CO3: identify ethical issues in AI applications through case study analysis, engage in meaningful discussions on ethical principles, and develop ethical guidelines for AI systems in healthcare.
CO4: Understand risks in healthcare datasets, apply data anonymization and de-identification techniques, and utilize tools for privacy risk assessment and mitigation.
CO5: Implement advanced data privacy techniques like differential privacy and federated learning and evaluate the balance between data utility and privacy in AI healthcare applications.
CO6: Identify and mitigate cybersecurity threats, apply encryption and access control mechanisms, and develop and test incident response plans to protect AI systems in healthcare.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	050

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Suggested List of Practicals:

Sr No.	Title of Practicals
1	Familiarize participants with AI tools and platforms commonly used in healthcare.
2	Implement basic machine learning algorithms in a healthcare context.
3	Analyze ethical challenges in AI systems through real-world scenarios (case study)
4	Identifying privacy risks in sample healthcare datasets.
5	Applying differential privacy techniques to healthcare datasets.
6	Identifying and mitigating common cybersecurity threats in AI systems.
7	Implementing techniques to reduce bias in AI models.
8	Reviewing HIPAA, GDPR, and other relevant regulations.
9	Building AI models with fairness and transparency in mind.

Course Name: Embedded Linux System

Course Code: BM54T

Category: Honours Course

Preamble:

The rapid growth of Linux as an embedded operating system in many products is due to the ease of using embedded Linux to replace home-grown operating systems. Linux-based embedded systems are widely used in smartphones, in-vehicle infotainment systems, in countless consumer electronics and for numerous industrial applications. It may be the need for TCP/IP networking, USB support, Secure Digital support, or some other standard that causes a company to dump their current operating system and switch to Linux. But it is the joy of developing with Linux that keeps the engineers promoting it for future products. The objective of the course is to give students solid introductory knowledge on Linux OS and internals of Linux for embedded system design.

Pre-requisites:

- C Programming
- Object Oriented Programming
- Microprocessor and microcontroller

Course Objectives:

- To understand role of operating system in embedded system development.
- To understand architecture of operating systems for embedded system applications.
- To understand different types of kernels.
- To understand kernel module of Linux.
- To understand communication between user and operating system.
- Use Linux operating system in embedded system application.

Course Outcomes:

Student will be able to:

CO1: Understand fundamental concepts of operating System.

CO2: Understand architecture of Linux operating system for embedded system applications.

CO3: Understand concept of kernel.

CO4: Use Linux kernel module.

CO5: Do communication between user space and kernel space.

CO6: Develop applications.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	2	2	1

Assessment Guidelines:

Head	ISA	MSA	ESE	Total (Passing @40% of total)
Theory	15	20	40	75
Lab	25	--	25	50

The assessment guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module no	Module name	Content	No of Hours
1	RTOS and Linux based Embedded Systems: An Introduction	Introduction to Real Time Operating Systems: Characteristics of RTOS, Tasks Specifications and types, Real-Time Scheduling Algorithms, Concurrency, Inter-process Communication and Synchronization mechanisms, Priority Inversion, Inheritance and Ceiling. Operating systems for embedded systems, Why Linux-based embedded systems? Linux evolution Embedded Linux Vs Desktop Linux, Embedded Linux Distributions, System calls, Static and dynamic libraries, Cross tool chains. Linux-based embedded system: example	05
2	Embedded Linux Architecture and Kernel Architecture	Architecture of Embedded Linux- Real Time Executive, Monolithic kernels, Microkernel. Linux Kernel Architecture- Hardware Abstraction Layer (HAL), Memory manager, Scheduler, File System, I/O and Networking subsystem, IPC. User space, Linux Start-up sequence.	05
3	Building and Debugging	Building the Kernel, Building Applications, Building the Root File System, Integrated Development Environment, Debugging Virtual Memory Problems, Kernel Debuggers, Profiling	05
4	Introduction to Linux kernel modules	Introduction, CPU – I/O interface, I/O interface with polling, I/O interface with interrupt, I/O interface, I/O interface latency, Direct memory access (DMA) architecture - transfer modes, I/O taxonomy, Typical operations, Linux devices, The Virtual File System (VFS) abstraction. Linux kernel modules – the initialization function, the cdev data structure, the initialization function, the clean-up function, custom VFS functions.	06
5	Communication Between Kernel and	Introduction, The reference use case, The CPU/Device interface, The module level – file operations, ioctl()	06

	User Space	implementation, open()/release() implementation, read() implementation, Passing data to/from the kernel, write() implementation, communication with the device, Memory mapped I/O – initialization, clean-up, read, write, GPIO-based I/O – initialization, clean-up, read, write, Interrupts, Requesting the interrupt line, Freeing the interrupt line, The interrupt handler, Interrupt handling, Top-half and bottom-half, Needed support, Work queue, The user level, The user level – the application	
6	Porting Applications	Architectural Comparison, Application Porting Roadmap, Programming with Pthreads, Operating System Porting Layer (OSPL), Kernel API Driver.	03
Total			**30**

Textbooks:

1. "Embedded Linux System Design and Development", P Raghvan, Amol Lad, Sriram Neelakandan, Auerbach Publications.
2. "Mastering Embedded Linux Programming", Chris Simmonds Second Edition, PACKT Publications Limited.
3. "Embedded Linux Primer: A Practical Real World Approach", Christopher Hallinan, Prentice Hall, 2nd Edition, 2010

Reference Books:

1. "Building Imbedded Linux Systems", Karim Yaghmour, O'Reilly & Associates.
2. Embedded Linux Systems with the Yocto Project, Rudolf K. Sterif

Assessment:

1. **ISA (In-Semester-Assessment):** In semester assessment will carry total 15 marks. It will consist of weekly graded assignments based on modules (each carrying 10 marks). The assignments are self-study work and need to be completed by individual students separately. Every student will be submitting four completed assignments. Students are encouraged to develop their own problem solution and devise a proper method/technique. Importance will be given to the concept understanding and applying it to solve the industrial problem using coding.
2. **MSA (Mid-Semester-Assessment):** Mid Semester Assessment will consist of three mid semester internal theory test carrying 20 marks based on completion of minimum modules. This test will be common for all the students. ***Repeat examination will not be conducted.***
3. **ESE (End-Semester-Examination):** End Semester Examination will be conducted for total of 40 marks based on the completion of remaining modules post completion of mid semester examination or an entire syllabus. This test will be common for all the students.

Course Name: Embedded Linux System Laboratory

Course Code: BM54T

Category: Honours Course

Preamble:

The rapid growth of Linux as an embedded operating system in many products is due to the ease of using embedded Linux to replace home-grown operating systems. Linux-based embedded systems are widely used in smartphones, in-vehicle infotainment systems, in countless consumer electronics and for numerous industrial applications. It may be the need for TCP/IP networking, USB support, Secure Digital support, or some other standard that causes a company to dump their current operating system and switch to Linux. But it is the joy of developing with Linux that keeps the engineers promoting it for future products. The objective of the course is to give students solid introductory knowledge on Linux OS and internals of Linux for embedded system design.
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Pre-requisites:

- C Programming
- Object Oriented Programming
- Microprocessor and microcontroller

Course Objectives:

- To understand role of operating system in embedded system development.
- To understand architecture of operating systems for embedded system applications.
- To understand different types of kernels.
- To understand kernel module of Linux.
- To understand communication between user and operating system.
- Use Linux operating system in embedded system application.

Course Outcomes:

Student will be able to:

CO1: Demonstrate fundamental concepts of operating System.

CO2: Demonstrate architecture of Linux operating system for embedded system applications.

CO3: Demonstrate concept of kernel.

CO4: Use Linux kernel module with standard commands.

CO5: Establish communication from user space to kernel space.

CO6: Develop embedded system applications based on Linux operating system.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment Scheme:

Head	ISA	MSA	ESA	Total
Practical	25	-	25	25

Suggested List of Practical:

1. Introduction to the Board and Workspace Set-Up.
2. Custom Embedded Linux Build Using the Manual Approach.
3. Introduction to Linux Kernel Modules under Yocto.
4. Handling General Purpose I/O Using Linux Kernel Modules.
5. Handling Hc-Sr04 Ranging Sensor Using Linux Kernel Modules.
6. Introduction to Code Development and Debugging Using Yocto.
7. Introduction to Linux Kernel and Application Profiling.
8. Installing Linux kernel and configuration of Rasp-berry Pi computer (SBC)
9. Installation of Free RTOS and integration with Keil IDE for multithreaded application.

Practical can be designed using project based approach.

Textbooks:

1. "Embedded Linux System Design and Development", P Raghvan, Amol Lad, Sriram Neelakandan, Auerbach Publications.
2. "Mastering Embedded Linux Programming", Chris Simmonds Second Edition, PACKT Publications Limited.
3. "Embedded Linux Primer: A Practical Real World Approach", Christopher Hallinan, Prentice Hall, 2nd Edition, 2010

Reference Books:

1. "Building Imbedded Linux Systems", Karim Yaghmour, O'Reilly & Associates.
2. Embedded Linux Systems with the Yocto Project, Rudolf K. Sterif

Assessment: In-Semester-Assessment (25 Marks)

1. ***All the students are required (mandatory) to be present in person during the laboratory conduction session.*** The ISA will consist of awarding marks for the complete, successful and in time submission of minimum 10 dually graded experiments (project based).
2. ***Project prototype to be developed and demonstrated.***

3. ***Graded marks for 10 experiments will be converted to ISA marks of 25. Only one repeat session is allowed to cover up the missed lab session.***
4. Students will be awarded grade / or marks on each experiment based on his / her own contribution, showcasing the knowledge application skills, demonstrating measurement work, developing code / solution to the given problem and peer interaction. ***Student will lose the marks if he or she remains absent for the Laboratory Practical Session.***

Course Name: Structural Imaging Technology

Course Code: BM55T

Category: Honours Course

Preamble:

This course will lay a foundation knowledge for students to understand concepts of structural imaging technology. Structural imaging focusses on techniques used to create detailed images of the human anatomy and structure.

Pre-requisites:

- Physics for Biomedical Engineering (BS20T)
- Human Anatomy and Physiology (BS18T)
- Electronic Devices and Circuits (BM03T)

Course Objectives:

- Understand the principles of X-ray production, interaction with matter, and attenuation, and apply them to operate a total radiographic system effectively.
- Master techniques in advanced imaging modalities such as fluoroscopy, digital subtraction angiography, computed radiography, digital radiography, and mammography.
- Gain proficiency in utilizing CT technology, including scanner configurations, reconstruction techniques, and applications in clinical settings, as well as understanding the production and clinical applications of RF waves and linear accelerators.

Course Outcomes:

Learner will be able to:

CO1: Understand the basics of X-ray technology.

CO2: Explain the working principles of radiographic procedures.

CO3: Understand the working principles of different digital imaging technologies like computed radiography (CR) and digital radiography (DR).

CO4: Understand the working CT imaging technique.

CO5: Illustrate advanced applications of CT imaging.

CO6: Understand the components of linear accelerators.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2+1 (O)	-	2	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	75

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No. of Hours
1	X-ray Imaging	Properties of X rays, production of X rays, X ray interaction with matter, Attenuation Total radiographic System: X –ray tubes, Rating of X ray tubes, X –ray generators, Filters, Grids, Beam Restrictors, Control Panel, X ray Film	7
2	Fluoroscopic Imaging	Fluoroscopic Imaging and X ray Image Intensifier, Digital subtraction Angiography	4
3	Computed Radiography and Digital Radiography	Computed Radiography and Digital Radiography Mammography	4
4	Principle of Computed tomography	Scanner configurations/generations, CT system: Scanning unit(gantry), detectors, CT Number, Data Acquisition System, Spiral CT: technology and applications, Reconstruction Techniques: - Radon Transform, Iterative, Filtered back projection, Fourier reconstruction, CT artifacts, Clinical applications of CT	7
5	Advancements in CT	Multi-detector computed tomography (MDCT), Flat panel detectors CT-Angiography, Contrast agents in CT	4
6	Linear Accelerators	Production and transport of the RF wave, Major components of linear accelerator, Clinical Applications	4
Total			**30**

Suggested list of Assignments:

1. Compare and contrast the characteristics of different types of X-ray tubes.
2. Investigate the principles of X-ray generator operation and assess the factors affecting X-ray tube ratings.
3. Research and compile a comprehensive guide on the use of filters, grids, and beam restrictors in radiographic imaging.
4. Write a critical review paper on the evolution of fluoroscopic imaging technology, focusing on advancements in image intensifiers, digital fluoroscopy systems, and their impact on clinical practice.
5. Present a case study showcasing the application of digital subtraction angiography (DSA) in diagnosing vascular conditions.
6. Conduct a comparative analysis of computed radiography (CR) and digital radiography (DR) systems, evaluating their image quality, workflow efficiency, and cost-effectiveness in clinical settings.
7. Explore the technological advancements in mammography systems, including digital mammography, breast tomosynthesis, and contrast-enhanced mammography. Assess their roles in breast cancer screening and diagnosis.
8. Prepare a presentation outlining the various configurations and generations of CT scanners, discussing their design features, advantages, and limitations. Include examples of clinical applications for each configuration.
9. Research and compare different reconstruction techniques used in CT imaging, such as Radon Transform, iterative reconstruction, and filtered back projection. Evaluate their impact on image quality and diagnostic accuracy.
10. Write a comprehensive report on the clinical applications of multi-detector computed tomography (MDCT) and CT angiography (CTA).

Suggested List of Value-Added Home Assignments:

1. Design of Instructional Videos.
2. Design of Demographics and uploading on Social Media Platform.
3. Creation of a Wikipedia page.
4. Problem Based Assignment.

Suggested Online Courses:

1. Introduction to Biomedical Imaging
   https://www.edx.org/course/introduction-to-biomedical-imaging

2. Fundamentals of Biomedical Imaging: Ultrasounds, X-ray, positron emission tomography (PET) and applications
   https://www.edx.org/course/fundamentals-of-biomedical-imaging-ultrasounds-x-r

Reference Books:

1. Thomas S. Curry, James E. Dowdey, Robert C. Murry, "Christensen's Physics of Diagnostic Radiology", Lippincott Williams & Wilkins, 1990.
2. William R. Hendee, E. Russell Ritenour, "Medical Imaging Physics", Wiley-Liss, 2002.
3. Angela M. Duxbury, Pam Cherry, "Practical Radiotherapy: Physics and Equipment ", Wiley-Blackwell, 2009.
4. James Moore, George Zouridakis, "Biomedical Technology and Devices", CRC Press, 2013.
5. David Dowsett, Patrick A Kenny, R Eugene Johnston, "The Physics of Diagnostic Imaging", CRC Press, 2006.

Course Name: Structural Imaging Technology Lab

Course Code: BM55P

Category: Honours Course

Preamble:

This course will lay a foundation knowledge for students to understand concepts of structural imaging technology. Structural imaging focusses on techniques used to create detailed images of the human anatomy and structure.

Pre-requisites:

- Physics for Biomedical Engineering (BS20T)
- Human Anatomy and Physiology (BS18T)
- Electronic Devices and Circuits (BM03T)

Course Objectives:

- Understand the principles of X-ray production, interaction with matter, and attenuation, and apply them to operate a total radiographic system effectively.
- Master techniques in advanced imaging modalities such as fluoroscopy, digital subtraction angiography, computed radiography, digital radiography, and mammography.
- Gain proficiency in utilizing CT technology, including scanner configurations, reconstruction techniques, and applications in clinical settings, as well as understanding the production and clinical applications of RF waves and linear accelerators.

Course Outcomes:

Learner will be able to:

CO1: Understand the basics of X-ray technology.

CO2: Explain the working principles of radiographic procedures.

CO3: Understand the working principles of different digital imaging technologies like computed radiography (CR) and digital radiography (DR).

CO4: Understand the working CT imaging technique.

CO5: Illustrate advanced applications of CT imaging.

CO6: Understand the components of linear accelerators.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	50	-	50	100

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Suggested list of Practicals:

1. Design and Implementation of X-Ray System Component-Timing Circuit.
2. Design and Implementation of X-Ray System Component-Exposure Circuit.
3. Design and Implementation of Digital Subtraction in sample X-Ray Images.
4. Generate Sinogram of Image.
5. Perform CT Windowing on an Image.
6. Design and Implementation of Back Projection Algorithm for CT Images.
7. Problem Based Activity on assigned topic

Guidelines to conduct practical sessions:

1. The Laboratory work is to be conducted by a group of three-five students.
2. To encourage project-based learning in the curriculum students may either select one of the commercial biosensors for a review.
3. Each group along with subject faculty shall identify a potential biosensor, on which the study can be conducted. They can perform real or virtual experiments related to the topic selected in the laboratory along with regular experiments.
4. Students should prepare working models, power point presentation, posters etc. on the selected topics.
5. The assessment will be done at the end of the semester.

Suggested Online Courses:

1. Introduction to Biomedical Imaging
   https://www.edx.org/course/introduction-to-biomedical-imaging
2. Fundamentals of Biomedical Imaging: Ultrasounds, X-ray, positron emission tomography (PET) and applications
   https://www.edx.org/course/fundamentals-of-biomedical-imaging-ultrasounds-x-r

Reference Books:

1. Thomas S. Curry, James E. Dowdey, Robert C. Murry, "Christensen's Physics of Diagnostic Radiology", Lippincott Williams & Wilkins, 1990.
2. William R. Hendee, E. Russell Ritenour, "Medical Imaging Physics", Wiley-Liss, 2002.
3. Angela M. Duxbury, Pam Cherry, "Practical Radiotherapy: Physics and Equipment ", Wiley-Blackwell, 2009.
4. James Moore, George Zouridakis, "Biomedical Technology and Devices", CRC Press, 2013.
5. David Dowsett, Patrick A Kenny, R Eugene Johnston, "The Physics of Diagnostic Imaging", CRC Press, 2006.

Course Name: Foundations of UI and UX

Course Code: BM56T

Category: Minor Course

Preamble:

Usability engineering is a framework for evaluating digital products or services that focuses on the optimization of usability. It incorporates theories from both psychology and computer science. It involves an iterative approach to design by considering the needs, abilities, or even limitations of the intended users. UX designers focus on the interactions that people have with products like websites, mobile apps, and physical objects. UX designers make those everyday interactions usable.

Pre-requisites:

Nil

Course Objectives:

1. To stress the importance of User Interface and User Experience.
2. To Learn User Experience Process.
3. To understand how to design Effective and Efficient User Interfaces for intended users.
4. To Learn user research techniques
5. To create personas
6. To understand UX guidelines

Course Outcomes:

1. Understand the importance of user interface and User Experience.
2. Learn user experience process
3. Understand how to design Effective and Efficient User Interfaces for intended users.
4. Learn user research techniques.
5. Create personas.
6. Understand UX guidelines.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	075

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall decide her/his assessment methodology based on the course's nature. Faculty may propose the revised assessment methodology for his/her

course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Sr. No.	Module	Detailed Content	Hrs
0	Prerequisite	Web Technologies, Software Engineering Process	03
1	Introduction	What is UX, Ubiquitous interaction, Emerging desire for usability, From usability to user experience, Emotional impact as part of the user experience, User experience needs a business case, Roots of usability.	06
2	The Wheel: A Lifecycle Template	Introduction, A UX process lifecycle template, Choosing a process instance for your project, The system complexity space, Meet the user interface team, Scope of UX presence within the team, More about UX lifecycles.	06
3	Contextual Inquiry: Eliciting Work Activity Data	Introduction, User research , User work activity gathering, Look for emotional aspects of work practice, Abridged contextual inquiry process, Data-driven vs. model-driven inquiry, History. ,Contextual Analysis, Extracting Interaction Design Requirements, Constructing Design-Information Models.	10
4	Design Thinking, Ideation, and Sketching,	Introduction, Design paradigms, Design thinking, Design perspectives, User personas, Ideation, Sketching, More about phenomenology, Mental Models and Conceptual Design, Wireframe, Prototyping	10
5	Wireframes and Prototyping	Introduction to wireframes, types of woreframes, prototyping , types of prototyping	08
6	UX Design Guidelines	Introduction, Using and interpreting design guidelines, Human memory limitations, Selected UX design guidelines and examples, Planning, Translation, Physical actions, Outcomes, Assessment, Overall.	05

Online resources

https://nptel.ac.in/courses/107/103/107103083/

https://www.uxbeginner.com/ux-courses/

Books and References:

A. Books:

1. The UX Book by Rex Hartson and Pardha Pyla
2. Smashing UX Design by Jesmond Allen and James Chudley
3. Lean UX: Applying Lean Principles to Improve User Experience by Jeff Gothelf and Josh Seiden
4. Don't Make Me Think, Revisited by Steve Krug
5. The User Experience Team of One by Leah Buley
6. The Elements of User Experience by Jesse James Garrett

7. Sketching User Experiences: The Workbook by Saul Greenberg, Sheelagh Carpendale, Nicolai Marquardt and Bill Buxton

B. References:

1. A Project Guide to UX Design by Russ Unger and Carolyn Chandler
2. Agile Experience Design by Lindsay Ratcliffe and Marc McNeill
3. Universal Principles of Design by William Lidwell, Kritina Holden and Jill Butler
4. Human Computer Interaction by Alan Dix

Course Name: Foundations of UI and UX Lab

Course Code: BM56P

Category: Minor Course

Preamble:

Usability engineering is a framework for evaluating digital products or services that focuses on the optimization of usability. It incorporates theories from both psychology and computer science. It involves an iterative approach to design by considering the needs, abilities, or even limitations of the intended users. UX designers focus on the interactions that people have with products like websites, mobile apps, and physical objects. UX designers make those everyday interactions usable.

Pre-requisites:

Nil

Course Objectives:

1. To stress the importance of User Interface and User Experience.
2. To Learn User Experience Process.
3. To understand how to design Effective and Efficient User Interfaces for intended users.
4. To Learn user research techniques
5. To create personas
6. To understand UX guidelines

Course Outcomes:

1. Understand the importance of user interface and User Experience.
2. Learn user experience process
3. Understand how to design Effective and Efficient User Interfaces for intended users.
4. Learn user research techniques.
5. Create personas.
6. Understand UX guidelines.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	25	-	-	25

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall decide her/his assessment methodology based on the course's nature. Faculty may propose the revised assessment methodology for his/her

course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Suggested Experiments

1. Perform user research
2. User requirement collection
3. User Requirement Analysis
4. Create User personas, user scenarios , customer journey maps etc
5. Create Wireframes
6. Create Prototypes
7. Set UX Goals
8. Any two case studies or mini project covering the above syllabus

Course Name: Blockchain Technology

Course Code: BM57T

Category: Minor Course

Preamble: Blockchain Technology course provides students with a comprehensive understanding of blockchain fundamentals, decentralized systems, and their applications. Through lectures, case studies, and hands-on exercises, students will learn about the underlying principles of blockchain technology, its evolution, and its potential impact on various industries. Topics covered include distributed ledger technology, consensus mechanisms, smart contracts, cryptocurrencies, and real-world use cases.

Pre-requisites:
Computer Network

Course Objectives:

1. To understand conceptual elements for Blockchain Technologies.
2. To summarize the major developments related to Blockchain and crypto currencies.
3. To identify Real-world applications of block chain.

Course Outcomes:
Learner will be able to:
CO1: Identify the importance of Blockchain technology
CO2: Interpret the fundamentals and basic concepts in Blockchain
CO3: Summarize the requirements of the basic design of blockchain.
CO4: Compare the working of different blockchain platforms
CO5: Summarize the different technologies and latest trends in Blockchain
CO6: Analyze the importance of blockchain in finding the solution to the real-world problems.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	20	30	50	100

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall decide her/his assessment methodology based on the course's nature. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours
1	Introduction to Blockchain Technology	Basic ideas behind block chain, how it is changing the landscape of digitalization, introduction to cryptographic concepts, Hashing, public key cryptosystems, private vs public block chain and use cases, Hash Puzzles.	5
2	Blockchain Fundamentals	Basic architecture of Blockchain, different terminologies associated, Characteristics of Block chain, Types of networks, Introducing Smart contract concept in Blockchain.	5
3	Components of Blockchain	Core components of Blockchain, Types of Block chains; Blockchain Protocol, Permission & Permission less Block chains.	5
4	Digital Ledger	Short History of Money and Trust, Bitcoin Mechanics, Introduction to Ethereum, Introduction to Hyperledger, Hyperledger Fabric and its architecture, Hyperledger Composer	5
5	Emerging Trends in Blockchain:	Cloud-based block chain, Multi chain, Geth , Stellar , Ripple, R3 Corda, Blockchain API, Blockchain Sandboxes	5
6	Block Chain Use Cases	Supply Chain Management, Finance, Health Care, Internet of Things (IoT), Remittance, Land Records, Voting and election, Loyalty Programs, Go Green (Renewable Energy).	5
Total			**30**

Textbooks:

1. Artemis Caro, "Blockchain: The Beginners Guide to Understanding the Technology Behind Bitcoin & Crypto currency".
2. Scott Marks, "Blockchain for Beginners: Guide to Understanding the Foundation and Basics of the Revolutionary Blockchain Technology", Create Space Independent Publishing Platform

Reference Books:

1. Mark Watney, "Blockchain for Beginners".
2. Alwyn Bishop, "Blockchain Technology Explained".

Suggested Online Courses

1. NPTEL Course "Introduction to Blockchain Technology & Applications" https://nptel.ac.in/courses/106/104/106104220/
2. NPTEL Course on "Blockchain Architecture &Use Cases" https://nptel.ac.in/courses/106/105/106105184/

Course Name: Blockchain Technology Lab

Course Code: BM57P

Category: Minor Course

Preamble: Blockchain Technology course provides students with a comprehensive understanding of blockchain fundamentals, decentralized systems, and their applications. Through lectures, case studies, and hands-on exercises, students will learn about the underlying principles of blockchain technology, its evolution, and its potential impact on various industries. Topics covered include distributed ledger technology, consensus mechanisms, smart contracts, cryptocurrencies, and real-world use cases.

Pre-requisites:
NIL

Course Objectives: After completion of the course, students will have adequate background, conceptual clarity and knowledge related to:
1. The working of blockchain technology
2. The real-world applications of Blockchain.

Course Outcomes:
Learner will be able to:

CO 1. Understand the working of Blockchain.

CO 2. Creating Cryptographic hash using merkle tree.

CO 3. Understand data protection using Blockchain.

CO 4. Understand the cryptographic basis for cryptocurrency.

CO 5. Creating genesis block using open-source tool.

CO6. Choose a blockchain implementation based on real time scenario

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	50

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be

approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Suggested list of experiments:

Sr. No.	List of experiments
1	Case Study on various Blockchain platforms.
2	Cryptography in Blockchain, Merkle root tree has
3	Two Factor Authentication using blockchain
4	Blockchain based application Crypto Exchange and Wallet.
5	Create the genesis block using Puppeth, a CLI tool.
6	Implement simple Smart Contracts in Remix IDE

Textbooks:

1. Artemis Caro, "Blockchain: The Beginners Guide to Understanding the Technology Behind Bitcoin & Crypto currency".
2. Scott Marks, "Blockchain for Beginners: Guide to Understanding the Foundation and Basics of the Revolutionary Blockchain Technology", Create Space Independent Publishing Platform

Reference Books:

1. Mark Watney, "Blockchain for Beginners".
2. Alwyn Bishop, "Blockchain Technology Explained".

Suggested Online Courses

1. NPTEL Course "Introduction to Blockchain Technology & Applications" https://nptel.ac.in/courses/106/104/106104220/
2. NPTEL Course on "Blockchain Architecture &Use Cases" https://nptel.ac.in/courses/106/105/106105184/

Syllabus for Advanced Learning Course (ALC)

Course Name: Biomedical Microsystems

Course Code: BM15T

Category: Core Engineering

Preamble:
This course introduces students to MEMS materials, microfabrication, and packaging of MEMS Devices. It also covers the applications of MEMS in Biomedical Engineering

Pre-requisites:

- Human Anatomy & Physiology
- Engineering Physics
- Engineering Chemistry

Course Objectives:

- To enable learners to learn the properties of MEMS materials.
- To enable learners to understand MEMS processes steps and procedure.
- To enable learners to learn the basics of soft-lithography technique.
- To enable learners to study fundamentals of Lab-on-Chip technology.
- To enable learners to understand the application of MEMS as drug delivery system.
- To enable learners to apply MEMS process knowledge in MEMS packaging.

Course Outcomes:

Learner will be able to:

CO1: Understand the different MEMS materials properties and their applications in MEMS.
CO2: Analyze & study different MEMS processes to make micro devices for a specific application.
CO3: Choose appropriate soft lithography technique for developing microstructures.
CO4: Differentiate different parts of the micro total analysis systems and understand the purpose of individuals.
CO5: Relate the microstructures and their applications in drug delivery systems.
CO6: Compare the MEMS packaging techniques.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	75

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No. of Hours
1	MEMS Materials	Clean room classification, MEMS, Substrates and Wafers, Properties of Silicon Compounds Polymers in MEMS	4
2	MEMS Processes	Wafer cleaning processes, Deposition process, Doping, Etching, Lithography techniques, and Surface characterization techniques	10
3	Soft lithography	SAMs, Types: Micro contact Printing, Micro molding techniques: replica molding, microtransfer molding,	4
4	Micro Total Analysis Systems (μTAS)	Flow techniques in μ-fluidics: pressure driven force, electro-osmosis, electrophoresis, Micropump, microvalves: types and fabrication, Microchannels: Types and fabrication (SU8, glass, silicon)	4
5	Drug Delivery Devices	Overview of drug delivery systems, Types of drug delivery systems, MEMS based drug delivery systems: Implantable drug delivery systems (IDDS), Micro needles and its fabrication, Micro particles for oral drug delivery	4
6	Microsystem Packaging	Packaging materials, Levels of packaging, Comparison between IC and MEMS packaging	4
Total			**30**

Suggested list of Assignments:

1. Classification of MEMS materials.
2. MEMS processes with case study
3. Overview of replica techniques.
4. Application of MEMS in Biomedical Engineering.
5. MEMS Packaging techniques.

Suggested List of Value-Added Home Assignments:

1. Reviewing MEMS products and new technologies.
2. Novel technical paper writing based on recent advancements.
3. Problem Based Learning on MEMS sensor development.

Suggested Online Courses:

1. Micro and Nanofabrication (MEMS)
   https://www.edx.org/course/micro-and-nanofabrication-mems

Reference Books:

1. Marc Madou, "Fundamentals of Microfabrication", CRC Press, 1997.
2. Steven S. Saliterman , "Fundamentals of BioMEMS and Medical Microdevices", SPIE Press Monograph Vol. PM153 by Wiley Interscience, 2012.
3. W. Menz, J. Mohr, 0. Paul, "Microsystem Technology", WILEY-VCH, 2001.
4. James J. Allen , "Electro Mechanical System Design", Taylor & Francis Group, 2005.
5. Neelina H. Malsch, "Biomedical Nanotechnology", CRC PRESS, Taylor and Francis Group, 2005.

Course Name: Biomedical Microsystems Lab

Course Code: BM15P

Category: Core Engineering

This course introduces students to MEMS materials, microfabrication, and packaging of MEMS Devices. It also covers the applications of MEMS in Biomedical Engineering

Pre-requisites:

- Human Anatomy & Physiology
- Engineering Physics
- Engineering Chemistry

Course Objectives:

- To enable learners to learn the properties of MEMS materials.
- To enable learners to understand MEMS processes steps and procedure.
- To enable learners to learn the basics of soft-lithography technique.
- To enable learners to study fundamentals of Lab-on-Chip technology.
- To enable learners to understand the application of MEMS as drug delivery system.
- To enable learners to apply MEMS process knowledge in MEMS packaging.

Course Outcomes:

Learner will be able to:

CO1: Understand the different MEMS materials properties and their applications in MEMS.
CO2: Analyze & study different MEMS processes to make micro devices for a specific application.
CO3: Choose appropriate soft lithography technique for developing microstructures.
CO4: Differentiate different parts of the micro total analysis systems and understand the purpose of individuals.
CO5: Relate the microstructures and their applications in drug delivery systems.
CO6: Compare the MEMS packaging techniques.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	50

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Suggested list of Practicals:

1. Demonstration of scaling law for miniaturized structure.
2. Materials in MEMS technology and application- Case study.
3. Nanopattern collapsing due to capillary forces: Study & suppression techniques.
4. Surface characterization techniques and applications as a case study.
5. Soft Lithography Techniques- Replication technique for polypropylene microneedles
6. Selection of separation Techniques in uTAS System for sensing application.
7. Design of Biosensor for NSA removal.
8. Packaging Techniques in MEMS for different applications.
9. Sensitivity enhancement for sensor a case study.

Guidelines to conduct practical sessions:

1. The Laboratory work is to be conducted by a group of three-five students.
2. To encourage project-based learning in the curriculum students may either select one of the commercial biosensors for a review.
3. Each group along with subject faculty shall identify a potential biosensor, on which the study can be conducted. They can perform real or virtual experiments related to the topic selected in the laboratory along with regular experiments.
4. Students should prepare working models, power point presentation, posters etc. on the selected topics.
5. The assessment will be done at the end of the semester.

Suggested Online Courses:

1. Micro and Nanofabrication (MEMS)
   https://www.edx.org/course/micro-and-nanofabrication-mems

Reference Books:

1. Marc Madou, "Fundamentals of Microfabrication", CRC Press, 1997.
2. Steven S. Saliterman , "Fundamentals of BioMEMS and Medical Microdevices", SPIE Press Monograph Vol. PM153 by Wiley Interscience, 2012.
3. W. Menz, J. Mohr, 0. Paul, "Microsystem Technology", WILEY-VCH, 2001.
4. James J. Allen , "Electro Mechanical System Design", Taylor & Francis Group, 2005.
5. Neelina H. Malsch, "Biomedical Nanotechnology", CRC PRESS, Taylor and Francis Group, 2005.