Vidyalankar Institute of Technology

An Autonomous Institute affiliated to University of Mumbai

Bachelor of Technology

in

Biomedical Engineering

with Multidisciplinary Minor

Third Year Scheme & Syllabus

(R-2023)

(As per NEP 2020, with effect from Academic Year 2025-26)

Preamble

The National Education Policy (NEP) framework aims to break the mould from teacher centric to student centric educational practices. It empowers the students with flexibility in terms of choosing courses across different faculties and mode of learning.

This multidisciplinary approach will encourage learners to follow their passion and inherent interests. The learner is free to learn at a pace that he is comfortable with and this enables lifelong learning. It also enhances the scope for holistic personality development.

This premise is truly reflected in preamble of the NEP document, "The future of nation is decided in the classrooms of the schools and colleges today".

Details of implementation:

NEP curriculum framework enables us to accelerate change, redesign systems with equity in mind, respond to feedback, encourage collaboration, catch and pollinate ideas and create a culture of research and development. It will allow us to offer the required academic flexibility which will focus on improving the competency level of students with diverse strengths.

The curriculum planned by VIT has vertical **Program Courses** consisting of core courses (PCC) of branch of engineering positioned and sequenced to achieve sequential and integral learning of the entire breadth of the specific branch. This vertical also includes Programme Elective courses (PEC) which offer flexibility and diversity to learners to choose specialization from a basket of recent developments in their field of technology. The selection of unique Programme Elective courses based on industrial requirements and organizing them into tracks is a special feature of this curricula ensuring employability.

The vertical **Multidisciplinary Courses** consist of Open Elective (OE) courses and multidisciplinary minor (MD M) courses. Special vocational and skill development courses are included as a part of **Skill courses** vertical that make students capable to work in industrial environment.

The student is expected to demonstrate their ability through course in **Experiential Learning Courses** vertical like internships/On Job Training, Community Engagement Project, Real Industry Project/ research problem. Our curriculum also introduces Social Service Internship and Internship with institutes abroad along with courses like Design Thinking. This will lead to creation of products and/ or patents through this program.

For holistic development of students, apart from technical courses, Ability Enhancement Courses, Entrepreneurship/Economics/Management Courses, Indian Knowledge System and Value Education courses from vertical **Humanities and Social Science and Management** develop the required soft-skills and attitude amongst learners.

In **Liberal Learning** vertical courses like Various Dance Forms, Global citizenship Education, Facets of Astronomy etc. aim to create balance in brain hemispheres and hence improve learners' clarity in thoughts and responses.

In addition, our framework offers Honors/ Honours by Research/ Double Minor (Multidisciplinary Minor and Specialization Minor) degree in each UG programme of engineering. It includes specialized courses along with field/ domain study that make students capable of working on Industry relevant problems.

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 **Preferred Semester: V**

Course Structure and Assessment guidelines

Vertical_ Subvertical	Course		Head of Learning	Credits	Assessment guidelines (Marks)			Total marks (Passing@40% of total marks)
	Code	Name			ISA	MSE	ESE	
PC_PCC	PCBM09T	Diagnostic and Monitoring Equipment	Theory	2	15	20	40	075
PC_PCC	PCBM09P	Diagnostic and Monitoring Equipment Lab	Practical	1	25	-	25	050
PC_PCC	PCBM10T	Microprocessors and Microcontrollers	Theory	2	15	20	40	075
PC_PCC	PCBM10P	Microprocessors and Microcontrollers Lab	Practical	1	25	-	25	050
PC_PCC	PCBM11T	Biomedical Digital Signal Processing	Theory	2	15	20	40	075
PC_PCC	PCBM11P	Biomedical Digital Signal Processing Lab	Practical	1	25	-	25	050
PC_PCC	PCBM12T	Medical Imaging Equipment	Theory	2	15	20	40	075
PC_PCC	PCBM12P	Medical Imaging Equipment Lab	Practical	1	25	-	25	050
PC_PEC	PEBMXXT	Prof. Elective 1	Theory	2	15	20	40	075
PC_PEC	PEBMXXP	Prof. Elective 1 Lab	Practical	1	25	-	25	050
MDC_MDM	MDMXX	Multidisciplinary Minor Course-1	Theory	4	45	30	50	125
ELC_PRJ	PRJBM01	Mini Project	Practical	2	25	-	50	075
	Total			**21**				
Course credits completed during the previous inter-semester break will appear in this semester marksheet								
MDC-OE	OEC01	Collaborative Inter-Institute Studies (Credit Transfer)	As per course	4	-	-	125	125

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 Programme Elective Courses and Specialization Certificate – Refer Appendix-A

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

Programme Elective Courses-1 (PEBMXXT and PEBMXXP)

Specialization Track Name#	Course		Head of Learning	Credits	Assessment Guidelines (Marks)			Total marks (Passing@40% of total marks)
	Code	Name			ISA	MSE	ESE	
Artificial Intelligence and Machine Learning (AIML)	PEBM01T	Integrated Data Management	Theory	2	15	20	40	075
	PEBM01P	Integrated Data Management Lab	Practical	1	25	-	25	050
Internet of Things (IoT)	PEBM02T	Modern Sensors for Internet of Things (IoT)	Theory	2	15	20	40	075
	PEBM02P	Modern Sensors for Internet of Things (IoT) Lab	Practical	1	25	-	25	050
Biomedical Technology and Innovation	PEBM03T	Bio-Photonics	Theory	2	15	20	40	075
	PEBM03P	Bio-Photonics Lab	Practical	1	25	-	25	050

#For details of Specialization Certificate, refer Appendix-A

Guidelines for Multidisciplinary Elective Courses and Minor Degree – Refer Appendix-B

Learners are required to go through the Appendix-B carefully before selecting the Multidisciplinary Elective courses. Detailed guidelines regarding Multidisciplinary Elective courses, Minor Degree Titles and courses relevant to each MDM Title are given in Appendix-B.

Multidisciplinary Elective Course1 (MDMXX)

MDM Title	Course		Head of Learning	Credits	Assessment Guidelines (Marks)			Total marks (Passing@40% of total marks)
	Code	Name			ISA	MSE	ESE	
Bioinformatics	MDMBI01	Introduction to Bioinformatics	Theory+ Tutorial	4	45	30	50	125
Innovation, Entrepreneurial and Venture Development	MDMIE01	Foundations of Innovation and Entrepreneurship	Theory+ Tutorial	4	45	30	50	125
Business Development, Marketing and Finance	MDMBD01	Introduction to Business Development and Marketing Principles	Theory+ Tutorial	4	45	30	50	125
Computer Science	MDMCS01	Computational Logic and Data Structures	Theory+ Practical	4	45	30	50	125

Guidelines for Award of Honours/ Honours by Research / Double Minor (Multidisciplinary and Specialization) Degree

Before the end of Semester 5, learners are required to go through the Honours/ Honours by Research/ Specialization Minor Degree Programme document carefully to opt for Honours/ Honours by Research/ Double Minor Degree. Learners willing to opt for Honours/ Honours by Research/ Specialization Minor degree programme are required to satisfy the eligibility criteria stated in the document.

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

Course Structure and Assessment guidelines

Vertical_ Subvertical	Course		Head of Learning	Credits	Assessment guidelines (Marks)			Total marks (Passing@40% of total marks)
	Code	Name			ISA	MSE	ESE	
PC_PCC	PCBM13T	Critical Care Equipment	Theory	2	15	20	40	075
PC_PCC	PCBM13P	Critical Care Equipment Lab	Practical	1	25	-	25	050
PC_PCC	PCBM14T	Digital Image Processing	Theory	2	15	20	40	075
PC_PCC	PCBM14P	Digital Image Processing Lab	Practical	1	25	-	25	050
PC_PCC	PCBM15	Biomedical Microsystems	Theory	2	15	20	40	075
PC_PCC	PCBM16	Hospital Management	Theory	2	15	20	40	075
PC_PEC	PEBMXXT	Prof. Elective 2	Theory	2	15	20	40	075
PC_PEC	PEBMXXP	Prof. Elective 2 Lab	Practical	1	25	-	25	050
PC_PEC	PEBMXXT	Prof. Elective 3	Theory	2	15	20	40	075
PC_PEC	PEBMXXP	Prof. Elective 3 Lab	Practical	1	25	-	25	050
MDC_MDM	MDMXX	Multidisciplinary Minor-2	Theory	4	45	30	50	125
ELC_PRJ	PRJBM02	Project Synopsis	Theory	2	25	-	50	075
	Total			**22**				

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

*Selection based on the subset of courses made available by the Institute for the semester.

#Selection based on the MD M Title chosen by the student.

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 (PEBMXXT and PEBMXXP)

Specialization Track Name#	Course		Head of Learning	Credits	Assessment Guidelines (Marks)			Total marks (Passing@40% of total marks)
	Code	Name			ISA	MSE	ESE	
Artificial Intelligence and Machine Learning (AIML)	PEBM04T	Artificial Intelligence	Theory	2	15	20	40	075
	PEBM04P	Artificial Intelligence Lab	Practical	1	25	-	25	050
Internet of Things (IoT)	PEBM05T	Principles of Internet of Things (IoT)	Theory	2	15	20	40	075
	PEBM05P	Principles of Internet of Things (IoT) Lab	Practical	1	25	-	25	050
Biomedical Technology and Innovation	PEBM06T	Robotics in Medicine	Theory	2	15	20	40	075
	PEBM06P	Robotics in Medicine Lab	Practical	1	25	-	25	050

#For details of Specialization Certificate, refer Appendix-A

Professional Elective-3 Courses (PEBMXXT and PEBMXXP)

Specialization Track Name#	Course		Head of Learning	Credits	Assessment Guidelines (Marks)			Total marks (Passing@40% of total marks)
	Code	Name			ISA	MSE	ESE	
Artificial Intelligence and Machine Learning (AIML)	PEBM07T	Machine Learning	Theory + Tutorial	3	40	20	40	100
	PEBM07P	Machine Learning Lab	Theory + Tutorial	3	40	20	40	100
Internet of Things (IoT)	PEBM08T	Embedded System Design with Tiny Operating System	Theory	2	15	20	40	075
	PEBM08P	Embedded System Design with Tiny Operating System Lab	Practical	1	25	-	25	050
Biomedical	PEBM09T	Point of Care	Theory	2	15	20	40	075

Specialization Track Name#	Course		Head of Learning	Credits	Assessment Guidelines (Marks)			Total marks (Passing@40% of total marks)
	Code	Name			ISA	MSE	ESE	
Technology and Innovation		Technology						
	PEBM09P	Point of Care Technology Lab	Practical	1	25	-	25	050

#For details of Specialization Certificate, refer Appendix-A

Multidisciplinary Elective Course-2 (MDMXX)

MD M Title	Course		Head of Learning	Credits	Assessment Guidelines (Marks)			Total marks (Passing@40% of total marks)
	Code	Name			ISA	MSE	ESE	
Bioinformatics	MDMBI02	Algorithms and Data Structures in Bioinformatics	Theory+ Tutorial	4	45	30	50	125
Innovation, Entrepreneurial and Venture Development	MDMIE02	Startup Planning and Development	Theory+ Tutorial	4	45	30	50	125
Business Development, Marketing and Finance	MDMBD02	Financial Basics for Engineers and Technopreneurs	Theory+ Tutorial	4	45	30	50	125
Computer Science	MDMCS02	Operating Systems and Computer Networks	Theory+ Practical	4	45	30	50	125

Third Year B. Tech. Biomedical Engineering - Summer Break

Course		Head of Learning	Credits	Assessment Guidelines (Marks)			Total marks (Passing@40% of total marks)
Code	Name			ISA	MSE	ESE	
OJT01	Industry Internship-1	Practical	5	75	-	75	150

*150+ hours of industry internship to be done during inter semester break between semester 6 and semester 7.

NOTE: As per Institute guidelines, the results of courses completed in inter-semester break will appear in the marksheet of the next semester.

Detailed Syllabus of Third Year Semester-V

Course Name: Diagnostic and Monitoring Equipment

Course Code: PCBM09T

NEP Vertical _Basket: PC_PCC

Category: Program 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 (PCBM03T)
2. Biomedical Transducers and Control Systems (PCBM02T)
3. Analytical and Clinical Equipment (PCBM06T)

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: Classify different types of arrhythmias and explain the electronic system required for arrhythmia, ambulatory and cardiac stress monitoring.

CO2: Describe techniques and electronic system involved in measurement of heart rate, pulse rate, blood pressure, respiration rate and body temperature monitoring.

CO3: Classify and discuss different techniques for measurement of blood flow and cardiac output.

CO4: Describe principle and working on oximeters.

CO5: Illustrate working principle and technical specifications of physiotherapy equipments.

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	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: PCBM09P

NEP Vertical _Basket: PC_PCC

Category: Program 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 (PCBM03T)
2. Biomedical Transducers and Control Systems (PCBM02T)
3. Analytical and Clinical Equipment (PCBM06T)

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:

Learners will be able to:

CO1: Provide a better understanding about various bioelectrical signal recorders and patient safety.

CO2: Demonstrate the principles of electronics used in designing various biomedical monitoring equipment.

CO3: 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: PCBM10T

NEP Vertical _Basket: PC_PCC

Category: Program Core

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 (PCBM04T)
2. Structured Programming (VSEC01T)
3. Electronic Devices and Circuits (ESC10T)

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: PCBM10P

NEP Vertical _Basket: PC_PCC

Category: Program Core

Preamble:

This course is to create a strong foundation b y 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 (PCBM04T)
2. Structured Programming (VSEC01T)
3. Electronic Devices and Circuits (ESC10T)

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:

Learners 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: PCBM11T

NEP Vertical _Basket: PC_PCC

Category: Program 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 (BSC02)
2. Engineering Mathematics-II (BSC04)
3. Engineering Mathematics-III (BSC06)
4. Engineering Mathematics-IV (BSC08)

Course Outcome:

Learners 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	75

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.	06
02	Discrete Fourier transform	Introduction to DFT, Properties of DFT, DIT and DIF, FFT algorithms, use of FFT in linear filtering, discrete cosine transforms.	06
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	02
06	Biomedical	Preliminaries, biomedical signals (ECG, EMG, EEG) origin &	04

Module No.	Module Name	Module Contents	No. of Hours
	Signal 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			**30**

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: PCBM11P

NEP Vertical _Basket: PC_PCC

Category: Program Core

Preamble:

The course will help students 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 of practical discrete time systems.
- To gain the knowledge of various medical applications of Digital Signal Processing.

Pre-requisites:

1. Engineering Mathematics-I (BSC02)
2. Engineering Mathematics-II (BSC04)
3. Engineering Mathematics-III (BSC06)
4. Engineering Mathematics-IV (BSC08)

Course Outcome:

Learners 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	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. 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: PCBM12T

NEP Vertical _Basket: PC_PCC

Category: Program 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.

Pre-requisites:
Human Anatomy and Physiology (PCBM03)
Electronic Devices and Circuits (ESC10)

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: PCBM12P

NEP Vertical _Basket: PC_PCC

Category: Program Core Courses

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 (PCBM03)
Electronic Devices and Circuits (ESC10)

Course Outcome:

Learners 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: PEBM01T

NEP Vertical _Basket: PC_PEC

Category: Program Elective Course (Artificial Intelligence -Machine Learning Track)

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:
Structured Programing (VSEC01)

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:

Learners 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	75

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	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 management, and concurrency control	6
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: PEBM01P

NEP Vertical _Basket: PC_PEC

Category: Program Elective Course (Artificial Intelligence -Machine Learning Track)

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:
Structured Programing (VSEC01)

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	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 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: PEBM02T

NEP Vertical _Basket: PC_PEC

Category: Program Elective Course (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:

Learners will be able to:
CO1: Understand fundamentals of Sensors and their characteristics.
CO2: Use different types of 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 sensors.

Course Scheme:

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

Assessment Guidelines:

Head	ISA	MSA	ESA	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	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: PEBM02P

NEP Vertical _Basket: PC_PEC

Category: Program Elective Course (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 types of sensors and their application.
- To understand communication protocol and their use in sensor network.
- To understand various types of communication protocols required in IoT applications and their characteristics.
- To learn to develop small IoT or Embedded system using sensor.

Course Outcomes:

Learners 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	50

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: Bio photonics

Course Code: PEBM03T

NEP Vertical _Basket: PC_PEC

Category: Program Elective Course (Biomedical Technology and Innovation Track)

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

Pre-requisites:
Physics for Biomedical Engineering (PCBM01)
Biomedical Transducers and Control Systems (PCBM02)

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:

Learners 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	-	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 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.	4
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	6
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.	4
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.	6
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,	4

		Neurosurgery, Oncology, Ophthalmology, Orthopaedics, Otolaryngology (ENT), Urology, lasers and fibers in skin treatment.	
Total			**30**

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: Bio photonics Lab

Course Code: PEBM03P

NEP Vertical _Basket: PC_PEC

Category: Program Elective Course (Biomedical Technology and Innovation Track)

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

Pre-requisites:

Physics for Biomedical Engineering (PCBM01)
Biomedical Transducers and Control Systems (PCBM02)

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 purposes.

Course Outcomes:

Learners 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 systems 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	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. 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: Introduction to Bioinformatics

Course Code: MDMBI01

NEP Vertical _Basket: MDC_MDM

Category: Multidisciplinary Minor Course

Preamble:

This course is designed with the objective of equipping students with a robust understanding of the integration between biology and computational science, key bioinformatics concepts, methodologies, and applications. Through a combination of theoretical knowledge and practical applications, students will develop a holistic understanding of how computational methods can enhance the comprehension of biological processes. It also emphasizes on real-world biological questions and research challenges, empowering them to make meaningful contributions to the rapidly evolving field of bioinformatics

Course Objectives:

- To enable learners to understand the basic principles of bioinformatics.
- Build foundational understanding of biology, types of biological data, and the role of computing in biology.

Course Outcomes:

Student will be able to:

CO1: Explain foundational molecular biology concepts and their relevance to bioinformatics, including DNA, RNA, proteins, and gene functions.
CO2: Access, compare, and utilize various biological databases and sequence file formats to retrieve and analyze genomic and proteomic data effectively.
CO3: Apply key sequence alignment algorithms and computational techniques to analyze biological sequences and construct phylogenetic relationships.
CO4: Implement bioinformatics algorithms and data structures to solve problems in genomics, proteomics, and systems biology, including gene prediction and motif discovery.
CO5: Evaluate current applications and emerging trends in bioinformatics, including personalized medicine, big data analytics, ethical issues, and the integration of AI/ML technologies in biological research.

Course Scheme:

Course Code	Contact Hours		Credits Assigned	
	Theory	Tutorial	Theory	Practical
MDMBI01	3	1	3	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory+Tutorial	45	30	50	125

The assessment/evaluation guidelines for the courses of different credits are mentioned. 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	Basics of Molecular Biology	Structure and function of DNA, RNA, and proteins Central Dogma of Molecular Biology (Replication, Transcription, Translation) Codons and genetic code Types of genes (structural, regulatory) Mutations and their biological effects.	8
2	Biological Databases	Types: Primary, Secondary, Specialized databases, GenBank, EMBL, DDBJ – comparative study, UniProt, PDB, RefSeq, Ensembl, Sequence file formats (FASTA, GenBank, GFF, SAM/BAM), Querying biological databases (using NCBI Entrez, EBI search tools)	8
3	Sequence Analysis	Types of biological sequences: DNA, RNA, Protein,Pairwise and Multiple Sequence Alignment (MSA),Scoring matrices (PAM, BLOSUM),Tools: BLAST, FASTA, ClustalW, Applications: gene finding, phylogeny, structure prediction	8
4	Genomics & Human Genome Project	Genome organization and structure, Sequencing techniques: Sanger, Next Generation Sequencing (NGS), Nanopore, Applications: disease gene identification, forensic genomics, Human Genome Project: goals, achievements, ethical issues, Comparative genomics	12
5	Applications of Bioinformatics	Bioinformatics in personalized medicine, Drug discovery and vaccine design, Agriculture and animal genomics Role of AI/ML in bioinformatics	9
Total			**45**

Books and Resources:

1. Bioinformatics: Sequence and Genome Analysis by Mount D., Cold Spring Harbor Laboratory

Press, New York. 2004
2. Bioinformatics- a Practical Guide to the Analysis of Genes and Proteins by Baxevanis, A.D. and Francis Ouellellette, B.F., Wiley India Pvt Ltd. 2009
3. Introduction to bioinformatics by Teresa K. Attwood, David J. Parry-Smith. Pearson Education. 1999

Course Title: Foundations of Innovation and Entrepreneurship

Course Code: MDMIE01

NEP Vertical _Basket: MDC_MDM

Category: Multidisciplinary Minor Course

Pre-requisites: NIL

Course Objectives:

- To introduce the foundational concepts of innovation and entrepreneurship.
- To build awareness of opportunity recognition, creativity, and idea validation.
- To expose students to business modelling and startup ecosystems.

Course Outcomes:

Students will be able to:
CO1: Understand key entrepreneurial traits and innovation drivers
CO2: Apply ideation tools to identify entrepreneurial opportunities.
CO3: Create basic business models using Business Model Canvas.
CO4: Evaluate entrepreneurial case studies and pitch early-stage ideas.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Tutorial	Theory	Tutorial
3	1	3	1

Assessment Guidelines:

Head of learning	ISA	MSE	ESE	Total
Theory+Tutorial	45	30	50	125

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 Entrepreneurship	• Definition, importance, and scope • Types of entrepreneurs • Entrepreneurial mindset and characteristics	8
2	Innovation Basics	• Types of innovation (product, process, business model) • Disruptive vs. incremental innovation Design Thinking fundamentals	8
3	Opportunity Identification & Evaluation	• Creativity and ideation tools (brainstorming, SCAMPER, mind-mapping) • Problem-solving frameworks • Validating ideas	10
4	Business Model Design	• Business Model Canvas • Value Proposition Design • Customer Segments and Customer Discovery	6
5	Entrepreneurial Ecosystem	• Role of incubators, accelerators, and funding bodies • Startup India, Atal Innovation Mission, etc	7
		Total	**45**

Tutorials (1 Credit):

- Case studies on startups
- Group exercises on ideation
- Hands-on practice with the Business Model Canvas
- Ideation workshops
- Business Model Canvas exercises
- Case studies and short group presentations

Textbooks:

- Steve Blank, The Startup Owner's Manual, K&S Ranch Publishing Inc
- Alexander Osterwalder, Business Model Generation, John Wiley and Sons
- Peter F. Drucker, Innovation and Entrepreneurship, HarperCollins Publishers Inc

Course Name: Introduction to Business Development and Marketing Principles

Course Code: MDMBD01

NEP Vertical _Basket: MDC_MDM

Category: Multidisciplinary Minor Course

Preamble:

The objective of this course is to introduce engineering students to the fundamentals of business development and marketing using a customer centric lens. Students will learn how to conceptualize a basic business idea, understand market needs, and align engineering innovations with customer demand.

Pre-requisites:

None

Course Objectives:

- Understand basic business structures and concepts.
- Identify customer needs and conduct basic market research.
- Learn fundamentals of marketing strategy in a technology-driven world.
- Appreciate the role of engineering in business innovation.

Course Outcomes:

Students will be able to:

CO1: Explain key concepts in business development and marketing relevant to engineers.
CO2: Conduct simple market research and competitor analysis for a tech-based idea.
CO3: Draft a basic value proposition and elevator pitch.
CO4: Identify business opportunities through innovation in telecom and electronics domains.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Tutorial	Theory	Tutorial
3	1	3	1

Assessment Guidelines:

Head of learning	ISA	MSE	ESE	Total
Theory+Tutorial	45	30	50	125

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	Foundations of Business	Types of businesses, vision-mission-goals, legal forms of business, introduction to entrepreneurship.	8
2	Marketing Essentials	Needs vs wants, Segmentation, targeting, positioning, Marketing mix (4Ps), digital vs traditional marketing.	8
3	Customer Focus	Basics of customer journey, personas	7
4	Technology Product Planning	Basics of product lifecycle, innovation funnel, idea screening.	10
5	Market Research Basics	Research Types, Research steps, Sampling,, Surveys, interviews, SWOT, competitor analysis.	6
6	Business Idea Pitch	Business idea pitch, value proposition canvas, storytelling.	6
		Total	**45**

Textbooks:

1. Marketing Management by Kotler

Reference Books:

1. Marketing Basics PDF by MIT OpenCourseWare

Course Name: Computational Logic and Data Structures

Course Code: MDMCS01

NEP Vertical _Basket: MDC_MDM

Category: Multidisciplinary Minor Course

Preamble:

The course introduces students to key concepts in discrete structures and data structures, providing a foundational understanding essential for many areas in computer science. Students will explore topics related to organization, management, and manipulation of data, as well as learn about basic data structures, their associated algorithms, and principles of design and analysis. Emphasis will be placed on both theoretical understanding and practical application, enabling students to effectively use these concepts to solve complex computational problems.

Pre-requisites:

1. ES04T (Structured Programming).
2. ES05T (Object Oriented Programming)

Course Objectives:

- To establish foundational knowledge of discrete mathematical structures and their properties, enabling students to recall and apply these concepts in computational problem-solving.
- To develop conceptual understanding of linear/non-linear data structures (stacks, queues, trees, graphs), their memory representations, and operational principles for efficient data organization.
- To build practical skills in implementing, analyzing, and optimizing data structure operations while evaluating time/space complexity using asymptotic notations.
- To apply integrated knowledge of discrete mathematics and data structures to design solutions for real-world engineering challenges.

Course Outcomes:

Learners will be able to:

CO1: Recall fundamental concepts of set theory, logic, relations, and algebraic structures, including definitions, properties, and notations.

CO2: Explain the working principles of linear and non-linear data structures (stacks, queues, trees, graphs) and their representations in memory.

CO3: Explain the principles of linear and non-linear data structures (stacks, queues, trees, graphs) and their memory representations.

CO4: Implement basic operations (insert/delete/search) on linear data structures (arrays, stacks, queues, linked lists) using appropriate programming constructs.
CO5: Analyze and compare time/space complexity of different data structure implementations using asymptotic notations (Big-O, Omega, Theta).
CO6: Evaluate the application of discrete mathematical concepts (graph theory, algebraic structures) in solving engineering problems like network design or cryptography.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	2	3	1

Assessment Guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	45	30	50	125

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	Set Theory and Logic	Definition and representation of Sets, Types of sets, operations on sets, Laws of set, Principle of Inclusion & Exclusion (3 sets), Partition of set. Counting principle, Pigeonhole Principle, Mathematical Induction.	6
2	Relations and Functions	Relation: Definition, Representation of relation, Properties of relation, Closure properties of relation (Reflexive, Symmetric and Transitive), partial order and equivalence relation. Function: Definition, Types of function, Inverse function, composite functions.	8
3	Algebraic Structures	Algebraic structures with one binary operation: Groupoid, Semigroup, Monoid and Group, Abelian group, Cyclic groups, order and subgroup, Group Homomorphism, Isomorphism and Automorphism.	7

Module No	Module name	Content	No of Hours
4	Introduction to Data Structures and Complexity	Introduction to Data Structures, Types of Data Structures-Linear and Nonlinear, Operations on Data Structures. Time Complexity of Algorithm. Space Complexity of Algorithm. Notations (Big O, Omega and Theta).	4
5	Stack, Queue and Linked List	Introduction of Stack, Operations on Stack, Array Implementation of Stack. Introduction of Queue, Operations on Queue, Array Implementation of Queue, Types of Queue-Circular Queue, Priority Queue, Double Ended Queue. Introduction to Linked List, Representation of Linked List, Linked List v/s Array, Singly Linked List.	10
6	Graph and Trees	Introduction to Graph , Graph Terminologies, Representation of Graph, Graph Traversals-Depth First Search (DFS) and Breadth First Search (BFS). Introduction to Tree, Tree Terminologies, Binary Tree, Types of Binary Tree, Binary Tree Traversals. Binary Search Tree, Operations on Binary Search Tree. Applications of Binary Tree-Expression Tree, Huffman Encoding	10
Total			**45**

Text Books:

1. C. L. Liu, "Elements of Discrete Mathematics", TMH, ISBN 10:0-07-066913-9.
2. N. Biggs, "Discrete Mathematics", 3rd Ed, Oxford University Press, ISBN 0 –19-850717–8.
3. Kenneth H. Rosen, "Discrete Mathematics and its Applications", Tata McGraw-Hill, ISBN 978- 0-07-288008-3
4. Cryptograph and Network Security by B. A. Forouzan & D. Mukhopadhyay, 11th edition, McGraw Hill Publication.
5. Network Security and Cryptograph by Bernard Menezes, Cengage Learning Publication.
6. Reema Thereja," Data Structures using C", 2nd edition, Oxford Press, 2014
7. Aaron M Tenenbaum, Yedidyah Langsam, Moshe J Augenstein, "Data Structures Using C", First Edition, Pearson Publication, 2019

Reference Books:

1. Bernard Kolman, Robert C. Busby and Sharon Ross, "Discrete Mathematical Structures", Prentice-Hall of India /Pearson, ISBN: 0132078457, 9780132078450.
2. Narsingh Deo, "Graph with application to Engineering and Computer Science", Prentice Hall of India, 1990, 0 – 87692 – 145 – 4.

3. Eric Gossett, "Discrete Mathematical Structures with Proofs", Wiley India Ltd, ISBN:978-81-265-2758-8.
4. Sriram P. and Steven S., "Computational Discrete Mathematics", Cambridge University Press, ISBN 13: 978-0-521-73311-3.
5. Elementary Number Theory and its applications by Kenneth H. Rosen, 5th edition, Addison Wesley Publication.
6. Richard F. Gilberg and Behrouz A. Forouzan, "Data Structures: A Pseudocode Approach with C", 2ndEdition, CENGAGE Learning, 2004.
7. P.S. Deshpande, O.G. Kakde, "C and Data Structures", First Edition, Dreamtech Press, 2003
8. E. Balagurusamy, "Data Structure Using C", First Edition, Tata McGraw-Hill Education India, 2013

Course Name: Mini Project

Course Code: PRJBM01

NEP Vertical _Basket: Experiential Learning

Category: Community Engagement Project (CEP)/Field Project (FP)

Preamble:

The Mini Project course provides students with hands-on experience in applying engineering principles to solve defined problems. It emphasizes innovation, design thinking, and teamwork, preparing students for real-world engineering challenges. Students are encouraged to ideate, prototype, test, and present feasible solutions, promoting critical thinking and professional competencies in line with graduate attributes.

Pre-requisites:
Basic background of programming courses, fundamentals of electronic devices and transducers, circuit design and analysis.

Course Objectives:
- To promote independent learning, problem-solving, and creative thinking through project work.
- To identify and define a technical problem relevant to current trends or societal needs.
- To design and develop a working model, simulation, or software solution.
- To cultivate teamwork, time management, and professional ethics.
- To improve skills in technical writing, project documentation, and oral presentation.

Course Outcomes:
Learners will be able to:
CO1: Identify a meaningful technical problem and define its scope and objectives.
CO2: Design a technical solution through simulation, modeling, or prototyping.
CO3: Apply domain knowledge, tools, and techniques to implement and test the project.
CO4: Demonstrate teamwork, ethics, and consideration for environmental or societal aspects.
CO5: Communicate project outcomes effectively through reports, presentations, and demos.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
-	4	0	2

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25		50	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 of Third Year Semester-VI

Course Name: Critical Care Equipment

Course Code: PCBM13T

NEP Vertical _Basket: PC_PCC

Category: Program Core

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:

Human Physiology & Anatomy (PCBM03)
Electronic Devices and Circuits (ESE10)
Diagnostic and Monitoring Equipment (PCBM09)

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 the 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 Anaesthesia 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: PCBM13P

NEP Vertical _Basket: PC_PCC

Category: Program Core

Preamble:

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

Pre-requisites:

Human Physiology & Anatomy (PCBM03)
Electronic Devices and Circuits (ESE10)
Diagnostic and Monitoring Equipment (PCBM09)

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 machines 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: PCBM14T

NEP Vertical _Basket: PC_PCC

Category: Program Core

Preamble:

The course will help students 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.

Pre-requisites:

1. Engineering Mathematics-II (BSC04)
2. Engineering Mathematics-III (BSC05)
3. Biomedical Digital Signal Processing (PCBM11)

Course Objectives:

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

Course Outcome:

Learners 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 operations 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	04

Module No.	Module Name	Module Contents	No. of Hours
		and thickening; Chain Codes, Polygonal approximations, Signatures; Fourier descriptors, Moments.	
06	Feature Recognition and Classification	Object recognition and classification, connected components labelling, Features, Statistical classification, Structural/syntactic classification, Applications in medical image analysis	04
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: PCBM14P

NEP Vertical _Basket: PC_PCC

Category: Program Core

Preamble:

The course will help students 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 the real world will help students to relate well to the subject

Pre-requisites:

1. Engineering Mathematics-II (BSC04)
2. Engineering Mathematics-III (BSC05)
3. Biomedical Digital Signal Processing (PCBM11)

Course Objectives:

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

Course Outcome:

Learners 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 transformation techniques on the image for analysis and compression of images.
CO5: Compare morphological operations 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: PCBM15T

NEP Vertical _Basket: PC_PCC

Category: Program Core

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:

Physics for Biomedical Engineering (PCBM01)
Human Anatomy & Physiology (PCBM03)
Engineering Chemistry (BSC11)

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 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: Hospital Management

Course Code: PCBM16T

NEP Vertical _Basket: PC_PCC

Category: Program 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 (PCBM06)
Diagnostic and Monitoring Equipment (PCBM09)
Critical Care Equipment – (PCBM13)
Human anatomy and Physiology (PCBM03)

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	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	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.	8

Module No.	Module Name	Module Contents	No. of Hours
		B) Auxiliary Services: Waste management, Hospital Infection 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: Artificial Intelligence

Course Code: PEBM04T

NEP Vertical _Basket: PC_PEC

Category: Program Elective Course (Artificial Intelligence-Machine Learning-Track)

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:
- 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 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

Module No.	Module Name	Content	No of Hours
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: PEBM04P

NEP Vertical _Basket: PC_PEC

Category: Program Elective Course (Artificial Intelligence-Machine Learning-Track)

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: PEBM05T

NEP Vertical _Basket: PC_PEC

Category: Program Elective Course (IoT- Track)

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:

Structured Programming (VSEC 01)
Object Oriented Programming (VSEC 02)
Microprocessor and Microcontroller (PCBM10)

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:

Learners 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

Module No.	Module Name	Content	No. of Hours
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 microcontrollers 4.5 Introduction to embedded system design principles	5
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: PEBM05P

NEP Vertical _Basket: PC_PEC

Category: Program Elective Course (IoT- Track)

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:

Structured Programming (VSEC 01)
Object Oriented Programming (VSEC 02)
Microprocessor and Microcontroller (PCBM10)

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:

Learner 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 an 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 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: PEBM06T

NEP Vertical _Basket: PC_PEC

Category: Program Elective Course (Biomedical Technology and Innovation-Track)

Preamble:

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

Pre-requisites:

1. Engineering Mathematics-III (BSC 05)
2. Digital Image Processing Lab (PCBM14P)

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. .

Course Outcome:

Learner will be able to:

CO1: Describe basic types and classes of robots.
CO2: Describe direct and inverse kinematics of robots.
CO3: Describe workspace envelopes 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	75

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 Robotics in Medicine Lab

Course Code: PEBM06P

NEP Vertical _Basket: PC_PEC

Category: Program Elective Course (Biomedical Technology and Innovation-Track)

Preamble:

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

Pre-requisites:

1. Engineering Mathematics-III (BSC05)
2. Digital Image Processing Lab (PCBM14P)

Course Objectives:

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

Course Outcome:

Learner will be able to:

CO1: Describe basic types and classes of robots
CO2: Describe direct and inverse kinematics of robots
CO3: Describe workspace envelopes 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	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. Prove that composite rotations are not commutative.
2. Homogeneous Translation and Rotations are not commutative. But Screw Transformations are commutative
3. Kinematic configurations and Link Coordinate Transformations matrix
4. Direct Kinematics of 2-3 axis Planar Robot and find the location of Tool tip. But there are multiple ways to reach a particular point. Prove
5. Direct Kinematic Analysis of 4,5 Axis Robot
6. Develop Work Envelop for 2,3 axis Robot
7. To study segmentation using edge detection technique
8. An articulated robot needs to be used for an arc welding of straight line. Suggest a Trajectory Planning
9. You are given with a gray scale image and a part. Suggest a method to check whether the part is a subset of image
10. Gross motion planning is a part of task planning of robot. Suggest any method of gross motion planning so that the task can be completed without hitting obstacles

Suggested List of Project:

1. Robot path planning algorithms
2. Applications in Medicine
3. Robot Vision Techniques
4. Problem Based Assignment

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, NewYork 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: PEBM07T

NEP Vertical _Basket: PC_PEC

Category: Program Elective Course (Artificial Intelligence-Machine Learning-Track)

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-I (BSC02)
Engineering Mathematics-II (BSC04)
Engineering Mathematics-III (BSC06)
Engineering Mathematics-IV (BSC08)

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:

Learners 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	75

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

Module No.	Module Name	Content	No of Hours
6	Introduction to Deep Networks	What is deep network? Advantages and challenges, Concepts of CNN, RNN, GRU and LSTM	2
		Total	**30**

Textbooks:

1. "Introduction to Machine Learning" by Ethem Alpaydın, 4th Edition, MIT press
2. "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: PEBM07P

NEP Vertical _Basket: PC_PEC

Category: Program Elective Course (Artificial Intelligence-Machine Learning-Track)

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:
Python Programming Lab (VSEC04P)

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:
Learners 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	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 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: PEBM08T

NEP Vertical _Basket: PC_PEC

Category: Program Elective Course (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 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 systems and use of operating systems in the development of embedded systems.

Pre-requisites:

Structured Programming (SC_VSEC)
Object Oriented Programming (VSEC 02)
Microprocessor and Microcontroller (PCBM10)

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:

Learners 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	-

Assessment Guidelines:

Head	ISA	MSA	ESE	Total (Passing @40% of 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	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 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 (Dream tech 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

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

Course Code: PEBM08P

NEP Vertical _Basket: PC_PEC

Category: Program Elective Course (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 learners to use the concept of tiny machine learning and Real Time Operating System for design of embedded systems.

Pre-requisites:

Structured Programming (SC_VSEC)
Object Oriented Programming (VSEC 02)
Microprocessor and Microcontroller (PCBM10)

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:

Learners 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: PEBM09T

NEP Vertical _Basket: PC_PEC

Category: Program Elective Course (Biomedical Technology and Innovation-Track)

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. (PCBS20T)
Biomedical Transducers and Control Systems (PCBS02T)

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	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 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

Module No.	Module Name	Content	No. of Hours
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: PEBM09P

NEP Vertical _Basket: PC_PEC

Category: Program Elective Course (Biomedical Technology and Innovation-Track)

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 (PCBM01)
Biomedical Transducers and Control Systems (PCBM02)

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:

Learners 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	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 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: Algorithms and Data Structures in Bioinformatics

Course Code: MDMBI02

NEP Vertical _Basket: MDM

Category: MDM (Bioinformatics (BI))

Preamble:

This course is designed with the objective of equipping students with a robust understanding of the integration between biology and computational science, key bioinformatics concepts, methodologies, and applications. Through a combination of theoretical knowledge and practical applications, students will develop a holistic understanding of how various data structures and algorithms can enhance the comprehension of biological processes. It also emphasizes on real-world biological questions and research challenges, empowering them to make meaningful contributions to the rapidly evolving field of bioinformatics

Course Objectives:

- To enable learners to understand the basic data structures for Bioinformatics.
- Build foundational understanding of various algorithms

Pre-requisites:

Introduction to Bioinformatics (MDMBI01)

Course Outcome:

Learner will be able to:

.CO1: Apply fundamental data structures and algorithms (arrays, trees, graphs, hashing, etc.) to solve computational problems in bioinformatics.

CO2: Analyze and implement sequence alignment algorithms for comparing DNA, RNA, and protein sequences, including global, local, and heuristic approaches.

CO3: Construct and interpret phylogenetic trees using distance-based and character-based algorithms for evolutionary analysis.

CO4: Use algorithmic and statistical models, such as HMMs and motif-finding tools, to predict genes and regulatory elements in genomic sequences.

CO5: Design and evaluate scalable bioinformatics workflows and pipelines using big data technologies and cloud platforms for handling large-scale genomic datasets.

Course Scheme:

Contact Hours		Credits Assigned
Theory	Practical	Total
3	1	4

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory+ Tutorial	45	30	50	125

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	Review of Data Structures and Algorithms	Arrays, strings, stacks, queues, Graphs and trees: DFS/BFS with examples from biological data, Suffix trees, suffix arrays, tries, Hashing techniques for genome indexing	8
02	Sequence Alignment Algorithms	Needleman-Wunsch algorithm (global alignment) Smith-Waterman algorithm (local alignment) Space optimization (Hirschberg's algorithm) Heuristic alignment methods (BLAST internals) Complexity analysis of sequence alignment algorithms Self-Learning Topics: Recent advances in sequence alignment techniques	10
03	Phylogenetic Tree Construction	Multiple Sequence Alignment (MSA) pre-processing Distance-based methods: UPGMA, Neighbor-Joining Character-based methods: Maximum Parsimony, Maximum Likelihood,Tree visualization tools: MEGA, iTOL Self-Learning Topics: Bayesian approaches in phylogenetics	10
04	Gene Prediction and Motif Finding	Regulatory elements in genomes Basics of Hidden Markov Models (HMMs) Motif discovery tools (MEME, FIMO) Promoter and enhancer identification Use of regular expressions in motif searches	10

Module No.	Module Name	Module Contents	No. of Hours
		Self-Learning Topics: Deep learning methods for gene prediction	
05	Big Data in Bioinformatics	Challenges of large-scale genomic and multi-omics data, Hadoop and Spark frameworks for bioinformatics, Bioinformatics pipelines: Snakemake, Nextflow,Cloud platforms for genomics: AWS, Google Genomics, Case studies: 1000 Genomes Project, Cancer Genome Atlas Self-Learning Topics: Emerging big data technologies in bioinformatics	07
Total			**45**

Reference Books / Articles

1. Bioinformatics: Sequence and Genome Analysis by Mount D., Cold Spring Harbor Laboratory Press, New York. 2004
2. Bioinformatics- a Practical Guide to the Analysis of Genes and Proteins by Baxevanis, A.D. and Francis Ouellellette, B.F., Wiley India Pvt Ltd. 2009
3. Introduction to bioinformatics by Teresa K. Attwood, David J. Parry-Smith. Pearson Education. 1999

Course Name: Startup Planning and Development

Course Code: MDMIE02

NEP Vertical _Basket: MDM

Category: MDM (Innovation Entrepreneurial and Venture Development (BI))

Preamble:

Pre-requisites: NIL

Course Objectives:

- To develop skills for building, validating, and planning a new venture.
- To understand basic startup finance, legalities, and market strategy.
- To enable students to create business plans and investor pitches.

Course Outcomes:

Learner will be able to:
CO1: Design MVPs and apply lean startup methods
CO2: Conduct market and competitor analysis.
CO3: Prepare financial models and pitch decks.
CO4: Understand legal frameworks and intellectual property.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
3	1(Tutorial)	3	1

Assessment Guidelines:

Head of learning	ISA	MSE	ESE	Total
Theory	45	30	50	125

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	Lean Startup Methodology	• MVP (Minimum Viable Product) • Pivoting and iteration • Build-Measure-Learn loop	8
2	Market Research and Strategy	• TAM-SAM-SOM analysis • Competitive analysis • Go-to-market strategy	8
3	Startup Finance	• Basics of financial modelling • Unit economics, pricing, and revenue models • Funding sources: bootstrapping, angels, VCs, crowdfunding	10
4	Legal & Regulatory Aspects	• Company formation: types and registration • IPR basics: patents, trademarks, copyrights • Compliance and taxation	6
5	Business Plan Development	• Writing an effective business plan • Pitch deck essentials	7
		Total	**45**

Tutorials (1 Credit):

- Building a mock startup pitch deck
- Simulated investor pitch
- Budgeting and forecasting exercises

Textbooks:

1. Peter Thiel ,Zero to One: Notes on startups, or how to build the future, Crown Business 2014
2. E,ric Ries The Lean Startup, Crown Business 2011
3. Brad Feld ,Venture Deals, Wiley Publications

Course Name: Financial Basics for Engineers and Technopreneurs

Course Code: MDMBD02

NEP Vertical _Basket: MDM

Category: MDM (Business Development (BI))

Preamble:

The objective of this course is to equip students with basic financial skills needed to evaluate and manage technical projects or business ventures. It covers the principles of cost analysis, budgeting, financial statements, and introduction to funding models.

Pre-requisites:

Introduction to Business Development and Marketing Principles

Course Objectives:

- Learn basic financial terminology and concepts.
- Understand components of a budget and perform break-even analysis.
- Analyse financial viability of a project or startup.
- Gain exposure to funding options.

Course Outcomes:

Student will be able to:
CO1: Interpret and analyze basic financial statements (P&L, balance sheet).
CO2: Prepare a project cost sheet and conduct break-even analysis.
CO3: Explain sources of capital and funding stages for startups.
CO4: Apply budgeting techniques to engineering project proposals

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
3	1(T)	3	1(T)

Assessment Guidelines:

Head of learning	ISA	MSE	ESE	Total
Theory	45	30	50	125

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 Finance	Financial definitions, roles in business, overview of income, expenses, assets, liabilities, cash flows.	8
2	Costing and Budgeting	Types of costs (fixed/variable), project budgeting, break-even analysis, basic forecasting.	8
3	Financial Statements	Structure and interpretation of P&L, balance sheet, cash flow statements.	10
4	Time Value of Money	Simple vs compound interest, Net Present Value (NPV), Internal Rate of Return (IRR) concepts.	6
5	Funding Sources	Equity, debt, bootstrapping, angel investment, venture capital, crowdfunding.	7
6	Financial Decision Making	Financial ratios (ROI, ROE), pricing basics, cost-benefit analysis, breakeven models.	6
Total			**45**

Textbooks:

1. Finance for Non-Finance Managers, by: V.G. Narayanan, Publisher: Cengage India, ISBN: 9789353501786
2. Finance for Non-Financial Managers by Gene Siciliano, McGraw Hill, Second Edition, (pdf available online)

Reference Books:

1. Introduction to Finance - Yale Online Course
2. Investopedia - Financial Statements Guide

Course Name: Operating Systems and Computer Networks

Course Code: MDMCS02

NEP Vertical _Basket: MDM

Category: MDM (Computer Science(CS))

Preamble:

This course introduces the basics of Operating Systems and intermediate concepts in Computer Networks, focusing on how systems manage processes and enable communication. Students will learn key OS functions, networking protocols, and explore their integration through hands-on tasks like scheduling, subnetting, and socket programming. The course emphasizes real-world relevance in areas like virtualization, cloud computing, and secure communications.

Pre-requisites:

3. ES04T (Structured Programming)
4. ES04T (Object Oriented Programming)

Course Objectives:

- To establish foundational understanding of operating system principles, including process management, memory management, and system-level functionalities, enabling students to recall and apply these concepts in computing tasks.
- To develop conceptual clarity of computer networking fundamentals such as layered architectures, addressing schemes, protocols, and network models to support effective communication between systems.
- To build practical skills in configuring networks, analysing traffic using tools, and simulating OS-level tasks like scheduling and memory allocation for system efficiency.
- To apply integrated knowledge of operating systems and computer networks in designing and implementing basic client-server applications and exploring modern environments like cloud and containerized systems.

Course Outcomes:

Learner will be able to:
CO1: Recall fundamental concepts of operating systems such as process states, memory management techniques, and system calls.
CO2: Explain core principles of computer networks including OSI and TCP/IP models, IP addressing, and transport layer protocols.
CO3: Describe the interaction between operating systems and network components for enabling process communication and data transfer.

CO4: Implement basic OS-level algorithms such as process scheduling and memory allocation and simulate network operations using tools.
CO5: Analyse the performance of OS and network mechanisms with respect to efficiency, scalability, and resource utilization.
CO6: Evaluate the role of OS and networking integration in solving real-world problems such as secure communication, client-server architecture, and containerized deployment.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
3	2	3	1

Assessment Guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	45	30	50	125

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 Operating Systems	Overview of Operating Systems, types of OS (batch, multitasking, real-time), components (kernel, shell), system calls, functions and services of OS, booting process.	6
2	Process and Memory Management	Process concepts, process states, scheduling algorithms (FCFS, SJF, Round Robin), memory management basics, paging and segmentation (conceptual).	6
3	Network Fundamentals	OSI and TCP/IP models, data encapsulation, IP addressing (IPv4 basics), subnetting, MAC address, ARP, DHCP, DNS, routing and switching fundamentals.	12

Module No	Module name	Content	No of Hours
4	Transport and Application Layer Protocols	TCP vs UDP, 3-way handshake, flow and congestion control, protocols: HTTP, FTP, SMTP, HTTPS. Use of port numbers, socket basics.	8
5	Wireless Networking and Security	Wireless networks (WLAN, Bluetooth, 5G basics), VPN, firewalls, basics of encryption (symmetric vs. asymmetric), SSL/TLS, secure browsing practices.	7
6	OS-Network Integration & Application	Role of OS in networking: sockets, inter-process communication, threads with network programming, introduction to container networking (Docker), client-server applications.	6
Total			**45**

Text Books:

1. Abraham Silberschatz, Peter B. Galvin, Greg Gagne, *Operating System Concepts*, 10th Edition, Wiley, ISBN: 978-1119456339
2. Andrew S. Tanenbaum, Herbert Bos, *Modern Operating Systems*, 4th Edition, Pearson, ISBN: 978-0133591620
3. Behrouz A. Forouzan, *Data Communications and Networking*, 5th Edition, McGraw-Hill, ISBN: 978-0073376226
4. James F. Kurose, Keith W. Ross, *Computer Networking: A Top-Down Approach*, 7th Edition, Pearson, ISBN: 978-0136681557
5. William Stallings, *Operating Systems: Internals and Design Principles*, 9th Edition, Pearson, ISBN: 978-0134670959

Reference Books:

1. William Stallings, *Data and Computer Communications*, 10th Edition, Pearson, ISBN: 978-0133506488
2. Daniel P. Bovet, Marco Cesati, *Understanding the Linux Kernel*, 3rd Edition, O'Reilly Media, ISBN: 978-0596005658
3. Douglas E. Comer, *Computer Networks and Internets*, 6th Edition, Pearson, ISBN: 978-0133587937
4. Tanenbaum and Steen, *Distributed Systems: Principles and Paradigms*, 2nd Edition, Pearson, ISBN: 978-8131734031
5. Thomas L. Floyd, *Network Fundamentals*, Pearson Education, ISBN: 978-0131973831

Course Name: Project Synopsis

Course Code: PRJBM02

Category: Project and Internship

Preamble:

The "Project Synopsis" course is designed to initiate undergraduate students into the process of structured problem-solving through research and design in the field of Biomedical Engineering. This course provides a platform for students to identify real-world healthcare challenges, review relevant literature, and formulate a viable project proposal under faculty guidance. It emphasizes interdisciplinary thinking, innovation, and planning, laying the groundwork for the major project in the final semester. By focusing on ethical, technical, and societal aspects, the course prepares students to undertake meaningful biomedical research or product development.

Pre-requisites:
Basic background of programming courses, fundamentals of electronic devices and transducers, circuit design and analysis.

Course Objectives:

- To enable students to identify and define a significant biomedical engineering problem through critical analysis and literature review.
- To develop the ability to formulate a research or development plan, including defining objectives, scope, methodology, and anticipated outcomes.
- To enhance students' skills in technical writing and oral presentation by preparing a comprehensive synopsis and communicating the project proposal effectively to a technical audience.

Course Outcomes:

Learner will be able to:
CO1: Design a programme (Plan) to conduct a project on a chosen topic.
CO2: Define the problem statement & objectives for the Project.
CO3: Construct literature review and theoretical study required for the project.
CO4: Determine the most suitable methodology for data collection and experimental study.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2		2	-

Assessment guidelines:

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

Course Name: Industry Internship
Course Code: OJT01
NEP vertical: Experiential Learning courses
Category: Community Engagement Project (CEP)/Field Project (FP)
Preamble:

The Industry Internship aims to bridge the gap between academic learning and industry practices by exposing students to real-time industrial environments. This experience enables them to understand professional expectations, analyze real-world problems, and apply domain knowledge effectively. The internship enhances technical competency, teamwork, communication, ethical responsibility, and problem-solving skills — all essential graduate attributes for future professionals.

Pre-requisites: NIL
Course Objectives:

- To expose students to the real-time functioning, tools, and processes used in industry.
- To develop the ability to identify industry-based technical or managerial problems.
- To formulate structured problem statements and apply academic knowledge for solutions.
- To encourage professional ethics, teamwork, and awareness of societal, safety, and environmental aspects.
- To develop skills in effective communication, documentation, and project presentation.

Course Outcomes: Learners will be able to:

CO1: Analyze and understand industrial workflows, technologies, and tools through direct exposure.
CO2: Identify and define real-time technical or managerial problems encountered in the industry.
CO3: Propose and/or assist in implementing practical or technical solutions in the industrial context.
CO4: Demonstrate ethical behavior, professional responsibility, and awareness of sustainability and safety.
CO5: Communicate project progress effectively through reports, presentations, and team interaction.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	150 hrs (Total)	0	5

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	75	-	75	150

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.