NATIONAL INSTITUTE OF ELECTRONICS AND INFORMATION TECHNOLOGY
DEEMED TO BE UNIVERSITY UNDER DISTINCT CATEGORY
(AN AUTONOMOUS INSTITUTION UNDER MINISTRY OF ELECTRONICS & IT, GOVT. OF INDIA)

Curriculum and Syllabi for

M.Tech - IoT and Sensor Systems

(2025-26 Scheme)

रा.इ.सू.प्रौ.सं
NIELIT
Deemed to be University

Main Campus at Ropar and Constituent Units at Aizawl, Agartala, Aurangabad, Calicut, Gorakhpur, Imphal, Itanagar, Kekri, Kohima, Patna and Srinagar

Vision

To be a leader by imparting in-depth knowledge in Electronics Engineering, nurturing engineers, technologists, and researchers of the highest competence, who would engage in sustainable development to cater the global needs of industry and society.

Mission

Create and maintain an environment to excel in teaching, learning, and applied research in the fields of electronics, Internet of Things, Embedded Systems, and allied disciplines that pioneer sustainable growth.

Equip our students with the necessary knowledge and skills that enable them to be lifelong learners, to solve practical problems, and to improve the quality of human life.

Program Education Objectives

1. Serve as engineering practitioners and leaders, contributing to the resolution of technological challenges in industry.
2. Act as engineering professionals, innovators, or entrepreneurs engaged in technology development, deployment, or system implementation across industrial sectors.
3. Perform professional roles with a sense of social awareness and responsibility.
4. Collaborate effectively with peers from other disciplines in industry and society, contributing to the nation's economic growth.
5. Successfully pursue higher studies in engineering or management.
6. Follow career paths in teaching or research.

Program Outcomes

PO 1: Having the ability to apply mathematics & science in engineering applications.

PO 2: Having the ability to design a component or a product applying all the relevant standards and with realistic constraints, including public health, safety, culture, society and environment

PO 3: Having the ability to design and conduct experiments, as well as to analyse and interpret data, and synthesize information

PO 4: Having the ability to use techniques, skills, resources, and modern engineering and IT tools necessary for engineering practice

PO 5: Having problem-solving ability- to assess social issues (societal, health, safety, legal, and cultural) and engineering problems

PO 6: Having adaptive thinking and adaptability about environmental context and sustainable development

PO 7: Having a clear understanding of professional and ethical responsibility

PO 8: Having good cognitive load management skills related to project management and finance

Program Specific Outcomes

On completion of M. Tech. (Internet of Things & Sensor Systems) programme, graduates will be able to

PSO1: Competent and innovative with a strong cognizance in the area of sensors, IoT, data science, controllers, and signal processing through the application of acquired knowledge and skills

PSO2: Apply advanced techniques and tools of sensing and computation to solve multi-disciplinary challenges in industry and society.

PSO3: To exhibit independent and collaborative research with strategic planning, while demonstrating the professional and ethical responsibilities of the engineering profession.

CATEGORY WISE CREDIT DISTRIBUTION

Category	Category Code	Credits
Skill / Employment Enhancement Courses (Project/Internship/Seminar/Dissertation/Research)	EE	36
Audit Courses (without grade or credit)	AU	0
Open Elective Courses	OE	8
Professional Elective Courses	PE	16
Program Core Courses	PC	20
Total Credits (Common track)		**80**

EVALUATION AND ASSESSMENT

1. Performance of a student in a semester shall be evaluated through continuous Class assessment, Tutorial/Lab assessment, Mid-Semester Examination (MSE) and End-Semester Examination (ESE). Both the MSE and ESE shall be the University examination and will be conducted as notified by the Controller of Examinations (CoE) of the University.

2. The continuous assessment shall be based on assignments, tutorials, paper presentation / quizzes/ viva-voce / flipped classes, lab work / projects / fieldwork and attendance, etc.

3. The MSE/ESE shall be comprising of written papers.

4. The overall assessment of the students will be done as per the following scheme:

S. No.	Assessment Type	Marks Weightage
1.	Mid Semester Examination	20
2.	End Semester Examination	40
3.	Continuous Assessment - Practical /Lab/ Tutorial	25
4.	Continuous Assessment - Theory	15
Total		**100**

For more details, please refer the applicable ordinance for this programme and Assessment SOPs.

CURRICULUM

Semester 1						
Semester Code	**Course Code**	**Course Title**	**L**	**T**	**P**	**Cr**
PC-MTEISS-101	DOEE250095	Embedded Systems and Internet of Things	2	1	2	4
PC-MTEISS-102	DOEE250125	IoT Fundamentals and Architecture	3	0	2	4
PE-MTEISS-103	Elective	Program Elective				4
OE-MTEISS-104	Elective	Open Elective				4
PC-MTEISS-105	DASH250095	Research Methodology and IPR	3	1	0	4
AU-MTEISS-106	Elective	Audit Elective				0

Semester 2						
Semester Code	**Course Code**	**Course Title**	**L**	**T**	**P**	**Cr**
PC-MTEISS-201	DOEE250206	Wireless Sensor Network and IOT	3	0	2	4
PC-MTEISS-202	DOEE250182	Sensors and Wearable Technology	3	0	2	4
PE-MTEISS-203	Elective	Program Elective				4
PE-MTEISS-204	Elective	Program Elective				4
AU-MTEISS-205	Elective	Audit Elective				0
EE-MTEISS-206	EE	Mini Project				4

Semester 3						
Semester Code	**Course Code**	**Course Title**	**L**	**T**	**P**	**Cr**
PE-MTEISS-301	Elective	Program Elective				4
OE-MTEISS-302	Elective	Open Elective				4
EE-MTEISS-303	EE	Dissertation/Project-I				12

Semester 4						
Semester Code	**Course Code**	**Course Title**	**L**	**T**	**P**	**Cr**
EE-MTEISS-401	EE	Dissertation/Project-II				20

Elective Courses

Elective Courses for PE Category

Course Code	Course Title	L	T	P	Cr	For Sem./Code
DASH250082	Multi-disciplinary Product Development	3	1	0	4	
DCSA250041	IoT Applications and Web development	3	0	2	4	
DCSA250042	IoT Security and Trust	3	1	0	4	
DOAI250032	Machine Learning	3	0	2	4	
DOEE250030	Automotive Sensors and in-Vehicle Networking	3	0	2	4	
DOEE250039	Chemical and Environmental Sensor	3	1	0	4	
DOEE250082	Electronic Product Design using EDA Tools	2	1	2	4	
DOEE250102	Flexible and Wearable Sensors	3	1	0	4	
DOEE250113	Green Internet of Things	3	1	0	4	
DOEE250124	IOT and its Applications	3	1	0	4	
DOEE250161	Principles of Industrial IoT	3	0	2	4	
DOEE250172	Python for IoT	3	0	2	4	
DOEE250177	RF and Microwave Sensors	3	0	2	4	
DOEE250204	Wearable Technology and IoT	3	0	2	4	

Elective Courses for OE Category

Students may opt courses under MOOC, NPTEL, SWAYAM, NSQF/NCVET aligned courses or other relevant technical subjects not included in their core curriculum. The exercise of option shall be subject to the Course Schedule of the respective Constituent Unit, the credit requirements and availability of seats. Guidelines for choosing MOOC/Online courses are given separately and shall have to be adhered to.

Elective Courses for AU (Audit) Category

Course Code	Course Title	L	T	P	Cr
DASH240027	Disaster Management	2	0	0	0
DASH240047	English for Research Paper Writing	2	0	0	0
DASH240052	Environmental Science	3	0	0	0
DASH240085	Pedagogy Studies	2	0	0	0
DASH240086	Personality Development through Life Enlightenment Skills	2	0	0	0
DASH240097	Sanskrit for Technical Knowledge	2	0	0	0
DASH240103	Stress Management by Yoga	2	0	0	0
DASH240104	Technical Presentation and Report Writing	0	0	2	0
DASH240106	Value Education	2	0	0	0
DASH240124	Constitution of India - AU	2	0	0	0
DASH250023	Constitution of India	2	1	0	0
DASH250027	Disaster Management	3	0	0	0
DASH250034	Energy and Environmental Engineering	3	0	0	0
DASH250047	English for Research Paper Writing	2	0	0	0

DASH250054	Essence of Indian Knowledge and Tradition	2	0	0	0
DASH250085	Pedagogy Studies	2	0	0	0
DASH250086	Personality Development	2	0	0	0
DASH250097	Sanskrit for Technical Knowledge	3	0	0	0
DASH250103	Stress Management by Yoga	3	0	0	0
DASH250106	Value Education	2	0	0	0
DASH250117	Innovative Thinking and Entrepreneurship Skills	1	0	0	0
DASH250118	Intellectual Property Rights	2	0	0	0
DCSA240080	Training on Computer Networking	0	0	2	0
DCSA240304	Lab Based on Statistical Package	0	0	2	0
Any other Scheduled Course as per the Course Schedule of the respective Constituent Unit can also be chosen, subject to availability of seats. However, there shall be no assessment and grading for the course chosen as Audit Course.					

The choice of all type of Electives available shall be as per the Course Schedule of the respective Constituent Unit.

Guidelines for Massive Open Online Courses (MOOC) / approved Online Courses

1. Relevant Swayam, MOOC, NPTEL, NIELIT NSQF and any other online courses approved by UGC/AICTE shall also be allowed as Open Electives(OE).

2. One credit of MOOC course should be minimum of 30 hours.

3. A student can choose any approved online course as Open Elective, subject to minimum credit requirements.

4. The students willing to opt OE under MOOC in their next semester, will submit their request to the MOOC Coordinator at their respective campus.

5. Once approved, the campus shall display the list of accepted courses.

6. The student has to submit certificate issued by the institution offering the MOOCs course, along with the number of credits and grades, to get credits transferred into his/her marks certificate issued by NDU.

7. The transfer of credits shall be as adopted by NDU.

Detailed Syllabus

Course Code	Course Name	L	T	P	Cr
DOEE250095	Embedded Systems and Internet of Things	2	1	2	4

Course Outcomes:

CO1: Explain Intel and ARM Cortex-M processor architectures, microarchitectural techniques, and peripheral programming.
CO2: Apply ARM Cortex-M instruction sets and Thumb instruction sets in robotics applications using MSP432 kits.
CO3: Analyze communication networks, protocols, and challenges in IoT, including 5G and LPWAN technologies.
CO4: Implement IoT-specific low-power protocols (Zigbee, BLE, 6LoWPAN) and design application-oriented IoT solutions.
CO5: Evaluate modern networking concepts, IoT data analytics, cloud/fog computing, and lightweight cryptographic security solutions.

Module 1:

Introduction to Processor Architecture: Architecture of Intel processors from 80286 to Pentium-Microarchitectural techniques of advanced processors –pipelining-superscalar concept –Out of order execution –Speculative execution – branch prediction –register renaming -Multicore processors- Processors beyond Pentium-Architecture of ARM Cortex-M – NVIC – WIC--Sleep modes – peripheral programming of a Cortex-M processor.

Module 2:

Robotics Design And Application Instruction Set And Thumb Instruction Set: Robotics – Designing robotics applications using ARM cortex-M in MSP 432 Robotics kit GPU Processing.
Instruction Set: Data Processing Instructions, Addressing Modes, Branch, Load, Store Instructions, PSR Instructions, Conditional Instructions
Thumb Instruction Set: Register Usage, Other Branch Instructions, Data Processing Instructions, Single-Register and Multi Register Load-Store Instructions, Stack, Software Interrupt Instructions.

Module 3:

Communication and Networking in IoT: Review of Communication Networks, Challenges in Networking of IoT Nodes, range, bandwidth Machine-to-Machine (M2M) and IoT Technology Fundamentals, Medium Access Control (MAC) Protocols for M2M Communications Standards for the IoT Basics of 5G Cellular Networks and 5G IoT Communications, Low-Power Wide Area networks (LPWAN)Wireless communication for IoT: channel models, power budgets, data rates.Networking and communication aspects: IPv6, 6LoWPAN, COAP, MQTT, Operating Systems need and requirements for IoT..

Module 4:

IoT Protocols: Low power, low range protocols –Zigbee –BLE – 6LoWPAN. Applications for IoT-Smart home, city, agriculture etc, - IoT services Project work on Design and development of an IoT product.

Module 5:

Modern Networking: Cloud computing: Introduction to the Cloud Computing, History of cloud computing, Cloud service options, Cloud Deployment models, Business concerns in the cloud, Hypervisors, Comparison of Cloud providers, Cloud and Fog Ecosystem for IoT Review of architecture IoT Data analytics and Security: OLAP and OLTP, NoSQL databases, Row and column Oriented databases, Introduction to Columnar DBMS CStore , Run :Length and Bit vector Encoding, IoT Data Analytics. Cryptographic algorithms, Analysis of Light weight Cryptographic solutions IoT security, Key exchange using Elliptical Curve Cryptography, Comparative analysis of Cryptographic Library for IoT

Labs / Practicals:

Module 1: ARM Cortex-M Processor Basics

1. LED Blinking using ARM Cortex-M (MSP432)

o Objective: Blink an onboard LED using GPIO with a delay.

o Concepts: GPIO, delay loops, register-level programming or driverlib.

2. UART, I2C, and SPI Communication on MSP432

o Objective: Demonstrate UART, I2C, and SPI by sending/receiving data between MSP432 and peripheral/sensor (e.g., EEPROM, temperature sensor).

o Concepts: Serial communication protocols, data transfer, bus configuration.

Module 2: Thumb Instruction Set & Robotics

3. Basic Arithmetic Using ARM Thumb Assembly

o Objective: Perform addition, subtraction, and multiplication using Thumb instruction set in Keil IDE.

o Concepts: ARM registers, instruction format, branching.

4. PWM Motor Speed Control for Line Following Robot

o Objective: Control speed of DC motors using PWM to simulate a basic line following robot behavior.

Module 3: IoT Communication & Networking

5. Wi-Fi-based Sensor Data Transmission Using ESP32

o Objective: Interface DHT11/LM35 with ESP32 and send data over Wi-Fi to serial monitor.

o Concepts: Sensor interfacing, Wi-Fi configuration.

6. MQTT-based IoT Communication Using ESP32

o Objective: Publish temperature data to MQTT broker and subscribe from another node.

Module 4: IoT Protocols and Communication

7. BLE-based Smart Home Simulation

o Objective: Control an LED or fan using BLE from a smartphone app.

o Tools: ESP32 or nRF52 board, BLE scanner app.

8. Aries VAGA Processor-Based I2C/SPI Communication

o Objective: Demonstrate communication between Aries board (VAGA processor) and an I2C/SPI device like BMP180 or EEPROM.

o Concepts: Embedded communication, device addressing.

Module 5: Cloud Computing and Security

9. Sending Sensor Data to ThingSpeak Cloud

o Objective: Interface ESP32 with DHT11 and log temperature/humidity to ThingSpeak.

o Concepts: HTTP, REST APIs, IoT cloud platforms.

10. Client-Server Communication Using Socket Programming (Simulation)

- Objective: Write a basic client-server program using Python/C to simulate IoT node-to-server communication.
- Concepts: TCP/IP basics, socket programming.

References:

The x86 Microprocessors: 8086 to Pentium, Multicores, Atom, and the 8051 Microcontroller – Architecture, Programming and Interfacing
— Lyla B. Das, Second Edition, Pearson Education, India, 2014

Architecture, Programming, and Interfacing of Low-power Processors – ARM7, Cortex-M
— Lyla B. Das, Cengage, 2017

From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence
— Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, 1st Edition, Academic Press, 2014

Internet of Things: A Hands-On Approach
— Arshdeep Bahga, Vijay Madisetti, 2015

Understanding the Linux Kernel

— Daniel P. Bovet, Marco Cesati, 3rd Edition, O'Reilly, 2005

Course Code	Course Name	L	T	P	Cr
DOEE250125	IoT Fundamentals and Architecture	3	0	2	4

Course Outcomes:

CO1: Explain IoT fundamentals, characteristics, application domains, challenges, and future scope.
CO2: Describe IoT architectures, functional blocks, enabling technologies, and role of VLSI in IoT.
CO3: Analyze IoT devices, embedded platforms, sensors/actuators, protocols, and RTOS integration.
CO4: Evaluate IoT communication models, protocol stacks, data flow, cloud integration, and edge AI accelerators.
CO5: Design secure and power-optimized embedded IoT nodes using hardware/software co-design methodology.

Module 1:

Introduction to IoT
- IoT: Definition, characteristics, and evolution
- IoT vs M2M Communication
- Embedded systems, role in IoT
- Application areas: Industrial IoT, Healthcare, Smart Home, Precision Agriculture, VLSI-based sensing systems, Industry 4.0
- Challenge and Future Scope: Power, scalability, and real-time performance

Module 2:

IoT Architecture
- Basic IoT Architecture: Three-layer and Five-layer models
- Functional architecture: Device, Gateway, Network, Application
- Functional blocks of IoT: Device, Gateway, Data Processing, Application
- Role of Embedded Hardware in each layer
- Hardware-software partitioning and interface design
- Role of VLSI design in IoT (low-power ASICs, sensor interfaces, SoCs)
- IoT enabling technologies: RFID, NFC, Zigbee, Bluetooth, Wi-Fi, 5G
- Edge and Fog Computing: Concepts and Architecture

Module 3:

IoT Devices and Embedded Platforms
- Embedded IoT platforms: Raspberry Pi, BeagleBone, ESP32, STM32, TI CC3200
- Sensor and Actuator Types, Interfaces, and Applications
- Microcontrollers and Embedded Boards: Arduino, Raspberry Pi, ESP32
- Microcontroller features relevant for IoT: GPIOs, ADC/DAC, PWM, Timers, Communication modules (UART, SPI, I2C)
- IoT Communication models and APIs
- Communication protocols: MQTT, CoAP, HTTP, AMQP
- Wireless sensor networks and LPWAN (LoRa, NB-IoT, Sigfox)
- Real-time OS for IoT (RTOS basics, FreeRTOS, RIOT OS)
- Integration of FPGA/ASICs in IoT edge systems

Module 4:

Communication, Protocol Stack, and IoT Platform Integration for Data Flow
- IoT communication models and APIs
- Embedded communication protocols: UART, SPI, I2C in sensor data handling

●IoT network protocols: IPv6, 6LoWPAN, RPL
●Application layer protocols: MQTT, CoAP, HTTP/REST
●Wireless technologies: BLE, ZigBee, LoRa, Wi-Fi, NB-IoT — suitability for VLSI-based systems
●IoT Gateways: Functions and interface with edge nodes
●Cloud integration: AWS IoT, Azure IoT Hub, IBM Watson
●Data flow from sensor to cloud (Edge → Gateway → Cloud)
●Embedded data processing and local decision-making
●Use of VLSI accelerators for edge AI (TinyML, low-power inference engines)

Module 5:

Design Methodology and Security in IoT
●Embedded design methodology for IoT nodes: Specification to Modeling to Hardware/Software Co-design to Testing
●Power optimization for battery-powered IoT devices
●IoT security fundamentals: hardware root-of-trust, secure boot, data encryption
●Role of hardware-based security in VLSI (TPM, PUFs, Crypto Engines)
●Case Study: Design of a secure, power-efficient embedded IoT node

Labs / Practicals:

Lab Exercise 1: Sensor Interfacing with Embedded Platform
●Objective: Interface a temperature and humidity sensor (e.g., DHT11 or DHT22) with an ESP32 or STM32 microcontroller.
●Tasks:
  Configure GPIO and ADC (if needed).
  Read sensor data and display it on a serial monitor or OLED screen.
Lab Exercise 2: Implement MQTT Protocol for IoT Communication
●Objective: Publish sensor data to an MQTT broker using Wi-Fi.
●Tasks:
  Connect ESP32 to a Wi-Fi network.
  Use MQTT client library to send data to a public broker (e.g., HiveMQ).
  Visualize data using MQTT Dashboard or Node-RED.
Lab Exercise 3: Controlling Actuators via Cloud (Blynk or Firebase)
•Objective: Create a simple cloud-based control interface to operate an actuator (e.g., LED or Relay).
•Tasks:
  Use Firebase or Blynk to turn ON/OFF a device from a mobile.
  Implement logic on the microcontroller to sync with the cloud state
Lab Exercise 4: Secure Data Transmission Using Encrypted Communication
●Objective: Send encrypted data from the microcontroller to a server/cloud.
●Tasks:
  Implement basic AES or TLS-based communication.
  Demonstrate secure transmission of sensitive sensor data.
Lab Exercise 5: Mini Project – End-to-End IoT System
●Objective: Design an IoT-based environmental monitoring system.
●Tasks:
  Collect data from multiple sensors (e.g., temperature, light, gas).
  Process data locally and upload to the cloud in real time.
Create a dashboard to visualize trends and send alerts.

References:

1.Arshdeep Bahga, Vijay Madisetti, Internet of Things: A Hands-on Approach, Universities Press.
2.Raj Kamal, Internet of Things: Architecture and Design Principles, McGraw Hill.
3.David E. Simon, An Embedded Software Primer, Pearson.
4.IEEE papers on IoT Security, VLSI for IoT, and Embedded IoT Systems.

Course Code	Course Name	L	T	P	Cr
DASH250095	Research Methodology and IPR	3	1	0	4

Course Outcomes:

CO1: Understand the principles and process of research methodology.
CO2: Apply appropriate research design and data collection methods in computing projects.
CO3: Analyze and interpret qualitative and quantitative data using statistical tools.
CO4: Develop ethically sound, well-documented research or project reports conforming to academic and industrial standards.
CO5: Understand various forms of intellectual property and apply processes for protection and patent filing.

Module 1:

Introduction to Research and Research Ethics
Definition and objectives of research, types of research – fundamental, applied, exploratory, empirical, significance of research in computer applications, research ethics and integrity, plagiarism, citation styles (APA, IEEE), tools for plagiarism check.

Module 2:

Research Design and Data Collection
Research problem identification and formulation, hypothesis generation, literature review techniques, types of research design: experimental, descriptive, analytical, sampling techniques, primary and secondary data sources, survey design, case study design.

Module 3:

Data Analysis and Interpretation
Quantitative and qualitative data analysis, measures of central tendency and dispersion, t-test, ANOVA, correlation and regression, chi-square test, software tools: Excel, R, SPSS (demo-level), data visualization and result interpretation.

Module 4:

Technical Writing and Project Report Preparation
Structure of research papers and reports, abstract, introduction, literature review, methodology, results, and conclusions, referencing tools (Mendeley/Zotero), IEEE/ACM/SCI journal guidelines, thesis and dissertation formatting, proposal writing basics.

Module 5:

Intellectual Property Rights and Patent Process
Introduction to IPR: patents, copyrights, trademarks, industrial design, Indian and international patent systems (WIPO, TRIPS), criteria for patentability, patent filing process in India (IPINDIA portal), open-source licenses, patent drafting basics, IPR in software and AI innovations.

Labs / Practicals:

N/A

References:

1. C.R. Kothari & Gaurav Garg – Research Methodology: Methods and Techniques, New Age International.
2. Ranjit Kumar – Research Methodology – A Step-by-Step Guide, Sage Publications India.
3. P. Narayan – Intellectual Property Law, Eastern Book Company.
4. Neeraj Pandey & Khushdeep Dharni – Intellectual Property Rights, PHI Learning.
5. Yogesh Kumar Singh – Fundamentals of Research Methodology and Statistics, New Age International.
6. Bharat Bhushan – Research Methodology in Computer Science, Himalaya Publishing.
7. WIPO and IPIndia Manuals – Guidelines for Filing Patents in India.

Course Code	Course Name	L	T	P	Cr
DOEE250206	Wireless Sensor Network and IOT	3	0	2	4

Course Outcomes:

CO1: Describe the architecture, components, and operation of WSN and IoT systems.
CO2: Analyze communication protocols and data routing strategies in WSNs.
CO3: Develop IoT applications using microcontrollers and sensor networks.
CO4: Integrate WSN/IoT devices with cloud platforms for real-time monitoring.
CO5: Evaluate performance, scalability, and security in WSN and IoT deployments.

Module 1:

Introduction to Wireless Sensor Networks
• WSN architecture and applications
• Components: nodes, sinks, base stations
• Sensing, computation, and communication
• WSN design issues: energy, latency, throughput
• Comparison with traditional wireless networks

Module 2:

Communication Protocols in WSN
• Wireless communication basics: Zigbee, 6LoWPAN, BLE, LoRa
• MAC protocols: S-MAC, T-MAC, B-MAC
• Routing protocols: LEACH, PEGASIS, Directed Diffusion, Rumor Routing
• Energy-efficient protocols and sleep scheduling

Module 3:

IoT Architecture and Protocol Stack
• IoT definition and evolution
• IoT architecture: perception, network, middleware, application layers
• Protocols: MQTT, CoAP, HTTP, WebSockets
• Data formats: JSON, XML
• Interoperability and open standards

Module 4:

Embedded Systems and IoT Hardware
• Overview of microcontrollers: Arduino, NodeMCU (ESP8266/ESP32)
• Sensor integration: temperature, humidity, motion, proximity, etc.
• IoT connectivity: Wi-Fi, Bluetooth, LoRa
• Data acquisition and signal conditioning
• IoT software platforms: Blynk, ThingSpeak, Firebase, Node-RED

Module 5:

Applications, Security, and Challenges
• Smart home, smart agriculture, smart cities
• Environmental monitoring and healthcare
• IoT cloud integration and dashboards
• Security challenges: authentication, encryption, privacy
• Scalability, reliability, and power optimization

• Future trends: Edge AI, 5G IoT, Digital Twins

Labs / Practicals:

1. Interfacing a temperature and humidity sensor with ESP32/Arduino
2. Sending sensor data to cloud using MQTT protocol
3. Creating a dashboard on ThingSpeak/Blynk for IoT data visualization
4. Wireless communication using Zigbee/BLE modules
5. Implementing a smart home application with multiple sensor nodes
6. Real-time alert system using IoT (e.g., gas leak detection)
7. LoRa-based long-range sensor communication demo
8. Design of a basic WSN using multiple ESP32/LoRa nodes
9. Energy-efficient data collection using sleep mode in microcontrollers
10. Capstone mini-project: Smart application using WSN & IoT integration

References:

1. K. Sohraby, D. Minoli, T. Znati, Wireless Sensor Networks: Technology, Protocols and Applications, Wiley
2. Raj Kamal, Internet of Things: Architecture and Design, McGraw-Hill
3. Olivier Hersent, The Internet of Things: Key Applications and Protocols, Wiley
4. C. S. Raghavendra, Wireless Sensor Networks, Springer
5. Arduino, ESP32, NodeMCU documentation
6. Online tutorials: Adafruit, Hackster.io, Blynk, ThingSpeak
7. IEEE IoT Journal & NPTEL Lectures on WSN/IoT

Course Code	Course Name	L	T	P	Cr
DOEE250182	Sensors and Wearable Technology	3	0	2	4

Course Outcomes:

CO1: Explain the principles, types, and characteristics of sensors used in wearables.
CO2: Interface different sensors with microcontrollers for data acquisition.
CO3: Design low-power wearable systems with appropriate sensor selection.
CO4: Develop prototypes for health, fitness, and industrial applications.
CO5: Analyze and evaluate the performance, privacy, and ethical issues in wearable technologies.

Module 1:

Introduction to Sensors and Wearable Systems
- Definition and scope of sensors
- Classification: mechanical, thermal, optical, chemical, biological
- Evolution of wearable technology
- Components of wearable systems
- Role of sensors in wearable applications

Module 2:

Sensor Characteristics and Interfacing
- Sensor performance characteristics: accuracy, sensitivity, resolution, drift
- Static and dynamic characteristics
- Signal conditioning: amplification, filtering, ADC
- Interfacing sensors with microcontrollers (Arduino, ESP32, etc.)

Module 3:

Biometric and Physiological Sensors
- Temperature sensors (LM35, DS18B20)
- Heart rate and SpO_2 sensors (MAX30100/30102)
- ECG, EMG, EEG sensors
- GSR (Galvanic Skin Response) sensor
- Motion sensors: accelerometers, gyroscope, magnetometer
- Sensor placement and human factors

Module 4:

Embedded Systems in Wearables
- Overview of microcontrollers for wearable systems
- Low-power design techniques
- Power sources: batteries, wireless charging, energy harvesting
- Data logging and real-time monitoring
- Communication: BLE, Wi-Fi, NFC in wearable systems
- Integration with mobile apps/cloud platforms

Module 5:

Applications and Design of Wearable Devices
- Healthcare: heart monitoring, fall detection, smart bandages
- Fitness: activity trackers, smart shoes, smart clothing
- Industrial: fatigue sensors, posture monitoring, AR wearables

- Military and assistive technologies
- Ethical, privacy, and security concerns in wearable data
- Case studies and future trends in smart wearables

Labs / Practicals:

1. Interfacing a Digital Temperature Sensor (DS18B20) with ESP32
Objective: Measure body/environment temperature and display data on OLED or serial monitor.
2. Implementation of a Heart Rate and SpO_2 Monitor using MAX30102 Sensor
Objective: Develop a wearable prototype to measure pulse rate and oxygen level.
3. Motion Tracking using MPU6050 (Accelerometer + Gyroscope)
Objective: Monitor body movement and orientation for fitness or fall detection.
4. Development of a BLE-enabled Wearable Sensor Node
Objective: Transmit real-time sensor data to a mobile device via Bluetooth Low Energy (BLE).
5. Design of a Stress Detection Band using GSR Sensor
Objective: Measure skin conductance as an indicator of stress or emotional arousal.
6. Gesture Detection using Flex Sensors for Smart Gloves
Objective: Detect hand gestures using resistive flex sensors and display actions.
7. Battery Level Monitoring and Power Optimization in Wearable Devices
Objective: Measure voltage and implement deep sleep modes in ESP32/Arduino.
8. Integration of an E-Textile (Conductive Fabric) for Touch Input
Objective: Create a basic wearable interface using textile-based touchpads.
9. Cloud Connectivity using ThingSpeak for Remote Health Monitoring
Objective: Send sensor data to cloud and visualize parameters over time.
10. Capstone Mini Project: Design and Demonstration of a Wearable System
Examples:
   - Smart shoe for step counting and activity monitoring
   - Sleep monitoring headband
   - Smart watch prototype for temperature, heart rate, and stress

References:

- Edward Sazonov, “Wearable Sensors: Fundamentals, Implementation and Applications”, Academic Press
- Jacob Fraden, “Handbook of Modern Sensors: Physics, Designs, and Applications”, Springer
- John G. Webster, “Medical Instrumentation: Application and Design”, Wiley
- Saeed B. Niku, Introduction to Robotics: Analysis, Control, Applications, Wiley, 2020.
- Dan Zhang & Bin Wei, Advanced Mechatronics and MEMS Devices II, Springer, 2017.
- Bonato, Paolo, Wearable Monitoring Systems, Springer, 2010.
- Online datasheets and microcontroller documentation (Arduino, ESP32, etc.)

Course Code	Course Name	L	T	P	Cr
DASH250082	Multi-disciplinary Product Development	3	1	0	4

Course Outcomes:

CO1: Understand the processes, challenges, and models in product development across disciplines.
CO2: Apply system thinking and engineering design principles to conceptualize IoT/sensor-based products.
CO3: Analyze user needs, market trends, and design specifications to guide innovation.
CO4: Evaluate product lifecycle, manufacturability, cost, and sustainability of sensor-enabled solutions.
CO5: Design a multidisciplinary product prototype integrating hardware, software, and system modeling.

Module 1:

Introduction to Multi-disciplinary Product Development
Overview of product development process; stages – Idea, Design, Prototype, Test, Launch; Innovation in IoT, embedded and sensor-based products; case studies of Indian startups (e.g., Detect Technologies, Tork Motors); TRIZ, design thinking, and agile design.

Module 2:

System Design and Requirement Analysis
System architecture for IoT and sensor solutions; Requirement analysis – functional and non-functional; Hardware-Software co-design; Modularity and platform thinking; Human-centered design and usability.

Module 3:

Prototyping, Simulation and Modelling
Rapid prototyping – 3D printing, breadboards, simulation tools (MATLAB/Simulink, Proteus, TinkerCAD); sensor selection, integration, and calibration; interfacing with microcontrollers and SoCs; digital twins and system-level modeling.

Module 4:

Costing, Testing and Product Lifecycle
Bill of Materials (BoM), cost estimation techniques, design for manufacturability (DFM), reliability, and maintainability; testing protocols; standards and certifications (ISO, BIS, CE); product lifecycle management (PLM); regulatory compliance.

Module 5:

Innovation, Sustainability and Industry Trends
Sustainable product design – material, energy, and packaging; IP generation and protection; Start-up India and MSME schemes; integration with AI, blockchain, 5G; trends – wearable tech, agri-tech, med-tech, smart cities; role of incubators and innovation hubs.

Labs / Practicals:

N/A

References:

1. B. S. Raghuwanshi & M.K. Gaur – Product Design and Development, PHI Learning
2. T.K. Nagsarkar & M.S. Sukhija – Basics of Product Design and Development, Oxford University Press
3. R.G. Kaduskar & V.B. Baru – Electronic Product Design, Wiley India
4. K. Vijayakarthikeyan – Engineering Design Thinking, Notion Press
5. Gautam Mahajan – Total Customer Value Management, SAGE India

Course Code	Course Name	L	T	P	Cr
DCSA250041	IoT Applications and Web development	3	0	2	4

Course Outcomes:

CO1: Create basic web pages using HTML, CSS, and DHTML with good design and user experience.
CO2: Use JavaScript and J2ME to build interactive applications and simple IoT solutions.
CO3: Develop simple mobile apps in Android using layouts, events, and database connections.
CO4: Explain and apply IoT techniques in smart farming systems like weather monitoring and drones.
CO5: Apply IoT concepts in energy monitoring, home automation, smart grids, and smart city services.

Module 1:

Introduction to Markup language, HTML document structure, HTML forms, Style (CSS), Multiple CSS stylesheets, DHTML, Tools for image creation and manipulation, User experience design, IoT development using charts

Module 2:

Introduction to JavaScript, Functions, DOM, Forms, and Event Handlers, Object Handlers, Input validation, J2ME, application design using J2ME , IoT development using Real time rules, platforms, alerts

Module 3:

Mobile app development: Android Development environment, Simple UI Layouts and layout properties, GUI objects, Event Driven Programming, opening and closing a Database

Module 4:

Smart Farming: Weather monitoring, Precision farming, Smart Greenhouse, Drones for pesticides.

Module 5:

Energy Consumption Monitoring, Smart Energy Meters, Home automation, Smart Grid and Solar Energy Harvesting, Intelligent Parking, Data lake services scenarios.

Labs / Practicals:

NA

References:

1. John Dean, Web Programming with HTML5, CSS and JavaScript, 2018, Jones and Bartlett Publishers Inc., ISBN-10: 9781284091793
2. DiMarzio J. F., Beginning Android Programming with Android Studio, 2016, 4th ed.,Wiley, ISBN-10: 9788126565580
3. Fadi Al-Turjman, Intelligence in IoT- enabled Smart Cities, 2019, 1st edition, CRC Press, ISBN-10: 1138316849

Course Code	Course Name	L	T	P	Cr
DCSA250042	IoT Security and Trust	3	1	0	4

Course Outcomes:

CO1. Understand the cryptography algorithms.
CO2. Solve network security problems in various networks.
CO3. Build security systems using elementary blocks.
CO4. Build Trustable cloud-based IoT systems and solve IoT security problems using light weight cryptography.
CO5. Appreciate the need for cyber security laws and methods.

Module 1:

Cryptography – Need and the Mathematical basics- History of cryptography, symmetric ciphers, block ciphers, DES – AES. Public-key cryptography: RSA, Diffie-Hellman Algorithm,Elliptic Curve Cryptosystems, Algebraic structure, Triple Data Encryption Algorithm (TDEA) Blockcipher.

Module 2:

IIOT security frame work, Security in hardware,Bootprocess, OS & Kernel, application,run time environment and containers. Need and methods of Edge Security, Network Security: Internet, Intranet, LAN, Wireless Networks, Wireless cellular networks, Cellular Networks and VOIP.

Module 3:

Vulnerability of IoT and elementary blocks of IoT Security, Threat modeling – Key elements. Identity management Models and Identity management in IoT, Approaches using User-centric,Device-centric and Hybrid.

Trust management lifecycle, Identity and Trust, Web of trust models. Establishment: Cryptosystems – Mutual establishment phases – Comparison on security analysis. Identitymanagement framework.

Module 4:

Capability-based access control schemes,Concepts, identity-based and identity-driven, Lightweight cryptography, need and methods , IoT use cases, Cloud security , Digital identity management in cloud, Classical solutions, alternative solutions,Management of privacy and personal data in Cloud.

Module 5:

Cyber Crimes and Laws – Hackers – Dealing with the rise tide of Cyber Crimes – Cyber Forensicsand incident Response – Network Forensics.

Labs / Practicals:

NA

References:

1. John R. Vacca, “Computer and Information Security Handbook”, Elsevier, 2013. Parikshit Narendra Mahalle , Poonam N. R
2. William Stallings, “Cryptography and Network security: Principles and Practice”, 5th Edition, 2014, Pearson Education, India.
3. Christof Paar and Jan Pelzl, “Understanding Cryptography – A Textbook for Students andPractitioners”, Springer, 2014

Course Code	Course Name	L	T	P	Cr
DOAI250032	Machine Learning	3	0	2	4

Course Outcomes:

CO1: Identify and extract relevant features from raw IoT data suitable for applying appropriate Machine Learning (ML) techniques.
CO2: Evaluate and compare the strengths and limitations of various ML algorithms across diverse application domains, particularly in IoT.
CO3: Select and implement appropriate ML models based on data characteristics and application requirements.
CO4: Mathematically formulate and analyze ML models and algorithms, including their underlying assumptions and performance metrics.
CO5: Design and validate machine learning-based solutions for real-world problems in IoT, demonstrating practical understanding and technical proficiency.

Module 1:

Module 1
Introduction: Introduction to Machine Learning: Introduction. Different types of learning, Hypothesis space and inductive bias, Evaluation. Training and test sets, cross validation, Concept of over fitting, under fitting, Bias and Variance.
Linear Regression: Introduction, Linear regression, Simple and Multiple Linear regression, Polynomial regression, evaluating regression fit.

Module 2:

Module 2
Decision tree learning: Introduction, Decision tree representation, appropriate problems for decision tree learning, the basic decision tree algorithm, hypothesis space search in decision tree learning, inductive bias in decision tree learning, issues in decision tree learning, Python exercise on Decision Tree.
Instance based Learning: K nearest neighbor, the Curse of Dimensionality, Feature Selection: forward search, backward search, univariate, multivariate feature selection approach, Feature reduction (Principal Component Analysis), Python exercise on KNN and PCA. Recommender System: Content based system, Collaborative filtering based.

Module 3:

Probability and Bayes Learning: Bayesian Learning, Naïve Bayes, Python exercise on Naïve Bayes, Logistic Regression.
Support Vector Machine: Introduction, the Dual formulation, Maximum margin with noise, nonlinear SVM and Kernel function, solution to dual problem.

Module 4:

Artificial Neural Networks: Introduction, Biological motivation, ANN representation, appropriate problem for ANN learning, Perceptron, multilayer networks and the back propagation algorithm.

Module 5:

Ensembles: Introduction, Bagging and boosting, Random forest, Discussion on some research papers.
Clustering: Introduction, K-mean clustering, agglomerative hierarchical clustering, Python exercise on k-mean clustering.

Labs / Practicals:

1 Write a Python program that imports a dataset of your choice, displays the first five rows, and prints the data type of the DataFrame as a whole. Then, generate and display the statistical summary (mean, median, standard deviation, etc.) for each column and provide complete information about the DataFrame.

2 Write a Python program to import (or create) a dataset with missing values, display the count of missing values per column, and handle them using both imputation and dropping methods. Then, compare the dataset before and after handling missing values, and display the final cleaned dataset.
3 Write a Python program to load (or create) a dataset, split it into training and testing sets, and standardize the features using StandardScaler from sklearn. preprocessing. Finally, display the dataset before and after standardization to observe the changes.
4 Write a Python program to load (or create) a dataset, separate it into predictor variables (X) and target variable (y), and then split the dataset into training and testing sets. Finally, print both the training and testing datasets.
5 Apply EM algorithm to cluster a set of data stored in a .CSV file. Use the same data set for clustering using k-Means algorithm. Compare the results of these two algorithms and comment on the quality of clustering. You can add Python ML library classes in the program.
6 Write a Python program to load (or create) a dataset with missing values, count missing values in each column, and handle them by replacing with NaN, the column mean, and the most frequent value. Finally, display the dataset before and after performing the replacements.
7 Write a Python program to load (or create) a dataset, split it into training and testing sets, and apply feature scaling to the data. Finally, display the dataset before and after scaling to observe the changes.
8 Write a program to implement k-Nearest Neighbour algorithm to classify the iris data set. Print both correct and wrong predictions. Python ML library classes can be used for this problem.
9 Implement the working principle of Artificial Neural Network with feed forward and feed backward principle.
10 Implement and demonstrate the working of SVM algorithm for classification.

References:

1. Kevin P. Murphy, “Machine Learning: A Probabilistic Perspective”, MIT Press, 2012.
2. C. M. Bishop. Pattern Recognition and Machine Learning. First Edition. Springer, 2006. (Second Indian Reprint, 2015).
3. Tom M. Mitchell, “Machine Learning”, McGraw-Hill, 2010
4. P. Flach. Machine Learning: The Art and Science of Algorithms that Make Sense of Data. First Edition, Cambridge University Press, 2012.

Course Code	Course Name	L	T	P	Cr
DOEE250030	Automotive Sensors and in-Vehicle Networking	3	0	2	4

Course Outcomes:

CO1: Explain the fundamentals of power-train, transmission, braking, and the role of electronics in modern automotive systems.
CO2: Demonstrate working principles and applications of engine-related sensors such as λ sensors, NOx, PM, fuel, torque, and pressure sensors.
CO3: Analyze vehicle motion and safety-related sensors including wheel speed, steering position, acceleration, ABS, and stability sensors.
CO4: Evaluate advanced automotive safety and driver-assist technologies such as airbag systems, keyless entry, radar, tire pressure monitoring, and anti-collision techniques.
CO5: Assess sensor-based occupant protection, vehicle diagnostics, and future trends in intelligent, safe, and reliable automotive electronics.

Module 1:

Power-train, Combustion Engines, Transmission, Differential Gear, Braking Systems, Introduction to Modern Automotive Systems and need for electronics in Automobiles, Application areas of electronics in the automobiles, Possibilities and challenges in the automotiveindustry, Enabling technologies and Industry trends.

Module 2:

λ sensors, exhaust temperature sensor, NOx sensor, PM sensor, fuel quality sensor, level sensor, torque sensor, speed sensor, mass flow sensor,and manifold pressure sensor.

Module 3:

Wheel speed sensors/direction sensors, steering position sensor (multi turn), acceleration sensor(inertia measurement), brake pneumatic pressure sensor, ABS sensor, electronic stability sensor

Module 4:

Gas sensors (CO_2), Temperature/humidity sensor, air bag sensor, key less entering sensor, radar sensors. Tire pressure monitoring systems, Two wheeler and Four wheeler security systems, parking guide systems, anti-lock braking system, future safety technologies, Vehicle diagnostics and health monitoring, Safety and Reliability, Traction Control, Vehicle, dynamics control, Accelerators and tilt sensors for sensing skidding and anti-collision, Anticollision techniques using ultrasonic Doppler sensors.

Module 5:

Principal Sensor Functions, Distributed Front Air Bag sensing systems, Single-Point Sensingsystems, Side-Impact Sensing, and Future Occupant Protection systems

Labs / Practicals:

NA

References:

1. Automotive Electrics, Automotive Electronics: Systems & Components, 2014, 5th Edition,BOSCH.
2. John Turner, Automotive Sensors, 2010, 1st Edition, Momentum Press, New York
3. Jiri Marek, Hans-Peter Trah, Yasutoshi Suzuki, IwaoYokomori, Sensors for AutomotiveTechnology, 2010, 4th Edition, Wiley, New York.

Course Code	Course Name	L	T	P	Cr
DOEE250039	Chemical and Environmental Sensor	3	1	0	4

Course Outcomes:

CO1: Explain the principles of thermodynamics, electrochemistry, ionic conductivity, and phase diagrams relevant to sensor applications.
CO2: Demonstrate the working of potentiometric and amperometric sensors, including ion-selective electrodes and enzyme-based biosensors.
CO3: Analyze advanced biosensing techniques such as fiber-optic, fluorescence, luminescence, immunosensors, and microbial biosensors for environmental and biomedical monitoring.
CO4: Evaluate exhaust gas sensors, OBD strategies, and control sensors for monitoring and reducing automotive emissions.
CO5: Apply measurement techniques for particulate matter and specific gaseous pollutants (SOx, NOx, CO, hydrocarbons) for air quality and emission control.

Module 1:

Thermodynamics, , Enthalpy, Entropy, Gibbs free Energy, Law of Mass Action, simple Galvanic Cells, Electrode – Electrolyte Interface, Fluid Electrolytes, Dissociation of Salt, Solubility Product, Ion Product, pH Value, Ionic Conductivity, Ionic Mobility, Phase Diagrams.

Module 2:

Potentiometric- Ion selective electrodes- pH linked, Ammonia linked, CO2 linked, Silver sulfide linked, Iodine selective, amperometric -bio sensors and gas sensors, Amperometric enzyme electrodes: substrate and enzyme activity, Detection mode and transduction method, mediated and modified electrodes, pH glass and ion selective electrodes, solid state and redox electrodes

Module 3:

Fiber optic biosensor, Fluorophore and chromophore based biosensor, Bioluminescence and chemiluminescence based biosensors, Non-labeled and labeled immune sensors, Microbial Biosensors: electrochemical, photomicrobial, Microbial thermistor. Application of microbial biosensors in glucose, ammonia, acetic acid, alcohol, BOD, methane sensing

Module 4:

Engine combustion process, Catalytic exhaust after treatment, Emission limits, Exhaust sensors and Engine control, Emission test cycles, On-board diagnose (OBD): Diagnose Strategies, Exhaust sensors for OBD, Control Sensors: Hydro-Carbon Sensors, NOx Sensors, Temperature Sensors, Oxygen Sensors.

Module 5:

Measurement techniques for particulate matter in air. Specific gaseous pollutants analysis and control-Measurement of oxides of sulphur, oxides of nitrogen unburnt hydrocarbons, carbon-monoxide, dust mist and fog.

Labs / Practicals:

NA

References:

1. Janata, Jiri,"Principles of Chemical sensors", 2014, 2nd edition, Springer, New York.
2. Brian R Eggins, “Chemical Sensors and Biosensors”, (Part of AnTS Series), 2010, 1stedition, John Wiley Sons Ltd, New York
3. Peter Grundler, "Chemical Sensors: Introduction for Scientists and Engineers", 2011, 1stedition, Springer, New York.

Course Code	Course Name	L	T	P	Cr
DOEE250082	Electronic Product Design using EDA Tools	2	1	2	4

Course Outcomes:

CO1: Understand and apply EDA tools for schematic capture, simulation, synthesis, and layout design.
CO2: Perform schematic design, simulation, and signal integrity verification using industry-standard methodologies.
CO3: Apply logic synthesis, optimization, and timing analysis for efficient digital circuit design.
CO4: Develop layout design with placement, routing, and physical verification ensuring manufacturability.
CO5: Integrate advanced EDA techniques in a complete design flow and demonstrate through project work.

Module 1:

Introduction to Electronic Design Automation (EDA) Tools: Overview of EDA tools for electronic product design, Introduction to popular EDA software suites (e.g., Cadence, Synopsys, Mentor Graphics), Basic concepts of schematic capture, simulation, synthesis, and layout design.

Module 2:

Schematic Design and Simulation: Schematic capture techniques using EDA tools, Component selection, placement, and connectivity considerations, Introduction to simulation methodologies (e.g., transient, DC, AC, and transient analysis), Verifying circuit functionality, performance, and signal integrity through simulation.

Module 3:

Synthesis and Optimization: Principles of logic synthesis and optimization, Utilizing EDA tools for RTL (Register Transfer Level) synthesis, Optimization techniques for area, power, and timing constraints, Timing analysis and constraints setup for synchronous digital designs.

Module 4:

Layout Design and Physical Verification: Introduction to layout design principles and methodologies, Floor planning, placement, and routing techniques using EDA tools, Understanding Design Rule Checks (DRC) and Layout vs. Schematic (LVS) verification, Physical verification techniques to ensure design manufacturability and reliability.

Module 5:

Advanced Topics and Project Work: Advanced concepts such as analog/mixed-signal design, power analysis, and formal verification, Integration of EDA tools into a complete electronic product design flow, Hands-on project work involving the design, simulation, synthesis, layout, and verification of a complex electronic product using EDA tools, Presentation and documentation of project outcomes.

Labs / Practicals:

1. Schematic Design Exercise:
• Create a schematic diagram for a simple digital circuit using EDA software, ensuring proper component selection and connectivity.
2. Simulation Analysis:
• Conduct transient analysis on the designed circuit to verify its functionality and transient response using EDA simulation tools.
3. Logic Synthesis and Optimization Task:
• Perform RTL synthesis and optimization for a given digital design, optimizing for area, power, and timing constraints.
4. Timing Constraints Setup:
• Set up timing constraints and perform timing analysis for synchronous digital designs to ensure proper operation within specified timing requirements.

5. Layout Design Challenge:
• Design the layout for the synthesized digital circuit, considering floor planning, placement, and routing techniques to optimize layout area and signal integrity.
6. Design Rule Checks (DRC) Evaluation:
• Conduct DRC checks on the layout design to identify and rectify violations, ensuring compliance with manufacturing rules and constraints.
7. Layout vs. Schematic (LVS) Verification Task:
• Perform LVS verification to ensure consistency and accuracy between the schematic and layout designs, resolving any mismatches or discrepancies.
8. Physical Verification Assignment:
• Perform physical verification tasks including DRC, LVS, and other checks to ensure design manufacturability and reliability.
9. Advanced Design Exploration Project:
• Explore advanced design concepts such as analog/mixed-signal design or power analysis, implementing a small-scale project using EDA tools.
10. Comprehensive Project Presentation:
11. Present and document a comprehensive project involving the entire electronic product design flow, demonstrating proficiency in using EDA tools for design, simulation, synthesis, layout, and verification.

References:

1. "EDA for IC Implementation, Circuit Design, and Process Technology" by Luciano Lavagno, Igor L. Markov, and Louis K. Scheffer
2. "Digital Integrated Circuits: A Design Perspective" by Jan M. Rabaey, Anantha Chandrakasan, and Borivoje Nikolić
3. "Introduction to VLSI Circuits and Systems" by John P. Uyemura
4. "SystemVerilog for Design" by Stuart Sutherland, Simon Davidmann, and Peter Flake
5. "ASIC Design in the Silicon Sandbox: A Complete Guide to Building Mixed-Signal Integrated Circuits" by Keith Barr

Course Code	Course Name	L	T	P	Cr
DOEE250102	Flexible and Wearable Sensors	3	1	0	4

Course Outcomes:

CO1: Explain the history, materials, and fabrication technologies used in flexible electronics.
CO2: Describe low-temperature processing techniques, dielectric deposition, and device stability aspects.
CO3: Analyze materials for flexible electronics and evaluate print processing methods for device fabrication.
CO4: Discuss thin-film transistor technologies, IGZO-based devices, and plastic electronics applications.
CO5: Assess wearable electronics, their attributes, challenges, opportunities, and future trends.

Module 1:

History of flexible electronics - Materials for flexible electronics: degrees of flexiblility, substrates, backplane electronics, front plane technologies, encapsulation -Fabrication technology for flexible electronics - Fabrication on sheets by batch processing, fabrication on web by Roll-to- Roll processing - Additive printing.

Module 2:

Fundamental issues for low temperature processing - low temperature amorphous and nano- crystalline silicon - characteristics of low temperature dielectric thin film deposition –low temperature silicon nitride and silicon oxide characteristics - Device structures and materials processing - Device performance - Contacts for the device - Device stability.

Module 3:

Materials considerations for flexible electronics: Overview, Inorganics semiconductors and dielectrics, organic semiconductors and dielectrics, conductors - Print processing options for device fabrication: Overview, control of feature sizes of jet printed liquids, jet printing for etch mask patterning, methods for minimizing feature size, printing active materials.

Module 4:

Introduction -Thin film transistors: Materials and Technologies - Review of semiconductors employed in flexible electronics - Thin film transistors based on IGZO - Plastic electronics for smart textiles - Improvements and limitations.

Module 5:

World of wearables - Attributes of wearables - Textiles and clothing: The meta wearable -Challenges and opportunities - Future of wearables - Need for wearable haptic devices -Categories of wearable haptic and tactile display

Labs / Practicals:

NA

References:

1. Michael J. McGrath, Cliodhna Ni Scanaill, Dawn Nafus, “Sensor Technologies: Healthcare, Wellness and Environmental Applications”, 201, 1st Edition , Apress Media LLC, New York.
2. William S. Wong, Alberto Salleo, Flexible Electronics: Materials and Applications, 2011, 1stEdition, Springer, New York.

Course Code	Course Name	L	T	P	Cr
DOEE250113	Green Internet of Things	3	1	0	4

Course Outcomes:

CO1: Explain energy sources, harvesting techniques, and photovoltaic cell technologies for power generation.
CO2: Describe piezoelectric materials, transducers, and electromechanical modeling for energy harvesting.
CO3: Analyze magnetic energy harvesting principles, scaling effects, and nonlinear vibration control techniques.
CO4: Evaluate power sources, conversion methods, and microelectronic circuits for wireless sensor networks.
CO5: Assess energy harvesting applications in biomedical devices, RF sensors, and structural health monitoring nodes.

Module 1:

Introduction – Energy sources – energy harvesting based sensor networks –photovoltaic cell technologies – generation of electric power in semiconductor PV cells– types

Module 2:

Piezoelectric materials – transducers – harvesters – microgenerators – strategies for enhancing the performance of energy harvesters. Electromechanical modeling of Lumped parameter model and coupled distributed parameter models and closed-form solutions

Module 3:

Basic principles – micro fabricated coils and magnetic materials – scaling – power maximations – micro and macro scale implementations. Non-linear techniques –vibration control & steady state cases

Module 4:

Power sources for WSN – Power generation – conversion – examples – case studies. Harvesting micro electronic circuits – power conditioning and losses

Module 5:

Case studies for Implanted medical devices – Bio-MEMS based applications –harvesting for RF sensors and ID tags – powering wireless SHM sensor nodes

Labs / Practicals:

NA

References:

1. Carlos Manuel Ferreira Carvalho, Nuno Filipe Silva VeríssimoPaulino, “CMOS Indoor Light Energy Harvesting System for Wireless Sensing Applications”, springer
2. Danick Briand, Eric Yeatman, Shad Roundy ,“Micro Energy Harvesting”

Course Code	Course Name	L	T	P	Cr
DOEE250124	IOT and its Applications	3	1	0	4

Course Outcomes:

CO1: Understand the basics of IoT.
CO2: Implement the state of the Architecture of an IoT.
CO3: Understand design methodology and hardware platforms involved in IoT.
CO4: Understand how to analyze and organize the data.
CO5: Compare IOT Applications in Industrial & realworld.

Module 1:

FUNDAMENTALS OF IoT- Evolution of Internet of Things, Enabling Technologies, M2M Communication, IoT World Forum (IoTWF) standardized architecture, Simplified IoT Architecture, Core IoT Functional Stack, Fog, Edge and Cloud in IoT, Functional blocks of an IoT ecosystem, Sensors, Actuators, Smart Objects and Connecting Smart Objects.

Module 2:

IoT PROTOCOLS- IoT Access Technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4, 802.11ah and Lora WAN, Network Layer: IP versions, Constrained Nodes and Constrained Networks,6LoWPAN, Application Transport Methods: SCADA, Application Layer Protocols: CoAP and MQTT.

Module 3:

DESIGN AND DEVELOPMENT- Design Methodology, Embedded computing logic, Microcontroller, System on Chips, IoT system building blocks
IoT Platform overview: Overview of IoT supported Hardware platforms such as: Raspberry pi, Arduino Board details

Module 4:

DATA ANALYTICS AND SUPPORTING SERVICES:
Data Analytics: Introduction, Structured Versus Unstructured Data, Data in Motion versus Data at Rest, IoT Data Analytics Challenges, Data Acquiring, Organizing in IoT/M2M,
Supporting Services: Computing Using a Cloud Platform for IoT/M2M Applications/Services, Everything as a service and Cloud Service Models.

Module 5:

CASE STUDIES/INDUSTRIAL APPLICATIONS: IoT applications in home, infrastructures, buildings, security, Industries, Home appliances, other IoT electronic equipments, Industry 4.0 concepts.

Labs / Practicals:

NA

References:

1. The Internet of Things – Key applications and Protocols, Olivier Hersent, David Boswarthick, Omar Elloumi and Wiley, 2012 (for Unit2).
2. “From Machine-to-Machine to the Internet of Things – Introduction to a New Age of Intelligence”,Jan Ho¨ ller, VlasiosTsiatsis, Catherine Mulligan, Stamatis,

Karnouskos, Stefan Avesand. David Boyle and Elsevier, 2014.
3. Architecting the Internet of Things,Dieter Uckelmann, Mark Harrison, Michahelles and Florian (Eds), Springer,2011.
4. Recipes to Begin, Expand, and Enhance Your Projects, 2nd Edition,Michael Margolis,Arduino Cookbook and O‟Reilly Media,2011.

Course Code	Course Name	L	T	P	Cr
DOEE250161	Principles of Industrial IoT	3	0	2	4

Course Outcomes:

CO1: Understand the enabling technologies, catalysts, and use cases that drive the development of Industrial IoT systems.
CO2: Describe and design IIoT Reference Architecture and identify the role of network, middleware, and application layers.
CO3: Analyze IIoT communication protocols, including Access Networks and WAN technologies, used in industrial environments.
CO4: Examine the importance of information security and data protection strategies in Industrial IoT systems.
CO5: Develop and experiment with IoT-based solutions for real-time industrial applications aligned with Industry 4.0 concepts.

Module 1:

Industry 4.0: (8 Hours)

Cyber Physical Systems and Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Augmented Reality and Virtual Reality, Artificial Intelligence, Big Data and Advanced Analysis

Module 2:

Industrial IoT: (8 Hours)

IIoT-Introduction, Industrial IoT: Business Model and Reference Architecture: IIoT-Business Models, Industrial IoT- Layers: IIoT Sensing, IIoT Processing, IIoT Communication, IIoT Networking

Module 3:

IIoT Analytics: (8 Hours)

Big Data Analytics and Software Defined Networks, Machine Learning and Data Science, Julia Programming, Data Management with Hadoop.

Module 4:

IoT Security: Industrial IoT (8 Hours)

Security and Fog Computing - Cloud Computing in IIoT, Fog Computing in IIoT, Security in IIoT

Module 5:

Case Study: (8 Hours)

Industrial IoT- Application Domains: Oil, chemical and pharmaceutical industry, Applications of UAVs in Industries, Real case studies: Milk Processing and Packaging Industries, Manufacturing Industries

Labs / Practicals:

1. Experiment No.1: Interfacing Industrial Sensors with Microcontroller (e.g., Temperature, Pressure, Proximity): Read data from industrial-grade sensors (e.g., LM35, MQ-135, ultrasonic, IR) using Arduino or NodeMCU.
2. Experiment No.2: Data Acquisition and Visualization using IoT Platform (e.g., ThingSpeak, Blynk): Send real-time sensor data to the cloud via Wi-Fi and visualize readings on dashboards.
3. Experiment No.3: Industrial Actuator Control using Microcontroller (Relay, Motor): Control devices like relays, fans, or valves using digital outputs based on sensor input or remote commands.

4. Experiment No.4: MQTT Protocol Implementation for IIoT Communication: Set up an MQTT broker (e.g., Mosquitto) and publish/subscribe to topics for device communication using Python or NodeMCU.
5. Experiment No.5: Edge Device Programming for Data Filtering and Local Decision Making: Implement basic logic on microcontrollers (like NodeMCU) to process sensor data locally before transmission.
6. Experiment No.6: Wireless Sensor Network Simulation using LoRa or Zigbee: Demonstrate long-range communication using LoRa or Zigbee modules between multiple IIoT nodes.
7. Experiment No.7: Industry 4.0 Use Case Simulation (Predictive Maintenance or Smart Monitoring): Simulate a condition-monitoring system using vibration, temperature, or pressure sensors and generate alerts.
8. Experiment No.8: Security Implementation in IIoT (Data Encryption using AES or RSA): Encrypt sensor data using AES before transmission and decrypt at the receiver end using Python or C.
9. Experiment No.9: Data Logging and Analysis using Raspberry Pi and Python: Collect sensor data, store it in CSV or database (SQLite/MySQL), and plot trends using Matplotlib or Pandas.
10. Experiment No.10: Mini Project: Industrial IoT Prototype (Smart Factory, Warehouse Monitoring, etc.): Develop a working prototype integrating sensors, edge devices, and a cloud dashboard for an industrial application.

References:

1. Industry 4.0: The Industrial Internet of Things”, by Alasdair Gilchrist (Apress), 2017
2. Industrial Internet of Things: Cyber manufacturing Systems “by Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat (Springer), 2017
3. Hands-On Industrial Internet of Things: Create a powerful Industrial IoT by Giacomo Veneri, Antonio Capasso, Packt, 2018.

Course Code	Course Name	L	T	P	Cr
DOEE250172	Python for IoT	3	0	2	4

Course Outcomes:

CO1: Explain IoT fundamentals, architecture, protocols, platforms, components, and Raspberry Pi basics.
CO2: Apply Python programming concepts for data processing and control in IoT applications.
CO3: Interface and integrate various sensors and communication modules with Raspberry Pi.
CO4: Design and implement IoT applications using Raspberry Pi with web-server and automation features.
CO5: Utilize Node-RED and MQTT protocols for IoT data communication and visualization.

Module 1:

Overview of IoT: Understanding IoT fundamentals, IOT Architecture, protocols, Various Platforms for IoT, Real time Examples of IoT, Overview of IoT components and IoT Communication Technologies, Getting started with Raspberry Pi.

Overview of Raspberry Pi: Introduction to Raspberry Pi, Comparison of various Rpi Models, Understanding SoC architecture and SoCs used in Raspberry Pi, Pin Description of Raspberry Pi , On-board components of Rpi.

Module 2:

RPi using Python and Sensing Data using Python: Introduction, Python vs. Other Languages, Applications of Python.
Understanding Python Interpreted Languages: Variables, Keywords, Operators and Operands, Data Types in Python, Importing Libraries, Flow Control, Conditional Statement, Loops

Module 3:

Sensors Interfacing: Temperature and Humidity Sensor DHT11), Motion Sensor PIR), Obstacle detection using Ultrasonic sensor, etc.
Communicating using RPi- GSM interfacing, Accessing on-board Wi-Fi, Connecting Database with RPi

Module 4:

IoT Design using Raspberry Pi
IoT Applications based on Pi, LAMP Web-server, GPIO Control over WebBrowser, Creating Custom Web Page for LAMP, Communicating data using on-board module, Home automation using P

Module 5:

Node-RED, MQTT Protocol, Using Node-RED Visual Editor on Rpi

Labs / Practicals:

NA

References:

1. Programming the Raspberry Pi, Second Edition: Getting Started with Python 2nd Edition by Simon Monk McGraw Hill Professional, 04-Jun-2021 - Technology & Engineering -208 pages
2. Exploring Raspberry Pi: Interfacing to the Real World with Embedded Linux 1st Edition by Derek Molloy, wiley publications 2016.

Course Code	Course Name	L	T	P	Cr
DOEE250177	RF and Microwave Sensors	3	0	2	4

Course Outcomes:

CO1: Explain the fundamentals, parameters, radiation mechanisms, and applications of microwave antennas.
CO2: Analyze the design, modeling, and characterization of printed and wearable antennas for WBAN applications.
CO3: Describe RADAR principles, range equations, and various RADAR types including MTI, Doppler, SAR, and CW.
CO4: Evaluate RADAR applications in automotive, remote sensing, agriculture, medicine, and defense.
CO5: Apply radiative transfer theory and radiometer concepts for applications in environmental and medical fields.

Module 1:

Microwave Antenna-Introduction, types of Antenna, fundamental parameters of antennas, radiation mechanism, Fresnel and Fraunhofer regions. Antenna for communication and Antenna for sensing, radiometer and radar

Module 2:

Concepts of Printed Antennas, Broadband Microstrip Patch Antennas, Antennas for Wearable Devices, Design Requirements, Modeling and Characterization of Wearable Antennas, WBAN Radio Channel Characterization and Effect of Wearable Antennas, Domains of Operation, Sources on the Human Body, Compact Wearable Antenna for different applications.

Module 3:

Introduction to RADAR, RADAR range equation, MTI and pulse Doppler RADAR, Tracking RADAR, SAR pulse RADAR, CW RADAR

Module 4:

Automotive, remote sensing, agriculture, medicine, detection of buried objects, NDT, defense factors affecting the performance of RADAR, RADAR transmitters, Receivers

Module 5:

Radiative transfer theory, SMMR, Types of radiometers - and Bolometers, Applications in automotive, agriculture, medicine, weather forecasting

Labs / Practicals:

NA

References:

1. Finkenzeuer Klaus, “RFID Handbook”, 2011, 3rd edition, John Wiley and Sons, New Jersey
2. Constantine A. Balanis, “Antenna Theory Analysis and Design”, 2016, 4th edition, JohnWiley and Sons, New Jersey.

Course Code	Course Name	L	T	P	Cr
DOEE250204	Wearable Technology and IoT	3	0	2	4

Course Outcomes:

CO1: Understand the fundamentals and evolution of wearable technologies and IoT.
CO2: Identify and apply sensors, microcontrollers, and communication protocols in wearables.
CO3: Design and simulate simple wearable IoT systems using embedded platforms.
CO4: Evaluate applications and challenges in health monitoring, sports, and smart textiles.
CO5: Implement data acquisition and cloud integration in wearable systems.

Module 1:

Introduction to Wearable Technology and IoT
- Overview and history of wearable tech
- Market trends and evolution
- Role of IoT in wearable devices
- Architecture of IoT-enabled wearables
- Key components: Sensors, processors, displays, connectivity

Module 2:

Sensors and Hardware Platforms
- Biometric sensors: ECG, EMG, PPG, temperature, SpO_2, accelerometers
- Motion sensors: Gyroscope, magnetometer, IMU
- Microcontrollers: Arduino, ESP32, Raspberry Pi
- Flexible electronics and e-textiles
- Wearable displays: OLED, E-ink

Module 3:

Communication Technologies for Wearables
- Bluetooth, BLE, Zigbee, Wi-Fi, NFC
- LPWAN for low-power wearable applications
- Data transmission and power optimization techniques
- Body area networks (BAN)
- Safety and electromagnetic considerations

Module 4:

Wearable System Design and Power Management
- Power sources: batteries, energy harvesting (solar, thermal)
- Low-power design principles
- Embedded system design considerations
- Integration with cloud platforms (Firebase, ThingSpeak, Blynk)
- Wearable data storage and logging

Module 5:

Applications and Case Studies
- Wearables in healthcare and medical diagnostics
- Sports and fitness monitoring
- Smart clothing and textiles
- Military, industrial, and augmented reality wearables
- Security, privacy, and ethical issues in wearable data

Labs / Practicals:

1.Interfacing a Heart Rate Sensor (e.g., MAX30100) with Arduino/ESP32
Objective: Measure and display pulse rate using an OLED display or serial monitor.

2.Developing a Temperature Monitoring Wearable Using LM35/DS18B20
Objective: Design a simple body temperature sensing wearable and transmit data to a mobile app or cloud.

3. Activity Recognition using Accelerometer (ADXL345 or MPU6050)
Objective: Detect walking, running, or standing using motion data.

4. Bluetooth Low Energy (BLE) Communication with Smartphone App
Objective: Transmit sensor data (e.g., heart rate) to a mobile app via BLE.

5. Wi-Fi Based Wearable Health Monitoring System (using ESP32/NodeMCU)
Objective: Send real-time sensor data to an IoT cloud platform like ThingSpeak or Blynk.

6. Battery Monitoring and Power Management Simulation for Wearables
Objective: Monitor battery voltage and implement basic power-saving code in a wearable device.

7. Smart Glove Prototype using Flex Sensors
Objective: Detect finger movements and display them as gestures or text.

8. Wearable Fall Detection System using IMU (MPU6050) and ESP32
Objective: Detect sudden falls and trigger alerts using Wi-Fi/BLE.

9. Creating a Wearable Dashboard on Blynk/ThingSpeak for Health Parameters
Objective: Visualize heart rate, temperature, and step count on mobile/cloud dashboard.

10.Capstone Mini Project: Design and Demonstration of a Complete IoT-enabled Wearable Device.

References:

• Edward Sazonov, “Wearable Sensors: Fundamentals, Implementation, and Applications,” Academic Press
• Ovidiu Vermesan & Peter Friess, “Internet of Things—From Research and Innovation to Market Deployment”
• Adrian McEwen, Hakim Cassimally, “Designing the Internet of Things,” Wiley
• Online resources from Arduino, ESP32, MIT OpenCourseWare on wearable tech