Industrial IoT and Industry 4.0:

Course Objectives	● Introduce students to the principles and techniques of Plant Simulation and discrete event simulation. ● Develop students' understanding of layout design principles, resource allocation strategies, and their impact on system performance. ● Explore the concepts and applications of Industry 4.0 and IoT technologies in smart manufacturing. ● Enhance students' practical skills in designing and implementing IoT solutions for predictive maintenance and supply chain optimization.
Course Outcomes	● Apply Plant Simulation software to model and simulate manufacturing systems for process optimization. ● Design and evaluate facility layouts using simulation techniques and industry best practices. ● Optimize resource allocation and balance production lines to improve overall system performance. ● Integrate IoT devices, sensors, and actuators into manufacturing systems for real-time data collection. ● Utilize IoT technologies for predictive maintenance and supply chain management in smart factories. ● Evaluate the security considerations and challenges associated with IoT-based systems.

Course Duration: 45 Hours

Course Curriculum:

UNIT 1: Introduction to IIoT

Definition and Evolution of IIoT - Differentiating IIoT from IoT - Historical context and development - Key Components of IIoT - Sensors and actuators - Connectivity technologies - Connectivity and Networking - Wireless Technologies - 5G in IIoT - LPWAN (Low-Power Wide-Area Network) - Network Topologies.

UNIT 2: Introduction to Sensor Technology

Definition of Sensors and Transducers - Importance and Applications of Sensors - Classification of Sensors (based on measurement, working principle, etc.) - Overview of Sensor Characteristics (sensitivity, accuracy, precision, etc.) - Basic sensor types and principle - Sensor Signal Conditioning - Amplification and Filtering – Analog to- Digital Conversion (ADC) - Digital Signal Processing (DSP) for Sensors - Calibration and Compensation Techniques - Sensor Interfaces and Communication - Analog and Digital Interfaces - Wireless Sensor Networks (WSN) - Communication Protocols (I2C, SPI, UART, etc.).

UNIT 3: Implementation and Deployment Challenges in Industrial IoT

Interoperability and Compatibility-Security Concerns-Cybersecurity Risks Data Privacy-Scalability and Complexity-System Scalability- Complexity Management Legacy Systems Integration-Compatibility with Existing Infrastructure- Reliability and Maintenance- Data Management and Analytics-Data Overload-Real- time Processing.

UNIT 4: Industry-Specific Applications

Manufacturing (Smart factories, predictive maintenance)-Energy (Smart grids, asset monitoring)-Healthcare (Remote patient monitoring, medical device management)-Agriculture (Precision farming, livestock tracking- Transportation (Fleet management, logistics optimization)

UNIT 5: Advanced Local Network Communication in Industrial IoT

Wireless Sensor Networks-Long-Range Connectivity (Lora) to server data communication - Multiple local networks to single server- Master slave communication - Local network security system.

Test Projects:

Use Cases:

The below use cases will be thought in class during the training:

1. Research a real-world application of IoT technology in a specific domain (e.g., smart homes, agriculture, industrial automation).

2. Create a basic diagram illustrating the architecture of an IoT system, highlighting components like sensors, actuators, and communication protocols.

3. Identify and compare different communication protocols commonly used in IoT (e.g., Wi-Fi, Bluetooth, LoRaWAN).

4. Simulate data collection using readily available sensors (e.g., temperature sensor connected to a computer) and explore data visualization techniques.

5. Choose a popular single-board computer for IoT development (e.g., Raspberry Pi, Arduino) and explore its capabilities and resources

6. Experiment with connecting an LED or another basic actuator to your chosen development board and control it using code.

7. Combine your learnings to design and build a more comprehensive IoT project addressing a specific problem or automating a task (e.g.,smart home , pet feeder with remote monitoring).

The below cases will be given to students as assessment:

Research and present different types of actuators used in IoT systems (e.g., smart plugs, robotic arms) and their applications.

Set up a simple IoT system using your chosen development board and sensor to collect real-time data (e.g., temperature readings).

Utilize cloud platforms (e.g., ThingSpeak) to store and visualize the data collected from your IoT system.

Explore basic data analytics techniques (e.g., calculating averages, identifying trends) on the collected IoT data to extract insights.

Implement basic data filtering and anomaly detection algorithms on your IoT sensor data to identify unusual patterns.

Develop a simple IoT application using a platform like Arduino IDE to control an LED based on sensor readings (e.g., turn on light when temperature exceeds a threshold).

Choose a pre-built IoT project kit (e.g., weather station) and assemble it, understanding the hardware and software components involved.

Integrate your IoT system with a cloud service (e.g., IFTTT) to trigger automated actions based on sensor data (e.g., receive a notification if temperature reaches a critical level).

Explore mobile app development platforms (e.g., MIT App Inventor) to create a user interface for interacting with your IoT system and visualizing data.

Research common security vulnerabilities in IoT systems (e.g., weak passwords, unencrypted data transmission).

Explore best practices for securing IoT deployments, including strong authentication, encryption, and regular firmware updates.

Simulate a potential security attack on a vulnerable IoT system (in a controlled environment) to understand the risks involved.

Develop a security checklist for deploying IoT systems, outlining essential security measures to be implemented.