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:

1. **GreenHouse:** Constructing an Industrial IOT for a "GreenHouse" in which the environment is continuously monitored based on various factors such as temperature, soil, humidity, and power on/off.
2. **Poultry Farming:** Develop an industrial IOT project where we would be creating a virtual twin of "Poultry Farming". Poultry Farming is a domestic or commercial breeding of birds primarily for their meat, eggs, and feathers. In this instance, it is necessary to continuously monitor the real-time data in order to automate the feeding and temperature.
3. **Smart Solar Panels:** Solar panels are devices that collect energy from the Sun in the form of sunlight and convert it into electricity. Creating a digital replica of actual solar panels and adjusting their angle to face the direction of the sun would result in more effective electricity production. With the aid of this Industrial IOT system, a clever method for a more advanced power generation is implemented.
4. **Smart Home Technology:** Creating an Industrial IOT based on smart home technology in a large residential space where an automatic shutdown system is installed. Here the sensor receives the physical world data to find whether any human presence is around and would cause all electrical equipment to turn off.
5. **Pick & Place Robot:** Developing an Industrial IOT that controls a factory robot to perform any pick-and-place tasks. These industrial robots are monitored to implement automated solutions like lifting or moving objects which do not require a lot of thought processes.
6. **Supply Chain System:** A supply chain system plays a vital role in the production pipeline from raw goods to finished products. Conveyors are employed in these situations to facilitate simple and quick supply chain support. In order to incorporate industrial metaverse in supply chain management, an Industrial IOT is deployed to control and observe the conveyor system.
7. **Heavy Vehicles - Load Monitoring System :** A lorry, truck, or other large vehicle used to transport freight weighing in tonnes is a heavy duty vehicle. A maximum of 2.5 Tons of industrial materials can be loaded upon an industrial vehicle, which has the dimensions in feet (9 L x 5.5 W x 5 H). We are deploying an Industrial IOT that intelligently monitors the weight of the vehicles by playing an alarm during the overload situation to track the load units (kgs) in heavy duty trucks.
8. **Smart Street Lights:** In rural areas, street lights are usually operated manually or

automatically switched on/off based on time. We also observe street lights that turn on and off in response to passing automobiles. We are creating a virtual twin of street lights and adjusting the light source's intensity to enable smartness. The light changes from bright to dim depending on the passing vehicle.

9. **Gantry Crane Machine:** A gantry crane machine can be used to carry objects horizontally as well as lift and lower them. The majority of its applications involve lifting big objects and moving them to new locations. We are developing an Industrial IOT for monitoring and controlling the Gantry crane based on real-time data.
10. **Fish Farming:** Fish farming or pisciculture involves commercial breeding of fish, mainly for food, in fish tanks or artificial enclosures such as fish ponds. An Industrial IOT that helps us keep track of the water level is being deployed in this situation. Based on the amount of water in the tank, the motor is designed to automatically turn on and off.
11. **Reservoir Automation:** A reservoir is an artificial lake where water is stored. Most reservoirs are formed by constructing dams across rivers. The majority of reservoirs are created by building dams across rivers. Building an Industrial Metaverse that uses Industrial IOT technology to automate, manage, and track reservoirs
12. **Hospital Monitoring:** Developing an Industrial IOT of the hospital to help with forecasting and decision-making about the availability of beds, ambulances, doctors, and other services to shorten the response time for each patient.