GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma Engineering
Level: Diploma
Branch: Automation and Robotics
Subject Code : DI04041051
Subject Name : Industrial Internet of Things

w. e. f. Academic Year:	2025-26
Semester:	4th
Category of the Course:	Professional Elective - I

Prerequisite:	Basic knowledge of sensors, microcontrollers, industrial communication systems, and automation fundamentals.
Rationale:	Industrial Internet of Things (IIoT) integrates sensors, communication networks, cloud platforms, and data analytics to create smart, automated, and connected industrial systems. The course introduces IIoT architecture, industrial sensors, communication protocols, edge and cloud computing, data handling, dashboards, and cybersecurity fundamentals. By the end of this course, students will be able to design and implement IIoT-based monitoring and control systems aligned with modern industry requirements.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
1	Describe IIoT architecture, components, and industrial applications.	R
2	Interface sensors & actuators with microcontrollers for IIoT applications.	U
3	Implement IIoT communication using MQTT/HTTP and industrial protocols.	A
4	Connect devices to cloud platforms and visualize data dashboards.	A
5	Apply cybersecurity and data handling practices in IioT systems.	A

**Revised Bloom's Taxonomy (RBT)*

Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+(PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial / Practical		
L	T	PR	C	ESE(E)	PA(M)	PA(I)	ESE(V)	
3	0	2	4	70	30	20	30	150

Course Content

Unit	Topics and Sub-topics	No. Of Hrs.	% Weightage
Unit 1 : Introduction to IIoT	**1.1 Introduction to IoT and IIoT** 1.1.1 Definition of IoT and IIoT 1.1.2 Key differences between IoT and IIoT (Reliability, Safety, Scale, Real-time) 1.1.3 Need of IIoT in modern industries 1.1.4 Role of IIoT in automation and robotics **1.2 IIoT Architecture** 1.2.1 Basic block diagram / architecture of IIoT. 1.2.3 Components of each layer 1.2.4 Data flow in IIoT—sensor to cloud **1.3 Enabling Technologies in IIoT** 1.3.1 AI and Machine Learning in IIoT 1.3.2 Cloud computing 1.3.3 Edge computing 1.3.4 Big data analytics 1.3.5 Cyber-physical systems **1.3 Industrial Applications of IIoT** **1.4 Challenges in IIoT**	8	18
Unit 2 : Sensors, Actuators and Edge Devices for IIoT	**2.1 Smart Sensors** 2.1.1 Concept and general block diagram 2.1.2 Sensor calibration & diagnostics 2.1.3 Sensor fusion **2.2 Microcontrollers and IIoT Devices** 2.2.1 ESP8266 architecture and features 2.2.2 ESP32 architecture and features 2.2.3 Raspberry Pi architecture and features 2.2.4 Comparison of popular IIoT devices **2.3 Actuators** 2.4.1 Electrical actuators (Relays, solenoids, servo motors, stepper motors) 2.4.2 Pneumatic actuators 2.4.3 Hydraulic actuators 2.4.4 Interfacing actuators with controllers **2.4 Sensor Interfacing & Data Acquisition** 2.4.1 Analog interfacing (ADC, sampling rate, resolution) 2.4.2 Digital interfacing (I2C, SPI, UART) **2.5 Industrial Interface Standards**	10	22

	2.6.1 4–20 mA current loop and 0-10 V voltage signal 2.6.2 RS-485 standard 2.6.3 Modbus RTU fundamentals 2.6.4 Industrial communication gateways **2.6 Edge Computing** 2.6.1 Concept of edge Computing in relevance with IIoT 2.6.2 Need of edge computing 2.6.3 Applications, Advantages and Limitations		
Unit 3 IIOT Networking and Communication Protocols	**3.1 Networking Fundamentals** 3.1.1 OSI layers and relevance to IIoT 3.1.2 Network types: PAN, LAN, WAN 3.1.3 Industrial networks (Fieldbus, Industrial Ethernet) **3.2 Wireless Technologies** 3.2.1 Wi-Fi – architecture, advantages, limitations 3.2.2 Bluetooth & BLE – applications in IIoT 3.2.3 LoRa & LoRaWAN – long-range networks 3.2.4 ZigBee basics **3.3 Industrial Protocols** 3.3.1 MQTT • Publish-subscribe model • MQTT Broker and Client • MQTT vs HTTP 3.3.2 HTTP/HTTPS • Request/response model • REST APIs 3.3.3 Modbus RTU / TCP • Registers & addressing • Framing • Master/slave concept **3.4 Gateways** 3.4.1 Role of IoT gateways 3.4.2 Types of IoT Gateway 3.4.3 Applications, Advantages and Challenges	10	22
Unit 4 : Cloud Platforms and IIoT data management	**4.1 Cloud Platforms** 4.1.1 What is Cloud Platform 4.1.2 Why we need cloud platform 4.1.3 Importance, Applications and Advantages of cloud plateforms. 4.1.4 Examples of cloud platforms (AWS IoT Core, Microsoft Azure IoT Hub, Google IoT Core, Third-party platforms – Blynk, Ubidots, Thingspeak) **4.2 Data Analytics in IIoT**	10	22

	4.2.1 Basic components of Data Analytics 4.2.2 Applications of Data Analytics in IIoT 4.2.3 Challenges **4.3 Data Handling** 4.3.1 Definition 4.3.2 Types of Data Handling 4.3.3 Basic Steps for Data Handling 4.3.4 Use cases **4.3 Data Visualization** 4.3.1 Definition 4.3.2 Need of Data Visualization 4.3.2 Tools for Data Visualization 4.3.3 Applications and challenges **4.5 Digital Twins** 4.5.1 Definition and Working 4.5.2 Types of Digital Twins 4.5.3 Applications and Advantages		
Unit 5 : Security and Industrial Applications	**5.1 IIoT Security Fundamentals** 5.1.1 Importance of industrial security 5.1.2 Authentication & authorization 5.1.3 Access control methods **5.2 Device Security** 5.2.1 Secure boot 5.2.2 Firmware security 5.2.3 Device identity management **5.3 Data Security** 5.3.1 Encryption (TLS, SSL basics) 5.3.2 End-to-end security **5.4 Network Security** 5.4.1 Firewalls 5.4.2 VPN 5.4.3 Secure MQTT communication **5.5 Industrial IIoT Applications (Case Studies)** 5.5.1 Predictive maintenance of motors/pumps 5.5.2 Smart energy monitoring in robotics labs 5.5.3 Robot telemetry monitoring system 5.5.4 Smart manufacturing – SCADA + IIoT integration 5.5.5 Inventory tracking in warehouses	7	16

SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) that are the sub-components of the COs. *Some of the **PrOs** marked **'*'** are compulsory, as they are crucial for that particular CO. These PrOs need to be attained at least at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'.*

S.No.	Practical Outcomes (PrOs)	Approx. Hrs. required
1	Study the hardware and software components used in an IIoT system.	2
2	Interface a temperature sensor with ESP32/NodeMCU and read real-time data.	2
3	Interface a humidity or pressure sensor and display its readings on the serial monitor.	2
4	Measure a 4–20 mA industrial sensor signal using an ADC interface module.	2
5	Apply basic filtering techniques to reduce noise from sensor data.	2
6	Control a relay or LED actuator using ESP32 based on sensor input.	2
7	Connect the ESP32/NodeMCU to a Wi-Fi network and verify connectivity.	2
8	Send sensor data to a cloud platform using HTTP GET/POST through REST API.	2
9	Publish and subscribe messages using the MQTT protocol with a public broker.	2
10	Develop an MQTT-based remote monitoring and control setup.	4
11	Send structured sensor data in JSON format to a cloud server.	2
12	Interface an RS-485 Modbus RTU sensor and read data registers.	4
13	Use LoRa or LoRaWAN module to transmit sensor data over long distances.	4
14	Send sensor readings to a mobile app using Bluetooth Low Energy (BLE).	2
15	Create a real-time IIoT data dashboard on Blynk, Ubidots, or Thingspeak.	4
16	Analyze historical and live cloud data to observe trends and variations.	2
17	Implement edge processing on ESP32 by making decisions locally before sending data to cloud.	2
18	Enable secure MQTT communication using TLS/SSL for encrypted data transfer.	4

S.No.	Practical Outcomes (PrOs)	Approx. Hrs. required
19	Implement basic IIoT cybersecurity practices like secure passwords and protected API keys.	2
20	Set up automated SMS or email alerts based on threshold sensor values from the cloud.	2
	Total	50

Note

i. *More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*
ii. *The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency.*

MAJOR EQUIPMENT/ INSTRUMENTS AND SOFTWARE REQUIRED

These major equipment/instruments and Software required to develop PrOs are given below with broad specifications to facilitate procurement of them by the administrators/management of the institutes. This will ensure conduction of practical in all institutions across the state in proper way so that the desired skills are developed in students.

Sr. No.	Equipment Name
1	ESP32 / NodeMCU development boards
2	Industrial sensors (temperature, pressure, proximity etc.)
3	Wi-Fi router
4	RS-485/Modbus interface module
5	Cloud platforms (Thingspeak/Blynk/Ubidots/AWS IoT)
6	Laptop/PC with Arduino IDE / Python / MQTT tools
7	Multimeter and testing tools

AFFECTIVE DOMAIN OUTCOMES

The following sample Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs and PrOs. More could be added to fulfil the development of this competency.

– Professional discipline and responsibility
– Teamwork and cooperation
– Ethical data-handling practices
– Safe laboratory work
– Engineering problem-solving mindset

SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

- Prepare report on any one industrial IIoT application.
- Create comparison chart of MQTT, Modbus, HTTP.
- Prepare mini-dashboard for real-time data.

SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

Following Sample strategies teacher can use to accelerate the attainment of the various outcomes in this course:

– Demonstration-based learning
– Hands-on cloud dashboards
– Use of simulation & hardware practice
– Case studies on Industry 4.0

SUGGESTED MICRO-PROJECTS

– Smart plant monitoring
– Industrial parameter logger
– Predictive maintenance prototype

SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1	Industrial Internet of Things: Technologies, Design, and Applications	Sudan Jha, Usman Tariq, Gyanendra Prasad	

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
		Joshi, Vijender Kumar Solanki	
2	Introduction to Industrial Internet of things and Industry 4.0	Anandarup Misra, Sudip | Roy, Chandana | Mukherjee	15/12/2020 ISBN : 978-0367897581
3	Industry 4.0: The Industrial Internet of Things	Alasdair Gilchrist	Apress - 1/1/2019 ISBN : 978-1484249703

SUGGESTED LEARNING WEBSITES

i. NPTEL Videos
   a. https://onlinecourses.nptel.ac.in/noc20_cs69/preview

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