GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma Engineering
Level: Diploma
Branch: Electrical Engineering / Renewable Energy
Subject Code: DI04000191
Subject Name: Introduction to IoT

w.e.f. Academic Year:	2025-26
Semester:	4th
Categoryof theCourse:	MOPEC

Prerequisite:	Acquaintance with basic concepts of electrical circuits, sensors & actuators, microcontroller fundamentals, and basic programming knowledge to implement IoT-based electrical applications.
Rationale:	"IoT for Electrical Engineering" is a specialized course that explores the fusion of Internet of Things (IoT) technologies with contemporary electrical systems to enable intelligent monitoring, automation, and control. It delves into key components such as IoT architecture, sensors, actuators, microcontrollers, communication protocols, and cloud-based platforms. Students learn how these technologies are applied in areas like smart grids, energy optimization, and predictive maintenance. By completing this course, learners gain the expertise to develop and deploy smart electrical solutions that improve efficiency, reliability, and sustainability across residential, commercial, and industrial infrastructures.

❖ **Course Outcome:**

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
1	Explain the basic concepts, architecture, and components of IoT systems	R
2	Identify and classify various sensors and actuators used for electrical applications.	U
3	Develop Arduino programs to interface sensors and actuators for data acquisition and control.	A
4	Compare and select suitable IoT communication protocols.	U
5	Analyze real-world IoT applications.	A

Revised Bloom's Taxonomy(RBT)

GUJARAT TECHNOLOGICAL UNIVERSITY

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Teaching and Examination Scheme:

Teaching Scheme (in Hours)			TotalCredits L+T+(PR/2)	AssessmentPatternandMarks				Total Marks
				Theory		Tutorial/ Practical		
L	**T**	**PR**	**C**	**ESE (E)**	**PA(M)**	**PA(I)**	**ESE (V)**	
2	0	2	3	70	30	20	30	150

Course Content:

Unit No.	Content	No.of Hours	% of Weightage
1.	**Introduction to IoT** (1) Definition of IoT, evolution, and scope in electrical engineering. (2) Key characteristics: connectivity, data-driven operation, remote access, real-time monitoring. (3) IoT Architecture (4 layers): sensing, network, processing, application. (4) IoT system components: • Sensors/Devices (data collection) • Gateways (communication via Wi-Fi, Zigbee, etc.) • Cloud/Server (data storage & processing) • User Interface (mobile app/web dashboard)	4	11%
2.	**Sensors & Actuators** (1) Classification of sensors: analog, digital. (2) Working principle, Arduino pin type (Analog/Digital/I2C), and applications of various sensor below: • PIR Sensor (motion detection) • LDR (light intensity) • Ultrasonic sensor (distance measurement) • Temperature & Humidity Sensor (DHT11/DHT22) • Voltage Sensor (ZMPT101B) • Current sensor (ACS712) • Potentiometer (variable resistance input) • Soil Moisture sensor (agriculture/irrigation systems) (3) Actuators – working principle, control pins, and usage of: • LED (status indication, PWM brightness) • Servo Motor (position control) • DC Motor (speed/rotation control with driver) • Stepper Motor (precise step rotation) • Relay Module (switching AC loads)	6	25%

GUJARAT TECHNOLOGICAL UNIVERSITY
Program Name: Diploma Engineering
Level: Diploma
Branch: Electrical Engineering / Renewable Energy
Subject Code: DI04000191
Subject Name: Introduction to IoT

	• Buzzer (alert systems) (4) Criteria for selecting sensors & actuators for specific electrical applications. (5) Practical interfacing methods and safety considerations in circuits		

3.	**Programming with Arduino**
	(a) Arduino UNO R3
	(1) Types of Arduino, Arduino UNO R3 – architecture, Pin diagram, Function of each pin, interface with PC
	(2) ESP32 bord: features, built-in Wi-Fi/Bluetooth, comparison with Arduino Uno.
	(b) Software requirement and Programming
	(1) Arduino IDE: installation, sketch structure, compiling, and uploading programs.
	(2) Data types, constants, and operators used in Arduino programming.
	(3) Control statements (if-else, switch, loops: for, while, do-while).
	(4) Functions: built-in functions and user-defined functions.
	(5) Common Arduino library functions:
	   • pinMode(), digitalRead(), digitalWrite()
	   • analogRead(), analogWrite()
	   • Serial.begin(), Serial.print(), Serial.read()
	(6) Interfacing sensors & actuators with coding examples (reading analog/digital inputs, PWM outputs).
	(7) Serial communication – monitoring sensor data in real-time.
	(8) Mini projects (LED blink, temperature monitoring, relay control)
		8	32%

4.	**IoT Communication Protocols**
	(1) Importance of communication in IoT for electrical applications.
	(2) Messaging/Application Layer Protocols:
	   • Publish/subscribe, lightweight messaging- MQTT
	(3) Transport/Physical Protocols:
	   • BLE (short range, low power)
	   • Wi-Fi (high-speed connectivity, cloud applications)
	(4) Sensor Network Topologies:
	   • Point-to-Point (simple 1-to-1)
	   • Mesh (self-healing networks, ZigBee)
	   • Ring (loop structure)
	   • Star (hub-based Wi-Fi networks)
	(5) Comparative study of protocols – speed, power, range, cost, and application suitability.
		5	11%

5.	**Applications of IoT**
	(1) Control LED /Buzzer as per delay time set by user:
	   • Connect Led/Buzer to Arduino as Digital Output
	   • First try to ON/OFF Led/Buzer with fix delay.		

GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma Engineering
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	• Then replace fix delay with variable for user control.
	(2) Interfacing LDR sensor with Arduino to measure light intensity
	    • First Connect LDR to Arduino as Analog Input.
	    • Adjust Light on LDR and see variation in value on serial monitor
	(3) Smart Temperature & Humidity Monitor
	    • Reads temperature & humidity using Arduino + DHT11 sensor
	(4) Interfacing Voltage sensor with Arduino for monitoring supply voltage
	    • Connect voltage sensor to Arduino as Analog Input. (ZMPT101B)
	    • Regulate voltage across sensor and see variation in value on serial monitor
	    • Scale to real voltage value and display it on LCD
	(5) IoT-Based Smart Light Control
	    • Use Arduino + Relay Module + ESP8266 + Bulb,
	    • Control home lights through a mobile app or web interface using Wi-Fi.
	(6) Smart Irrigation System (IoT)
	    • Use Arduino + Soil Moisture Sensor + Relay + Pump + ESP8266
	    • Monitors soil moisture and turns pump ON automatically → Sends live status and control to mobile.
	(7) Smart Parking System
	    • Use Arduino + Ultrasonic Sensor + buzzer
	    • Detects parking space availability and updates it on a display mounted outside of parking.
	Prepare detailed Case studies on (above application 1 to 7) including hardware and sensor selection, connection layout, Arduino pin mapping, code explanation, results and benefits.
		7	21%

	Total	**30**	**100 %**

❖ **SuggestedSpecificationTablewithMarks (Theory):**

Distribution of Theory Marks (in%)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
25%	35 %	40 %	-	-	-

WhereR: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (asper Revised Bloom's Taxonomy)

GUJARAT TECHNOLOGICAL UNIVERSITY
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References/Suggested Learning Resources:

(a) Books:

Sr. No.	Title of Book	Author(s)	Publication (Place)	Year	ISBN
1	Internet of Things: Principles and Paradigms	Rajkumar Buyya, Amir Vahid Dastjerdi	Elsevier, USA	2016	978-0-12-805395-9
2	Internet of Things: Architecture and Applications	Raj Kamal	McGraw Hill Education, New Delhi	2017	978-93-5260-841-4
3	Getting Started with the Internet of Things	Cuno Pfister	O'Reilly Media, California	2011	978-1-4493-9357-1
4	Power Electronics for IoT-Enabled Smart Grids and Industrial Automation	Raj Kumar Gupta, Atul A. Barhate, Vijay D. Chaudhari, Dipesh B. Pardeshi,	Rade-Mics (Place not stated)	2025	978-9349552111
5	Internet of Things with Arduino Cookbook	Marco Schwartz	Packt Publishing, Birmingham	2016	978-1-78528-658-2
6	Exploring Arduino: Tools and Techniques for Engineering Wizardry	Jeremy Blum	Wiley, New Jersey	2013	978-1-118-54936-0
7	Programming Arduino: Getting Started with Sketches	Simon Monk	McGraw Hill Education, New Delhi	2016 (2nd Ed.)	978-1-259-64567-5
8	Mastering Internet of Things	Peter Waher	Packt Publishing, Birmingham	2018	978-1-78829-295-5

GUJARAT TECHNOLOGICAL UNIVERSITY
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(b)Open-sourcesoftwareand website:

Sr. No.	Software / Website	Purpose / How it Helps
1	Arduino IDE (arduino.cc)	Open-source programming environment for Arduino Uno, ESP8266, and ESP32. Essential for Unit-3 coding and sensor interfacing.
2	Platform IO (platformio.org)	Advanced open-source IoT development platform, integrates with VS Code. Supports Arduino, ESP32, STM32 for larger projects.
3	Blynk IoT Platform (blynk.io)	Free cloud + mobile app builder for IoT. Perfect for Unit-5 applications like energy monitoring dashboards.
4	Thing Speak (thingspeak.com)	Open IoT cloud by MathWorks for data logging, visualization, and MATLAB integration. Useful for smart energy monitoring.
5	Node-RED (nodered.org)	Open-source flow-based programming tool to connect devices, APIs, and dashboards. Great for Unit-4 communication protocols.
6	Tinker cad Circuits (tinkercad.com/circuits)	Online simulator for Arduino, sensors, and actuators. Helps beginners practice before using real hardware.
7	Freeboard Dashboard (freeboard.io)	Open-source web dashboard for IoT visualization. Students can plot real-time current/voltage data from sensors.
8	Open Energy Monitor (openenergymonitor.org)	Open hardware + software platform for energy monitoring, power quality, and smart grid IoT applications.
9	MQTT Broker (Eclipse Mosquitto) (mosquitto.org)	Lightweight open-source MQTT broker. Hands-on for Unit-4 (publish/subscribe protocol).
10	Instructables IoT Projects (instructables.com)	Huge library of free DIY IoT tutorials (Arduino + ESP32 + sensors). Excellent for student projects (Unit-5).

GUJARAT TECHNOLOGICAL UNIVERSITY

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Suggested Course Practical List:

Sr. No.	Practical Outcome / Title of Experiment	CO1	CO2	CO3	CO4	CO5
1	Study of IoT architecture and system components using block diagrams and case studies	√				
2	Familiarization with Arduino IDE and writing first program (in built led blink)	√	√			
3	Interfacing Motion sensor with Arduino to measure light intensity.		√	√		
4	Interfacing Temperature Sensor (eg. DHT11) sensor and displaying temperature & humidity		√	√		
5	Interfacing PIR motion sensor with Arduino to control LED/buzzer		√	√		
6	Interfacing Soil Moisture sensor and controlling pump using relay		√	√		√
7	Interfacing Ultrasonic sensor for distance measurement		√	√		
8	Interfacing Current sensor (ACS712) to measure load current		√	√		√
9	Interfacing Voltage sensor (ZMPT101B) with Arduino for monitoring supply voltage		√	√		√
10	Controlling DC motor using Arduino and motor driver module (PWM speed control)		√	√		
11	Controlling Servo motor using potentiometer input.		√	√		
12	IoT communication using ESP8266/ESP32 with MQTT broker		√		√	
13	Sending sensor data (e.g. voltage, current, power factor temperature) to ThingSpeak Cloud and visualizing		√		√	√
14	IoT-based home automation (controlling LED/appliance via Blynk app)		√		√	√
15	IoT-based energy monitoring (voltage, current, power factor) using ESP32 and PZEM-004T		√	√	√	√

GUJARAT TECHNOLOGICAL UNIVERSITY
Program Name: Diploma Engineering
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Subject Code: DI04000191
Subject Name: Introduction to IoT

16	IoT-based transformer health monitoring (temperature + current + alert)		√	√	√	√
17	IoT-based solar PV monitoring system (voltage, current, temperature → cloud)		√	√	√	√
18	IoT-based smart streetlighting (LDR + PIR + relay)		√	√		√
19	IoT-based predictive maintenance of inductionmotor (vibration + temperature sensors + alert)		√	√		√
20	Mini project: Design and demonstrate a complete IoT application (energy meter, grid load management, smart building etc.)	√	√	√	√	√
21	Build automatic brightness control system using LDR, LED, Potentiometer		√	√		√
22	Develop safety monitoring system using MQ-2 gas sensor, Buzzer, LCD		√	√		√
23	Interface and control DC motors using joystick		√	√		
24	Develop automated plant watering system using Soil moisture sensor, Water pump, Relay, IoT platform		√	√	√	√

❖ **ListofLaboratory/LearningResourcesRequired:**

Sr. No.	Resource / Equipment	Quantity (Approx.)	Purpose / Use
A. Essential Resources (Minimum Required)			
1	Arduino Uno Boards (ATmega328P)	10–20	Core microcontroller board for basic IoT experiments
2	Breadboards & Jumper Wires	Multiple	For circuit prototyping and connections
3	Basic Sensors Kit (PIR, LDR, Ultrasonic HC-SR04, DHT11, Soil Moisture)	4–5 each	Sensor interfacing practicals
4	Basic Actuators Kit (LEDs, Buzzer, Relay modules, DC motors, Servo motors)	4–5 each	Output control and automation
5	Motor Driver Modules (L293D / L298N)	5	For motor control experiments
6	Power Supply Units (5V, 12V DC) /	5	Powering Arduino boards,

GUJARAT TECHNOLOGICAL UNIVERSITY

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	Adapters		sensors, and actuators
7	LCD Display (16x2 or 20x4, I2C based)	5	Display of sensor readings and IoT status
8	PCs/Laptops with Arduino IDE	10–20	Programming and simulation
9	Wi-Fi Router (basic network)	1	IoT connectivity for ESP-based boards
10	Multimeters	5	Verification of voltage, current, and electrical parameters
B. Optional / Advanced Resources (For Projects & Research)			
1	ESP8266 NodeMCU Boards	5	For cloud-connected IoT applications
2	ESP32 Development Boards	5	Advanced IoT with Wi-Fi + Bluetooth
3	Extended Sensors Kit (Current sensor ACS712, Voltage sensor ZMPT101B, MPU6050 Gyro, Gas Sensor MQ-series, Sharp IR, PT100 RTD, CT sensors)	2 each	Electrical measurements, power quality, and predictive maintenance
4	Stepper Motors + Drivers	2–3	Precision control experiments
5	OLED Displays (0.96"/1.3")	2–3	Compact display for IoT dashboards
6	LCD Display (16*2)	8-10	Compact display for IoT dashboards
7	Simulation Tools (Tinkercad, Proteus IoT,Everycircuit)	Installed	Virtual IoT circuit building & debugging
8	Smart Energy Meter Demo Kit	1	Real-world IoT energy monitoring project
9	Cloud Accounts (ThingSpeak, Blynk, Node-RED, Freeboard)	Free accounts	IoT data logging and visualization
10	Project Accessories (PCB kits, connectors, enclosures, sensor stands)	As required	For final project development
11	PC specification	1	Minimum 4 GB RAM

List of activities for students:

GUJARAT TECHNOLOGICAL UNIVERSITY
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Sr. No.	Activity	Purpose / Expected Outcome	Linked COs
1	Prepare a report on latest IoT applications in electrical power systems (e.g., smart grid, Motor Protection, Industry 4.0).	Awareness of real-world electrical IoT applications.	CO1, CO5
2	Develop a mini-Arduino project (e.g., automatic fan control using DHT11 sensor).	Hands-on experience in Arduino coding and actuator control.	CO2, CO3
3	DIY Energy Monitoring Setup: Build a small IoT system to measure voltage & current using ACS712 + ZMPT101B + ESP8266.	Exposure to IoT-based measurement and cloud monitoring.	CO2, CO3, CO5
4	Create a dashboard on Thing Speak or Blynk to display energy consumption data using PZEM-004T sensor.	Skill in IoT cloud visualization.	CO2, CO4
5	Case Study Presentation: Compare IoT communication protocols (MQTT, CoAP, Wi-Fi, BLE) with examples.	Ability to analyze and justify protocol selection.	CO4
6	Simulation Activity on Tinkercad/Proteus: Design and simulate an IoT circuit before implementing it in hardware.	Safe, cost-effective design practice.	CO2, CO3
7	Prepare poster/presentation on IoT security challenges in electrical applications.	Understanding risks in IoT-enabled power systems.	CO1, CO5
8	Group Activity – Smart Street Light System: LDR + PIR + Relay + Arduino.	Learn teamwork, project development, and system integration.	CO2, CO3, CO5
9	Hackathon / Mini Project Competition on IoT-based solutions for electrical engineering problems.	Innovation and application of IoT knowledge.	CO2, CO3, CO5
10	Field Visit / Virtual Tour: Observe IoT-enabled systems in industry (smart substation, renewable plant, or smart metering).	Exposure to industrial IoT systems.	CO5
11	Develop technical blog/video tutorial on interfacing a sensor with Arduino.	Improves communication skills + peer learning.	CO2, CO3