



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma Engineering

Level: Diploma

Branch: Information Technology

Subject Code: DI05016071

Subject Name: Hands on Practice using IoT

w. e. f. Academic Year:	2026-27
Semester:	5 th
Category of the Course:	MOPEC

Prerequisite:	Basic knowledge of programming (Python) and networking.
Rationale:	The Internet of Things (IoT) enables physical devices to connect, communicate, and exchange data through the Internet. IoT plays an important role in smart homes, healthcare, agriculture, and industrial automation. This course introduces the basic concepts of IoT, sensors, actuators, microcontrollers, cloud platforms, and real-world IoT applications. Students will learn to develop simple IoT systems using ESP32 and cloud technologies.

Course Outcome:

After Completion of the Course, Student will be able to:

No	Course Outcomes	RBT Level
01	Understand IoT fundamentals, architecture, communication, and challenges.	Understand
02	Identify and interface IoT sensors, actuators, and hardware platforms with their working and applications.	Apply
03	Apply ESP32 with Arduino IDE for interfacing, GPIO programming, and basic Wi-Fi communication.	Apply
04	Analyse various communication protocols used in IoT environments.	Analyse
05	Develop IoT applications to upload sensor data to cloud services for real-time monitoring and analysis.	Apply

**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
L	T	PR	C	Theory		Tutorial / Practical		
				ESE(E)	PA(M)	PA(I)	ESE(V)	
0	2	2	3	00	00	50	50	100



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Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	Introduction to IoT 1.1 Definition and Characteristics of IoT 1.2 Evolution of IoT and M2M Communication 1.3 IoT Architecture • Sensing Layer • Network Layer • Data Processing Layer • Application Layer 1.4 Introduction to Communication APIs. 1.5 Differences between Machine-to-Machine (M2M) communication and IoT. 1.6 Challenges in IoT System • Design, Security and Deployment Challenges	04	10
2.	IoT Sensors, Actuators and Hardware Platforms 2.1 Introduction to Sensors 2.2 Role of sensors in IoT 2.3 Classification of Sensors • Temperature Sensor • Humidity Sensor • LDR Sensor • Ultrasonic Sensor • PIR Motion Sensor 2.4 Introduction to Actuators 2.5 Role of actuators in IoT 2.6 Classification of actuators • Relay • Servo Motor • DC Motor • Stepper Motor 2.7 Introduction to Hardware Platforms for IoT • Arduino UNO, ESP32 and Raspberry Pi	06	25
3.	Introduction to ESP32 and Development with Arduino IDE	09	35



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	3.1 Introduction to ESP32 • Overview of ESP32 microcontroller • Features of ESP32 • Dual-core processor architecture • Memory organization of ESP32 • Built-in peripherals: Wi-Fi, Bluetooth, ADC, DAC, PWM 3.2 ESP32 Development Environment • Installing Arduino IDE • Configuring Arduino IDE for ESP32 development • Board package installation • Drivers and port configuration • Arduino IDE interface and tools 3.3 GPIO Programming using ESP32 • Introduction to GPIO pins of ESP32 • Pin configuration and numbering • Digital input and digital output programming • Analog input using ADC • Analog output / PWM concepts 3.4 ESP32 Core Libraries and Wi-Fi Programming • Introduction to ESP32 core libraries • Library management in Arduino IDE • Wi-Fi library for ESP32 • Connecting ESP32 to Wi-Fi network • Checking network status and IP address 3.5 Basic Interfacing Concepts • LED interfacing using GPIO • Push button interfacing • Sensor interfacing Temperature and Humidity Sensor. • Actuator interfacing basics		
4.	IoT Communication protocols and Networking	04	10



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	4.1 IoT Communication Models 4.2 Wireless Communication Technologies • BLE • Zigbee 4.3 IoT Communication Protocols • MQTT • CoAP • XMPP 4.4 Sensor Network Topologies • Star • Mesh • Ring 4.5 Device-to-Device and Device-to-Cloud Communication		
5.	IoT Cloud Platforms and Applications of IoT 5.1 Introduction to Cloud Computing • Concept of cloud computing • Types of cloud (Public, Private, Hybrid) 5.2 Role of Cloud in IoT 5.3 IoT Cloud Platforms • Features and basic implementation • ThingSpeak • Blynk IoT • Arduino IoT Cloud 5.4 Categories of IoT Applications • Consumer IoT, Commercial IoT, Industrial IoT, Infrastructure IoT and Medical IOT 5.5 Smart Home Automation 5.6 Smart Agriculture System 5.7 Smart Health Monitoring 5.8 Smart Parking System 5.9 Smart City Applications • Smart street lighting, Waste management and Environmental monitoring	07	20
	Total	30	100



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Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
-NOT APPLICABLE-					

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1	Internet of Things: Architecture and Design Principles	Rajkamal	McGraw Hill Education, 2017
2	An Introduction to Internet of Things: Connecting Devices, Edge Gateway, and Cloud with Applications	Rahul Dubey,	Paperback, 2019 ISBN: 9789353501020
3	IoT Fundamentals Networking Technologies, Protocols and Use Cases for Internet of Things	David Hanes, Gonzalo salgueiro	Cisco Press ,2017
4	Internet of Things (A Hands-on-Approach)	Vijay Madisetti and Arshdeep Bahga	Paperback, 2015 ISBN: 978-0996025515
5	Designing the Internet of Things	Adrian McEwen,Hakim Cassimally	John Wiley and Sons, Ltd. 2014

(b) Open-source software and website:

- <https://nptel.ac.in/courses/106105166>
- Online Simulator for Arduino: <https://www.tinkercad.com/dashboard>
- Arduino IDE (arduino.cc)



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Suggested Course Practical List:

The following practical outcomes (PrOs) are the subcomponents of the COs. These PrOs need to be attained to achieve the COs.

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	Study the 4-layer IoT architecture and analyse real-world applications like Smart Homes and Industrial IoT.	1	2
2	Compare hardware platforms (Arduino UNO, ESP32 and Raspberry Pi) and Study of the ESP32 pinout, dual-core architecture, and GPIO capabilities.	2	2
3	Write a Study Practical on Configuration of the Arduino IDE for ESP32 and install necessary drivers.	2	2
4	Write and execute a program to toggle an external LED (Digital Output) to understand the setup() and loop() structure.	2	2
5	Develop and test interfacing of a PIR Motion Sensor (Digital Input) and an LDR Sensor (Analog Input) with the ESP32, and read their values.	3	2
6	Write and execute a program to interface the DHT11/DHT22 (Temperature and Humidity) sensor with the ESP32 using specific sensor libraries.	3	2
7	Write and execute a program to interface an Ultrasonic Sensor (Distance) with the ESP32 using specific sensor libraries.	3	2
8	Develop an IoT application using ESP32 as an MQTT client to publish real-time temperature and humidity data to a public MQTT broker.	4	2
9	Write and execute a program to subscribe the ESP32 to an MQTT topic so that an external client (like a smartphone or PC) can remotely control an onboard LED or Relay over the internet.	4	2



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10	Write and execute a program using HTTP GET/POST API methods to send ESP32 Temperature sensor data to the cloud platform for storage and graphical visualization.	5	2
11	Develop an IoT application to integrate ESP32 Ultrasonic Sensor (Distance) with the cloud platform.	5	2
12	Develop a cloud based two-way mobile dashboard to monitor live sensor data and control physical actuators using virtual buttons.	5	2
13	(a) Write and execute a program to interface soil moisture and DHT sensors with ESP32 and Read real-time sensor data and process it in the microcontroller. Display the values on the Serial Monitor for verification. (b) Write and execute a program to connect ESP32 to Wi-Fi, send temperature, humidity, and soil moisture data to the cloud at regular intervals, visualize the data on a dashboard, and define threshold values.	5	2
14	Develop and demonstrate an IoT-based mini project by designing a smart application such as Smart Home Automation, Smart Agriculture, Smart Health Monitoring, Smart Parking, Smart City Service, Smart Street Lighting, Waste Management, or Environmental Monitoring using suitable sensors, ESP32, cloud platform, and remote monitoring/control features.	5	4
	Total		30

Note :- 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.

Suggested List of Laboratory/Learning Resources Required:

Sr. No.	Laboratory/Learning Resources/Equipment Name with Broad Specifications	PrO. No.
1	Computer system with operating system: Windows 7 or higher version / macOS / Linux, with 4GB or higher RAM, Python versions: 2.7.X, 3.6.X, or higher version.	All



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2	ESP32 Development Board, Micro-USB Data Cable, DHT11, Ultrasonic Distance Sensor, PIR Sensor, LDR, Relay Module, Servo Motor, DC Motor & Driver, Breadboard, Jumper Wires, LEDs (Red, Green, Yellow, Blue), Resistors, Push Buttons, Potentiometer, Digital Multi meter.	2– 14
3	Cloud Platforms: Arduino IoT Cloud (Open Source), ThingSpeak and Blynk IoT	10-14

Suggested Project List:

- Automated Irrigation and Soil Monitoring
- Smart Waste Management System
- Comprehensive Weather Station with Predictive Alerts
- Urban Flood & Water Level Alert System
- Smart Agriculture Soil & Pump Automator

Suggested Activities for Students:

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

- a. Undertake micro-projects in teams.
- b. Give a seminar on any relevant topics.
- c. Visit any Industry with IoT in your area and learn the IoT systems used in Industry.
- d. Students are encouraged to register themselves in various MOOCs such as: Swayam, Coursera, Udemy etc to further enhance their learning.
- e. Undertake Swayam MOOC online course: “Introduction to Internet of Things”:

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