GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma Engineering

Level: Diploma

Branch: Biomedical Engineering

Subject Code: DI04003061

Subject Name: IOT in Healthcare

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

Prerequisite:	Basic knowledge of Microcontroller, Basic communication protocols
Rationale:	The Internet of Things (IoT) connects sensors, devices, and cloud platforms, enabling data-driven automation in healthcare, agriculture, industry, homes, and smart cities. For diploma students, IoT knowledge develops hands-on skills in sensor interfacing, microcontroller programming, wireless communication, and cloud connectivity. This subject prepares students for modern applications in biomedical monitoring, smart healthcare, and emerging Industry 4.0 technologies.

Course Outcome:

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

No	Course Outcomes	RBT Level
1	Understand IoT concepts, architecture, system components, and real-world applications.	Remember
2	Explain IoT enabling technologies such as WSN, embedded systems, cloud, WoT, CPS and their roles in IoT systems.	Understand
3	Apply networking fundamentals including IP addressing, communication models, and protocol suite in IoT scenarios.	Apply
4	Apply IoT communication technologies and protocols to transmit biomedical data.	Analyze
5	Demonstrate interfacing of IoT hardware, cloud platforms, sensors, actuators, and perform basic IoT application development.	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
				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 No.	Content	No. of Hours	% of Weightage
1	**Introduction to IoT & Applications**	12	
	1. Basics of IOT • Definition • Evolution of IoT • Importance, Advantages & disadvantages • Characteristics: connectivity, sensing, intelligence • Introduction to M2M • IoT vs M2M 2. IoT System Components • Sensors: 1. Definition, need and working principle 2. Digital sensors: PIR, IR, Ultrasonic 3. Analog sensors**:** Temperature (LM35), gas sensor, soil moisture, light sensor (LDR), potentiometer • Actuators 1. Basics and classifications 2. Relay and switching devices 3. Motor actuators: DC motor, servo motor, stepper motor 3. IoT Architecture • 3-Layer Architecture • 5-Layer Architecture		25%

	4. IoT Applications • Wearable ECG, SpO_2, Body temperature monitor • Smart wheelchairs, prosthetics, rehabilitation devices • Home automation • Smart Irrigation		
2	**IoT Enabling Technologies**	9	
	1. Wireless Sensor Networks (WSN) • Concept & importance • Sensor node components • Use of WSN in IoT 2. Embedded Systems for IoT • What is embedded hardware? • Microcontroller vs microprocessor • Introduction to Arduino 3. Cloud Computing • What is cloud? • Need of cloud in IoT • Cloud data storage in IoT • Basics of Edge & Fog computing 4. Web of Things (WoT) • Meaning & concept • IoT vs WoT • Simple examples 5. Cyber Physical Systems (CPS) • Definition • Role in healthcare, automation, transportation		20%
3	**Networking Basics for IoT**	9	
	1. Basics of Networking • PAN, LAN, WAN • Wired vs Wireless networks 2. IP Addressing • Need of IP Address • IPv4 basics • IPv6 basics		25%

	• Why IoT needs IPv6 • Real examples 3. Internet Protocol Suite • TCP • UDP • Difference (simple explanation) 4. Issues in IoT Networking • Low bandwidth • Low power • Range limitations • Data loss		
4	**IoT Communication Technologies & Protocols**	9	
	1. Network & Communication Basics • OSI model and TCP/IP • Concept of MAC address • Types of IoT network topologies 2. Wireless Communication Technologies • Bluetooth • WiFi (802.11) • ZigBee • LoRa / LPWAN • NFC, RFID • Comparison of PAN, LAN, and WAN technologies 3. IoT Communication Protocols • Serial communication (UART) • SPI & I2C • MQTT (Message Queuing Telemetry Transport) • CoAP (Constrained Application Protocol) • HTTP/HTTPS for IoT 4. IoT Security Basics • Need for IoT security • Authentication, data encryption (basics)		15%

	• Cloud security considerations		
5	**IoT Hardware, Interfacing & Applications**	6	
	1. IoT Hardware Platforms • Arduino board basics • Node MCU (ESP8266) • ESP32 • Raspberry Pi (Introduction) 2. Major Cloud Platforms • Thingspeak • Blynk • Google Firebase 3. Interfacing basics • Digital input/output • Analog input • PWM control (Motor Control)		15%
	Total	**45 Hrs.**	**100 %**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
40 %	**40 %**	**20 %**	--	--	--

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:

1. Arshdeep Bahga, Vijay Madisetti, "Internet of Things – A Hands-on Approach", Universities Press / Oxford University Press.
2. Raj Kamal, *"Internet of Things: Architecture and Design Principles"*, McGraw-Hill Education.
3. Rahul Dubey, "An Introduction to Internet of Things: Connecting Devices, Edge Gateway, and Cloud with Applications", Paperback, 2019

4. N. Sudha, G. Raghava, S. Jagan, "Internet of Things", Wiley India Pvt. Ltd.
5. Cromwell, Weibell & Pfeiffer, *"Biomedical Instrumentation and Measurement"*, Pearson Education.
6. Miodrag Bolic, David Simplot-Ryl, *"Wearable Sensors: Fundamentals, Implementation and Applications"*, Elsevier.

(b) Open-source software and website:

1. https://www.arduino.cc/
2. https://github.com/esp8266
3. https://iot4beginners.com
4. https://ocw.mit.edu/
5. https://thingspeak.com/
6. NPTEL online course on IoT: https://onlinecourses.nptel.ac.in/noc18_cs08
7. https://docs.arduino.cc/learn/starting-guide/getting-started-arduino
8. http://tutorials.ptnetacad.net/
9. IoT Tutorial point www.tutorialspoint.com
10. https://www.allaboutcircuits.com/
11. https://nodered.org/
12. https://wokwi.com/
13. https://www.physionet.org/

Suggested Course Practical List: If any

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. hours required.
1	Identify Arduino/Node MCU components, ports, and IDE environment.	V	02
2	Demonstrate basic digital input/output using LED and switch.	V	02
3	Read temperature using LM35 and display on serial monitor.	I	02
4	Read multiple analog sensors and display values.	I	02
5	Speed control of DC motor (PWM) and angle control of servo.	I	02
6	Demonstrate relay interfacing for IoT-based home automation.	I	02
7	Construct serial data communication using UART between Arduino and PC	IV	02
8	Uploading Sensor Data to Cloud Platform (Thing Speak) using Node MCU	V	02
9	Study different cloud system of IoT.	V	02
10	Implementing MQTT Publish–Subscribe Communication in IoT	IV	02
11	Configure ESP8266/Node MCU to connect with Wi-Fi network	IV	02
12	Operate Bluetooth Low Energy (BLE) for wireless device control	IV	02

13	Develop a simple Web of Things (WoT) application using Raspberry Pi (GPIO control via web)	II	02
14	Apply edge computing by performing local data processing before cloud upload	II	02
15	Implement and verify basic IoT security techniques (Authentication & Data Encryption)	IV	02

List of Laboratory/Learning Resources Required:

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

1. Hardware Development Boards:
   Arduino Uno / Mega boards, Node MCU (ESP8266), ESP32 Development Boards, Raspberry Pi (optional but recommended), LoRa / LPWAN Development Boards (SX1278 / RFM95), Bluetooth Modules (HC-05 / HC-06 / BLE modules)
2. Sensors (Analog and Digital):
   Analog Sensors: LM35 Temperature Sensor, Soil Moisture Sensor, Gas Sensor (MQ series), Light Dependent Resistor (LDR), Potentiometer
   Digital Sensors: PIR Motion Sensor, Ultrasonic Sensor (HC-SR04), IR Sensor, DHT11 / DHT22 (Temp + Humidity), Pulse Sensor (For wearable IoT demo)
3. Actuators: Motors, Servo Motors, Stepper Motors, Relay Modules (Single and 4-channel), Buzzer /Alarms, LED, and Indicator Modules
4. Communication Modules
   Wi-Fi Modules (ESP8266 inbuilt / separate), Bluetooth Modules (HC-05, BLE), RFID Reader + Tags, LoRa Modules, NRF24L01 Wireless Modules, GPS Modules (optional)
5. Power & Measurement Equipment
   DC Power Supply (5V, 12V), Digital Multimeter, USB Cables, Battery Packs / Power Banks, Breadboards, Jumper Wires (Male–Male, Male–Female, Female–Female), Resistors, Capacitors, Diodes, Transistors, Small tools: Cutter, Screwdriver, Soldering Iron (optional)
6. Software Tools
   Arduino IDE, Python + Thonny/IDLE (for Raspberry Pi), Node MCU Flasher Tool (ESP8266), ESP Home / ESP Tool, MQTT Broker (Mosquito / Hive MQ Cloud), ThingSpeak Account (Free Cloud), Blynk IoT Platform, Google Firebase, Wireshark (for networking basics), Any Web Dashboard Tool (Grafana optional)

7. Cloud & Networking Resources
   Internet/Wi-Fi for uploading data, ThingSpeak Cloud (Free), IBM Node-RED (optional), MQTT Broker Access (Local or Cloud), Blynk/Mobile IoT App, Google Cloud / Firebase (Basic free tier)

Suggested Project List:

The projects serve as practical learning experiences for students in the field of Biomedical Engineering. These projects integrate theoretical knowledge with hands-on application, fostering competency development across various Course Outcomes (COs). Below are guidelines for designing and executing projects:

- **Project Types:**
  - It can be industry-based, workshop-based, laboratory-based, or field-based.
  - Each project should align with specific COs and address real-world challenges.
- **CO Integration:**
  - It should encompass two or more COs.
  - Integration involves aligning Program Outcomes (PrOs), Unit Outcomes (UOs), and Assessment and Design Outcomes (ADOs).
- **Project Duration:**
  - Students are encouraged to maintain a dated work diary to document their individual contributions and sufficient engagement time for each project should be allocated by faculty during the course.
- **Project Demonstration:**
  - Before submission, students must give a project demonstration on their project.
  - The presentation should highlight the project's objectives, methodology, results, and relevance to industry-oriented COs.
- **Seminar Presentation:**
  - Before submission, students must give a seminar presentation on their project.
  - The presentation should highlight the project's objectives, methodology, results, and relevance to industry-oriented COs.

Following are suggestive projects, and additional ones can be tailored to specific course objectives. Encourage students to explore innovative solutions and apply their engineering skills effectively.

Using various fundamental knowledge of digital electronics engineering students may develop mini/micro projects based on team/individual basis which concrete their fundamentals of digital

electronics hardware and can work as prototypic models in various societal applications. Following is the suggested list of projects:

1. Smart Home Automation System
2. Weather Monitoring & Reporting Station
3. Smart Agriculture & Soil Moisture Monitoring System
4. IoT-Based Smart Water Level Monitoring System
5. IoT-Based Health Monitoring System
6. Smart Parking System with IoT
7. IoT-Based Air Quality Index (AQI) Monitoring
8. IoT-Based Fire & Gas Leakage Alert System
9. Smart Door Lock System
10. Smart Attendance System

Suggested Activities for Students: If any

In addition to classroom and laboratory learning, students are encouraged to engage in co-curricular activities that enhance their understanding and practical skills. These activities can be conducted in groups on breadboard or PCB should be used and it should be documented in 5-page reports. Collecting physical evidence of their work will also contribute to their portfolio, which can be valuable during placement interviews.

Hands-on Sensor Interfacing Activity

- Activity: Students will interface **basic sensors** (temperature, humidity, motion, gas) with ESP32/Arduino and display values on Serial Monitor / LCD.

Create an IoT Dashboard on Cloud

- Activity: Students will create a free dashboard on platforms like: ThingSpeak, Blynk, Ubidots, Adafruit IO and visualize sensor data.

Configure and Use MQTT Protocol

- Activity: Hands-on activity to publish/subscribe messages on an MQTT broker.

Mobile App Development for IoT Control

- Activity: Students design a simple mobile app using: MIT App Inventor, Blynk to control an LED, fan, or relay.

Mini-Project Group Activity

- Activity: In small teams, students develop a working prototype

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