Gyanmanjari Innovative University

Syllabus
Gyanmanjari Institute of Technology
Semester-4 (B. Tech.)

Subject: IoT and Applications: Smart Devices, Connectivity, and Automation-BE1CE14308

Type of course: Professional Core

Prerequisite: Basic Knowledge of Internet of Things

Rationale:

The Internet of Things (IoT) is transforming how devices communicate and operate by connecting physical objects to the internet. This course helps students understand how sensors, actuators, and microcontrollers work together to collect and process data. Students will learn to build real-time IoT applications using Arduino/ESP32 and communication technologies like Wi-Fi, Bluetooth, and MQTT. The course focuses on practical implementation, allowing students to design smart systems such as home automation, smart agriculture, and monitoring systems. Learners will explore challenges such as security, data privacy, and power management in IoT applications. By the end of the course, students will be able to create, test, and deploy IoT projects, preparing them for innovation and future industry demands.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks		Total Marks
CI	T	P	C	SEE	CCE	
2	0	4	4	100	50	150

Legends: CI-Class Room Instructions; T – Tutorial; P - Practical; C – Credit; SEE - Semester End Evaluation; CCE-Continuous and Comprehensive Evaluation.

Course Content:

Sr. No	Course Content	Hrs.	% Weightage
1	**Introduction to Internet of Things (IoT) and Basic Concepts :** ***Theory Topics:*** The Internet of Things (IoT) has evolved from basic connected devices to advanced smart systems that communicate through sensors and the internet. Its physical design includes hardware like sensors and microcontrollers, while the logical design focuses on data flow, communication, and processing. IoT works through different levels and deployment models, from sensing to cloud-based analysis. Although IoT improves automation, efficiency, and remote monitoring, it also faces challenges such as security, privacy, and power consumption. IoT operates by collecting data, processing it, and triggering actions automatically. It offers many advantages, including convenience and smart control, but also has disadvantages like network dependency. IoT is widely used in home automation, healthcare, agriculture, industry, and smart cities. ***Practical:*** 1) Detect human movement using a PIR sensor and activate a buzzer or LED. 2) Display temperature and humidity on serial monitor or LCD using DHT11. 3) Turn ON a water pump when soil moisture is low. 4) Use HC-05 Bluetooth module to switch ON/OFF an LED or fan using a phone app. 5) Control AC appliances (bulb/fan) with a relay module using switches or an app. 6) Use an ultrasonic sensor to detect water tank level and show output on Serial/LCD. 7) Interface a keypad with Arduino enter a password to rotate the servo and unlock the door. 8) Scan RFID tag to allow access trigger buzzer for invalid card. 9) Measure water flow rate using a flow sensor and display usage in liters.	18	20%

10) Explain 4 Levels of IOT :

- Level 1
- Level 2
- Level 3
- Level 4

Draw a layered diagram showing how data passes from the device to the application.

Evaluation Method:

Sr. No.	Evaluation Methods	SEE	CCE
1	**IoT Level Mapping** AgroSense is a smart agriculture IoT project that automates irrigation using a soil moisture sensor, Arduino, and cloud monitoring. It covers all six IoT levels from sensing to user control. Students have to identify these levels and explain how the system works step by step.	20	
2	**IoT Smart Tank Fillup using Home Automation** The IoT Smart Tank Fillup system uses an Arduino and a water-level sensor to automate tank filling. It turns the motor ON when water is low and OFF when the tank is full, preventing overflow and saving water. Students have to identify the IoT Sensors and Process used in this system and explain how sensing, processing, and control work step by step.		10
	Total	20	10

Examination Style:

IoT Level Mapping (20 Marks)

AgroSense is a smart agriculture IoT project that automates irrigation using a soil moisture sensor, Arduino, and cloud-based monitoring. It demonstrates all six IoT levels, showing how data moves from sensing to user control. Students have to study this project model, identify each

	IoT level clearly, and explain how sensing, communication, processing, storage, and user interaction work together in the system. **IoT Smart Tank Fillup using Home Automation. (10 Marks)** The IoT Smart Tank Fillup system uses an Arduino and a water-level sensor to automate tank filling. It turns the motor ON when water is low and OFF when the tank is full, preventing overflow and saving water. Students have to identify the IoT sensors and processes used in this system and explain how sensing, processing, and control work step by step. They should describe the chosen sensor type (ultrasonic, float, or probe), how the sensor readings are converted into digital values, and how the Arduino processes these values against preset thresholds. The explanation must include signal conditioning or ADC use (if any), debouncing or filtering techniques, and the decision logic (including hysteresis or timeout) that prevents rapid relay switching. Finally, students should detail the actuator control (relay or motor driver), safety measures (fuse, isolation, fail-safe timeout), and optional cloud reporting for remote monitoring and logging.		
2	**Sensors, Microcontrollers and their Interfacing:** ***Theory Topics:*** In IoT systems, sensors detect environmental changes (e.g., MQ-02 gas sensors for fumes, IR for motion, ultrasonic for distance, gyro for orientation. LDR for light, and heartbeat for pulse) and convert them into data. Actuators respond by performing actions like activating motors. Interfacing connects these to microcontrollers, such as the 8051 family for basic tasks or ARM processors for advanced, low-power applications. Together, they enable automation in smart homes, healthcare, and industry, ensuring real-time connectivity and efficiency. ***Practical:*** 11) Use an MQ-02 gas sensor with Arduino to detect smoke or LPG and turn ON a buzzer when gas concentration crosses a limit. 12) Build a security alert system where the IR sensor detects motion and activates an LED or buzzer. 13) Create an automatic light control system that turns ON lights when darkness is detected. 14) Measure distance using an ultrasonic sensor and display the value on an LCD or Serial Monitor. 15) Use a heartbeat sensor with Arduino to measure pulse rate and	18	20%

display BPM in real time.

16) Detect tilt or rotation and show X, Y, Z values on Serial Monitor.
17) Use a temperature sensor with a servo motor to automatically adjust airflow or vent angle.
18) When IR detects a person, open the door using a servo motor and close after a delay.
19) Control appliances (light, fan, pump) automatically using sensor input through a relay module.
20) Connect multiple sensors (LDR, temperature, gas) to an 8051 or ARM microcontroller and display readings on Serial/LCD for real-time monitoring.

Evaluation Method:

Sr. No.	Evaluation Methods	SEE	CCE
1	**IoT Design & Develop Activity** The student must select one IoT project from the given list of sensors and independently design the complete system. The student will build the circuit, write the Arduino code, and test the working of the project. They must also explain the components used, the sensor processing flow, and the final output behavior of the system. Finally, the student should document the entire work clearly and prepare it for submission.	20	
2	**Active Learning Assignment** **Think Smart, Build Smart, Solve Smart** In this project, students identify real-life challenges and apply IoT-based solutions using sensors and microcontrollers. Each student explores how their project can be useful in real applications and demonstrates how smart technology can solve everyday problems through innovation.		10
	Total	20	10

	Examination Style: **IoT Design & Develop Activity (20 Marks)** The student must select one IoT project from the provided list of sensors and independently design the entire system. They will create the hardware circuit with correct sensor and controller connections and write the necessary Arduino code. After building the system, the student must test and verify that the sensor readings and output actions work as expected. They should also provide a clear explanation of all components used, along with the sensing, processing, and control flow of the project. Additionally, the student must describe the final behavior of the system based on real sensor data. In the end, a well-organized and neatly prepared documentation of the complete project must be submitted. **Think Smart, Build Smart, Solve Smart (10 Marks)** In this project, students will identify real-life problems such as automation, safety, monitoring, or energy-saving challenges and design IoT-based solutions using sensors and microcontrollers like Arduino. Each team will justify the choice of sensors, explain how data flows through the system, and represent their working using a block or circuit diagram. Students will also describe the real-world application, benefits, and impact of their solution. This activity helps them understand how IoT improves efficiency and convenience while developing teamwork, problem-solving, and practical technical skills through hands-on innovation.Finally, students must upload a PDF of this complete documentation on the GMIU web portal.		
3	**IoT-Bridge Protocol :** ***<u>Theory Topics:</u>*** Messaging Protocols in IoT: Introduction to MQTT and CoAP, publish–subscribe architecture of MQTT, request–response model of CoAP, comparing MQTT vs CoAP based on speed, reliability, lightweight nature, suitability for constrained devices, and communication structure. Transport Protocols in IoT: Overview of BLE, Li-Fi, and Wi-Fi, wireless data transmission methods, characteristics, range, and energy consumption, comparison of Li-Fi and Wi-Fi based on medium (light vs radio waves), speed, security, and interference. Internet Layer Protocols: Introduction to IPv4, IPv4 packet format, header fields, fragmentation, routing, and classification	18	25%

GYANMANJARI INNOVATIVE UNIVERSITY BHAVNAGAR GMIU of IPv4 addresses. Understanding IPv6: IPv6 packet format, header fields, auto-configuration, hierarchical addressing, comparison between IPv4 and IPv6 based on address size, speed, security, header complexity, and efficiency. Identification in IoT: Introduction to URI (Uniform Resource Identifier), syntax and components, role of URI in uniquely identifying IoT resources in communication networks.

Practical:

21) Send temperature or LDR sensor data from ESP32 to an MQTT broker using the publish–subscribe model.
22) Subscribe ESP32 to an MQTT topic and control LED ON/OFF using a mobile MQTT client.
23) Use a CoAP client (Copper plugin/Californium) to send a GET request to ESP32-CoAP server and read a sensor value.
24) Send the same sensor data using MQTT and CoAP and measure time delay using timestamps.
25) Send small sensor data packets via Bluetooth Low Energy (BLE).
26) Transmit binary data using an LED (transmitter) and LDR (receiver).
27) Create a Wi-Fi web server using ESP32 that shows sensor values in the browser.
28) Capture packets from ESP32 web server and identify IPv4 header fields such as version, header length, source/destination IP, TTL, checksum.
29) Enable IPv6 on router/ESP32 and capture IPv6 packets using Wireshark.
30) Use ESP32 web server and identify its URI structure (scheme, host, path, query).

Evaluation Method:

Sr. No.	Evaluation Methods	SEE	CCE
1	**Smart Garbage Monitoring using Ultrasonic Sensor.** In a Smart Garbage Monitoring System, students identify how an ultrasonic sensor measures the dustbin's fill level and how the controller processes the data. The system sends alerts through	20	

	indicators or cloud notifications using protocols like MQTT or HTTP. This helps students understand smart waste management, overflow prevention, and real-time IoT communication.		
2	**Active Learning Assignment** **Play Music on a Speaker from Your Phone Using Li-Fi** Li-Fi (Light Fidelity) is a technology that transfers data using LED light instead of radio waves like Wi-Fi or Bluetooth. In this problem, students study how Li-Fi works, how data is transmitted through visible light, and how it can be used for high-speed and secure communication. They also learn to compare Li-Fi with traditional wireless technologies and understand its advantages and limitations.		10
	Total	20	10

Examination Style:

Smart Garbage Monitoring using Ultrasonic Sensor(using MQTT) (20 Marks)

In a Smart Garbage Monitoring System, students must identify how the ultrasonic sensor measures the fill level of a dustbin and understand the working process behind it. The system detects when the bin is getting full and sends an alert through an indicator or cloud notification. Students should explain how the sensor reads distance, how the controller processes that data, and how communication takes place using IoT protocols such as MQTT or HTTP to send updates to a server or mobile app. By studying this system, students learn how IoT technology helps maintain cleanliness, prevent overflow, and improve smart waste management through intelligent sensing and real-time communication.

	How to Play Music on a Speaker from Your Phone Using Li-Fi (10 Marks) Li-Fi (Light Fidelity) is an advanced wireless communication technology that transfers data using LED light instead of radio waves used by Wi-Fi or Bluetooth. It works by rapidly varying the intensity of the LED light, which is detected by a photodiode and converted back into digital data. In this problem, students study how Li-Fi enables high-speed, secure communication in environments where radio signals are limited or restricted. They also learn how Li-Fi can be applied in smart homes, hospitals, and underwater systems. Additionally, students analyze the advantages and limitations of Li-Fi and compare it with traditional wireless technologies to understand its practical uses in IoT.		
4	**ArduinoLink IoT:** ***<u>Theory Topics:</u>*** Arduino is an open-source microcontroller platform that operates based on a simple and efficient architecture consisting of a microcontroller, input/output pins, power circuitry, and communication interfaces. Programming an Arduino is done through an Arduino Sketch, which follows a specific structure including two main functions: setup() (executed once for initialization) and loop() (runs repeatedly to execute the main logic). While writing programs, various data types such as int, float, char, and boolean are used to store different types of values, and operators like arithmetic, comparison, logical, and assignment operators help perform operations and decisions in the program. Functions play a key role in Arduino programming—predefined library functions allow interaction with hardware, while user-defined functions help organize and reuse code. A basic example of Arduino programming is LED blinking. ***<u>Practical:</u>*** 31) Write a sketch using setup() and loop() to blink an LED ON and OFF with a delay. 32) Use an integer data type to store delay time and change LED blinking speed. 33) Use a digital input pin and digitalRead() to detect a button press and control LED. 34) Modify a variable using arithmetic operators (+, −) to change blink timing. 35) Use comparison operators (>, <) to check if a sensor value crosses a	18	20%

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36) Write a custom function blinkLED() and call it from loop() for structured code.
37) Read analog values using a sensor (like LM35) and display data on Serial Monitor.
38) Turn ON LEDs when multiple conditions are true using logical operators.
39) Use a boolean variable to toggle LED ON/OFF each time button is pressed.
40) Use Serial.begin(), Serial.print(), and different data types to show output.

Evaluation Method:

Sr. No.	Evaluation Methods	SEE	CCE
1	**Mini Project using Arduino** Students have to work on a real-world project with this unit concept.	20	
2	**Develop a Document** The Arduino block diagram includes a microcontroller, input/output pins, power pins, and an ADC section that converts analog sensor data into digital form. With USB connectivity and built-in power regulation, Arduino can easily interface with sensors and control devices for various IoT projects. Students must study this block diagram and create a clear chart that explains each block's function and how they work together in an Arduino-based system.		10
	Total	20	10

Examination Style:

Mini Project using Arduino (20 Marks)

Design the circuit using sensors and microcontrollers (Arduino), write and upload Arduino code to read sensor values, implement functions and control logic (e.g., LED/relay activation based on sensor data),

	handle real-time events using serial monitoring, and ensure reliable operation through debugging and testing. Students will also demonstrate automation using multiple sensors and explain how the system reacts to environmental conditions. Each group must first define the problem statement of their project and then collaboratively work as a team to implement and present their IoT solution. **Develop a Document (10 Marks)** The Arduino block diagram shows how different components inside the board work together to perform various tasks. At its core is the microcontroller, which processes instructions and manages the entire system. The digital and analog I/O pins enable Arduino to connect with sensors and control external devices, while the power pins provide stable voltage levels like 3.3V, 5V, and GND. The ADC section converts analog sensor signals into digital values that the microcontroller can understand. A USB interface is used for uploading programs and powering the board, supported by a voltage regulator that keeps the system safe even with external power sources. Communication interfaces such as UART, I2C, and SPI allow the board to connect with modules like displays, Wi-Fi units, and other peripherals. Together, these components make Arduino ideal for automation and IoT applications. Students must study this complete block diagram and create a detailed chart explaining the purpose and function of each block.		
5	**Application Building with IOT:** ***Theory Topics:*** IoT (Internet of Things) is used in many real-life applications to improve efficiency and automation. In the food industry, IoT helps monitor temperature and storage conditions to maintain food quality. In healthcare, wearable devices and sensors allow continuous monitoring of patient health data. Home automation enables control of lights, fans, and appliances using smartphones or voice assistants. In smart agriculture, sensors automate irrigation by monitoring soil moisture, temperature, and humidity. IoT systems like water quality monitoring using Arduino check pH and turbidity values to ensure safe drinking water. In driver assistance, sensors help detect obstacles and improve road safety. IoT reduces human effort, saves resources, and provides smart solutions across different fields.IoT (Internet of Things) is used in many real-life applications to improve efficiency and automation. In the	18	15%

food industry, IoT helps monitor temperature and storage conditions to maintain food quality. In healthcare, wearable devices and sensors allow continuous monitoring of patient health data. Home automation enables control of lights, fans, and appliances using smartphones or voice assistants. In smart agriculture, sensors automate irrigation by monitoring soil moisture, temperature, and humidity. IoT systems like water quality monitoring using Arduino check pH and turbidity values to ensure safe drinking water. In driver assistance, sensors help detect obstacles and improve road safety. IoT reduces human effort, saves resources, and provides smart solutions across different fields.

Practical:

41) This project uses temperature and humidity sensors inside a food container or refrigerator to continuously monitor storage conditions. If the temperature goes beyond safe limits, the system sends an alert to the user through a mobile app or buzzer. This helps maintain food quality and avoid spoilage.
42) Using heartbeat and temperature sensors, a wearable device can continuously track a patient's health. The data is sent to a mobile app or cloud dashboard so doctors or family members can monitor real-time health status. Alerts are generated if abnormal readings are detected.
43) This project allows users to control lights, fans, and home appliances using a smartphone or voice commands. An Arduino or ESP32 connects to Wi-Fi and operates relays based on user input. It increases comfort, saves electricity, and enhances home security.
44) A soil moisture sensor measures water level in the soil. When the moisture level falls below the required limit, the Arduino automatically turns on a water pump. It stops the pump when the soil is wet enough. This reduces water waste and helps maintain healthy crops.
45) Using sensors like pH and turbidity modules, the system measures water purity in real time. Arduino reads the values and sends alerts if the water becomes unsafe. This project helps ensure the quality of drinking water in homes or villages.
46) An ultrasonic sensor is mounted on a vehicle model to detect nearby obstacles. The system alerts the driver with a buzzer or LED if something comes too close. This improves road safety and reduces accidents.

Evaluation Method:

Sr. No.	Evaluation Methods	SEE	CCE
1	**Implementation of Home Automation** In a Home Automation system, Arduino controls appliances like lights, fans, and AC using a mobile app through Wi-Fi or Bluetooth. This allows users to operate home appliances remotely, making daily life smarter, efficient, and convenient.	20	
2	**Active Learning Assignment GreenGrow System** In our Smart Agriculture System, Arduino works with sensors to monitor soil moisture and environmental conditions. When the soil becomes dry, the system automatically turns ON the water pump for irrigation. This reduces manual effort, saves water, and helps improve crop growth efficiently.		10
	Total	20	10

Examination Style:

Implement of Home Automation (20 Marks)

In a Home Automation system, Arduino is used to control appliances like lights, fans, and AC through a mobile application. Sensors and relays are connected to the Arduino to interface with household appliances, allowing users to operate them wirelessly using Wi-Fi or Bluetooth technology. The system provides comfort, saves electrical energy, and enables remote control of devices from anywhere using a smartphone. This automation makes daily household operations smarter, efficient, and more convenient. Students can be awarded marks based on correct explanation of the system, proper use of technical terms, clarity of working principle, and relevance of applications described in the answer.

	GreenGrow System (10 Marks) In our Smart Agriculture System, we use Arduino along with different sensors to monitor and automate farming activities. The soil moisture sensor checks the moisture level in the soil and automatically controls the water pump when irrigation is required. A temperature and humidity sensor (DHT) helps measure environmental conditions to support crop growth. The system is designed to reduce manual effort, save water, and improve farming efficiency. All collected data can be viewed on a display or a mobile interface, allowing farmers to make better decisions and maintain healthy crop conditions.Finally, students must upload a PDF of this complete documentation on the GMIU web portal.		

Suggested Specification Table:

Distribution of Marks **(Revised Bloom's Taxonomy)**						
Level	Remembrance (R)	Understanding (U)	Application (A)	Analyze (N)	Evaluate (E)	Create (C)
Weightage %	10%	10%	20%	10%	10%	40%

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from the above table.

Course Outcome:

After learning the course, the students should be able to:	
CO1	Analyze the basic concept of IoT.
CO2	Explore IOT uses and all the sensors and their information.
CO3	Develop Arduino applications using protocols like Message protocols, Transport protocols and topologies.
CO4	Evaluate to write code in Arduino, its Datatype, Operators, Libraries, Control system, Loops, Functions and LED blinking program.
CO5	Understand how an IOT application works in our real-world.

Instructional Method:

The course delivery method will depend upon the requirement of content and needs of students. The teacher, in addition to conventional teaching methods by black board, may also use any tools such as demonstration, role play, Quiz, brainstorming, MOOCs etc.

From the content 10% topics are suggested for flipped mode instruction.
Students will use supplementary resources such as online videos, NPTEL/SWAYAM videos, e-courses, Virtual Laboratory.

The internal evaluation will be done on the basis of the Active Learning Assignment.

Practical/Viva examination will be conducted at the end of semester for evaluation of performance of students in the laboratory.

Reference Books:

[1] Internet Of Things, Architecture and Design Principal by Raj Kamal, Mc Graw Hill.

[2] Designing the Internet of Things by Adrian McEwen, Wiley.

[3] Internet of Things for Beginners by Thompson Charter, Lincoln Publication.

[4] Connecting the Internet of Things by Anil Kumar, Jafer Hussain, Apress Publication .

[5] Internet of Things Programming Projects, Packt Publications.

Evaluation Rubric

Module-1: Introduction to Internet of Things (IoT) and Basic Concepts

IoT Level Mapping (20 Marks)		
Criteria	**Description**	**Marks**
Problem Understanding	Identifying the irrigation problem and project goal	5

Design & Methodology	Planning, IoT level mapping, and system workflow	5
Implementation	Working model with sensors, Arduino code, and pump control	5
Report Quality & Presentation & Viva	Clear documentation, diagrams, and code explanation and Justification of work and proper explanation in viva.	5
	Total	20

Module-2: Sensors, Microcontrollers and their Interfacing

IoT Design & Develop Activity (20 Marks)		
Criteria	**Description**	**Marks**
Project Selection & Understanding	The student selects one IoT project and clearly understands the problem and objective.	5
Circuit Design	Proper wiring of sensors and Arduino.	5
Code Implementation	Correct and working Arduino code.	5
Sensor Processing Explanation & Final Output & Documentation	Explanation of components and data flow and Working model + clear report submission.	5
	Total	20

Module-3: IoT-Bridge Protocol

Smart Garbage Monitoring using Ultrasonic Sensor (20 Marks)		
Criteria	**Description**	**Marks**
Sensor Identification & Working	Correct identification of ultrasonic sensor and clear explanation of how it measures dustbin fill level.	5

Data Processing Logic & Communication Protocol Usage	Explanation of how the controller (Arduino) reads sensor data and decides alert conditions and Proper use and explanation of MQTT/HTTP for sending alerts or notifications.	5
System Workflow & Automation	Accurate description of how overflow prevention and automated monitoring work in real-time.	5
Output Interpretation & Documentation & Explanation Quality	Correct explanation of notifications, indicators, or cloud alerts produced by the system and Well-structured writing, clarity, and proper organization of project explanation.	5
	Total	20

Module-4: ArduinoLink IoT

Mini Project using Arduino (20 Marks)		
Criteria	**Description**	**Marks**
Problem & Objective	Clear problem selection and project aim.	5
Circuit Design	Correct wiring and neat hardware setup.	5
Arduino Code & Sensor Integration	Error-free code with proper logic and Proper connection and working of sensors/modules.	5
Project Working & Documentation	Demonstration matches expected output and Short report with diagram and explanation.	5
	Total	20

Module-5: Application Building with IOT

Implementation of Home Automation (20 Marks)		
Criteria	**Description**	**Marks**
System Design &	Clear explanation of Arduino, Wi-Fi/Bluetooth module, and	5

Components	home appliance connections.	
Mobile App Interface	Proper design of the mobile app layout for controlling lights, fans, AC, etc.	5
Circuit Implementation	Correct wiring of appliances with relays, sensors, and Arduino ensuring safe operation.	5
Communication Setup & Functionality Testing	Successful use of Wi-Fi/Bluetooth for remote control and smooth communication between phone and Arduino and Appliances respond correctly to commands, reliable ON/OFF control, error-free working.	5
	Total	20