Hands-on Foundations of IoT with ESP32

Module-wise Content Outline

Module 1: Introduction to IoT and Embedded Systems (4 hours)

• Understanding IoT: Features, domains, and relevance

• Evolution from traditional systems to smart devices

• Basics of embedded systems in the IoT context

• Overview of ESP32 architecture and comparison with other boards

Hands-on: Exploring ESP32 pin configuration, on-board peripherals, and development environment setup (Arduino IDE)

Module 2: Programming Essentials and GPIO Handling (5 hours)

• Setting up ESP32 in Arduino IDE

• Digital Input/Output programming

• Working with LEDs, buttons, and buzzers

• Looping structures, delay functions, and I/O timing control

Hands-on: LED control (patterns), push button input reading, buzzer alerts with code logic

Module 3: Sensor Integration and Data Collection (6 hours)

• Classification of sensors (analog, digital)

• Working principles: DHT11, Ultrasonic, IR

• Data reading using serial monitor

• Basic error handling and sensor calibration

Hands-on: Reading temperature, humidity, distance; using conditional statements for decision-making

Module 4: Actuator Control and Device Behavior (5 hours)

• Role of actuators in IoT systems

• Controlling outputs based on sensor inputs

• Real-time feedback systems

• Pulse-width modulation (PWM) basics for motor and LED dimming

Hands-on: Creating interactive systems (e.g., automatic fan control, object detection with alerts)

Module 5: Wireless Connectivity and Data Communication (5 hours)

• Connecting ESP32 to Wi-Fi

• Basics of HTTP and MQTT protocols

• Data exchange between ESP32 and cloud servers

• Cloud platforms overview: ThingSpeak, Blynk (demo-level)

Hands-on: Sending sensor data to cloud dashboard and visualizing it on

web/mobile Module 6: Final Project Build and Demonstration (5 hours)

• Project planning: Problem selection and solution outline

• Building integrated systems combining all learned concepts

• Testing and troubleshooting

• Final demonstration with explanation of design, logic, and implementation

Sample Projects: • Smart Weather Reporter • Motion-activated Alert System • IoT-enabled Room Automation