

Embedded Systems Training Program

A hands-on training program designed to build strong foundations in Embedded Systems, Microcontrollers, IoT, and RTOS development.

Detailed Syllabus

Module 1 – Basics of Embedded Systems

- Definition & Characteristics of Embedded Systems
- Difference between General-Purpose Computers & Embedded Systems
- Embedded System Architecture
- Microcontrollers vs. Microprocessors
- Common Microcontroller Architectures
- Memory Types in Embedded Systems
- Classification: Real-Time vs. Non-Real-Time, Hard vs. Soft RTOS
- Applications in Consumer, Automotive, Medical, etc.
- Design Considerations: Power, Reliability, Cost, Size

Module 2 – Foundations of Arduino Programming

- Introduction to Arduino Platform & IDE Setup
- Basic Components (LEDs, Resistors, etc.)
- Programming Basics in C/C++
- Variables, Data Types, Operators, Control Structures
- Functions & Libraries (Standard & Custom)

Module 3 – Sensor Integration & Project Development

- Introduction to Sensors & Transduction Mechanisms
- Analog vs. Digital Sensors, Calibration & Accuracy
- IR Sensors, Environmental Sensors (Soil, Rain, Temp, Humidity)
- Ultrasonic & Touch Sensors
- Specialized Sensors (LDR, Gas, Fire Detection)
- Mini Projects with Different Sensors

Module 4 – Bare-Metal Coding

- Bare-Metal Programming Fundamentals
- GPIO Drivers & Sensor Interfacing
- Register-Level Programming for Interrupts & Timers
- ADC Drivers & Analog Sensor Integration

Module 5 – Communication Protocols & Driver Development

- Overview of UART, SPI, I2C
- Register-Level Programming of Communication Protocols
- Implementing UART, SPI, I2C Drivers
- Multi-Protocol Integration Projects

- Debugging & Troubleshooting Communication

Module 6 – Introduction to PIC Microcontrollers & MPLAB IDE

- Introduction to PIC MCUs & Applications
- PIC Architecture & Memory Organization
- MPLAB IDE Setup & Programming Flow
- Using PICKIT3 Debugger for Programming & Debugging

Module 7 – PIC Microcontroller Module Implementation

- ADC Configuration & Applications
- GPIO Configuration & Projects
- Timers, Capture/Compare/PWM (CCP) Modules
- Real-World Embedded Projects with PIC

Module 8 – IoT & ESP32 Microcontroller

- IoT Concepts & Applications
- ESP32 Overview & Comparison with Other MCUs
- ESP32 Development Environment (Arduino IDE, ESP-IDF)
- GPIO Configuration & Programming on ESP32
- IoT Mini Project with Sensors

Module 9 – RTOS with ESP32 (FreeRTOS)

- Introduction to RTOS & Need in Embedded Systems
- Basics of Multitasking & Scheduling
- FreeRTOS Features & Setup on ESP32
- Task Management, Inter-Task Communication
- Synchronization Mechanisms (Semaphores, Mutex, Queues)
- Timers & ISRs in FreeRTOS
- Real-Time IoT Projects using ESP32 + FreeRTOS