

**ADD ON COURSE 2023-24**  
**EMBEDDED CONTROLLERS and RTOS**

Duration: 31 Hours

Course code: EC-EMC

**Course Description:**

This course introduces students to the design, programming, and interfacing of embedded systems using microcontrollers. Students will learn about the architecture and operation of microcontrollers, programming in C/C++, real-time operating systems (RTOS), and interfacing with peripherals and sensors. Through hands-on projects and laboratory exercises, students will gain practical experience in developing embedded systems for various applications.

**Course Objectives:**

1. Understand the architecture and operation of microcontrollers.
2. Learn programming techniques for embedded systems using C/C++.
3. Explore real-time operating systems (RTOS) and their applications.
4. Develop skills in interfacing microcontrollers with peripherals and sensors.
5. Design and implement embedded systems for specific applications.
6. Gain hands-on experience through laboratory exercises and projects.
7. Apply knowledge of embedded controllers to solve real-world problems.

**Module 1:**

**06 Hours**

**Introduction to Embedded Systems**

- Definition and characteristics of embedded systems
- Overview of microcontrollers and their applications
- Introduction to development tools and software

**Microcontroller Architecture**

- CPU architecture and instruction set
- Memory organization (ROM, RAM, Flash)
- Input/output (I/O) ports and peripheral interfaces

**Module 2:**

**07 Hours**

**Programming in C/C++ for Embedded Systems**

- Basics of C/C++ programming language
- Data types, variables, and operators
- Control structures (loops, conditionals)

**Interrupts and Timers**

- Interrupt handling mechanisms
- Timer/counters and their applications
- Implementing interrupts in embedded systems

**Module 3:**

**08 Hours**

**Real-Time Operating Systems (RTOS)**

- Overview of real-time operating systems
- Task scheduling and multitasking
- Inter-task communication and synchronization

**Interfacing with Peripherals**



- Serial communication (UART, SPI, I2C)
- Analog-to-digital conversion (ADC)
- Pulse-width modulation (PWM)

**Module 4:**

**08 Hours**

**Communication Protocols**

- Wireless communication protocols (Bluetooth, Wi-Fi)
- Internet of Things (IoT) protocols (MQTT, CoAP)
- Implementing communication protocols in embedded systems

**Memory Management and Optimization**

- Memory management techniques
- Code optimization for embedded systems
- Power management and low-power design

**Embedded System Design**

- Design considerations and trade-offs
- Project planning and implementation
- Testing and debugging techniques

**Textbook:**

"Embedded Systems: Introduction to ARM Cortex-M Microcontrollers" by Jonathan W. Valvano

**References:**

1. "Programming Embedded Systems in C and C++" by Michael Barr
2. "RTOS Programming: Concepts for Microcontroller" by Prasad Gudem

