

Course Code	Course Title	L	T	P	C
MCOA506L	Real Time Embedded systems	2	0	0	2
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives:					
1. Identify modern embedded systems requirements and its' design constraints					
2. Acquire hardware and software skills required for the role of embedded system engineer					
3. Build automated control systems for real world problems using low cost embedded platforms					
Course Outcomes:					
On the completion of this course the student will be able to:					
1. Identify a microcontroller based on application specifications.					
2. Develop embedded software using commercial integrated development environments					
3. Interface sensors and actuators using suitable communication protocols					
4. Design data acquisition system for embedded measurement and control applications					
5. Design and implement real-time embedded control applications					
Module:1	Embedded systems	2 hours			
Embedded system components; Examples of embedded system; Attributes; Characteristics; Challenges in embedded computing system design; Typical embedded system software operations					
Module:2	ARM Cortex-M Architecture	3 hours			
CPU core: Architecture, Registers, Operating modes; Memory organization; Instructions: Instruction formats, and addressing modes; Exceptions and Interrupts; Commercial ARM Cortex-M microcontrollers					
Module:3	Programming Embedded Systems	3 hours			
Embedded C programming: Number systems, Data types, Data structures, Functions, Bitwise operations; Improving responsiveness: Interrupts, Finite state machines; Concurrency; Scheduling; Context switching; Real-time systems; Embedded software development: Host and target, Compiler, Assembler, Linker, and Loader; Hardware and software debugging, In system programming					
Module:4	Peripherals and Interfacing	5 hours			
Memory mapped IO; GPIO programming: Push-Pull, Open-Drain modes, Pull up and Pull down modes, Input and output devices; Timing generation and measurements: Timers, and PWM, Input capture; ADC, DAC, Analog comparator; Block data transfer using DMA; Real Time Clock (RTC); Power management					
Module:5	Serial Communication Protocols	5 hours			
Serial communication protocols: UART, I2C, SPI, and CAN; Architecture; electrical considerations; message formats; message types; transmission and arbitration; Data visualization using logic analysers					
Module:6	Data acquisition System Design	5 hours			
Analog interfacing and data acquisition; Transducers; Current to voltage circuit, Instrumentation amplifier, isolation, Anti-aliasing filters; Nyquist theory to determine sampling rate; Measurement of voltage, current, and temperature; Analysis of noise; Techniques to reduce noise; Optical encoders for speed and position measurement; Data acquisition case studies					
Module:7	Embedded Control System	5 hours			
Closed loop control system: Set-point control and trajectory tracking; Design process for a PID controller; Fixed point vs. Floating point representation, Implementation of PID controller; Implementation of digital filters, Quantization, Overflow and resource issues; Case					

studies: Digital power supply design and motor control			
Module:8	Contemporary Issues		2 hours
	Total Lecture hours:		30 hours
Text Book(s)			
1.	Alexander G Dean, Embedded Systems Fundamentals with Arm Cortex-M based Microcontrollers: A Practical Approach, ARM Education Media, 2021.		
2.	Jonathan W. Valvano, Embedded Microcomputer Systems: Real Time Interfacing, Third Edition, Cengage Learning, 2010.		
Reference Books			
1.	Yifeng Zhu, Embedded Systems with ARM Cortex-M Microcontrollers in Assembly Language and C, Third Edition, 2018.		
2.	Marilyn Wolf, Computers as Components: Principles of Embedded Computing Design, Third Edition, Morgan Kaufmann, 2012.		
3.	Raj Kamal, Embedded Systems- Architecture, Programming and Design, Third Edition, McGraw Hill Education India, 2017.		
Mode of Evaluation: CAT, Laboratory Assessment/Assignment / Quiz / FAT			
Recommended by Board of Studies		09-07-2022	
Approved by Academic Council		No. 67	Date 08-08-2022