| EMBEDDED SYSTEMS [ Revised Credit System] (Effective from the academic year 2018-19) SEMESTER - IV | | | |
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| Subject Code | CSE2253 | IA Marks | 50 |
| Number of Lecture Hours/Week | 04 | Exam Marks | 50 |
| Total Number of Lecture Hours | 48 | Exam Hours | 03 |
| CREDITS - 04 | | | |

**Course objectives:** This course will enable students to

- Understand ARM Cortex-M Architecture and embedded systems
- Write assembly language programs using ARM instructions
- Interface various devices to the ARM microcontroller and program using embedded C

| Module -1 | Teaching Hours |
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| **INTRODUCTION TO EMBEDDED SYSTEMS AND ARM CORTEX-M MICROCONTROLLER:**<br><br>Introduction to Embedded Systems, Microprocessors and Microcontrollers, An overview of ARM-Cortex- M Architecture: General purpose registers, ARM memory map, Load store instructions in ARM, ARM CPSR, ARM Data format, Pseudo instructions and Directives, Introduction to ARM Assembly Programming, The Program Counter and Program Memory space in the Arm, Some ARM Addressing modes, RISC Architecture in ARM<br><br>**Text 1: Ch 1: 1.1, Ch 2: 2.1-2.10**<br>**Text 2: Ch 2: 2.1** | **06 Hours** |
| **Module -2** | |
| **ARITHMETIC AND LOGICAL INSTRUCTIONS, BRANCH, CALL AND LOOPING IN ARM:**<br><br>Arithmetic Instructions, Logic Instructions, Rotate and Barrel Shifter, Shift and Rotate Instructions, BCD and ASCII Conversion, Looping and Branch Instructions, Calling Subroutine and Return, Conditional execution, Recursion, Conditional Execution<br><br>**Text 1: Ch 3: 3.1-3.5, Ch 4: 4.1-4.2, 4.4** | **10 Hours** |

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| **Text 2: Ch 5: 5.5** | |
| **Module – 3** | |
| **ARM MEMORY MAP, MEMORY ACCESS AND STACK:**<br><br>ARM Memory Map and Memory Access, Advanced Indexed Addressing Mode, Stack and Stack usage in ARM, ARM Bit Addressable Memory Region, ADR, LDR and PC Relative addressing<br><br>**Text 1: Ch 6: 6.1-6.5** | **06 Hours** |
| **Module-4** | |
| **INPUT/OUTPUT (IO) PROGRAMMING:**<br><br>Pin connect block, Pin function select registers, General Purpose Input and Output (GPIO) registers, GPIO configuration, GPIO programming using ARM C language, Interfacing: LEDs, Seven segment, LCD, keyboard, DC motor, Stepper motor.<br><br>**Text 2: Refer Ch 4, Ch 5**<br>**Ref: UM10360, LPC 176x/5x User Manual** | **08 Hours** |
| **Module-5** | |
| **TIMER/ COUNTER PROGRAMMING:**<br><br>Timer versus counter, timer registers, timer architecture and operation, PWM timer and architecture, timer/counter programming, PWM programming.<br><br>**Text 2: Refer Ch 4, Ch 5, Ch 8**<br>**Ref: UM10360, LPC 176x/5x User Manual** | **06 Hours** |
| **Module-6** | |
| **SERIAL, ADC AND DAC INTERFACING:**<br><br>General introduction to serial interfacing, RS232, MAX 232, UART, UART programming, data acquisition system, Analog to Digital Converter (ADC), ADC registers, Digital to Analog converter (DAC), DAC registers, ADC and DAC programming. | **06 Hours** |

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| **Text 2: Refer Ch 8, Ch 10**<br>**Ref: UM10360, LPC 176x/5x User Manual** | |

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| **Module-7** | |

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| **INTERRUPT PROGRAMMING:**<br><br>Hardware and software synchronization, multithreading, Nested Vectored Interrupt Controller (NVIC), external hardware interrupts, IO interrupts, SysTick interrupts, timer/counter interrupts, ADC and DAC interrupts, UART interrupts, interrupt programming.<br><br>**Text 3: Refer Ch 2, Ch 4, Ch 5**<br>**Ref: UM10360, LPC 176x/5x User Manual** | **06 Hours** |

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| **Course outcomes:** |

After studying this course, students will be able to:

1. Explain the architecture of ARM Cortex- M microcontroller and understand the associated addressing modes
2. Develop assembly language programs using ARM instruction set.
3. Compare and contrast different types of stack in ARM
4. Create the embedded C code for interfacing I/O devices such as LEDs, Seven segment, LCD, keyboard, DC motor, Stepper motor, UART, ADC, DAC.
5. Demonstrate timer/counter and interrupt programming

**Text Books:**

1. Muhammad Ali Mazidi, Sarmad Naimi, Sepehr Naimi, Shujen Chen, *ARM Assembly Language Programming & Architecture* (2e), MicroDigitalEd, 2016
2. Jonathan W. Valvano., *Embedded systems: Introduction to Arm(r) Cortex-M Microcontrollers (5e),* Createspace Independent publishing platform, June 2014.
3. Jonathan W. Valvano., *Embedded systems: real-time interfacing to ARM Cortex-M microcontrollers (4e),* Createspace Independent Publishing Platform, 2017.

**Reference Books:**

1. UM10360, LPC 176x/5x User Manual, NXP Semiconductors, Rev. 4.1, 2016.
2. Toulson and Tim Wilmshurst., *Fast and Effective Embedded System Design applying the ARM mbed*, Elsevier, 2017.
3. Joseph V., *A definitive Guide to ARM Cortex-M3 and Cortex-M4 processors (3e),* Elsevier, 2014