DISCIPLINE SPECIFIC ELECTIVES (DSE-7)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Advanced Embedded System Design with ARM ELDSE7G	**4**	**3**	**-**	**1**	**Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices**	

Learning Objectives

The course aims to introduce students to ARM microcontroller architectures. Students will gain an understanding of the core features, instruction sets, and peripheral interfacing capabilities of ARM Cortex-M3 microcontrollers. The course further intends to equip students with practical skills in assembly and embedded C programming, along with foundational knowledge of real-time operating systems (RTOS), enabling them to design, develop, and troubleshoot embedded systems effectively.

Learning outcomes

On successful completion of the course, student will be able to:

- Describe the architectural features and instructions of ARM Cortex-M3 microcontroller.
- Apply the knowledge gained for programming ARM Cortex-M3 to interface peripherals for different applications.
- Apply RTOS concepts such as task scheduling, synchronization, interrupts, and timers in embedded systems.
- Analyze and debug embedded system applications using ARM Cortex-M3 microcontrollers.

SYLLABUS OF ELDSE-7G **Total Hours- Theory: 45 Hours, Practicals: 30 Hours**

Unit – I (11 lectures)
ARM Microcontroller Architecture:
Introduction to ARM microcontroller families, features, and applications. Thumb-2 technology, Architecture of ARM Cortex-M3, various units in the architecture, General Purpose Registers, Special Registers, Exceptions, Interrupts, Stack Operation, Reset Sequence, Debugging Support.

Unit – II (11 lectures)
ARM Cortex-M3 Instruction Set:
Assembly basics, Addressing Modes, Instruction lists and description, Thumb and ARM instructions, Special instructions, Useful instructions, CMSIS, simple assembly language programs.

Unit - III (11 lectures)
ARM Cortex-M3 Peripherals:
ARM Cortex M3 Peripherals: GPIO control, Timer configurations, and basic Interrupt handling, Introduction to Embedded C programming for ARM. Peripheral programming in Assembly and Embedded C language.

Unit - IV (12 lectures)
RTOS Based Embedded System Design:
Operating System Basics, Types of Operating Systems, Architecture of an RTOS, Important features of RTOS, Embedded Systems Programming, Locks and Semaphores, Operating System Timers and Interrupts, Exceptions, Tasks. Task states and scheduling, Synchronization, Real-time clock and system clock.

Practical component (if any) – Advanced Embedded System Design with ARM Lab
(Practicals to be performed using Hardware/Simulator)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Write Assembly language/C Language program for ARM Processor.
- Able to interface and program peripherals like LED, actuators, LCD display etc. on ARM Ports.
- Prepare the technical report on the experiments carried.

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

1. Write a program to perform arithmetic operations on two 32-bit numbers.
2. Write a program to generate an A.P. / G.P. / Fibonacci series.

3. Write a program to sort a given list of 32-bit numbers in ascending/descending/reverse order.
4. Write a program to configure and blink / toggle GPIO pins at a specific rate.
5. Write a program to design a counter (decade, hexadecimal, etc.) on an LCD / 7-segment display.
6. Write a program to read a 4×4 keyboard and display the key code on an LCD / 7-segment display.
7. Write a program to generate PWM signals to control the brightness of an LED.
8. Write a program to control the speed of a DC motor
9. Design RTOS Based Parameter Monitoring and Controlling System for collecting the data from sensor interfaced with microcontroller.
10. Implement a real-time clock using RTOS timers

Note: Students shall sincerely work towards completing all the above listed practicals for this course. In any circumstance, the completed number of practicals shall not be less than nine.

Essential/recommended readings

1. Joseph Yiu, "The Definitive Guide to ARM CORTEX - M3 and CORTEX M4 Processors" 3rd Edition, Newnes, (Elsevier), 2014. ISBN: 978-0124080829.
2. K.V.K.K Prasad, "Embedded Real Time Systems", Dreamtech Publications, 2003. ISBN: 978-8177224610
3. Raj Kamal, "Embedded Systems", 3rd Edition, McGraw Hill Publications, 2017. ISBN: 978-9332901490
4. Colin Walls, "Embedded RTOS Design: Insights and Implementation", 1st Edition, Newnes, (Elsevier), 2020. ISBN: 978-0128228517

Suggestive readings

1. Yifeng Zhu, "Embedded Systems with ARM Cortex-M Microcontrollers in Assembly Language and C", 3rd Edition, E-Man Press LLC, 2017, ISBN: 978-0982692660
2. Jonathan W. Valvano, "Embedded Systems: Real-Time Operating Systems for ARM Cortex-M Microcontrollers", 2nd Edition, Createspace Independent Pub, 2012. ISBN: 978-1466468863

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.