Academic Year: 2021-2022	Semester: IV
Course Name: Microcontroller and Embedded Systems	Course Code: 18CS44
Total Contact hours: 40	Credits:3
SEE Marks: 60 ; CIE: 40	Total Marks: 100
Course Plan Author: G Soujanya	Date: 29.04.2022

Course Prerequisites: Computer Organization

Course Objectives:

- Understand the fundamentals of ARM based systems, basic hardware components, selection methods and attributes of an embedded system.
- Program ARM controller using the various instructions
- Identify the applicability of the embedded system
- Comprehend the real time operating system used for the embedded system

Course Outcomes:

CO Number	Course Outcome At the end of the course, student should be able to . . .	Blooms' Level
CO1	Describe the architectural features and instructions of ARM Microcontroller	Understand, Apply
CO2	Develop application for Programming skills using ARM microcontroller	Understand, Apply
CO3	Interface external hardware devices such as Stepper Motor, DC Motor, DAC with ARM Microcontroller	Understand, Apply
CO4	Able to explain about Embedded systems, Characteristics details and Implementation	Understand, Apply
CO5	Illustrate the need of Real Time Operating System for embedded system applications	Understand, Apply

Program Outcomes and Program Specific Outcomes

PO, PSO	1.Engineering Knowledge; 2.Problem Analysis; 3.Design / Development of Solutions; 4.Conduct Investigations of Complex Problems; 5.Modern Tool Usage; 6.The Engineer and Society; 7.Environment and Sustainability; 8.Ethics; 9.Individual and Teamwork; 10.Communication; 11.Project Management and Finance; 12.Life-long Learning; PSO1. Graduates will have the ability to adapt, contribute and innovate ideas in the field of Artificial Intelligence and Machine Learning; PSO2. To provide a concrete foundation and enrich their abilities to qualify for Employment, Higher studies and Research in various domains of Artificial Intelligence and Machine Learning such as Data Science, Computer Vision, Natural Language Processing with ethical values; PSO3 Graduates will acquire the practical proficiency with niche technologies and open source platforms and to become Entrepreneur in the domain of Artificial Intelligence and Machine Learning

CO – PO Mapping

Course Outcomes	Program Outcomes														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	0	2	2	2	0	3	2	0	2	3	3	3
CO2	3	3	3	1	3	3	3	2	3	2	2	1	3	3	3
CO3	3	2	3	3	3	3	3	2	3	2	3	2	3	3	3
CO4	2	0	2	0	2	2	-	0	3	2	2	1	3	3	1
CO5	3	0	2	1	2	3	3	0	3	2	0	2	2	3	1

Course Content (Syllabus)

Module 1 : Microprocessors versus Microcontrollers, ARM Embedded Systems: The RISC design philosophy, The ARM Design Philosophy, Embedded System Hardware, Embedded System Software. ARM Processor Fundamentals: Registers, Current Program Status Register, Pipeline, Exceptions, Interrupts, and the Vector Table , Core Extensions
Text book 1: Chapter 1 - 1.1 to 1.4, Chapter 2 - 2.1 to 2.5

Module 2 : Introduction to the ARM Instruction Set : Data Processing Instructions , Branch Instructions, Software Interrupt Instructions, Program Status Register Instructions, Coprocessor Instructions, Loading Constants ARM programming using Assembly language: Writing Assembly code, Profiling and cycle counting, instruction scheduling, Register Allocation, Conditional Execution, Looping Construct
Text book 1: Chapter 3:Sections 3.1 to 3.6 (Excluding 3.5.2), Chapter 6(Sections 6.1 to 6.6)

Module 3 : Embedded System Components: Embedded Vs General computing system, History of embedded systems, Classification of Embedded systems, Major applications areas of embedded systems, purpose of embedded systems Core of an Embedded System including all types of processor/controller, Memory, Sensors, Actuators, LED, 7 segment LED display, stepper motor, Keyboard, Push button switch, Communication Interface (onboard and external types), Embedded firmware, Other system components.
Text book 2:Chapter 1(Sections 1.2 to 1.6),Chapter 2(Sections 2.1 to 2.6)
RBT: L1, L2

Module 4 : Embedded System Design Concepts: Characteristics and Quality Attributes of Embedded Systems, Operational quality attributes ,non-operational quality attributes, Embedded Systems-Application and Domain specific, Hardware Software Co-Design and Program Modelling, embedded firmware design and development
Text book 2: Chapter-3, Chapter-4, Chapter-7 (Sections 7.1, 7.2 only), Chapter-9
08
(Sections 9.1, 9.2, 9.3.1, 9.3.2 only)

Module 5 : RTOS and IDE for Embedded System Design: Operating System basics, Types of operating systems, Task, process and threads (Only POSIX Threads with an example program), Thread preemption, Multiprocessing and Multitasking, Task Communication (without any program), Task synchronization issues – Racing and Deadlock, Concept of Binary and counting semaphores (Mutex example without any program), How to choose an RTOS, Integration and testing of Embedded hardware and firmware, Embedded system Development Environment – Block diagram (excluding Keil), Disassembler / Decompiler, simulator, emulator and debugging techniques, target hardware debugging, boundary scan.
Text book 2: Chapter-10 (Sections 10.1, 10.2, 10.3, 10.4 , 10.7, 10.8.1.1, 10.8.1.2, 10.8.2.2, 10.10 only), Chapter 12, Chapter-13 (block diagram before 13.1, 13.3, 13.4, 13.5, 13.6 only)

Schedule of Instruction

Sl.no	Class no	Module	Topic	Reference (Book, Page no.)	Course Outcome	Delivery mode
1	1	**Module1:** Microprocessors versus Microcontrollers, ARM Embedded Systems:	Microprocessors versus Microcontrollers, ARM Embedded Systems: The RISC design philosophy,	T1, 4	CO1	Lecture, PPT, Video
2	2		The ARM Design Philosophy,	T1, 5	CO1	Lecture, PPT
3	3		Embedded System Hardware,	T1, 6	CO1	Lecture, PPT
4	4		Embedded System Software.	T1,12	CO1	Lecture, PPT
5	5		ARM Processor Fundamentals: Registers	T1,21	CO1	Lecture, PPT
6	6		Pipeline	T1,29	CO1	Lecture, PPT
7	7		Exceptions, Interrupts, and the Vector Table	T1,33	CO1	Lecture, PPT
8	8		Core Extensions	T1,34	CO1	Lecture, PPT
9	1	**Module 2:** Introduction to the ARM Instruction Set	Data Processing Instructions	T1,50	CO2	Lecture, PPT
10	2		Branch Instructions	T1,58	CO2	Lecture, PPT
11	3		Software Interrupt Instructions	T1,73	CO2	Lecture, PPT
12	4		Program Status Register Instructions	T1,76	CO2	Lecture, PPT
13	5		Coprocessor Instructions	T1,78	CO2	Lecture, PPT
14	6		Loading Constants ARM programming using Assembly language: Writing Assembly code	T1,158	CO2	Lecture, PPT
15	7		Profiling and cycle counting	T1,163	CO2	Lecture, PPT
16	8		instruction scheduling, Register Allocation	T1,171	CO2	Lecture, PPT
17	9		Conditional Execution, Looping Construct	T1,180	CO2	Lecture, PPT

18	1	**Module 3:** Embedded System Components	Embedded Vs General computing system, History of embedded systems	T2,4	CO3	Lecture, PPT
19	2		Classification of Embedded systems, Major applications areas of embedded systems	T2,7		Lecture, PPT
20	3		purpose of embedded systems	T2,8	CO3	Lecture, PPT
21	4		Core of an Embedded System including all types of processor/controller, Memory, Sensors, Actuators	T2,17	CO3	Lecture, PPT
22	5		LED, 7 segment LED display Interface	T2,37	CO3	Lecture, PPT
23	6		stepper motor	T2,39	CO3	Lecture, PPT
24	7		Keyboard, Push button switch	T2,42	CO3	Lecture, PPT
25	8		Communication Interface (onboard and external types)	T2,45	CO3	Lecture, PPT
26	9		Embedded firmware	T2,59	CO3	Lecture, PPT
27	10		Other system components	T2,60	CO3	Lecture, PPT
28	1	**Module 4:** Embedded System Design Concepts:	Characteristics and Quality Attributes of Embedded Systems	T2,73	CO4	Lecture, PPT
29	2		Operational quality attributes	T2,75	CO4	Lecture, PPT
30	3		Non-operational quality attributes	T2,77	CO4	Lecture
31	4		Embedded Systems-Application and Domain specific	T2,83	CO4	Lecture, PPT
32	5		Hardware Software Co-Design	T2,205	CO4	Lecture, PPT
33	6		Program Modelling	T2,214	CO4	Lecture, PPT
34	7		embedded firmware design and development	T2,302	CO4	Lecture, PPT
37	1	**Module 5:** RTOS and IDE for Embedded System Design	Operating System basics	T2,382	CO5	Lecture, PPT
38	2		Types of operating systems,	T2,386	CO5	Lecture, PPT
39	3		Task, process and threads (Only POSIX Threads with an example program)	T2,390	CO5	Lecture, PPT
40	4		Thread preemption	T2,392	CO5	Lecture,

						PPT
41	5		Multiprocessing and Multitasking	T2,402	CO5	Lecture, PPT
42	6		Task Communication	T2,426	CO5	Lecture, PPT
43	7		Task synchronization issues – Racing and Deadlock	T2,442	CO5	Lecture, PPT
44	8		Concept of Binary and counting semaphores	T2,448	CO5	Lecture, PPT
45	9		Integration and testing of Embedded hardware and firmware	T2,557	CO5	Lecture, PPT
46	10		Disassembler / Decompiler, Simulator, Emulator and Debugging Techniques, Target Hardware Debugging	T2,597	CO5	Lecture, PPT

**L – Lecture, V- Videos or any other mode*

Textbooks	
T1	Andrew N Sloss, Dominic Symes and Chris Wright, ARM system developers guide, Elsevier, Morgan Kaufman publishers, 2008.
T2	Shibu K V, "Introduction to Embedded Systems", Tata McGraw Hill Education, Private Limited, 2 nd Edition
Reference books	
R1	Raghunandan. G.H, Microcontroller (ARM) and Embedded System, Cengage learning Publication,2019
R2	The Insider's Guide to the ARM7 Based Microcontrollers, Hitex Ltd.,1st edition, 2005.
R3	Steve Furber, ARM System-on-Chip Architecture, Second Edition, Pearson, 2015
R4	Raj Kamal, Embedded System, Tata McGraw-Hill Publishers, 2nd Edition, 2008

Web links and Video Lectures (e-Resources):	
1	https://tinyurl.com/47myh3pa
2	https://sites.google.com/skit.org.in/4thsemester/about-the-course

Assessment Schedule:						
Sl.No.	**Assessment type**	**Contents**	**CO**	**Duration In Hours**	**Marks**	**Date & Time**
1	**CIE Test 1**	M1, M2	CO1,CO2	1	30	
2	**CIE Test 2**	M3	CO3	1	30	
3	**CIE Test 3**	M4, M5	CO4 CO5	1	30	
4	**Assignment 1**	M1, M2	CO1 CO2		10	
5	**Assignment 2**	M3	CO3		10	
6	**Seminar** **Quiz**	M4, M5 M4, M5	CO4, CO5		05 05	
6	**Semester End Examination**	M1, M2, M3, M4, M5	CO1 – CO5	3	60	

Faculty Incharge DAC Chairman