K. S. SCHOOL OF ENGINEERING AND MANAGEMENT, BANGALORE

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

SESSION: 2023-24 (ODD SEMESTER)

CO-PO MAPPING

Course Title: Computer Organization and ARM Microcontroller			
Type: Core		Course Code: 21EC52	
No of Hours			
Theory (Lecture Class)	Practical/Field Work/Allied Activities	Total hours/Week	Total teaching hours
4	2	6	40 hours Theory + 13 Lab slots
Marks			
Internal Assessment	Examination	Total	Credits
50	50	100	4

Aim/Objective of the Course:

1. To understand the basic organization of a computer system.
2. To Study the functioning of different sub systems, such as processor, Input/ Output and Memory.
3. To describe the architectural features and instructions of 32-bit microcontroller ARM cortex M3.
4. To apply the knowledge gained for programming ARM cortex M3 for different applications.
5. To study the basic hardware components and their selection method based on the characteristics and attributes of an embedded system.

Course Learning Outcomes

After completing the course, the students will be able to

CO1	**Utilize** the clock rate and Performance measurement techniques in basic organization of a computer system.	**Applying (K3)**
CO2	**Identify** functioning of different sub systems, such as processor, Input/ output and memory.	**Applying (K3)**
CO3	**Organize** ARM RISC philosophy and different protocol methods	**Applying (K3)**
CO4	**Make use of** the architectural features and instructions of ARM for writing programs	**Applying (K3)**
CO5	**Choose** between ARM and embedded C Programming for different applications.	**Applying (K3)**

Syllabus Content:	
Module 1: Basic Structure of Computers: Basic operational Concepts, Bus Structures, Performance-Processor Clock, Basic Performance Equation, Clock Rate, Performance Measurement. **Input/output Organization:** Accessing I/O Devices, Interrupts- Interrupt Hardware, Direct Memory Access, Buses, Interface Circuits, Standard I/O Interfaces- PCI Bus, SCSI Bus, USB. **LO**: At the end of this session the student will be able to, 1. Understand the basic operational concepts, bus structures. 2. Describe basic performance equation, clock rate 3. Accessing I/O devices, Interrupts- Interrupt hardware 4. Understanding standard I/ O Interfaces	**CO1** 10hrs PO1-3 PO2-2 PO3-2 PO5-2 PO6-2 PO9-2 PO12-1 PSO1-2 PSO2-2
Module 2: Memory System: Basic Concepts, Semiconductor RAM Memories, Read Only Memories, Speed size, and Cost, Cache Memories- Mapping Functions, Replacement Algorithms, Performance Considerations. **Basic Processing Unit:** Some Fundamental Concepts, Execution of a complete Instruction, Multiple Bus Organization, Hard-wired Control, Micro programmed Control, Basic concepts of pipelining. **LO**: At the end of this session the student will be able to, 1. Understand Semiconductor RAM, Read only Memories 2. Describe the Speed size, cost and Cashe memories 3. Some basic concepts along with execution of complete instruction 4. Understanding basic concepts of pipelining	**CO2** 10 hrs PO1-3 PO2-3 PO3-3 PO5-2 PO6-2 PO9-2 PO12-1 PSO1-3 PSO2-2
Module 3: ARM Embedded Systems: Introduction, RISC design philosophy, ARM design philosophy, Embedded system hardware- AMBA bus protocol, ARM bus technology, Memory, Peripherals, Embedded system software- Initialization (BBOT) code, Operating system, Applications. ARM Processor Fundamentals, ARM core dataflow model, registers, current program status register, Pipeline, Exceptions, Interrupts and Vector Table, Core extensions. **Laboratory Experiments:** **1)** ALP to multiply two 16-bit numbers and add two 64-bit numbers **2)** ALP to find the sum of first 10 integer numbers **LO**: At the end of this session the student will be able to, 1. Understand the RISC design and ARM design philosophy 2. Gain basic knowledge about ARM bus technology, memory, and embedded system software initialization 3. Understanding ARM processor fundamentals and core dataflow model 4. Describing CPSR, pipeline and exceptions	**CO4** 10 hrs PO1-3 PO2-2 PO3-2 PO4-1 PO5-3 PO6-2 PO9-2 PO12-1 PSO1-2 PSO2-2

Module 4: Introduction to ARM Instruction Set: Introduction, Data processing instructions, Load- store instructions, program status register instructions, loading constants, ARMv5E extensions, Conditional Execution. **Laboratory Experiments:** 1) ALP to find factorial of a number 2) ALP to add an array of 16-bit numbers and store the 32-bit result in internal RAM 3) ALP to find the square of a number using look-up table 4) ALP to find largest and smallest numbers in an array 5) ALP to arrange a series of 32-bit numbers in ascending/descending order. **LO**: At the end of this session the student will be able to, 1. Understand different assembly basics and instruction sets 2. Learn about ARMv5E extensions 3. Program ARM Cortex M3 using the various instructions 4. Work in embedded system environment using Keil.	**CO3** 10 hrs PO1-3 PO2-3 PO3-3 PO4-1 PO5-3 PO6-2 PO9-2 PO12-1 PSO1-3 PSO2-2
Module 5: Introduction to THUMB instruction Set: Introduction, THUMB register usage, ARM-THUMB interworking, other branch instructions, Data processing instructions, Software interrupt instructions. Efficient C Programming: Overview of C Compilers and optimization, Basic C data types, C looping structures. **Laboratory Experiments:** 1) ALP to count the number of ones and zeros in two consecutive memory locations also to scan a series of 32-bit numbers to find how many are negative. 2) Interface a stepper motor and rotate it in clockwise and anticlockwise direction. 3) Interface DAC and generate triangular and square waveforms. 4) Display the HEX digits 0 to F on a 7 segment LED interface 5) Interface a simple switch and display its status through Relay, Buzzer and LED **LO**: At the end of this session the student will be able to, 1. Understand the features 32 bit microcontroller ARM Cortex M3. 2. Understand instruction set of ARM Cortex microcontroller. 3. Program ARM Cortex M3 using the various instructions and C language for different applications. 4. Gain basic knowledge of programming.	**CO5** 10hrs PO1-3 PO2-2 PO3-2 PO4-1 PO5-3 PO6-2 PO9-2 PO12-1 PSO1-3 PSO2-2

Text Books: -

1. Carl Hamachar, Zvonko Vranesic, Safwat Zaky, "Computer Organization", 5th Edition, Tata McGraw Hill, 2002.
2. Andrew N Sloss, Dominic System and Chis Wright, "ARM System Developers Guide", Elsevier, Morgan Kaufman Publisher, 1st Edition, 2008.

Useful Websites

1. https://www.keil.com/
2. Embedded Systems: https://www.guru99.com/embedded-systems-tutorial.html
3. NPTEL: Embedded Systems: https://nptel.ac.in/courses/106105193
4. https://embeddedcomputing.com/application/industrial/a-to-z-of-embedded-system-design
5. https://www.youtube.com/watch?v=nccWuB5ypxI&list=PLcbIZiT62e1gNZ-VWPO3rpTpXkHBMZa2n
6. Embedded Systems Projects for Engineering Students:
   https://www.electronicshub.org/arm-based-projects/
   https://www.elprocus.com/arm-based-projects/

Useful Journals

1. IEEE transaction on Embedded Systems:- www.ieee.org/
2. https://www.eecs.umich.edu/courses/eecs373/readings/ARM_Cortex_AppNote179.pdf
3. IEEE transaction on ARM and Embedded Systems:- www.ieee.org/
4. International Journals of Embedded Systems:
   https://www.inderscience.com/jhome.php?jcode=ijes
5. IEEE Journal on Robotics and Automation
6. Publications on ARM: https://www.arm.gov/research/publications

Teaching and Learning Methods:

Lecture class: 40 hrs.

Practical classes: 2hrs (Separate practical class in curriculum)

Assessment:

Type of test/examination: Written examination

Continuous Internal Evaluation (CIE) : :1) Three Tests each of 20 marks (duration 1 hour)

2) Two assignments each of 10 Marks

3) Programming Labs and IA - 20 Marks

Total CIE: 50 Marks

Semester End Exam (SEE) : 100 marks (students have to answer 5 full questions selecting one question from each module) which will be reduced to 50 Marks.

Test duration: 1 hrs

Examination duration: 3 hrs

CO - PO Mapping

PO1: Science and engineering Knowledge **PO2:** Problem Analysis **PO3:** Design & Development **PO4:** Investigations of Complex Problems **PO5:** Modern Tool Usage **PO6:** Engineer & Society	**PO7:** Environment and Society **PO8:** Ethics **PO9:** Individual & Team Work **PO10:** Communication **PO11:** Project Mgmt. & Finance **PO12:** Life-long Learning

PSO1: Be able to acquire knowledge and apply concepts in the field of Engineering and interdisciplinary subjects

PSO2: Be able to identify the existing problems, effectively utilize tools to provide solutions and disseminate the information

CO	PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
21 EC52															
CO1	K3	3	2	2	-	2	2	-	-	2	-	-	1	2	2
CO2	K3	3	3	3	-	2	2	-	-	2	-	-	1	3	2
CO3	K3	3	2	2	1	3	2	-	-	2	-	-	1	2	2
CO4	K3	3	3	3	1	3	2	-	-	2	-	-	1	3	2
CO5	K3	3	2	2	1	3	2	-	-	2	-	-	1	3	2

Course Incharge

HOD

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