GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3170914
ADVANCED MICROCONTROLLERS
7thSEMESTER

Type of course: Engineering

Prerequisite: Basics of Microprocessors and Microcontrollers

Rationale: Microprocessor and microcontrollers are used to design and develop processor and computer based automatic smart electronics systems for home and industry application. This subject is devoted to the study of Advanced Microcontrollers which are used to develop and design embedded systems having low cost, low energy consumption with limited memory and having real time response. The students would learn the architecture and programming of ARM Controller in 'C' and in Assembly Language. They would also be able to develop simple applications by interfacing various sensor and actuators with the ARM controller.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	**Basics of ARM Controllers:** The Acorn RISC Machine, Architectural inheritance, The ARM Programmer's model, ARM development tools [1]	02
2	**ARM Architecture & Assembly Language Programming:** The General Purpose Registers in ARM, The ARM Memory Map, Load and Store Instructions in ARM, ARM CPSR, ARM Data Format & Directives, Introduction to ARM Assembly Programming, Assembling an ARM Program, The Program Counter and Program ROM Space in ARM, Some ARM addressing modes, RISC Architecture in ARM, Viewing Registers and Memory with ARM Keil IDE.[2]	06
3	**Arithmetic and Logic Instructions & Program**: Arithmetic Instructions, Logic Instructions, Rotate and Barrel Shifter, Shift and Rotate Instructions in ARM Cortex, BCD and ASCII Conversions.[2]	05
4	**Branch, Call and Looping in ARM:** Looping and Branch Instructions, Calling Subroutine with BL, ARM Time Delay and Instruction Pipeline, Conditional Execution [2]	05
5	**Signed Numbers and IEEE 754 Floating Point :** Signed Numbers Concept, Signed Number Instructions and Operations, IEEE 754 floating point standards[2]	02
6	**ARM Programming Using C:** Overview of C compilers and Optimization, Basic 'C' data types, C looping Structures, Register Allocation.[3]	05

7	**Exception & Interrupt Handling:** ARM Processor Exception and Modes, Vector Table, Exception Priorities, Link Register Offsets, Interrupts, Assigning Interrupts, Interrupt Latency, IRQ and FIQ exceptions, Basic Interrupt Stack Design and Implementation[3]	**05**
8*	**Microcontroller development Boards**: About STM32F401 Nucelo board, PWM and the Interrupt on STM32F401, Mbed C Programming Environment.[4] ,	**03**
9*	**Interfacing of Microcontroller development Boards:** Interfacing of STM32F401 Board, Interfacing LED and LCD, Serial port terminal application, Interfacing of temperature sensor, Interfacing of LDR light sensor, Speaker interfacing, Microphone interfacing, Speed control of DC motor using STM32, Accelerometer and its interfacing with STM32, Bluetooth interfacing, Interfacing of gas sensor with STM32 [4]	**12**

*Students are advised to refer NPTEL course of "Embedded system Design with ARM" by Indranil Sengupta & Kamalika Datta and download course (but not limited to) Lecture Nos: 10, 11, 15, 16, 18, 19, 20, 22, 23, 24, 25, 26, 28, 29, 32, 38, 39, 40, 41 for understanding topics given in Sr. No 8 and Sr. No 9. (Link: https://nptel.ac.in/courses/106/105/106105193/)

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	**20**	**30**	**10**	**10**	**10**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books & Online Course:

1. ARM, System-on-chip architecture by Steve Furber, *Addison Wesley Publications*
2. ARM Assembly Language Programming & Architecture by Muhammad Ali Mazidi, Sarmad Naimi, Sepehr Naimi, Janice Mazidi *E-book available*
3. Arm system Developer's Guide –Designing and Optimizing System Software by Andrew Sloss, Dominic Symes and Chris Wright – *Morgan Kaufman Publishers*
4. NPTEL course entitled "Embedded system Design with ARM" by Indranil Sengupta & Kamalika Datta

Course Outcomes:

After learning the course, the students should be able to:

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	Describe the basics of RISC machine and ARM controller	
CO-2	Develop assembly language/ embedded C- language code for a given problem	
CO-3	Use ARM development boards and its exception and interrupt handling functionality	
CO – 4	Evaluate the various unsupervised Learning algorithms using appropriate Dataset.	
CO-5	Interface microcontroller development board with various sensors and display devices for given application/problem	

Suggested List of Experiments:

1. Introduction to ARM architecture
2. Assembly language programming of ARM using data transfer, arithmetic and logical group instructions. (Use of ARM Keil is recommended)
3. Assembly language programming of ARM using branching group (Use of ARM Keil is recommended)
4. LED and LCD interfacing with STM32
5. Interfacing of LM35 temperature sensor with STM32F401 Nucleo board
6. Interfacing of electric bulb with STM32 through SRD-05DC-SL-C relay
7. Interfacing of LDR with STM32 board
8. Speed control of DC motor using STM32
9. Bluetooth interfacing with STM32
10. Accelerometer interfacing with STM32