GUJARAT TECHNOLOGICAL UNIVERSITY

ELECTRICAL ENGINEERING (09)
ADVANCE MICROCONTROLLERS
SUBJECT CODE: 2160909
B.E. 6th SEMESTER

Type of course: Engineering (Elective)

Prerequisite: Analog and Digital Electronics, Basics of microprocessor and microcontroller

Rationale: This subject focuses on the study of advanced microcontroller along with the use of microcontroller. It also briefs the students about interfacing of memory and various I/O devices like A to D converter, D to A converter LED, LCD to advanced microcontrollers. The students learn the Programming language (Embedded C) used for microcontrollers. They will be able to use the advanced fast microcontroller in electrical engineering related fields like Power system protection, instrumentation, power electronics, Electrical Drives and control of Electrical Equipments.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks			Practical Marks			
				ESE (E)	PA (M)		ESE (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	0	2	5	70	20	10	20	10	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1.	Advanced concepts in 8051 architecture: Review of 8051 architecture, concept of synchronous serial communication, SPI and I2C communication protocols, study of SPI port on 89LP 51RD2, study of SAR ADC/DAC MCP3304 / MCP 33, interfacing concepts for SPI based ADC/DAC, study of watchdog timer, study of PCA timer in different modes like capture mode, PWM generation mode, High speed output toggle mode Embedded 'C' programming for the above peripherals	15	35
2.	Introduction to ARM CORTEX M profile: CORTEX M0 and M4 cores, Harvard and Von Neumann architectures, CPU Registers, CPU Operating Modes, Thumb-2 Instruction Set, Memory Map, Bus Interface, bit bending , interrupt handling ,NVIC(Nested Vectored Interrupt Controller), system tick timer, Debug system	5	15
3.	Introduction to STM32F4xx architecture: Features of STM32F4XXDSC, Memory and bus architecture, Multilevel AHB bus matrix, Memory organization, Memory map, NVIC Operation Exception Entry And Exit , Reset and Clock Circuit	5	15
4.	Advanced concepts in Embedded 'C' programming: Pointers, structures, unions, pointers to structures, pointers to functions, addressing mechanism for memory mapped registers, enumerators, Interrupt Handlers	7	15

	Embedded software architecture: Round robin architecture, Round robin with interrupt architecture		
5.	STM32F4 PERIPHERALS & PROGRAMING GPIO, General Purpose Timers, GPIO :Introduction, Main Features , Function Description, Registers, Basic timers (TIM6&TIM7): introduction, main features, functional description, registers Embedded C Programming for GPIO and Timers	10	20

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:

1. Datasheet of 89V51RD2 (www.nxp.com, www.atmel.com)
2. Datasheet MCP3304/MCP4822 (www.microchip.com)
3. The 8051 Microcontroller and Embedded Systems Using Assembly and C, By Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin McKinlay
4. David E. Simon. "An Embedded Software Primer" Addision Wesley Pearson Education, 1999.
5. "The Definitive Guide to ARM® CORTEX®-M3 and CORTEX®-M4 Processors (Third Edition)", By *Joseph Yiu,* Newnes, Elsevier
6. "The insider's guide to the STM32 ARM based Microcontroller", (www.hitex.com)
7. Datasheet, programming and user reference manual of STM32F4xx (www.st.com)
8. "The Designer's Guide to the Cortex-M Processor Family: A Tutorial Approach", By Trevor Martin, Newnes, Elsevier

Course Outcome:

After learning the course the students should be able to:

1. Understand how microcontroller and its peripherals function.
2. Interface to external peripherals
3. Program an embedded system in assembly and C
4. Design, implement and test a single-processor embedded systems for real-time applications
5. Optimizing embedded software for speed and size for industrial applications.

List of Experiments: (This is a suggestive list only)

1. Introduction to Integrated Development Environment KEIL Micro Vision IV
2. Programming of PCA Timer for 8-bit PWM Generation
3. Programming of PCA timer for Variable frequency square wave generation
4. Programming of PCA Timer for Frequency measurement and display on LCD using Capture mode.
5. Programming of SPI port for Interfacing with ADC MCP3304
6. Programming of SPI port for interfacing with DAC MCP4822

7. Programming of Watchdog Timer
8. Introduction to KEIL Microvision IV MDK-ARM IDE
9. Programming of GPIO port with LED toggling and key interface
10. Programming of Base timer for accurate delays
11. Introduction to auto code generation for STM32F4 target using MATLAB Toolbox and Simulink

Design based Problems (DP)/Open Ended Problem:

Implementation of embedded system for industrial application (e.g. instrumentation, control, automation but not limited to these) using any of the 16-bit or 32-bit microcontroller available in the market, in guidance of course instructor

Major Equipment: Kit for advanced 8051 controller, and advanced 16bit/32 bit controllers, µVISION2/3/4 IDE,

List of Open Source Software/learning website: NPTEL, www.infineon.com, www.silabs.com

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.