



GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code: 3174106

Semester – VII

Subject Name: Embedded Systems

Type of course: Engineering Science (Professional Core Course – I)

Prerequisite: Zeal to learn the course

Rationale:

The purpose of this course is to provide an understanding of Digital Signal Processing. Learn the to provide the overview of embedded system design principles To understand the concepts of real time operating systems To provide exposure to embedded system development tools with hands on experience in using basic programming techniques.

Teaching and Examination Scheme:

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

Content:

Sr. No.	Content	Total Hrs
1	Introduction to Embedded Systems Embedded Systems, Processor Embedded into a System, Embedded Hardware Units and Devices In a System, Embedded Software in a system, Examples of Embedded Systems, Embedded System-on-chip (SOC) and Use of VLSI Circuit Design Technology, Complex Systems Design and Processors, Design Process in Embedded System, Formulation of System Design, Design Process and Design Examples, Classification of Embedded Systems, Skills Required for an Embedded System Designer.	3
2	Device and Communication Bus for Devices Network IO Types and examples, Serial communication devices, Parallel Device ports, Sophisticated Interfacing Feature in Devices Ports, Wireless Devices, Timer and Counting Devices, Watch dog timer, Real time clock, Network Embedded Systems, Serial Bus Communication Protocols, parallel Bus Devices protocol- Parallel communication Network using ISA, PCI, PCI-X and advanced buses, Internet Enabled Systems- Network protocols, Wireless and mobile system protocol.	5
3	Device Drivers and Interrupt Services Mechanism Programmed-I/O Busy-wait Approach without Interrupt Services Mechanism,ISR Concept, Interrupt Sources, Interrupt Servicing(Handling) Mechanism, Multiple	8



GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code: 3174106

	Interrupts, Context and the Periods for Context Switching, Interrupt Latency and Deadline, Classification of Processor Interrupt Service Mechanism from Context-Saving Angle, Direct Memory Access, Device Driver Programming.	
4	Interprocess Communication and Synchronization of processes, Threads and Tasks: Multiple process in an application, Multiple Threads in an application, Task and Task state, Task and Data, Clear-cut Distinction between Functions, ISRS and Tasks by their Characteristics, Concept of Semaphores, Shared Data, Inter process Communication, Signal Function, Semaphore Functions, Message Queue Functions, Mailbox Functions, Pipe Functions, Socket Functions, RPC Functions.	7
5	Real Time Operating System: Operating system service, Process management, Timer function, Event function, Memory management, Device , File and I/O subsystem management, Interrupt routine in RTOS environment and handling of interrupt Sources calls, Real Time Operating Systems, Basic Design Using an RTOS, RTOS Task Scheduling Models, Interrupt Latency and Response of the Tasks as Performance Metrics, OS Security Issues.	9
6	Case Study: Case Study: Motivation for MSP 430 Microcontrollers: MSP430 RISC CPU architecture, Compiler-friendly features, Instruction set, Clock system, Memory subsystem. Understanding of different MSP430 families. Introduction to Code Composer Studio (CCS) and use CCS for Embedded C. Digital I/O – I/O ports programming using C, Understanding the muxing scheme of the MSP430 pins, interrupt programming On-chip peripherals - Watchdog Timer, Basic Timer, Real Time Clock (RTC), ADC, Universal Serial Communication Interface (USCI). Interfacing LED, LCD, Seven segment LED modules interfacing. Example – Real-time clock, Low-power features of MSP430	9

Suggested Specification table with Marks (Theory): (For BE only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
35%	15%	15%	15%	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. Embedded System: Architecture, Programming and Design by Rajkamal, 2 edition,2010, Tata McGraw Hill.
2. MSP430 Microcontroller Basics by John H. Davies Elsevier; First edition (2010).



GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code: 3174106

3. Computer as Components: Principles of Embedded Computing System Design, Wayne Wolf, 2nd edition, 2008, Morgan Kaufmann Publication.
4. Rajkamal, 'Embedded System – Architecture, Programming, Design', Tata Mc Graw Hill, 2011.

Course Outcomes: After learning the course the students should be able to:

Sr. No.	CO statement	Marks % weightage
CO-1	Understand the concepts of Embedded Systems	10
CO-2	Understand interfacing of IO devices and other peripherals.	20
CO-3	Device driver programming & interrupt service mechanisms	20
CO-4	Understand Inter-process Communication and Synchronization of processes, Threads and Tasks	20
CO-5	Learn OS functions and Real Time Operating System	15
CO-6	Able to use MSP430 along with analog and digital peripherals..	15

List of Experiments:

1. Introduction to MSP430 Kit and Programming Environment with program to work with ports
2. Configure timer block with capture/compare channel 0 & 1 to generate 4.096 KHz & 1.024 KHz signal.
3. Configure watchdog timer in watchdog & interval mode.
4. Test various Power Down modes in MSP430.
5. Read Temperature of MSP430 with the help of ADC.
6. Use Timer to trigger ADC for reading analog signal in most efficient manner to reduce power consumption.
7. Configure DAC to generate positive ramp signal.
8. Use Comparator to compare the signal threshold level.
9. Implement Hardware Multiplier to multiply two arrays to perform MAC operation.
10. Implement DMA controller for basic convolution algorithm.
11. Use I2C protocol for communication between more than two MSP430 connected on I2C bus.
12. Use SPI protocol for communication between two MSP430

Major Equipments:

1. MSP430 Launch pad and Development board
2. MSP430 FET Debugger
3. Function Generator
4. Oscilloscope
5. Digital Multi-meter
6. DC Power Supply (0-30 V)
7. Log analyser

List of Open Source Software/learning website:



GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code: 3174106

1. Interface a pressure sensor giving full scale range output as 10 mV for 300 mmHg with MSP430. Design appropriate signal conditioning circuit and write a 'c' program to monitor the pressure in mmHg.
2. A load cell is required to be interface with MSP430 which gives 2mV as its full scale output Design appropriate signal conditioning circuit and write a 'c' program to acquire the weight data and display this data on 3 and ½ multiplexed display field.
3. Use timer to generate a Pulse Width Modulated wave whose duty cycle is varied such that the average voltage is equal to the analog signal in the range of 0 to 2.5 Volts. Write a 'c' program for this task.
4. Use hardware multiplier to calculate RMS value of current and power associated with sinusoidal analog signal given as input to MSP430.
5. With the help of DMA controller implement digital FIR filter and use this filter for implementing Low Pass Filter action for the analog signal given as input to MSP430.
6. Implement suitable RTOS on suitable MCU platform to explore RTOS fundamentals.

List of Software:

1. IAR Embedded Workbench
2. TI Code Composer Studio
3. Energia

Learning website: www.nptel.org, <http://ocw.mit.edu>, <https://cnx.org/content>