

# GUJARAT TECHNOLOGICAL UNIVERSITY

**BRANCH NAME: Electronics Engineering / Electronics & Communication Engineering / Electronics & Telecommunication Engineering**

**SUBJECT NAME: Embedded Systems**

**SUBJECT CODE: 2171005**

**B. E. 7<sup>th</sup> SEMESTER**

## Teaching and Examination Scheme:

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

Sr. No	Course Content	Total Hrs.
1	<b>Introduction to Embedded Systems</b> 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, Formulization of System Design, Design Process and Design Examples, Classification of Embedded Systems, Skills Required for an Embedded System Designer	3
2	<b>Device and Communication Bus for Devices Network</b> 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.	6
3	<b>Device Drivers and Interrupt Services Mechanism</b> Programmed-I/O Busy-wait Approach without Interrupt Services Mechanism, ISR Concept, Interrupt Sources, Interrupt Servicing(Handling) Mechanism, Multiple 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	5

4	<p><b>Interprocess Communication and Synchronization of processes, Threads and Tasks:</b>  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</p>	8
5	<p><b>Real Time Operating System:</b>  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</p>	11
6	<p><b>Case Study:</b>  Case Study : Motivation for MSP 430 Microcontrollers:</p> <p>MSP430 RISC CPU architecture, Compiler-friendly features, Instruction set, Clock system, Memory subsystem. Understanding of different MSP430 families.</p> <p>Introduction to Code Composer Studio (CCS) and use CCS for Embedded C.</p> <p>Digital I/O – I/O ports programming using C, Understanding the muxing scheme of the MSP430 pins, interrupt programming</p> <p>On-chip peripherals - Watchdog Timer, Basic Timer, Real Time Clock (RTC), ADC, Universal Serial Communication Interface (USCI).</p> <p>Interfacing LED, LCD, Seven segment LED modules interfacing. Example – Real-time clock, Low-power features of MSP430.</p>	9

### Books:

1. Embedded System: Architecture, Programming and Design by Rajkamal, 2<sup>nd</sup> edition, 2010, Tata McGraw Hill
2. MSP430 Microcontroller Basics by John H. Davies Elsevier; First edition (2010)
3. Computer as Components: Principles of Embedded Computing System Design, Wayne Wolf, 2<sup>nd</sup> edition, 2008, Morgan Kaufmann Publication

### Manuals and other study materials:

- 1) <http://www.ti.com/ww/en/launchpad/launchpads-msp430-msp-exp430g2.html#project0>
- 2) <http://coder-tronics.com/msp430-programming-tutorial-pt1/>
- 3) <http://coder-tronics.com/msp430-programming-tutorial-pt2/>
- 4) <http://mspsci.blogspot.in/2010/08/tutorial-10-something-completely.html>
- 5) <http://mspsci.blogspot.in/2011/10/tutorial-16a-getting-serial.html>

- 6) <http://mbspsci.blogspot.in/2010/08/tutorial-09-timers.html>
- 7) <http://mbspsci.blogspot.in/2010/07/tutorial-08-beating-heart-bcs-part-i.html>

### **Course Outcomes:**

After learning the course the students should be able to:

1. Understand the concepts of Embedded Systems
2. Understand interfacing of IO devices and other peripherals.
3. Device driver programming & interrupt service mechanisms
4. Understand Inter-process Communication and Synchronization of processes, Threads and Tasks
5. Learn OS functions and Real Time Operating System
6. Able to use MSP430 along with analog and digital peripherals.

### **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.

### **Open Ended Problems:**

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.

**Major Equipments:**

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

**C. List of Software:**

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

**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 be submitted to GTU.