

GUJARAT TECHNOLOGICAL UNIVERSITY

ELECTRONICS & COMMUNICATION (EMBEDDED SYSTEM) (54)

MIXED SIGNAL CONTROLLERS

SUBJECT CODE: 2725404

SEMESTER: II

Type of course: Analog and Digital mixed design

Prerequisite: Fundamental knowledge of microprocessor and analog circuit design.

Rationale: Students of ME (Embedded Systems) should possess the skills of developing a system where it is required to acquire and process analog signals, digitize them and to send them to output units. Here a CPU architecture having analog signal processing capabilities will be helpful in developing compact and power efficient design. This course takes care for such design aspects.

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)			
					ESE	OEP	PA	RP		
3	0	2#	4	70	30	20	10	10	10	150

Content:

Sr. No.	Topics	Teaching Hrs.	Module Weightage
1	MSP430 series Microcontroller: Architecture of MSP430 Microcontrollers: Central Processing Unit and Registers, Basic Clock Module and operation: Digital Controlled Oscillator and Registers Digital Input-Output: Input, Output Registers, Function Select Register, Port Interrupts, Pull Up/Down Registers Timers: Timer Block diagram and Operation, Timer Modes, Output Unit, Timer Interrupts, Low Power Down Modes, Watchdog Timer and operation	10	25
2	Mixed Signal Systems: Analog to Digital Convertors: General Issues for Analog to Digital Convertors regarding Resolution, Precision, Accuracy, Signal to Noise Ratio, Successive Approximation Register (SAR) ADC Architectural Block diagram, Operation of ADC10 and ADC 12 in MSP430 Microcontrollers, Timing and Triggering options of ADC, Low power and Interrupt operation with ADC, Conversion modes for Single and Repeated conversion, Special Function Registers for ADC operation	12	35
3	Digital to Analog Convertors: Basics of Digital to Analog Convertor (DAC12) in MSP430 Microcontroller, Architectural Block Diagram and Operation of DAC12, Data format, port selection, Timer operation in association with DAC12, Special Function Registers for DAC operation	06	10
4	Comparator: Architecture and Operation of Comparator, Special Function Registers, Applications of Comparator Hardware Multiplier: Hardware Multiplier Operation, Registers	06	15
5	Direct Memory Access Controller (DMA): Direct Memory Access (DMA) Controller Block diagram and operation, DMA Transfer Modes,	05	10

	DMA Trigger Operation, Using ADC12 and DAC12 in association with DMA		
6	Embedded Signal Processing : Basics of convolution, Implementation of FIR Filter using MSP430 Microcontroller with the help of ADC12, DMA Controller and DAC12	03	5

Reference Books:

1. MSP430 Microcontrollers Basics, John H Devis, 1st Edition, Newnes Publishers
2. MSP430 Microcontrollers in Embedded System Projects, C P Ravikumar, 1st Edition, Elite Publishing House
3. Analog and Digital Circuits for Electronic Control System Applications: Using the TI MSP430 Microcontroller, Jerry Luecke, 1st Edition, Elsevier Science

Course Outcome:

After learning the course the students should be able to:

1. To study the architecture of advanced 16 bit mixed signal microcontroller.
2. To study the analog and digital peripherals along with their programming for embedded system design.
3. To understand fundamentals of digital signal processing algorithm implementation with 16 bit microcontroller core.
4. To carry out case studies of embedded system design for understanding complex problem design

List of Experiments:

1. Introduction to MSP430 launch pad and Programming Environment with program to work with ports and also initialize clock module to generate ACLK, MCLK and SMCLK on port pin
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.

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.

Major Equipments:

- i. MSP430 Launchpad and Development board
- ii. MSP430 FET Debugger
- iii. Function Generator
- iv. Oscilloscope
- v. Digital Multi-meter
- vi. DC Power Supply (0-30 V)

C. List of Software:

IAR Embedded Workbench

Learning website:

www.ti.com

Review Presentation (RP): The concerned faculty member shall provide the list of peer reviewed Journals and Tier-I and Tier-II Conferences relating to the subject (or relating to the area of thesis for seminar) to the students in the beginning of the semester. The same list will be uploaded on GTU website during the first two weeks of the start of the semester. Every student or a group of students shall critically study 2 papers, integrate the details and make presentation in the last two weeks of the semester. The GTU marks entry portal will allow entry of marks only after uploading of the best 3 presentations. A unique id number will be generated only after uploading the presentations. Thereafter the entry of marks will be allowed. The best 3 presentations of each college will be uploaded on GTU website