Course Title :**Embedded Systems**	Course Code: **15EC62T**
Semester : **6**	Course Group: **CORE**
Teaching Scheme in Hrs (L:T:P) : **4:0:0**	Credits : **4**
Type of course: **Lecture + activity**	Total Contact Hours: **52**
CIE : **25 Marks**	SEE : **100 Marks**

Prerequisites
Basics of digital Systems and programming.

Course Objectives
1. To understand the basic concepts and applications of embedded systems.
2. To introduce the architectural features and application capabilities of MSP430.

Course Outcomes
On completion of the course, students will be able to

	Course Outcome	CL	Linked PO	Teaching Hrs
CO1	Understand the concept, classification, characteristics, quality attributes and applications of Embedded Systems.	*R/U/A*	1,2,5,6,10	**6**
CO2	Understand the architecture of embedded system and basics of real-time operating system.	*U/A/AN/EV*	1,2,10	**9**
CO3	Understand the architecture, addressing modes and applications of MSP430.	*U/A/AN*	1,2,3,4,10	**10**
CO4	Analyse instruction set of MSP430 and develop programs for control applications using assembly language and embedded C.	*U/A/EV/C*	1,2,3,4,10	**9**
CO5	Use ADC and comparator for simple applications.	*U/A/ /EV*	1,2,3,4,10	**8**
CO6	List and describe the features of Mixed Signal System using comparator and ADC.	*U/A/AN*	1,2,3,4,10	**7**
	Total sessions including 3hrs student activity			**52**

Legends: PO-Program Outcome, CO-Course Outcome, CL-Cognitive Level, R-Remember, U-Understand, A-Apply, AN-Analyse, EV-Evaluate, C-Create

Mapping Course Outcomes with Program Outcomes

Course Outcomes	Programme Outcomes									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	*	*	--	--	*	*	--	--	--	*
CO2	*	*	--	--	--	--	--	--	--	*

	1	2	3	4	5	6	7	8	9	10
CO3	*	*	*	*	--	--	--	--	--	*
CO4	*	*	*	*	--	--	--	--	--	*
CO5	*	*	*	*	--	--	--	--	--	*
CO6	*	*	*	*	--	--	--	--	--	*

*Legend: * Linked, -- No link*

Course-Po Attainment Matrix

Course	Programme Outcomes									
	1	2	3	4	5	6	7	8	9	10
Embedded Systems	3	3	3	3	1	1	--	--	--	3

Legend: Addressing levels: 1-Slight, 2-Moderate, 3-Substantial, -- Not addressed

Quantification Method: *This is to relate the level of PO with the number of hours devoted to the COs which address the given PO. If ≥40% of classroom sessions addressing a particular PO, it is considered that PO is addressed at Level 3; if 25 to 40% , Level 2; if 5 to 25%, Level 1; and if < 5%, not addressed.*

Course content and pattern of marks for SEE

Unit No	Unit Name	Hour	Questions to be set ForSEE						Marks Weightage	Weightage (%)
			R	U	A	AN	EV	C		
1	Introduction to embedded system	6	05	10	--	--	--	--	15	11
2	Architecture of Embedded System	9	--	10	10	05	05	--	30	20
3	Introduction to MSP430 Architecture	10	--	10	15	05	--	--	30	20
4	MSP430 Assembly and Embedded C Programming	9	--	10	10	--	05	05	30	20
5	MSP430 GPIO, Timer and On-chip Peripherals	8	--	10	10	05	--	--	25	18
6	MSP430: Mixed Signal Systems	7	--	05	10	--	--	--	15	11
	Total	52	05	55	55	15	10	05	145	100

Legend: R- Remember, U-Understand A-Application,AN-Analyse,EV-Evaluate, C-Create

Course Content

Unit-1: Introduction toEmbedded System   Duration: 6hrs

Embedded System-Definition, History, Classification, Major Application Areas, Purposewith example,Embedded system vs. General Computing system, Characteristics and quality attributes of Embedded System, Application Case study: Smart running shoes

Unit-2: Architecture of Embedded SystemDuration: 9hrs

Hardware Architecture: Elements of Embedded System,Block diagram**,** Core of embedded system, Memory, Sensors and Actuators, Communication Interface, timing circuits-reset, watchdog timer, brownout protection and RTC, PCB and Passive components.**Software Architecture**: Embedded Firmware, Operating System Basics,Characteristics and role of RTOS in embedded systems, Software Architecture of an Embedded System.

Unit-3: Introduction to MSP430 Architecture   Duration: 10hrs

MSP430: Features of MSP430 suitable embedded application, Different families and naming of MSP430, **MSP430 Architecture:** Data sheet reading of MSP430-TheOutside View—Pin-Out, The Inside View—Functional Block Diagram. **Central Processing Unit:**Program Counter (PC), Stack Pointer (SP), Status Register (SR), Constant Generators, General-Purpose Registers, Memory, Memory-Mapped Input and Output, Clock Generator, **Exceptions:** Interrupts and Resets**Addressing Modes:**Register Mode, Indexed Mode, Indirect Register Mode, Indirect Auto-increment Register Mode.Low-Power Modes of Operation of MSP430.Comparison of MSP430 and 8051 Architectures.

Unit-4: MSP430 Assembly and Embedded C Programming   Duration: 9hrs

MSP430 Instruction Set: Classification-Constant Generator and Emulated Instructions**,** **Movement** Instructions, Arithmetic and Logic Instructions with Two Operands, Shift and Rotate Instructions, Flow of Control instructions. Simple assembly language programs.**Program development:** Features of embedded C as applicable to MSP430**,** development environment, simple Embedded C programs such as programs to control LEDs, access switches, generating delays and so on.

Unit-5: MSP430 GPIO, Timer and On-chip Peripherals   Duration: 8hrs

Digital Input-Output: Non Interruptible I/O and Interruptible I/O: Pin logic diagram Different Control Register, Port register Table.**Timers:**Classification of timers. Timer_A- Block diagram, Capture/Compare channels, interrupts and application notes.**Watchdog Timer:**Features and applications.**Hardware Multiplier:**Features and applications.**LCD Driver**: LCD Driver features.

Unit-6: MSP430: Mixed Signal Systems   Duration: 7hrs

Comparator A: Architecture,operation and applications of comparator. Use of comparator for Capacitative Touch Sensing. **ADCs:** Architecture ,Features of ADC 10 and ADC 12. Use of ADC10 for simple temperature Sensing.

References

1. *Introduction to Embedded Systems*- K V Shibu , McGraw Hill-ISBN-978-0-0701-4589-4
2. *MSP430 Microcontroller Basics* - John Davies, Elsevier, 2008 – ISBN-978-0-7506-8276-3
3. *Embedded Systems Design Using the TI MSP430 Series, 1st Edition* - Chris Nagy, Elsevier, 2003 – ISBN- 9780750676236
4. *Analog and Digital Circuits for Electronic Control System Applications-Using the TI MSP430 Microcontroller*- Jerry Luecke, Elsevier, 2004- ISBN-978-0-7506-7810-0

5. *Introduction to Embedded Systems Using Microcontrollers and the MSP430*-Manuel Jiménez, Rogelio Palomera, IsidoroCouvertier, Springer, 2014 – ISBN- 978-1-4614-3142-8
6. Texas Instrument MSP430 reference Page: http://www.ti.com/lsds/ti/microcontrollers_16-bit_32-bit/msp/overview.page
7. *IDE User Guide for MSP430:* 1)Code Composer Studio™ v6.1 for MSP430™ User's Guide:http://www.ti.com/lit/ug/slau157an/slau157an.pdf   2)   IAR   Embedded Workbench™   Version   3+   for   MSP430™   User's   Guide: http://www.ti.com/lit/ug/slau138an/slau138an.pdf   3) Energia is an open-sourced, community-driven IDE- http://energia.nu/guide/

Suggested List of Student Activities   Duration: 3hrs
Note:**The following activities or similar activities for assessing CIE (IA) for 5 marks (Any one)**

Sl. No.	Activity	Duration (Hrs)
1	Install AR Embedded Workbench for MSP430/Code composer studio for MSP430/Energia for MSP430: Create Project from Scratch, debug and run any twoprograms in assembly and Embedded C. Example programs given below: 1. Data Transfer - Block move 2. Block Exchange 3. Addition/subtraction 4. multiplication 5. Division 6. Finding largest element in an array 7. Sorting 8. Code conversion: BCD – ASCII 9. Code conversion: ASCII – Decimal; Decimal - ASCII; 10. Code conversion :HEX - Decimal and Decimal – HEX	3
2	Any one activity from following list or similar activity. 1. Prepare a report on the case study on working of embedded system with respect to: a) Washing Machine b) Microwave Oven 2. Conduct case studies for working of embedded systems for the following topics: a) Air Conditioner b) Automobile 3. Conduct case studies for MSP430 embedded systems for any two topics. 4. List and Explain different types of sensors and actuators used in Embedded System	

Execution Mode
1. Every student should perform Project activity 1 and 2 independently as assigned by the teacher based on interest of the student. Student can also choose any other similar activity with a prior approval from the concerned teacher.
2. Project activities shall be carried out throughout the semester and present the project report at the end of the semester.
3. Report-size shall be qualitative and not to exceed 6 pages;
4. Each of the activity can be carried out off-class; however, demonstration/presentation should be done during laboratory sessions.
5. Assessment shall be made based on quality of activity, presentation/demonstration and report.
6. Assessment is made based on quality of work as prescribed by the following rubrics table.

Institutional Activities

Sl. No.	Activity
1	Organize Seminar, workshop or Lecture from experts on the topic embedded system Design.
2	Organize workshop from experts onMSP430 application development.

Course Delivery

The course will be delivered through lectures, presentations and support of modern tools.

Course Assessment and Evaluation Scheme

Assessment Method	What		To Whom	Assessment mode /Frequency /timing	Max. Marks	Evidence Collected	Course Outcomes
Direct assessment	CIE	IA	Students	Three tests[+]	20	Blue Books	1 to 6
				Activity*	05	Activity Sheets	1 to 6
	SEE	End exam		End of the course	100	Answer Scripts at BTE	1 to 6
				Total	125		
Indirect assessment	Student feedback on course		Students	Middle of the Course	Nil	Feedback Forms	1 to 3& Delivery of course
	End of course survey			End of the Course	Nil	Question-naires	1 to 6, Effectiveness of delivery instructions & assessment methods

Legends: CIE-Continuous Internal Evaluation, SEE- Semester End-exam Evaluation
[+] Every I.A. test shall be conducted for 20 marks. Average of three tests, by rounding off any fractional part thereof to next higher integer, shall be considered for IA.

*Students should do activity as per the list of suggested activities/ similar activities with prior approval of the teacher. Activity process must be initiated well in advance so that it can be completed well before the end of the term and assessed through appropriate Rubrics.

Questions for CIE and SEE will be designed to evaluate the various CLs as per the weightage shown in the following table.

Sl. No.	Cognitive Levels (CL)	Weightage (%)
1	Remembering	05
2	Understanding	35
3	Applying	35
4	Analyse	10
5	Evaluate	10
6	Create	05
	Total	**100**

Continuous Internal Evaluation (CIE) pattern

(i) Student Activity (5 marks)

The following student activities or similar activities can be assigned for assessing CIE (IA) marks

Sl. No.	Activity	Duration (Hrs)
1	InstallIAR Embedded Workbench for MSP430/Code composer studio for MSP430/Energia for MSP430: Create Project from Scratch, debug and run any twoprograms in assembly and Embedded C. Example programs given below: 1. Data Transfer - Block move 2. Block Exchange 3. Addition/subtraction 4. multiplication 5. Division 6. Finding largest element in an array 7. Sorting 8. Code conversion: BCD – ASCII 9. Code conversion: ASCII – Decimal; Decimal - ASCII; 10. Code conversion :HEX - Decimal and Decimal – HEX	3
2	Any one activity from following list or similar activity. 1. Prepare a report on the case study on working of embedded system with respect to: a) Washing Machine b) Microwave Oven 2. Conduct case studies for working of embedded systems for the following topics: a) Air Conditioner b) Automobile 3. Conduct case studies for MSP430 embedded systems for any two topics. 4. List and Explain different types of sensors and actuators used in Embedded System	

Execution Mode
1. Every student should perform Project activity 1 and 2 independently as assigned by the teacher based on interest of the student. Student can also choose any other similar activity with a prior approval from the concerned teacher.
2. Project activities shall be carried out throughout the semester and present the project report at the end of the semester.
3. Report-size shall be qualitative and not to exceed 6 pages;
4. Each of the activity can be carried out off-class; however, demonstration/presentation should be done during laboratory sessions.
5. Assessment shall be made based on quality of activity, presentation/demonstration and report.
6. Assessment is made based on quality of work as prescribed by the following rubrics table.

(ii) Model of rubrics for assessing student activity

Dimension	Scale					Marks (Example)
	1 Unsatisfactory	2 Developing	3 Satisfactory	4 Good	5 Exemplary	
1. Research and gathering information	Does not collect information relate to topic	Collects very limited information, some relate to topic	Collects basic information, most refer to the topic	Collects more information, most refer to the topic	Collects a great deals of information, all refer to the topic	3
2. Full-fills team roles and duties	Does not perform any duties assigned to the team role	Performs very little duties	Performs nearly all duties	Performs almost all duties	Performs all duties of assigned team roles	2
3. Shares work equality	Always relies on others to do the work	Rarely does the assigned work, often needs reminding	Usually does the assigned work, rarely needs reminding	Always does the assigned work, rarely needs reminding.	Always does the assigned work, without needing reminding	5
4. Listen to other team mates	Is always talking, never allows anyone to else to speak	Usually does most of the talking, rarely allows others to speak	Listens, but sometimes talk too much,	Listens and talks a little more than needed.	Listens and talks a fare amount	3
					Total marks	ceil(13/4)= 4

(iii) CIE/IA Tests (20 Marks)

Three tests have to be conducted in accordance with the test pattern given below and average marks of them are considered for CIE/IA with specified schedule.

(iv) Format of CIE/IA test question paper

CIE Question Paper							
Institution Name and Code							
Course Co-ordinator/Teacher							
Program Name		*Test No.*			*Units*		
Class/Sem		*Date*			*CL*		
Course Name		*Time*			*COs*		
Course Code		*Max. Marks*			*POs*		
Note to students: Answer all questions							
Question No.	**Question**			**Marks**	**CL**	**CO**	**PO**
1							
2							
3							
4							

Legends: PO-Program Outcome, CO-Course outcome, CL-Cognitive Level, R-Remember, U-Understand, A-Apply
Note: Internal choice may be given in each CO at the same cognitive level (CL).

(v) Model question paper for CIE

CIE Question Paper						
Institution Name and Code						
Course Co-ordinator/Teacher						
Program Name	Electronics and Communication	*Test No.*	1	*Units*	1 & 2	
Class/Sem	5thSem	*Date*	1/1/2017	*CL*	R/U/A	
Course Name	Embedded Systems	*Time*	10-11AM	*COs*	1 & 2	
Course Code	15EC54A	*Max. Marks*	20	*POs*	1, 2,5.6 & 10	
Note to students: Answer all questions						
No.	**Question**		**Marks**	**CL**	**CO**	**PO**
1	Define Embedded System. Distiguish this from general purpose system. OR Explain the various possible purposes of using and embedded system		05	R/U/A	1	1,2,10
2	Explain the characteristics of an embedded system.		05	U/A	1	1,2,5,6
3	Write short note on Commercial off-the-shelf Component (COTS). Explain the role of COTS in Embedded System. OR Differentiate between SRAM and DRAM.		05	U/A	2	1,2,10
4	Explain the role of Brown-out Protection Circuit in Embedded System.		05	A	2	1,2,10

Semester End-exam Evaluation (SEE)

(i)   End-exam question-paper pattern

.Unit No.	Unit Name	Study Duration (Hrs.)	No. Questions for End-exam	
			5 marks Part - a	10 marks Part - b
I	Introduction to embedded system	6	1	1
II	Architecture of Embedded System	9	2	2
III	Introduction to MSP430 Architecture	10	2	2
IV	MSP430 Assembly and Embedded C Programming	9	2	2
V	MSP430 GPIO, Timer and On-chip Peripherals	8	1	2
VI	MSP430: Mixed Signal Systems	7	1	1
	Total	52	09 (45 Marks)	10 (100 Marks)

(ii)   Model question paper

Course Title   **: Embedded Systems**

Course Code   **: 15EC54A**   Time   **: 3 Hrs**

Semester   **: 5**   Max. Marks**: 100**

Instructions*: 1. Answer any **SIX** question from **Part A** (5x6=30 Marks)*

*   2. Answer any **SEVEN** full questions from **Part B** (7x10=70 Marks)*

Part A

1. Define Embedded System. Distiguish this from general purpose system.
2. Explain the components of a typical Embedded System.
3. Write short note on Digital Signal Processor (DSP). Explain the role of DSP in Embedded System.
4. Explain the low power modes of MSP430 microcontroller.
5. Tabulate CPU Registers of MSP430 microcontroller.
6. Explain Layout of Assembly Language.
7. Explain MSP430 shift and rotate instructions.
8. Explain MSP430 Interruptible I/O with pin logic diagram.
9. Explain Architecture of MSP430 Comparator_A with block diagram.

Part B

10. Explain the Quality Attributes of an embedded system
11. Explain the role of following Circuit in Embedded System a) Real-Time Clock b) Watchdog Timer
12. Tabulate different types of memory used in Embedded System and explain their role of each.
13. a) Explain the memory mapping of MSP430 microcontroller.
    b)Write short note on MSP430 Status Register.
14. Explain the addressing modes of MSP430 microcontroller.
15. Explain aspect of Embedded C Program a)Declarations b) Shifts c) Low-Level Logic Operations d) Masks to Test Individual Bits e) Bit Fields f) Unions

16. Write MSP430 assembly and C program to flash LEDs with a frequency of roughly 1Hz using a software delay
17. Explain Hardware Multiplier with hardware multiplier registers. List the advantage of Hardware multiplier.
18. a) Explain Architecture of MSP430 ADC10 with block diagram.
    b) Describe how we can use ADC10 in Temperature sensor.

Model Question Bank

Course Title : **Embedded Systems**	Course Code: **15EC62T**

UNIT-1Introduction to embedded system
05 Marks
Remember
1. List classification of embedded systems
2. List some applications of embedded systems

Understand
1. Define Embedded System with the help of an example
2. Define Embedded System. Distinguish this from general purpose system.
3. Explain the various possible purposes of using and embedded system
4. Explain the characteristics of an embedded system
5. Explain the Operational Quality Attributes of an embedded system
6. Write short note on the non-Operational quality attributes of an embedded system.
7. Write short note on History of an embedded system.

Application
1. Differentiate between general purpose computers & embedded systems
2. Explain major application areas of an embedded system.
3. Explain the characteristics of an embedded system.
4. Summarize the Purpose of an embedded system.

10 Marks
Understand
1. a) Define Embedded System with the help of an example
   b) List the working elements of an embedded system
2. a) List some applications of embedded systems
   b) Explain the various possible purposes of using and embedded system

Application
1. Explain the characteristics of an embedded system
2. Explain the Quality Attributes of an embedded system

UNIT-2Architecture of Embedded System
05 Marks
Remember
1. Tabulate the components used as core of Embedded System
2. List different types of RAM used in Embedded System.
3. List different on-board Communication Interfaces.
4. List different external Communication Interfaces.

Understand
1. Explain the components of a typical Embedded System.
2. Define Application Specific Integrated Circuit (ASIC). Explain the role of ASIC in Embedded System.
3. Explain the advantage of flash over other program storage memory in Embedded System Design.
4. Define Sensor. Explain the role in Embedded System with example.
5. Define Actuator. Explain the role in Embedded System with example.
6. Define Relay. List different types of relay.
7. Explain the role of Rest Circuit in Embedded System.
8. Explain the role of Brown-out Protection Circuit in Embedded System.
9. Explain the role of Real-Time Clock in Embedded System.
10. Explain the role of Watchdog Timer in Embedded System.

Application
1. Write short note on Digital Signal Processor (DSP). Explain the role of DSP in Embedded System.
2. Write short note on Programmable Logic Devices (PLD). Explain the role of PLD in Embedded System.
3. Write short note on Commercial off-the-shelf Component (COTS). Explain the role of COTS in Embedded System.
4. Write short note on Input and Output subsystem of Embedded System.
5. Write short note on Relay. Explain the role of in Embedded System.

Analyse
1. Differentiate between ASIC and ASSP.

Evaluate
1. Comparison of Microprocessor and Microcontroller.
2. Explain RAM and ROM.
3. Importance of SRAM and DRAM.

10 Marks

Understand
1. a) Define Sensor. Explain the role in Embedded System with example.
   b) Define Actuator. Explain the role in Embedded System with example.
2. Explain the role of following Circuit in Embedded System a) Rest Circuit b) Brown-out Protection Circuit
3. Explain the role of following Circuit in Embedded System a) Real-Time Clock b) Watchdog Timer
4. a) Define Sensor. Explain the role in Embedded System with example.
   b) Define Actuator. Explain the role in Embedded System with example

Application
1. Tabulate the components used as core of Embedded System. Explain the merits and drawbacks.
2. Explain different categories of core of the Embedded System.
3. Tabulate different types of memory used in Embedded System and explain their role of each.
4. Explain different Input and Output subsystem of Embedded System.
5. Explain different on-board Communication Interfaces in brief.
6. Explain different external Communication Interfaces in brief.
7. Explain Communication Interfaces with respect to embedded system.

UNIT-3 Introduction to MSP430 Architecture
05 Marks

Remember
1. List the features make the MSP430 suitable for low-power and portable applications.
2. List the features of MSP430 microcontroller.
3. List the functions of different pins of MSP430.
4. List the addressing modes of MSP430 microcontroller.

Understand
1. Explain naming and different families of MSP430.
2. Explain the low power modes of MSP430 microcontroller.
3. Explain MSP430 Clock generator.
4. Write short note on MSP430 Exceptions.

Application
1. Explain the architecture of MSP430 microcontroller with block diagram.
2. Explain the memory mapping of MSP430 microcontroller.
3. Tabulate CPU Registers of MSP430 microcontroller.
4. Write short note on MSP430 Status Register.
5. Explain the Constant Generator and Emulated Instructions of MSP430 microcontroller.

Analyse
1. Compare the 8051 and MSP430 Architecture

10 Marks

Understand
1. a) Explain naming and different families of MSP430.
   b) Explain the low power modes of MSP430 microcontroller.
2. a) Explain the memory mapping of MSP430 microcontroller.
   b)Write short note on MSP430 Status Register.

Application
1. Explain the architecture of MSP430 microcontroller with block diagram.
2. Explain the CPU of MSP430 microcontroller with diagram.
3. Explain the addressing modes of MSP430 microcontroller.

UNIT-4 MSP430 Assembly and Embedded C Programming
05 Marks

Remember
1. List MSP430 different category of instruction set.

Understand
1. Explain Sizes and Types of Variables in Embedded C.
2. Explain Coding Guidelines for C.
3. Explain Layout of Assembly Language.

Application
1. Explain MSP430 flow control instructions.
2. Explain MSP430 movement instruction and stack operation.
3. Explain MSP430 arithmetic instructions with one and two operands.
4. Explain MSP430 logical instructions with one and two operands.
5. Explain MSP430 byte manipulation instructions and Operations on Bits in Status Register instructions.
6. Explain MSP430 shift and rotate instructions.

Create
1. Write MSP430 assembly program to light the LEDs

2. Write MSP430 assembly program to light LED when button is pressed.
3. Write MSP430 assembly program to flash LEDs with a frequency of roughly 1Hz using a software delay
4. Write MSP430 C program to light the LEDs
5. Write MSP430 C program to light LED when button is pressed.
6. Write MSP430 C program to flash LEDs with a frequency of roughly 1Hz using a software delay

10 Marks

Understand
1. Explain aspect of Embedded C Program a)Declarations b) Shifts c) Low-Level Logic Operations d) Masks to Test Individual Bits e) Bit Fields f) Unions
2. a) Explain Layout of Assembly Language.
   b) Write MSP430 assembly code for data transfer-block move.

Application
1. Explain Editor, Assembler/Compiler, Linker, Stand-alone Simulator, Embedded emulator/debugger, Flash programmer and IDE.
2. Explain MSP430 instruction set. a) arithmetic instructions b) flow control instructions
3. Write MSP430 assembly and C program to light the LEDs
4. Write MSP430 assembly and C program to light LED when button is pressed.
5. Write MSP430 assembly and C program to flash LEDs with a frequency of roughly 1Hz using a software delay

UNIT-5MSP430 GPIO, Timer and On-chip Peripherals
05 Marks

Understand
1. Explain Timer block in Timer_A.
2. Explain Timer_ACapture/Compare Channels.
3. Explain Timer_Acapture/compare control register
4. Explain advantage of Hardware multiplier.
5. Explain MSP430 Interrupts from Timer_A

Application
1. Explain MSP430 Non Interruptible I/O with pin logic diagram.
2. Explain MSP430 Interruptible I/O with pin logic diagram.
3. Explain MSP430 Timer_A with block diagram.
4. Explain Timer different Output modes for capture/compare channel.
5. Explain Watchdog Timer with control Register.
6. Explain Hardware Multiplier with hardware multiplier registers.
7. Explain MSP LCD driver with control registers.

Analyse
1. Differentiate between Non Interruptible I/O and Interruptible I/O

10 Marks

Understand
1. Explain Hardware Multiplier with hardware multiplier registers. List the advantage of Hardware multiplier.
2. a) Explain MSP430 Interrupts from Timer_A
   b) Explain Watchdog Timer with control Register.

Application
1. Explain MSP430 Non Interruptible I/O and Interruptible I/O with pin logic diagram, control registers.

2. Explain MSP430 Timer_A with block diagram and explain Timer block, Capture Channel.

UNIT-6 MSP430: Mixed Signal Systems
05 Marks
Understand
1. Explain operation of MSP430 Comparator_A
2. Explain Basic Operation of the ADC10.
3. ExplainBasic Operation of the ADC12.

Application
1. Explain Architecture of MSP430 Comparator_A with block diagram.
2. Describe how we can use Comparator_Ain Capacitative Touch Sensing.
3. Explain control register of Comparator_A.
4. Explain Architecture of MSP430 ADC10 with block diagram.
5. Describe how we can use ADC10 in Temperature sensor.
6. Describe Timing and Triggering options of ADC.
7. Explain control register of ADC10.

10 Marks
Understand
1. Explain Architecture and operation of MSP430 Comparator_A with block diagram
2. Explain Basic Operation of the ADC10 and ADC12.

Application
8. a) Explain Architecture of MSP430 Comparator_A with block diagram.
   b) Describe how we can use Comparator_A in Capacitative Touch Sensing.
9. a) Explain Architecture of MSP430 ADC10 with block diagram.
   b) Describe how we can use ADC10 in Temperature sensor.

End