ECT342	EMBEDDED SYSTEMS	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: This course aims to design an embedded electronic circuit and implement the same.

Prerequisite: ECT 203 Logic Circuit Design, ECT 202 Analog Circuits ,ECT 206 Computer Architecture and Microcontrollers

Course Outcomes: After the completion of the course the student will be able to

CO 1 K2	Understand and gain the basic idea about the embedded system.
CO 2 K3	Able to gain architectural level knowledge about the system and hence to program an embedded system.
CO 3 K3	Apply the knowledge for solving the real life problems with the help of an embedded system.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	2		1			2				2
CO 2	3	3	3		3			2				2
CO 3	3	3	3		3			2	3			2

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember K1	10	10	10
Understand K2	20	20	20
Apply K3	20	20	70
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Test (2 numbers) : 25 marks

Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1) : Understand the embedded system fundamentals and system design (K1).

1. Give the challenges of embedded computing.
2. Give the structural description of embedded system.
3. What are the phases of EDLC ?.

Course Outcome 2 (CO2): Understand the peripheral devices and their interfacing with the processor. (K2)

1. Compare and contrast the PCI bus and PCI-X bus.
2. How the ROM memories are classified? Explain.
3. How the peripheral devices are connected with processors?

Course Outcome 3 (CO3): To understand the ARM processor architecture and pipeline processor organization. (K3)

1. Give the architecture of the ARM processor and explain the registers.
2. Explain the pipelined architecture of ARM processor.
3. Write an ARM assembly language program to print the sum of two numbers.

Course Outcome 4 (CO4): To write programs in assembly and high level languages for ARM processor. (K3)

1. Write a note on Thumb single register in ARM processor.
2. Briefly discuss about the Advanced Microcontroller Bus Architecture (AMBA).
3. What are the data types supported by ARM programming high level languages?

Course Outcome 5 (CO5): To understand the basics of real time operating systems and their use in embedded systems. (K2)

1. What are the functions of a Kernel?
2. Describe the process ," Deadlock"
3. Give the features of a real time operating system.

SYLLABUS

Module 1 : Introduction to Embedded Systems(06 Hours)

1.1 Complex Systems and Microprocessors

Embedding Computers, Characteristics of Embedded Computing Applications, Application of Microprocessors, The Physics of Software, Challenges in Embedded Computing System, Characteristics and quality attributes of an embedded system, Performance in Embedded Computing

1.2 The Embedded System Design Process

Requirements, Specification , Architecture Design, Designing Hardware and Software Components ,System Integration.

1.3 Formalisms for System Design

Structural Description, Behavioral Description, An embedded system design example.

1.4 Embedded product development cycle (EDLC)

Different phases of EDLC, EDLC models

Module 2 : Embedded system interfacing and peripherals (06 Hours)

2.1 Communication devices

Serial Communication Standards and Devices - UART, HDLC and SPI. Serial Bus Protocols - I^2C Bus, CAN Bus and USB Bus. Parallel communication standards ISA, PCI and PCI-X Bus.

2.2 Memory

Memory devices and systems – ROM-Flash, EEPROM,RAM-SRAM, DRAM, Cache memory, memory mapping and addresses, memory management unit– DMA .

2.3 I/O Device

Interrupts--Interrupt sources, recognizing an interrupt, ISR – Device drivers for handling ISR, Shared data problem, Interrupt latency.

Module 3 : ARM Processor fundamentals (07 Hours)

3.1 ARM Processor architecture

The Acorn RISC Machine, Architectural inheritance, The ARM programmer's model, ARM development tools.

3.2 ARM Assembly Language Programming

Data processing instructions, Data transfer instructions, Control flow instructions, writing simple assembly language programs.

3.3 ARM Organization and Implementation

Three stage pipeline ARM organization, Five stage pipeline ARM organization, ARM instruction execution, ARM implementation, The ARM coprocessor interface.

Module 4: ARM Programming (10 Hours)

4.1 Architectural Support for High-Level Languages

Abstraction in software design, Data types, Floating-point data types, The ARM floating-point architecture, Expressions, Conditional statements, Loops, Functions and procedures, Use of memory, Run-time environment.

4.2 The Thumb Instruction Set

The Thumb bit in the CPSR, The Thumb programmer's model, Thumb branch instructions, Thumb software interrupt instruction, Thumb data processing instructions, Thumb single register data transfer instructions, Thumb multiple register data transfer instructions, Thumb breakpoint instruction, Thumb implementation, Thumb applications.

4.3 Architectural Support for System Development

The ARM memory interface, The Advanced Microcontroller Bus Architecture (AMBA).

4.4 Programming

Assembly and C language programming applications of embedded systems.

Module 5: Real Time Operating Systems (07 Hours)

5.1 Operating system basics

Kernel, types of operating systems.

5.2 Real time operating systems

Tasks, process, threads, multiprocessing and multi-tasking, task scheduling, types, threads and process scheduling, task communication, task synchronization, device drivers, choosing an RTOS.

Text Books

1. 1. Raj kamal, Embedded Systems Architecture, Programming and Design, TMH, 2003
2. K.V. Shibu, Introduction to Embedded Systems, 2e, McGraw Hill Education India, 2016.
3. Wayne Wolf, Computers as Components: Principles of Embedded Computing System Design, Morgan Kaufman Publishers - Elsevier 3ed, 2008
4. Steve Furber, ARM system-on-chip architecture, Addison Wesley, Second Edition, 2000

Reference Books

1. David E. Simon, An Embedded Software Primer, Pearson Education Asia, First Indian Reprint 2000.
2. Steve Heath, Embedded Systems Design, Newnes – Elsevier 2ed, 2002
3. Andrew N. Sloss, Dominic Symes, Chris Wright, ARM System Developer's Guide Designing and Optimizing System Software, Morgan Kaufmann Publishers 2004
4. Frank Vahid and Tony Givargis, Embedded Systems Design – A Unified Hardware / Software Introduction, John Wiley, 2002.
5. Tammy Noergaard, Embedded Systems Architecture, A Comprehensive Guide for Engineers and Programmers, Newnes – Elsevier 2ed, 2012
6. Iyer - Embedded Real time Systems, 1e, McGraw Hill Education New Delhi, 2003
7. Lyla B. Das, Embedded Systems: An Integrated Approach, 1/e , Lyla B. Das, Embedded Systems, 2012

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Introduction to Embedded Systems**	
1.1	Complex Systems and Microprocessors	2
1.2	The Embedded System Design Process	1
1.3	Formalisms for System Design	2
1.4	Embedded product development cycle (EDLC)	1
2	**Embedded system interfacing and peripherals**	
2.1	Communication devices	3
2.2	Memory	2
2.3	I/O Device	2

3	**ARM Processor fundamentals**	
3.1	ARM Processor architecture	2
3.2	ARM Assembly Language Programming	3
3.3	ARM Organization and Implementation	2
4	**ARM Programming**	
4.1	Architectural Support for High-Level Languages	2
4.2	The Thumb Instruction Set	3
4.3	Architectural Support for System Development	2
4.4	Programming	3
5	**Real Time Operating Systems**	
5.1	Operating system basics	2
5.2	Real time operating systems	5

Simulation Assignments:

1. At least one assignment should be of programming (Both assembly and C languages) of embedded processor with simulation tools like Keil, Eclipse.
2. Another assignment should be an embedded system design mini project.

Programming assignments can be the following

(a) Print "HELLO WORLD" or any text (b) Data transfer, copy operations (c) Arithmetic operations (d) Sorting operations (e) input/output control (f) programs using functions (g) Interrupts and ISR (h) controller design

Mini project can be done in the following areas.

(a) Elevator controller design (b) Chocolate vending machine design (c) Industrial controller using sensors (d) IOT applications using sensors, communication devices and actuators

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION, (**Model Question Paper)**

Course Code: ECT342

Course Name: EMBEDDED SYSTEM DESIGN

Max. Marks: 100 Duration: 3 Hours

PART A

(Answer ALL Questions. Each Question Carries 3 Marks.)

1. Define an embedded system
2. Write any 3 challenges of embedded system design
3. Explain how an RS232 device is interfaced to a processor
4. What is interrupt latency?
5. Write the contents of CPSR register of ARM processor and their use.
6. Draw the five stage pipeline architecture of ARM processor
7. What is the use of thumb instruction set in ARM processor?
8. What a note on ARM memory interface
9. What is a real time operating system?
10. What are tasks, processes and threads? [10 X 3= 30]

PART – B

(Answer one question from each module; each question carries 14 marks)

Module – I

11. (a) What are the characteristics of an embedded system? Explain. [07 Marks]
    (b) Explain the different phases of EDLC. [07 Marks]

OR

12. (a) Write different steps involved in the embedded system design process. [07Marks]

    (b) Explain the structural description of embedded system design. [07 Marks]

Module – II

13. (a) What is serial and parallel port communication? Explain with the help of necessary diagrams. [07 Marks]

(b) What is interrupt? How interrupts are handled in a processor? Explain ISR.[07 Marks]

OR

14. (a) With the help of a diagram show how ROM and RAM are interfaced to a processor. Explain the read/write processes. [07 Marks]

(b) Explain how a memory management unit is used in a processor. What are its uses? What is DMA ? [07 Marks]

Module – III

15. (a) Write a note on ARM processor architecture and its registers. [07 Marks]

(b) Write a note on data processing and data transfer instructions with the help of examples [07 Marks]

OR

16. (a) What is pipeline architecture? Explain how an ARM instruction is executed in a 5 stage pipeline processor with the help of an example. [08 Marks]

(b) Write an ARM assembly language program to print text string "Hello World". [06 Marks]

Module – IV

17. (a) Explain ARM floating point architecture and discuss how floating point numbers are handled [07 Marks]

(b) Write a note on Thumb single register and multiple register data transfer instructions with the help of examples. [07 Marks]

OR

18. (a) What is Thumb instruction set? Why it is used? Explain Thumb progrmmers model. [07 Marks]

(b) Draw the block diagram of AMBA architecture. What are the different types of buses used in the architecture? [07 Marks]

Module V

19. (a) What are the different services of Kernel? Explain different types of Kernels. [07Marks]

(b) Explain pre-emptive and non-pre-emptive scheduling algorithms with the help of an example. [07 Marks]

OR

20. (a) What are the basic functions of real time Kernel? Explain. [07 Marks]

(b) Write a note on the following (a) shared memory (b) message passing (c) deadlock [07 Marks]