**Course Name: Embedded Systems**

**Module 1**

1. Define an embedded system.
2. What are the differences between general purpose computing system and embedded system?
3. What are the differences between microprocessors and microcontrollers?
4. What are the components/peripherals of an embedded system?
5. List the steps involved in a Top down embedded system design process
6. Compare RISC and CISC processors
7. Compare Von Neumann and Harvard architectures
8. What are little endian and big endian processors?
9. What is load and store architecture in microcontrollers?
10. With the help of GPS moving display as an example discuss the top down design process of an embedded system
11. With the help of Chocolate vending machine as an example discuss the top down design process of an embedded system
12. With the help of Smart card as an example discuss the top down design process of an embedded system
13. With the help of Digital camera as an example discuss the top down design process of an embedded system
14. What is embedded product Development Life Cycle (EDLC)? What are its objectives?
15. Explain the use of Unified Modelling Language (UML) in embedded system design Process.
16. What are the characteristics and qualities of an embedded system? Explain any seven characteristics/qualities.
17. What are the challenges of embedded system design?
18. Design a GPS moving display system using top down approach.
19. What are classes and objects in UML?
20. Show how structural description is used in UML with the help of examples.
21. With the help of a diagram explain the state machine diagram in UML.
22. With the help of a diagram explain the sequence diagram in UML.
23. Using Unified Modelling Language (UML) design a model train controller. Show class diagram, state diagram and sequence diagram.
24. Explain the different phases of embedded product Development Life Cycle (EDLC) with the help of a diagram.
25. Explain the following EDLC modelling approaches (a) Water flow model (b) Iterative/Fountain model (c) Prototyping model (d) Spiral model.

**Module 2**

1. Write notes on the following communication protocols with the help of necessary diagrams, and frame formats. (a) I2C (b) SPI (c) UART (d) RS232 (e) HDLC (f) CAN (g) USB
2. Discuss the advantages and disadvantages of serial and parallel communication protocols.
3. Write notes on the following parallel communication protocols (a) ISA (b) PCI (c) PCI-X
4. What are the common peripheral devices connected to a processor? List at least 10 such devices.
5. What are different types RAM and ROM memories used in embedded systems? Explain their characteristics.
6. What are the differences between SRAM and DRAM?
7. With the help of diagrams explain how RAM and ROM are interfaced to a processor.
8. What is cache memory? How they are used in processor based systems?
9. What is MMU? Why they are used? Explain with the help of diagrams.
10. What is memory mapping, address translation, virtual addresses and physical addresses? Explain.
11. Explain how a processor communicates with peripheral devices (a) through handshaking (b) through DMA access. Show timing diagrams.
12. What are the differences between parallel and serial communications?
13. With the help of diagrams explain the I2C communication. Explain the packet frame format and discuss in detail how communication takes place between master and slaves.
14. With the help of diagrams explain the SPI communication. Explain in detail how communication takes place between master and slaves.
15. With the help of diagrams explain the UART communication. Explain the packet frame format and discuss in detail how communication takes place between two devices.
16. What is HDLC protocol? Explain the frame format.
17. Explain CAN bus protocol and explain how the devices are connected with the help of frame format and physical connections.
18. Explain USB protocol? What are the different modes of communication used in USB?
19. Explain the following parallel communication buses with the help of diagrams. (a) ISA bus (b) PCI and PCI/X bus (c) AMBA bus.

**Interrupts**

1. What are different types of interrupt sources? Explain.
2. What is ISR? Explain interrupt service mechanism.
3. What is interrupt and explain how interrupts are handled in a processor?
4. Discuss the following terms associated with interrupts (a) interrupt priority (b) context switching (c) interrupt latency (d) shared data problem (e) deadlock (f) deadline (g) critical section.
5. With the help of diagrams explain the calculation of interrupt latency in all caseswhen multiple interrupt occurs (Hint: three cases 1. Normal interrupt, 2. Higher priority interrupts 3. When critical sections are executed and the interrupt is disabled).
6. What are the methods to solve shared data problem in embedded systems?
7. What are device drivers? Explain their functions.

**Module 3**

**ARM Architecture**

1. Explain the differences between ARM mode and Thumb mode in ARM instruction set.
2. With the help of diagrams explain ARM programmer’s model. Explain the user registers, registers used in exceptions, CPSR and SPSR.
3. Explain the ARM 3 stage pipeline organization with advantages and disadvantages.
4. Discuss the two issues with pipeline architecture. Use diagrams to explain the concepts.
5. What are the features of ARM processor and its instruction set?
6. What features are taken from RISC architecture and what not? Explain.
7. Explain exception handling in ARM processor. Explain how they are handled and the use of system mode registers.
8. What are the different exception modes in ARM architecture?
9. What are the CISC like features included in ARM processor (Hint: memory access, code density, thumb instruction set).

**ARM Programming**

1. Write a note ARM data processing instructions with examples (Hint: Explain data movement, arithmetic, logical, comparison, shift instructions with at least 1 example)
2. Write a note on ARM control flow instructions with examples (Hint: B, BL, BX, BLX instructions and the use of conditional codes like BNE)
3. Write a note on ARM data transfer instructions with examples (Hint: LDR/STR instructions and multiple transfer instructions like LDM/STM with appropriate extensions like IA/IB, DA/DB)
4. Write a note on multiple register PUSH and POP instructions in ARM processor (Hint: LDMFA/STMFA, LDMFD/STMFD, LDMEA/STMEA, LDMED/STMED)
5. Write an assembly language program for computing 64 bit addition in ARM processor.
6. Write an assembly language program for multiplying the contents of a register with 45 in ARM processor.
7. Write an assembly language program for transferring 10 words of data from specific locations to different locations in ARM processor.
8. Write an assembly language program for transferring 10 bytes of data from specific locations to different locations in ARM processor.
9. Write an assembly language program to compute sum of 10 words stored in memory locations and to store the result in another memory location in ARM processor.

**ARM Pipeline execution**

1. Draw ARM 3 stage pipeline architecture and explain how an instruction is executed.
2. Explain the execution of a multi cycle instruction in ARM 3 stage pipeline and discuss the issues.
3. Write a note on the PC behaviour of ARM 3 stage pipeline execution. Why does r15 give pc + 8 in the first cycle of an instruction and pc + 12 in subsequent cycles on an ARM7?
4. What is memory bottleneck in ARM pipeline execution? How it is solved in 5 stage pipeline architecture?
5. Draw ARM 5 stage pipeline architecture and explain how an instruction is executed.
6. What are forwarding paths in ARM 5 stage pipeline architecture? Why are they used.
7. Explain how data processing operations are executed in ARM 3 stage pipeline architecture.
8. Explain how data transfer operations are executed in ARM 3 stage pipeline architecture.
9. Explain how branch operations are executed in ARM 3 stage pipeline architecture.

**ARM Implementation**

1. Write a note on clock scheme and data path timing in ARM
2. Write a note on ARM ALU architecture
3. Write a note on Barrel shifter in ARM processor
4. Write a note on multiplier architecture in ARM
5. Write a note on ARM register cell circuit.
6. Write a note on ARM control logic structure.
7. Explain ARM coprocessor architecture and interface (Hint: Explain architecture, interface, handshake signals)