VIT®

Vellore Institute of Technology

(Deemed to be University under section 3 of UGC Act, 1956)

CHENNAI

Final Assessment Test(FAT) - Apr/May 2025

Programme	B.Tech.	Semester	Winter Semester 2024-25
Course Code	BCSE305L	Faculty Name	Prof. Vijayakumar P
Course Title	Embedded Systems	Slot	E1+TE1
		Class Nbr	CH2024250501594
Time	3 hours	Max. Marks	100

Instructions To Candidates

- Write only your registration number in the designated box on the question paper. Writing anything elsewhere on the question paper will be considered a violation.

Course Outcomes

CO1: Identify the challenges in designing an embedded system using various microcontrollers and interfaces.
CO2: To summaries the functionality of any special purpose computing system, and to propose smart solutions to engineering challenges at the prototype level.
CO3: To examine the working principle and interface of typical embedded system components, create programme models; apply various optimization approaches including simulation environment and demonstration using debugging tools.
CO4: To evaluate the working principle of serial communication protocols and their proper use, as well as to analyze the benefits and drawbacks of real-time scheduling algorithms and to recommend acceptable solutions for specific challenges.

Answer all Questions (10 × 10 Marks)

01. With a clear functional block or architectural sketch, explain the key features of an 8-bit microcontroller based on the Harvard architecture.

[10] (CO1/K1)

02. Write an Arduino program to implement a temperature monitoring system for greenhouse farming using an LM35 temperature sensor interfaced with an ADC. The system should monitor the temperature and take automated actions. Draw the connection diagram and write a program to implement this system. [3+7 marks]

- If the temperature exceeds 35°C, Display the message "High Temperature! Fan ON" on the serial monitor and turn on the fan and buzzer.
- If the temperature falls below 15°C, display a message "Low Temperature! Heater ON" on the serial monitor and turn ON the heater and buzzer.
- If the temperature is within the normal range (15°C - 35°C) – Display a message "Temperature is Normal" on the serial monitor and keep the fan, heater, and buzzer OFF.

[10] (CO1/K3)

03. Design an Arduino-based EEPROM data logging system interfaced via the Serial Peripheral Interface (SPI) protocol. The system should store and retrieve sensor data, ensuring efficient memory utilization. Draw the connection diagram and write a program to implement this system. [3+7 marks]

- To store sensor readings (e.g., temperature or humidity values) in the EEPROM at sequential memory locations.
- Implement a function to read and display stored data from EEPROM on the serial monitor.
- Ensure that data logging continues without overwriting previous data unless explicitly reset.
- Display a message "Data Logged Successfully" when writing is complete and "Retrieved Data: [values]" when reading from EEPROM.

[10] (CO1/K3)

04. A media technology company specializes in optimizing images and videos for efficient storage and transmission.

i) The company applies JPEG encoding to high-resolution images. Explain the key steps involved in JPEG compression and illustrate with an example of how an 8×8 pixel block is transformed using the Discrete Cosine Transform (DCT) and quantization. *(5 Marks)*
ii) To optimize video streaming, the company uses MPEG encoding. Describe how MPEG compression reduces video file size, and explain how frames contribute to efficient video encoding. *(5 Marks)*

[10] (CO2/K1)

05. A company is developing an embedded software application for a hardware platform based on an ARM9 processor.
i) Explain the embedded software development process, highlighting the important factors that contribute to efficient software execution on the target hardware. Discuss how the build procedure ensures proper compilation and linking. *(6 Marks)*
ii) Discuss how to load and execute the built software on the hardware platform using a bootloader or JTAG interface. *(2 Marks)*
iii) Identify and troubleshoot common build errors that may occur during the compilation and linking stages. *(2 Marks)*

[10] (CO3/K1)

06. A parking management system for a multi-level parking lot needs to be developed, handling vehicle entry, exit, and payment transactions concurrently. The system should incorporate the following functionalities

Vehicle Entry and Parking Allocation
- Assign an available parking spot upon vehicle arrival.
- If the parking lot is full, the system should indicate "No Parking Available".

Timed Parking Charges Calculation:
- Parking fees are charged based on the duration of stay: ₹20 for up to 1 hour, ₹50 for 1-3 hours, ₹100 for more than 3 hours
- The system should calculate the total fee upon exit.

Payment Processing
- Accept payments in denominations of ₹20, ₹50, and ₹100.
- If excess money is inserted, the system should compute and dispense change using available denominations.

Concurrent Vehicle Transactions Handling
- The system should allow multiple users to enter and exit simultaneously without errors in spot allocation or payment processing.

Develop an appropriate programming model to implement this system, ensuring real-time synchronization and efficient handling of concurrent vehicle operations

[10] (CO3/K3)

07. Assume that the following tasks are real-time periodic tasks shown in Table .1
Examine whether the given set of tasks is schedulable or not using EDF scheduling algorithm. Draw the Gantt chart for the same

Table 1: Task Set for EDF Scheduling

Task	Computation Time (C)	Deadline (D)	Period (T)
T1	2	6	12
T2	3	7	15
T3	1	4	8

[10] (CO4/K3)

08. (i) Define an RTOS and explain its key characteristics. (4 Marks)
(ii) Compare the different types of RTOS with relevant examples for each type. (3 Marks)
(iii) Analyze how an RTOS ensures real-time performance in an industrial automation application. (3 Marks)

[10] (CO4/K1)

09. Describe the steps involved in the embedded design process of an Advanced Driver Assistance System (ADAS). Provide a detailed explanation along with a neat architectural block diagram.

[10] (CO4/K1)

10. Ms. Alice is developing a real-time data acquisition system that collects high-frequency sensor data from multiple industrial sensors. Suggest a suitable SPI mode for this application by analyzing different SPI modes. Additionally, discuss how clock synchronization can impact SPI communication when multiple sensors operate at different speeds. Propose a method to handle simultaneous data collection from multiple sensors without collisions or data loss in a real-time system.

[10] (CO4/K2)

BL-Bloom's Taxonomy Levels - (K1-Remembering,K2-Understanding,K3-Applying,K4-Analysing,K5-Evaluating,K6-Creating)