03.	In an automotive airbag deployment system, the microcontroller board is connected to an I2C-supported accelerometer module for detecting rapid deceleration during collision. (i).With a neat diagram elaborate the step-by-step procedure involved in how the microcontroller communicates with the accelerometer module (6 Marks) (ii).Draw the I2C frame format to read the acceleration information from the accelerometer by assuming its device address as 0x6C and acceleration value is stored in the register address 0xB3. (4 Marks)	10	5	1
04.	In a modern packaging system, an IR sensor is used to accurately count the number of products moving through a conveyor belt before they get sealed in packets. Then, the count value is transferred to the central monitoring system using UART communication for real-time monitoring and data analysis. Draw a neat connection diagram and write a C++ program with mbed APIs using UART to transmit the count value from one STM32 Nucleo board attached with an IR sensor to another STM32 Nucleo board, which prints the count value on the serial monitor. Before transferring the count value, send the message "Device-1 Count begins" and after the counting, send the message "Device-1 Count ends". Assume the number of products to be packed in each packet is 5. *[Assume, the STM32 Nucleo board pins PC_10 (TX), PC_11(RX) are connected to the UART and PC_0 pin is connected to the IR sensor]*	10	5	3

Section - II

Answer all Questions (4 × 15 Marks)

*M - Marks

Q.No	Question	*M	CO	BL
05.	Consider you are designing a search and rescue drone which is designed to detect people drowning in water and save their lives by dropping a life buoy ring with the following key modules. • **Flight Control Module**: Includes the flight controller, GPS, IMU, and compass for stable and autonomous flight. • **Communication Module**: Utilizes radio communication for control, data streaming, and remote operation. • **Camera and Vision System**: Equipped with high-resolution cameras for visual and thermal imaging with advanced algorithms to detect human drowning conditions. • **Life Buoy Delivery System**: Features mechanisms for dropping rubber swim rings to save lives and loudspeakers for announcement. • **Sensor module**: Contains LIDAR, ultrasonic, proximity, and environmental sensors for obstacle detection and navigation. • **Power and Propulsion System:** Includes high-efficiency motors, battery packs and battery monitoring for extended and reliable operation. For the above application, apply an embedded system design process and neatly explain with the necessary diagrams. Assume all the non-technical requirements in addition to the given technical requirements.	15	1	3

Vellore Institute of Technology

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

Final Assessment Test(FAT) - Nov/Dec 2024

Programme	B.Tech.	Semester	Fall Semester 2024-25
Course Code	BECE403E	Faculty Name	Prof. Prakash V
Course Title	Embedded Systems Design	Slot	A1+TA1
		Class Nbr	CH2024250100160
Time	3 hours	Max. Marks	100

General Instructions

- Write only Register Number in the Question Paper where space is provided (right-side at the top) & do not write any other details.

Course Outcomes

1. Design any application, based on the given specifications by keeping in mind different design metrics.
2. Apply the skills attained to differentiate Microprocessor/Microcontroller and interface various peripherals for a particular application.
3. Demonstrate proficiency in using device drivers, firmware and debugging tools.
4. Analyze the specific perspective of the embedded application using different modelling languages
5. Compare and contrast various wired and wireless protocols
6. Explore the concepts of RTOS and apply the knowledge for developing real-time systems

Section - I

Answer all Questions (4 × 10 Marks)

*M - Marks

Q.No	Question	*M	CO	BL
01.	Discuss the embedded software build process with a neat diagram. How does it differ from the traditional software development process?	10	3	1
02.	Consider an IoT based Smart Parking Management System with the following modules. • **Smart Gate Control**: Automatically detects the vehicle at the entrance/exit to open/close the gate using ultrasonic sensor. • **Smart Cameras:** Detect types of vehicle and read number plate using image processing technique. • **Smart free slot sensing**: IR sensors for sensing parking slot occupancy. • **Smart bill generation:** Calculate the time duration of vehicle occupancy in parking slot and generate the bill accordingly. • **Real-time free slot status:** Continuously update to webserver for looking up the availability of space for vehicle parking. For the given application, identify and consider other essential requirements to implement the complete system. Then, represent the entire system behaviour using the UML Sequence and Use Case diagram with proper notations.	10	4	3

06. Consider a voice controlled smart home assistant which allows voice-activated control of home devices, automation of routines, and integration with IoT-enabled appliances has following modules: 15 2 3

- **Microphones and Speakers**: Detect voice commands and provide audio feedback.
- **Voice Recognition Software**: Interprets user commands and queries.
- **Wi-Fi / Bluetooth Module**: Connects to other smart devices and the internet for cloud-based processing.
- **Microcontroller**: Executes voice commands and controls smart home devices.

(i). Analyse and tabulate various technical and non-technical features required for choosing an appropriate microcontroller/processor. [9 Marks]

(ii).Analyse various power supply design considerations involved. [6 Marks]

07. In the ice cream manufacturing plant, the milk storage tank monitoring system will continuously monitor the temperature and the level of the milk in the storage tank. If the temperature deviates from the desired 23°C or if the milk level is above or below the predefined level (15 cm from the top of the storage lid), alerts will be issued through a buzzer. This system consists of, 15 2 3

- **LM35 Temperature Sensor:** Measures accurate milk temperature
- **HC-SR04 Ultrasonic Sensor:** Measures the milk level in the tank
- **Buzzer:** To generate an alert signal when milk level or milk temperature deviate from its desired values.
- **16x2 LCD:** Display the current readings of milk temperature on the first line and milk level on the second line.

To implement this monitoring system using STM32 Nucleo board,

(i). Draw the connection diagram [5 Marks]

(ii).Write a C++ program using appropriate mbed APIs. [10 Marks]

[Assume, buzzer is connected in PC_10, LM35 is connected in PC_3, HC-SR04 is connected in PC_8, PC_6, LCD is connected in PC_0,PC_1,PB_0,PA_4,PA_1,PA_0 pins of the STM32 Nucleo board]

08. (a) Discuss how Mutex is used for synchronization in RTOS and compare its key features with Semaphore. [5 Marks] 15 6 2

(b) Consider a set of tasks running on an Automotive control system with its computation time and period as given in the below table. Assume all tasks are arriving at the same time instance t=0, and all tasks have their deadline which is equal to their period. [10 Marks]

(i). Calculate the CPU utilization factor for each task given in the task set and examine whether the given tasks are schedulable or not using Earliest Deadline First (EDF) scheduling algorithm.

(ii). Draw the Gantt chart to show the execution of each task for 0 to 15 time unit under EDF.

Task (T_i)	Computation Time (C_i)	Period=Deadline ($P_i = D_i$)
Speed measurement Task (T_1)	2	5
Infotainment control Task (T_2)	2	8
Fuel injection Task (T_3)	3	12
ABS control Task (T_4)	4	15

BL-Bloom's Taxonomy Levels - (1.Remembering, 2.Understanding, 3.Applying, 4.Analysing, 5.Evaluating, 6.Creating)