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CHENNAI

22BAI-N61

**Final Assessment Test(FAT) - Apr/May 2025**

| | | | |
|---|---|---|---|
| Programme | B.Tech. | Semester | Winter Semester 2024-25 |
| Course Code | BCSE305L | Faculty Name | Prof. Sritama Roy |
| Course Title | Embedded Systems | Slot | G1+TG1 |
| | | Class Nbr | CH2024250501690 |
| 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

## Section - I

**Answer all Questions (2 × 10 Marks)**

01. The tracking system of the solar panels uses a stepper motor to adjust their orientation towards the sun. The stepper motor is interfaced with a single-chip microcontroller that uses a complex instruction set computing architecture. Identify and draw a schematic representation of this microcontroller architecture. Explain briefly each block of the microcontroller's architecture and also highlight the microcontroller's salient features with appropriate specifications.

**[10] (CO1/K3)**

02. Illustrate the use of appropriate embedded systems to monitor the bedside vital parameters of patients in a hospital. Draw the block diagram of the system and explain its functional characteristics and need for an embedded system in such an application

**[10] (CO4/K3)**

## Section - II

**Answer all Questions (5 × 16 Marks)**

03. Develop an Arduino-based code to design a temperature-based kiln management system used in ceramic industries. Illustrate with test cases and connection diagrams. (2)

(i) Read the temperature sensor connected to analog input A0. The temperature sensor used has a resolution of 13.5 mV/degC with an ADC resolution of 10 bit with the operating reference voltage at 3.3 V. (4)

(ii) When the temperature of the kiln goes beyond 120 deg, the Buzzer with RED LED connected to the Digital pins 2 and 3 is activated in the control room else the Buzzer and LED is in the OFF state. (3)

(iii) The servo DC motor is connected to an air blower to control the airflow. The change in airflow controls the temperature. The DC servo motor is connected to digital pin 7. (2)

(iv) Connect a push button to switch between automatic and manual mode operation of the DC servo motor. The DC servo motor turns on automatically when the temperature is above 120 deg. The motor could be controlled manually by the operator. (5)

**[16] (CO2/K3)**

04. a) In an embedded system, use a suitable lossless data compression method to encode the following uncompressed data "FFFFGGGHHIIJJJJJKKKKLLLL". Consider the size of the symbols as 8 bits. Compute the total size of the data before and after compression. Justify your claims. (8)

b) Use appropriate lossless compression technique based on the frequency as follows (A:10, E:15, I:12, O:3, N:4, R:13, P:1, L:2). Represent encoding technique using tree diagram to encode the following strings "PRONE", "PEARL", "APRON" . Decode "000100110011111111011" to the appropriate text using the tree diagram. (8)

**[16] (CO2/K3)**

05. a) Design an embedded system model for an Automated Shop Billing System for Amazon-based stores to facilitate cashless transactions. Identify the static structural UML class diagram to represent the functionalities of the system. The system should handle product listings, shopping carts, customer accounts, order processing, payments, invoices, and delivery tracking. It should support multiple payment methods (credit/debit cards, digital wallets, and Amazon Pay) and automatically generate bills after checkout. The system must also update stock levels and provide order history for customers. Identify the key classes, their attributes, methods, and relationships to accurately model the system. (8)

b) Develop a UML use case diagram for an Agriculture-Based Export Quality Grape Sorting embedded System. The system should automate the process of sorting grapes based on size, color, and quality parameters to meet export standards. It should involve actors such as farmers, quality inspectors, system operators, and export managers. The system should support functions like grape batch registration, automated sorting, quality assessment, rejection handling, packaging, and export approval. Identify the primary use cases, their interactions with actors, and any dependencies between them. (8)

**[16] (CO3/K3)**

06. Consider the following set of tasks running on the electronics control unit in an automobile.

| Task No. | Period (ms) | Scheduling parameters | | |
|---|---|---|---|---|
| | | Waiting time(ms) | Arrival Time (ms) | CPU Burst (ms) |
| ABS | 6 | 0 | 1 | 1 |
| EBS | 10 | 1 | 1 | 1 |
| Hill assist | 15 | 2 | 2 | 1 |

i. Determine the completion time, turn around time (2)
ii. Schedule using RMS (4)
iii. Schedule using EDF (4)
iv. Schedulability tests (4)
v. Justify the better scheduling method (2)

**[16] (CO4/K3)**

07. a) Identify the appropriate communication protocol used for short-range, low-cost, wireless audio streaming between a wide range of devices, such as laptops, tablets, smartphones, car stereos, speakers, and headphones. (1)
(i) Draw the schematic of the protocol architecture and explain the working characteristics of the protocol. (2)
(ii) Highlight the general format of the packet structure used in the protocol. (2)
(iii) Discuss in brief the bonding, pairing, and connection process. (2)
(iv) Classify the different connection modes of the protocol (3)

b) Design an architecture for a low-powered, short-distance communication protocol to monitor humidity levels in a pharmaceutical-based industry. Draw the Medium Access Control format structure (6)

**[16] (CO4/K3)**

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