



UNIVERSITI TUN HUSSEIN ONN MALAYSIA

**FINAL EXAMINATION
SEMESTER I
SESSION 2022/2023**

COURSE NAME : REAL TIME EMBEDDED SYSTEM
COURSE CODE : BEJ 44303
PROGRAMME CODE : BEJ
EXAMINATION DATE : FEBRUARY 2023
DURATION : 3 HOURS
INSTRUCTION : 1. ANSWER ALL QUESTIONS
2. THIS FINAL EXAMINATION IS CONDUCTED VIA **CLOSED BOOK**.
3. STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK

THIS QUESTION PAPER CONSISTS OF **THREE (3)** PAGES

- Q1** (a) Explain the following characteristics and show them in the temporal scopes of a task:-
 (i) Elapse time
 (ii) Completion time
 (4 marks)
- (b) A system has three independent tasks A, B, and C as given in the Table Q1.

Table Q1: Task Specification

Task	CPU resources (ms)	Period (ms)	Deadline (ms)
A	5	10	7
B	1	40	5
C	8	20	20

- (i) If the priority level of Task A > Task B > Task C, draw a task activation diagram for the first 50 ms of system operation.
 (6 marks)
- (ii) Examine the start delay, elapse time, and completion time for each task.
 (6 marks)
- (c) Analyze the schedulability of the tasks in Table Q1 by using a full test of rate monotonic schedulability (RMS).
 (14 marks)

- Q2** An ESP32-based microcontroller system consists of a variable resistor, a LED indicator, and a UART interface. This system has the same time specification as in Table Q1 and the task operation is given in Table Q2.

Table Q2: Task Operation

Task	Description of Operation	ESP32 Pin	Stack Size
A	Read analog voltage of the variable resistor and save data in a float variable (Vin). Assume that the voltage reference of ADC is 3.3V and the resolution is 12-bit.	G32 (ASC1_CH4)	2048 bytes
B	Send the value of Vin variable through USB interface (UART0) with 9600 baud rate setting.	G1 (Tx)	2048 bytes
C	Turn on LED if Vin is over 2.5V, and else turn off LED. The LED connection is based on sinking mode.	G26	1024 bytes

- Create complete C-code programming to handle all tasks by using FreeRTOS functions that is based on the priority order in Q1(c).
 (25 marks)



- Q3** (a) Describe a FreeRTOS queue for intertask communication. (2 marks)
- (b) A system in **Q2** will be improved by using FreeRTOS queue API. Assume that you have declared a global variable of type QueueHandle_t as "QueueHandle_t QVin;".
- (i) Determine a statement of coding in the void setup() for creating 10 elements of the queue and return a result into the global variable QueueVin. (3 marks)
- (ii) Determine a statement of coding in the infinite loop of the Task A function for sending a variable Vin into queue elements without a timeout block. (3 marks)
- (iii) Rewrite a complete function of Task B for receiving a queue element data without a timeout block. (7 marks)
- Q4** (a) Define the following terminology:-
- (i) Binary semaphore
- (ii) Counting semaphore
- (iii) Mutex (6 marks)
- (b) Describe the situation that will occur the following condition: -
- (i) Deadlock
- (ii) Starvation
- (iii) Priority inversion. (9 marks)
- (c) Propose a new solution of complete coding based on semaphore or mutex for **Q2** in handling the global variable Vin. (15 marks)

-END OF QUESTIONS -