Universiti Tun Hussein Onn Malaysia

# UNIVERSITI TUN HUSSEIN ONN MALAYSIA

## FINAL EXAMINATION
## SEMESTER II
## SESSION 2022/2023

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| COURSE NAME | : | REAL TIME EMBEDDED SYSTEM |
| COURSE CODE | : | BEH 42003 / BEJ 44303 |
| PROGRAMME CODE | : | BEJ |
| EXAMINATION DATE | : | JULY/AUGUST 2023 |
| DURATION | : | 3 HOURS |
| INSTRUCTIONS | : | 1. ANSWER *ALL* QUESTIONS<br>2. THIS FINAL EXAMINATION IS CONDUCTED VIA **OPEN BOOK**.<br>3. STUDENTS ARE **NOT PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA OPEN BOOK. |

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

**Q1** A push button with a **pull-up** resistor is connected to D10. A blue LED was connected to D11 with **sourcing mode**. A red LED was connected to D11 with **sinking mode**. Construct a C program for Arduino IDE in which the blue LED will light up but the red LED will not light up when the push button is not pressed.

(10 marks)

**Q2** Calculate the hyperperiod of a real-time system that consists of four tasks of T1(15,4), T2(30,4), T3(40,4), and T4(20,2).

(5 marks)

**Q3** Write a source code, in which, a subrountine TaskB will be ready once for every 100ms to read analog signal from pin A0.

(5 marks)

**Q4** Analyse the longest completion time for a real-time system of three tasks TA(20, 8), TB(5, 1), and TC(25, 3) when all tasks are released at the same time, in which, the Rate Monotonic scheduling algorithm was used.

(10 marks)

**Q5** Analyse the scheduleability of a real-time system of three tasks of TA(20,8), TB(5,1), and TC(20,4) based on its total utilization.

(5 marks)

**Q6** Construct the subrountine of a task, in which, with a function name of Task1(), the system will send "TaskMutex" via serial communcation when the mutex is available within 100ms. Or else, the task will be in block state for 50ms.

(6 marks)

**Q7** Construct the subrountine of a task, in which, with a function name of Task1(), the task will be in block state for 20ms if mutex is always available when Task1() is released.

(6 marks)

**Q8** Construct the subrountine of a periodic task that fulfills the following observation.

(i) with a function name of **TaskMutex()**,
(ii) **TaskMutex()** has the highest priority among other periodic tasks,
(iii) when xSemaphoreGive(xSemaphore) has been called for 5 times in the higher priority event task, Serial.println("TaskMutex") will be executed in each 200ms for 3 times,
(iv) the total block time will be 700ms when xSemaphore is not available.

(8 marks)

**Q9** A real-time system contains three tasks of TA(10, 2, 5), TB(15, 6), and TC(20, 2). Construct an Arduino IDE compatible programming so that an Arduino Uno microcontroller can produce the desired real-time response when TC has the highest priority, followed by TA, and TB.

(15 marks)

**Q10** A real-time system contains three tasks of TA(15, 6, 10), TB(10, 2, 5), and TC(20, 2, 2).

(a) Constructe the activation diagram of this system in one hyperperiod, and then analyze the time delay and completion time of each task of the system when Rate Monotonic scheduling algorithm is used.

(15 marks)

(b) Constructe the activation diagram of this system in one hyperperiod, and then analyze the time delay and completion time of each task of the system when Earliest Deadline First scheduling algorithm is used.

(12 marks)

(c) Analyze the effectiveness of the above scheduling algoriths based on the results that obtained at **Q10(a)** and **Q10(b)**.

(3 marks)

**- END OF QUESTIONS -**