



**UNIVERSITI KUALA LUMPUR
Malaysia France Institute**

**FINAL EXAMINATION
SEPTEMBER 2013 SESSION**

SUBJECT CODE : FSB 33904
SUBJECT TITLE : REAL-TIME SYSTEMS
LEVEL : BACHELOR
TIME / DURATION : x.xx pm – x.xx pm
(3 HOURS)
DATE :

INSTRUCTIONS TO CANDIDATES

1. Please read the instructions given in the question paper CAREFULLY.
 2. This question paper is printed on both sides of the paper.
 3. Please write your answers on the answer booklet provided.
 4. Answer should be written in blue or black ink except for sketching, graphic and illustration.
 5. This question paper consists of TWO (2) sections. Section A and B. Answer all questions in Section A. For Section B, answer three (3) questions only.
 6. Answer all questions in English.
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THERE ARE 5 PAGES OF QUESTIONS, EXCLUDING THIS PAGE.

SECTION A (Total: 40 marks)**INSTRUCTION: Answer ALL questions.****Please use the answer booklet provided.****Question 1**

- (a) Discuss the role of a dispatcher in CPU scheduling. (2 marks)
- (b) State what a real-time system is and identify its important aspect. (3 marks)
- (c) Briefly describe on TWO (2) ways tasks are structured when writing code for tasks. (4 marks)
- (d) List FIVE (5) key characteristics of an RTOS (*Real-Time Operating Systems*). (5 marks)
- (e) Define *Rate monotonic analysis (RMA)*, *Rate monotonic scheduling (RMS)* and *Rate monotonic priority assignment*. (6 marks)

Question 2

- (a) Define *race condition* and explain how they occur. (4 marks)
- (b) Describe the difference between a *process* and a *thread*. (4 marks)
- (c) Kernel objects are special constructs that are the building blocks for application development for real-time embedded systems. Identify and describe THREE (3) most common RTOS kernel objects. (6 marks)
- (d) Briefly explain TWO (2) operations that are supported in semaphores. (6 marks)

SECTION B (Total: 60 marks)**INSTRUCTION: Answer THREE (3) questions only.****Please use the answer booklet provided.****Question 3**

- (a) Generally, THREE (3) main states are used in most typical preemptive-scheduling kernels. Summarize and sketch the state diagram of *Task States* in RTOS. (12 marks)
- (b) There are four tasks ready to run in the system, where the arrival time and service time of the task is given in Table 1. Assuming that each task has the same priority, construct a figure that shows how all tasks can be completed using *round robin and preemptive* scheduling with the given time slices of 4ms.

Table 1: Property of four tasks.

TASK	ARRIVAL TIME (ms)	SERVICE TIME (ms)
T1	0	8
T2	1	4
T3	2	9
T4	3	5

(8 marks)

Question 4

A real-time embedded system has a preemptive priority-based scheduler. Table 2 shows the five tasks in the form of pseudo code which consists of *one data buffer, one 8-bit digital I/O port, and two serial ports involved.*

Table 2: Pseudo code for five tasks.

<p>Task 1:</p> <ol style="list-style-type: none"> 1. Initialize digital I/O port for input 2. Read digital input 3. Count rising edges on each input <p>Task 2:</p> <ol style="list-style-type: none"> 1. Read Data from serial port 1 2. Check CRC byte for errors in serial data 3. If data buffer is empty { write data payload to buffer } <p>Task 3:</p> <ol style="list-style-type: none"> 1. Initialize digital I/O port to output 2. Write data to digital outputs 3. Toggle bit 0 of digital I/O port on and off (i.e. make a brief pulse on bit 0). <p>Task 4:</p> <ol style="list-style-type: none"> 1. If data buffer is full { take data from buffer } 2. Write data to serial port 2 <p>Task 5:</p> <ol style="list-style-type: none"> 1. Count number of bytes in data buffer 2. Display byte count on LCD

Based from the task given on Table 2, answer the following questions:

- (a) Determine which resources are shared by these tasks. (2 marks)
- (b) Based from your answer on 4(a), determine which task contains critical sections for each resource. (6 marks)
- (c) Identify the specific lines of pseudo code above, which is critical section. (8 marks)
- (d) Using mutex semaphore, address the critical section problem in this case. Give specific details. (4 marks)

Question 5

Table 3 describes three tasks with their respective worst-case execution times and periods of execution. Answer the questions based on the given property for each task.

Table 3: Property of three tasks.

TASK	EXECUTION TIMES (C_i)	PERIOD LENGTH (T_i)
A	1	5
B	2	7
c	1	4

- (a) Calculate the total utilization of the set. (3 marks)
- (b) Check whether the set of task is schedulable or not. Show the calculation. (3 marks)
- (c) Set up the priority of the tasks when using rate monotonic priorities. (1 marks)
- (d) Assuming that the tasks are assigned rate monotonic priorities, draw the timeline (starting all three tasks at time 0). (5 marks)
- (e) Add 1 unit to the execution time of task B. Calculate the total utilization of the resulting task set and determine whether the new task set is schedulable or not according to both basic RMA (*Rate Monotonic Analysis*) schedulability test and a timeline figure. (8 marks)

Question 6

In a particular application, there are three interacting processes that used two shared semaphores, U and V as shown in Figure 1. Within each process, the statements are executed sequentially, but statements from different processes can be interleaved in any order that is consistent with the constraints imposed by the semaphores. Assume that once execution begins, the processes will be allowed to run until all three processes are stuck in a wait() statement, at which point execution is halted.

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Semaphore U = 3;
Semaphore V = 0;

Process-1          Process-2          Process-3
-----
L1:  wait (U)      L2:  wait (V)      L3:  wait(V)
     type ("C")    type ("A")      type ("D")
     signal (V)    type ("B")      goto L3
     goto L1       signal (V)
                   goto L2
    
```

Figure 1: Three interacting processes that use two shared semaphores, U and V.

- (a) Assuming execution is eventually halted, evaluate the numbers of 'C' are printed when the set of processes runs. Justify your answer. (5 marks)
- (b) Determine the smallest number of 'A' that might be printed when this set of processes runs. Justify your answer. (5 marks)
- (c) Check whether 'CABABDDCABCABD' is a possible output sequence or not when this set of processes runs. Justify your answer. (5 marks)
- (d) Check whether 'CABACDBCABDD' is a possible output sequence or not when this set of processes runs. Justify your answer. (5 marks)

END OF QUESTIONS