

Jadavpur University
Master of Engineering 2nd Semester Examination 2017
Real-Time Embedded Systems

Answer Any Five
 Time: 3 hours

Full Marks 100

1a. A real-time system comprises 2 tasks T_1 and T_2 with periods P_1 and P_2 and execution times C_1 and C_2 . If $P_2 > P_1$, prove that the critical instant for task T_2 occurs when the request for T_2 coincides with that of T_1 .

1b. Prove that for the above system, if the task set is schedulable by a priority assignment with priority of T_2 greater than that of T_1 , it is schedulable with Rate Monotonic scheduling.

10+10

2. Deduce an expression for Processor Utilization for a set of tasks $\tau = [T_1, T_2, \dots, T_n]$ with periods P_1, P_2, \dots, P_n and Worst Case Execution Times (WCETs) C_1, C_2, \dots, C_n and hence deduce its least upper bound for RM scheduling.

5+15

2+8

3a. Define task response time and relative deadline of a task.

3b. Define the criterion for schedulability of a task set by any scheduling in terms of the parameters in 3a.

6+2

3c. Consider a set of 3 tasks with relative deadlines 4, 5 and 10 secs. and WCETs 1, 2 and 3 secs. Assuming relative deadline of each task equals its period draw the execution profiles of the tasks for 1 complete schedule of 20 secs. assuming Earliest Deadline First (EDF) scheduling and RM scheduling. Comment on the similarity or difference in the two profiles.

12

4. Represent a binary full adder as a Mealy Machine

5

A coke vending machine accepts 1 dollar and 50 cent coins and dispenses water or soft drinks. A can of soft drinks costs 1 dollar and a bottle of water costs 50 cents. A buyer can enter the price in any combination of the above referred denominations and the system responds with display of the option and the remaining amount before dispensing the can or the bottle. Model the system using either a suitable FSM or MATLAB Stateflow.

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5. Distinguish between Burst and FIFO mode semaphores.

6

3 tasks T_1, T_2 and T_3 , with priorities in the same sequence are synchronized using a flag semaphore. Initially T_1 and T_2 are in the blocked state when T_3 runs for 50 ms after having set the semaphore, when it is pre-empted by T_2 . T_2 runs for 30 ms. more before it is blocked again, while trying to set the same semaphore, and T_3 runs for a further period of 10 ms. when it is pre-empted by T_1 which runs for 20 ms. and gets blocked again when it tries to set the semaphore set by T_1 . T_3 then runs for 15ms. and resets the semaphore. If T_2 and T_1 take further 20 ms. each to complete the activities for the particular cycle, draw the execution profile and calculate the time spent by T_1 in blocked mode assuming a) a burst mode semaphore and b) a FIFO mode semaphore. What is the processor utilization in this case? Does this depend on the execution profile or the semaphore mode?

6+6+2

6. Define bitwise efficiency and message efficiency of a communication protocol. 4
A FIFO with 8 elements is used in asynchronous serial communication operating at 19.2kbps with 8 bit, no parity, 2 stop-bits data. Calculate the maximum time allowable for reading the FIFO.

6

Two stations on a CAN start transmitting messages with IDs 12 and 10 in a 8-bit identifier field with a data speed of 1Mbps. Calculate the time for which both the stations communicate on the network.

10

7. How would you code 00101100 using Manchester Coding and 1111111100000001 using bit stuffing?

6

A system consists of 2 independent data streams which need to be read periodically and processed. Represent the system using a DFD augmented with relevant control structures and control flow and obtain a suitable task decomposition from this using relevant cohesion criteria.

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8. Write short notes on a)Explicit and Implicit Synchronization b)Priority inversion avoidance techniques in a RTOS.

10+10