

Jadavpur University
ME(Power Engg.)/ME(Nuclear Engg)
First Year 2nd Semester Examination 2024-2025

Real-time Embedded Systems

Answer Any Five

Full Marks : 100

Time: 3hrs.

1. Define WCET, Laxity, Deadline and Relative Deadline of a Task. 6

Define *Response Time* of a task state the condition for schedulability of a set of N tasks. 4
 Consider a 2 task system with a set of 2 tasks T_1, T_2 with WCETS C_1, C_2 and periods P_1, P_2 respectively. Assuming $P_1 > P_2$ and RM scheduling compute the lower bound of maximum processor utilization. 10

2. Enumerate the different properties of a RTOS. 4

Consider a 2 task system with a set of 2 tasks T_1, T_2 with WCETS C_1, C_2 and periods P_1, P_2 respectively. Assuming $P_1 > P_2$ and RM scheduling show that the Critical Instant for the task T_1 occurs when the request for T_1 coincides with that of T_2 . 6

Consider a 3 task system with a set of 3 tasks T_1, T_2, T_3 with WCETS 1, 2 and 2 ms. respectively and the corresponding relative deadline of 4, 5 and 8 ms. Draw the execution profile of the task-set for the first 4 cycles with EDF scheduling, assuming that the relative deadline of a task equals its period. What is the maximum achievable processor utilization in this case? 10

3. An RTES consists of 4 scanners with request periods of 10ms and WCETs 0.5ms each. The data is received by a data handler task which takes 0.5 ms. What should be the maximum request period of the data handler? All tasks receive stimulation from a Watchdog timer with a period of 100micro sec and a WCET of 10 micro-sec. If scheduling takes 1 micro-sec what should be the BTU (real-time clock period) for the system so that the system has no overload, assuming RMS scheduling? If one of the scanners now has a request period of 5ms. , what should be the new BTU? 14+6

4. With a 3 task system T_1, T_2, T_3 with the priorities in descending order and in the same sequence explain Priority Inversion with a suitable diagram.
 Design a suitable synchronization mechanism for the problem in Q3.

5. Differentiate between Burst Mode and FIFO mode semaphores. 6
 Three tasks T_1, T_2, 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 type?

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6. Consider a Token Operated automatic vending machine which can be used to dispense coffee, tea or hot chocolate only with the same token. Once a token is inserted, the machine
 - (i) validates the token and displays error message for an invalid token
 - (ii) prompts for a choice if the token is valid, validates the choice and displays error message if the choice is invalid
 - (ii) for a valid choice dispenses a cup of coffee, tea or hot chocolate by **opening a valve for a certain fixed time**

With a suitable FSM or MATLAB Stateflow constructs model the system.

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