Jadavpur University
ME(Software Engg.)/ME(Power Engg.)ME(Nuclear Engg)
2nd Semester Examination 2023-2024
Real-time Embedded Systems

Answer All Questions

Full Marks : 100 Time: 3hrs.

1. Define WCET, Laxity, Deadline and Relative Deadline of a Task. 6
Enumerate the different properties of an RTOS 4
Enumerate between FIFO, Interrupt-Driven and Priority based Pre-emptive scheduling. 4
Illustrate with an example how a GPOS can be modified to serve as an RTOS 6

OR

Define response time of a task in an RTOS. 4
Define a task in an RTOS and establish the relationship between schedulability of a set of Tasks in terms of Response Time of the tasks. 6
Define context switch latency for an RTOS and state how it depends on Basic Time Unit (BTU) 4
Enumerate the different desirable properties of a Real-time Embedded System . What do you mean by *Hard* and *Soft* Real-time Systems 6

CO (2)

2. 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. Derive necessary results used by you. 20

OR

If a task-set is schedulable with any priority assignment, is it schedulable by RM scheduling? Substantiate mathematically. 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 3 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

Deduce the corresponding Processor Utilization and the Lower bound of Maximum Processor Utilization with RMS scheduling for the case above. 4

[Turn over

CO (3)

3. 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 and explain further how you can avoid this. 12+8

OR

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? 14

CO(4)

4. 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 **design** the system. 20

5. Draw the template for a standard message frame and deduce an expression for Bit-wise efficiency from that. Now consider a **Token Passing** system with **N** nodes. Calculate the worst case message efficiency for the system. 4+6

   Represent the string 11001100 with Manchester Coding and calculate the transmission time for a 1Mbps line. What would be the bit stuffed version of 11111111110000001? What would the transmission time be for this bit stream over the same 1 Mbps line. 10

OR

A communication system comprises 4 CAN nodes operating at a Bus Speed of 1Mbps. The stations pass messages with IDs 0x01,0x02,0x03 and 0x04. If the two higher priority message is transmitted once in every 50ms and the two lower priority messages are transmitted once in every 100ms **, establish**
(i) the upper bound of message latency for the system
(ii) the effect of a higher bus speed on (i) .