

Birla Institute of Technology & Science, Pilani

First Semester 2023-2024

Comprehensive Examination

BITS G553-REAL TIME SYSTEMS Closed Book

Weightage: 35%

Duration : 3 Hours

Date of Exam : 11 Dec 20223

Closed Book

Max Marks: 10

Suggested Time for this part 30 minutes

Q1. Mention a few memory management techniques avoided in hard real-time systems. Also specify the reason for the same. [2M]

Q2. Which types of fragmentation are reduced through demand-paging technique? Which type of fragmentation can still occur in demand-paging? Why? [2M]

Q3. Mention any two examples of observable and non-observable specifications of a design [2M]

Q4. Mention at least two advantages of mutex over a semaphore? [2M]

Q5. Mention two advantages of sporadic server over deferrable server. [2M]

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Max Marks: 40

Suggested Time for this part: 2hr 30 minutes

Note: 1)All parts of a question should be answered consecutively.

2)All the symbols have their usual meaning unless specified.

Q1. A system of three tasks $T_1(6, 1)$; $T_2(8,1.5)$, $T_3(12,1)$ and $T_4(12,2)$ are scheduled using EDF. If sporadic jobs $S_i(r_i, e_i, d_i) = S_1(2, 1, 11)$; $S_2(8, 2, 22)$; $S_3(6, 1.5, 16)$ arrive. Which of the sporadic jobs can be accepted? (Show relevant calculations, partial schedules and specify the reasons for the decision made). [8M]

Q2. A program consists of five tasks, A, B, C, D, E (these are listed in priority order with A having the highest priority), and six resources R_1, \dots, R_6 (protected by semaphores, implementing the Priority Ceiling Protocol). The resource accesses have critical sections given in Table-1. Resources are used by the tasks according to the Table-2 below. Calculate the blocking time for each task in the above table. [10]

R1	R2	R3	R4	R5	R6
10	40	20	50	50	60

Table-1

Table-2 →

Task	Users
A	R3
B	R1, R2
C	R3, R4, R5
D	R1, R5, R6
E	R2, R6, R1

Q3. An embedded computer is required to control a pedestrian crossing. The crossing has Traffic lights for controlling the movement of vehicles, a button for pedestrians to press when they wish to cross the road, an illuminated pedestrian figure and a beeper for signaling to pedestrians that it is safe to cross. It should work as follows:

- When the system is initialized the traffic lights are set to green, the illuminated figure is set to red, the beeper is off, and the button is enabled.
- When button is pressed, button is disabled.
- After 20 seconds, the traffic lights are turned to amber.
- After a further 10 seconds, the traffic lights are turned to red, the illuminated figure is turned to green and beeper is turned on.
- After a further 30 seconds, beeper is turned off, the illuminated figure is set to flashing green and the traffic lights are set to flashing amber.
- After a further 10 seconds, the illuminated figure is set to red, the traffic lights are set to green and the button is enabled.

Assume and define suitable places and transitions. Show a Petri net to describe the above system. Write the firing table up to 4 entries. [12 M]

Q4. Three periodic tasks $T_i(P_i, e_i, D_i) = \{(12, 2, 17), (14, 3, 15), (30, 3, 32)\}$ are scheduled using DMA. Comment on the schedulability of these tasks without performing the actual simulation. [10 M]