MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
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II SEMESTER M.TECH.(EMBEDDED CONTROL AND AUTOMATION/INTERNET OF THINGS)
END SEMESTER EXAMINATIONS MAY 2024

Real Time Operating Systems (ICE 5214)
Note: Answer All questions.

Time:3 Hours **03-05 -2024** **MAX. MARKS: 50**

Instructions to Candidates:

- Answer **ALL** the questions.

Q.No.	Description	M	CO	PO'S	BL
1A	With appropriate examples, explain each service available in cloud computing.	**3**	**CO5**	**1,2,6**	**2**
1B	A real-time preemptive Rate Monotonic Scheduler (RMA) is used to schedule the periodic task set shown in Table Q1B with the restrictions throughout its operation as: uniprocessor, period and deadline are relative to arrival time. If priorities of tasks are equal assume a secondary rule of considering the task with lower index as the highest priority. Check the feasibility of the task set using analytical calculations for time demand analysis and verify the same with graphical method.	**4**	**CO2**	**1,2,3,6**	**4**
1C	A cyclic scheduler is to be used to run the following set of periodic tasks (T) on a processor with execution time (e) in (ms) and period (P) in (ms) as given: T_1 $(e_1 = 1,\ p_1 = 4)$, T_2 $(e_2 = 1,\ p_2 = 5)$, T_3 $(e_3 = 1,\ p_3 = 20)$, T_4 $(e_4 = 2,\ p_4 = 20)$. Select an appropriate frame size with justification.	**3**	**CO1**	**1,2,3,6**	**3**
2A	Consider a real time system with pre-emptive periodic task (T) set given in Table Q2A, Using DMA, schedule the tasks on the time line in the time interval [0-250]ms. Verify whether all the tasks meet their deadlines.	**3**	**CO2**	**1,2,3,6**	**4**

Table Q1B

T	Arrival (ms)	Period (ms)	Execution (ms)	Deadline (ms)
T1	25	30	10	20
T2	40	40	7	40
T3	60	60	10	50
T4	20	150	25	100

Assume only task 1 has a phase of 50ms and remaining tasks have zero phase, deadline is relative to the phase.

1/4

Table Q2A

T	Period (ms)	Execution (ms)	Deadline (ms)
T1	50	25	100
T2	62.5	10	20
T3	125	25	50

2B Schedule the task set (T) shown in the Table Q2B using Least Slack Time (LST) scheduling method. Show the time-line [0 to 23]ms of the schedule. Show all the intermediate steps in your calculations for schedule. (Assume secondary priority rule of higher index as higher priority). **3 CO2 1,2,3,6 4**

Table Q2B

Task	Release (ms)	Execution (ms)	Deadline (ms)
T1	0	10	33
T2	4	3	28
T3	5	10	29

2C A real time system is operating with 2 tasks and deferrable server (DS) as shown in Table Q2C. An aperiodic task of execution time of 1.7ms arrives at a time t=2.8ms. Schedule the given system using Earliest Deadline First (EDF) scheduler and calculate the response time for the aperiodic task. Draw the time-line for task scheduling and the server budget consumption graph. Assume deadline and period are relative to the phase. **4 CO3 2,3,6** 4

Table Q2C

Task	Phase	Period (ms)	Execution (ms)	Deadline (ms)
T1	2	3.5	1.5	3.5
T2	0	6.5	0.5	6.5
DS	0	3	1	-

3A **3 CO3 2,3,6 3**

A real time system having preemptive nature has to be scheduled using latest release time scheduler. The precedence graph and the task set are shown in Fig Q3A and Table Q3A respectively. Develop the schedule for the task set and explain each scheduling step. Show the timeline for the time interval [0-8] ms and check whether all the tasks meet their deadlines.

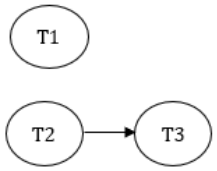

Fig: Q3A

Table Q3A

Task	Release (ms)	Execution (ms)	Deadline (ms)
T1	2	2	7
T2	0	3	6
T3	5	2	8

3B A system has 6 tasks: T1, T2, T3, T4, T5 and T6. 3 critical resources are shared: CR1, CR2, CR3. Assume tasks have priority values same as their index numbers. Task T_1 has highest priority and task T_6 has least priority. The resource requirements of these tasks and the duration for which the tasks need the three resources have been shown in Fig. Q3B. Compute the different types of inversions that each task might have to undergo for the given task set. **4 CO4 2,3,6 4**

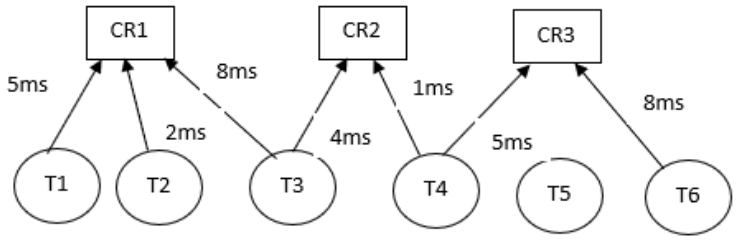

Fig Q3B

3C Compare and contrast the working of Priority inheritance protocol (PIP) and Highest Locker protocol (HLP) with the help of suitable examples. Highlight the limitations of PIP and how HLP overcome these. **3 CO4 2,3,6 4**

4A With suitable examples, justify the following with respect to priority ceiling protocol (PCP) **4 CO4 2,3,6 4**

i) How is deadlock avoided in PCP
ii) How is unbounded priority inversion avoided in PCP
iii) How is chain blocking avoided in PCP

4B The specifications of set of 10 periodic real-time tasks is shown in Table Q4B. Assume that the task set need to run on a multi-processor with four processors and each processor are to be scheduled using RM algorithm. Describe the working of next-fit algorithm and allocate the tasks to the processor using next-fit algorithm. **4 CO4 2,3,6 3**

Table Q4B

Task	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10
Execution(ms)	5	5	3	1	8	11	1	3	9	17
Period(ms)	10	22	22	24	30	40	50	55	70	75

4C	Explain the working of utilization balancing algorithm for task assignment in a multi-processor real-time system with an example.	**2**	**CO1**	**1.2,3,6**	**2**
5A	With help of state machine diagram explain a printer operation. Develop a C code for the same	**4**	**CO5**	**1,2,6**	**3**
5B	Develop a C code for a PID controller which is deployed as an embedded controller for temperature process.	**4**	**CO5**	**1,2,6**	**4**
5C	Justify with proper explanation and example on the requirements for an operating system to be called as a real time operating system.	**2**	**CO5**	**1,2,6**	**3**