Reg. No.									

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

VII SEMESTER B.TECH (ELECTRICAL & ELECTRONICS ENGINEERING)

END SEMESTER EXAMINATIONS, NOVEMBER 2023

REAL TIME SYSTEMS [ELE 4064]

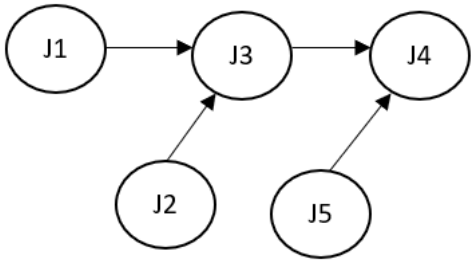
REVISED CREDIT SYSTEM

Time: 3 Hours **Date: 30 NOVEMBER 2023** **Max. Marks: 50**

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitably assumed.

1A. Develop a schedule for the Job set consisting of 5 Jobs on a uniprocessor timeline considering it to be a preemptive system. Consider the following release time (ms) and execution time (ms) of each job: J_1 (r_1=1, e_1=1), J_2 (r_2=0, e_2=2), J_3 (r_3=2, e_3=4), J_4 (r_4=6, e_4=2), J_5 (r_5=3, e_5=3). The precedence graph is given in the figure below. Consider phase (ø) of 5 ms for Job 3. Assume higher priority for jobs with lower index. ***(02)***



1B. Consider a real-time system with preemptive periodic task set shown in the below table. Compare the feasibility of the task set using Rate Monotonic (RM) Scheduler and Earliest Deadline First (EDF) scheduler for timeline [0-110]ms. Assume period and deadline are relative to arrival time. If priorities of tasks are equal, then consider the task with lower index as the highest priority. ***(04)***

Tasks	Release time (ms)	Period (ms)	Execution Time (ms)	Deadline (ms)
T1	25	30	10	20
T2	40	40	8	50
T3	50	55	15	45
T4	60	60	5	50
T5	20	100	10	90

1C. Analyze and schedule the preemptive periodic task set in the below table using Rate Monotonic (RM) Scheduler for timeline of [0-25]ms. Also, verify the feasibility of the task set graphically using time demand analysis. ***(04)***

Tasks	Phase (ms)	Period (ms)	Execution Time (ms)	Deadline (ms)
T1	3	3	1.5	5
T2	0	5	1	8
T3	1	7	0.8	10
T4	0	9	1.5	15
T5	0	11	0.5	20

2A. Analyze and schedule the task set shown in the below table using Least Slack Time (LST) scheduling method on a timeline of [0-21]ms. Show all the intermediate steps in your calculations for schedule. (Assume secondary priority rule of higher index as higher priority) ***(04)***

Tasks	Arrival Time (ms)	Execution Time (ms)	Deadline (ms)
T1	0	10	30
T2	2	2	25
T3	4	3	28
T4	6	5	29
T5	8	4	32

2B. Cyclic Scheduler must be employed for scheduling the following task set with the given execution time (ms) and period (ms) for a real time system. Accordingly, compute a suitable frame size: ***(02)***

T1 = (e1 = 1 , P1 = 4)
T2 = (e2 = 2 , P2 = 6)
T3 = (e3 = 3 , P3 = 20)

2C. A real time system consists of the following periodic and aperiodic tasks. Periodic tasks are defined w.r.t their period (ms) and execution time (ms) as: T1(3,0.5), T2(20,5), T3(60,10); Aperiodic task: A1 with execution time of 1.5ms arrives at 5ms. Analyze and schedule the following tasks using RMA and deferrable server after computing the period and server budget for the deferrable server. Also, sketch the server budget graph. ***(04)***

3A. Consider a real time system with the following periodic task set. ***(04)***

Tasks	Period (ms)	Execution Time (ms)	Deadline (ms)
T1	4	1	4
T2	8	2	8
T3	12	3	12

Divide the timeline [0-24] ms with frame size of 4, Analyze and schedule the tasks using Rate Monotonic (RM) scheduler. A sporadic job of length e=1ms arrives with deadline of D=15ms at t=1ms. A Aperiodic job of length e=0.5ms arrives at t=6ms.

i. Using the acceptance test, verify whether the sporadic job will be accepted/rejected by the processor.
ii. If accepted, will the sporadic job meet its deadline.
iii. Determine the response time of the aperiodic job.

3B. Consider a real time system with the below task set consisting of three periodic tasks T1, T2, T3 and two aperiodic tasks A1, A2. ***(04)***

Tasks	Period (ms)	Execution Time (ms)
T1	4	1.1
T2	15	2.1
T3	10	3

Aperiodic task: 'A1' released at 4ms and execution time of 1.5ms.
Aperiodic task: 'A2' released at 9.5ms and execution time of 0.5ms.
Schedule the task set on the timeline [0-20]ms using Rate Monotonic (RM) Scheduler considering the below approaches.

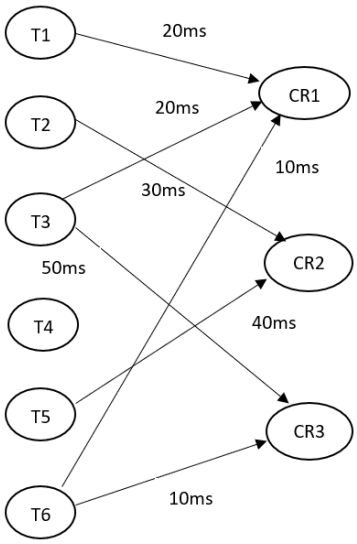
i. Without slack stealing
ii. With slack stealing

Evaluate, which of these methods is better for scheduling aperiodic jobs.

3C. Outline the working principle of Highest Locker protocol (HLP). Illustrate with an example how HLP overcomes the drawbacks of Priority Inheritance Protocol (PIP). ***(02)***

4A. A system has six tasks: T1, T2, T3, T4, T5 and T6. Three critical resources are shared: CR1, CR2, CR3. Assume tasks have priority values same as their index numbers. Task T6 has highest priority and task T1 has least priority. ***(04)***

The resource requirements of these tasks and the duration for which the tasks need the three resources have been shown in the below figure. Analyze the different types of inversions that each task might have to undergo for the given task set.



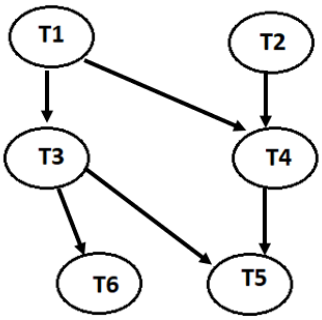
4B. The specifications of a set of 10 periodic real-time tasks (T_1-T_{10}) are shown in the below table. Assume that the task set need to run on a multi-processor system with four processors. Allocate the tasks to the processors using next-fit algorithm and utilization balancing algorithms. ***(04)***

Task	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}
e_i	5	7	3	1	10	16	1	3	9	17
p_i	10	21	22	24	30	40	50	55	70	100

4C. With suitable examples, show how the resource grant rule and resource release rule of PCP protocol help in preventing deadlocks and chain blocking. Also highlight the drawbacks of PCP. ***(02)***

5A. Analyze and schedule the below task set using Deadline Monotonic (DM) scheduler on timeline [0-25]ms considering the precedence constraints shown in the below figure. ***(04)***

Tasks	Release Time (ms)	Execution Time (ms)	Period (ms)
T1	0	1	10
T2	6	2	15
T3	0	3	25
T4	0	1	40
T5	0	5	65
T6	5	5	70



5B. Explain the requirements of a hard real time operating system in comparison with general operating system used for soft real time applications. ***(02)***

5C. Explain the working principle of static and dynamic priority assigning protocols used for node communication over networks. Also highlight the advantages and disadvantages of each. ***(04)***