Reg. No.									

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

VII SEMESTER B.TECH (ELECTRICAL & ELECTRONICS ENGINEERING)

ONLINE EXAMINATIONS, JANUARY- FEBRUARY 2021

REAL TIME SYSTEMS [ELE 4004]

REVISED CREDIT SYSTEM

Time: 3 Hours **Date: 01 February 2021** **Max. Marks: 50**

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitably assumed. Representation of time is in mili-seconds.
- Nomenclature: Period(P); Execution time(E); Deadline(D); Arrival (A); Aperiodic (AP); Task (T)

1A. I. Compare semaphore and Mutex for a real time operating system with suitable example.

II. Why event driven schedulers are invariably used in all moderate and large-sized applications having many tasks, whereas cyclic schedulers are predominantly used in small applications?

III. In a simple priority-driven preemptive scheduler, two periodic tasks T1 and T2 and a background task are scheduled. The periodic task T1 has the highest priority and executes once every 20ms and required 10ms of execution time each time. T2 requires 20ms of processing every 50ms. T3 is a background task and requires 100ms to complete. If all the tasks start at time 0, determine the time at which T3 will complete. ***(05)***

1B. I. Rate-Monotonic Algorithm is used to schedule a set of periodic hard real-time tasks in a system. Is it possible in this system that a higher priority task misses its deadline, whereas a lower priority task meets its deadlines? If your answer is negative, prove your assertion. If your answer is affirmative, give an example involving three tasks scheduled using RMA where the lower priority task meets all its deadlines whereas the higher priority task misses its deadline.

II. You are given a system of independent periodic tasks 'i' to be scheduled on a single processor in a pre-emptive manner: T = {Ti} for i = 1... n where Ti = (φi, Pi, Ei, Di) for each i. Assume that Pi = Di for each i. What is the maximum schedulable utilization of the Rate Monotonic algorithm for this system? Is this a necessary and sufficient condition? IF You are provided with the following system definition (all tasks are independent, and are scheduled pre-emptively on a single processor system): T1 = (0, 2, 0.4, 2), T2 = (1, 4, 1, 4) and T3 = (0, 5, 1.5, 5)} Can these tasks be scheduled using the Rate Monotonic algorithm? Explain. ***(05)***

2A. Consider the following (partial)specifications of a real time systems, identify all possible timing constraints in the system and construct a Extended Finite State Machine (EFSM) diagram for each of them.

"The velocity of a spacecraft must be sampled by a computer on-board the spacecraft at least once every second (sampling event is denoted by S). After sampling the ***(05)***

velocity, the current position is computed (denoted by event c) within 100ms, parallelly the expected position of the spacecraft is retrieved from the database within 200ms (denoted by R). Using these data, the deviation from the normal course of spacecraft must be determined within 100ms (denoted by D) and corrective velocity adjustments must be carried out before a new velocity value is sampled in (velocity adjustment event is denoted by A). Calculated position must be transferred to earth station at last once every minute (position transmission event denoted by T)".

2B. I. The following statement was made by a student studying real time systems "When preemption is allowed and jobs do not contend for resources, the EDF algorithm can produce a feasible schedule of a set T of independent jobs with arbitrary release times and deadlines on a processor if and only if T has feasible schedules". Do you agree with the statement? If so provide a generalizable proof for the same, if not justify the same with an example.

II. Schedule the task set given in **Table 2B** below using Earliest Deadline First (EDF) scheduler for a timeline of T (0 to 10ms). Mention any one advantage and disadvantage of EDF scheduler

Table 2B		
Task	Period	Execution
T1	2	1
T2	5	2.5

(05)

3A. You have joined a firm which specializes on Real Time systems and your predecessors' journal had following statement. "A system T of independent, pre-emptible, periodic tasks with relative deadlines equal to their periods can be feasibly scheduled (under EDF) on one processor if and only if its total utilization U is at most one." Do you agree with the statement, if so prove it for any and all such systems, if not justify the same. ***(05)***

3B. Write an Algorithm/Flowchart to show the working of Priority Ceiling Protocol (PCP) considering all the clauses/rules. Support the explanation by generating suitable example/s using set of tasks and resources for all the clauses/rules. ***(05)***

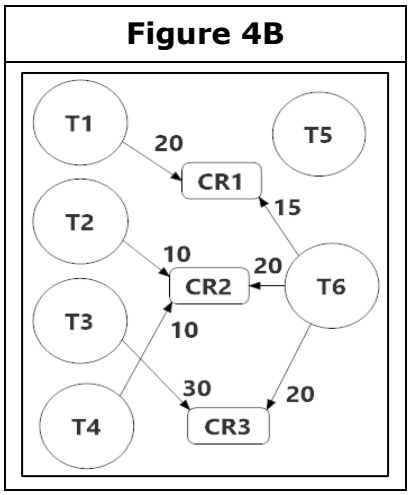
4A. Check for feasibility of a pre-emptive Rate Monotonic (RM) scheduler used for task set shown in **Table 4A** using analytical calculations for time demand analysis and verify the same with graphical method and also by scheduling tasks in timeline upto10ms.

Table 4A		
T	P	E
T1	3	1
T2	5	1.5
T3	7	1.25
T4	9	0.5

(05)

4B. A system has tasks $T_1, T_2, T_3, T_4, T_5,$ and T_6 with priority order given as: $T_1 > T_2 > T_3 > T_4 > T_5 > T_6$. The resource and computing requirements of these tasks are shown in **Figure 4B**. Compute different type of inversion under PCP that each task might undergo in the worst-case condition. State the reason for each such computation.

Figure 4B



(05)

5A. The **Table 5A** shows specifications of set of 10 periodic real-time tasks. Assume that task set need to run on a multiprocessor 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.

Table 5A

T	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10
E	5	5	10	1	8	11	20	3	9	17
P	10	22	22	24	30	40	50	55	70	75

(05)

5B. A real-time system runs on pre-emptive RM scheduler with three periodic task (T) set and three Aperiodic (AP) job arrives at instances (A) as shown in **Table 5B**. Schedule the task set in the timeline if, a simple sporadic-server with period of 5ms and execution budget of 1.5ms is used. Schedule the task set in the timeline and draw the server budget consumption graph for a duration of 0 to 25ms.

Table 5B

T	**P**	**E**	**AP**	**A**	**E**
T1	3	0.5	A1	3	1
T2	4	1	A2	7	2
T3	19	4.5	A3	15.5	2

(05)