MANIPAL INSTITUTE OF TECHNOLOGY

(A constituent unit of MAHE, Manipal)

SEVENTH SEMESTER B.TECH. (INSTRUMENTATION AND CONTROL ENGG.) END SEMESTER DEGREE EXAMINATIONS, JANUARY - 2021

REAL TIME EMBEDDED SYSTEMS [ICE 4003]

01-02-2021

TIME: 3 HOURS

MAX. MARKS: 50

Instructions to candidates : Answer ALL questions and missing data may be suitably assumed.

- 1A. In a hard real time system, is it necessary that every task in the system be of hard real-time type? Explain using a suitable example.
- 1B. How are the scheduling points determined in (i) clock-driven (ii) event driven (iii) hybrid schedulers? How do the definition of scheduling points for the three classes of schedulers change with (a) self-suspension of tasks (b) context switching overhead of tasks.
- 1C. Explain cyclic scheduler with relevant figures. List the constraints for selecting the frame size.

(2+3+5)

- 2A. Consider 7 processes P₁, P₂, P₃, P₄, P₅, P₆ and P₇ arriving in ready queue at time t=0 with priority 2,4,6,10,8,12 and 9 respectively with 2 as lowest and 12 as highest priority. If the burst time requirements are 4, 2, 3, 5, 1, 4 and 6 respectively, use the non preemptive priority scheduling method to find average Turn Around Time, average Waiting Time and Response Time.
- 2B. Determine whether the following set of periodic real-time tasks is schedulable on a uniprocessor using Rate Monotonic Algorithm.

Task	Processing Time	Period (ms)	Deadline (ms)
	(ms)		
T_1	25	150	100
T_2	7	40	40
<i>T</i> ₃	10	60	50
T_4	10	30	20

2C. How are deadlocks and chain blocking prevented using Priority Ceiling Protocol?

(4+4+2)

3A. Compute different types of inversions that each task might have to undergo for the task graph shown in Fig. Q 3A and explain each of the inversions. Assume tasks have been sorted in order of priority. Task T_1 has highest priority and task T_5 has least priority.



Fig Q 3A

- 3B. Modern commercial real-time operating systems use gigahertz clocks, while the clock resolution provided is rarely finer than few hundreds of milliseconds. Why?
- 3C. In a distributed system with six clocks, the maximum difference between any two clocks is 10 ms. The individual clocks have a maximum rate of drift of 2 * 10⁶. Ignore clock setup times and communication latencies. (a) What is the rate at which the clocks need to resynchronize using simple central time server method? (b) What is the communication overhead or total number of message exchanges required per hour?

(5+2+3)

4A. Answer the following in the context of a Chemical manufacturing company that wishes to automate its process control application:

(a) What problems might arise if an attempt is made to implement the chemical plant control software using the Ethernet LAN available in the factory?

(b) If Rate Monotonic Algorithm of packets is to be supported, what is the maximum channel utilization that can be achieved?

- 4B. Compare i) focussed addressing and bidding ii) the buddy schemes with respect to communication overhead and scheduling proficiency.
- 4C. Compare the advantages and disadvantages of using i) A ring network ii) A collision based network for real-time communication.

(4+4+2)

- 5A. Can any real-time priority level be assigned to tasks for implementing PCP in Windows NT with computing ceiling values? Justify.
- 5B. Why is dynamically changing the priority levels of tasks important for traditional operating systems? How does this property affect real-time systems?
- 5C. A real time network consists of four nodes, and uses IEEE 802.4 protocol. The real-time requirement is that node N_i should able to transmit up to b_i bits over each period of duration P_i ms, where b_i and P_i are given in the table below.

Node	b_i	P_i
N ₁	1 K	10000
N ₂	4 K	50000
N ₃	16 K	90000
N_4	16 K	90000

Compute a suitable Target Token Rotation Time (TTRT) and obtain suitable values of f_i (total number of bits that can be transmitted by node N_i once every cycle). Assume that the system bandwidth is 1 Mbps.

(3+3+4)