

National Exam May 2002

98-Soft-B1

Real-time Systems

Note:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.
2. Candidates may use one of two calculators, the Casio or Sharp approved model. This is a Closed Book exam.
3. Any five questions constitute a complete exam paper. Only the first five questions as they appear in the answer book will be marked.
4. All questions are of equal weight (20% each).

Question 1

Explain in brief the following terms in the context of real-time systems:

- (1) Latency jitter; (2) Error-detection latency; (3) Hard real-time; (4) Soft real-time; (5) tick; (6) TTP; (7) Laxity; (8) Sporadic task; (9) Thrashing; (10) UART.

Question 2

Answer the following questions in the context of real-time systems:

- (1) What are the major differences in requirements between a multi-user operating system and a multi-tasking operating system?
- (2) What is the principal difference between a pool and a channel? Explain why you would use (a) a pool and (b) a channel?
- (3) What role does a background task typically play in a real-time system?
- (4) What is the difference between 'parallelism' and 'concurrency'?

Question 3

In a real-time system, if it is assumed that a failure process obeys the exponential failure law, and it is known that the MTTF (Mean Time To Failure) is 1000 hours, and MTBF (Mean Time Between Failures) is 1200 hours, calculate: (a) the failure rate; and (b) the system availability.

Question 4

In a pre-emptive priority system, for each task, the time required to complete and the priority (1 being the highest) are given in Table 1:

Table 1: Question 4

Tasks	Time required (ms)	Priority
Task 1	10	2
Task 2	20	1
Task 3	30	4
Task 4	40	3

If the tasks arrive in the order (1, 2, 3, 4) and if we assume that the interrupt latency is 1.0 ms, (a) how much time does it take to complete task 3? (b) How much time would it take if the system uses cooperative scheduling?

Question 5

In a real-time closed-loop control system, the main control algorithms within the computer can be arranged into the following two different execution sequences:

(A)

- 1: send out the control signal to actuator for sample interval (k-1)
- 2: read the measured plant data for the sample interval k
- 3: calculate the controller output for the sample interval k

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Which scheme is a better arrangement as far as the quality of control is concerned? why is this so?

Question 6

A multi-level interrupt timing diagram is shown in Fig. 1. Explain the sequence of events associated with this diagram.

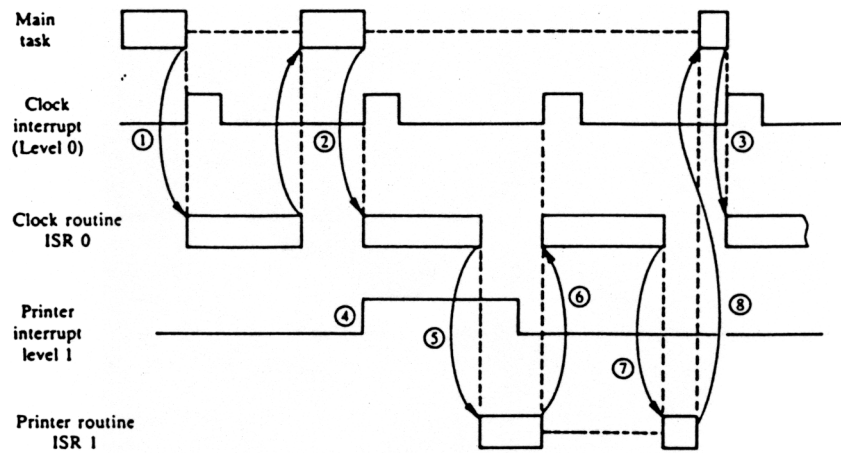


Fig. Timing diagram for Question 6

Question 7

A telephone answering machine has several operational states, including dormant, sending outgoing message, receiving incoming message, saving message on the tape, and playing back previous messages.

- Draw a state transition diagram for this system;
- List all the conditions that cause a transition between states;
- Which input peripherals to a small real-time system would be needed to detect these conditions;
- Choose one of these conditions and specify the actions that the real-time system must take to detect it.