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OLLSCOIL NA hÉIREANN
THE NATIONAL UNIVERSITY OF IRELAND, GALWAY

SEMESTER II EXAMINATIONS 1999/2000

CT 420

Real Time Systems

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Time Allowed: **Three Hours**

Answer question 1 and 4 others

1. How does scheduling in a real-time operating system differ from that of a conventional operating system.

   Six processes (A..F) have to be scheduled. The table shows their arrival times, priority (1. Hard Real-Time, 2. Soft 3. Non-real time), dead-line and expected execution time. What scheduling algorithms would you use to ensure all of these processes are executed within their deadlines.

Process	Arrival Time	Execution Time	Deadline	Priority
A	0	10	15	1
B	0	10	25	2
C	10	5	15	1
D	15	10	40	3
E	20	5	35	1
F	30	10	50	3

2. What is real time?

   Two PCs connected via an unreliable computer network have to be synchronised to accuracy of 100ms. Only one of the machines has access to time service such as GPS. What measures could you take to achieve this synchronisation?

p.t.o.

3. A Dublin stock-broker offers a global share purchasing scheme whereby their clients can invest on specified stock markets throughout the world. Key to this scheme is the latency between a stock being quoted by the exchange and the transaction being made. Describe a possible design for this system. How would you ensure that the bids made by the clients are received by the respective stock markets within a guaranteed time – say within 5 seconds of the quotation.

4. Why is ADA a better language for real-time and embedded systems than C or FORTRAN?

   Look at the following pseudo code – how would this be written in ADA?

   WHILE (*not_end_of_input*)
   INPUT *Pressure, Time, Temperature*
   STORE *Pressure, Time, Temperature*
   IF *Pressure, Temperature* out of bounds **THEN** *raise_alarm*
   ENDWHILE

5. What makes a computer control system reliable?

   You have been asked to design the control system for a nuclear power station. The system is to have at least three independent computer systems. These each have a failure probability of 10^{-4} / year. Ancillary systems, e.g. hardware voting units, have a failure probability of 10^{-8} / year. How would you ensure that the final configuration has a total failure probability that is less than 10^{-10} /year?

6. What elements would make a conventional database have real-time characteristics?

   A control system records independently the pressure, temperature in a reactor vessel within a large chemical works using two processes p_0 and p_1. These data items are stored in a data-base which is then interrogated by the safety system. The absolute validity interval for the pressure/temperate pair is 100ms. The relative validity interval is 25ms. What is the maximum period which p_0 and p_1 that ensures we will always have a valid temperature-pressure pair.

7. A toll-bridge consists of two payment booths and two fast prepayment lanes. In the latter a car has a transponder that enables the control system to identify it. When a car approaches the toll-bridge the presence or absence of a transponder is noted. If the transponder is present and the account is up to date then the car is directed to one of the fast lanes. Otherwise the car is directed towards one of payment booths. Describe the timing constraints within this system and analyse it using a timed Petri net.

8. Contrast a real-time operating system with a conventional one. To what precision can a real-time operating system, such as QNX, be said to be real-time? Why is MSDOS a good example of a real-time operating system?