Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/M.TECH/SE/(CSE/IT/SE)/SEM-1/PGIT-105/PGCSE-102/PGSE-102/2010-11

2010-11

REAL TIME OPERATING SYSTEMS, DISTRIBUTED REAL TIME OPERATING SYSTEMS, ADVANCED OPERATING SYSTEMS

Time Allotted : 3 Hours | Full Marks : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

Answer Question No. *1* from *Section - A* and any *two* questions each from *Sections B* and *C*.

Section - A

1. a) How does Real Time operating system differ from general purpose operating system ? 5

   b) A naive implementation of EDF would be to maintain all tasks that are ready for execution in a queue. Any freshly arriving task would be inserted at the end of the queue. Every node in the queue would contain the absolute dead line of the task. At every pre-emption point, the entire queue would be scanned from the beginning to determine the task having the shortest dead line.

With the given implementation as the starting point, answer the following questions :

i) Analyze the complexity of the above scheme. 3

ii) Propose a modification of the above scheme that will improve the efficiency of the implementation. Analyze the complexity of the modified scheme. 5

iii) Now, if we restrict the possible number of distinct relative dead lines that tasks in applications (supported by our real time system) can have, propose an efficient implementation of EDF algorithm that would reduce the scheduling complexity to 0 (1). 7

Section - B

Answer any *two* questions. 2 × 15 = 30

2. a) What is the usefulness of hyper period in the Periodic Task Model of a Real Time (RT) System ? 2

b) What is a feasible schedule ? What is an optimal scheduler ? 1 + 1

c) Using an example of your own choice, demonstrate that Basic Priority Inheritance Protocol does not prevent deadlocks. 5

d) Define competitive factor' of an on-line scheduling algorithm. Demonstrate using an example of your choice that competitive factor of EDF algorithm is 0. 3 + 3

3. a) How would you implement the NPCS protocol in an RTOS (such as eCos) which does not support it ? 2

b) Name and briefly describe three performance metrics used to measure the performance of schedulers used for scheduling jobs in a Real Time System. 3

c) State the rules of the Basic Priority Ceiling Protocol. 5

d) With reference to the rules stated in your answer to Question 3 (c) above, describe using a suitable example how the Basic Priority Ceiling Protocol succeeds in preventing deadlocks. 5

4. a) Prove that on single processor based systems with independent pre-emptable tasks, fixed priority scheduling algorithms can never be optimal. 4

b) Prove that the execution of every job in a set of independent, pre-emptable jobs with fixed release times is predictable when scheduled in a priority-driven manner on one processor. 6

c) Using an example of your choice, demonstrate that EDF is less deterministic than RMS during system overload. 5

Section - C

Answer any *two* questions. 2 × 10 = 20

5. a) Consider three pre-emptive periodic tasks (to be scheduled on a single processor based system) :

T1 : (4, 1), T2 : (5, 2) and T3 : (9, 4) that have no feasible schedule. By how much must the execution time of T1 be reduced, in order for the tasks to be schedulable using the LST algorithm ? 4

b) Consider the following five fixed priority tasks (lower the task index, higher the task priority) :

T1 = (10, 2), T 2 = (14, 2), T3 = (15, 3), T4 = (50, 1) and T5 = (24, 3).

Suppose that the scheduler makes a scheduling decision every 1 unit of time, that is, the tick size is 1.0. Each time, it takes 0.1 unit of time regardless of whether there are jobs waiting to be scheduled and 0.2 additional unit of time to schedule each waiting job. Write the time-demand function w3 (t) of T3. Is T3 schedulable ? 6

6. You are designing a local area network for an automobile. The network is a shared medium that connects all sensors, actuators and controllers in the vehicle. The network supports upto 45 kbps (Kilobits per second).

A crank position sensor sends 2 bytes to the engine controller 16 times per engine revolution. The engine controller also gets 4 bytes of input from an airflow meter 100 times per second and 4 bytes from an oxygen sensor 10 times per second. Using these inputs, the engine controller sends 2 bytes 4 times per revolution to an ignition controller.

An anti-lock braking system (ABS) shares the same network. The ABS gets 2 bytes of input 100 times per second from a wheel position sensor. When the ABS controller detects lockup, it sends 3 bytes every 100 ms to modulate the brakes.

a) Identify the tasks that are using the network and indicate whether they are periodic, sporadic, or a mperiodic and why. 2

b) For sporadic tasks, find the period, execution time and relative deadline. 4

c) For sporadic tasks give the execution time, relative deadline and estimate the minimum job inter-release time. 2

d) What is the system utilization ?

[When determining execution time, assume no overhead to send a message on the network (Except the limit set by the speed of the network). Also assume the engine speed is limited to 2500 RPM]. 2

7. a) Suppose we have a stream of sporadic jobs whose inter-release times are uniformly distributed from 9 to 11. Their execution times are uniformly distributed from 1 to 3.

i) What are the parameters of the periodic task if we were to use such a task to model the stream ? 1

ii) Compare the utilization of the periodic task in (i) with the average utilization of the sporadic job stream. 2

b) A system contains the following 4 periodic tasks (R_x and R_y are resources used) :

T1 (0, 5, 1 [R_x ; 0.5]) (requests R_x after running for 0.2 time units)

T2 (0, 6, 3 [R_x ; 1]) (requests R_x after running for 1 time units)

T3 (2, 3, 1 [R_y ; 0.5]) (requests R_y after running 0.1 time units)

T4 (1, 5, 0.5)

The tasks are scheduled by the LST algorithm and the priority inheritance protocol. Show the schedule produced during the first 15 time units. 7