

## CS 424. Homework #3.

Please work on the homework independently. It is due Tuesday Oct 31st, in class. **Please return the answer sheet only (i.e., the last page).**

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**Q1: Please find the best answer to each of the following questions.**

1. An aperiodic task server is used to schedule aperiodic tasks in a real-time system with rate monotonic scheduling. The server has a period of 1 second, and a budget of 100ms. Which of the following server types would you *eliminate* first if your primary objective is to maximize the schedulability (i.e., utilization bound) of periodic tasks? **(1 point)**

- a) Polling server
- b) Deferrable server
- c) Priority exchange server
- d) Slack stealing server

2. (Needs some thinking) You are scheduling a large number of independent periodic tasks on a uniprocessor using *non-preemptive* earliest-deadline-first (EDF) scheduling. What would be the utilization bound? (If you answer (d), please fill in the blank.) **(1 point)**

- a) 0%
- b) 69%
- c) 100%
- d) Other (please indicate value in the answer sheet)

3. Which of the following scheduling policies has the highest utilization bound in the context of (preemptive) scheduling of independent periodic tasks on a single processor (core)? **(1 point)**

- a) Rate Monotonic
- b) EDF
- c) Shortest Job First
- d) FIFO

4. Which of the following policies ensures deadlock-free scheduling? **(1 point)**

- a) Priority-ceiling
- b) Priority-inheritance
- c) FIFO
- d) None of the above

5. Three periodic tasks T1, T2 and T3, have periods  $P_1=50$ ,  $P_2=20$ , and  $P_3=10$  seconds, and computation times  $C_1=10$ ,  $C_2=1$ , and  $C_3=5$  seconds. They are scheduled using rate monotonic scheduling. The computation time,  $C_1$ , includes a critical section of size  $B_1=5$  second. Similarly, the computation time,  $C_3$ , includes a critical section of size  $B_3=1$  seconds. (Both are for the same resource.) The priority ceiling protocol is used. What is the processor utilization of this task set? (Note: The question asks about *utilization*, not *utilization bound*.) (1 point)

- a) 75%
- b) 77%
- c) 85%
- d) 95%

6. In the task set in Problem 5, what is the maximum amount of priority inversion (i.e., blocking experienced by a higher priority task due to lower priority tasks) that a task can experience? (1 point)

- a) None
- b) 1 second
- c) 5 seconds
- d) 6 seconds

7. Using the exact schedulability test, determine the exact worst case response time of task  $T_2$  in each of the following three task sets, *if task  $T_2$  is schedulable*. On the other hand, if the task is not schedulable, just say “unschedulable”. In each task set,  $C_i$ ,  $P_i$ , and  $D_i$  denote the processing time, period, and relative deadline of task  $i$  respectively. Assume that *deadline-monotonic* scheduling is used. (4 points)

a)

Task 1:  $C_1 = 2$ ,  $P_1 = 8$ ,  $D_1 = 6$

Task 2:  $C_2 = 6.1$ ,  $P_2 = 13$ ,  $D_2 = 10.5$

b)

Task 1:  $C_1 = 3.4$ ,  $P_1 = 10$ ,  $D_1 = 7$

Task 2:  $C_2 = 8$ ,  $P_2 = 12$ ,  $D_2 = 70$

c)

Task 1:  $C_1 = 5$ ,  $P_1 = 12$ ,  $D_1 = 11$

Task 2:  $C_2 = 6$ ,  $P_2 = 15$ ,  $D_2 = 8$

d)

Task 1:  $C_1 = 1$ ,  $P_1 = 2$ ,  $D_1 = 2$

Task 2:  $C_2 = 15$ ,  $P_2 = 50$ ,  $D_2 = 32$

**Please copy your answers to the answer sheet on the next page and return the answer sheet only.**

Name \_\_\_\_\_

NetID \_\_\_\_\_

Answers:

Please write (a), (b), (c), or (d):

1)

2)

3)

4)

5)

6)

Please write the response time, or say "unschedulable"

7)

8)

9)

10)