

## CS 424. Homework #3.

Please work on the homework independently. It is due Thursday Oct 17th, 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. You are scheduling a very large number of independent periodic tasks on a uniprocessor using *preemptive rate monotonic* scheduling. What would be the utilization bound? (If you answer (d), please fill in the blank.) **(1 point)**

- a) 0
- b)  $\ln 2$
- c) 1
- d) Other (please indicate value in the answer sheet)

2. How would the answer above change if the rate monotonic scheduler was non-preemptive? **(1 point)**

- a) 0
- b)  $\ln 2$
- c) 1
- d) Other (please indicate value in the answer sheet)

3. Which of the following scheduling policies is the optimal fixed priority scheduling policy for tasks with relative deadlines that are *smaller than or equal to* periods? **(1 point)**

- a) Rate Monotonic
- b) Deadline Monotonic
- c) EDF
- d) FIFO

4. Which of the following combinations of scheduling policy and locking protocol offers the best schedulability for independent periodic tasks? **(1 point)**

- a) Deadline monotonic scheduling with priority-ceiling protocol
- b) Deadline monotonic scheduling with priority-inheritance protocol
- c) Deadline monotonic scheduling with regular lock/unlock operations (i.e., neither of the above protocols)
- d) FIFO scheduling with regular lock/unlock operations

5. Three periodic tasks T1, T2 and T3, have periods  $P_1=100$ ,  $P_2=40$ , and  $P_3=16$  seconds, and computation times  $C_1=13$ ,  $C_2=3$ , and  $C_3=2$  seconds. They are scheduled using rate monotonic scheduling. The computation time,  $C_1$ , includes a critical section of size  $B_1=10$  seconds. Similarly, the computation time,  $C_2$ , includes one critical section of size  $B_2=2$  seconds. (Both are for the same resource.) The priority ceiling protocol is used. What is the processor utilization for this task set? (Note: The question asks about *utilization*, not *utilization bound*.) (1 point)

- a) 33%
- b) 38%
- c) 43%
- d) 48%

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) 2 seconds
- c) 10 seconds
- d) 12 seconds

7. Using the exact schedulability test, determine the exact worst case response time of task  $T_1$  in the above example.

- a) 13 seconds
- b) 18 seconds
- c) 20 seconds
- d) 22 seconds

**Q2:** For each of the following three task sets, use the exact schedulability test to determine the worst-case response time of task  $T_2$  if it is schedulable. Otherwise, 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. If relative deadline is not mentioned, assume that it is equal to period. Assume that *deadline-monotonic* scheduling is used. (3 points)

**a)**

Task 1:

$$C_1 = 5, P_1 = 8, D_1 = 7$$

Task 2:

$$C_2 = 2.2, P_2 = 11, D_2 = 9.3$$

**b)**

Task 1:

$$C_1 = 4.2, P_1 = 10, D_1 = 9$$

Task 2:

$$C_2 = 2, P_2 = 12, D_2 = 6$$

**c)**

Task 1:

$$C_1 = 4.5, P_1 = 7$$

Task 2:

$$C_2 = 5.4, P_2 = 13$$

**Please copy your answers to the answer sheet below and return the answer sheet only.**

**Name** \_\_\_\_\_

**NetID** \_\_\_\_\_

**Answers:**

**Q1. Please write (a), (b), (c), or (d):**

**1)**

**2)**

**3)**

**4)**

**5)**

**6)**

**7)**

**Q2: Please write the response time, or say “unschedulable”**

**a)**

**b)**

**c)**

**Thank you.**