

Real-Time and Embedded Systems

Written Test #1, April 2022

All the tasks in the following questions are priority-based, periodic, and preemptive ones.

Tasks are numbered by their priorities, e.g., T1 has a higher priority than T2.

- [14 pts] Test the schedulability of the following task sets for RM (Rate-Monotonic) scheduling using the Liu-and-Layland utilization bound:
 - $\{(2,10),(2,12),(3,15)\}$
 - $\{(2,10),(4,12),(5,15)\}$
- [14 pts] Continued from Question 1, test the schedulability of the two task sets using response-time analysis.
- [14 pts] Continued from Question 1, let the scheduling algorithm be EDF. Test the schedulability of the two task sets.
- [12 pts] What is the critical instance of a periodic task for RM? What is that for EDF? Why is the critical instance useful in building a schedulability test for real-time scheduling algorithms?
- [4 pts] Consider that periodic tasks are scheduled using RM. Show a set of 10 tasks that fails the utilization bound test but are actually schedulable by RM.
- [4 pts] Prove or disprove using a counter-example: EDF always produces more task preemptions than RM.
- [12 pts] Consider the task set in Fig. 1. Calculate the longest blocking time of tasks T1, T2, T3, and T4 under NPCS, CPP, and PCP.
- [9 pts] Consider the following task set $\{(1,2,6),(1,1,8),(0,2,20)\}$ scheduled by RM. A task is denoted by (b,c,p) , in which b is the longest blocking time, c is the execution time, and p is the period. Test the schedulability of the task set using the utilization bound test.
- [9 pts] Based on Question 8, let the scheduler be EDF. Test the schedulability of the tasks.
- [8 pts] Consider three tasks T1, T2, and T3 that share some resources. Let the tasks be scheduled by RM. Show an example (by drawing the scheduler) that the three tasks are deadlocked without any resource synchronization management. Also show how PCP avoids this problem. Notice that 1) all the three tasks must be involved in the circular waiting condition of a deadlock and 2) the resource ceilings and system ceiling must be shown.

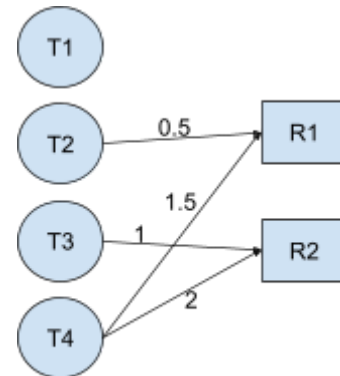


Fig. 1

Test: 10:10 am~12 NN

Upload file of your answer sheet (PDF/JPG/JPEG) before 12:20pm

This is an open-book test, but discussion is not allowed.