EE 4710 Exam 3. Name______________________________

5 pages. Open Book. Open Notes. Closed Internet. Cheating will result in a score of 0.

Part 1. Short Answer.

1. (2 pts) (true/false) If a task attempts to write to a full mailbox, the task is blocked until the mailbox is empty.
2. (2 pts) Which of the following strategies can real-time tasks use to cooperate? (circle all that apply)
   (a) They can run independently but use (locked) shared memory to communicate
   (b) They can signal each other by setting flags
   (c) They can signal each other using semaphores
   (d) They can communicate through mailboxes
   (e) They can communicate through message queues
   (f) They can communicate through a psychic medium.
3. (2 pts) (true/false) It is possible to control access to shared memory on a multi-processor system by disabling interrupts.
4. (2 pts) (true/false) It is a mistake to dynamically allocate memory before real-time processing begins.
5. (2 pts) A device that reduces average memory access time but should be avoided in real-time systems because of its unpredictability is called a(n) ___________________
6. (2 pts) What is the difference between a valid schedule and a feasible schedule?
   ____
   ____
7. (2 pts) When using the _____________________ protocol, resources are assigned a fixed priority, tasks run at the highest priority of all the resources they hold, and there is no $\hat{\Pi}(t)$.
8. (2 pts) (true/false) The nonpreemptive critical section protocol (NPCS) risks uncontrolled priority inversion.
9. (2 pts) What is the difference between a binary semaphore and a counting semaphore?
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Part 2. Problems.

10. (6 pts) Determine if the tasks $T_1 = (5,2)$, $T_2 = (11,4)$ and $T_3 = (16,2,10)$ are schedulable using the deadline monotonic (DM) algorithm. Justify your answer.

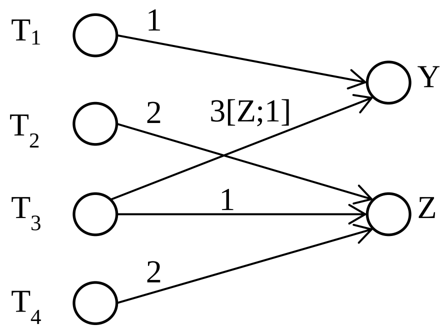
11. Assume a system has 3 tasks, $T_1 = (2,1)$, $T_2 = (4,1.2,3.5)$ and $T_3 = (8,0.3,3)$ (i.e. $D_2 = 3.5$ and $D_3 = 3$).
    (a) (6 pts) Use a Gantt chart to show the EDF schedule for one hyperperiod. Show start and completion times for each job.

    (b) (6 pts) Instead, suppose a clock-driven technique is to be used to schedule these tasks. Find the candidate frame size(s).

    (c) (6 pts) Choose a frame size (if there are two or more) from part (b) then use it to schedule the tasks for one hyperperiod. (Be sure your schedule is feasible.)

12. (6 pts) A system has tasks $T_1 = (4,1)$, $T_2 = (5,2)$, $T_3 = (9,4)$,$T_4 = (12,2)$, $T_5 = (18,5)$ and $T_6 = (36,6)$. Assign the 6 tasks to processors P_1 and P_2.so that the RM schedules on both processors are feasible. (Hint: it is possible, but you will have to group simple periodic tasks.)

13. A system of 4 tasks has the resource requirement graph shown below.



(a) (6 pts) Show the direct blocking and inheritance blocking tables.

(b) (6 pts) Find the blocking time due to resource conflicts, $b_i(rc)$, for all tasks.

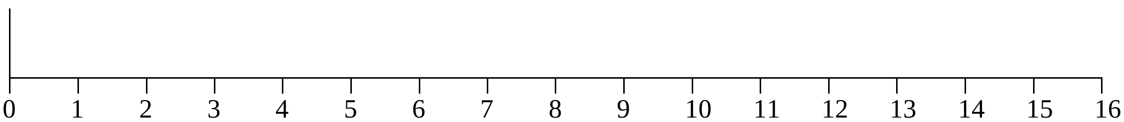
14 In a system with 2 tasks, the higher priority task $T_1 = (30,12)$ releases the lower priority task $T_2 = (120,35)$. T_1 experiences release time jitter of 1ms and self-suspends twice, once for 3-7ms before releasing T_1 and a second time for 4-6ms afterward.
(a) (4 pts) What is the (effective) release-time jitter of T_2?

(b) (6 pts) Find the blocking time due to self-suspension (and release-time jitter), $b_i(ss)$ for both tasks.

15. Suppose $T_1 = (8,3)$, $T_2 = (15,4)$ and $T_3 = (25,5)$ and that tasks take and release resources symmetrically as shown below (each cell represents 1 ms):

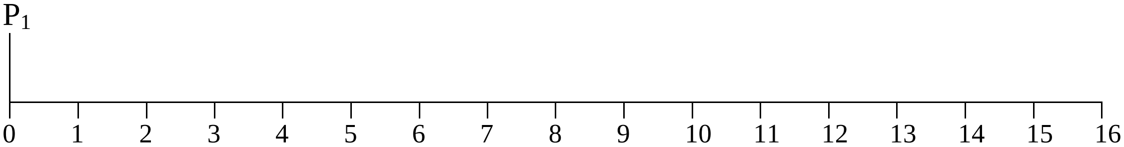
T_1		A		T_2		B	B		T_3		B	AB	B		

(a) (6 pts) Suppose r_1=1.5, $r_2 = 0$, $r_3 = 3$ and that resource access control is accomplished with server tasks. Use a Gantt chart to show the ceiling priority protocol schedule. (Schedule until all tasks complete once.)

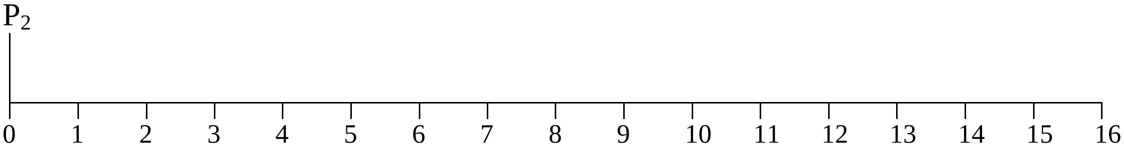


(b) (6 pts) Suppose T_1, T_2 and T_A are assigned to P_1 while T_3 and T_B are assigned to P_2. Assuming the same release times in part (a), use a Gantt chart to show the *multi-processor* ceiling priority protocol schedule. (Schedule until all tasks complete once.)

P_1



P_2



16. A system has 3 tasks, $T_1 = (7,2.5)$, $T_2 = (13,4)$ and $T_3 = (22,1.5)$. T_1 self-suspends twice and uses resource A. T_3 also uses resource A but does not self-suspend. T_2 self-suspends once.

(a) (6 pts) Assuming the context switch overhead is 0.05ms and one of the priority ceiling protocols is used, find the effective execution times of these tasks.

(b) (6 pts) Assume the blocking times are given in the table below. Find the time demand functions $w_i(t)$ for all three tasks.

Task	$b_i(ss)$	$b_i(rc)$	$b_i(np)$
1	1.4ms	0.5ms	0.4ms
2	2.0ms	0.5ms	0.2ms
3	2.2ms	0.0ms	0.0ms

(c) (6 pts) Plot $w_i(t)$ and use time demand analysis to determine whether or not these tasks are schedulable.