Mechatronics/Software Engineering 4AA4 Test 2

Wednesday, October 25, 2016 Duration: 50 Minutes
McMaster University (CAS) Instructor: Dr. Wenbo He

Student Name: ID:

This test paper includes 10 pages. You are responsible for ensuring that your copy of the test is complete. Bring any discrepancy to the attention of your invigilator.

Special Instructions:
1. Put all answers on the test paper.
2. Try to keep your answers brief. Use point form if need be.
3. Other than one page containing handwritten notes, no memory aids or text books of any kind are allowed during the test.
4. Electronic calculator may be utilized.
5. The mark weighting for each question is given within the square brackets.
6. The burden of communication is upon you. Solutions not properly explained will not be considered correct. If we cannot decode "what you wrote, we cannot grade it as a correct answer.
7. For any re-read (re-mark) to occur, answers must be in pen.

Grading

Section	Grade	
Question #1 – True or False	10 points	_____
Question #2 – Multiple Choice	8 points	_____
Question #3 – Short Answer Questions	12 points	_____
Question for Extra Credit	1 point	_____
Total:	30points	_____

Student Name: ID:

Question 1: Answer the following questions (10 points):

1) Under the Priority Ceiling Protocol (PCP), a task entering a critical section immediately boosts its priority to the priority ceiling value of the resource used in that critical section. (F)

2) Priority Ceiling Protocol (PCP) guarantees deadlock-free operation. (T)

3) Both Non-preemptive Critical Section (NPCS) protocol and Priority Inheritance Protocol (PIP) cannot avoid deadlocks. (F)

4) Priority Inversion is a phenomenon that can occur when preemptive tasks share non-preemptible resources. (T)

5) The given set of periodic task: T1(9,6,9), T2(15, 5, 15), T3(6,1,6) is scheduable with EDF. (F)

6) Priority Ceiling Protocol can be applied to prevent the deadlock whenever RM, DM or EDF scheduling approaches are used. (F)

7) Sufficient RM schedulability condition is based on processor utilization. It can be efficiently calculated at run-time upon task arrival, but will lead to poor processor utilization. (T)

8) Because of the priority inheritance in priority ceiling protocol (PCP), the task holding the non-preemptive resource(s) always has the highest priority in the system. (F)

9) The benefit of the priority inheritance protocol (PIP) over the Non-preemptive Critical Section (NPCS) protocol is that if there is resource conflict in the system, PIP is more efficient than NPCS. (F)

10) DM and EDF are both based on deadlines. For a given set of periodic pre-emptive tasks, they are the same if the relative deadlines of tasks are fixed. (F)

Question 2: Multiple Choice Questions (8 points):

1) Given the task set: T1(4, 1); T2(5, 1); T3(10, 2), and you are asked to find a Cyclic Executive (CE) schedule using flow graph as shown in Figure 1. Assume that the frame size is 2. Which of the following is true?

a) There are 11 job nodes and 10 frame nodes in the flow graph.

b) There are 14 job nodes and 11 frame nodes in the flow graph.

c) Using the network flow to model the task scheduling cannot handle the task split in CE.

d) The algorithms finding the solution to network flow problem is NP-complete.

2) The _____ scheduling algorithm schedules periodic tasks using a static priority policy with preemption.

a) earliest deadline first

b) rate monotonic

c) first cum first served

d) priority

3) What does the term priority inversion refer to?

a) A situation where a process has been assigned the wrong priority.

b) A data structure where the priority queue is stored backwards.

c) A situation where a low priority process must wait for a high priority process.

d) A situation where a high priority process must wait for a low priority process.

4) How can a priority inversion be corrected?

a) Temporarily lowering the priority of a high priority process.

b) Temporarily raising the priority of a low priority process.

c) Not allowing a low priority process to perform system calls.

d) Not allowing a high priority process to perform system calls.

5) If a set of processes cannot be successfully scheduled by rate monotonic scheduling algorithm, then:

a) they can be scheduled by EDF algorithm

b) they cannot be scheduled by EDF algorithm

c) they cannot be scheduled by any other algorithm

d) None of the above

6) Consider the task set T = {(8, 4), (10, 2), (12, 3)}, which of the following is true:

a) T is both RM and EDF schedulable.

b) T is not RM scheduable but EDF schedulable.

c) T is neither RM nor EDF scheduable.

d) T is not EDF scheduable but RM scheduable.

i=1, e1<p1 (OK)
i=2, try t=8,10
t=8: e1+e2=6<8
t=10: 2e1+e2=10 (OK)
i=3, try t=8,10,12
t=8: e1+e2+e3=9>8
t=10:2e1+e2+e3=13>10
t=12:2e1+2e2+e3=15>12
So it is not RM scheduable.

7) Which of the following protocol is able to handle the deadlock and priority inversion?
a) Priority Inheritance
b) Non-preemptive Critical Section
c) Priority Ceiling
d) Mutex

8) A Task set consists of n pre-emptive and periodic tasks. If the task is NOT RM schedulable which of the following is correct?
a) The CPU utilization is over 1.
b) The CPU utilization is over 0.693
c) The task set is DM scheduable
d) The task set is EDF scheduable

Question 3: Short Answer Questions:

1. EDF is an optimal uniprocessor scheduling algorithm, why we still prefer RM instead of EDF in many situations? [2points]

   Answer: RM is more predictable. By RM, we can tell which task will miss deadline. However, by EDF we do not know beforehand which task will miss the deadline.

2. You are required to schedule the following set of independent, preemptable periodic tasks using Rate Monotonic(RM) scheduling algorithm: T1(50; 12); T2(40; 10); T3(30; 10). Use a suitable necessary and sufficient schedulability test to determine if all or part of the tasks can be scheduled. Show your work. [5 points]

   Answer:
   When i=1, t=30: since e3<p3 → OK
   When i=2, t=30, 40:
   w(30)=e3+e2=20<30 → OK;
   w(40)=2e3+e2=30<40 → OK
   When i=3, t=30, 40 and 50:
   w(30) = e1 + e2 + e3 = 32 > 30
   w(40) = 2e3 + e2 + e1 = 42 > 40
   w(50) = 2e3 +2e2 +e1 = 52 > 50

   So task T3 and T2 will be successfully scheduled using RM.

3. A system contains the following four periodic tasks. The tasks are to be scheduled using RM algorithm.
   T_1 = (10; 24; 4; 24; [A; 1])
   T_2 = (7; 25; 4; 25; [A; 1][B; 1])
   T_3 = (4; 26; 4; 26; [B; 1][A; 1])
   T_4 = (0; 27; 11; 27; [A; 5[B; 2[C; 1]]])

Given that:

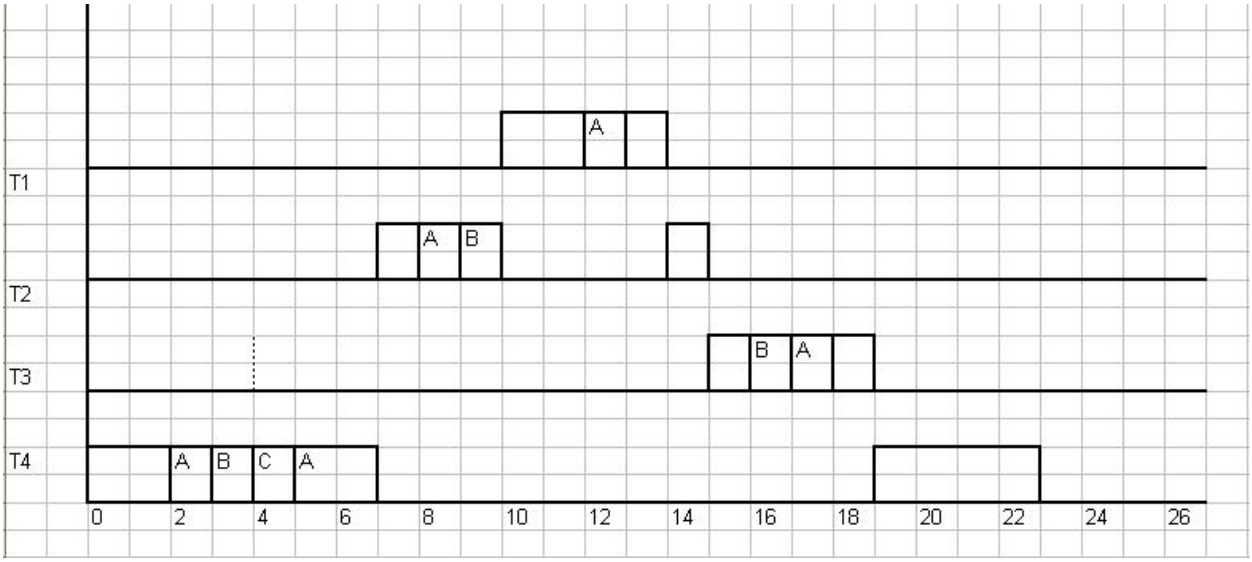
T_1 executes for 2 units of time then requests resource A

T_2 executes for 1 unit of time then requests resource A followed by resource B

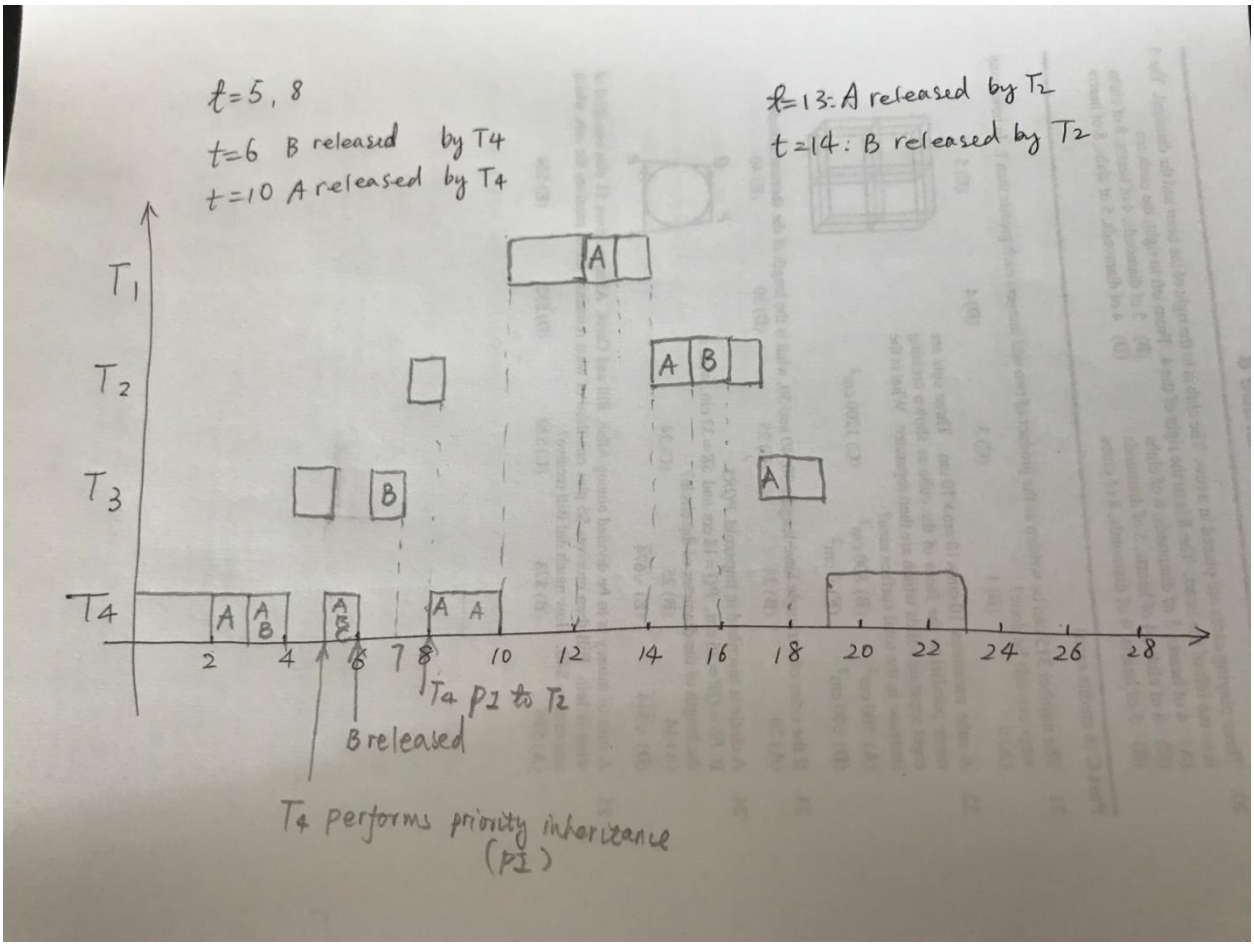
T_3 executes for 1 units of time then requests resource B followed by resource A

T_4 executes for 2 units of time then requests resource A, holds it for 1 unit of time then requests resource B, followed by resource C after using resource B for 1 time unit and finally finishes with resource A such that A is held for a total of 5 units of time starting from the time it was first locked by this task.

(1) Graphically show the schedule for 26 units of time using the NPCS protocol for resource access control. [2 points]



(2) Graphically show the schedule for 26 units of time using the Priority Inheritance protocol for resource access control. [2 points]



(3) What is the advantage of PIP over NPCS? [1 point]

Answer: Even where there is no resource contention (or conflict), a higher priority task will be blocked by a lower priority task NPCS. But if no resource contention, a lower priority task cannot block higher priority tasks.

Extra-credit Question:

4. Consider n periodic tasks Ti:(p_i, e_i) for $1 \leq i \leq n$, where $p_i = 2^i$, and $e_i = 1$. Give the value of largest n, so that the task set is (Rate Monotonic) RM schedulable? Give the Show your work. [1 point]

   n → infinity, the task set is RM schedulable. Since the sum of 2^(-i) (i from 1 to infinity) approaches to 1. The total utilization is 1 when i goes to infinity.