CIS 721 - Real-Time Systems **Name: _____**
Quiz #1
Spring 2014

Friday, Feb. 28, 2014

Please show all work on the quiz.

1. (30 points) Consider the following set of tasks scheduled using **preemptive** priority-based scheduling.

Task	Run Time (e_i)	Period (p_i)	Deadline (D_i)
A	8	24	24
B	3	12	12
C	2	8	8

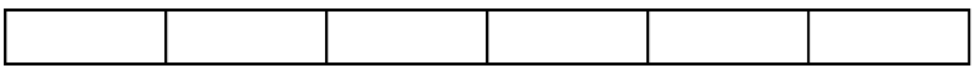
a) Suppose that the **rate monotonic (RM)** algorithm is used to assign priorities. In what order would these tasks be prioritized from highest to lowest priority? (Fill in the blanks with A, B, C)

Highest priority: _____, middle priority: _____, lowest priority: _____

b) What is the total utilization, U, of all tasks? _____. Can Liu and Layland's Test be used to try to check if the task set is schedulable? _____. If the test can be used, what conclusions, if any, can be made after applying Liu and Layland's Test? If the test cannot be applied, explain why not. Hint: 3*(2^1/3 – 1) = 0.779763.

c) Use Response Time Analysis to determine if the task set is feasible. Show work.

d) Draw the Gannt Chart (using the template shown below) showing how the tasks would be scheduled over one hyperperiod.



2. (30 points) Consider the following set of tasks scheduled using **non-preemptive** priority-based scheduling. Assume that the **deadline monotonic (DM)** algorithm is used to assign priorities.

Task	**Run Time (e_i)**	**Period (p_i)**	**Deadline (D_i)**
A	2	5	5
B	2	10	10
C	3	20	9

a) In what order would these tasks be prioritized from highest to lowest priority?

Highest priority: _____, middle priority: _____, lowest priority: _____

b) What is the worst-case blocking time for each task?

B_A = _____, B_B = _____, B_C = _____

c) What conclusions (if any) can be made by applying a Utilization-Based Test to the given task set? Show work.

d) Is the task set schedulable based on Response Time (Time-Based) Analysis? Show work.

3. (20 points) Preemption Thresholds: Suppose that the task sets shown above in **Problems 1 and 2** are scheduled using **priority-based scheduling with preemption thresholds**.

   a) What does it mean for a task set to be simply periodic?

   Is the task set shown in **Problem 1 simply periodic**? _____
   Is the task set shown in **Problem 2 simply periodic**? _____

   b) Is there a particular assignment of **priorities and preemption thresholds** that makes the task set shown in **Problem 1** schedulable using **priority-based scheduling**? _____ If so, give an assignment using 3=high priority and 1=low priority:

   - π_A = _____, γ_A = _____
   - π_B = _____, γ_B = _____
   - π_C = _____, γ_C = _____

   c) Is there a particular assignment of **priorities and preemption thresholds** that makes the task set shown in **Problem 2** schedulable using **priority-based scheduling**? _____ If so, give an assignment using 3=high priority and 1=low priority:

   - π_A = _____, γ_A = _____
   - π_B = _____, γ_B = _____
   - π_C = _____, γ_C = _____

   d) Briefly describe an optimal algorithm to assign preemption thresholds for a given task set if the priorities are given.

4. (20 points) Consider the task set consisting of the following three preemptive, periodic tasks (denoted using the notation $\tau_i = (p_i, e_i, D_i)$):

   $\tau_1 = (12, 2, 6)$
   $\tau_2 = (12, 4, 12)$
   $\tau_3 = (24, 5, 12)$

   The system is to be scheduled and executed using a fixed cyclic schedule.

a) Determine an appropriate frame size, and draw a network flow graph that can be used to find a fixed (static) cyclic schedule of the tasks. Hint: Remember to indicate the **maximum** allowable flows on all edges in the graph. Clearly indicate which nodes represent jobs and which nodes represent frames.

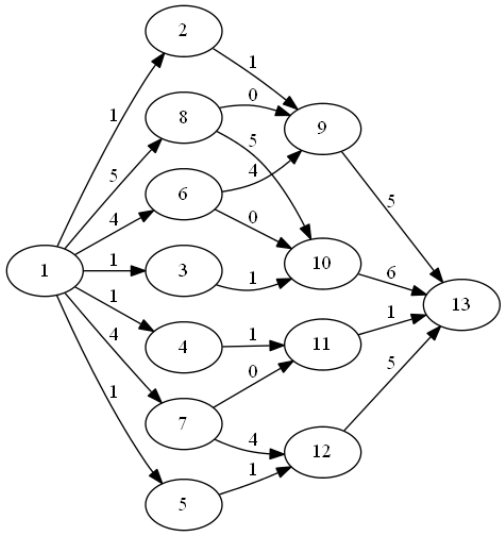
Frame Size = _____

$\tau_1 = (12, 2, 6)$
$\tau_2 = (12, 4, 12)$
$\tau_3 = (24, 5, 12)$

b) Suppose that the task set is modified so that $\tau_1 = (6, 1, 6)$. Further, suppose that a solution is obtained by using the following input file describing allowable flows in a directed graph, and by passing it as input to the maximum flow algorithm to compute a maximum flow of 17, with the corresponding flow values as shown in the graph:

```
p max 13 21
n 1 s
n 13 t
a 1  2   1
a 1  3   1
a 1  4   1
a 1  5   1
a 1  6   4
a 1  7   4
a 1  8   5
a 2  9   6
a 3  10  6
a 4  11  6
a 5  12  6
a 6  9   6
a 6  10  6
a 7  11  6
a 7  12  6
a 8  9   6
a 8  10  6
a 9  13  6
a 10 13  6
a 11 13  6
a 12 13  6
```

hi_pr + convert + dot



Draw a Gannt Chart showing the corresponding schedule that is represented by these flows.

c) Could the same solution be used for part b) if the jobs are non-preemptive? Explain briefly.