**COSC6384 Real-Time Systems**  
**Assignment 1 (Spring 2014)**

**Question 1.**  
Explain the difference between preemptive and non-preemptive scheduling.

**Question 2.**  
Consider a set of jobs \( J(r, d) \) with the release time and the deadline. The precedence constraints are shown as in the graph below. Derive the formula of calculating the *effective* release time and deadline. Calculate the *effective* release time and deadline for each job in the set.

![Graph of precedence constraints](image)

**Question 3.**  
(a) Give two different explanations of why the periodic tasks \( (\text{Period}, \text{Computation time}), \) \((2, 1), (4, 1)\) and \((8, 2)\) are schedulable by the rate-monotonic algorithm.  
(b) Give two different explanations of why the periodic tasks \( (\text{Period}, \text{Computation time}), \) \((3, 1), (5, 1)\) and \((11, 2)\) are schedulable by the rate-monotonic algorithm.  
(c) Suppose that we add one more task into the task set in (b) where the new task’s utilization is 0.1. Is the new task set schedulable by the rate-monotonic algorithm? Be sure to explain your answer with *EXAMPLES.*
**Question 4.**
A system consists of three periodic tasks: (10, 2), (15, 5) and (25, 9).
Construct the RM, EDF and LLF schedule of this system in the interval (0, 50).

**Question 5.**
A job may be blocked for many reasons. The term *blocking time*, denoted by $b_i$, refers to the maximum total duration for which each job in task $T_i$ may be delayed by both lower-priority tasks and deferred execution of higher-priority tasks. Extend the schedulability conditions 2 & 3 to consider tasks that can be blocked.

**Question 6.**
(a) Use the time-demand analysis method to show that the set of periodic tasks (5, 1), (8, 2) and (14, 4) is schedulable according to the rate-monotonic algorithm.

(b) Suppose that we want to make the first $x$ units of each request in the task (8, 2) non-preemptive. What is the maximum value of $x$ so the system remains schedulable according to RM algorithm?

**Question 7.**
We call the density of a task $T$, $C/min(D, P)$, where $C$ is the computation time, $D$ is the relative deadline, and $P$ is the period.
Prove: A system of independent, preemptable tasks can be feasibly scheduled on one processor if its density is equal to or less than 1.

**Question 8.**
Consider a set of $n$ independent tasks. All tasks arrive at $t = 0$. Each task $T_i$ is characterized by its computation time $C_i$ and deadline $D_i$.
Prove that EDF is optimal for both preemptive AND non-preemptive cases.
**Question 9.**
Consider a two-task system where each preemption has an overload of \( x \). Given \( C1, C2, P1, P2 \) (\( P2 > P1 \)), obtain the minimum value of \( P1 \) for which the task set is RM-schedulable.

**Question 10.**
Determine whether there is a feasible schedule for the following set of periodic processes. If yes, show the schedule and the steps used to derive it.

- **T1**: \( c11 = 1, c12 = 2, d1 = 6, p1 = 6 \);
- **T2**: \( c21 = 2, c22 = 1, c23 = 4, d2 = 17, p2 = 18 \);
- **T3**: \( c3 = 1, d3 = p3 = 18 \).

T1 must rendezvous with T2 after the first, second, and third scheduling blocks (of T2). T2 must rendezvous with T1 after the first scheduling block (of T1).