Real Time and Embedded Systems/Problem Set #2

Due at 5:00PM on Wednesday, 18 February 2004.

1. Which of the following systems of periodic tasks are schedulable by the rate-monotonic algorithm? By the earliest-deadline-first algorithm? Explain your answers.
   a. **T** = { (, 8, 3), (, 9, 3), (, 15, 3) }
   b. **T** = { (, 8, 4), (, 12, 4), (, 20, 4) }
   c. **T** = { (, 8, 4), (, 10, 2), (, 12, 3) }

2. A system consists of three periodic tasks: (, 3, 1), (, 5, 2), and (, 8, 3)
   a. What is the total utilization?
   b. Construct a rate-monotonic schedule for this system in the interval [0, 32]. Label any missed deadlines.
   c. Construct an earliest-deadline-first schedule of this system in the interval [0, 32]. Label any missed deadlines.
   d. Suppose we want to reduce the execution time of the task with period 3 in order to make the task system schedulable according to the earliest-deadline-first algorithm. What is the minimum amount of reduction necessary for the system to be schedulable by the earliest-deadline-first algorithm?

3. Consider a system that contains two periodic tasks T_1 = (, 7, 2) and T_2 = (, 10, 3). There is a bandwidth-preserving server whose period is 6. Suppose that the periodic tasks and the server are scheduled rate-monotonically.
   a. Suppose that the server is a deferrable server.
      i. What is the maximum server size?
      ii. Consider two aperiodic jobs A_1 and A_2. The execution times of the jobs are equal to 1.0 and 2.0, respectively, and their arrival times are 2 and 5, respectively. What are their response times?
   b. Suppose that the server is a simple sporadic or SpSL sporadic server.
      i. What is the maximum server size?
      ii. Find the response times of jobs A_1 and A_2 in (a/ii) above if the server is a SpSL server.

4. A system contains five jobs. There are three resources X, Y, and Z. The resource requirements of the jobs are listed below.

   J_1: [X; 2]
   J_2: none
   J_3: [Y; 1]
   J_4: [X; 3 [Z; 1]]
   J_5: [Y; 4 [Z; 2]]

   The priority of J_i is higher than the priority of J_k for i < k. What are the maximum blocking times of the jobs under the nonpreemptable critical-section protocol and under the priority-ceiling protocol?