PH.D. QUALIFYING EXAM (SPRING 2015)  
(Area: Data Structures and Operating Systems)  

Data Structure and Algorithms

Question 1.

1. (50%) Describe how you could use a single array to implement three stacks. Implement your solution in your preferred programming language (slightly more specific than pseudo-code). Briefly describe two possible alternative solutions.

2. (50%) Implement a function to check if a binary tree is balanced in your preferred programming language (slightly more specific than pseudo-code). For the purpose of this question, a balanced tree is defined to be a tree such that the heights of the two subtrees of any node never differ by more than one.
Operating Systems

Question 2.

1. (40%) Five jobs are waiting to be run. Their expected run times are 9, 6, 4, 5, and X. In what order should they be run to minimize average response time? (Your answer will depend on X.)

2. (60%) Five batch jobs A through E, arrive at a computer center at almost the same time. They have estimated running times of 10, 6, 2, 4, and 8 minutes. Their (externally determined) priorities are 3, 5, 2, 1, and 4, respectively, with 5 being the highest priority. For each of the following scheduling algorithms, determine the mean process turnaround time. Ignore process switching overhead.
   a) Round robin.
   b) Priority scheduling.
   c) First-come, first-served (run in order 10, 6, 2, 4, 8)
   d) Shortest job first.

For (a), assume that the system is multiprogrammed, and that each job gets its fair share of the CPU. For (b) through (d) assume that only one job at a time runs, until it finishes. All jobs are completely CPU bound.