PH.D. QUALIFYING EXAM (SPRING 2013)
(Area: Data Structures and Operating Systems)

Data Structure and Algorithms

Question 1. Single-Source Shortest Paths Problem

Given a weighted, directed graph $G=(V, E)$, where V is the set of nodes/vertices and E is the set of edges, with source s and weight function $w: E \rightarrow R$.

a) (40%) Write the detailed pseudo-code to implement the Dijkstra's algorithm, *Dijkstra(G,w,s)*, assuming that $w(u,v)>=0$ for each edge *(u,v)* in E (nonnegative edge weight). It prodcues the shortest paths and their weights. Explain the data structure you choose to use.
b) (40%) Write the detailed pseudo-code to implement the Bellman-Ford algorithm, *Bellman-Ford (G, w, s)*. *w(u,v)* can be negative. It returns a boolean value indicating wether or not there is a negative-weight cycle that is reachable from the source. If there is such a cycle, the algorithm indicates that no solution exists. If there is no such cycle, the algorithm prodcues the shortest paths and their weights. Explain the data structure you choose to use.
c) (20%) Analyze and compare the complexity of Dijkstra's and Bellman-Ford algorithms. Point out their advantages and disadvantages.

Operating Systems

Question 2. Process Management

1. (50%) Given the following data

Process	Arrival Time	CPU Burst Time
0	0	35
1	0	33
2	6	25
3	8	15
4	11	2

   (a) (25%) Draw the Gantt chart for Shortest-Remaining-Time-First (SRTF) scheduling.

   (b) (25%) Draw the Gantt chart for Round-Robin (RR) scheduling. Use a time quantum (time slice) of 5. **Draw only the first ten time quanta.**

2. (50%) Consider two periodic processes, P1 and P2, where period p1=50, processing time t1=25, period p2=75, and processing time t2=30.

   (a) (25%)Compare the advantages and disadvantages of Rate-monotonic scheduling and earliest-deadline-first scheduling algorithms.

   (b) (25%)Calculate the CPU utilization assuming all processes can be scheduled to meet deadlines.