CS4328 & CS5305: Homework #2

Due on Feb 23 11:55 PM)

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PLEASE READ: You may discuss this problem set with other students. However, you must *write up your answers on your own*. You must also write the names of other students you discussed any problem with. Each problem has a different weight. Please state any assumptions you are making in solving a given problem. *Show your work*. Late assignments will not be accepted with prior arrangements. By submitting this assignment, you acknowledge that you have read the course syllabus.

Problem 1

Consider the following processes:

Process	Arrival Time	Processing Time
A	0	5
B	1	4
C	3	3
D	4	2
E	8	3

Show how the above processes execute over time on a single CPU system. Compute the completion time for each process, the average turnaround time and the average normalized turnaround time for all processes under each of the following schedulers:

(a) FCFS. [**5 pts**]

(b) Round Robin with (q = 1). [**5 pts**]

(c) Round Robin with (q = 2). [**5 pts**]

(d) Shortest Job First. [**5 pts**]

(e) Shortest Remaining Time First. [**5 pts**]

(f) HRRN. [**5 pts**]

(g) Multi-level Feedback with 2 queues. Queue serves 1 quantum (unit of time) at a time while queue 2 serves 2 quantums at a time. All processes get serviced from queue 1 initially in FCFS fashion and if they do not complete, they move to queue 2. Queue 2 runs a round robin scheduler. Assume that Queue 1 has a higher priority than Queue 2, and assume that a process arriving to queue 1 cannot preempt an already running process from queue 2 *within* its 2 quantum. [**5 pts**]

(h) PHRRN is a new scheduler proposed by some students based on their discussions of the regular HRRN. PHRRN stands for preemptive highest response ratio next. In PHRRN, the scheduler runs periodically (in addition to when a process completes) and the ratios are computed at that time to make scheduling decisions. Show the execution of the above processes when the scheduler is invoked every 2 time units. [**5 pts**]

Problem 2

Prove that the Shortest Job First scheduling algorithm achieves the minimum average waiting time for a group of processes that arrived at the same time.[**5 pts**]

Problem 3

Least Slack Process Next (LSPN) is a real-time scheduler for periodic tasks. Slack is the amount of time between when a task would complete if it started now and its next deadline. Thus it can be expressed as:

$$Slack \quad = \quad D - t - C \tag{1}$$

where D is the deadline time, t is the current time and C is the processor time needed. LSPN selects the task with the minimum slack time to execute next. If two tasks have the same slack, they are serviced based on FCFS. Answer the following questions:

(a) What does it mean for a task to have a slack of 0? **[2 pts]**

(b) What does it mean for a task to have a negative slack? **[2 pts]**

(c) How long may the scheduler delay starting a task (and still meet its deadline), if that task has a slack s? **[2 pts]**

(d) Consider 3 period tasks: A, B and C. Task A has a period 6 and execution time 2, task B has a period of 8 and execution time of 2 and task C has a period of 12 and execution time of 3. Illustrate (by drawing the executions of A, B and C over time) how LSPN would schedule these tasks in comparison to Earliest Deadline First and Rate Monotonic Scheduling. **[9 pts]**