Homework 4

1. (10 points) Ex 5.11 Of these two types of programs:
   a. I/O-bound
   b. CPU-bound

which is more likely to have voluntary context switches, and which is more likely to have nonvoluntary context switches? Explain your answer.

2. (10 points) Ex 5.20 (modified) Explain why each of the following can or cannot result in starvation?
   a. First-come, first-served
   b. Shortest job first
   c. Round robin
   d. Priority

3. (10 points) Ex 5.15 (modified) Consider the exponential average formula used to predict the length of the next CPU burst. What are the implications of assigning the following values to the parameters used by the algorithm?

   a. $\alpha = 0$ and $\tau_0 = 100$ milliseconds
   b. $\alpha = 0.5$ and $\tau_0 = 10$ milliseconds
   c. $\alpha = 1$ and $\tau_0 = 10$ milliseconds

4. (20 points) Ex 5.17 (modified) Consider the following set of processes, with the length of the CPU burst given in milliseconds:

Process	Burst Time	Priority
P_1	4	1
P_2	2	2
P_3	1	2
P_4	10	2
P_5	3	1

The processes are assumed to have arrived in the order P_1, P_2, P_3, P_4, P_5, all at time 0.

   a. Draw four Gantt charts that illustrate the execution of these processes using the following scheduling algorithms: FCFS, SJF, non-preemptive priority with FCFS tiebreaker (a lower priority number implies higher priority) and RR (quantum = 2).
   b. What is the average turnaround time for each of the scheduling algorithms in part a?
   c. What is the average waiting time for each of these scheduling algorithms?

5. (20 points) Consider the following set of processes, with the length of the CPU burst and arrival time given in milliseconds.

Process	Arrival Time	Burst Time
P_1	28	4
P_2	1	10
P_3	0	40
P_4	2	40

Assume these processes are scheduled using the multilevel feedback queues shown in Figure 5.9.

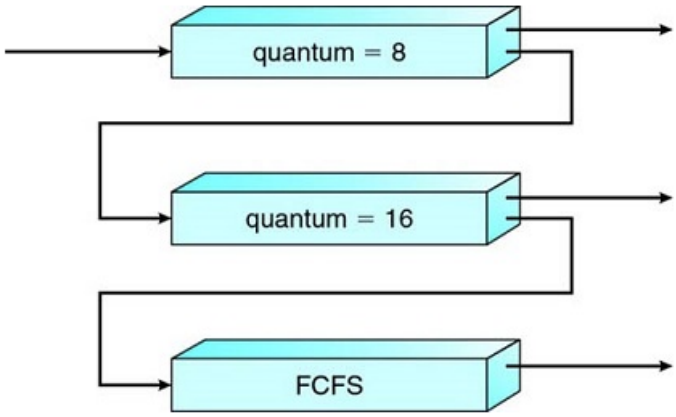

Figure 5.9 Multilevel feedback queues.

As described in the book:
"The scheduler first executes all processes in queue 0. Only when queue 0 is empty will it execute processes in queue 1. Similarly, processes in queue 2 will be executed only if queues 0 and 1 are empty. A process that arrives for queue 1 will preempt a process in queue 2. A process in queue 1 will in turn be preempted by a process arriving for queue 0."

"An entering process is put in queue 0. A process in queue 0 is given a time quantum of 8 milliseconds. If it does not finish within this time, it is moved to the tail of queue 1. If queue 0 is empty, the process at the head of queue 1 is given a quantum of 16 milliseconds. If it does not complete, it is preempted and is put into queue 2. Processes in queue 2 are run on an FCFS basis but are run only when queues 0 and 1 are empty."

When a process in a higher-priority queue preempts a process in a lower-priority queue, the preempted process will:

- be placed back on the head (at the front of the line) of the lower-priority queue and
- have the remainder of its time quantum recorded in its PCB, so when it returns to the running state it will only be allowed to run for the remaining time.

a. Draw a Gantt chart that illustrates the execution of the processes. Hint: the sum of all burst times is 94, therefore a good sanity check is to confirm the Gantt chart has a time range of 0 to 94.
b. What is the worst response time of any process in queue 0?
c. What is the total number of context switches used to complete all processes (don't count the initial process as a context switch)?
d. What is the average waiting time of all processes across all queues?

6. (10 points) Ex 5.33 Assume that two tasks, A and B, are running on a Linux system. The nice values of A and B are −5 and +5, respectively. Using the CFS scheduler as a guide, describe how the respective values of `vruntime` vary between the two processes given each of the following scenarios:

a. Both A and B are CPU-bound.
b. A is I/O-bound and B is CPU-bound.
c. A is CPU-bound and B is I/O-bound.