EI338 Computer System Engineering Homework 9

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Exercise 1 Consider the following set of processes, with the length of the CPU burst time given in milliseconds:

Process	Burst Time	Priority
P_1	2	2
P_2	1	1
P_3	8	4
P_4	4	2
P_5	5	3

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, nonpreemptive priority (a larger priority number implies a higher priority), and RR (quantum = 2).

b) What is the turnaround time of each process for each of the scheduling algorithms in part a?

c) What is the waiting time of each process for each of these scheduling algorithms?

d) Which of the algorithms results in the minimum average waiting time (over all processes)?

Solution.

1. See Figure 1.

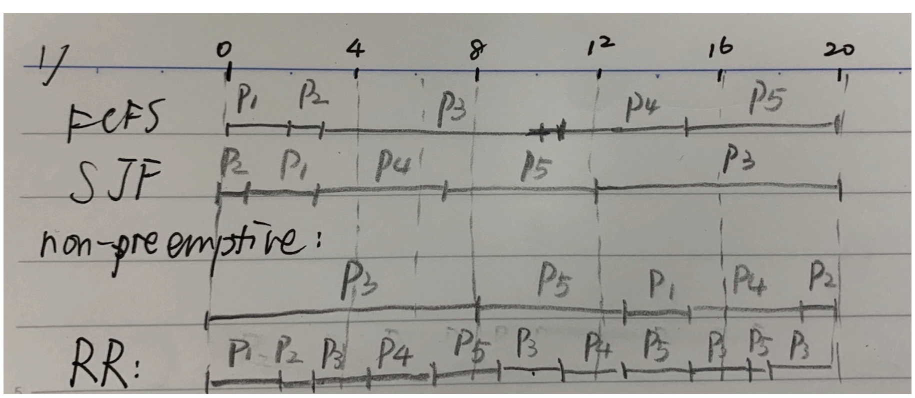

Figure 1: Exercise 1

Turnaround Time	P1	P2	P3	P4	P5
FCFS	2	3	11	15	20
SJF	3	1	20	7	12
Non-preemptive	15	20	8	19	13
RR	2	3	20	13	18

Table 1: Exercise 1-1

Waiting Time	P1	P2	P3	P4	P5
FCFS	0	2	3	11	15
SJF	1	0	12	3	7
Non-preemptive	13	19	0	15	8
RR	0	1	12	9	13

Table 2: Exercise 1-2

2. See Table 1.

3. See Table 2.

4. See Table 3. SJF results in minimum average waiting time.

□

Exercise 2 The following processes are being scheduled using a preemptive, round-robin scheduling algorithm. Consider the following set of processes, with the length of the CPU burst time given in milliseconds:

Each process is assigned a numerical priority,with a higher number indicating a higher relative priority. In addition to the processes listed below, the system also has an idle task (which consumes no CPU resources and is identified as P_{idle}). This task has priority 0 and is scheduled whenever the system has no other available processes to run. The length of a time quantum is 10 units. If a process is preempted by a higher-priority process, the preempted process is placed at the end of the queue.

a) Show the scheduling order of the processes using a Gantt chart.

b) What is the turnaround time for each process?

c) What is the waiting time for each process?

d) What is the CPU utilization rate?

Solution.

1. See Figure 2.

2. See Table 4.

3. CPU utilization rate = 105/120 = 87.5 %

□

	Average Waiting Time
FCFS	6.2
SJF	4.6
Non-preemptive	11
RR	7

Table 3: Exercise 1-3

Process	Priority	Burst	Arrival
P_1	40	20	0
P_2	30	25	25
P_3	30	25	30
P_4	35	15	60
P_5	5	10	100
P_6	10	10	105

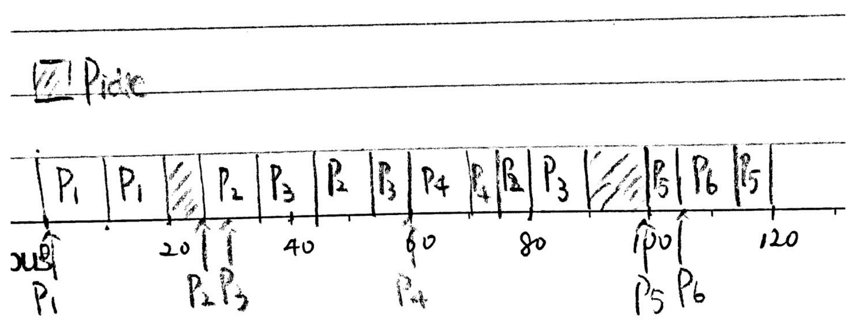

Figure 2: Exercise 2

Exercise 3 The traditional UNIX scheduler enforces an inverse relationship between priority numbers and priorities: the higher the number, the lower the priority. The scheduler recalculates process priorities once per second using the following function:

$$Priority = (\text{recent CPU usage}/2) + base \tag{1}$$

where base = 60 and recent CPU usage refers to a value indicating how often a process has used the CPU since priorities were last recalculated. Assume that recent CPU usage for process P_1 is 40, for process P_2 is 18, and for process P_3 is 10. What will be the new priorities for these three rocesses when priorities are recalculated? Based on this information, does the traditional UNIX scheduler raise or lower the relative priority of a CPU-bound process?

Solution.

$$\begin{aligned} Priority_1 &= 40/2 + 60 = 80 \\ Priority_2 &= 18/2 + 60 = 69 \\ Priority_3 &= 10/2 + 60 = 65 \end{aligned} \tag{2}$$

	P1	P2	P3	P4	P5	P6
Turnaround Time	20	55	60	15	20	10
Waiting Time	0	30	35	0	10	0

Table 4: Exercise 2

The scheduler will lower the relative priority. □