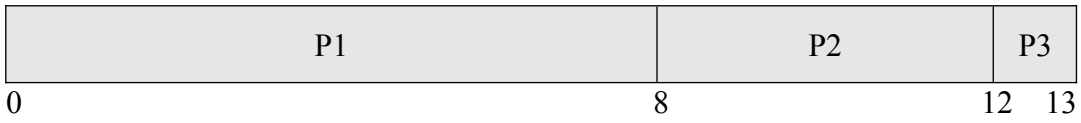
I. Suppose that the following processes arrive for execution at the times indicated. Each process will run for the amount of time listed.

Process	Arrival Time	Burst Time
P1	0.0	8
P2	0.4	4
P3	1.0	1

1. What is the average turnaround time for these processes with the FCFS scheduling algorithm?
2. What is the average waiting time for these processes with the FCFS scheduling algorithm?
3. What is the average turnaround time for these processes with the SJF scheduling algorithm?
4. What is the average waiting time for these processes with the SJF scheduling algorithm?

Ans: FCFS



Qn. 1.1 Average Turnaround Time ¿ $\frac{(8-0)+(12-0.4)+(13-1)}{3} = \frac{8+11.6+12}{3} = 10.53$

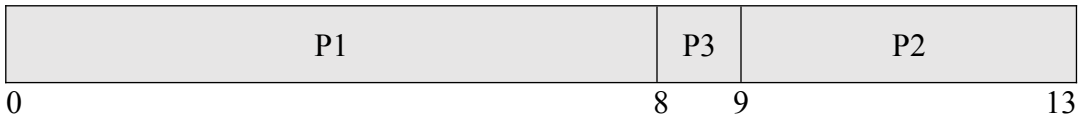
Note: Turnaround Time = Time of completion – Arrival time

Qn. 1.2 Average Waiting Time ¿ $\frac{(0-0)+(8-0.4)+(12-1)}{3} = \frac{0+7.6+11}{3} = 6.2$

Note: It is very easy to compute Waiting Time of each process from its Turnaround Time using the formula, Waiting Time = Turnaround Time – Burst time

Average Waiting Time = $\frac{(8-8)+(11.6-4)+(12-1)}{3} = \frac{0+7.6+11}{3} = 6.2$

Ans: SJF nonpreemptive



Qn. 1.3 Average Turnaround Time ¿ $\frac{(8-0)+(13-0.4)+(9-1)}{3} = \frac{8+12.6+8}{3} = 9.53$

Note: Turnaround Time = Time of completion – Arrival time

Qn. 1.4 Average Waiting Time ¿ $\frac{(0-0)+(9-0.4)+(8-1)}{3} = \frac{0+8.6+7}{3} = 5.2$

Alternate method: Waiting Time = Turnaround Time – Burst time Average Waiting Time ¿ $\frac{(8-8)+(12.6-4)+(8-1)}{3} = \frac{0+8.6+7}{3} = 5.2$

Ans: SJF preemptive

P1 arrives at time 0. No other process in the system now. P1 starts running, completes 0.4 P2 arrives at time 0.4. P1 needs 8 – 0.4 = 7.6 more CPU time. P2 needs 4. Since 4 < 7.6, P2 is shorter. In SJF, OS preempts P1, starts running P2. By the time P2 completes 0.6, P3 arrives at time 1. Now, P1 needs 7.6, P2 needs 4 – 0.6 = 3.4, P3 needs 1, the shortest. OS preempts P2 and starts P3. All processes have arrived, no more preemption required. P2 completes execution, then the next shortest P2, and then finishes with P1.

Qn. 1.3 Average Turnaround Time ¿ $\frac{(13-0)+(5.4-0.4)+(2-1)}{3} = \frac{13+5+1}{3} = 6.33$

Note: Turnaround Time = Time of completion – Arrival time

Qn. 1.4 Average Waiting Time ¿ $\frac{(0.6+1+3.4)+(1)+(0)}{3} = \frac{5+1+0}{3} = 2$

Alternate method: Waiting Time = Turnaround Time – Burst time

Waiting Time ¿ $\frac{(13-8)+(5-4)+(1-1)}{3} = \frac{5+1+0}{3} = 2$

II. Consider the following set of processes, with the length of the CPU burst given in milliseconds:

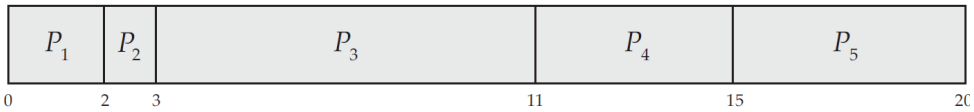
Process	Burst Time	Priority
P1	2	2
P2	1	1
P3	8	4
P4	4	2
P5	5	3

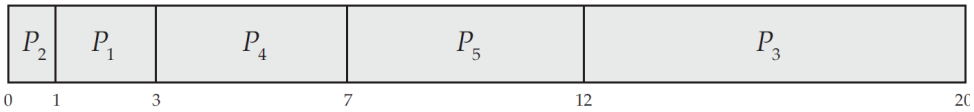
The processes are assumed to have arrived in the order P1, P2, P3, P4, P5, all at time 0.

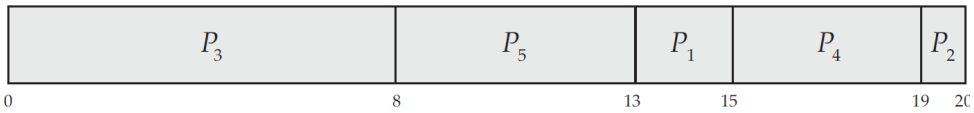
a. Draw four Gantt charts that illustrate the execution of these processes using the following scheduling algorithms: FCFS, SJF, RR (quantum = 2), and nonpreemptive priority (a larger priority number implies a higher priority)
b. What is the turnaround time of each process for each of the scheduling 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)?

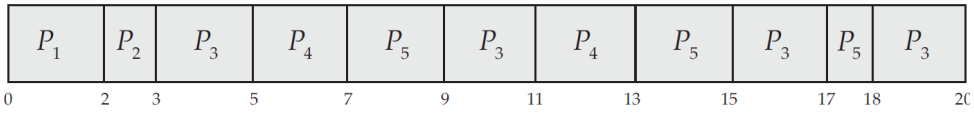
Answer:

a. The four Gantt charts are









b. Turnaround time

	FCFS	SJF	Priority	RR
P_1	2	3	15	2
P_2	3	1	20	3
P_3	11	20	8	20
P_4	15	7	19	13
P_5	20	12	13	18

c. Waiting time (turnaround time minus burst time)

	FCFS	SJF	Priority	RR
P_1	0	1	13	0
P_2	2	0	19	2
P_3	3	12	0	12
P_4	11	3	15	9
P_5	15	7	8	13

d. Shortest Job First