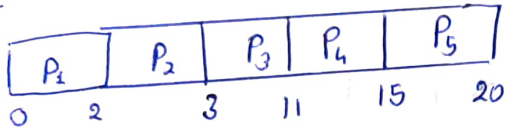


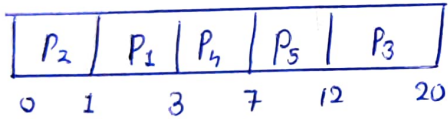
Solution 1.7

| process | Burst Time | priority | Arrival Time |
|----------------|------------|----------|--------------|
| P ₁ | 2 | 2 | 0 |
| P ₂ | 1 | 1 | 0 |
| P ₃ | 8 | 3 | 0 |
| P ₄ | 4 | 2 | 0 |
| P ₅ | 5 | 3 | 0 |

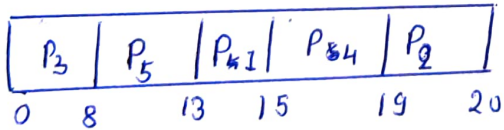
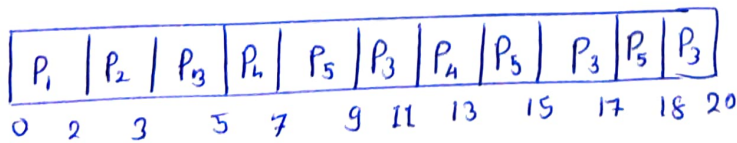
FCFS



SJF



NON-preemptive priority

RR

Solution, 1 b.

Turn around time for each process in each scheduling algo:-

| | FCFS | SJF | NPP | RR |
|----------------|------|-----|-----|----|
| P ₁ | 2 | 3 | 15 | 2 |
| P ₂ | 3 | 1 | 20 | 3 |
| P ₃ | 11 | 20 | 8 | 20 |
| P ₄ | 15 | 7 | 13 | 13 |
| P ₅ | 20 | 12 | 13 | 18 |

(c). Waiting time for each process.

| | FCFS | SJF | NPP | 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) Avg. Waiting Time

$$\text{FCFS} = \frac{31}{5}$$

$$\text{SJF} = \frac{23}{5}$$

$$\text{NPP} = \frac{55}{5}$$

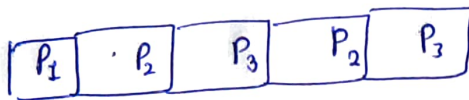
$$\text{RR} = \frac{36}{5}$$

Hence SJF has minimum waiting time.

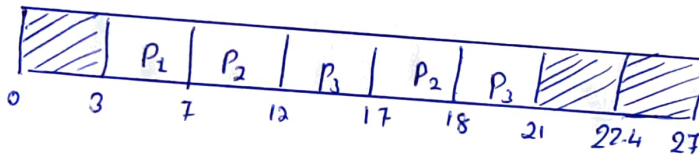
Solution 3:

| | Arrival Time | Total Execution | 30% | 40% | 30% |
|-------|--------------|-----------------|-----|-----|-----|
| P_1 | | 10 | 3 | 4 | 3 |
| P_2 | 0 | 15 | 4.5 | 6 | 4.5 |
| P_3 | 0 | 20 | 6 | 8 | 1 |
| P_3 | 0 | | | | |

Ready Queue



Gantt chart



Total CPU Time = 27

Total idle time = 9

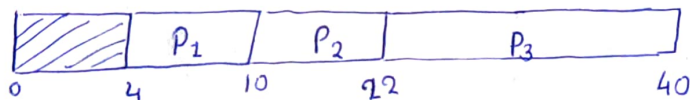
$$\% \text{ idle time} = \frac{9}{27} \times 100$$

$$= 33.3 \%$$

Solution 4.

| Process | Arrival | Execution time | I/O time | CPU Time |
|---------|---------|----------------|----------|----------|
| P1 | 0 | 10 | 4 | 6 |
| P2 | 0 | 20 | 8 | 12 |
| P3 | 0 | 30 | 12 | 18 |

Gantt chart



Since all the processes will do I/O and then CPU processing, process P1 spends 40% i.e. 4ms doing I/O. So CPU is not utilised for first 4ms. Then P1 spends 60% of their time i.e. 6ms in processing and P1 has completed I/O it is scheduled and then P3.

Total time = 40ms

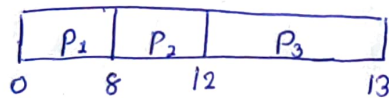
CPU Utilized time = $40 - 4 = 36$ ms

$$\begin{aligned} \text{Utilization} &= \frac{36}{40} \times 100 \\ &= 90\% \end{aligned}$$

Solution 5.

| <u>Process</u> | <u>Arrival Time</u> | <u>Burst Time</u> |
|----------------|---------------------|-------------------|
| P_1 | 0.0 | 8 |
| P_2 | 0.4 | 4 |
| P_3 | 1.0 | 1 |

Q. For FCFS



Waiting times of $P_1 = 0$, $P_2 = 7.6$, $P_3 = 11$

$$\begin{aligned} \text{Hence Turn around time } P_1 &= \text{Waiting time} + \text{Burst time} \\ &= 0 + 8 \\ &= 8 \end{aligned}$$

$$\begin{aligned} P_2 &= 7.6 + 4 \\ &= 11.6 \end{aligned}$$

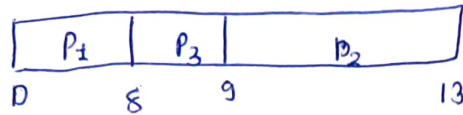
$$P_3 = 11 + 1 = 12$$

$$\text{Average Turn Around time} = \frac{P_1 + P_2 + P_3}{3}$$

$$= \frac{8 + 11.6 + 12}{3} = \underline{\underline{10.533}} \text{ Ans}$$

Solution 5.

b.



Waiting time $P_1 = 0$

$P_2 = 8.6$

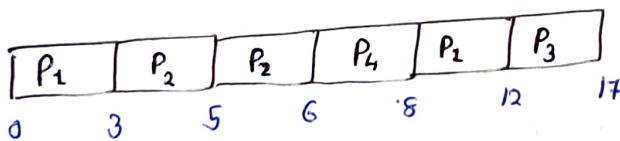
$P_3 = 7$

$$\text{Average Turn Around time} = \frac{\sum_{i=1}^3 (\text{waiting time} + \text{burst time}) P_i}{3}$$

$$= \frac{(0+8) + (8.6+4) + (7+1)}{3}$$

$$= 9.53$$

Solution 6.



| Pid | Arrival | Burst | Completion | Turn Around | Waiting |
|-----|---------|-------|------------|-------------|---------|
| 1 | 0 | 7 | 12 | 12 | 5 |
| 2 | 3 | 3 | 6 | 3 | 0 |
| 3 | 5 | 5 | 17 | 12 | 7 |
| 4 | 6 | 2 | 8 | 2 | 0 |

$$\text{Avg. Waiting Time} = \frac{0+5+7+0}{4} = 3 \text{ ms.}$$

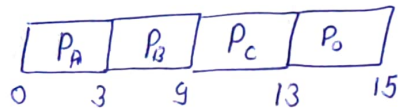
Solution 7 >

7 i

| process | Arrival | processing Time |
|---------|---------|-----------------|
| A | 0 | 3 |
| B | 1 | 6 |
| C | 4 | 4 |
| D | 6 | 2 |

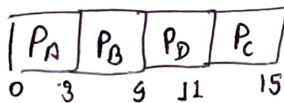
Gantt charts:

FCFS



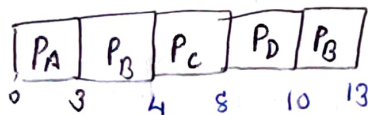
$$\text{Average Turnaround Time} = \frac{3 + 8 + 9 + 9}{4}$$
$$= \frac{29}{4}$$

SJF



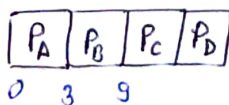
$$\text{Avg. TAT} = \frac{3 + 8 + 5 + 11}{4} = \frac{27}{4}$$

SRTF



$$\text{Avg. TAT} = \frac{3 + 1 + 4 + 4 + 4}{4} = \frac{25}{4} \approx \text{lowest}$$

HR RN



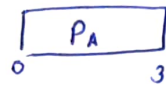
$$\text{Avg. TAT} = \frac{29}{4}$$

Hence SRTF gives lowest Turn Around Time = $\frac{25}{4}$

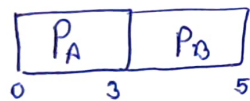
Solution:

| process No. | Arrival Time | Execution Time |
|-------------|--------------|----------------|
| A | 0 | 6 |
| B | 3 | 2 |
| C | 5 | 4 |
| D | 7 | 6 |
| E | 10 | 3 |

Say at $t=0$, P_A arrived it will start executing till 3

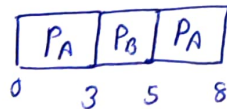


\therefore Burst time of $P_B = 2 <$ remaining time.

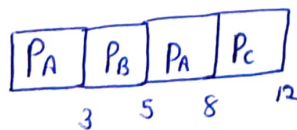


\therefore Remaining time of $P_B = 6 - 3 = 3 < P_A$

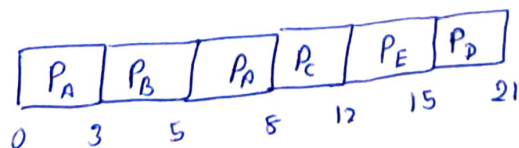
So,



\therefore Burst time of $P_C = 4 < P_D$



Similarly



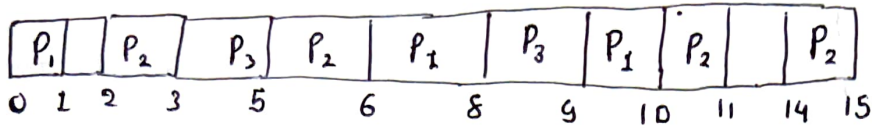
Average Turnaround Time

$$= \frac{8+2+7+14+5}{5}$$

$$= \frac{36}{5} = 7.20 \text{ ms}$$

Solution 9.

Gantt chart:



| PID | Arrival Time | Burst Time | Completion | Turn Around Time | Waiting Time |
|-----|--------------|------------|------------|------------------|--------------|
| 1 | 0 | 4 | 10 | 10 | 6 |
| 2 | 2 | 4 | 15 | 13 | 9 |
| 3 | 3 | 3 | 9 | 6 | 3 |

$$\text{Avg. Waiting Time} = \frac{6+9+3}{3} = 6$$

$$\text{Avg. Turn Around Time} = \frac{10+13+6}{3} = \frac{29}{3} = 9.665$$

Solution 10.

| Process | Arrival Time | Execution Time |
|----------------|--------------|----------------|
| P ₁ | 0 | 10 |
| P ₂ | 0 | 20 |
| P ₃ | 0 | 30 |

Given, time spend by first process in I/O

$$P_1 = \frac{20}{100} \times 10 = 2$$

$$P_2 = \frac{20}{100} \times 20 = 4$$

$$P_3 = \frac{20}{100} \times 30 = 6$$

Boost time by operation (70% of execution)

$$\text{So, } P_1 = 7$$

$$P_2 = 14$$

$$P_3 = 21$$

For I/O 10%

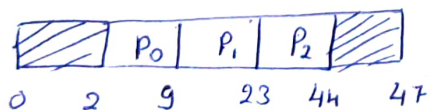
$$P_1 = 1$$

$$P_2 = 2$$

$$P_3 = 3$$

Now According to SRT

| PID | AT | IO | BT | IO |
|----------|----|----|----|----|
| P_0 | 0 | 2 | 7 | 1 |
| P_{21} | 0 | 4 | 14 | 2 |
| P_2 | 0 | 6 | 21 | 3 |



$$\text{Total Time} = 47$$

$$\text{Idle Time} = 5$$

$$\text{Idle time} = \frac{5}{47} \times 100$$

$$= 10.6\%$$