

CPU Scheduling Algorithms

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Arrival Time:

The time when the process is arriving into ready state is called arrival time

Burst Time:

The time required for the process to execute is called burst time or CPU time

Completion Time:

The time when process complete its execution is called completion time

Turn Around Time:

The time difference between completion and arrival time is called Turn Around Time.

FCFS

Criteria : Arrival Time

Mode : Non Preemptive

Process	AT	BT	Completion Time
P ₁	0	4	4
P ₂	1	3	7
P ₃	2	1	8
P ₄	3	2	10
P ₅	4	5	15

Gantt Chart



Waiting Time

Arrival from Gantt Chart

Arrival Time from given Table

$$P_1 \text{ wait} = 0 - 0 = 0 \text{ ms}$$

$$P_2 \text{ wait} = 4 - 1 = 3 \text{ ms}$$

$$P_3 = 7 - 2 = 5 \text{ ms}$$

$$P_4 = 8 - 3 = 5 \text{ ms}$$

$$P_5 = 10 - 4 = 6 \text{ ms}$$

19 ms ← Total Waiting Time

Average Waiting Time

$$= \frac{19}{5} = \underline{\underline{3.8 \text{ ms}}}$$

Turn Around Time: (Completion Time - Arrival Time) / 5 + P

Completion Time from Gantt chart
Arrival time from given table

$$P_1 = 4 - 0 = 4 \text{ ms}$$

$$P_2 = 7 - 1 = 6 \text{ ms}$$

$$P_3 = 8 - 2 = 6 \text{ ms}$$

$$P_4 = 10 - 3 = 7 \text{ ms}$$

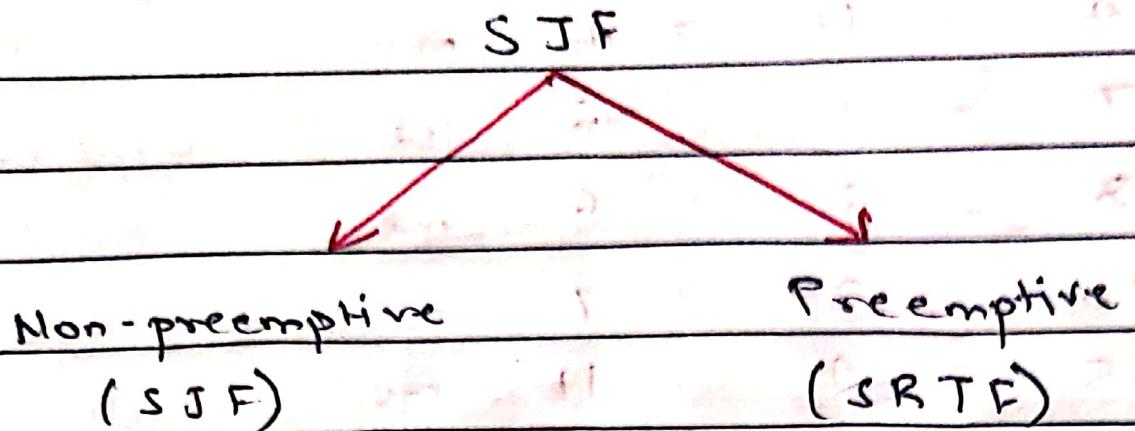
$$P_5 = 15 - 4 = 11 \text{ ms}$$

34 ms ← Turn Around Time

Average Turn around Time

$$= \frac{34}{5} = 6.8 \text{ ms}$$

SJF (Shortest Job First) scheduling

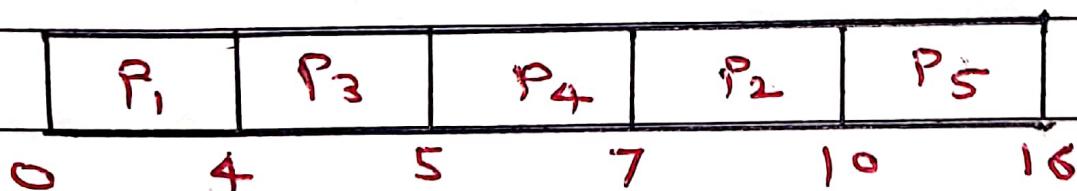


Criteria : Burst Time and Arrival time

Mode : Non-preemptive

Process	AT	BT
P ₁	0	4
P ₂	1	3
P ₃	2	1
P ₄	3	2
P ₅	4	6

Gantt Chart :



Waiting Time: ~~30 ms~~ ~~10 ms~~ ~~10 ms~~ ~~10 ms~~ ~~10 ms~~ ~~10 ms~~

\nwarrow Initial arrival time from Gantt chart
 \nwarrow Arrival Time from given table

$$P_1 = 0 - 0 = 0 \text{ ms}$$

$$P_2 = 7 - 1 = 6 \text{ ms}$$

$$P_3 = 4 - 2 = 2 \text{ ms}$$

$$P_4 = 5 - 3 = 2 \text{ ms}$$

$$P_5 = 10 - 4 = 6 \text{ ms}$$

$$2 \quad 5 \quad 16 \text{ ms} \leftarrow \text{Total waiting time}$$

Average Waiting Time

$$= \frac{16}{5} = 3.2 \text{ ms}$$

	0	1	2	3	4	5	6	7	8	9	10
P1	0										
P2		1									
P3			2								
P4				3							
P5					4						

Turn Around Time:

\nwarrow Completion Time from Gantt chart

\nwarrow Arrival Time from given table

$$P_1 = 4 - 0 = 4 \text{ ms}$$

$$P_2 = 10 - 1 = 9 \text{ ms}$$

$$P_3 = 5 - 2 = 3 \text{ ms}$$

$$P_4 = 8 - 3 = 5 \text{ ms}$$

$$P_5 = 16 - 4 = 12 \text{ ms}$$

$$32 \text{ ms} \leftarrow \text{Total Turn Around Time}$$

Average Turn Around Time

$$= \frac{32}{5} = 6.4 \text{ ms}$$

SRTF (Shortest Remaining Time First) scheduling

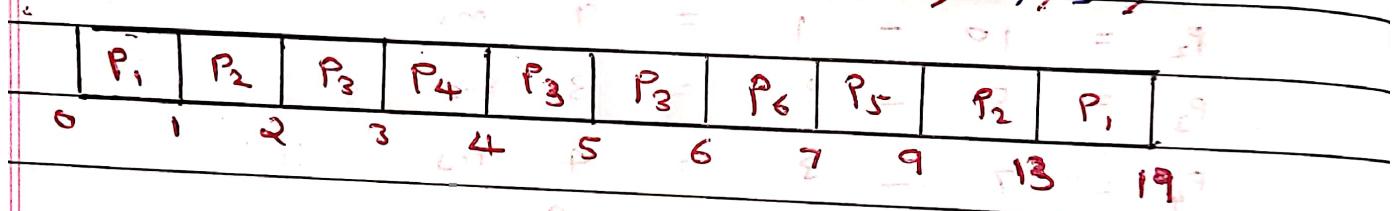
Premptive - SJF

Criteria : Burst Time

Mode : Preemptive

Process	AT	BT	Remaining Time
P ₁	0	7	6
P ₂	1	5	4
P ₃	2	3	2
P ₄	3	1	0
P ₅	4	2	
P ₆	5	1	

Gantt chart:



Turn Around Time

Completion Time from Gantt Chart
Arrival Time from given table

$$P_1 = 19 - 0 = 19 \text{ ms}$$

$$P_2 = 13 - 1 = 12 \text{ ms}$$

$$P_3 = 6 - 2 = 4 \text{ ms}$$

$$P_4 = 4 - 3 = 1 \text{ ms}$$

$$P_5 = 9 - 4 = 5 \text{ ms}$$

$$P_6 = 7 - 5 = 2 \text{ ms}$$

43 ms \leftarrow Total Turn Around Time

Average Turn Around Time

$$= \frac{43}{6} = 7.1 \text{ ms}$$

Waiting Time:

Turn Around Time

~~Wait Time from table~~

$$P_1 = 19 - 7 = 12 \text{ ms}$$

$$P_2 = 12 - 5 = 7 \text{ ms}$$

$$P_3 = 4 - 3 = 1 \text{ ms}$$

$$P_4 = 1 - 1 = 0 \text{ ms}$$

$$P_5 = 5 - 2 = 3 \text{ ms}$$

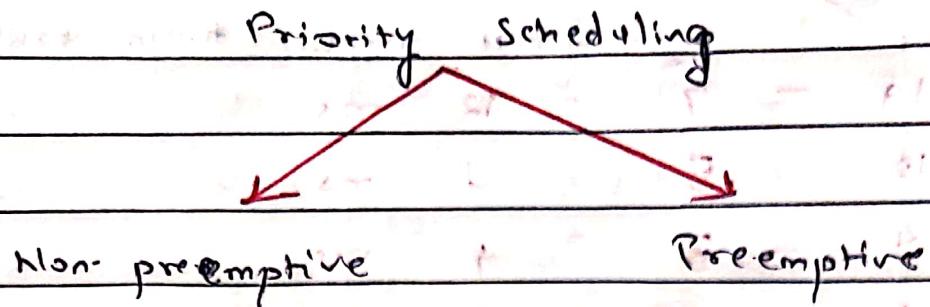
$$P_6 = 2 - 1 = 1 \text{ ms}$$

24 ms ← Total Waiting Time

Average Waiting Time

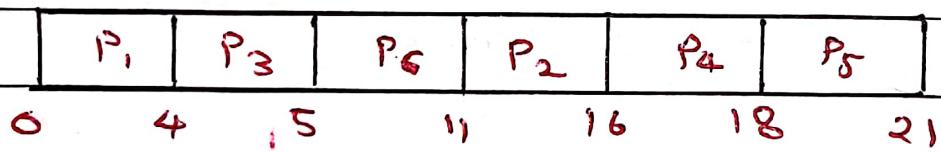
$$= \frac{24}{6} = 4 \text{ ms}$$

Priority Scheduling



Process	AT	BT	Priority	
P ₁	0	4	4	
P ₂	1	5	5	
P ₃	2	1	7 (HP)	Higher Priority
P ₄	3	2	2	
P ₅	4	3	1 (LP)	Lower Priority
P ₆	5	6	6	

Grant Chart :



Turn Around Time

Completion Time from Gantt Chart

$$P_1 = 5 - 4 = 0 \Rightarrow 4 \text{ ms}$$

$$P_2 = 16 - 1 = 15 \text{ ms}$$

$$P_3 = 25 - 2 = 23 \text{ ms}$$

$$P_4 = 18 - 3 = 15 \text{ ms}$$

$$P_5 = 21 - 4 = 17 \text{ ms}$$

$$P_6 = 11 - 5 = 6 \text{ ms}$$

60 ms ← Total Turn Around Time

Average Turn Around Time

$$= \frac{60}{6} = 10 \text{ ms}$$

Waiting Time

Turn Around Time

$$P_1 = 4 - 4 = 0 \text{ ms}$$

$$P_2 = 15 - 5 = 10 \text{ ms}$$

$$P_3 = 3 - 1 = 2 \text{ ms}$$

$$P_4 = 15 - 2 = 13 \text{ ms}$$

$$P_5 = 17 - 3 = 14 \text{ ms}$$

$$P_6 = 6 - 6 = 0 \text{ ms}$$

39 ms ← Total Waiting Time

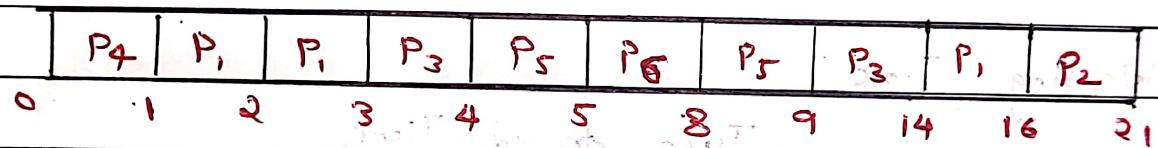
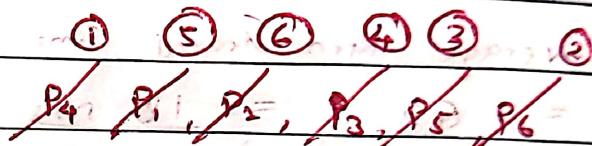
Average Waiting Time

$$= \frac{39}{6} = 6.5 \text{ ms}$$

Preemptive Priority Scheduling

Process	AT	Priority	BT	Remaining Time
P ₁	1	5	4	2 X
P ₂	2	2 (LP)	5	3
P ₃	3	6	6	5 X
P ₄	0	4	1	X
P ₅	4	7	2	1
P ₆	5	8 (HP)	3	X

Gantt Chart:



Turn Around Time = 0 + 1 + 2 + 3 + 4 + 5 = 19

Completion Time from Gantt chart

Arrival Time from given table

$$P_1 = 16 - 1 = 15 \text{ ms}$$

$$P_2 = 21 - 2 = 19 \text{ ms}$$

$$P_3 = 14 - 3 = 11 \text{ ms}$$

$$P_4 = 7 - 0 = 7 \text{ ms}$$

$$P_5 = 9 - 4 = 5 \text{ ms}$$

$$P_6 = 8 - 5 = 3 \text{ ms}$$

54 ms ← Total Turn Around Time

Average Turn Around Time

$$= \frac{54}{6} = 9 \text{ ms}$$

Waiting Time :

Turn Around Time

Burst Time from given table

$$P_1 = 15 - 4 = 11 \text{ ms}$$

$$P_2 = 19 - 5 = 14 \text{ ms}$$

$$P_3 = 11 - 6 = 5 \text{ ms}$$

$$P_4 = 1 - 1 = 0 \text{ ms}$$

$$P_5 = 5 - 2 = 3 \text{ ms}$$

$$P_6 = 3 - 3 = 0 \text{ ms}$$

33 ms \leftarrow Total Waiting Time

Average Waiting Time

$$= \frac{33}{6} = \underline{\underline{5.5 \text{ ms}}}$$

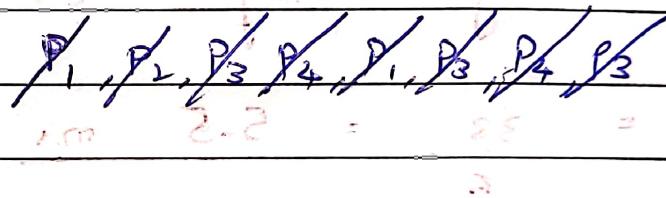
Round Robin Scheduling

Criteria : Time slice, AT, BT

Process	AT	BT	Remaining Time
P ₁	0	8	4
P ₂	1	4	3
P ₃	2	9	5
P ₄	3	5	2

(slice = 4) = 88

Gantt Chart:



P ₁	P ₂	P ₃	P ₄	P ₁	P ₃	P ₄	P ₃
0	4	8	12	16	20	24	25

Turn Around Time

Completion Time from Gantt Chart

Arrival Time from given Table

$$P_1 = 20 - 0 = 0 \text{ ms}$$

$$P_2 = 8 - 1 = 7 \text{ ms}$$

$$P_3 = 26 - 2 = 24 \text{ ms}$$

$$P_4 = 25 - 3 = 22 \text{ ms}$$

73 ms ← Total Turn Around Time

Average Turn Around Time

$$= \frac{73}{4} = 18.25 \text{ ms}$$

Waiting Time

Turn Around Time.

Burst Time from given table

$$\begin{aligned}P_1 &= 20 - 8 = 12 \text{ ms} \\P_2 &= 7 - 4 = 3 \text{ ms} \\P_3 &= 24 - 9 = 15 \text{ ms} \\P_4 &= 22 - 5 = \underline{17 \text{ ms}}\end{aligned}$$

47 ms \leftarrow Total Waiting Time

Average Waiting Time

$$= \frac{47}{4} = \underline{11.75 \text{ ms}}$$