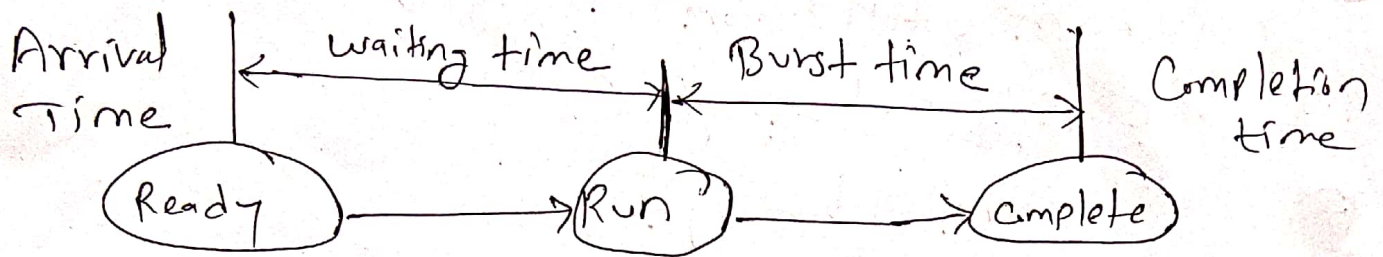


operating System



Related Terms of CPU Scheduling Algorithms

① **Arrival Time:** The time at which the process enters into the ready queue is called arrival time.

② **Burst time:** The amount of time required by the CPU to execute the process is called burst time. This does not include waiting time.

③ **Completion Time:** The time at which the process completes its execution is called completion time.

④ **turn-around Time:** The amount of time spent by the process from its arrival to its completion is called turnaround time.

$$TAT = CT - AT \quad / \quad TAT = WT + BT$$

⑤ **waiting Time:** The amount of time for which the process waits for the CPU to be assigned is called waiting time.

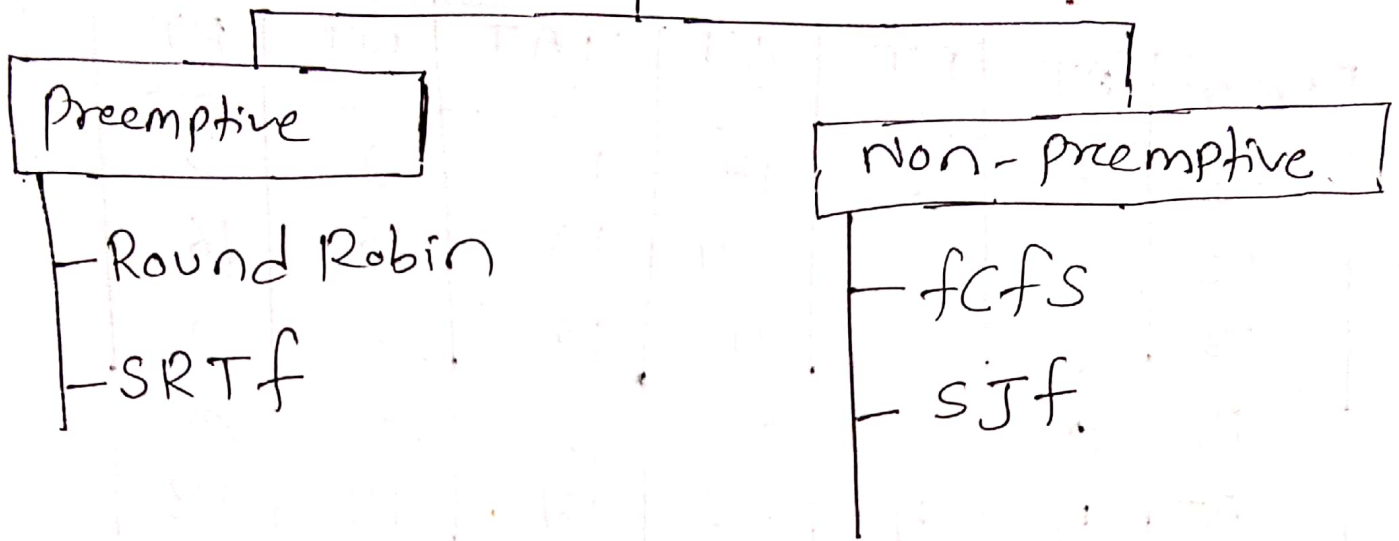
$$WT = TAT - BT$$

⑥ **Response Time:** Response time is the time spent when the process is in the ready queue and gets the CPU for the first time.

purpose of Scheduling Algorithms:

- ① maximum utilization of CPU
- ② fair Allocation of CPU
- ③ maximum throughput.
- ④ minimum waiting time

Scheduling Algorithms



① fcfs (first come first serve Algorithm)

fcfs scheduling Algorithm is non-preemptive. Nonpreemptive means, once the CPU has been allocated to a process, that process keeps the CPU until it executes a work or job or task and releases the CPU, either by requesting I/O.

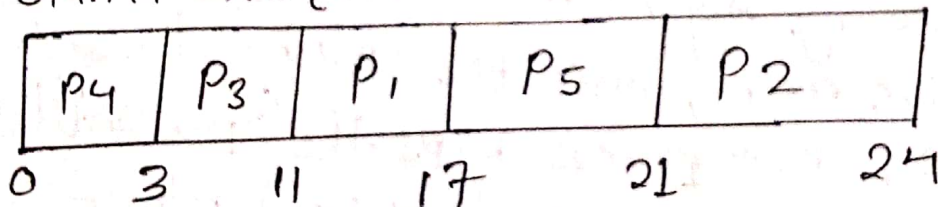
Buying a movie ticket from the ticket counter is the real-life example of a first come first serve (fcfs) Algorithm. The person who comes first and stands in the queue gets to buy the ticket first. Similarly in the fcfs scheduling Algorithms, the process that arrives first gets executed first.

Criteria: Arriva + time
Mode: Non-preemption

g. Calculate average waiting time using fcf's Algorithm

Process	AT	BT	CT	TAT	WT	RT
P1	2	6	17	15	9	9
P2	5	3	24	19	16	16
P3	1	8	11	10	2	2
P4	0	3	3	3	0	0
P5	4	4	21	17	13	13
No: 5			76	64	40	40

Grant chart



Average of waiting time

$$= \frac{9 + 16 + 2 + 0 + 13}{5}$$

$$= \frac{40}{5} = 8 \underline{\underline{Ans}}$$

formulas:

$$TAT = CT - AT$$

$$WT = TAT - BT$$

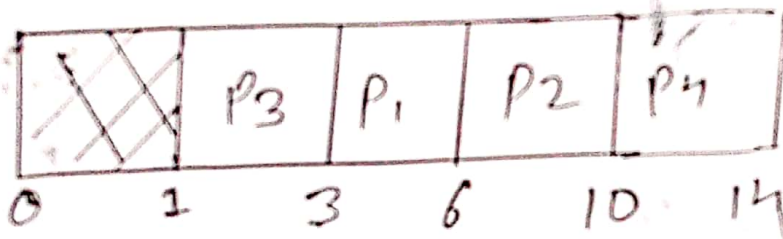
$$RT = (\text{CPU gets for the first time}) - AT$$

① SJF (Shortest job first) - Non Preemption

Calculate total Average time of TAT using SJF.

Process No	Arrival Time	BT Time	CT	TAT	WT	RT
P ₁	1	3	6	5	2	2
P ₂	2	4	10	8	4	4
P ₃	1	2	3	2	0	0
P ₄	4	4	14	10	6	6
				30		

Gantt chart



Criteria = "Best Time"
Mode = "Non-preemption"

$$TAT = CT - AT$$

$$WT = TAT - BT$$

$$\text{Avg. of TAT} = \frac{30}{4}$$

$$= 7.5 \text{ sec}$$

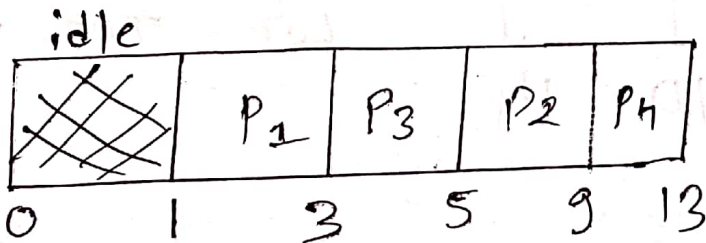
Q. Calculate total Average time of WT using SJF.

Process No	AT	BT	
P ₁	0	7	
P ₂	1	5	
P ₃	2	3	
P ₄	3	1	
P ₅	4	2	
P ₆	5	1	

Q.2 Calculate Average Turnaround time using FCFS Algorithm. (Questions for SJF Also)

Process No.	Arrival Time	Burst Time	Completion Time	TAT	WT	RT
P ₁	1	3				
P ₂	2	4				
P ₃	1	2				
P ₄	4	4				
5						

Gantt Chart



Q.3 Calculate Average Completion Time & TAT.

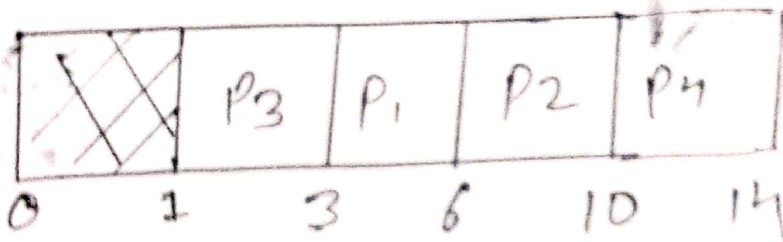
Process No.	Arrival Time	Burst Time	Completion Time	TAT	WT	RT
P ₁	0	2				
P ₂	1	2				
P ₃	5	3				
P ₄	6	4				
5						

⑪ SJF (Shortest job first) - Non Preemption

Calculate Total Average time of TAT using SJF

Process No	Arrival Time	BT Time	CT	TAT	WT	RT
P ₁	1	3	6	5	2	2
P ₂	2	4	10	8	4	4
P ₃	1	2	3	2	0	0
P ₄	4	4	14	10	6	6
				30		

Gantt Chart



Criteria = 'Best Time'
Mode = "Non-Preemption"

$$TAT = CT - AT$$

$$WT = TAT - BT$$

$$\text{Avg. of TAT} = \frac{30}{4}$$

$$= 7.5 \text{ sec}$$

Q. Calculate Total Average time of WT using SJF.

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

Round Robin Algorithm

Calculate Average of TAT and waiting time using Round Robin Algorithm having time quantum = 2 units.

P-ID	AT	BT	CT	TAT	WT	RT
P ₁	0	5 1	13	13	8	0
P ₂	1	3 1	12	11	8	1
P ₃	2	1	5	3	2	2
P ₄	3	2	9	6	4	4
P ₅	4	3 1	14	10	7	5

$$\frac{43}{5} = 8.6$$

Ready Queue

P ₁	P ₂ 2	P ₃ 3	P ₁	P ₄	P ₅ 5	P ₂	P ₁	P ₅
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Criteria: "time quantum"
Mode: "preemption"

Gantt Chart

P_1	P_2	P_3	P_1	P_4	P_5	P_2	P_1	P_5	
0	2	4	5	7	9	11	12	13	14

$$\text{Avg of TAT} = \frac{\text{Total of TAT}}{\text{No. of processes}}$$

$$= \frac{43}{5}$$

$$= 8.6$$

Formula:

$$\text{Turnaround Time (TAT)} = \text{CT} - \text{AT}$$

$$\text{Waiting Time (WT)} = \text{TAT} - \text{BT}$$

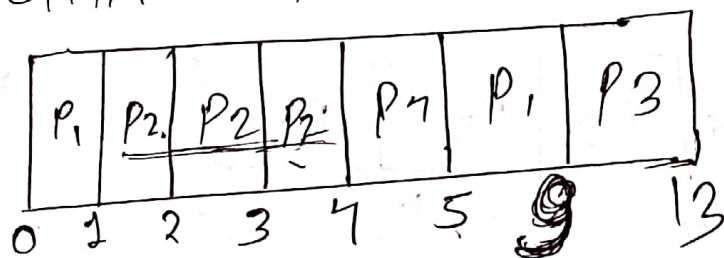
$$\text{Response Time (RT)} = (\text{first time CPU} - \text{AT})$$

SRTf (STf with Preemption)

Process No.	Arrival Time	Burst time	Completion Time	TAT	WT	RT
P ₁	0	8	9	9	4	0
P ₂	1	3	4	3	0	0
P ₃	2	4	13	11	7	7
P ₄	4	1	5	1	0	0



Gantt chart



Criteria "Burst Time"

Made "Preemption"

$$TAT = CT - AT$$

$$WT = TAT - BT$$

$$RT = (CPU \text{ first time} - AT)$$

P₁, P₂

P₁, P₂, P₃

P₁, P₂, P₃

P₁, P₂, P₃, P₄

P₁, P₃

$$\text{Avg TAT} = \frac{24}{4}$$

$$= 6$$

$$\text{Avg RT} = \frac{7}{4} = 1.75$$

SRTF (shortest Remaining time first) SJF with preemption.

PID	AT	BT	CT	TAT	WT	RT
P ₁	0	87	20	20	12	0
P ₂	1	43	10	9	5	0
P ₃	2	21	4	2	0	0
P ₄	3	10	5	2	1	1
P ₅	4	3	13	9	6	6
P ₆	5	2	7	2	0	0

Gantt Chart

Output Channel									
P ₁	P ₂	P ₃	P ₃	P ₄	P ₆	P ₂	P ₅	P ₁	
0	1	2	3	4	5	7	10	13	20

P₁

P₁ P₂

P₁ P₂ P₃

P₁ P₂ P₃ P₄

P₁ P₂ P₃ P₄ P₅

P₁ P₂ P₅ P₆

P₁ P₂ P₅

P₁ P₅

$$TAT = CT - AT$$

$$WT = TAT - BT$$

$$RT = (\text{first time CPU} - AT)$$