CS & IT ENGINEERING

2026

Operating System

CPU Scheduling

Lecture -1

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Recap of Previous Lecture

Topic — Process states

Topic — Process State Transition

Topic — Process Scheduling

Topic — Types of Schedulers

Topics to be Covered

Topic Process Scheduling

Topic Process Scheduling Algorithms

Topic FCFS Scheduling

Topic SJF Scheduling

$$n > m$$

#Q. Consider a system with n processes and m CPUs. Maximum and Minimum number of processes in each of the following states possible?

1. Ready state n 0
2. Running State m 0
3. Blocked State n 0

           max   min

Function:

- Make a selection

Goal

- Minimize Wait time and Turn-around time
- Maximize CPU utilization (Throughput)
- Fairness

Preemptive

Non-preemptive

- Arrival Time (AT): Time at which process arrives

- Burst/Service Time (BT): Amount of time needed to run on CPU

- Completion Time (CT): Time at which process completes

- Turn-Around Time (TAT): Amount of time process spends in system from arrival to completion.
  $$TAT = CT - AT$$

- Waiting Time (WT):
  Amount of time process waits in ready state.
  $$WT = TAT - BT$$

- Response Time (RT):

  Amount of time taken by process from arrival till first time getting CPU.

1. FCFS

2. SJF $\left.\vphantom{\begin{matrix}a\\b\end{matrix}}\right\}$ LJF

3. SRTF $\qquad$ LRTF

4. HRRN

5. Priority Based

6. Round Robin

7. Multilevel Queue Scheduling

8. Multilevel Feedback Queue Scheduling

No I/O requirement :-

Scheduling Criteria: smaller AT first | Tie breaker ⇒ smaller process id first

Type of Algorithm: Non-preemptive
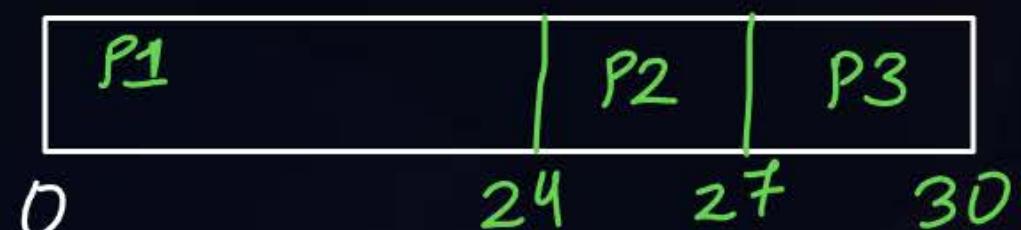
Process	Arrival Time	Burst Time
P1	0	24
P2	0	3
P3	0	3

Gantt Chart :- (always starts from 0)

P1	P2	P3

0   24   27   30

no. of process switch = 2
    (Context)

ignore at first &
last

Topic : FCFS (First Come First Serve)

Process	Arrival Time	Burst Time	Completion Time	Turnaround Time	Waiting Time	Response Time
P1	0	24	24	24	0	0
P2	0	3	27	27	24	24
P3	0	3	30	30	27	27
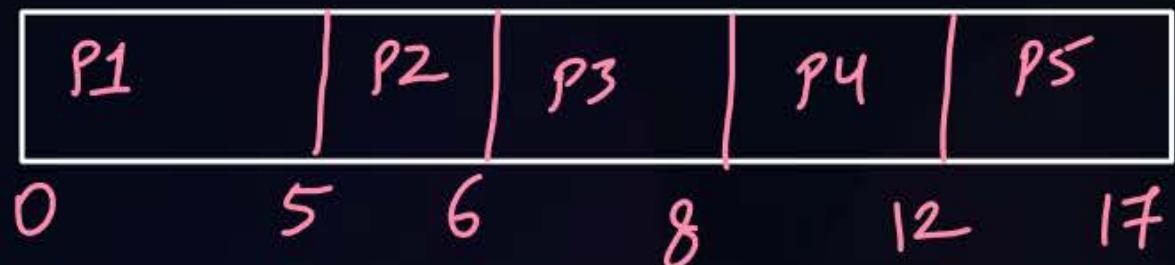
$$\text{avg } TAT = \frac{24 + 27 + 30}{3} = 27$$

$$\text{avg } WT = \frac{0 + 24 + 27}{3} = 17$$

Process	Arrival Time	Burst Time	CT	TAT	WT	Response time
P1	0	5	5	5	0	0
P2	1	1	6	5	4	4
P3	2	2	8	6	4	4
P4	3	4	12	9	5	5
P5	4	5	17	13	8	8

$$\text{avg TAT} = \frac{38}{5}$$
$$= 7.6$$

$$\text{avg WT} = \frac{21}{5}$$
$$= 4.2$$

P1	P2	P3	P4	P5

0   5   6   8   12   17

If at first and last, context switch are ignored,

then

no. of context switches in non-preemptive algo

$$= (n - 1)$$
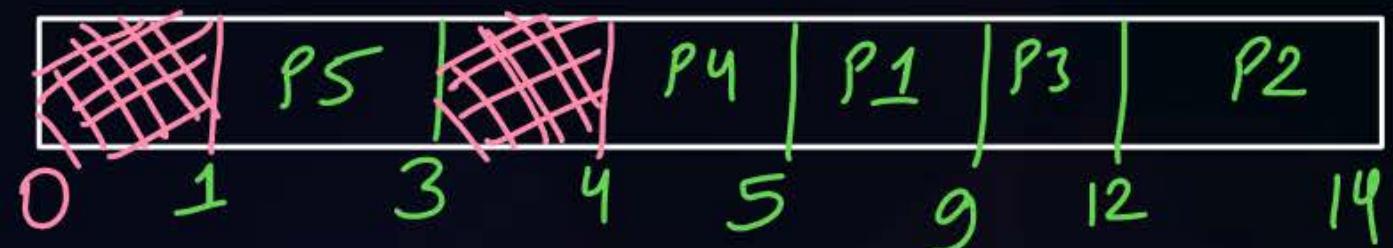
where n = no. of processes

Topic : FCFS (First Come First Serve)

Process	Arrival Time	Burst Time
P1	5	4
P2	8	2
P3	6	3
P4	4	1
P5	1	2

CT	TAT	WT	
9			
14			
12			
5			
3			

CPU idle time = $1+1 = 2$

% of time CPU is idle $= \dfrac{2}{14} * 100\%$

$= 14.3\%$

Gantt chart: P5 (1–3), P4 (4–5), P1 (5–9), P3 (9–12), P2 (12–14), with idle slots hatched at 0–1 and 3–4. Timeline marks: 0, 1, 3, 4, 5, 9, 12, 14.

$$\% \text{ of time CPU utilized} = \frac{12}{14} * 100\%$$

$$= 85.7\%$$

If a big process is scheduled first then other small processes will have to wait for long-long time.

It slows down system.

Advantages:

Easy to implement

No complex logic

No starvation

Disadvantages:

No option of Preemption

Convoy effect makes the system slow

Scheduling Criteria: smaller BT first | Tie breaker ⇒ FCFS
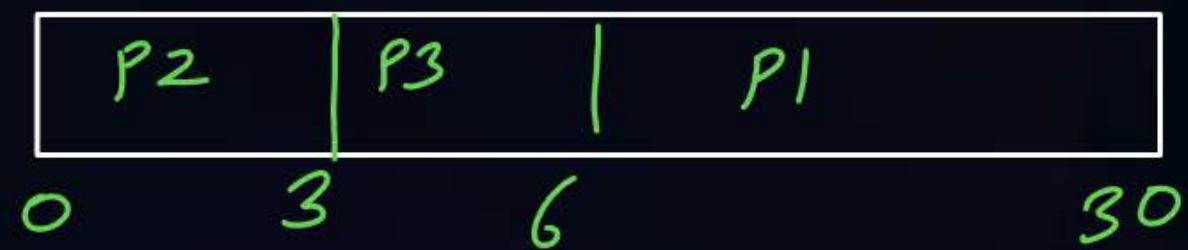
Type of Algorithm: Non-preemptive

$$BT \xrightarrow{\text{if equal}} AT \xrightarrow{\text{if equal}} id$$

Topic : SJF (Shortest Job First)

Process	Arrival Time	Burst Time	Completion Time	Turnaround Time	Waiting Time
P1	0	24	30	30	6
P2	0	3	3	3	0
P3	0	3	6	6	3

P2	P3	P1

0   3   6   30
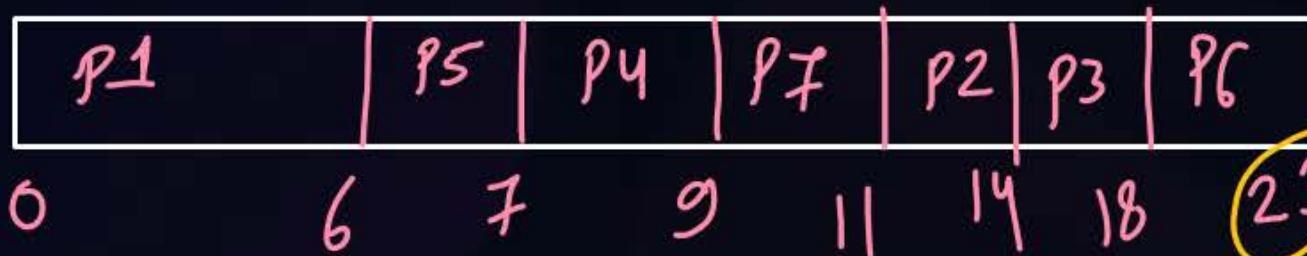
avg TAT = $\frac{39}{3}$
= 13

avg WT = $\frac{9}{3}$
= 3

Topic : SJF (Shortest Job First)

Process	Arrival Time	Burst Time	Completion Time	Turnaround Time	Waiting Time
P1	0	6	6	6	
P2	1	3	14	13	
P3	2	4	18	16	
P4	4	2	9	5	
P5	5	1	7	2	
P6	6	5	23	17	
P7	8	2	11	3	

P1		P5	P4	P7	P2	P3	P6

0   6   7   9   11   14   18   23 ← sum of all BT + idle time

and avg. TAT

Advantages:

1. Minimum average waiting time among non-preemptive scheduling
2. Better throughput in continuous execution

Disadvantages:

1. No practical implementation because Burst time is not known in advance
2. No option of Preemption $\longrightarrow$ Sol^n :— SRTF
3. Longer Processes may suffer from starvation

indefinite wait

$Sol^n \Rightarrow$ HRRN

Preemptive SJF

Scheduling Criteria: smaller BT time first | Tie breaker ⟹ FCFS
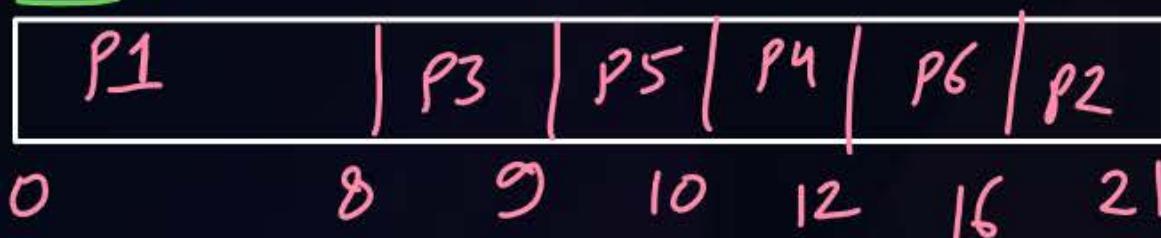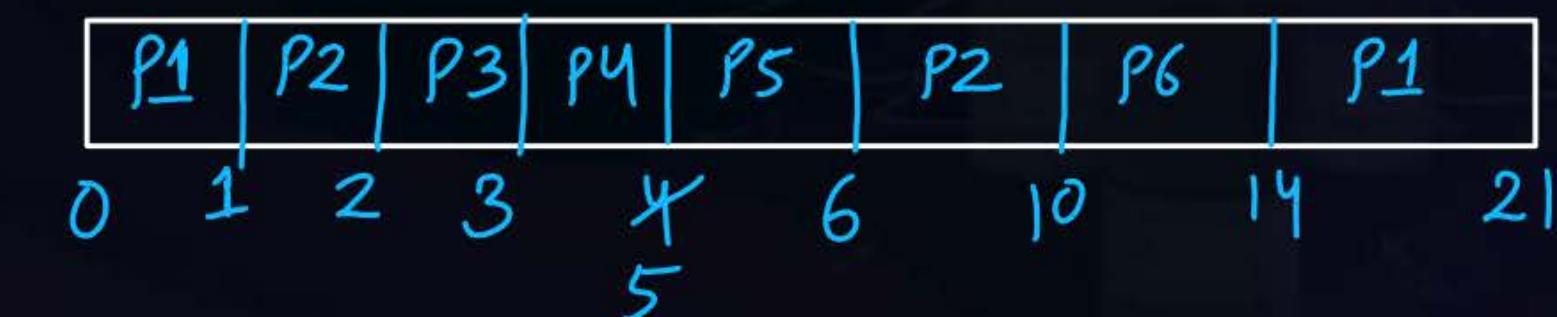
Type of Algorithm: Preemptive

Preemption ⟹ when new arriving process has BT smaller than remaining time of current running process.

Topic : SRTF (Shortest Job First)

Process	Arrival Time	Burst Time	Completion Time	Turnaround Time	Waiting Time	Response Time
P1	0	8	21	21	13	0
P2	1	5	10	9	4	0
P3	2	1	3	1	0	0
P4	3	2	5	2	0	0
P5	4	1	6	2	1	1
P6	5	4	14	9	5	5

SJF:-

P1		P3	P5	P4	P6	P2

0   8   9   10   12   16   21

SRTF:-

P1	P2	P3	P4	P5	P2	P6	P1

0   1   2   3   4   6   10   14   21

5

Topic : SRTF (Shortest Remaining Time First)

H.w.

Process	Arrival Time	Burst Time	Completion Time	Turnaround Time	Waiting Time
P1	4	7			
P2	5	5			
P3	3	1			
P4	1	2			
P5	2	1			
P6	0	4			

Topic : SRTF (Shortest Remaining Time First) H.W.

Process	Arrival Time	Burst Time	Completion Time	Turnaround Time	Waiting Time
P1	0	9			
P2	1	6			
P3	2	4			
P4	3	2			
P5	6	1			

2 mins Summary

Topic — **Process Scheduling**

Topic — **Process Scheduling Algorithms**

Topic — **FCFS Scheduling**

Topic — **SJF Scheduling**