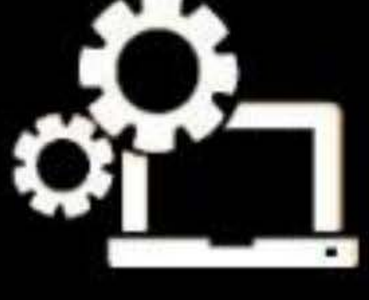
CS & IT ENGINEERING

OPERATING SYSTEMS

CPU Scheduling



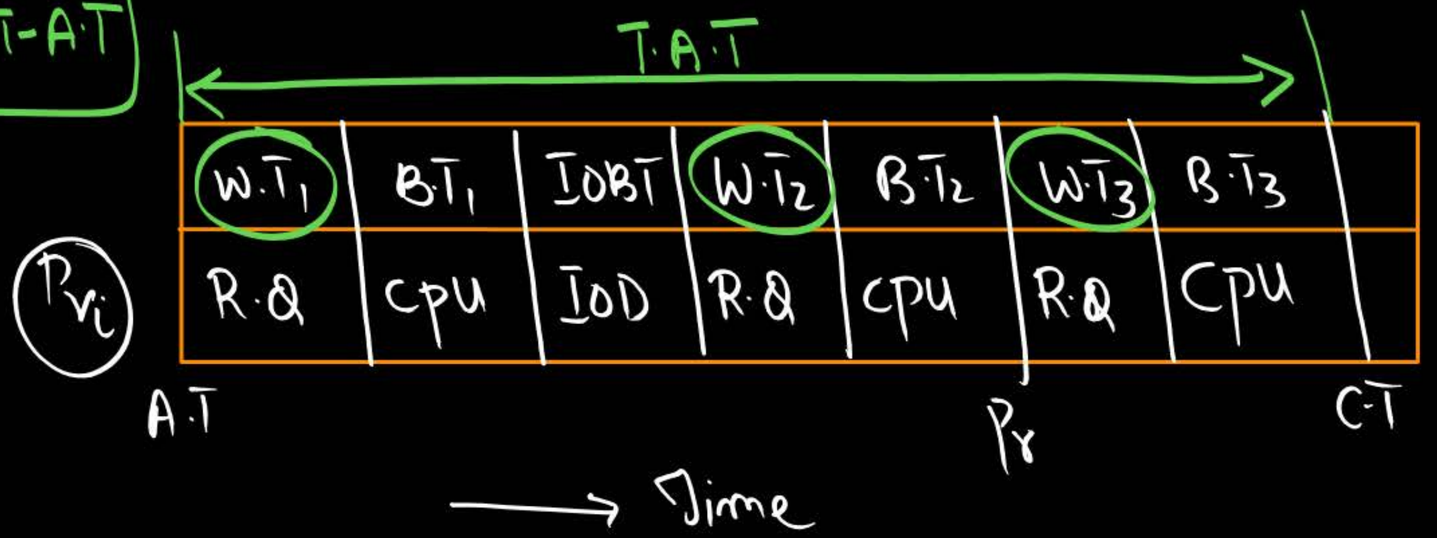
Lecture No. 1

By- Dr. Khaleel Khan Sir

- Process Times
- Scheduling Techniques
- FCFS

Process Times:

1) Arrival Time (A.T)
2) Waiting Time (W.T) = TAT − (BT + IOBT) $\Longrightarrow$ if IOBT = 0, WT = TAT − BT
3) Burst Time (B.T)
4) Io Burst Time (IOBT)
5) Completion Time (CT)
6) Turn Around Time (TAT) = CT − A.T



1) n-processes $(P_1 \cdots P_n)$
2) $A.T(P_i) = A_i$
3) $B.T(P_i) = x_i$
4) $IOBT(P_i) = y_i$
5) $C.T(P_i) = C_i$

$W.T = TAT - (BT + IOBT)$

b) $W.T(P_i) = (C_i - A_i) - (x_i + y_i)$

$$\text{Av. } W.T = \frac{\sum_{i=1}^{n} (C_i - A_i) - (x_i + y_i)}{n}$$

No. of Schedules with n-processes $= n!$ (Non-PreEmp)

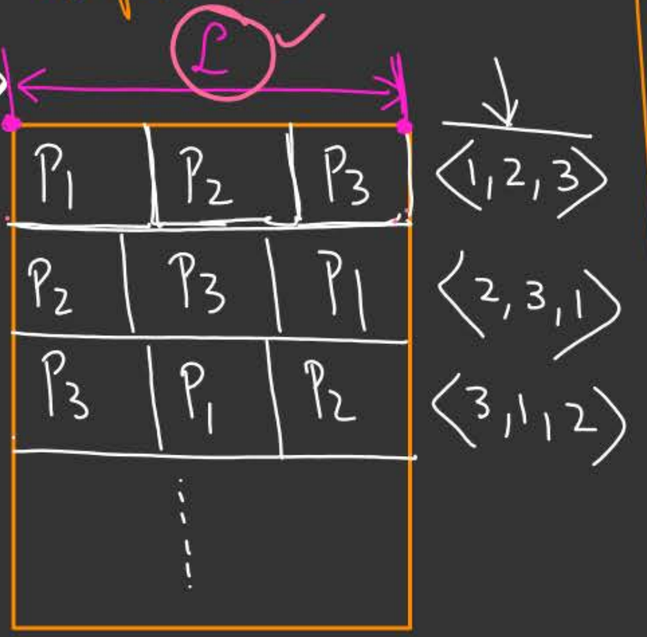
No. of Schedules with n-processes $= \infty$ (PreEmptive)

a) $TAT(P_i) = (C_i - A_i)$

$$\text{Average TAT} = \frac{\sum_{i=1}^{n} (C_i - A_i)}{n}$$

* Schedule length ($\mathcal{L}$): Total time taken to complete all 'n'-processes as per Schedule.

$n = 3$; $\langle P_1, P_2, P_3 \rangle$



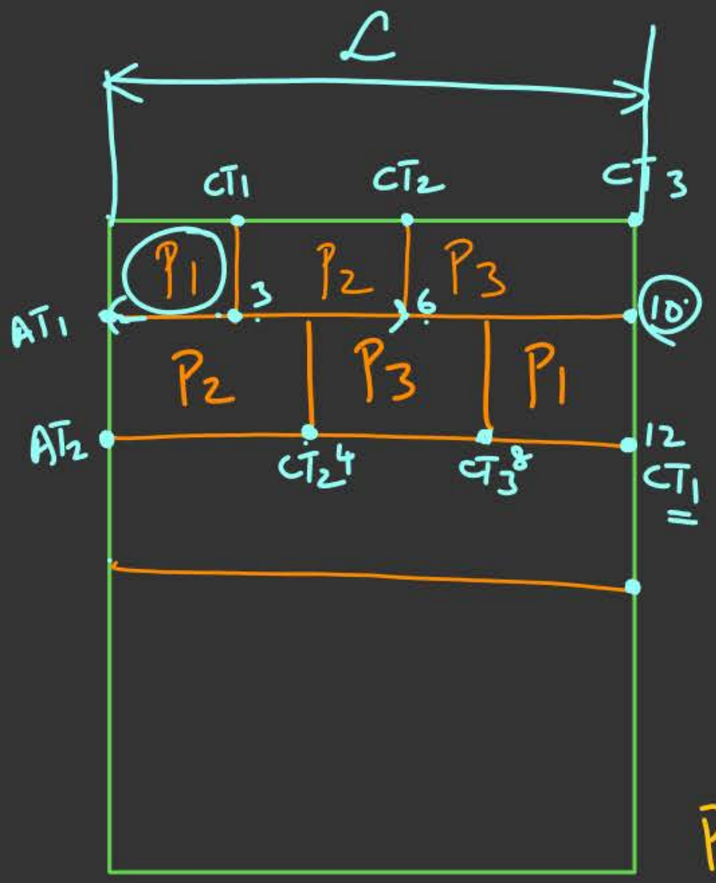
$n \longrightarrow \mathcal{L}$ units

? $\longleftarrow$ 1 Unit

$\mathcal{L} = Max(C_i) - Min(A_i)$

Throughput (η) = No. of Processes Completed Per Unit Time

$$\eta = \frac{n}{\mathcal{L}}$$



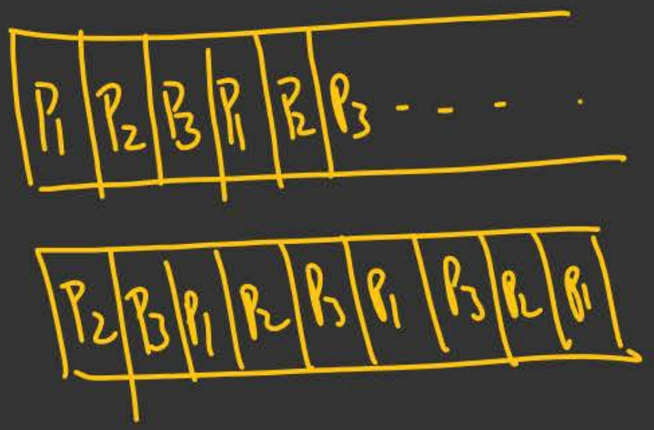
$\sum_{x}^{TAT}$ $\sum x_i$ X

TAT = CT − AT

L = (Completion time of Last Process) − (Arrival time of First Process)

$$L = Max(C_i) - Min(A_i)$$

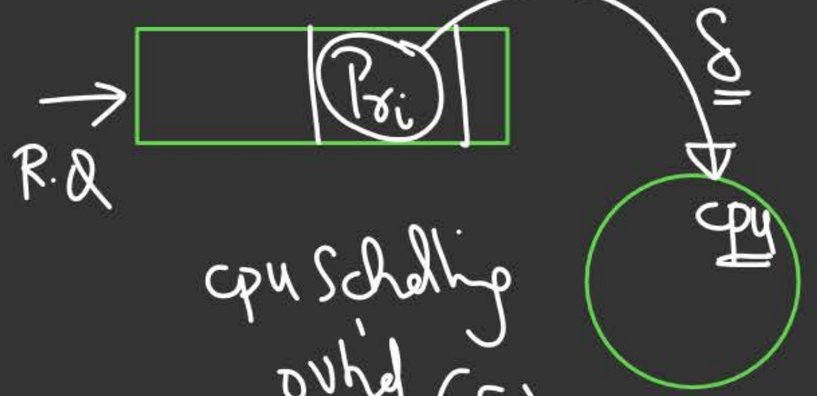
P1 P2 P3



Content-Switch Time

CPU Scheduling ovhd

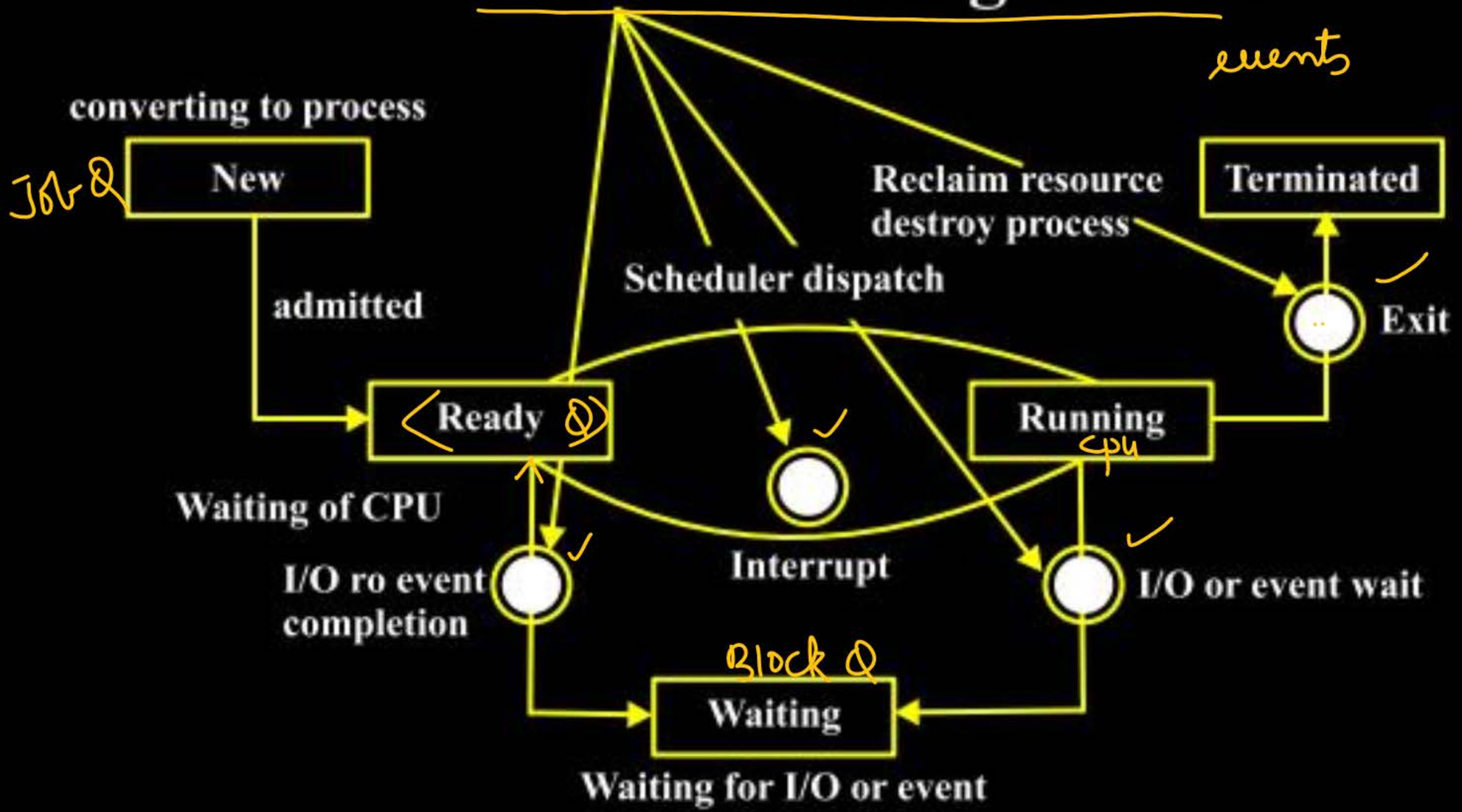
Let CPU-Scheduling ovhd = δ (Δ)



CPU Scheduling ovhd (δ)

(Time Taken to Load PCB of Process from R.Q onto CPU)

CPU Scheduling Occurs



Types of Techniques/Algo's

CPU Scheduling

Mode of operation

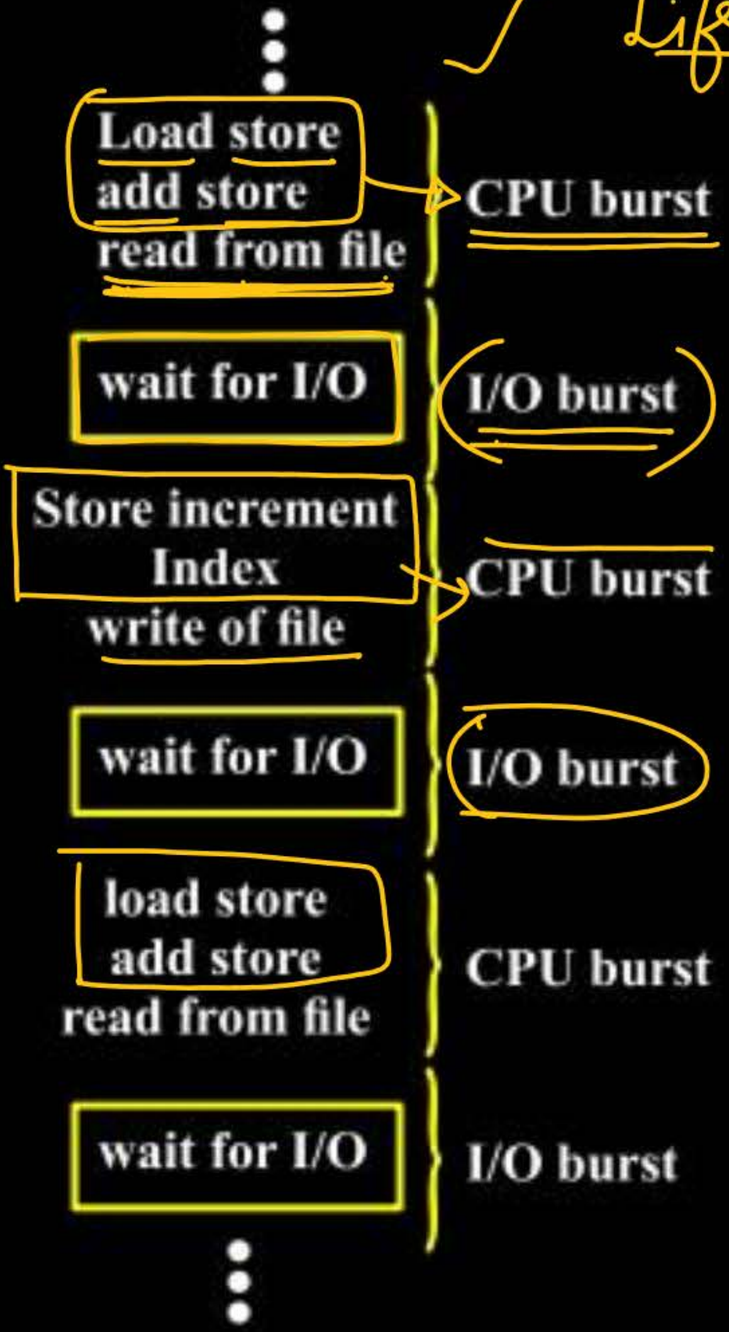
- Pre-emptive
- Non-Pre-emptive

Goals

Scheduling Criteria

- Maximize
  - Maximize:
    - CPU Utilization
    - Throughput
- Minimize
  - Minimize:
    - Turnaround time
    - Waiting time
    - Response time

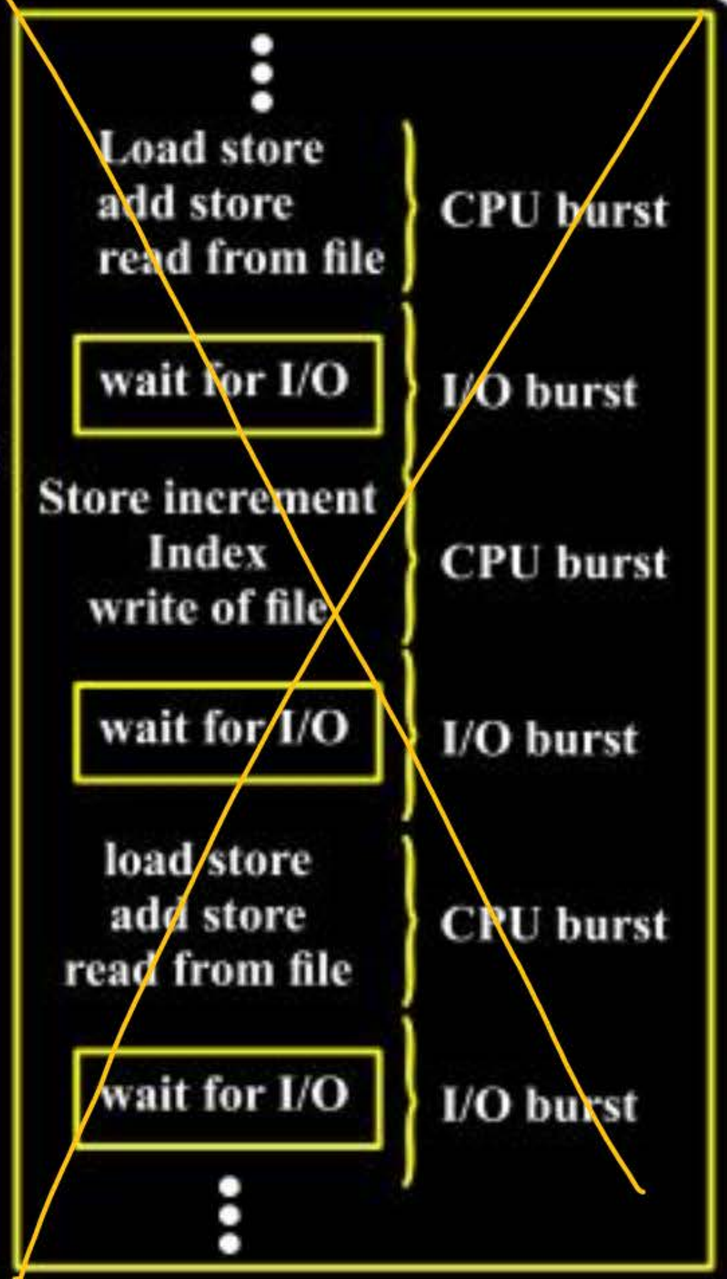
Lifecycle of Process



CPU-I/O bursts

Process execution consists of a cycle of CPU execution and I/O wait

- different processes may have different distributions of burts
  - CPU-bound process: performs lots of computations in long bursts, very little I/O
  - I/O-bound process: performs lots of I/O followed by short burst of computation
- ideally, the system admits a mix of CPU bound and I/O-bound processes to maximize CPU and I/O



1. FCFS <First Come First Served>

TAT = CT - AT

WT = TAT - BT

Selection criteria: A.T

Mode of operation: Non-Preemptive

Conflict resolution: Lower Pid

Assumptions:

(i) Time is in clock ticks

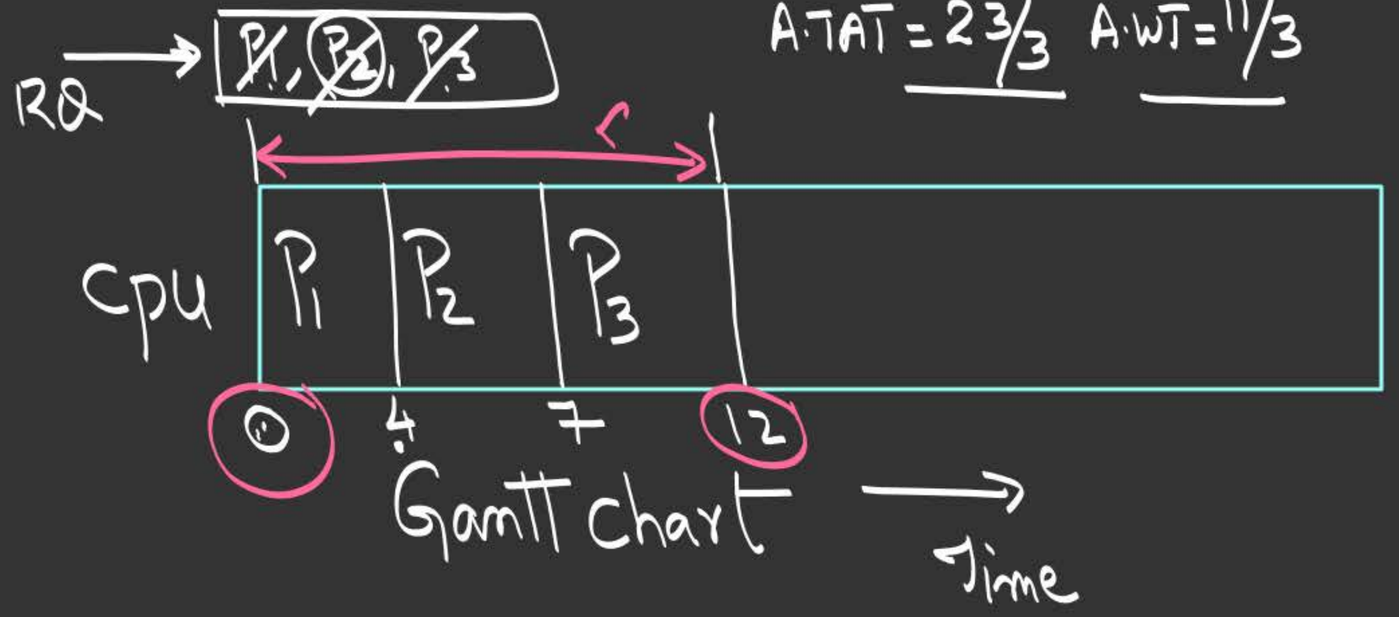
(ii) No IOBT's

(iii) Schdlng ovhd (δ) = 0

① $L = 12 - 0 = 12$

P.No	A.T	B.T	C.T	TAT	WT
1	0	4	4	4	0
2	0	3	7	7	4
3	0	5	12	12	7

A.TAT = 23/3 A.WT = 11/3



$L = 12$

P.No	A.T	B.T	C.T	T.A.T	W.T
×1	0	2	2	2	0
×2	0	1	3	3	2
×3	2	3	6	4	1
✓4	3	2	8	5	3
✓5	5	4	12	7	3
Pid				21/5	9/5

$TAT = CT - AT$

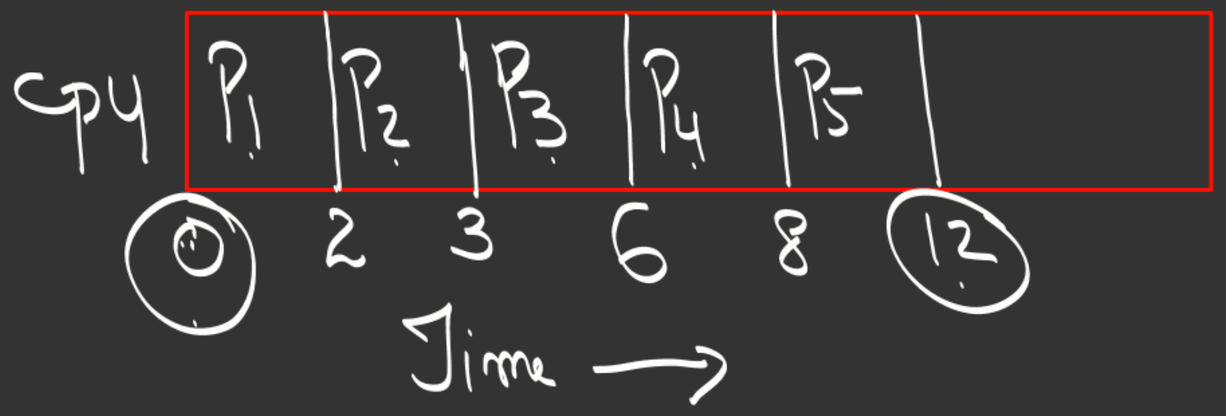
$WT = TAT - BT$

$L = Max(CT) - Min(AT)$

$\eta = \frac{n}{L}$

$= \frac{5}{12}$

FCFS:



criteria

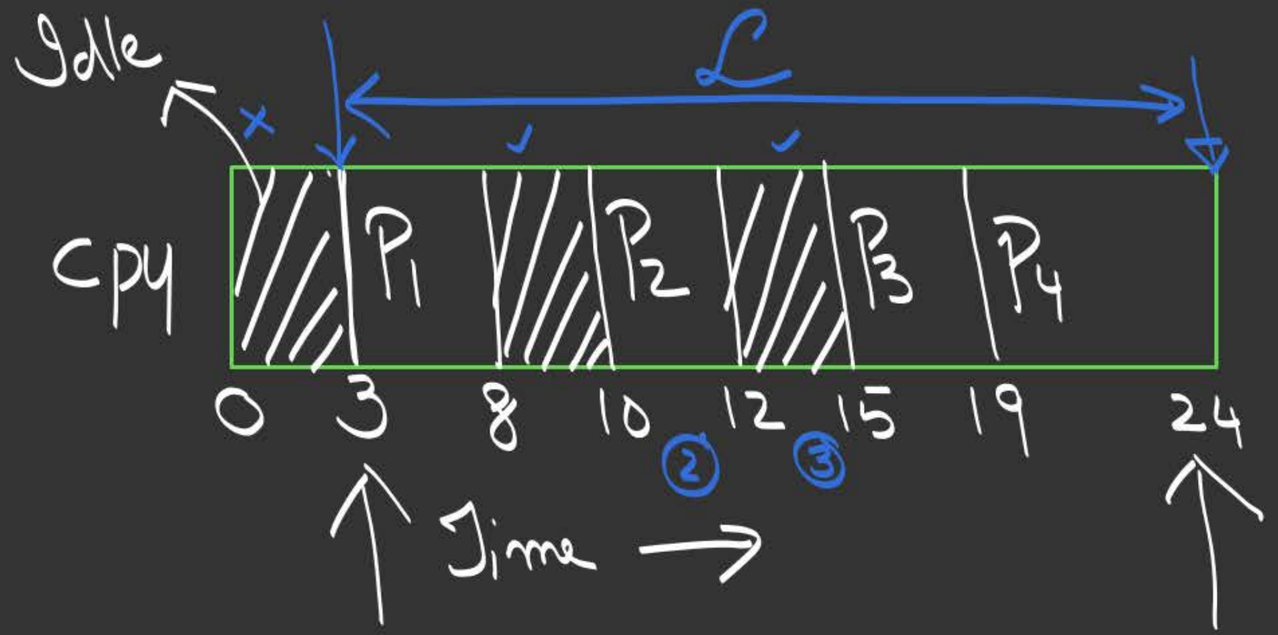
3)

P.No	A.T	B.T	C.T	TAT	W.T
1	3	5	8	5	0
2	10	2	12	2	0
3	15	4	19	4	0
4	18	5	24	6	1

$L =$

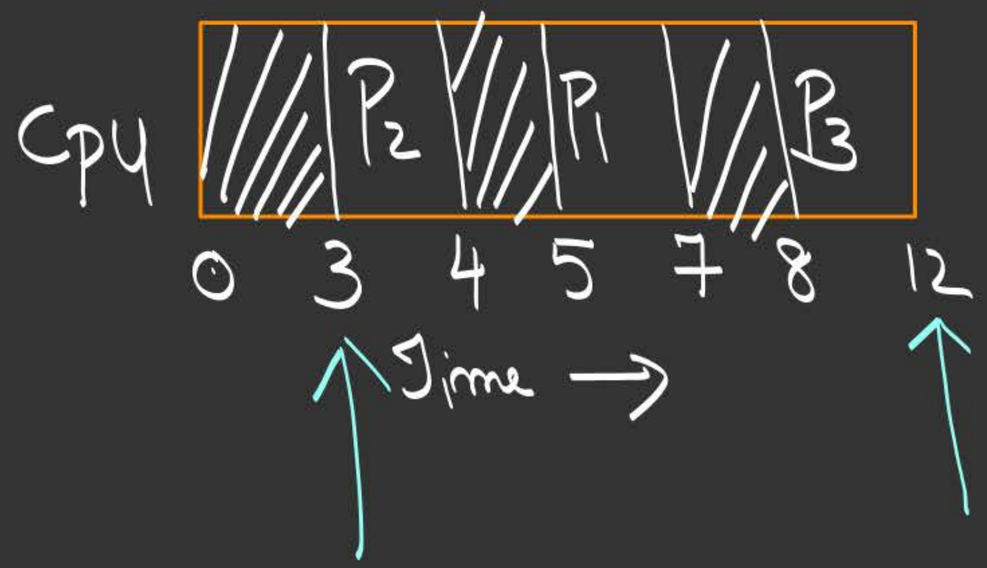
$L = 24 - 3 = 21$

$\% \left(\frac{\text{cpu Idleness}}{L} \right) = \left(\frac{5}{21} \right)$



	P.No	A.T	B.T
✗	1	5	2
✗	2	3	1
✓	3	8	4

$$L = 12 - 3 = 9$$



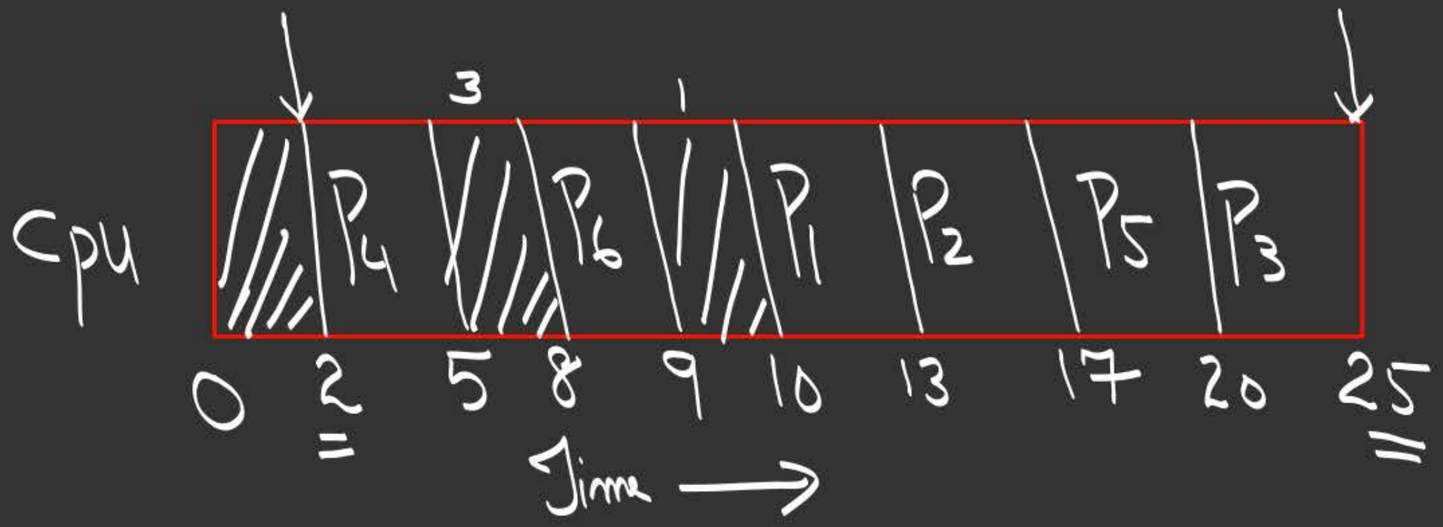
P.No	A.T	B.T
1	10	3
2	11	4
3	20	5
4	2	3
5	12	3
6	8	1

$L = 25 - 2 = 23$

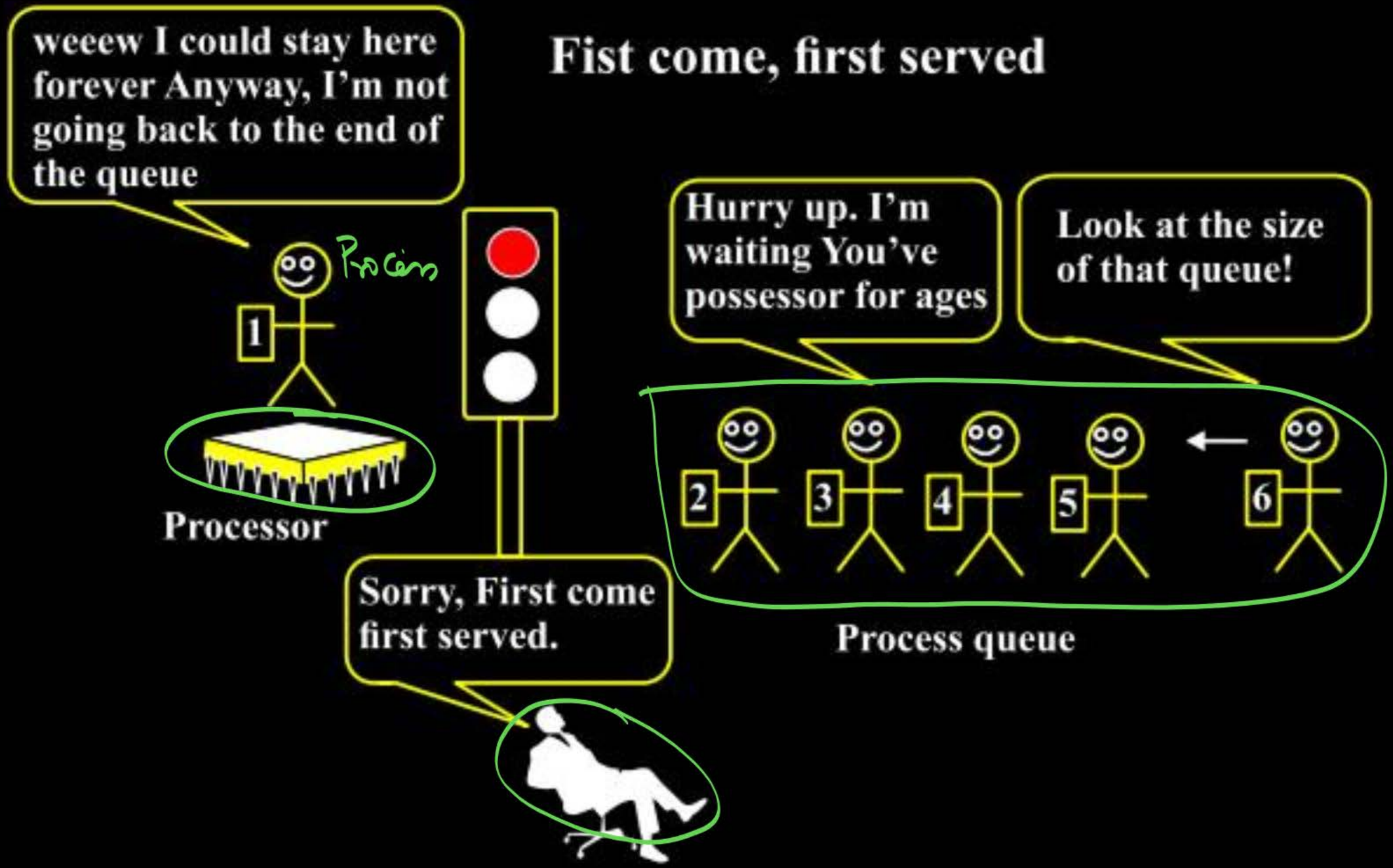
Av. TAT = 4.3 = ?

Av. WT = 7/6 = ?

∴ cpu Idleness = $\frac{4}{23}$



Fist come, first served



THANK YOU
GW
SOLDIERS !