ELSEWEDY UNIVERSITY OF TECHNOLOGY
- POLYTECHNIC OF EGYPT -

CPU Scheduling

Lab 7: CPU Scheduling

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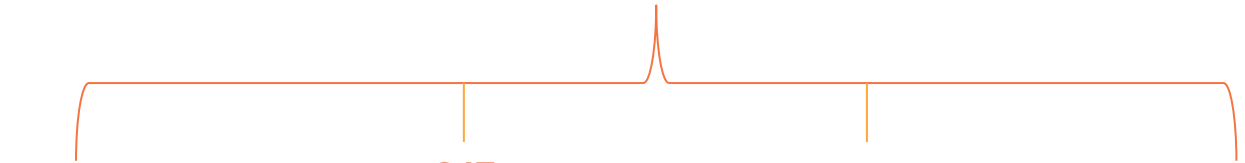
CPU Scheduling



FCFS
"First Come First Serve"

SJF
"Shortest Job First" (non-preemptive , preemptive)

Priority
(non-preemptive , preemptive)

R.R
(Round Robin)

Notes

- ***Waiting Time (WT):***

Definition: The total time a process spends waiting in the ready queue before being executed.

Calculation: WT = start time – arrival time
Significance: A lower WT indicates better efficiency and responsiveness of the scheduling algorithm.

- ***Turnaround Time (TT):***

Definition: The total time taken by a process from its arrival to its completion.

Calculation: TT = CT - AT (where CT is Completion Time and AT is Arrival Time)

Significance: A lower TT indicates faster overall processing of processes.

EX 1: FCFS (First Come First Serve)

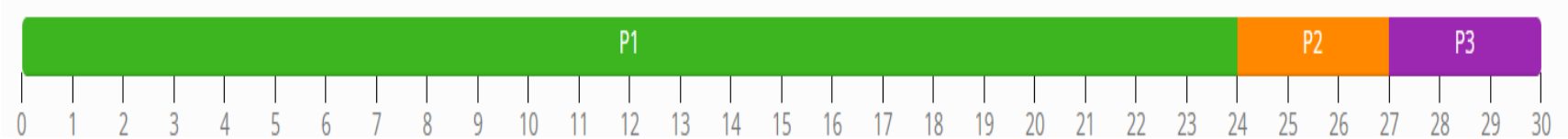
Process	Burst Time
P1	24
p1	3
p3	3

Suppose that the process arrive in order p1,p2,p3.

1. Draw **gannt chart** and calculate the **AWT (Average waiting Time)**

EX 1: Solution

A. Gannt chart :



B. Waiting Time for each process :

p1= 0 p2=24 p3=27

AWT(Average waiting Time)= $\frac{0+24+27}{3}$ = 17

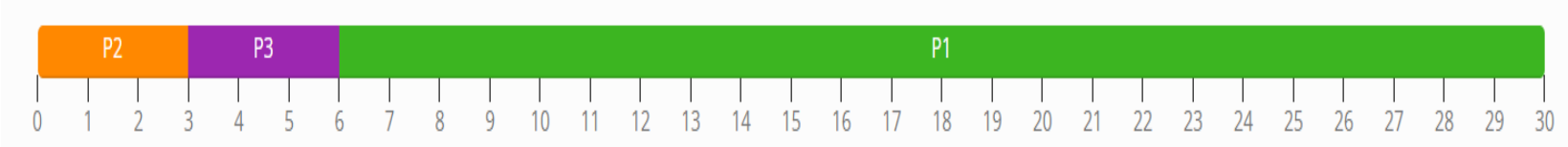
EX 2: FCFS (First Come First Serve)

Process	Burst Time
p1	24
P2	3
p3	3

- With Order p2 , p3 ,p1

EX 2: Solution

A. Gannt chart:



B. Waiting Time for each process :

p1=6 p2=0 p3=3

AWT(Average waiting Time)= $\frac{6+0+3}{3} = 3$

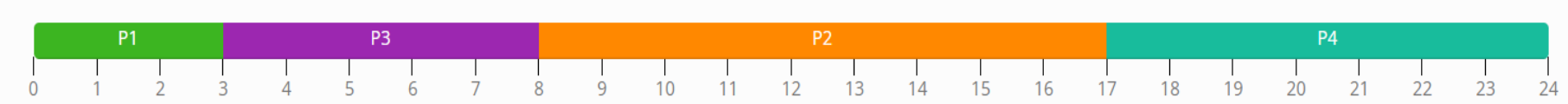
Ex 3: (FCFS)

- Suppose that the processes arrived in order p1, p3,p2 ,p4

Process	Burst Time
P1	3
P2	9
P3	5
P4	7

Ex 3 :Solution

A. Gannt chart:



B. Waiting Time for each process :

P1=0 p2=8 p3=3 p4=17

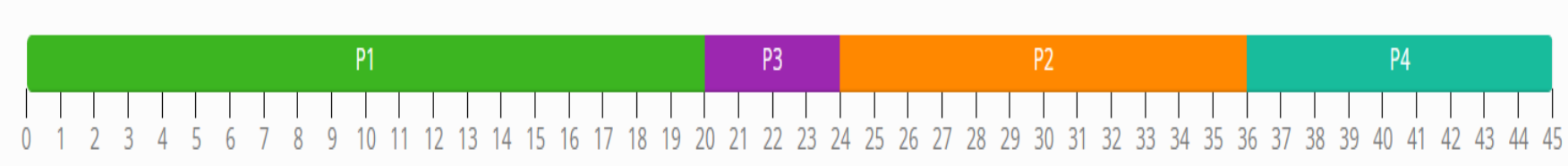
AWT=$\frac{0+8+3+12}{4} = 7$

Ex 4: (FCFS)

Process	Burst Time	Arrival Time
P1	20	0
P2	12	3
P3	9	2
P4	9	5

Ex 4: Solution

A. Gannt chart:



B. Waiting Time for each process :
Waiting time=start time-Arrival time

P1=0-0=0 p2=24-4=21 p3=20-2=18 p3=36-5=31

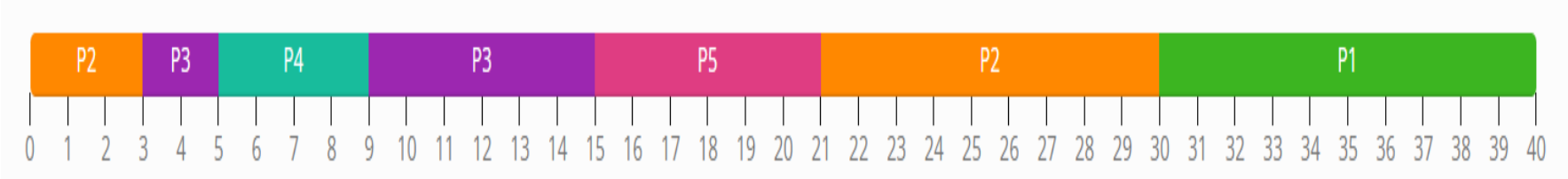
(AWT)Average waiting time=$\frac{0+21+18+31}{4} = 70/4$

EX 5: SJF(Shortest Job First) “Preemptive”

Process	Burst Time	Arrival Time
P2	12	0
P3	8	3
P4	4	5
P1	10	10
P5	6	12

EX 5: Solution

A. Gannt chart:



B. Waiting Time for each process :

p1=30-10=20 p2=(0-0)+(21-3)=18 p3=(3-3)+(9-5)=4

p4=(5-5)=0 p5=(15-12)=3

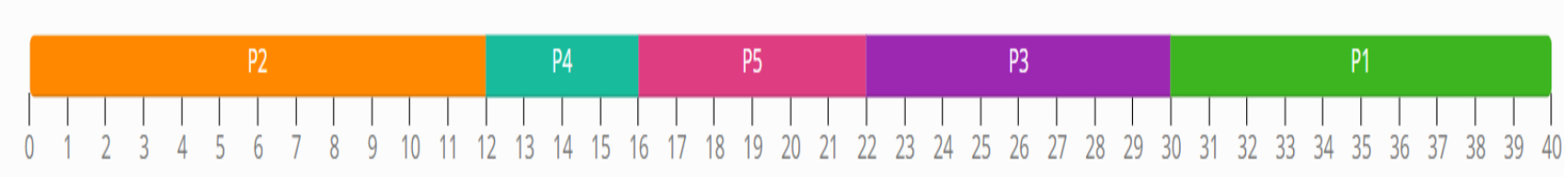
AWT=$\frac{20+18+4+0+3}{5} = 9$

Ex:6 (SJF) “non-preemptive”

Process	Burst time	Arrival time
P1	10	10
P2	12	0
P3	8	3
P4	4	5
P5	6	12

Ex 6: Solution

A. Gannt char



B. Waiting Time for each process :

p1=(30-10)=20 p2=(0-0)=0 p3=22-3=19 p4=12-5=7
p5=16-12=4

$$AWT=\frac{20+0+19+7+4}{5}=10$$

Ex 6: Solution

C. Turnaround Time=Completion time –Arrival time.

p1=(40-10)=30 p2=(12-5)=12 p3=(30-3)=27 p4=(16-5)=11
p5=(22-12)=10

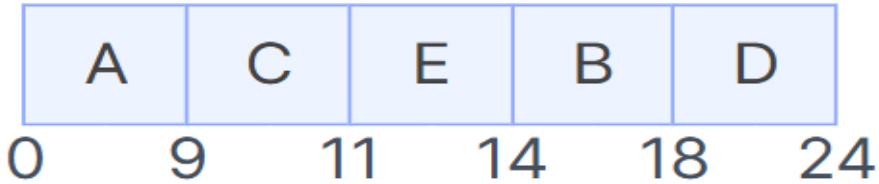
Average of turnaround time= $\frac{30+12+27+11+10}{5}$ =18

Ex 7 :Priority (non-preemptive & preemptive)

Process	Burst Time	Arrival Time	Priority
A	9	0	3
B	4	2	4
C	2	3	1
D	6	5	5
E	3	7	2

Ex 7:Solution (non-preemptive)

A. Gannt chart :



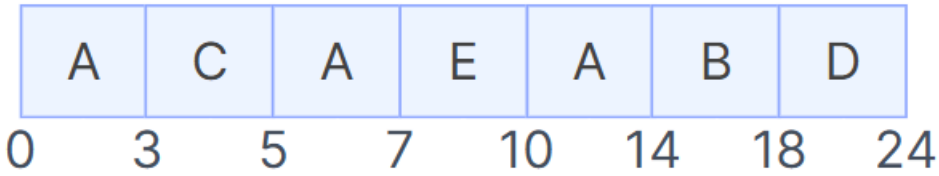
Waiting time :

A=0-0=0 B=14-2=12 C=9-3=6 D=18-5=13 E=11-7=4

AWT=$\frac{0+12+6+13+4}{5} = 7$

Ex 7:Solution (preemptive)

Gannt chart :



Waiting Time:

A=(0-0)+(5-3)+(10-6)=5 B=(14-2)=12 C=(3-3)=0 D=(18-5)=13

E=(7-7)=0

AWT=$\frac{30}{5} = 6$

EX:8

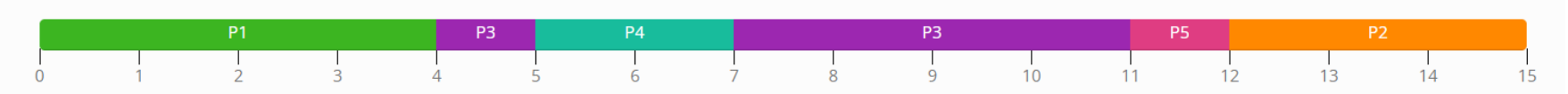
q. Consider the following processes with their arrival and burst time as well as their priority. A larger value means a higher priority. Assume preemptive priority scheduling according to the following protocol: if a new process arrives the ready queue or a process terminates, a new scheduling takes place. The CPU will be allocated to the process with the highest priority. Equal priority processes are scheduled in FCFS order.

Process	CPU Burst	Arrival time	Priority
P1	4	0	3
P2	3	2	1
P3	5	3	3
P4	2	5	4
P5	1	7	2

Preemtive priority :

a)Using preemptive priority scheduling, represent the order in which the processes are executed. Then calculate the average waiting time and the average turnaround time

➢ **Algorithm description:** Processes are scheduled based on priority (higher priority value is higher priority). If a new process with a higher priority arrives, it preempts the current process.



- **Waiting time of each process :**
  - P1: (0-0)=0
  - P2: (12-2)=10
  - P3: (4-3)+(7-5)=3
  - P4: (5-5)=0
  - P5: (11-7)=4
  - Average waiting time = (0+10+3+0+4)/5=3.4
- **Turnaround Time of each process :**
  - P1: 4-0=4
  - P2: 15-2=14
  - P3: 11-3=8
  - P4: 7-5=2
  - P5:12-7=5
  - Average turnaround time = (4+14+8+2+5)/5=6.6

First come first serve :

b)Repeat part (a) using First Come First Serviced (FCFS) scheduling algorithm.

- **Algorithm description:** Processes are executed in the order they arrive

- **Waiting time of each process :**
  - P1: (0-0)=0
  - P2: (4-2)=2
  - P3: (7-3)=4
  - P4: (12-5)=7
  - P5: (14-7)=7
  - Average waiting time = (0+2+4+7+7)/5=4
- **Turnaround Time of each process :**
  - P1: 4-0=4
  - P2: 7-2=5
  - P3: 12-3=9
  - P4: 14-5=9
  - P5:15-7=8
  - Average turnaround time = (4+5+9+9+8)/5=7

Ex9:

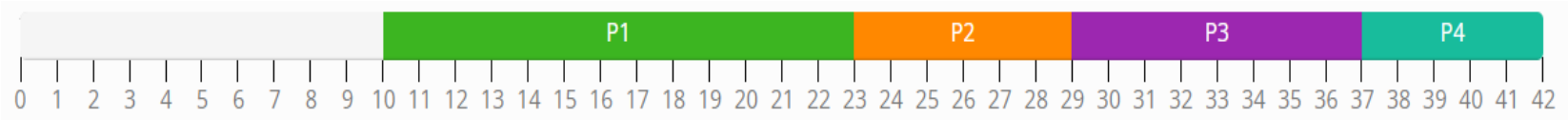
- **Given the following set of processes:**

Process Id	CPU burst time	Arrival time	Priority
P1	13	10	4
P2	6	15	2
P3	8	20	1(highest)
P4	5	25	3

  - **Compute the average waiting time and average turnaround time for the following cases:**

a) First-Come, First-Served (FCFS) Scheduling

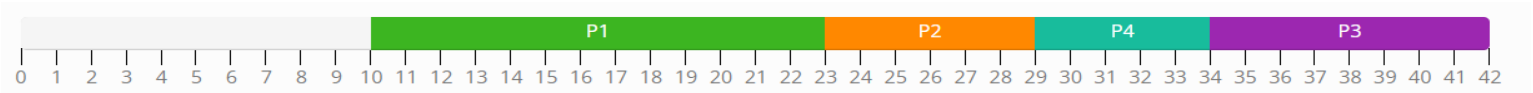
- **Algorithm:** Processes are executed in the order they arrive



- **Waiting time of each process :**
  - P1: 10-10=0
  - P2: 23-15=8
  - P3: 29-20=9
  - P4: 37-25=12
  - Average waiting time = (0+8+9+12)/4=7.25
- **Turnaround Time of each process :**
  - P1: 23-10=13
  - P2: 29-15=14
  - P3: 37-20=17
  - P4: 42-25=17
  - Average turnaround time = (13+14+17+17)/4=15.25

c) Preemptive Shortest-Job-First (SJF) scheduling

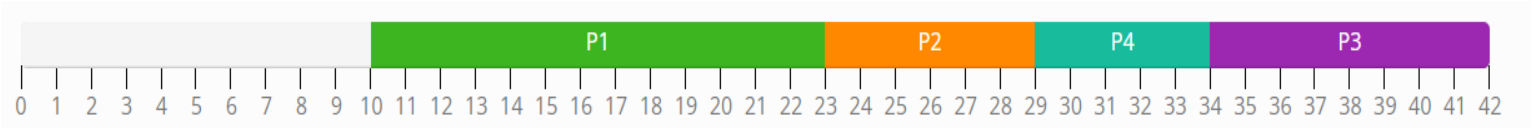
- **Algorithm:** The process with the shortest remaining burst time (SRT) is executed. If a new process with a shorter burst time arrives, it preempts the current process.



- **Waiting time of each process :**
  - P1: (10-10)+(21-15)=6
  - P2: 15-15=0
  - P3: 34-20=14
  - P4: 29-25=4
  - Average waiting time = (6+0+14+4)/4=6
- **Turnaround Time of each process :**
  - P1: 29-10=19
  - P2: 21-15=6
  - P3: 42-20=22
  - P4: 34-25=9
  - Average turnaround time = (19+6+22+9)/4=14.5

b) Non-preemptive Shortest-Job-First (SJF) :

- **Algorithm:** Shortest remaining burst time executes first.



- Waiting time of each process :
  - P1: 10-10=0
  - P2: 23-15=8
  - P3: 34-20=14
  - P4: 29-25=4
  - **Average waiting time** = (0+8+14+4)/4=6.5
- Turnaround Time of each process :
  - P1: 23-10=13
  - P2: 29-15=14
  - P3: 42-20=22
  - P4: 34-25=9
  - **Average turnaround time** = (13+14+17+17)/4=14.5

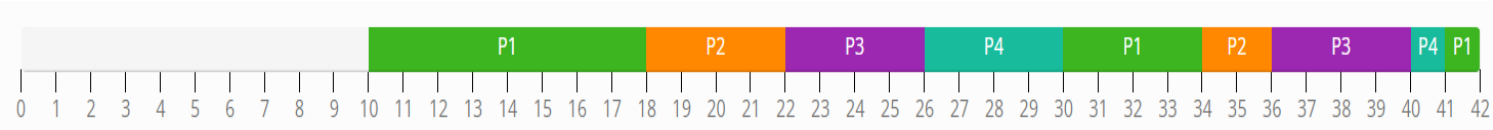
d) Non-preemptive Priority scheduling

- **Algorithm:** Processes are scheduled based on priority. If two processes have the same priority, FCFS is used.

- **Waiting time of each process :**
  - P1: (10-10)=0
  - P2: 31-15=16
  - P3: 23-20=3
  - P4: 37-25=12
  - Average waiting time = (0+16+3+12)/4=7.75
- **Turnaround Time of each process :**
  - P1: 23-10=13
  - P2: 37-15=22
  - P3: 31-20=11
  - P4: 42-25=17
  - Average turnaround time = (13+22+11+17)/4=15.75

e) Preemptive Priority scheduling

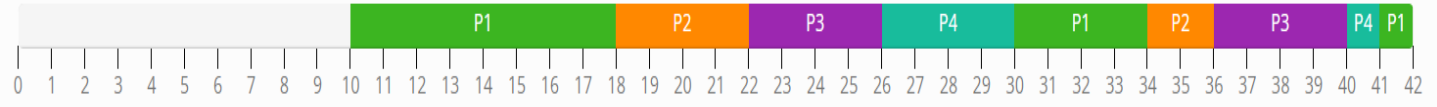
- **Algorithm:** Processes are scheduled based on priority (lower priority value is higher priority). If a new process with a higher priority arrives, it preempts the current process.



- **Waiting time of each process :**
  - P1: (10-10)+(34-15)=19
  - P2: (15-15)+(28-20)=8
  - P3: 20-20=0
  - P4: 29-25=4
  - Average waiting time = (19+8+0+4)/4=7.75
- **Turnaround Time of each process :**
  - P1: 42-10=32
  - P2: 29-15=14
  - P3: 28-20=8
  - P4: 34-25=9
  - Average turnaround time = (32+14+8+9)/4=15.75

f) Round robin (RR) with time quantum = 4 unit

- **Algorithm:** Each process gets a time slice (quantum) of 4 units. If the process doesn't finish, it is preempted and re-added to the queue, when a process's time quantum expires , it is moved to the back of the queue.



- **Waiting time of each process :**
  - P1: (10-10)+(30-18)+(41-34)=19
  - P2: (18-15)+(34-22)=15
  - P3: (22-20)+(36-26)=12
  - P4: (26-25)+(40-30)=11
  - Average waiting time = (19+15+12+11)/4=14.25
- **Turnaround Time of each process :**
  - P1: 42-10=32
  - P2: 36-15=21
  - P3: 40-20=20
  - P4: 41-25=16
  - Average turnaround time = (32+21+20+16)/4=22.25