

## Assignment 1.

Q. 1.

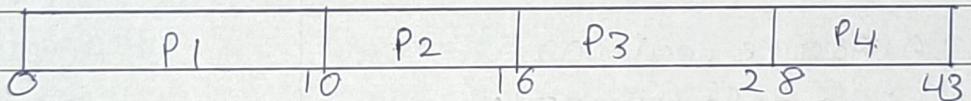
~~→ Q. 1. FCFS Scheduling algorithm~~

Process	Arrival Time	Burst Time
---------	--------------	------------

P <sub>1</sub>	0	10
P <sub>2</sub>	1	6
P <sub>3</sub>	2	12
P <sub>4</sub>	3	15

a. FCFS scheduling algorithm

Gantt chart



Turnaround time

$$TA \text{ for } P_1 = 10$$

$$TA \text{ for } P_2 = 16 - 1 = 15$$

$$TA \text{ for } P_3 = 28 - 2 = 26$$

$$TA \text{ for } P_4 = 43 - 3 = 40$$

Average turnaround

$$\text{time} = (10 + 15 + 26 + 40) / 4$$

Average turnaround

$$\text{time} = 22.75$$

Waiting time

$$WT \text{ for } P_1 = 0$$

$$WT \text{ for } P_2 = 9$$

$$WT \text{ for } P_3 = 14$$

$$WT \text{ for } P_4 = 22.5$$

∴ Average waiting time =

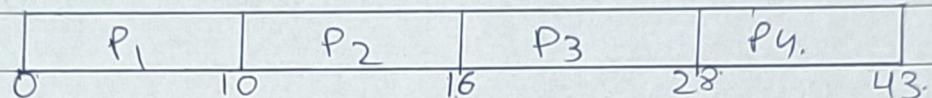
$$(0 + 9 + 14 + 22.5) / 4$$

∴ Average waiting time

$$= 12$$

## b. i. SJF (Non-preemptive)

Gantt chart:



Waiting time

$$WT \text{ for } P_1 = 0$$

$$WT \text{ for } P_2 = 9$$

$$WT \text{ for } P_3 = 14$$

$$WT \text{ for } P_4 = 25$$

Average waiting time

$$\text{Time} = (0+9+14+25)/4$$

Turnaround time

$$TA \text{ for } P_1 = 10$$

$$TA \text{ for } P_2 = 16 - 1 = 15$$

$$TA \text{ for } P_3 = 28 - 2 = 26$$

$$TA \text{ for } P_4 = 43 - 3 = 40$$

Average turnaround time

$$\text{Time} = (10+15+26+40)/4$$

∴ Average waiting time

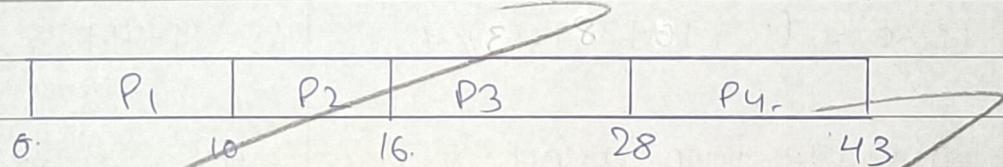
$$\underline{\text{Time}} = 12$$

∴ Average turnaround time

$$\underline{\text{Time}} = 22.75$$

## 2. SJF (Preemptive)

Gantt chart:



Manav Jawani - 17

8.1.3.

~~SJF (Preemptive)~~

→ From Gantt chart, we can see that SJF (Non-preemptive) and FCFS are same.

$$\therefore \text{Average waiting time} = 12$$

Average ultrasound time = 22.75

## Round Robin (Time Slice=2):

Gantt chart:

0	2	4	6	8	10	12	14	16	18	20	22
P <sub>1</sub>	P <sub>2</sub>	P <sub>3</sub>	R <sub>4</sub>	P <sub>1</sub>	P <sub>2</sub>	P <sub>3</sub>	P <sub>4</sub>	P <sub>1</sub>	P <sub>2</sub>	P <sub>3</sub> .	
R <sub>4</sub>	P <sub>1</sub>	P <sub>3</sub>	P <sub>4</sub> .	P <sub>1</sub>	P <sub>3</sub>	P <sub>4.</sub>	P <sub>3</sub>	P <sub>4</sub>	P <sub>4</sub>	P <sub>4</sub> .	
22	24.	26	28	30.	32	34	36	38.	40	42	44

Average waiting time =

$$\begin{aligned} & [(0-0) + (8-2) + (16-10) + (24-18) + (30-26)] + \\ & [(22-1) + (10-4) + (18-12)] + [(4-2) + (12-6) + (20-4) + (26-22)] \\ & + (32-28) + (36-34)] + [(6-3) + ((4-8) + (22-16) + (28-24) + \\ & (34-30) + (38-36))] \end{aligned}$$

$$\therefore \text{Average waiting time} = \frac{84}{4} = 21$$

$$\text{Average tournament time} = (32-0) + (20-1) + (38-2) + (43-3)/4.$$

$$\text{Average turnaround time} = \frac{127}{4} = 31.75$$

Q.1.b.

SJF (Preemptive).

Gantt chart:

	P <sub>1</sub>	P <sub>2</sub>	P <sub>1</sub>	P <sub>3</sub>	P <sub>4</sub>
	0	1	7	16	28

Average waiting time =

$$= \frac{[(0-0) + (7-1) + (1-1) + (16-2) + (28-3)]}{4}$$

$$= \frac{45}{4}$$

$$\therefore \text{Average waiting time} = \underline{11.25}$$

Average turnaround time =

$$= \frac{[(1-0) + (16-1) + (7-1) + (28-2) + (43-3)]}{4}$$

$$= \frac{88}{4}$$

$$\therefore \text{Average turnaround time} = \underline{22}$$

Comparing

Algorithm	AWT	ATAT	Throughput
1. FCFS	12	22.75	
2. SJF (Pre)	11.25	22	4/43 =
3. SJF (Non-Pre)	12	22.75	0.09302
4. Round Robin.	21	31.75	

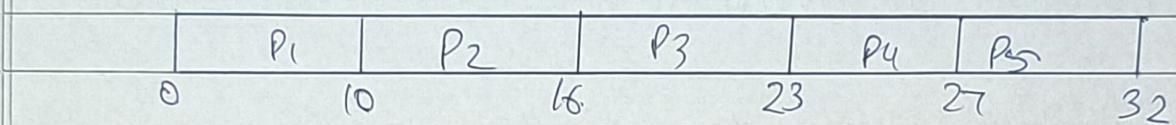
Q2.  
→

Process	Burst time	Arrival time	Priority
P1	10	0	5
P2	6	0	2
P3	7	4	4
P4	9	1	1
P5	5	2	3

a.

FCFS

Gantt chart:



Average waiting time =  $\frac{(0-0)+(10-0)+(16-1)+(23-1)+(27-2)}{5}$

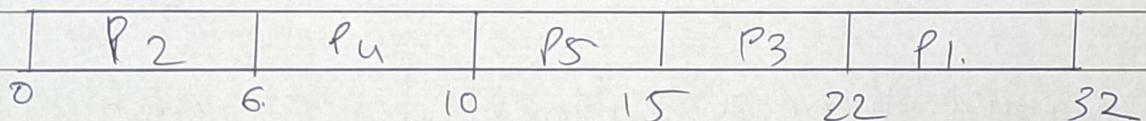
∴ Average waiting time =  $\frac{72}{5} = 14.4 \text{ ms}$

Average turnaround time =  $\frac{(10-0)+(16-0)+(23-1)+(27-1)+(32-2)}{5}$

∴ Average turnaround time =  $\frac{104}{5} = 20.8 \text{ ms}$

b. SJF (non-preemptive).

Gantt chart:



Q. 2. b.

$$\rightarrow \text{Average waiting time} = \frac{(0-0)+(6-1)+(10-2)+(15-10)+(22-0)}{5}$$

$$\therefore \text{Average waiting time} = \frac{49}{5} = 9.8 \text{ ms}$$

$$\text{Average turnaround time} = \frac{(6-0)+(10-1)+(15-2)+(22-10)+(32-0)}{5}$$

$$\therefore \text{Average turnaround time} = \frac{81}{5} = 16.2 \text{ ms}$$

c. Round Robin quantum = 3ms.  
Gantt chart

P <sub>1</sub>	P <sub>2</sub>	P <sub>3</sub>	P <sub>4</sub>	P <sub>5</sub>	P <sub>1</sub>	P <sub>2</sub>	P <sub>3</sub>	P <sub>4</sub>	P <sub>5</sub>	P <sub>1</sub>	P <sub>3</sub>	P <sub>1</sub>
3	6	9	12	15	18	21	24	27	30	33	36	39

$$\begin{aligned} \text{Average waiting time} &= [(0-0)+(15-3)+(27-18)+(31-30)] + \\ &[3-0]+[(8-6)] + [(6-1)+(21-9)+(30-24)] + [(9-1)+(24-12)] + \\ &[(12-2)+(25-15)] / 5 = \frac{100}{5} = 20 \text{ ms} \end{aligned}$$

$$\therefore \text{Average waiting time} = \underline{20 \text{ ms}}$$

$$\text{Average turnaround time} = \frac{[(32-0)+(21-0)+(31-1)+(25-1)+(27-2)]}{5}$$

$$\therefore \text{Average turnaround time} = \frac{132}{5} = \underline{26.4 \text{ ms}}$$

Q.3.9.

→

FCFS

Gantt chart:

	P <sub>1</sub>	P <sub>2</sub>	P <sub>3</sub>	P <sub>4</sub>	P <sub>5</sub>
	0	10	16	23	27

$$\text{Average waiting time} = \frac{(0-0) + (10-0) + (16-1) + (23-1) + (27-2)}{5}$$

$$\therefore \text{Average waiting time} = \underline{14.4 \text{ units}}$$

$$\text{Average turnaround time} = \frac{(10-0) + (16-0) + (23-1) + (27-1) + (32-2)}{5}$$

$$\text{Average turnaround time} = \underline{20.8 \text{ units}}$$

b

SJF

i.

Non-Preemptive

	P <sub>2</sub>	P <sub>4</sub>	P <sub>5</sub>	P <sub>3</sub>	P <sub>1</sub>
	0	6	10	15	22

$$\text{Average waiting time} = [(0-0) + (6-1) + (10-2) + (15-1) + (22-0)]/5$$

$$\therefore \text{Average waiting time} = \frac{49}{5} = \underline{9.8 \text{ units}}$$

$$\text{Average turnaround time} = [(6-0) + (10-1) + (15-2) + (22-1) + (32-0)]/5$$

$$\therefore \text{Average turnaround time} = \frac{81}{5} = \underline{16.2 \text{ ms}}$$

Q.3.b2. Preemptive.

→ Gantt chart:

P <sub>2</sub>	P <sub>4</sub>	P <sub>2</sub>	P <sub>5</sub>	P <sub>3</sub>	P <sub>1</sub>
0	1	5	10	15	22

Average waiting time =

$$\left\{ [0-0] + [5-0] + [1-0] + [10-2] + [15-1] + [22-0] \right\} / 5$$

Average waiting time =  $\frac{48}{5} = 9.6$  units

Average turnaround time =

$$[(32-0) + (10-0) + (22-1) + (5-1) + (15-2)] / 5$$

Average turnaround time =  $\frac{80}{5} = 16$  units

G

Priority (Non-preemptive)

Gantt chart

P <sub>2</sub>	P <sub>4</sub>	P <sub>5</sub>	P <sub>3</sub>	P <sub>1</sub>
0	6	10	15	22

Average waiting time =  $(22-0) + (0-0) + (15-1) + (6-1) + (10-5)] / 5$

Average waiting time =  $\frac{49}{5} = 9.8$  units

Q.3 C

$$\rightarrow \text{Average turnaround time} = [(320) + (6-0) + (22-1) + (10-1) + (15-2)] / 5$$

$$\therefore \text{Average turnaround time} = \frac{381}{5} = 16.2 \text{ units.}$$

D Round Robin (quantum = 5 units)  
Gantt chart:

	P <sub>1</sub>	P <sub>2</sub>	P <sub>3</sub>	P <sub>4</sub>	P <sub>5</sub>	P <sub>1</sub>	P <sub>1</sub>	P <sub>2</sub>
0	5	10	15	19	24	29	30	32

$$\begin{aligned} \text{Average waiting time} &= \\ &= [(0-0) + (24-5)] + [(5-0) + (29-5)] + [(10-1) + (10-5) + (15-1) + \\ &\quad (19-2)] / 5 \end{aligned}$$

$$\therefore \text{Average waiting time} = \frac{98}{5} = 19.6 \text{ units}$$

$$\begin{aligned} \text{Average turnaround time} &= \\ &= \cancel{[(29-0) + (30-0) + (32-1) + (19-1) + (24-2)]} \end{aligned}$$

$$= \{[(29-0) + (30-0) + (32-1) + (19-1) + (24-2)]\} / 5$$

$$\therefore \text{Average turnaround time} = \frac{150}{5} = 26 \text{ units}$$