Assignment-01: 20175| BSE-DAY

AOS (Applied Operating System):-

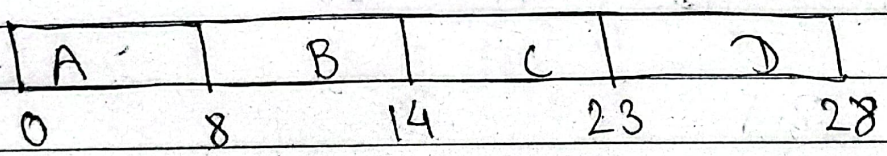
Process Scheduling Assignment:

Q)1) Given the following information's, draw GANTT charts & find the average waiting time & average turn-around time using FCFS, SJF, SRTF, RR (quantum=3), HRRN.

Process	Arrival Time	Burst Time
A	0	8
B	2	6
C	4	9
D	7	5

=> (i) FCFS Scheduling:

Gantt chart:



Turn Around Time (TAT) = C.T - A.T

A = 8 - 0 = 8

B = 14 - 2 = 12

C = 23 - 4 = 19

D = 28 - 7 = 21

Avg. TAT = $\frac{8+12+19+21}{4}$ = 15 ms

Waiting time = TAT - B.T

A = 8-8 = 0

B = 12-6 = 6

C = 19-9 = 10

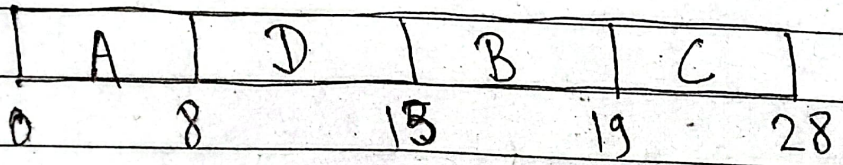
D = 21-5 = 16

Average waiting time = $\frac{0+6+10+16}{4}$ = 8 ms #

(11) Using Shortest Job First (SJF):-

Gantt chart:

| D | B | A | C |



At 8	B.T
B	6
D	5 (smaller)

TAT = C.T - A.T

A = 8-0 = 8

D = 13-8 = 5

B = 19-2 = 17

C = 28-4 = 24

Avg TAT = $\frac{8+6+17+24}{4}$ = 13.75ms

Again,

W.T = TAT - B.T

A: 8 - 8 = 0

B: 17 - 6 = 11

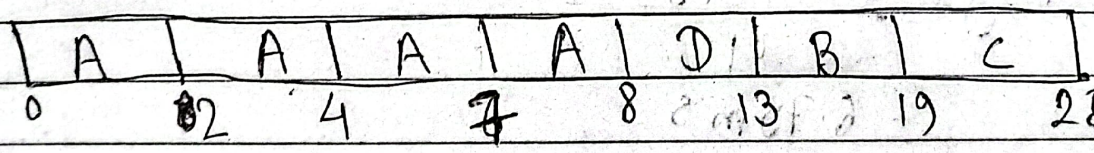
C: 24 - 9 = 15

D: 6 - 5 = 1

Avg. WT = $\frac{0+11+15+1}{4}$ = 6.75ms

(iii) Using SRTF (Preemptive) (*):

Gantt Chart:



At 2:	B.T
A	8-2=6
B	6

At 4:	B.T
A	6-2=4
B	6
C	9

At 7:	
A	4-3=1
B	6
C	9
D	5

At 8:	B.T
B	6
C	9
D	5

At 13	B.T
B	6
C	9

TAT = C.T - A.T

A = 8 - 0 = 8

B = 19 - 2 = 17

C = 28 - 4 = 24

D = 13 - 7 = 6

$$TAT_{avg} = \frac{8+17+24+8}{4}$$

$$= 13.75 ms$$

W.T = TAT - B.T

A = 8 - 8 = 0

B = 17 - 6 = 11

C = 24 - 9 = 15

D = 6 - 5 = 1

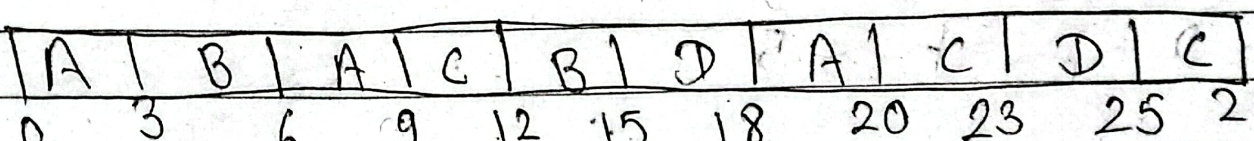
$$W.T_{Avg} = \frac{0+11+15+1}{4}$$

$$= 6.75 ms$$

(iv) Round Robin Technique:

Time quantum = 3ms

Gantt chart



TAT = C.T - A.T

A = 20 - 0 = 20

B = 15 - 2 = 13

C = 28 - 4 = 24

D = 25 - 7 = 18

Ready Queue

~~A~~
~~B~~
~~A~~
~~C~~
~~B~~
~~D~~
~~A~~
~~C~~
~~D~~
~~C~~

$$\text{Avg TAT} = \frac{20+13+24+18}{4}$$

$$= 18.75 \text{ ms.}$$

WT = TAT - B.T

A = 20 - 8 = 12

B = 13 - 6 = 7

C = 24 - 9 = 15

D = 18 - 5 = 13

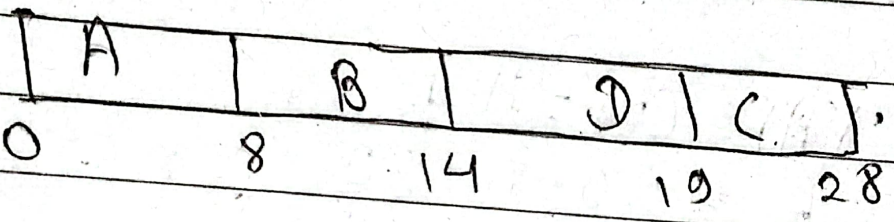
$$\text{Avg. WT} = \frac{12+7+15+13}{4}$$

$$= 11.75$$

HRRN

Process	A.T	B.T
A	0	8
B	2	6
C	4	9
D	7	5

Gantt chart:



At 8,

$R_R(B) = \frac{W.T + B.T}{B.T} = \frac{(8-2)+6}{6} = 2$ (highest ratio)

$R_R(C) = \frac{W.T + B.T}{B.T} = \frac{(8-4)+9}{9} = \frac{13}{9} = 1.45$

$R_R(D) = \frac{W.T + B.T}{B.T} = \frac{(8-7)+5}{5} = 1.2$

At 14,

$R_R(C) = \frac{W.T + B.T}{B.T} = \frac{(14-4)+9}{9} = 2.12$

$R_R(D) = \frac{W.T + B.T}{B.T} = \frac{(14-7)+5}{5} = \frac{12}{5} = 2.4$ (highest ratio)

$TAT = C.T - A.T$

A = 8 - 0 = 8
B = 14 - 2 = 12
C = 19 - 7 = 12
D = 28 - 4 = 24

$W.T = TAT - B.T$

A = 8 - 8 = 0
B = 12 - 6 = 6
C = 24 - 9 = 15
D = 12 - 5 = 7

$TAT_{Avg} = \frac{8+12+12+24}{4}$

$= 14 ms$

$WT_{avg} = \frac{0+6+15+7}{4}$

$= 7ms.$

Suppose six batch jobs P1, P2, P3, P4, P5 & P6 arrived at the service centre at time 0. They have the running time of 18, 20, 6, 10, 12 & 8 respectively. Their priorities are 4, 2, 1, 5 & 6 respectively with 1 being the highest priority. For each of the scheduling algorithms, determine the mean process turnaround time. Also determine the average system waiting time for

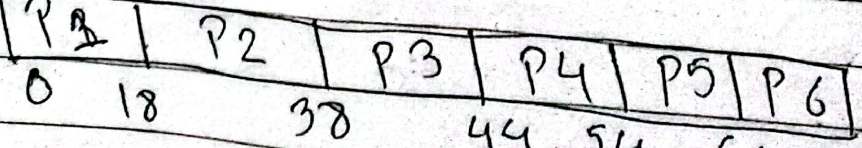
(a) FCFS (b) SJF (c) RR (quantum size 6) d. Priority Scheduling
(e) HRRN (f) SRTN

Here,

Jobs	Burst-Time	Priority
P1	18	4
P2	20	2
P3	6	1
P4	10	3
P5	12	5
P6	8	6

Using FCFS
∴ Since all jobs arrived at time 0ms.

Grantt Chart



TAT = C.T - AT

P1 = 18 - 0 = 18

P2 = 38 - 0 = 38

P3 = 44 - 0 = 44

P4 = 54 - 0 = 54

P5 = 66 - 0 = 66

P6 = 74 - 0 = 74

W.T = TAT - B.T

P1 = 18 - 18 = 0

P2 = 38 - 20 = 18

P3 = 44 - 6 = 38

P4 = 54 - 10 = 44

P5 = 66 - 12 = 54

P6 = 74 - 8 = 66

$TAT_{avg} = \frac{18+38+44+54+66+74}{6}$

$= 49$ ms

$W.T_{avg} = \frac{0+18+38+44+54+66}{6}$

$= 36.6667$ ms

(b) Using SJF:

Arrival time = 0ms

Grantt chart

| P3 | P6 | P4 | P5 | P1 | P2 |

0 6 14 24 36 54 74

TAT = C.T - AT

P1 = 54 - 0 = 54

P2 = 74 - 0 = 74

P3 = 6 - 0 = 6

P4 = 24 - 0 = 24

P5 = 36 - 0 = 36

P6 = 14 - 0 = 14

W.T = TAT - B.T

P1 = 54 - 18 = 36

P2 = 74 - 20 = 54

P3 = 6 - 6 = 0

P4 = 24 - 10 = 14

P5 = 36 - 12 = 24

P6 = 14 - 8 = 6

$TAT_{avg} = \frac{54+74+6+24+36+14}{6}$

$= 34.667$ ms

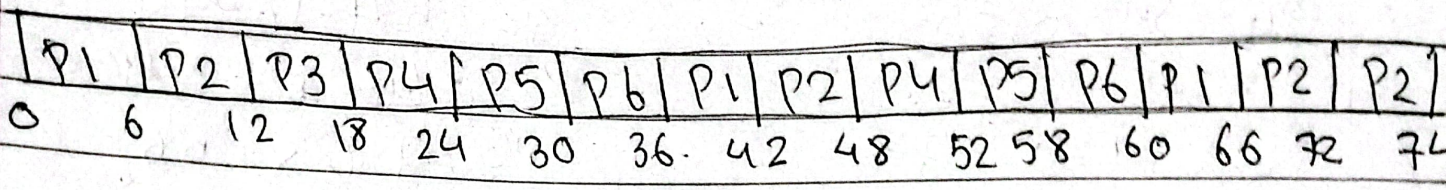
$W.T_{avg} = \frac{36+54+0+14+24+6}{6}$

$= 22.333$

(c) Using RR

quantum size = 6

Gantt chart



Ready queue

~~P1~~ ~~P1~~
~~P2~~ ~~P2~~
~~P3~~ ~~P4~~
~~P4~~ ~~P5~~
~~P5~~ ~~P6~~
~~P6~~ ~~P1~~
~~P2~~

TAT = C.T - A.T

P1 = 66 - 0 = 66
P2 = 74 - 0 = 74
P3 = 18 - 0 = 18
P4 = 52 - 0 = 52
P5 = 58 - 0 = 58
P6 = 60 - 0 = 60

W.T = TAT - B.T

P1 = 66 - 18 = 48
P2 = 74 - 20 = 54
P3 = 18 - 6 = 12
P4 = 52 - 10 = 42
P5 = 58 - 12 = 46
P6 = 60 - 8 = 52

$TAT_{avg} = \frac{66+74+18+52+58+60}{6}$

$= 54.6667$ ms

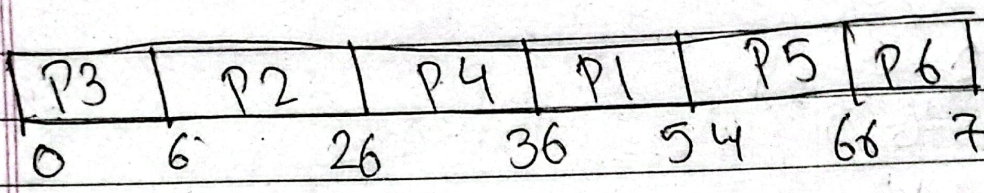
$W.T_{avg} = \frac{48+54+12+42+46+52}{6}$

$= 33.6667$ ms

(d) Priority Scheduling:

Here 1 as highest priority & so on.

Gantt chart:



TAT = C.T - A.T

P1 = 54-0=54
P2 = 26-0=26
P3 = 6-0=6
P4 = 36-0=36
P5 = 66-0=66
P6 = 74-0=74

W.T = TAT - B.T

P1 = 54-18=36
P2 = 26-20=6
P3 = 6-6=0
P4 = 36-10=26
P5 = 66-12=54
P6 = 74-8=66

$TAT_{avg} = \frac{54+26+6+36+66+74}{6}$

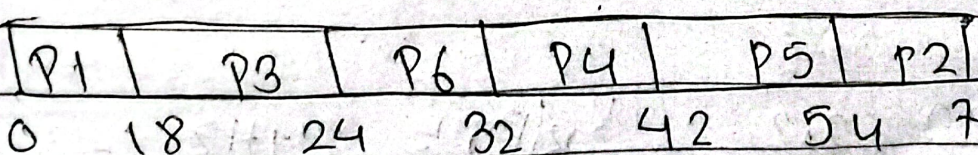
$= 43.6667 ms$

$W.T_{avg} = \frac{36+6+26+54+66}{6}$

$= 31.33 ms$

(e) HRRN:

Gantt chart:



At 0:

$R_R(P_1) = \frac{W.T + B.T}{B.T} = \frac{0+18}{18} = 1$

$R_R(P_2) = \frac{0+20}{20} = 1$

$R_R(P_3) = \frac{0+6}{6} = 1$

$R_R(P_4) = \frac{0+10}{10} = 1$

$R_R(P_5) = \frac{0+12}{12} = 1$

$R_R(P_6) = \frac{0+8}{8} = 1$

Apply FCFS

At 18

$R_R(P_2) = \frac{18+20}{20} = 1.9$ $\quad R_R(P_5) = \frac{18+12}{12} = 2.5$

$R_R(P_3) = \frac{18+6}{6} = 4$ (highest) $\quad R_R(P_6) = \frac{18+8}{18} = 3.25$

$R_R(P_4) = \frac{18+10}{10} = 2.8$

At 24

$R_R(P_2) = \frac{24+20}{20} = 2.2$ $\quad R_R(P_5) = \frac{24+12}{12} = 3$

$R_R(P_4) = \frac{24+10}{10} = 3.4$ $\quad R_R(P_6) = \frac{24+8}{8} = 4$ (highest)

→ At 32:

$RR(P_2) = \frac{32+20}{20} = 2.6$ $RR(P_5) = \frac{32+12}{12} = 3.6667$

$RR(P_4) = \frac{32+10}{10} = 4.2$ (highest)

→ At 42:

$RR(P_2) = \frac{42+20}{20} = 3.1$

$RR(P_5) = \frac{42+12}{12} = 4.5$ (highest)

TAT = C.T − A.T	W.T = TAT − B.T
P1 = 18 − 0 = 18	P1 = 18 − 18 = 0
P2 = 74 − 0 = 74	P2 = 74 − 20 = 54
P3 = 24 − 0 = 24	P3 = 24 − 6 = 18
P4 = 42 − 0 = 42	P4 = 42 − 10 = 32
P5 = 54 − 0 = 54	P5 = 54 − 12 = 42
P6 = 32 − 0 = 32	P6 = 32 − 8 = 24

$TATavg = \frac{18+74+24+42+54+32}{6}$ $W.TAvg = \frac{0+54+18+32+42+24}{6}$

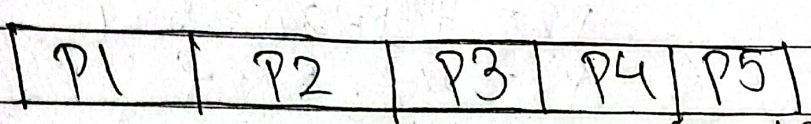
$= 40.6667$ ms $= 28.33$ ms

3) Consider the following set of processes, with the length of the CPU-burst time & arrival-time given in milliseconds:

Process	Burst Time	Arrival time	Priority
P1	10	0	2
P2	15	2	1
P3	22	3	4
P4	16	5	5
P5	5	6	3

Using FCFS:

Gantt Chart:



TAT = C.T - A.T

P1 = 10 - 0 = 10

P2 = 25 - 2 = 23

P3 = 47 - 3 = 44

P4 = 63 - 5 = 58

P5 = 63 - 6 = 62

~~W.T = TAT~~ W.T = TAT - B.T

P1 = 10 - 10 = 0

P2 = 23 - 15 = 8

P3 = 44 - 22 = 22

P4 = 58 - 16 = 42

P5 = 62 - 5 = 57

$$TAT_{avg} = \frac{10+23+44+58+62}{5}$$

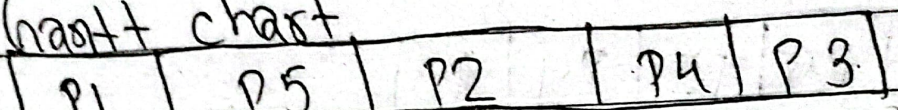
$$= 39.4 ms$$

$$WT_{avg} = \frac{0+8+22+42+57}{5}$$

$$= 25.8 ms$$

(11) Using SJF (non-preemptive)

Gantt chart



At 10,	B.T
P5	5
At 15	B.T
P2	15
At 30	B.T
P3	22
P4	16 (Shortest)

T.A.T = C.T - A.T

P1 = 10 - 0 = 10
P2 = 30 - 2 = 28
P3 = 68 - 3 = 65
P4 = 46 - 5 = 41
P5 = 15 - 6 = 9

W.T = T.A.T - B.T

P1 = 10 - 10 = 0
P2 = 28 - 15 = 13
P3 = 65 - 22 = 43
P4 = 41 - 16 = 35
P5 = 9 - 5 = 4

$$T.A.T_{avg} = \frac{10+28+65+41+9}{5}$$

$$= 30.6 \text{ ms}$$

$$W.T_{avg} = \frac{0+13+43+35+4}{5}$$

$$= 19 \text{ ms}$$

(iii) Using SJF (preemptive) :-

Gantt chart

P1	P1	P1	P1	P5	P2	P4	P3
0	2	3	5	6	10	15	30	46

P1	P1	P1	P1	P1	P5	P2	P4	P3
0	2	3	5	6	10	15	30	46	68

At 2	Burst time
P1	8 (shortest)
P2	15

At 3	Burst time
P1	7 (shortest)
P2	15
P3	22

At 5	Burst time
P1	5 (shortest)
P2	15
P3	22
P4	16

At 6	Burst time
P1	4 (shortest)
P2	15
P3	22
P4	16
P5	5

TAT = C.T - A.T

P1 = 10 - 0 = 10
P2 = 30 - 2 = 28
P3 = 68 - 3 = 65
P4 = 46 - 5 = 41
P5 = 15 - 6 = 9

W.T = TAT - B.T

P1 = 10 - 10 = 0
P2 = 28 - 15 = 13
P3 = 65 - 22 = 43
P4 = 41 - 16 = 25
P5 = 9 - 5 - 4

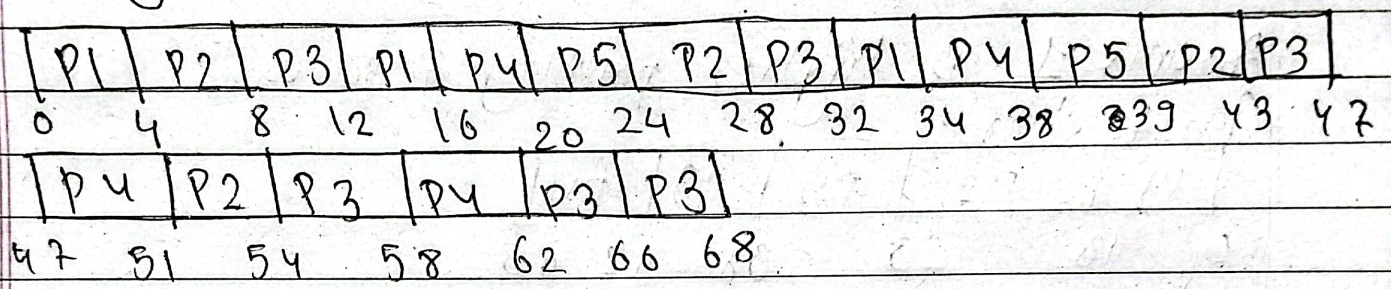
TA Tavg = $\frac{10+28+65+41+9}{5}$

= 30.6 ms

W.Tavg = $\frac{0+13+43+25+4}{5}$

= 19 ms

(iii) Using Round Robin:



Ready Queue

~~P1~~ ~~P4~~
~~P2~~ ~~P5~~
~~P3~~ ~~P2~~
~~P1~~ ~~P3~~
~~P4~~ ~~P4~~
~~P5~~ ~~P2~~
~~P2~~ ~~P3~~
~~P3~~ ~~P4~~
~~P1~~ ~~P3~~

TAT = CT - AT
P1 = 34 - 0 = 34
P2 = 54 - 2 = 52
P3 = 68 - 3 = 65
P4 = 62 - 5 = 57
P5 = 39 - 6 = 33

W.T = T.A.T - B.T
P1 = 34 - 10 = 24
P2 = 52 - 15 = 37
P3 = 65 - 22 = 43
P4 = 57 - 16 = 41
P5 = 33 - 5 = 28

$TAT_{avg} = \frac{34+52+65+97+33}{5}$

$= 48.2ms$

$W.T_{avg} = \frac{24+37+43+41+28}{5}$

$= 34.6ms$

(10) Using Priority (non-preemptive):

Assume 1 as highest priority & so on.

Gantt chart:

P1	P2	P5	P3	P4

0 10 25 38 52 68

At 10	priority
P2	1 (highest)
P3	4
P4	5
P5	3

T.A.T = C.T - A.T

P1 = 10-0 = 10

P2 = 25-2 = 23

P3 = 52-3 = 49

P4 = 68-5 = 63

P5 = 30-6 = 24

W.T = T.A.T - B.T

P1 = 10-10 = 0

P2 = 23-15 = 8

P3 = 49-22 = 27

P4 = 63-16 = 47

P5 = 24-5 = 19

$TAT_{avg} = \frac{10+23+49+63+24}{5}$

$= 33.8ms$

$W.T_{avg} = \frac{0+8+27+47+19}{5}$

$= 20.2ms$