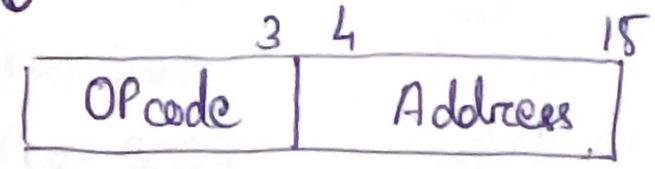
Q1) 0



a) Instruction Format

i) 0001 = Load AC from memory
ii) 0010 = Store AC to memory
iii) 0011 = Load AC from I/O
iv) 0101 = Add to AC from memory
vii) 0111 = Store AC to I/O

Program →

a) Load AC from device 6
b) Add content of memory location 880
c) Store AC to device 7

PC start from 300
→ $2^4 = 16$ diff opcode

So, a) for load AC from device 6

3006
0011 ↳ 12 bit address

b) 5880
Add to AC from memory ↳ ↳ 880 memory location

c) 7007
Store AC to I/O ↳ ↳ Device no. 7

Fetch Stage

Memory
300 → 3006
301 → 5880
302 → 7007

880 → 0008

I/O
006 → 000A
007 → ____

CPU Registers
300 → PC
→ AC
3006 → IR

Step-1

Execute Stage

Memory
300 → 3006
301 → 5880
302 → 7007

880 → 0008

I/O
006 → 000A
007 → ____

CPU Registers
→ 301 PC
000A AC
3006 IR

Step-2

Name:_____ Regd No.:_____

Memory
300 → 3006
301 → 5880
302 → 7007

880 → 0008

I/O
006 → 000A
007 → ____

CPU Registers
301 → PC
000A → AC
5880 → IR

Step 3

Memory
300 → 3006
301 → 5880
302 → 7007

880 → 0008

I/O
006 → 000A
007 → ____

CPU Registers
302 → PC
0012 → AC
7007 → IR

Step 4

Memory
300 → 3006
301 → 5880
302 → 0008

880 → 0008

I/O
006 → 000A
007 → 0012

CPU Registers
303 → PC
0012 → AC
7007 → IR

Step-6

CPU Registers
302 → PC
0012 → AC
5880 → IR

10+8 = 18
↓
in hexadecimal (12)

Step 5

Memory
300 → 3006
301 → 5880
302 → 0008

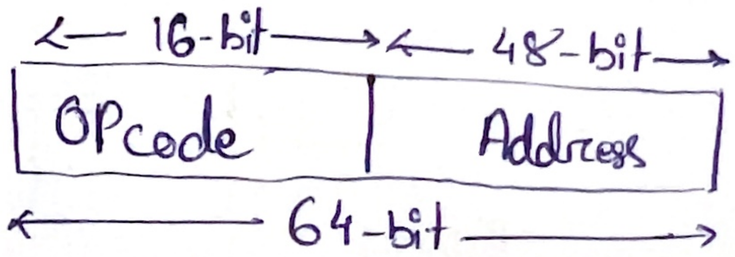
880 → 0008

I/O
006 → 000A
007 → ____

CPU Registers
302 → PC
0012 → AC
7007 → IR

Step 8

Q2) 64-bit microprocessor
→ 2 byte contain OPcode = 16 bit opcode



Maximum directly addressable memory = $2^{48} = 2^{40} \times 2^8$
= 256 TB

Q3) Cache access time = 50ns → Cache hit
Time to access main memory = 550ns
(including cache access) → This is the cache miss
Operation consist of
Reading + writing
↳ Including both memory and cache
may be cache hit or miss

Name:_____ Regd No.:_____

→ 70% of the operation is reading

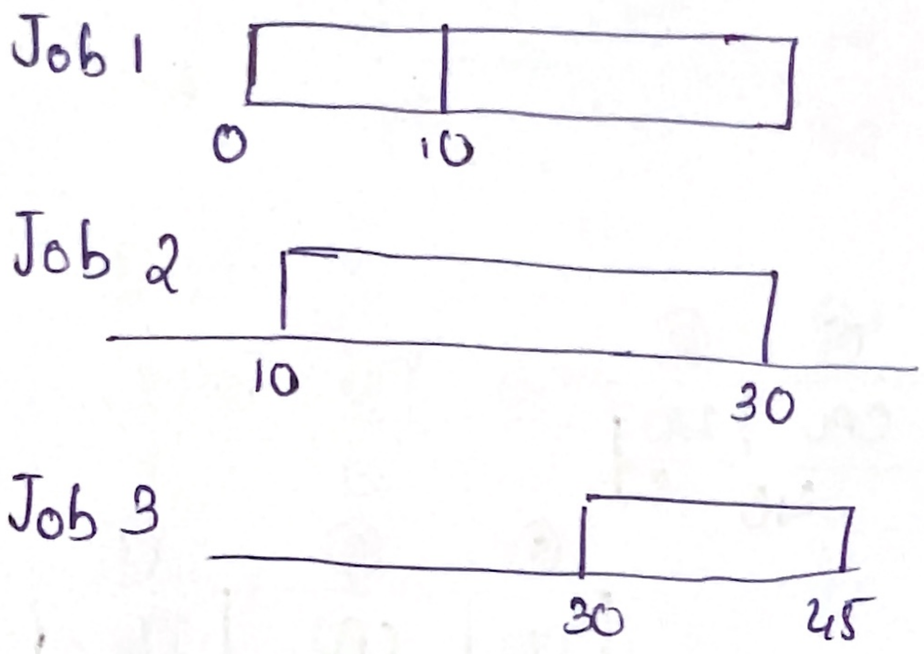
→ Cache hit ratio for read operation = 69

$T_{avg} = 0.7(0.9 \times 50ns + 0.1 \times 550) + 0.3 \times 550$ ⟶ As write oper° both include cache and memory

- 0.7 as 70% is read operation
- 50ns Time taken to access cache
- 550 Time to access memory through
- 0.3 → 30% of write oper°

$= 235\ ns$

4) Uniprogramming



Available Memory = 400 mb

Memory Utilization = $\frac{100 \times 10 + 150 \times 20 + 125 \times 15}{400 \times 45}$

$= 32.63\%$

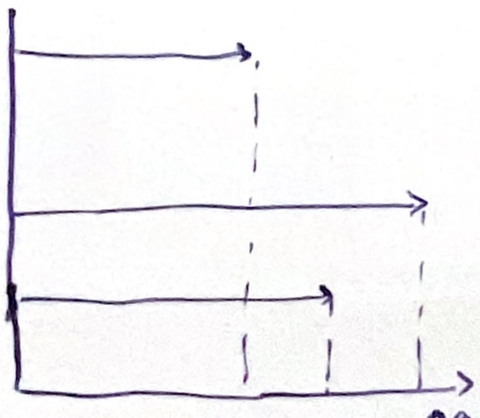
Total time = 45 min

→ Throughput = $3/45$ = 4 Jobs per 1 hour

CPU utilization = $\frac{(80\% \text{ of } 10\text{min}) + (10\% \text{ of } 20\text{min}) + (10\% \text{ of } 15\text{ min})}{45}$

$= \frac{8+2+1.5}{45} = 12.5/45 = 25.55\%$

Multiprogramming



As total memory size is 400 MB
and total memory required = 100+150+125
= 375 MB

So, it is possible

→ CPU utilization = $\frac{80\% \text{ of } 10 + 10\% \text{ of } 20 + 10\% \text{ of } 15}{20} = \frac{11.5}{20} \times 100$

$= 57.5\%$

Throughput = $3/20$ = 9 Jobs/hr

→ Memory utilization → for first 10 min + For next 5 min + For next 5 min

$= (375 \times 10\text{min} + 275 \times 5\text{min} + 150 \times 5\text{min})/400 \times 20 = 73\%$

Name:_____ Regd No.:_____

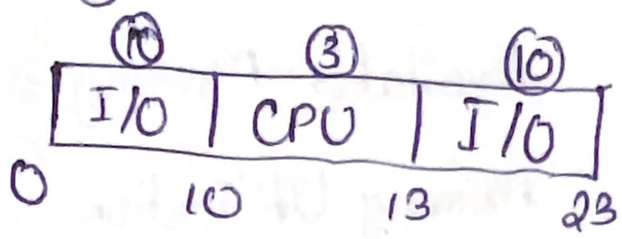
Q5)

	Job 1	Job 2	Job 3
CPU Time →	3ms	8ms	4ms
Total Time →	23ms	29ms	14ms
I/O Time →	20ms	24ms	10ms

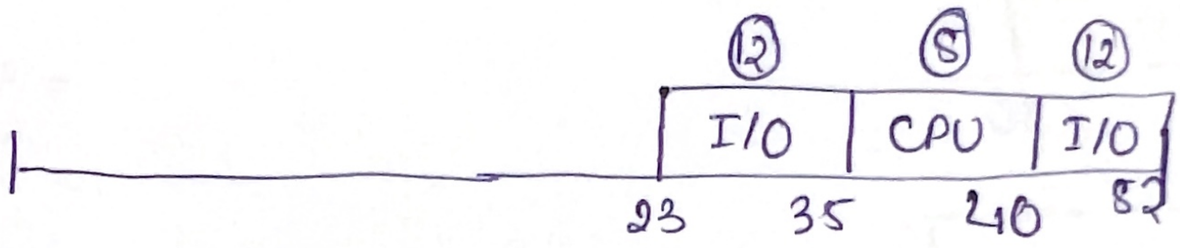
↳ Format of Execution ⟶ I/O + CPU + I/O
↳ Same Time span

Uniprogramming

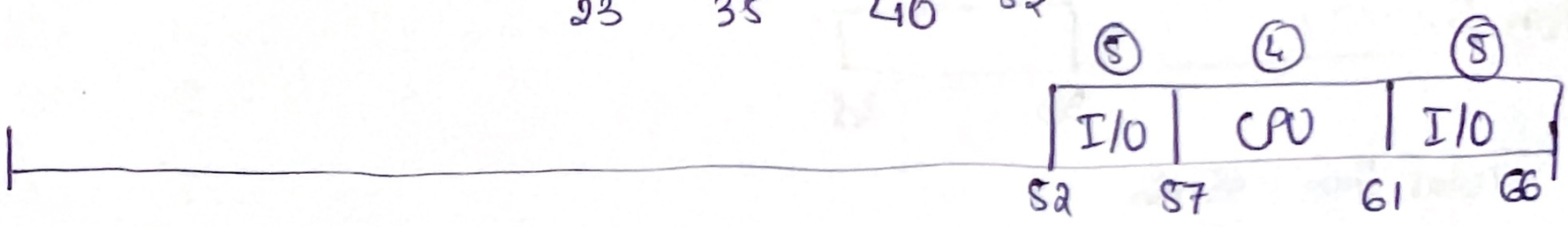
Job 1



Job 2

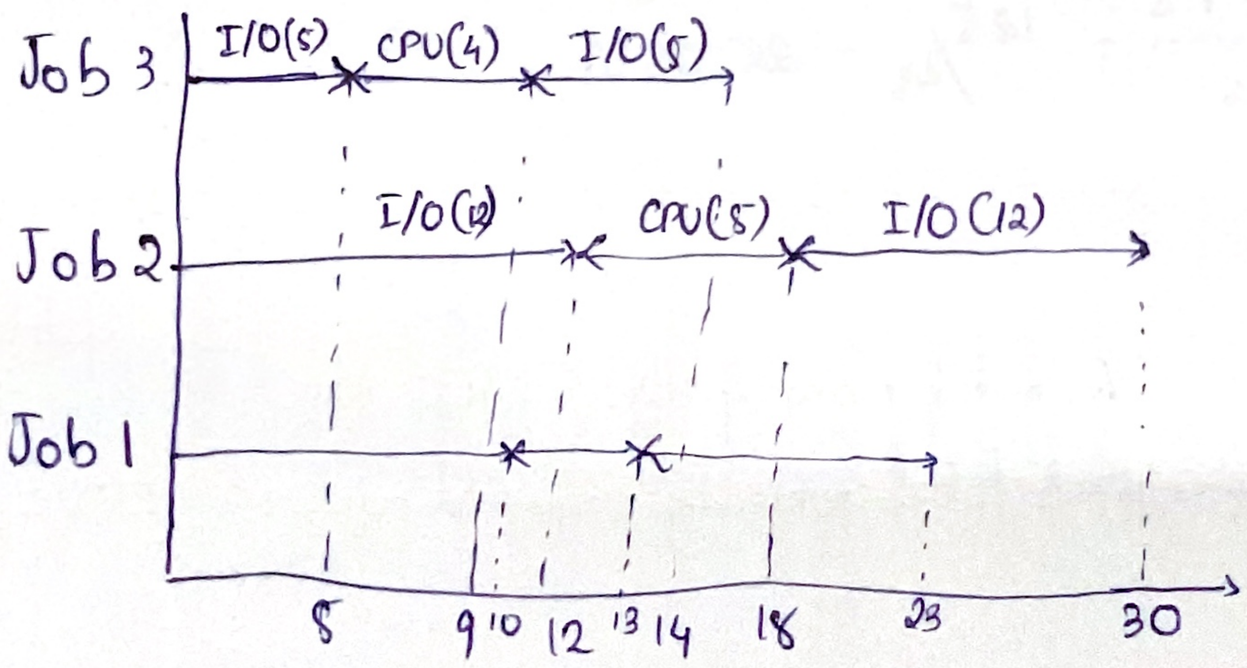


Job 3



CPU utilization = $\frac{3+5+4}{66} = \frac{12}{66} \times 100 = 18.18\%$.

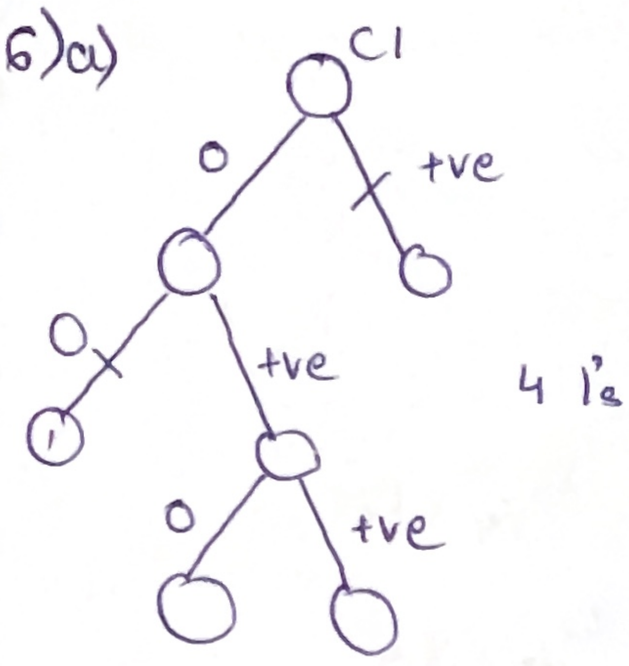
Multiprogramming →



CPU utilization = $\frac{12}{30} \times 100 = 40\%$.

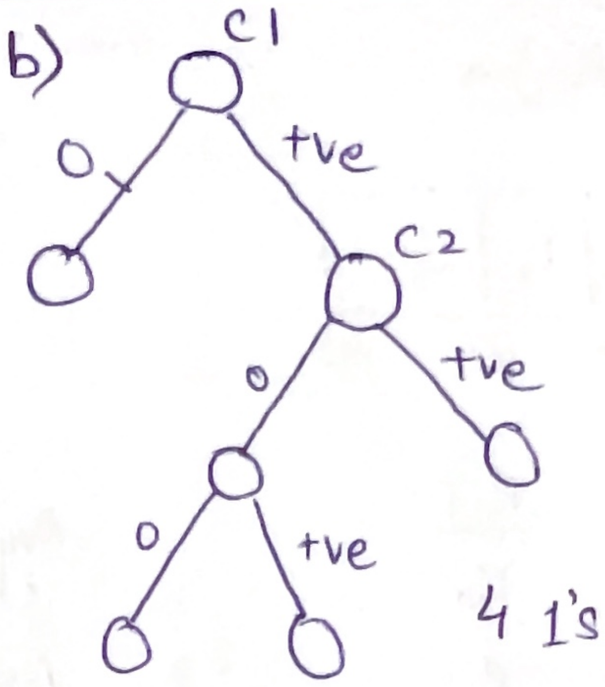
Name:_____ Regd No.:_____

6)a)



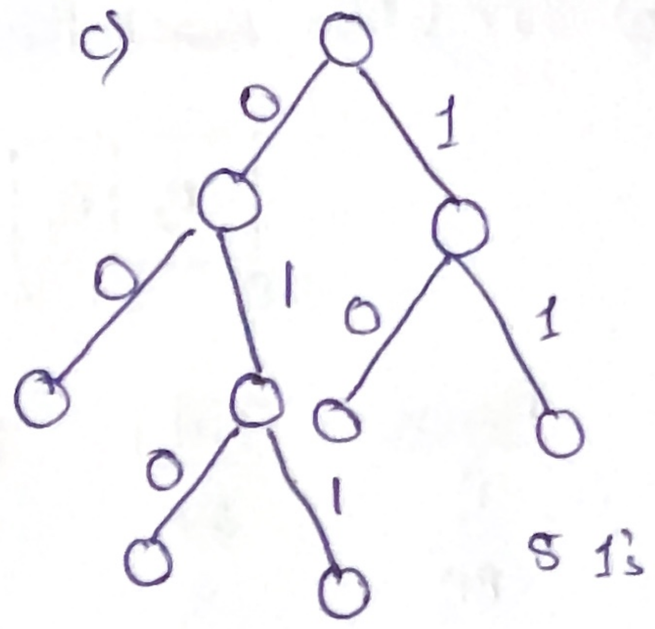
4 1's

b)



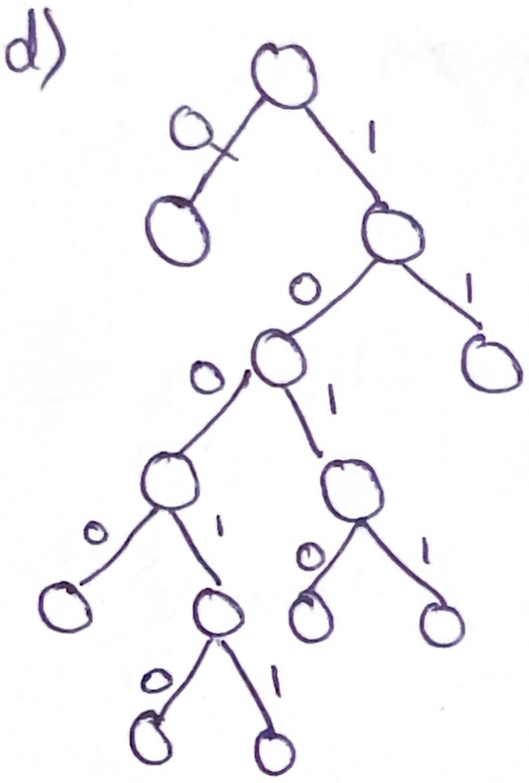
4 1's

c)



5 1's

d)



7 2's

7)

Process	A.T	B.T	Priority
P_1	0	11	1
P_2	0	8	0
P_3	12	2	3
P_4	2	6	2
P_5	9	16	4

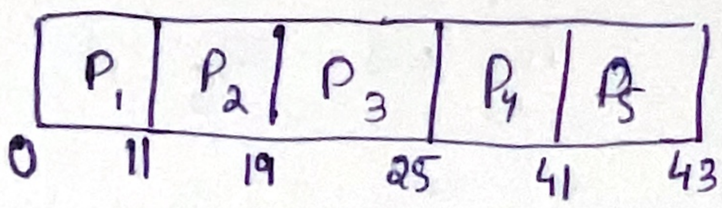
Avg W.T = 14.6

Avg T.A.T = $\frac{11+19+31+23+32}{5}$

$= \frac{116}{5} = 23.2$

Avg R.T = 14.6

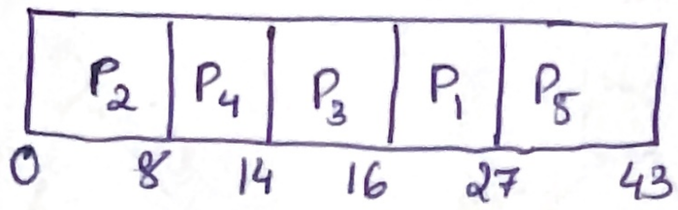
a) FCFS



Process	T:A.T	W.T	P.T
P_1	11	0	0
P_2	19	11	11
P_3	35	29	29
P_4	23	17	17
P_5	32	16	16

Name:_____ Regd No.:_____

b) SJF (Non ~~Premiti~~ Preempitive) →



Process	T.A.T	W.T	R.T
P_1	27	16	16
P_2	8	0	0
P_3	14	2	2
P_4	12	6	6
P_5	34	18	18
Total	85	42	42

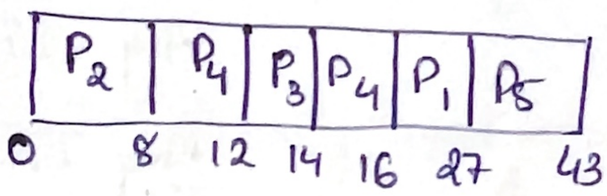
Avg T.A.T = $85/5 = 17$

Avg W.T. = $42/5 = 8.4$

Avg R.T = $42/5 = 8.4$

c) SRTF →

Process	A.T	B.T
P_1	0	11
P_2	0	8
P_3	12	2
P_4	2	2
P_5	9	16



Process	T.A.T	W.T.	R.T.
P_1	27	16	6
P_2	8	0	0
P_3	2	0	0
P_4	14	8	6
P_5	34	16	18
Total	85	42	40

Avg W.A.T = $42/5 = 8.4$

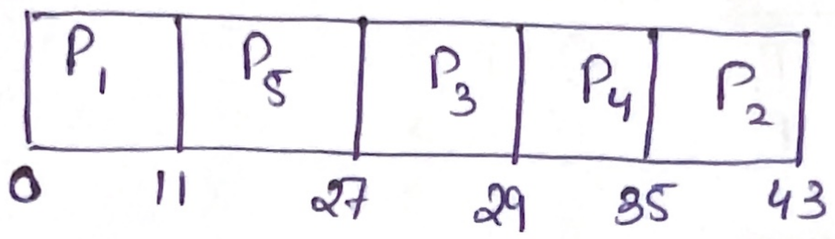
Avg T.A.T = $85/5 = 17$

Avg R.S = $40/5 = 8$

Name:_____ Regd No.:_____

d) Non Preemptive Priority Based →

Process	A.T	B.T	Priority
P_1	0	11	1
P_2	0	8	0
P_3	12	2	3
P_4	2	6	2
P_5	9	16	4



Process	T.H.T	W.T	R.T
P_1	11	0	0
P_2	43	35	35
P_3	17	15	15
P_4	33	27	27
P_5	18	2	2
	122	79	79

Avg T.A.T = 122/5 = 24.4

Avg W.T = 79/5 = 15.8

Avg RT = 79/5 = 15.8

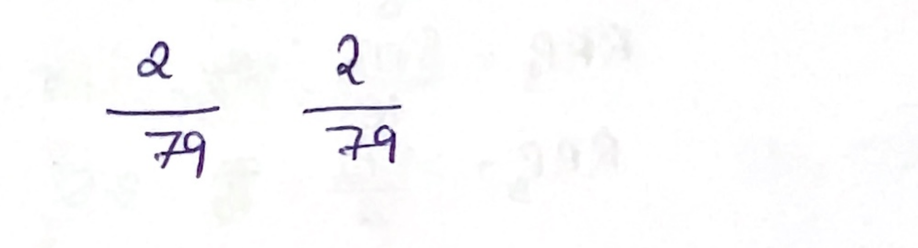
e) Preemptive Priority based Scheduling →

Process	A.T	B.T	Priority
P_1	0	9	1
P_2	0	7	0
P_3	12	2	3
P_4	2	6	3
P_5	9	16	4

Avg TAT = 116/5 = 23.2

Avg WT = 73/5 = 14.6

Avg RT = 21/5 = 4.2

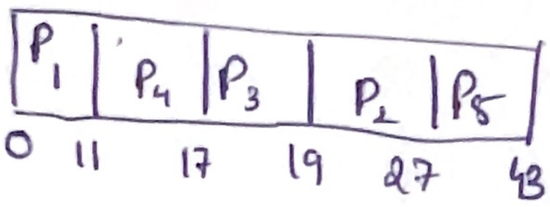


	T.H.T	W.T	R.T
P_1	36	25	0
P_2	43	35	8
P_3	15	13	13
P_4	6	0	0
P_5	16	0	0
	116	73	21

Name:_____ Regd No.:_____

f) Highest Response Ratio Rate →

Process	H.T	B.T
P_1	0	11
P_2	0	8
P_3	12	2
P_4	2	6
P_5	9	16



ATT_{14}

$RRP_2 = \frac{19+8}{8} = \frac{27}{8} = 3.375$

$RRP_5 = \frac{10+16}{16} = \frac{26}{16} = 1.625$

ATT_{27}

only one process P_5

Process	T.A.T	W.T.	R.T.
P_1	11	0	0
P_2	27	19	19
P_3	7	5	5
P_4	15	09	9
P_5	34	18	18
Total	94	51	51

ATT_0

P_1

P_2

ATT_{11}

$RRP_2 = \frac{11+8}{8} = \frac{19}{8} = 2.375$

$RRP_4 = \frac{9+6}{6} = \frac{15}{6} = 2.5$

$RRP_5 = \frac{2+16}{16} = 18/16 = 1.125$

ATT_{17}

$RRP_2 = \frac{17+8}{8} = 25/8 = 3.125$

$RRP_5 = \frac{8+16}{16} = 24/16 = 1.5$

$RRP_3 = \frac{5+2}{2} = 7/2 = 3.5$

Avg. TAT = $94/5 = 18.8$

Avg WT = $51/5 = 10.2$

Avg RT = $51/5 = 10.2$

g) Raund Robin →

T.Cq = 2

Process	A.T	B.T
P_1	0	~~11~~
P_2	0	~~8~~
P_3	12	~~02~~
P_4	2	~~6~~
P_5	9	~~16~~

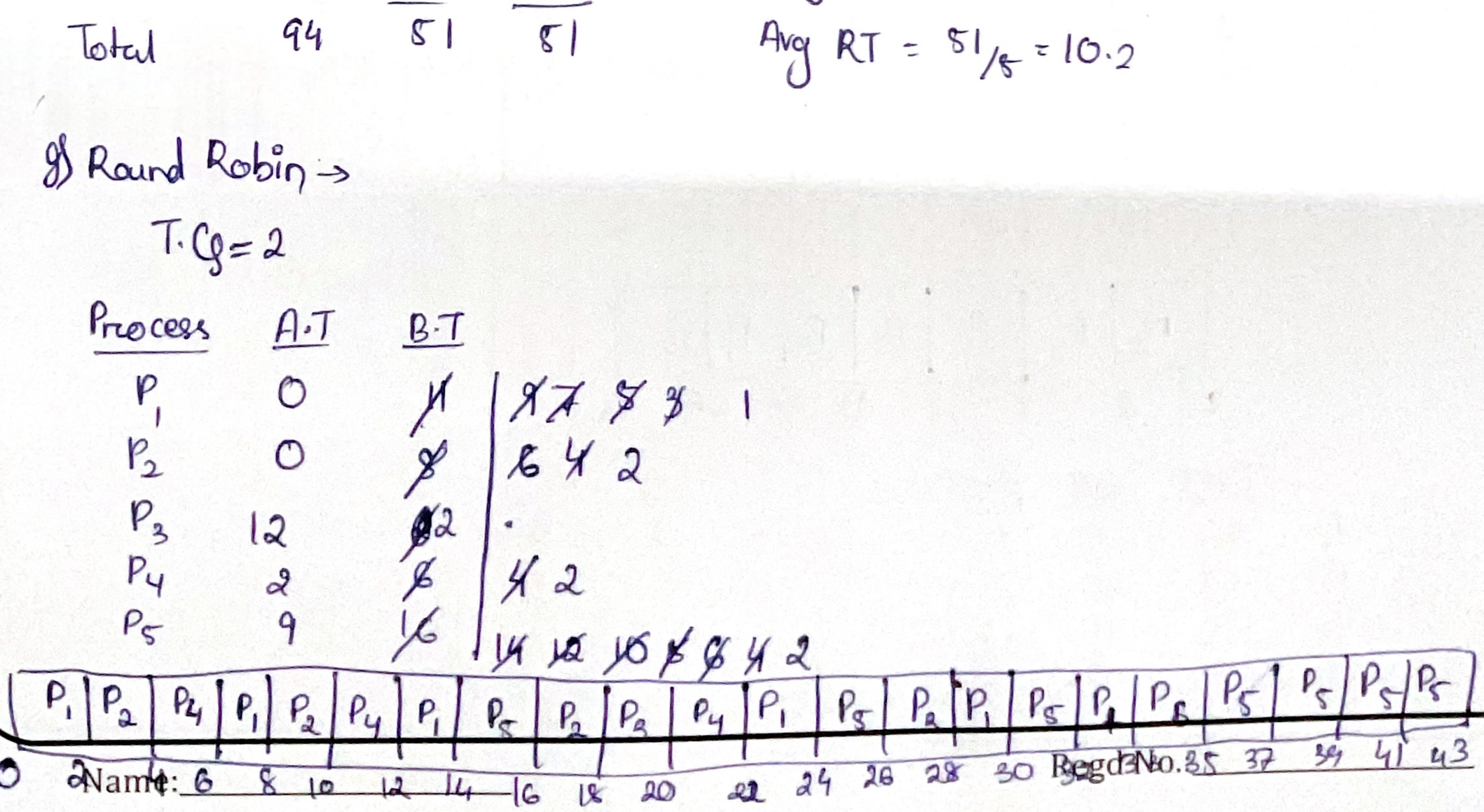
~~11~~ ~~9~~ ~~7~~ ~~5~~ 3 1

~~6~~ ~~4~~ 2

.

~~4~~ 2

~~14~~ ~~12~~ ~~10~~ ~~8~~ ~~6~~ ~~4~~ 2



Name: Regd No.

8) a)

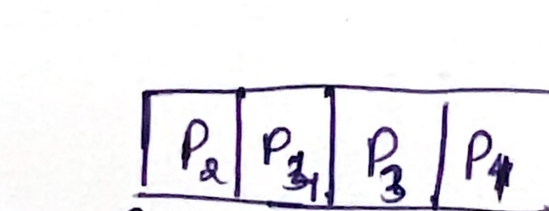
Process	A.T.	B.T.	Priority
P_1	0	4	3
P_2	0	2	1
P_3	1	3	2
P_4	2	2	4

FCFS

Process	T.A.T	W.T.	R.T.
P_1	4	0	0
P_2	6	4	4
P_3	8	5	5
P_4	9	7	7
	27	16	16

Avg. TAT = $27/4 = 6.75$

Avg W.T = $16/4 = 4$



b) SJF (non preemptive) →

Process	TAT	WT	RT
P_1	11	7	7
P_2	2	0	0
P_3	6	3	3
P_4	2	0	0
	21	10	10

Avg TAT = $21/4 = 5.25$

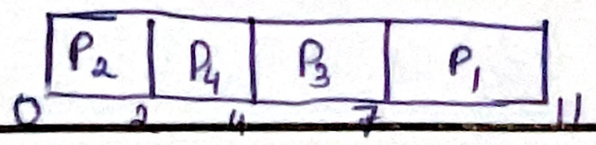
Avg RT, WT = $10/4 = 2.5$

c) SRTF (Preemptive) →

Process	T.A.T	W.T.	R.T
P_1	11	7	7
P_2	2	0	0
P_3	6	3	3
P_4	2	0	0

Avg T.A.T = 5.25

Avg W.T = avg RT = 2.5



Name:_____

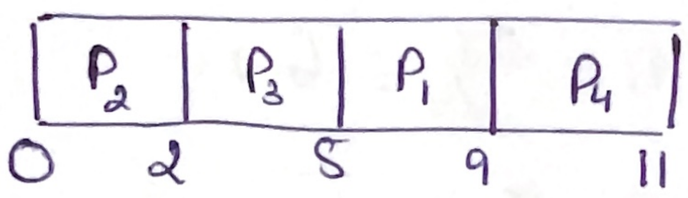
Regd No.:_____

d) Non Preemptive Priority based Scheduling →

Process	TAT	WT	RT
P_1	9	5	5
P_2	2	0	0
P_3	4	1	1
P_4	9	7	7
	24	13	13

Avg TAT = 24/4 = 6

Avg RT / WT = 13/4 = 3.25

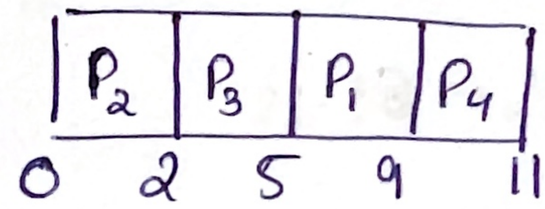


e) Preemptive Priority Based →

Process	AT	BT	Priority	TAT	WT	RT
P_1	0	4	3	9	5	5
P_2	0	2	1	2	0	0
P_3	1	3	2	4	1	1
P_4	2	2	4	9	7	7
				24	17	17

Avg TAT = 24/4 = 6

Avg WT / RT = 13/4 = 3.25

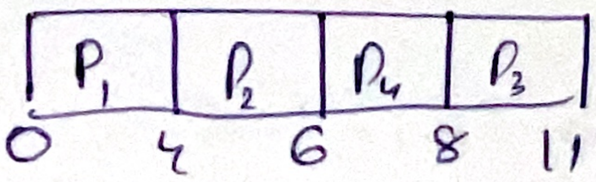


f) HRRN →

Process	TAT	WT	RT
P_1	4	0	0
P_2	6	4	4
P_3	10	7	7
P_4	4	4	4
	26	15	15

Avg TAT = 26/4 = 6.5

Avg WT / RT = 15/4 = 3.75



i) At_0

$RR_{P_1} = \frac{0+4}{4} = 1$

$RR_{P_2} = \frac{0+2}{2} = 1$

ii) At_4

$RR_{P_2} = \frac{4+2}{2} = 3$

$RR_{P_3} = \frac{3+3}{3} = 2$

$RR_{P_4} = \frac{2+2}{2} = 2$

Name:_____ Regd No.:_____

iii) Att$_C$

$RR\,P_3 = \frac{5+3}{3} = 8/3 = 2.66$

$RR\,P_4 = \frac{4+2}{2} = 3$

iv) Att$_B$

Only one process P_3

g) Round Robbin →

Process	TAT	WT	RT
P_1	10	6	0
P_2	4	2	2
P_3	10	7	3
P_4	6	4	4
	30	19	9

Avg TAT = $30/4 = 7.5$

Avg WT = $19/4 = 4.75$

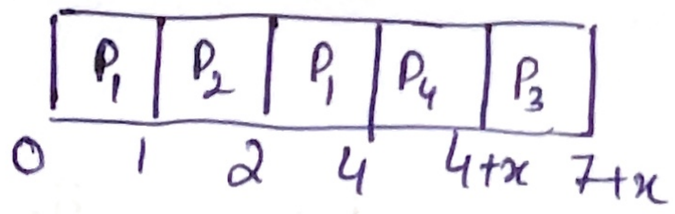
Avg RT = $9/4 = 2.25$

9)

Process	Arrival Time	Burst Time
P_1	0	3
P_2	1	1
P_3	3	3
P_4	4	X

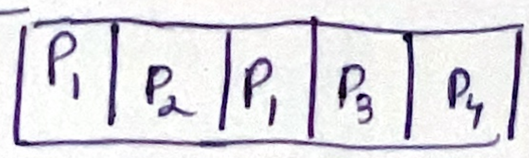
Using SRTF,

CPU



if $x \geq 3$ then

CPU



Avg WT = $\frac{1+0+1+3}{4} = 5/2 = 1.25$ x

if $x \geq 3$ = $\frac{1+0+(x+1)+0}{4}$

$= \frac{x+2}{4}$ (must be 1)

So, x should be 2

Name:_____ Regd No.:_____

10) (MLFBQ)

3 queues

q_1, q_2, q_3 → Use FCFS

q_1, q_2 → Use Round Robin

q_1 → highest priority

q_3 → Lowest Priority

q_1 having TQ = 3ms

q_2 having TQ = 5ms

→ Queue 1 →

→ Queue 2 →

→ Queue 3 →

→ All Process having AT = 0

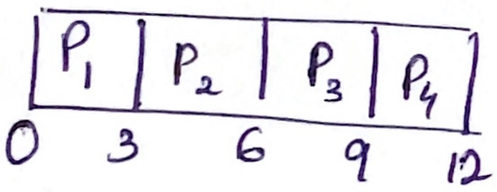
Process	BT
P_1	~~8~~ 5
P_2	~~22~~ ~~19~~ 14
P_3	~~4~~ 1
P_4	~~12~~ ~~8~~ 4

→ All first all process enter queue = zero

→ As all have AT = 0, so all enter to the queue 1

Queue 1 → P_1; P_2; P_3; P_4

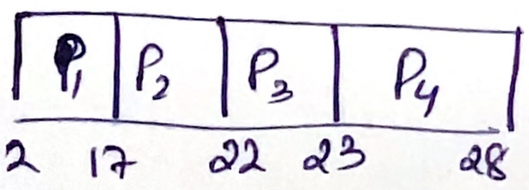
CPU



As all process preempted so they are now in queue

Queue → P_1; P_2; P_3; P_4 TQ = 5

3 6 9 12

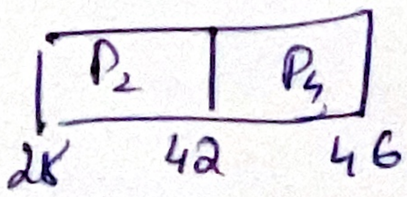


P_1, P_3 complete their execution and P_2, P_4 entering the queue 3

Queue 3 → P_2; P_4

22 28

CPU



Process	TAT	WT
P_1	17	9
P_2	42	20
P_3	23	19
P_4	46	34
	128	82

Avg TAT = 128/4 = 32

Avg WT = 82/4 = 20.5

Name:_____ Regd No.:_____

11) a) initialize S=0, T=1

Process P

```
while (true){
    Down (S);
    print ("1");
    print ("1");
    Up (T);
}
```

Process Q

```
while (true){
    Down (T);
    print ("0");
    print ("0");
    up (S);
}
```

b) initialise S=0, T=1

Process P

```
Down (S);
print ("1");
print ("2");
up (T)
```

Process Q

```
Down (T);
print ("3");
up (S);
Down (T);
print ("4");
up (S);
```

12) a) initialise S=1, T=0

Process P

```
Down (S);
print ("1");
up (T);
Down (S);
print ("2");
up (T);
```

Process Q

```
Down (T);
print ("3");
up (S)
Down (T)
print ("4");
up (S)
```

Name:_____ Regd No.:_____