

242466

## [ASSIGNMENT 2]

Q. 1

PROCESS	BT	AT	PRIORITY
P1	8	0	1
P2	20	1	3
P3	3	2	2
P4	6	3	5
P5	12	4	4

## [PRIORITY SCHEDULING - NON-PREEMPTIVE]

P1	P3	P2	P5	P4
0	8	11	31	49

## TAT - AROUND TIME

$$P1 = 8 - 0 = 8$$

$$P2 = 31 - 1 = 30$$

$$P3 = 11 - 2 = 9$$

$$P4 = 49 - 3 = 46$$

$$P5 = 48 - 4 = 39$$

$$AVG = 27$$

## WAITING TIME

$$P1 = 8 - 8 = 0$$

$$P2 = 30 - 20 = 10$$

$$P3 = 9 - 3 = 6$$

$$P4 = 46 - 6 = 40$$

$$P5 = 39 - 12 = 27$$

$$AVG = 16.6$$

## [PRIORITY SCHEDULING - PREEMPTIVE]

P1	P3	P2	P1	P5	P4
0	8	11	31	43	49

SINCE NO HIGHER PRIORITY ARRIVES BEFORE THE PRIORITY OF CURRENT PROCESS,

$$AVG TAT = 27$$

$$AVG WT = 16.6$$

[FIRST COME FIRST SERVE - FCFS]

P1	P2	P3	P4	P5
0	8	28	31	37

TAU - AROUND TIME

$$P1 = 8 - 0 = 8$$

$$P2 = 28 - 1 = 27$$

$$P3 = 31 - 2 = 29$$

$$P4 = 37 - 3 = 34$$

$$P5 = 49 - 4 = 45$$

$$AVG = 28.6$$

WAITING TIME

$$P1 = 8 - 8 = 0$$

$$P2 = 27 - 20 = 7$$

$$P3 = 29 - 3 = 26$$

$$P4 = 34 - 6 = 28$$

$$P5 = 45 - 12 = 33$$

$$AVG = 18.8$$

[SHORTEST JOB FIRST - SJF]

P1	P3	P4	P5	S	P2
0	8	11	17	29	49

TURN AROUND TIME

$$P1 = 8 - 0 = 8$$

$$P2 = 49 - 1 = 48$$

$$P3 = 11 - 2 = 9$$

$$P4 = 17 - 3 = 14$$

$$P5 = 29 - 4 = 25$$

$$AVG = 20.8$$

WAITING TIME

$$P1 = 8 - 8 = 0$$

$$P2 = 48 - 20 = 28$$

$$P3 = 9 - 3 = 6$$

$$P4 = 14 - 6 = 8$$

$$P5 = 25 - 12 = 13$$

$$AVG = 11$$

NXT Pg  
→

## [ROUND ROBIN]

TIME QUANTUM = 5

CYCLE 1	P1	P2	P3	P4	P5
0	5	10	15	18	23

CYCLE 2	P1	P2	P3	P4	P5
23	26	31	38	44	39

CYCLE 3	P1	P2	P3	P4	P5
39	44	46			

CYCLE 4	P1	P2	P3	P4	P5
46	49				

TURN AROUND TIME = 99 + 400 = 499 WAITING TIME

$$P1 = 26 - 0 = 26 \quad P1 = 0 \quad P1 = 18$$

$$P2 = 49 - 1 = 48 \quad P2 = 35$$

$$P3 = 13 - 2 = 11 \quad P3 = 9 - 8 = 1$$

$$P4 = 39 - 3 = 36 \quad P4 = 7 - 6 = 1$$

$$P5 = 46 - 4 = 42 \quad P5 = 11 - 10 = 1$$

$$AVG = 32.6 \quad AVG = 23.8$$

— [SJF] PROVIDES BEST AVERAGE WAITING AND TURN-AROUND TIME

Q. 2]

GIVEN

(c) ALLOCATION MATRIX =  $\begin{bmatrix} 0 & 1 & 0 & 1 & 0 \\ 0 & 0 & 1 & 0 & 1 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 2 & 1 & 0 & 0 \end{bmatrix}$

(r) REQUEST MATRIX =  $\begin{bmatrix} 1 & 0 & 1 & 0 & 1 & 2 \\ 0 & 1 & 0 & 2 & 1 & 0 \\ 0 & 2 & 0 & 3 & 1 & 0 \\ 0 & 2 & 1 & 1 & 0 & 0 \end{bmatrix}$

EXISTING (E) = [2, 4, 1, 4, 4, 0]

AVAILABLE (A) = [0, 2, 1, 1, 0]

STEP 1: VERY AVAILABLE RESOURCES

TOTAL ALLOCATED = [2, 3, 1, 2, 3] = SUM (C)

E - ALLOCATED = [0, 1, 0, 2, 1] = MATCHES (A)

STEP 2: EXECUTION

INITIAL = A = [0, 1, 0, 2, 1]

FINISH = [F, F, F, FS]

- ITERATION 1

⇒ P2 REQUEST ≤ WORK → FINISH P2

⇒ WORK = [0, 2, 0, 3, 1]

- ITERATION 2

⇒ P3 REQUEST ≤ WORK → FINISH P3

⇒ WORK = [0, 2, 0, 3, 2]

- ITERATION 3

⇒ P1 NEEDS RS1 - [AVAILABLE 0]

⇒ P4 NEEDS RS3 - [AVAILABLE 0]

⇒ BOTH BLOCKED

PROCESS	STATUS	BLOCKED
P1	DEADLOCKED	RS1 - NEEDS 1
P4	DEADLOCKED	RS3 - NEEDS 1
P2, P3	COMPLETED	-

Q. 3]

GIVEN

STRING = 1, 2, 3, 4, 2, 1, 5, 6, 2, 1, 2, 3, 7, 6, 3, 2, 1, 2, 3, 6

FRAME = 4

[FIRST IN FIRST OUT - FIFO]

1	2	3	4	2	1	5	6	2	1	2	3	7	6	3	2	1	2	3	6
1	1	1	1	2	5	5	5	5	3	3	3	3	3	3	1	1	1	1	1
2	2	2	1	1	2	6	6	6	6	7	7	7	7	7	7	7	7	3	3
3	3	3	3	3	3	2	2	2	2	2	2	6	6	6	6	6	6	6	6
4	4	4	4	4	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2
	x	x						x		x		x		x		x		x	

PAGE HIT = 6

PAGE FAULT = 14

NXT Pg  
→

[OPTIMAL PAGE]

1	2	3	4	2	1	5	6	2	1	2	3	7	6	3	2	1	2	3	6
1	1	1	1			1	1					1	1						
2	2	2				2	2					2	2						
3	3					3	3					3	3						
4						5	6					7	6						
						X	X	X	X	X		X	X	X	X	X	X	X	

PAGE HIT = 12

PAGE FAULT = 8

[LEAST RECENTLY USED → LRU]

1	2	3	4	2	1	5	6	2	1	2	3	7	6	3	2	1	2	3	6
1	1	1	1			1	1					1	1	6					6
2	2	2				2	2					2	2	2					
3	3					5	5	8		2	3	3	3	2					
4						4	5	2		2	0	7	7	8		1			A
						X	X			X	X	X		8	X	X	X	X	

PAGE HIT = 10

PAGE FAULT = 10

NXT Pg  
→

Q. 4]

GIVEN

STRING = 7, 0, 1, 2, 0, 3, 0, 4, 2, 3, 0, 3, 2, 1, 2, 0, 1, 7, 0, 1

FRAMES = 4

[LEAST RECENTLY USED - LRU]

7	0	1	2	0	3	0	4	2	3	0	3	2	1	2	0	1	7	0	1
7	7	7	7	3	3				3					3			7		
0	0	0	0	0	0				0					0			0		
1	1	1	1	4					1					1			1		
2	2	2	2						2					2			2		

PAGE HIT = 12

PAGE FAULT = 8

[FIRST IN FIRST OUT - FIFO]

7	0	1	2	0	3	0	4	2	3	0	3	2	1	2	0	1	7	0	1
7	7	7	7	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	
0	0	0	0	0	0	0	0	0	0	0	0	4	4	4	4	4	4	4	
1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	
2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	

PAGE HIT = 10

PAGE FAULT = 10

## OPTIMAL PAGE REPLACEMENT

7	0	1	2	0	3	0	4	2	3	0	3	2	1	2	0	1	7	0	1
7	7	7	7	3	3									1			1		
0	0	0	0	0	0									0			0		
1	1	1	1	4	4									4			7		
2	2	2	2											2			2		
				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

PAGE HIT = 12

PAGE FAULT = 8

Q.5]

INTERNAL FRAGMENTATION :

⇒ OCCURS WHEN ALLOCATED MEMORY EXCEEDS PROCESS REQUIREMENTS, CREATING UNUSABLE SPACE WITHIN PARTITIONS.

STATIC PARTITIONED ALLOCATION :

⇒ MEMORY IS DIVIDED INTO FIXED SIZE BLOCKS BEFORE EXECUTION AND PROCESSES ARE ALLOCATED BASED ON THEIR SIZE.

INITIAL	REQUESTS
400 KB	95 kb
180 kb	180 kb
100 kb	280 kb
300 kb	380 kb
45 kb	30 kb

[FIRST FIT]

400 kb	$\Rightarrow$	95 kb	-	305 kb left
180 kb	$\Rightarrow$	180 kb	-	0 kb left
100 kb	$\Rightarrow$	30 kb	-	70 kb left
300 kb	$\Rightarrow$	285 kb	-	15 kb left
45 kb				

→ — 380 kb is UNALLOCATED

[BEST FIT]

400 kb	$\Rightarrow$	380 kb	-	20 kb left
180 kb	$\Rightarrow$	180 kb	-	0 kb left
100 kb	$\Rightarrow$	95 kb	-	5 kb left
300 kb	$\Rightarrow$	285 kb	-	15 kb left
45 kb	$\Rightarrow$	30 kb	-	15 kb left

(Q. 6)

GIVEN

REQUEST : 100, 150, 20, 180, 30, 70, 190,  
50, 120

INITIAL HEAD : TRACK 80

TOTAL TRACKS : 200

DIRECTION : TOWARDS + 200

NXT Pg  
→

## [SSTF ALGORITHM]

PATH  
 80 → 70 (10) → 50 (20) → 30 (20)  
 → 20 (10) → 100 (80) → 120 (20)  
 → 150 (30) → 180 (30) → 190 (10)

TOTAL  $10 + 20 + 20 + 10 + 80 + 20 + 30 + 30 + 10 = 230$

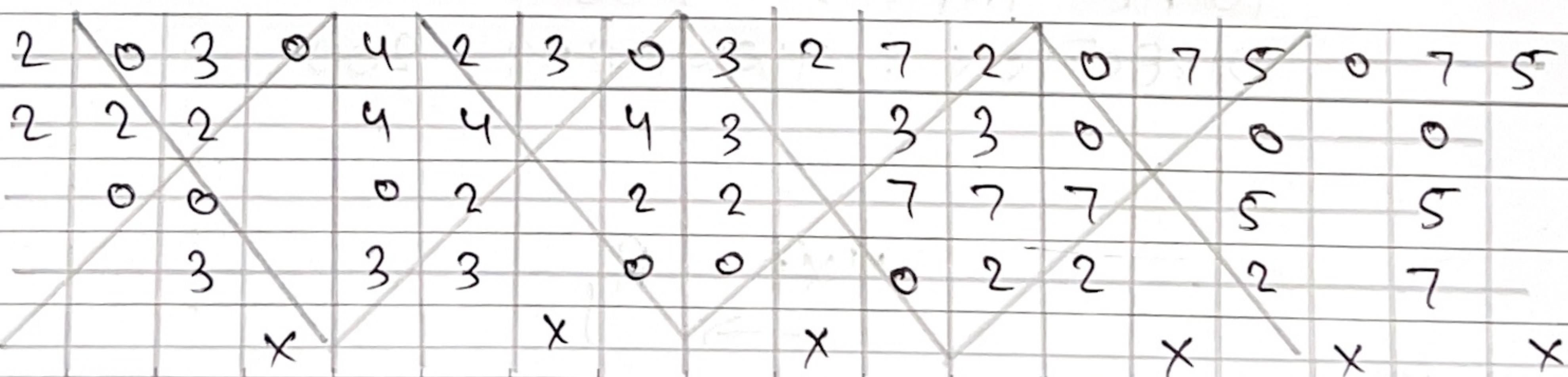
## [SCAN ALGORITHM]

PATH  
 80 → 100 (20) → 120 (20) → 150 (30) → 180 (30)  
 → 190 (10) → 200 (10) → 70 (130) → 50 (20)  
 → 30 (20) → 20 (10)

TOTAL  $20 + 20 + 30 + 30 + 10 + 10 + 130 + 20 + 20 + 10 = 290$

DIFFERENCE	SSTF	SCAN	DIFFERENCE
TOTAL	230	290	+ 60
EFFICIENCY	HIGHER	LOWER	+ 20.7 %

Q. 7] - FRAME SIZE = 3



2	0	3	0	4	2	3	0	3	2	7	2	0	7	5	0	7	5
2	2	2	.	4	4	4	0	.	7	7	7	7	.	.	.	.	.
0	0	.	0	0	3	3	.	3	0	0	0	0	.	.	.	.	.
3	3	3	2	2	2	2	.	2	2	2	5	.	.	.	.	.	.
	x				x	x		x	x	x	x	x	x	x	x	x	x

PAGE HIT = 8 , RATIO = 8:18

PAGE FAULT = 10 , RATIO = 10:18

— FRAME SIZE = 4

2	0	3	0	4	2	3	0	3	2	7	2	0	7	5	0	7	5
2	2	2	2	2	.	.	.	.	2	.	.	2	.	.	.	.	.
0	0	.	0	.	0	.	.	0	.	0	.	0	.	.	.	.	.
3	3	3	.	3	.	.	.	3	.	3	.	5	.	.	.	.	.
	4	4	4	4	4	4	4	4	7	7	7	7	7	7	7	7	7
	x			x	x	x	x	x	x	x	x	x	x	x	x	x	x

PAGE HIT = 12 , RATIO = 12:18

PAGE FAULT = 6 , RATIO = 8/6:18

Q. 8]

GIVEN

CYLINDER RANGE = 0 - 999

CURRENT POSITION = 345

REQUEST QUEUE = 123, 874, 692,  
475, 105, 376

[FIRST COME FIRST SERVED - FCFS]

PATH  $345 \rightarrow 123 (222) \rightarrow 874 (751) \rightarrow 692 (182)$   
 $\rightarrow 475 (217) \rightarrow 105 (370) \rightarrow 376 (271)$

TOTAL  $222 + 751 + 182 + 217 + 370 + 271 = 2013$

[SHORTEST SEEK TIME FIRST → SSTF]

PATH  $345 \rightarrow 376 (31) \rightarrow 475 (99) \rightarrow 692 (217)$   
 $\rightarrow 874 (182) \rightarrow 123 (751) \rightarrow 105 (18)$

TOTAL  $31 + 99 + 217 + 182 + 751 + 18 = 1298$

[SCAN ALGORITHM]

PATH  $345 \rightarrow 123 (222) \rightarrow 105 (18) \rightarrow 0 (105)$   
 $\rightarrow 376 (376) \rightarrow 475 (99) \rightarrow 692 (217)$   
 $\rightarrow 874 (182)$

TOTAL  $222 + 18 + 105 + 376 + 99 + 217 + 182 = 1219$

ALGORITHM	TOTAL	EFFICIENCY
FCFS	2013	worst
SSTF	1298	+ 35.5 % - FCFS
SCAN	1219	+ 6.1 % - SSTF

Q. 9]

INITIAL

100 kb  
500 kb  
200 kb  
300 kb  
600 kb

PROCESS

212 kb (P1)  
417 kb (P2)  
112 kb (P3)  
426 kb (P4)

[FIRST - FIT]

100 kb	FREE
500 kb	212 kb (P1) + 288 kb
200 kb	112 kb (P3) + 88 kb
300 kb	FREE
600 kb	417 kb (P2) 183 kb

- (P4) 426 kb IS UNALLOCATED

[BEST - FIT]

100 kb	FREE
500 kb	417 kb (P2) + 83 kb
200 kb	112 kb (P3) + 88 kb
300 kb	212 kb (P1) + 88 kb
600 kb	426 kb (P4) + 174 kb

- ALL PROCESSES ARE ALLOCATED

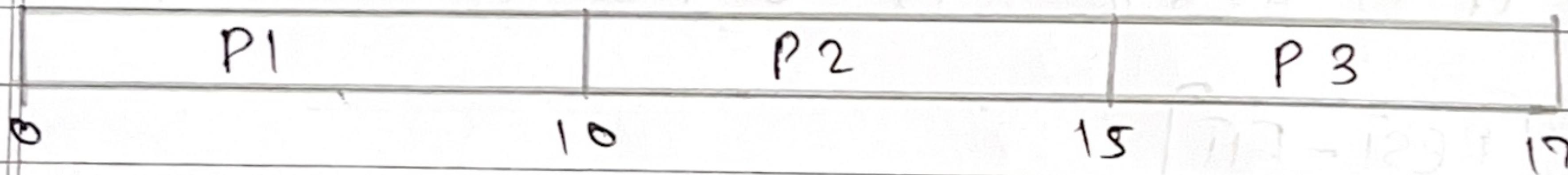
### [WORST-FIT]

100 kb	FREE
500 kb	417 kb (P2) + 83 kb
200 kb	FREE
300 kb	FREE
600 kb	212 kb (P1) + 388 kb → 112 kb P3 + 276 kb

Q. 10)

PROCESS	BT	AT
P1	10	0
P2	5	15
P3	2	17

### [FCFS]



### TAT

$$P1 = 10 - 0 = 10$$

$$P2 = 15 - 1 = 14$$

$$P3 = 17 - 2 = 15$$

$$AVG = 13$$

### WT

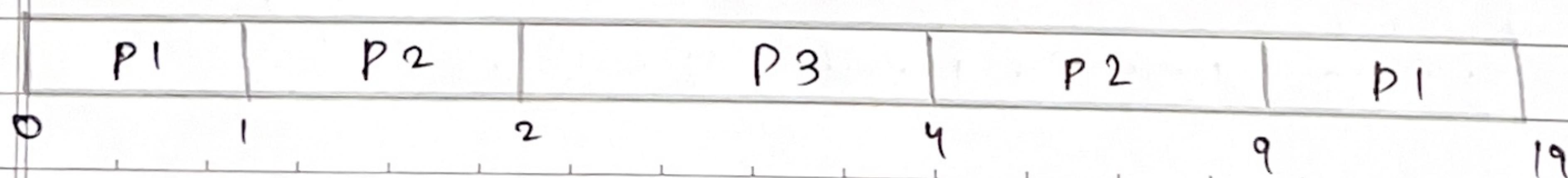
$$P1 = 0 - 0 = 0$$

$$P2 = 10 - 1 = 9$$

$$P3 = 15 - 2 = 13$$

$$AVG = 7.33$$

### [SJF PREEMPTIVE]



TAT

$$P_1 = 19 - 0 = 19$$

$$P_2 = 9 - 1 = 8$$

$$P_3 = 4 - 2 = 2$$

$$AVG = 9.67$$

WT

$$P_1 = 8$$

$$P_2 = 2$$

$$P_3 = 0$$

$$AVG = 3.33$$

[ROUND ROBIN]

TIME QUANTUM = 2

CYCLE 1	P1	P2	P3
0	2	4	6

CYCLE 2	P1	P2
6	8	10

CYCLE 3	P1	P2
10	12	14

CYCLE 4	P1	P2
14	16	17

CYCLE 5	P1
17	19

TAT

$$P_1 = 18 - 0 = 18$$

$$P_2 = 18 - 1 = 17$$

$$P_3 = 6 - 2 = 4$$

WT

$$P_1 = 8$$

$$P_2 = 7$$

$$P_3 = 2$$

$$AVG = 12$$

Q.11

STRING = 4, 3, 2, 1, 4, 3, 5, 4, 3, 2, 1, 5

FRAME = 3

4	3	2	1	4	3	5	4	3	2	1	5
4	4	4	1	1	1	5			5	5	
3	3	3	4	4	4				2	2	
2	2	2	3	3				3	1		

Q.12

PAGE HIT = 3

PAGE FAULT = 12

4	3	2	1	4	3	5	4	3	2	1	5
4	4	4	4		4				2	2	
3	3	3		3				3	1		
2	1			5			5	5			

Q.13

PAGE HIT = 5

PAGE FAULT = 7

4	3	2	1	4	3	5	4	3	2	1	5
4	4	4	1	1	1	5			2	2	2
3	3	3	4	4	4				4	1	1
2	2	2	3	3				3	3	5	

Q.14

PAGE HIT = 2

PAGE FAULT = 10

Q. 12

GIVEN

RANGE = 0 - 199

CURRENT POSITION = 54

REQUEST = 98, 183, 41, 122, 14, 124, 65, 67

[FCFS]

PATH  
54 → 98 (44) → 183 (85) → 41 (142)  
→ 122 (81) → 14 (108) → 124 (110)  
→ 65 (59) → 67 (2)

TOTAL 44 + 85 + 142 + 81 + 108 + 110 + 59 + 2 = 631

[SSTF]

PATH  
54 → 65 (11) → 67 (2) → 41 (26) → 14 (27)  
→ 98 (84) → 122 (24) → 124 (2) → 183 (59)

TOTAL 11 + 2 + 26 + 27 + 84 + 24 + 2 + 59 = 235

[SCAN ALGORITHM]

PATH  
54 → 65 (11) → 67 (2) → 98 (31) → 122 (24)  
→ 124 (2) → 183 (59) → 199 (18) → 41 (158)  
→ 14 (27)

TOTAL 11 + 2 + 31 + 24 + 2 + 59 + 18 + 158 + 27 = 300

Q.13

GIVEN

RANGE = 0-99

CURRENT POSITION = 50

REQUEST QUEUE = 45, 20, 90, 10, 50, 80, 80,  
25, 70

[SSTF]

PATH

50 → 50 (0) → 45 (5) → 60 (15) → 70 (10)  
→ 80 (10) → 90 (10) → 25 (85) → 20 (5)  
→ 10 (10)

TOTAL

$$0 + 5 + 15 + 10 + 10 + 10 + 65 + 5 + 10 = 130$$

[SCAN ALGORITHM]

PATH

50 → 50 (0) → 60 (10) → 70 (10) → 80 (10)  
→ 90 (10) → 99 (9) → 45 (54) → 25 (20)  
→ 20 (5) → 10 (10)

TOTAL

$$0 + 10 + 10 + 10 + 9 + 54 + 20 + 5 + 10 = 120$$

Q.14

PROCESS	MAX	ALLOCATED	AVAILABLE
P0	6, 0, 1, 2	4, 0, 0, 1	3, 2, 1, 1
P1	1, 7, 5, 0	1, 1, 0, 0	-
P2	2, 3, 5, 6	1, 2, 5, 4	-
P3	1, 6, 5, 3	0, 6, 3, 3	-
P4	1, 6, 5, 6	0, 2, 1, 2	-

① TOTAL INSTANCES CALCULATION —  
 $T = \text{ALLOCATED} + \text{AVAILABLE}$

RESOURCE	CALC.	TOTAL
A	$4+1+1+0+0+3$	= 9
B	$0+1+2+6+2+2$	= 11
C	$0+0+5+3+1+1$	= 10
D	$1+0+4+3+2+1$	= 11

② NEED MATRIX [MAX - ALLOCATED] —

PROCESS	NEED (A,B,C,D)
P0	2, 0, 1, 1
P1	0, 6, 5, 0
P2	1, 1, 0, 2
P3	1, 0, 2, 0
P4	1, 4, 4, 4

③ SAFETY CHECK —

STEP 1 INITIAIZE WORK = AVAILABLE = (3, 2, 1, 1)  
 FINISH = [F, F, F, F, F]

STEP 2 FIND PROCESS WHERE NEED  $\leq$  WORK —

— P0 NEED (2, 0, 1, 1)  $\leq$  WORK (3, 2, 1, 1)  
 WORK = (1, 2, 1, 2), FINISH = (T, F, F, F, F)  
 — P2 NEED (1, 1, 0, 2)  $\leq$  WORK (1, 2, 1, 2)  
 WORK = (8, 4, 6, 6), FINISH = (T, F, T, F, F)

- P3 NEED  $(1, 0, 2, 0)$   $\leq$  WORK  $(8, 4, 6, 6)$   
WORK =  $(8, 10, 9, 9)$ , FINISH =  $(T_F, T_I, T_{IF})$
- P4 NEED  $(1, 4, 4, 4)$   $\leq$  WORK  $(8, 10, 9, 9)$   
WORK =  $(8, 12, 10, 11)$ , FINISH =  $(T_F, T_I, T)$
- P5 NEED  $(0, 6, 5, 0)$   $\leq$  WORK  $(8, 12, 10, 11)$   
WORK =  $(9, 13, 10, 11)$ , FINISH =  $(T, T, T, T, T)$

SAFE SEQUENCE —

→ P0, P2, P3, P4, P1