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Q1

Process	Allocation A	B	C	D	Max A	B	C	D
P_0	2	0	2	1	9	5	5	5
P_1	0	1	1	1	2	2	3	3
P_2	4	1	0	2	7	5	4	4
P_3	1	0	0	1	3	3	3	2
P_4	1	1	0	0	5	2	2	1
P_5	1	0	1	1	4	4	4	4
Sum →	9	3	4	6				

6 processes — P_0, P_1, P_2, P_3, P_4, P_5

4 resources type - A - 15 instances B - 6 instances
C - 9 instances D - 10 instances

ii) Need (Max - Allocation)

Process	A	B	C	D
P_0	7	5	3	4
P_1	2	1	2	2
P_2	3	4	4	2
P_3	2	3	3	1
P_4	4	1	2	1
P_5	3	4	3	3

i) Available array → 9, 3, 4, 6

iii) Total available = Total resource - total allocated

A = 15 - 9 = 6
B = 6 - 3 = 3
C = 9 - 4 = 5
D = 10 - 6 = 4

Flag:

Process	flag	Available
P_0	F T	15 6 9 10
P_1	F T	6 4 6 5
P_2	F T	10 5 6 7
P_3	F T	11 5 6 8
P_4	F T	12 6 6 8
P_5	F T	13 6 7 9

New available = [6 3 5 4]

P_0 need ≤ available ?

$[7\ 5\ 3\ 4] \not\leq [6\ 3\ 5\ 4]$

P_1 need ≤ available

$[2\ 1\ 2\ 2] \leq [6\ 3\ 5\ 4]$

available = available + allocation

$= [6\ 3\ 5\ 4] + [0\ 1\ 1\ 1]$

$= [6\ 4\ 6\ 5]$

P_2 need ≤ available

$[3\ 4\ 4\ 2] \leq [6\ 4\ 6\ 5]$

available = available + allocation

$= [6\ 4\ 6\ 5] + [4\ 1\ 0\ 2]$

$= [10\ 5\ 6\ 7]$

P_3 need ≤ available

$[2\ 3\ 3\ 1] \leq [10\ 5\ 6\ 7]$

available = available + allocation

$= [10\ 5\ 6\ 7] + [1\ 0\ 0\ 1]$

$= [11\ 5\ 6\ 8]$

P_4 need $\leq$ available

$[4 \quad 1 \quad 2 \quad 1] \leq [11 \quad 5 \quad 6 \quad 8]$

available = available + allocation

$= [11 \quad 5 \quad 6 \quad 8] + [1 \quad 1 \quad 0 \quad 0]$

$= [12 \quad 6 \quad 6 \quad 8]$

P_5 need $\leq$ available

$[3 \quad 1 \quad 3 \quad 3] \leq [12 \quad 6 \quad 6 \quad 8]$

available = available + allocation

$= [12 \quad 6 \quad 6 \quad 8] + [1 \quad 0 \quad 1 \quad 1]$

$= [13 \quad 6 \quad 7 \quad 9]$

P_0 need $\leq$ available

$[7 \quad 5 \quad 3 \quad 4] \leq [13 \quad 6 \quad 7 \quad 9]$

available = available + allocation

$= [13 \quad 6 \quad 7 \quad 9] + [2 \quad 0 \quad 2 \quad 1]$

$= [15 \quad 6 \quad 9 \quad 10]$

iii) Yes, the current state is safe

Safe sequence - $\boxed{P_1 \quad P_2 \quad P_3 \quad P_4 \quad P_5 \quad P_0}$

Q2

Process	Allocation			Request		
	A	B	C	A	B	C
P0	1	0	1	0	0	1
P1	2	0	0	2	0	2
P2	1	0	3	0	1	0
P3	2	1	1	1	0	0

Process	flag	Available
P0	~~F~~ T	[1 0 2]
P1	F	∤
P2	F	
P3	F	

Available = 0 0 1

P0 request ≤ Available

[0 0 1] ≤ [0 0 1]

available = available + allocation

= [0 0 1] + [1 0 1]

= [1 0 2]

P1 [2 0 2] ∤ [1 0 2]

P2 request ∤ available [1 0 2]

[1 0 3] ∤ available. [1 0 2]

P3 [2 1 1] ∤ available [1 0 2]

- Deadlock exists