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SEC : B

SUB : OPERATION RESEARCH

PART-C

10. Solve the T.P by 1. NWCR 2. VAM 3. ROW-minima

| | I | II | III | Supply |
|---|---|---|---|---|
| A | 5 | 6 | 9 | 100 |
| B | 3 | 5 | 10 | 75 |
| C | 6 | 7 | 6 | 50 |
| D | 6 | 4 | 10 | 75 |
| demand | 70 | 80 | 120 | 270/300 |

Demand = Supply

It is an Unbalanced T.P

i) NWCR

| | | | | | |
|---|---|---|---|---|---|
| 5 | 70 | 30 | 6 | 9 | 0 |
| 3 | | 50 | 5 | 25 10 | 0 |
| 6 | | | 7 | 50 6 | 0 |
| 6 | | | 4 | 45 10 | 30 0 |

10/6 (30)(0)

7/5 (25)(0)

5/0 (0)

7/5 (30)(0)

9/0 (0) 8/0 (50) (0) 12/0 (95) (45)(0) 3/0 (0)

Total Cost = (5×70) + (30×6) + (50×5) + (25×10)

+ (50×6) + (45+10) + (30×0)

= 350 + 180 + 250 + 250 + 300 + 450 + 0

= 1780.

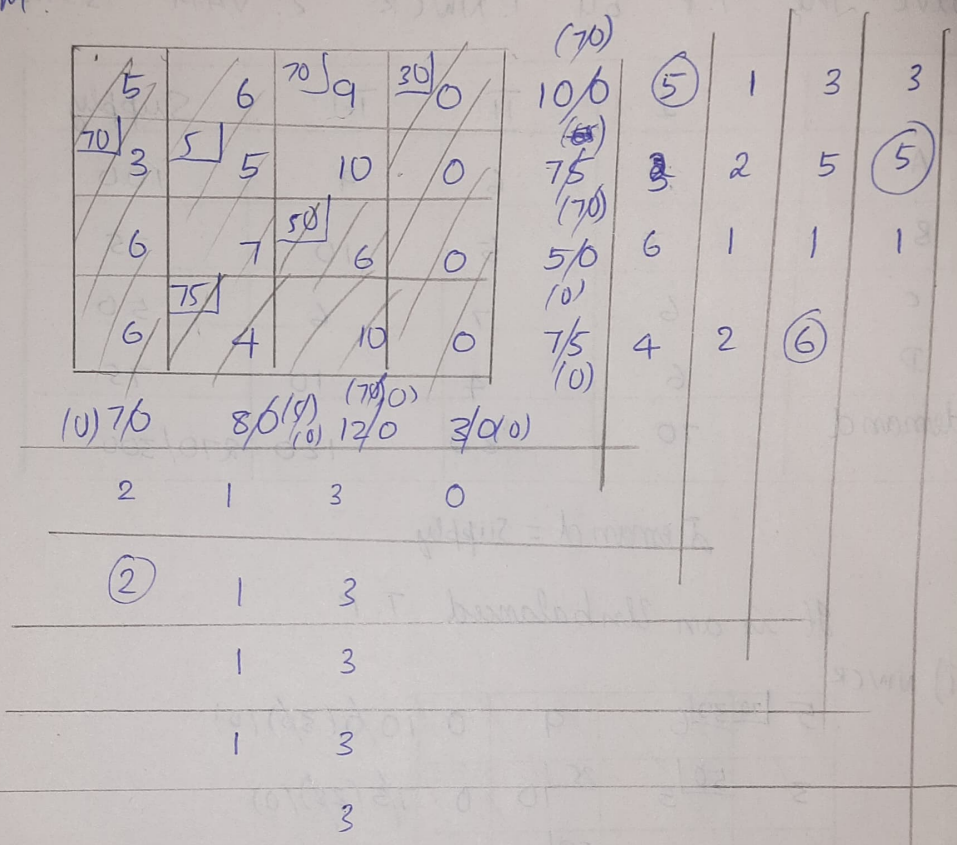
N. of allocation = m+n-1

= 4+4-1

= 7

It is an Non-Degenerat BFS.

ii) VAM.




Total Cost = (70×3) + (70×9) + (30×0) + (50×6)
+ (30×6) + (75×4)

= 210 + 630 + 0 + 25 + 300 + 300

= 1465.

No. of Allocation = m+n-1 = 4+4-1
= 7

It is an Degenerate BFS.

iii) row - minimum

| | | | | |
|---|---|---|---|---|
| 70 5 | 6 | 9 | 30 0 | 0 (70) 0 |
| 3 | 75 5 | 10 | 0 | 75 (0) |
| 6 | 7 | 50 6 | 0 | 50 (0) |
| 6 | 5 4 | 70 10 | 0 | 75 (70) (0) |
| 70 (0) | 80 (0) 0 | 120 | 30 | |

(70) (0)
(0)

Total cost = (70 × 5) + (30 × 0) + (75 × 5) + (50 × 6)
+ (5 × 4) + (70 × 10)

= 350 + 0 + 375 + 300 + 20 + 700

= 1745

No. of allocation = m + n - 1
= 4 + 4 - 1
= 7

It is an Degenarate BFS.

11. Solve the assignment and maximize the profit

| | | | |
|---|---|---|---|
| 51 | 53 | 54 | 50 |
| 47 | 50 | 48 | 50 |
| 49 | 50 | 60 | 61 |
| 63 | 64 | 60 | 60 |

$$\begin{pmatrix} 13 & 11 & 10 & 14 \\ 17 & 14 & 16 & 14 \\ 15 & 14 & 4 & 3 \\ 1 & 0 & 4 & 4 \end{pmatrix}$$

row wise

$$\begin{pmatrix} 3 & 1 & 0 & 4 \\ 3 & 0 & 2 & 0 \\ 12 & 11 & 1 & 0 \\ 1 & 0 & 4 & 4 \end{pmatrix}$$

Column wise

| | A | B | C | D |
|---|---|---|---|---|
| I | 2 | 1 | [0] | 4 |
| II | 2 | [0] | 2 | ~~0~~ |
| III | 11 | 11 | 1 | [0] |
| IV | [0] | 0 | 4 | 4 |

The assignment is

I → C, II → B, III → D, IV → A

The Total cost is ₹(54 + 50 + 61 + 63)

= ₹228

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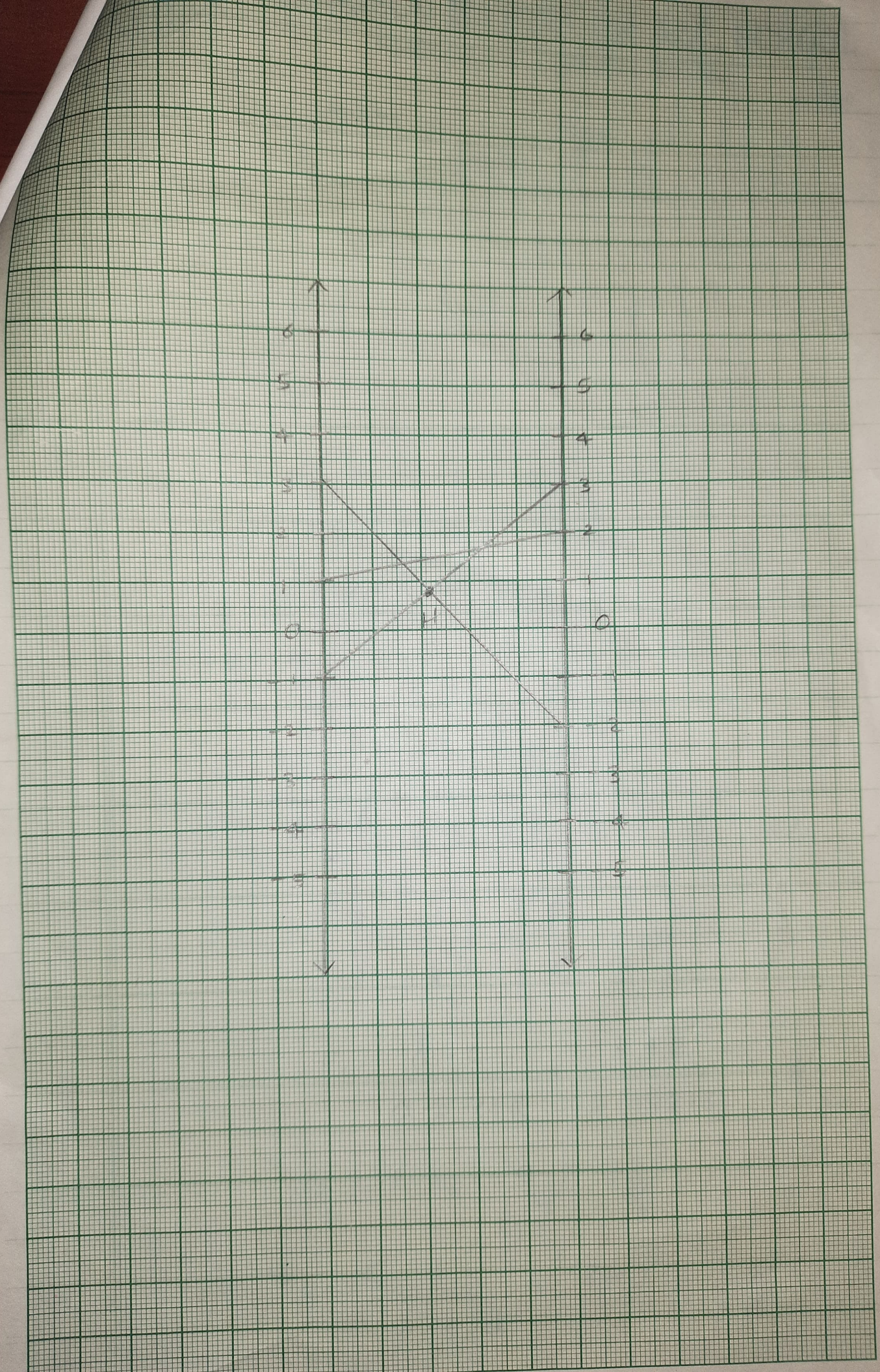
12. Solve the following game

Player B

Player A $\begin{pmatrix} 3 & -1 & 1 & 2 \\ -2 & 3 & 2 & 3 \\ 2 & -2 & -1 & 1 \end{pmatrix}$


6
5
4
3
2
1
0
-1
-2
-3
-4
-5
6
5
4
3
2
1
0
-1
-2
-3
-4
-5

Date..... Roll No..... Exam.....
Std..... Sec..... Subject.....

MARKS

$$\begin{pmatrix} 3 & -1 & 1 & 2 \\ -2 & 3 & 2 & 3 \\ 2 & -2 & -1 & 1 \end{pmatrix}$$

$$\begin{pmatrix} 3 & -1 & 1 & 2 \\ -2 & 3 & 2 & 3 \\ 2 & -2 & & 1 \end{pmatrix}$$

$$\begin{pmatrix} 3 & -1 & 1 \\ -2 & 3 & 2 \end{pmatrix}_{2\times n}$$

The points are $(3,-2)$ $(-1,3)$ $(1,2)$

$$\begin{bmatrix} 3 & -1 \\ -2 & 3 \end{bmatrix} = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$$

$$P_1 = \frac{d-c}{a-b-c+d} = \frac{3+2}{3+1+2+3} = \frac{5}{9}$$

$$P_2 = 1-P_1 = \frac{9-5}{9} = \frac{4}{9}$$

$$q_1 = \frac{d-b}{a-b-c+d} = \frac{3+1}{9} = \frac{4}{9}$$

$$q_2 = 1-q_1 = \frac{9-4}{9} = 5/9$$

value of the game $v = \frac{ad-bc}{a-b-c+d} = \frac{9-2}{9} = \frac{7}{9}$

The Str. for player A $[P_1\ P_2] = [5/9\ \ 4/9]$

The Str. for player B $[q_1\ q_2] = [4/9\ \ 5/9]$

value of the game $v = 7/9$

## PART-A

1. The Transportation Problem:

The Transportation problem is a special type of linear programming problem where the objective consists in minimizing transportation cost of a given commodity from a number of sources or origin.

Types of Transportation problem.

1. Balanced Transportation Problem
2. Unbalanced Transportation Problem.

2. The methods to find IBFS of Transportation problem are

i) North west Corner method

ii) Least Cost method

iii) VAM. (Penalty method).

3. Unbalanced Assignment Problem.

In an assignment Problem, no. of persons is less than the no. of jobs or the no. of jobs is less than the no. of persons, then

$c_{ij}$ matrix will not be a square matrix. Such an assignment is called an unbalanced assignment problem.

4. Find the order of Sequence of jobs for the following machines.

| Jobs | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| M - A | 10 | 2 | 18 | 6 | 20 |
| M - B | 4 | 12 | 14 | 16 | 8 |

The Sequence order is

| 2 | 4 | 3 | 5 | 1 |
|---|---|---|---|---|

5. Solve the following game:

$$\begin{pmatrix} 12 & 1 & 30 & -10 \\ 20 & 3 & 10 & 5 \\ -5 & -2 & 25 & 0 \\ 15 & -4 & 10 & 6 \end{pmatrix}$$

| | | | | row minimum |
|---|---|---|---|---|
| 12 | 1 | 30 | -10 | -10 |
| 20 | 3 | 10 | 5 | 3 |
| -5 | -2 | 25 | 0 | -5 |
| 15 | -4 | 10 | 6 | -4 |

maximin ($\underline{v}$) = 3

| | | | | |
|---|---|---|---|---|
| column maximum | 20 | 3 | 30 | 6 |

minimax ($\bar{v}$) = 3

maximin ($\underline{v}$) = minimax ($\bar{v}$) = value of the game ($v$) = 3

Saddle point = $a_{22}$.

Date..... Roll No..... Exam.....

Std..... Sec..... Subject.....

MARKS

## PART-B

7. Solve the assignment problem.

| | | | | |
|---|---|---|---|---|
| 10 | 11 | 4 | 2 | 8 |
| 7 | 11 | 10 | 14 | 12 |
| 5 | 6 | 9 | 12 | 14 |
| 13 | 15 | 11 | 10 | 7 |

| | I | II | III | IV | V |
|---|---|---|---|---|---|
| A | 10 | 11 | 4 | 2 | 8 |
| B | 7 | 11 | 10 | 14 | 12 |
| C | 5 | 6 | 9 | 12 | 14 |
| D | 13 | 15 | 11 | 10 | 7 |
| E | 0 | 0 | 0 | 0 | 0 |

Row wise

$$\begin{pmatrix} 8 & 9 & 2 & 0 & 6 \\ 0 & 4 & 3 & 7 & 5 \\ 0 & 1 & 4 & 7 & 9 \\ 6 & 8 & 4 & 3 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$

Column wise

| | | | | |
|---|---|---|---|---|
| 8 | 9 | 2 | 0 | 6 |
| 0 | 4 | 3 | 7 | 5 |
| ⊗ | 1 | 4 | 7 | 9 |
| 6 | 8 | 4 | 3 | 0 |
| ⊗ | 0 | 0 | ⊗ | 0 |

| | I | II | III | IV | V |
|---|---|---|---|---|---|
| A | 8 | 8 | 1 | 0 | 6 |
| B | 0 | 3 | 2 | 7 | 5 |
| C | ⊗ | 0 | 3 | 7 | 9 |
| D | 6 | 7 | 3 | 3 | 0 |
| E | 1 | ⊗ | 0 | 1 | 1 |

So, the assignment is

A → IV, B → I, C → II, D → V, E → III

Total minimum cost is = ₹ (2 + 7 + 6 + 7 + 0)

₹ 22 //.

8. Solve the game $\begin{vmatrix} 3 & -2 \\ -2 & 5 \end{vmatrix}$

$$\begin{bmatrix} 3 & -2 \\ -2 & 5 \end{bmatrix} = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$$

$$P_1 = \frac{a-b}{a-b-c+d} = \frac{5+2}{3+2+2+5} = \frac{7}{12}$$

$$P_2 = 1 - P_1 = \frac{12-7}{12} = \frac{5}{12}$$

$$q_1 = \frac{a-b}{a-b-c+d} = \frac{5+2}{3+2+2+5} = \frac{7}{12}$$

$$q_2 = 1 - q_1 = \frac{12-7}{12} = 5/12$$

value of the game $= \frac{ad-bc}{a-b-c+d}$

$$= \frac{15-4}{12} = 11/12$$

The Str. for Player A $[P_1, P_2] = [7/12 \quad 5/12]$

The Str. for Player B $[q_1, q_2] = [7/12 \quad 5/12]$

Value of the game $V = 11/12$.

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9. Determine the order and minimized time to complete all the jobs.

| Jobs | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| M-A | 5 | 7 | 2 | 6 | 3 | 4 |
| M-B | 2 | 5 | 4 | 9 | 1 | 3 |

The sequence order is

| 5 | 3 | 6 | 2 | 4 | 1 |
|---|---|---|---|---|---|

| Jobs | M-A | | M-B | | Idle | |
|---|---|---|---|---|---|---|
| | time in | time out | time in | time out | $M_A$ | |
| 5 | 0 | 3 | 3 | 4 | | 3 |
| 3 | 3 | 5 | 5 | 9 | X | 1 |
| 6 | 5 | 9 | 9 | 12 | | |
| 2 | 9 | 16 | 16 | 21 | X | 4 |
| 4 | 16 | 22 | 22 | 31 | X | 1 |
| 1 | 22 | 27 | 31 | 33 | 6 | |
| | | | | Total | 6 | 9 |

Total minimum elapsed time = 33 hrs
Idle time for player A - 6 hrs
Idle time for player B = 9 hrs

6. Solve the T.P by LCM method and minimize the profit

| | A | B | C | D | Supply |
|---|---|---|---|---|---|
| I | 15 | 51 | 42 | 33 | 23 |
| II | 80 | 42 | 26 | 81 | 44 |
| III | 90 | 40 | 66 | 60 | 33 |
| demand | 23 | 31 | 16 | 60 | |

Here Demand ≠ Supply

It is an unbalanced Transportation problem.

| | | | | |
|---|---|---|---|---|
| 15 | 51 | 42 | 23 33 | 23 (0) |
| 80 | 42 | 16 26 | 28 81 | 44 (28) (0) |
| 90 | 24 40 | 66 | 9 60 | 33 (9) (0) |
| 23 0 | 7 0 | 0 | 0 | 30 (7) (0) |
| 2/3 (0) | 3/1 (24) (0) | 16 (0) | 60 (37) (28) (0) | 130 130 |

ToTal Cost = $(23\times0) + (7\times0) + (24\times40) + (9\times60) +$
$(16\times26) + (28\times81) + (23\times33)$

$= 0 + 0 + 960 + 540 + 416 + 2268 + 759$

$= 4943.$

No. of Allocation $= m+n-1$

$= 4+4-1$

$= 7$

It is an Non-Degenerate Basic Feasible Solution