(PAGE) # 1

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SECTION:- #(A)

# QUESTION NO # 1

~~Paper~~ There are total 5 machines ~~on~~ and five employment are to be relajeted and the reletated cost network is per the following. locate the best possible task.

| | | MACHINES | | | | |
|---|---|---|---|---|---|---|
| | | A | B | C | D | E |
| J O B S | 1 | 6 | 12 | 3 | 11 | 15 |
| | 2 | 4 | 2 | 7 | 1 | 10 |
| | 3 | 8 | 11 | 10 | 7 | 11 |
| | 4 | 16 | 19 | 122 | 23 | 21 |
| | 5 | 9 | 5 | 7 | 6 | 10 |

P(3)

# ANSWER:-

## Solution:-

MACHINES

| Jobs | 1 | 2 | 3 | 4 | 5 | Row minimum |
|---|---|---|---|---|---|---|
| 1 | 6 | 12 | $\boxed{13}$ | 11 | $\boxed{15}$ | 3 |
| 2 | 4 | 2 | 7 | $\boxed{1}$ | 10 | 1 |
| 3 | 8 | 17 | 10 | 7 | $\boxed{11}$ | 7 |
| 4 | $\boxed{16}$ | 19 | 122 | 23 | 21 | 16 |
| 5 | 9 | $\boxed{5}$ | 7 | 6 | 10 | 5 |

Row Reduction

MACHINES

| Jobs | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 1 | 3 | 9 | 0 | 8 | 12 |
| 2 | 3 | 1 | 6 | 0 | 9 |
| 3 | 1 | 4 | 3 | 0 | 4 |
| 4 | 0 | 3 | 106 | 7 | 5 |
| 5 | 4 | 0 | 2 | 1 | 5 |
| | 0 | 0 | 0 | 0 | 4 |

P(4)

Column reduction

MACHINES

| Jobs | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 1 | 3 | 9 | $\boxed{0}$ | 8 | 8 |
| 2 | 3 | 1 | 6 | $\boxed{0}$ | 5 |
| 3 | 1 | 4 | 3 | 0 | $\boxed{0}$ |
| 4 | $\boxed{0}$ | 3 | 16 | 7 | 1 |
| 5 | 4 | $\boxed{0}$ | 2 | 1 | 1 |

J=5 optimal Solution

| JOBS | MACHINES | TIME |
|---|---|---|
| 1 | 3 | 3 |
| 2 | 4 | 1 |
| 3 | 5 | 11 |
| 4 | 1 | 16 |
| 5 | 2 | 5 |
| | | 36 |

Total processing time = 36 hours

## QUESTION No:- 2

Solve the following linear programming problem.

$$\min z = 2x_1 + 3x_2$$

$$\text{S.T.} \quad (1/2)x_1 + (1/4)x_2 \le 4$$

$$x_1 + 3x_2 \ge 20$$

$$x_1 + x_2 = 10$$

$$x_1, x_2 \ge 0$$

## ANSWER:-

SOLUTION:- Big M method for a max(min) linear programming problem.

* Introduce artificial variables in each row (with no basic variable).

Put the artificial variable into the objective function. For max problem

$$\max z = c^t x - Ma_1 - Ma_2 - \cdots - Ma_m.$$

(For minimum problem $\min z = c^t x + Ma_1 + Ma_2 + \cdots + Ma_m$.

* "clean up" the objective function.
* Solve the LP by Simplex.

If at option all $a_i = 0$ we got the optimal Solution for the Original LP otherwise (Some $a_i > 0$ at opt) the original LP is infeasible

$$\min z = 2x_1 + 3x_2$$

$$\text{s.t } (1/2)x_1 + (1/4)x_2 \le 4$$

$$x_1 + 3x_2 \ge 20$$

$$x_1 + x_2 = 10$$

$$x_1, x_2 \ge 0$$

In Standard Form:-

$$\min \quad z - 2x_1 - 3x_2 = 0$$

$$\text{S.t } (1/2)x_1 + (1/4)x_2 + S_1 = 4$$

$$x_1 + 3x_2 - C_2 = 20$$

$$x_1 + x_2 = 10$$

$$x_1, x_2, S_1, C_2 \ge 10$$

* Add artificial variable in constraints 2 and 3

$$\min z - 2x_1 - 3x_2 - Ma_2 - Ma_3 = 0$$

S.T

$$(1/2)x_1 + (1/4)x_2 + S_1 = 4$$

$$x_1 + 3x_2 - e_2 + a_2 = 20$$

$$x_1 + x_2 + a_3 = 10$$

$$x_1, x_2, S_1, e_2, a_2, a_3 \geq 0$$

* Tableau before "Cleam-up":

| z | $x_1$ | $x_2$ | $S_1$ | $e_2$ | $a_2$ | $a_3$ | RHS |
|---|---|---|---|---|---|---|---|
| 1 | -2 | -3 | 0 | 0 | -M | -M | 0 |
| 0 | 1/2 | 1/4 | 1 | 0 | 0 | 0 | 4 |
| 0 | 1 | 3 | 0 | -1 | 1 | 0 | 20 |
| 0 | 1 | 1 | 0 | 0 | 0 | 1 | 10 |

* First tableau (after "cleam up")

| z | $x_1$ | $x_2$ | $S_1$ | $e_2$ | $a_2$ | $a_3$ | RHS |
|---|---|---|---|---|---|---|---|
| 1 | 2M-2 | 4M-3 | 0 | -M | 0 | 0 | 30M |
| 0 | 1/2 | 1/4 | 1 | 0 | 0 | 0 | 4 |
| 0 | 1 | 3 | 0 | -1 | 1 | 0 | 20 |
| 0 | 1 | 1 | 0 | 0 | 0 | 1 | 10 |

* $x_2$ enters $a_2$ leaves the basis

Next tableau.

| z | $x_1$ | $x_2$ | $S_1$ | $e_2$ | $a_2$ | $a_3$ | RHS |
|---|---|---|---|---|---|---|---|
| 1 | $(2M-3)/3$ | 0 | 0 | $(M-3)/3$ | $(3-4M)/3$ | 0 | $(60+10M)/3$ |
| 0 | $-5/12$ | 0 | $-1$ | $1/12$ | $-1/12$ | 0 | $7/3$ |
| 0 | $1/3$ | 1 | 0 | $-1/3$ | $1/3$ | 0 | $20/3$ |
| 0 | $2/3$ | 0 | 0 | $1/3$ | $-1/3$ | 1 | $10/3$ |

* $x_1$ enters $a_3$ leaves the basis. Next tableau.

| z | $x_1$ | $x_2$ | $S_1$ | $e_2$ | $a_2$ | $a_3$ | RHS |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | $-1/2$ | $(1-2M)/2$ | $(3-2M)/2$ | 25 |
| 0 | 0 | 0 | 1 | $-1/8$ | $1/8$ | $-5/8$ | $1/4$ |
| 0 | 0 | 1 | 0 | $-1/2$ | $1/2$ | $-1/2$ | 5 |
| 0 | 1 | 0 | 0 | $1/2$ | $-1/2$ | $3/2$ | 5 |

Required ANSWER

## QUESTION NO:- 3

Use Vogel's Approximation method to obtain the initial feasible solution of. . .

## ANSWER:-

Destination

| Origin | 1 | 2 | 3 | 4 | Supply |
|---|---|---|---|---|---|
| 1 | 20 | 22 | 17 | 4 | 120 |
| 2 | 24 | 37 | 9 | 7 | 70 |
| 3 | 32 | 37 | 20 | 15 | 50 |
| Demand | 60 | 40 | 30 | 110 | 240 |

SOLUTION:-

| | 1 | 2 | 3 | 4 | Supply |
|---|---|---|---|---|---|
| 1 | 20 | 22 | 17 | 4 | 120 |
| 2 | 24 | 37 | 9 | 7 | 70 |
| 3 | 32 | 37 | 20 | 15 | 50 |
| Demands | 60 | 40 | 30 | 110 | 240 |

Demand = Supply

# Balanced transportation problem

| | 1 | 2 | 3 | 4 | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | X 20 | 40 22 | X 17 | 80 4 | 0 ~~80~~ ~~120~~ | 13 | 13 | - | |
| 2 | 10 24 | X 37 | 30 9 | 30 7 | 0 ~~10~~ ~~40~~ ~~70~~ | 2 | 2 | 2 | 17 |
| 3 | 50 32 | X 37 | X 20 | X 15 | ~~50~~ 0 | 5 | 5 | 5 | 17 |
| | ~~60~~ ~~50~~ 0 | ~~40~~ 0 | ~~30~~ 0 | 110 ~~30~~ 0 | | | | | |
| | 4 | 15 | 8 | 3 | | | | | |
| | 4 | - | 8 | 3 | | | | | |
| | 8 | - | 11 | 8 | | | | | |
| | 8 | - | - | 8 | | | | | |

$880 + 320 + 240 + 270 + 210 + (40 \times 22) + (80 \times 4)$

$+ (10 \times 24) + (30 \times 9) + (30 \times 7) + 1600$

$(50 \times 32) F \boxed{3520}$