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Section : (B)

paper : operation research

Semester : 4th

Class Timing : (WED : 8 ⇒ 11)

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Q1:- there are total q 5 machines and five employments are to be relegated and the related cost network is as per the following Locate the best possible task.

Machines

		A	B	C	D	E
	1	6	12	3	11	15
	2	4	2	7	1	10
Jobs	3	8	11	10	7	11
	4	16	19	122	23	21
	5	9	5	7	6	10

Phase 1:-

Answer:- Step 1:- Subtract the minimum value of each row from the entries of that row.

Machines

		A	B	C	D	E	Row Minimum
	1	6	12	3	11	15	3
	2	4	2	7	1	10	1
jobs	3	8	11	10	7	11	7
	4	16	19	122	23	21	16
	5	9	5	7	6	10	5

Row Reduction

Step7:- subtract the minimum value of each column from the entries of that column.

machiens		A	B	C	D	E
	1	3	9	0	8	12
	2	3	1	6	0	9
Jobs	3	1	4	3	0	4
	4	0	3	106	7	5
	5	4	0	2	1	5
column min		0	0	0	0	4

Phase 2: optimation of the problem.

Step 1:- Draw a minimum no of lines to cover all the zeros of the matrix.

procedure:-

a) Row Scanning: i) Starting from the first row, are the following equation. is the exactly one zero in that row! If yes mark a square around that zero entiy and draw a vertical line passing through that zero, otherwise skip that row.

column Reduction

		A	B	C	D	E
	1	3	9	$\boxed{0}$	8	8
	2	3	1	6	$\boxed{0}$	5
Jobs	3	1	4	3	0	$\boxed{0}$
	4	$\boxed{0}$	3	106	7	1
	5	4	$\boxed{0}$	2	7	7

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Jobs	Machines	Time
1	3	3
2	4	1
3	5	11
4	1	16
5	2	5
		36

total processing time = 36 chr.

Machines timing

	A	B	C	D	E
1	6	12	$\boxed{3}$	11	15
2	4	2	7	$\boxed{1}$	10
3	8	11	10	7	$\boxed{11}$
4	$\boxed{16}$	19	122	23	21
5	9	$\boxed{5}$	7	6	10

Q2:- page (P-5) Solve the following Linear programming problem.

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

Subject to : $\frac{1}{2}x_1 + \frac{1}{4}x_2 \leq 4$

$$x_1 + 3x_2 \geq 20$$

$$x_1 + x_2 = 10$$

$$x_1, x_2 \geq 0$$

Answer:-

Step 1:- Add Surpuls variable and artifitial variable.

$$\frac{1}{2}x + \frac{1}{4}x_2 + S_1 = 4$$

$$x_1 + 3x_2 - S_2 + a_1 = 20$$

$$x_1 + x_2 + a_2 = 10$$

Step 2:- Add slack variable. and set the obective function equal to 0.

$$\text{Min } Z = 2x_1 + 3x_2 + Ma_1 + Ma_2$$

$$Z - 2x_1 - 3x_2 - Ma_1 - Ma_2 = 0$$

Step 3:- creat simple tible

Z	x_1	x_2	s_1	s_2	a_1	a_2	
1	-2	-3	0	0	-M	-M	0
0	$\frac{1}{2}$	$\frac{1}{4}$	1	0	0	0	4
0	1	3	0	-1	1	0	20
0	1	1	0	0	0	1	10

In the above table "a1" and 'a2" both are basic variable and having co-fficient of "m" in the objective function, but according to the definition of basic variable, it shoul be zero Now we have to manipulate this Row inorder to get zero insted of 'm'.

(MR3 + R1)

Z	x_1	x_2	s_1	s_2	a_1	a_2	
1	M-2	3M-3	0	-M	0	-M	20M
0	$\frac{1}{2}$	$\frac{1}{4}$	1	0	0	0	4
0	1	3	0	-1	1	0	20
0	1	1	0	0	0	1	10

(P-7)

(MR4 + R1

$$\begin{array}{ccccccc|c}
z & x1 & x2 & s1 & s2 & a1 & a2 & \\
1 & 2M-2 & 4M-3 & 0 & -M & 0 & 0 & 30M \\
0 & \frac{1}{2} & \frac{1}{4} & 1 & 0 & 0 & 0 & 4 \\
0 & 1 & 3 & 0 & -1 & 1 & 0 & 20 \\
0 & 1 & 1 & 0 & 0 & 0 & 1 & 10
\end{array}$$

Now step 4: to find povit column, step5 to find povit Row, step 6: to find povit value.

$$\begin{array}{ccccccc|cl}
z & x1 & x2 & s1 & s2 & a1 & a2 & & \\
1 & 2M-2 & 4M-3 & 0 & -M & 0 & 0 & 30M & \\
0 & \frac{1}{2} & \frac{1}{4} & \underline{1} & 0 & 0 & 0 & 4 & : \frac{4}{\frac{1}{4}} = 8 \\
0 & \underline{1} & \boxed{3} & 0 & -1 & \underline{1} & 0 & 20 & = \frac{20}{3} \\
0 & \underline{1} & \underline{1} & 0 & 0 & 0 & \underline{1} & 10 & \frac{10}{1} = 10
\end{array}$$

Step 4 ↗
Piovt column

Step 6:
pivot value

Step 5
pivot
Row

(P - 8)

Step 7:- Perform row operations to make pivot equal to ~~zero~~ 1 and the remaining elements in the pivot column equal to zero.

$(\frac{1}{3}R3)$

z	x1	x2	s1	s2	a1	a2	
1	2M-2	4m-3	0	-M	0	0	30M
0	$\frac{1}{2}$	$\frac{1}{4}$	1	0	0	0	4
0	$\frac{1}{3}$	$\underline{1}$	0	$-\frac{1}{3}$	$\frac{1}{3}$	0	$\frac{20}{3}$
0	1	1	0	0	0	$\underline{1}$	10

$(-1R3+R4)$

z	x1	x2	s1	s2	a1	a2	
1	2M-2	4m-3	0	-M	0	0	30M
0	$\frac{1}{2}$	$\frac{1}{4}$	1	0	0	0	4
0	$\frac{1}{3}$	1	0	$-\frac{1}{3}$	$\frac{1}{3}$	0	$\frac{20}{3}$
0	$\frac{2}{3}$	0	0	$\frac{1}{3}$	$-\frac{1}{3}$	1	$\frac{10}{3}$

$(-\frac{1}{4}R_3 + R_2)$

z	x1	x2	s1	s2	a1	a2	
1	$2M-2$	$4M-3$	0	$-M$	0	0	30
0	$\frac{5}{12}$	0	1	$\frac{1}{12}$	$-\frac{1}{12}$	0	$\frac{7}{3}$
0	$\frac{1}{3}$	1	0	$-\frac{1}{3}$	$\frac{1}{3}$	0	$\frac{20}{3}$
0	$\frac{2}{3}$	0	0	$\frac{1}{3}$	$-\frac{1}{3}$	1	$\frac{10}{3}$

$((-4M+3)R_3 + R_1)$

z	x1	x2	s1	s2	a1	a2	
1	$(\frac{2}{3})M-1$	0	0	$((\frac{1}{3})M-1)$	$(1-\frac{4}{3}M)$	0	$20+\frac{10M}{3}$
0	$\frac{5}{12}$	0	1	$\frac{1}{12}$	$-\frac{1}{12}$	0	$\frac{7}{3}$
0	$\frac{1}{3}$	1	0	$-\frac{1}{3}$	$\frac{1}{3}$	0	$\frac{20}{3}$
0	$\frac{2}{3}$	0	0	$\frac{1}{3}$	$-\frac{1}{3}$	1	$\frac{10}{3}$

step 8:-
repeat process again find pivot column

Pivot Row, and pivot value

Step 4, 5, 6.

Z	x1	x2	S1	S2	a1	a2	
1	$(\frac{2}{3})M-1$	0	0	$(\frac{1}{3})M-1$	$1-\frac{4}{3}M$	0	$20+\frac{10}{3}M$
0	$\frac{5}{12}$	0	1	$\frac{1}{12}$	$-\frac{1}{12}$	0	$\frac{7}{3}$ =5.6
0	$\frac{1}{3}$	1	0	$-\frac{1}{3}$	$\frac{1}{3}$	0	$\frac{20}{3}$ =20
0	$\frac{2}{3}$	0	0	$\frac{1}{3}$	$-\frac{1}{3}$	1	$\frac{10}{3}$ =5

Step 7: . operation to make pivt value equal to 1 and remaining elements in the pivot column equal to 0

$((\frac{3}{2})R4)$

Z	x1	x2	S1	S2	a1	a2	
1	$\frac{2}{3}M-1$	0	0	$\frac{1}{3}M-1$	$1-\frac{4}{3}M$	0	$20+\frac{10}{3}M$
0	$\frac{5}{12}$	0	1	$\frac{1}{12}$	$-\frac{1}{12}$	0	$\frac{7}{3}$
0	$\frac{1}{3}$	1	0	$-\frac{1}{3}$	$\frac{1}{3}$	0	$\frac{20}{3}$
0	1	0	0	$\frac{1}{2}$	$-\frac{1}{2}$	$\frac{3}{2}$	5

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$(-\frac{2}{3}M+1)R4+R1$

Z	x1	x2	S1	S2	a1	a2	
1	0	0	0	$-\frac{1}{2}$	$\frac{1}{2}-M$	$\frac{3}{2}-M$	25
0	$\frac{5}{12}$	0	1	$\frac{1}{12}$	$-\frac{1}{12}$	0	$\frac{7}{3}$
0	$\frac{1}{3}$	1	0	$-\frac{1}{3}$	$\frac{1}{3}$	0	$\frac{20}{3}$
0	1	0	0	$\frac{1}{2}$	$-\frac{1}{2}$	$\frac{3}{2}$	5

$((-\frac{5}{12})R4+R2)$

Z	x1	x2	S1	S2	a1	a2	
1	0	0	0	$-\frac{1}{2}$	$(\frac{1}{2}-M)$	$\frac{3}{2}-M$	25
0	0	0	1	$-\frac{1}{8}$	$\frac{1}{8}$	$-\frac{5}{8}$	$\frac{1}{4}$
0	$\frac{1}{3}$	1	0	$-\frac{1}{3}$	$\frac{1}{3}$	0	$\frac{20}{3}$
0	1	0	0	$\frac{1}{2}$	$-\frac{1}{2}$	$\frac{3}{2}$	5

$$\left(-\frac{1}{3}R4 + R3\right)$$

$$\left[\begin{array}{ccccccc|c}
z & x_1 & x_2 & s_1 & s_2 & a_1 & a_2 & \\
1 & 0 & 0 & 0 & -\frac{1}{2} & \left(\frac{1}{2}-M\right) & \frac{3}{2}-M & 25 \\
0 & 0 & 0 & \underline{1} & -\frac{1}{8} & \frac{1}{8} & -\frac{5}{8} & \frac{1}{4} \\
0 & 0 & \underline{1} & 0 & -\frac{1}{2} & \frac{1}{2} & -\frac{1}{2} & 5 \\
0 & \underline{1} & 0 & 0 & \frac{1}{2} & -\frac{1}{2} & \frac{3}{2} & 5
\end{array}\right.$$

Minimum $z = 25$

$$\begin{array}{c|ccccccc|c}
 & z & x_1 & x_2 & s_1 & s_2 & a_1 & a_2 & \\
z & 1 & 0 & 0 & 0 & -\frac{1}{2} & \left(\frac{1}{2}-M\right) & \left(\frac{3}{2}-M\right) & 25 \\
S1 & 0 & 0 & 0 & 1 & -\frac{1}{8} & \frac{1}{8} & -\frac{5}{8} & \frac{1}{4} \\
x_2 & 0 & 0 & 1 & 0 & -\frac{1}{2} & \frac{1}{2} & -\frac{1}{2} & 5 \\
x_1 & 0 & \underline{1} & 0 & 0 & \frac{1}{2} & -\frac{1}{2} & \frac{3}{2} & 5 \\
\hline
\end{array}$$

Min $z = 25$ $\quad x_1 = 5 \quad S2 = 0$

$S1 = \frac{1}{4} \quad x_2 = 5 \quad a1 = 0$

$a2 = 0$

Q3:- Use vogel's Approximation Method to obtain the initial feasibe Solution Q:

Solution:-

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

Demand = Supply

Balanced Transportation problem.

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	1	2	3	4					
1	X 20	$\boxed{40}$ 22	X 17	$\boxed{80}$ 4	~~120~~ ~~80~~ 0	13	⑬	–	–
2	$\boxed{10}$ 24	X 37	$\boxed{30}$ 9	$\boxed{30}$ 7	~~70~~ ~~40~~ 0	2	2	2	⑰
3	$\boxed{50}$ 32	X 37	X 20	X 15	~~50~~ 0	5	5	5	17
	~~60~~ ~~50~~ 0	~~40~~ 0	~~30~~ 0	~~40~~ ~~30~~ 0					
	4	⑮	8	3					
	4	–	8	3					
	8	–	⑪	8					
	8	–	–	8					

$(40 \times 22) + (80 \times 4) + (10 \times 24) + (30 \times 9) + (30 \times 7) + (50 \times 32) = 3520$

$880 + 320 + 240 + 270 + 210 + 1600 = \boxed{3520}$

Ans 3520