Name = Zamin Shah

I D = 15277

Section = "B"

Depart = S.E

Paper = operational Research

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There are total 5 machines and 5 employments are to be relegated and the related cost network is as per the following ?

Solution :-

	Machines					
		A	B	C	D	E
Jobs	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

:- Row minimization :-

Jobs	Machines A	B	C	D	E	
1	6	12	3	11	15	3
2	4	2	7	1	10	1
3	8	11	10	7	11	7
4	16	19	129	93	21	16
5	9	5	7	6	10	5

→ step #2:-

Row subtraction :-

Jobs	MACHINES A	B	C	D	E	
	3	9	0	8	12	1
	3	1	6	0	9	2
	1	4	3	0	4	3
	0	3	106	6	5	4
	4	0	2	1	5	5

column Minimization

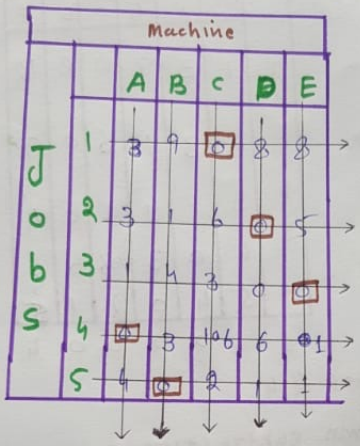
Jobs	Machines A	B	C	D	E
1	3	9	0	8	12
2	3	1	6	0	9
3	1	4	3	0	4
4	0	3	106	6	5
5	4	0	2	1	5
	0	0	0	0	4

→ step # 4

column subtraction :-

Jobs	Machine A	B	C	D	E	
1	3	9	0	8	8	1
2	3	1	6	0	5	2
3	1	4	3	0	0	3
4	0	3	106	6	1	4
5	4	0	2	1	1	5

Draw horizental & vestical lines through circles :-



Hence $5 = 5$

No. of circles = No. of lines.

optimal solution :

Step # 6

Timing :-

Jobs		Machines				
		A	B	C	D	E
	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

Jobs	operators	Time
1	C	3
2	D	1
3	E	11
4	A	16
5	B	5
		36

Total processing time = 36 or hr.

Ans

Question # 2.

minimization $Z = 2x_1 + 3x_2$

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

$x_1 + 3x_2 \geq 20$

$x_1 + x_2 = 10$

$x_1, x_2 \geq 0$

Solution :-

Step #1

$\frac{1}{2}x_1 + \frac{1}{4}x_2 + s_1 = 4$

$x_1 + 3x_2 - s_2 + a_1 = 20$

$x_1 + x_2 + a_2 = 10$

Step # 02 :-

Set the objective function equal to zero.

$Z = -2x_1 - 3x_2$ ∵ for minimization xing by (-1).

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

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

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

Create a simple table.

		x_1	x_2	s_1	s_2	a_1	a_2	z	
$\rightarrow R_1$	s_1	$\frac{1}{2}$	$\frac{1}{4}$	1	0	0	0	0	4
$\rightarrow R_2$	a_1	1	3	0	-1	1	0	0	20
$\rightarrow R_3$	a_2	1	1	0	0	0	1	0	10
$\rightarrow R_4$	z	2	3	0	0	m	m	1	0

$R_{4n} \rightarrow \quad R_4 + (-m R_3)$

	2	3	0	0	m	m	1	0
	-m	-m	0	0	0	-m	0	-10m
	2-m	3-m	0	0	m	0	1	-10m

		x_1	x_2	s_1	s_2	a_1	a_2	z	
$\rightarrow R_1$	s_1	$\frac{1}{2}$	$\frac{1}{4}$	1	0	0	0	0	4
$\rightarrow R_2$	a_1	1	3	0	-1	1	0	0	20
$\rightarrow R_3$	a_2	1	1	0	0	0	1	0	10
$\rightarrow R_4$	z	2-m	3-m	0	0	m	0	1	-10m

$2-m$	$3-m$	0	0	m	0	1	$-10m$
$-m$	$-3m$	0	m	$-m$	0	0	$-20m$
$2-2m$	$3-4m$	0	m	0	0	1	$-30m$

		x_1	x_2	S_1	S_2	a_1	a_2	Z	
$\rightarrow R_1$	S_1	$\frac{1}{2}$	$\frac{1}{4}$	1	0	0	0	0	4
$\rightarrow R_2$	a_1	1	3	0	-1	1	0	0	20
$\rightarrow R_3$	a_2	1	1	0	0	0	1	0	10
$\rightarrow R_4$	Z	$2-2m$	$3-4m$	0	m	0	0	1	$-30m$

Step # 4:-

Select the pivot column.

x_1	x_2	S_1	S_2	a_1	a_2	Z	
$\frac{1}{2}$	$\frac{1}{4}$	1	0	0	0	0	4
1	3	0	-1	1	0	0	20
1	1	0	0	0	1	0	10
$2-2m$	$3-4m$	0	m	0	0	1	$-30m$

Select the pivot Row.

	x_1	x_2	s_1	s_2	a_1	a_2	z	
s_1	$\frac{1}{2}$	$\frac{1}{4}$	1	0	0	0	0	$4 = 4/\frac{1}{4} = 16$
a_1	1	3	0	-1	1	0	0	$20 : \frac{20}{3} = 6.6$ ✓
a_2	1	1	0	0	0	1	0	$10 \quad \frac{10}{1} = 10$
z	$8-2m$	$3-4m$	0	m	0	0	1	$-30m$

Step # 6:

Select the pivot which is the entery in the pivot column & pivot Row.

	x_1	x_2	s_1	s_2	a_1	a_2	z	
s_1	$\frac{1}{2}$	$\frac{1}{4}$	1	0	0	0	0	4
a_1	1	3	0	-1	1	0	0	20
a_2	1	1	0	0	0	1	0	10
z	$8-2m$	$3-4m$	0	m	0	0	1	$-30m$

Perform Row operations to make pivot equal to 1 & the remaining elements in the pivot column equal to zero.

Multiplying R_2 by $1/3$.

	x_1	x_2	s_1	s_2	a_1	a_2	z	
s_1	$1/2$	$1/4$	1	0	0	0	0	4
a_1	$1/3$	1	0	$-1/3$	$1/3$	0	0	$20/3$
a_2	1	1	0	0	0	1	0	10
z	2-9m	3-4m	0	m	0	0	1	-30m

multiply R_1 by 4.

	x_1	x_2	s_1	s_2	a_1	a_2	z	
s_1	2	1	4	0	0	0	0	16
a_1	$1/3$	1	0	$-1/3$	$1/3$	0	0	$20/3$
a_2	1	1	0	0	0	1	0	10
z	2-2m	3-4m	0	m	0	0	1	-30m

$R_1 + (-1R_2)$

2	1	4	0	0	0	0	16
$-1/3$	-1	0	$1/3$	$-1/3$	0	0	$-20/3$
$\frac{6-1}{3}$	0	4	$1/3$	$-1/3$	0	0	$\frac{48-20}{3}$
$5/3$	0	4	$1/3$	$-1/3$	0	0	$28/3$

	x1	x2	s1	s2	a1	a2	Z	
s1	$5/3$	0	4	$1/3$	$-\frac{1}{3}$	0	0	$28/3$
a1	$1/3$	1	0	$-1/3$	$1/3$	0	0	$20/3$
a2	1	1	0	0	0	1	0	10
Z	3-3m	3-4m	0	m	0	0	1	-30m

$R_3 \rightarrow R_3 + (-1R_2)$

1	1	0	0	0	1	0	10
$-1/3$	-1	0	$1/3$	$-1/3$	0	0	$-20/3$
$\frac{3}{3}$	0	0	$1/3$	$-1/3$	1	0	$10/3$

	x1	x2	s1	s2	a1	a2	z	
s1	5/3	0	4	1/3	-1/3	0	0	28/3
a1	1/3	1	0	-1/3	1/3	0	0	20/3
a2	2/3	0	0	1/3	-1/3	1	0	10/3
z	2-2m	3-4m	0	m	0	0	1	-30m

$R_4 \rightarrow R_4 + (-(3-4m)R_2)$

2-2m	3-4m	0	m	0	0	1	-30m
-1+4m	-3+4m	0	1-4m	1+4m	0	0	-10+80m
1+2m	0	0	1-3m	1+4m	0	1	-10+50m

Step # 8

	x1	x2	s1	s2	a1	a2	z	
x2	5/3	0	4	1/3	-1/3	0	0	28/3
s1	1/3	1	0	-1/3	1/3	0	0	20/3
a2	2/3	0	0	1/3	-1/3	1	0	10/3
z	1+2m	0	0	1-3m	1+4m	0	1	-10+50m

Step # 8 :-

Repeat the identifying process by the most.

$x_2 = \frac{28}{3}$
$s_1 = \frac{20}{3}$
$a_2 = \frac{10}{3}$

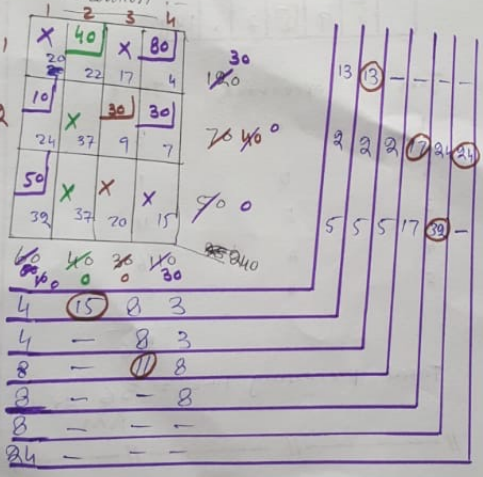
$z = -10 + 50m$

Ans.

Use Vogels approximation Method to obtain the initial feasible solution of:

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:-



Total cost = $40 \times 22 + 80 \times 4 + 10 \times 84 +$
$30 \times 9 + 30 \times 7 + 50 \times 32$

$= 880 + 320 + 240 + 270 + 210 +$
1600

Total cost = $\boxed{3520}$