

1. Maximize $Z = -x_1 + 3x_2$ subject to the constraints.

$$x_1 + x_2 \leq 6, \quad -x_1 + 2x_2 \leq 4, \quad x_1, x_2 \geq 0$$

→ soln,

let us introduce two slack variables s_1 and s_2 . The normal form or standard form of given LPP is

$$Z + x_1 - 3x_2 + 0 \cdot s_1 + 0 \cdot s_2 = 0$$

~~$x_1 + x_2 + s_1 = 6$~~

~~$-x_1 + 2x_2 + s_2 = 4$~~

Initial feasible solution table (IBFS table)

Z	x_1	x_2	$s_1 = 1 \cdot s_2$	$b(R.H.S)$	Minimum ratio
1	1	-3	0	0	$0/-3 = 0$
0	1	1	1	6	$6/1 = 6$
0	-1	$\frac{1}{2}$	0	4	$4/\frac{1}{2} = 8$

P.E

(z u) taking to $P_1 = \begin{pmatrix} z \\ x_1 \\ x_2 \\ s_1 \\ s_2 \\ b \end{pmatrix}$ only x_2 M

In first row the greatest negative element is -3 .

so, x_2 is pivot column. Minimum ratio is 4 .

∴ R_2 is pivot row and 1 is pivot element.

$$\text{Apply, } R_1 \rightarrow R_1 + 3R_3 \quad R_2 \rightarrow R_2 - R_3$$

Z	x_1	x_2	s_1	s_2	$b(R.H.S)$	Minimum ratio
1	-2	0	0	3	12	$12/-2 = -6$
0	$\underline{-2}$	0	1	-1	2	$2/2 = 1$
0	-1	1	0	1	4	$4/-1 = -4$

Apply $R_1 = R_1 + R_2$ & $R_3 \rightarrow 2R_3 + R_2$ in LPM

Z	x_1	x_2	s_1	s_2	b	Min Inv ratio
0	0	0	1	2	14	7
0	2	0	0	1	-1	2
0	0	2	1	-1	10	

$$D = 2x_1 + 2x_2 + s_1 - s_2 - 1x_1 \leq 0$$

since there is no negative element in first row. so, it has optimal solution on equation

Point A(2, 0) & Point Z = 14 are obtained.

$$(2 \cdot N \cdot R)d: 2x_1 = 22 \quad 2x_2 = 10$$

$$0 \quad x_1 = 10 \quad 0 \quad x_2 = 5$$

$$2 \quad 0 \quad 1 \quad 1 \quad 1 \quad 0$$

$$\text{Hence, } \begin{array}{cccccc} 1 & 0 & 1 & 1 & 1 & 0 \\ & & 3 & 9 & & \end{array}$$

Max value (Z) = 14 at point (1, 5)

with point feasible, not corner point.

After 2nd iteration feasible points are (0, 0), (2, 0), (1, 5), (0, 2).

$$8x_1 - 8x_2 \leftarrow 8 \quad 8x_1 + 10x_2 \leftarrow 18 \quad \text{in place}$$

S_1	S_2	x_1	x_2	b	Σ
8	0	1	0	8	1
0	1	0	1	8	0

Let us introduce two slack variables s_1 and s_2 . The normal form or standard form of given LPP is

$$Z - x_1 - 3x_2 + 0 \cdot s_1 + 0 \cdot s_2 = 0$$

$$x_1 + x_2 + s_1 = 7$$

$$x_1 + 2x_2 + s_2 = 10$$

Initial feasible solution table

Z	x_1	x_2	s_1	s_2	b	Min. ratio
1	-1	-3	0	0	6	$0/-3 = 0$
0	1	1	1	0	7	$7/1 = 7$
0	1	2	0	1	10	$10/2 = 5 \leftarrow$

In first row the greatest negative element is -3 and x_2 is pivot column. Min. ratio is 5 and R_3 is pivot row and 2 is pivot element

$$\text{Apply, } R_1 \rightarrow 2R_1 + 3R_3$$

$$R_2 \rightarrow 2R_2 - R_3$$

Z	x_1	x_2	s_1	s_2	b
2	1	0	0	3	30
2	1	0	2	-1	-4
0	1	2	0	1	10
0	1	2	0	1	10

since there is no negative element in
first row - so if has optimal solution on equation

$$2z = 30$$

$$\therefore z = 15$$

$$0 = 2 \cdot 0 + 12 \cdot 0 + 2 \cdot 8 - 10 = 8$$

$$\therefore x_1 = 0$$

$$2x_2 = 10$$

$$0 = 2 \cdot 0 + 10$$

$$\therefore x_2 = 5$$

max value (\bar{z}_1) = 15 at (0, 5) of feasible

0	2	12	8	-10	0	5
0	0	0	8	-10	0	1
0	0	1	1	1	1	0
0	1	0	8	-10	5	0

so maximum feasible int was found at
either at first formula finding ei er bno e-
tannato finding as x1 was found at 0, 5

$$8x_1 + 10x_2 \leftarrow 10 \text{ , platz}$$

$$8x_1 + 10x_2 \leftarrow 50$$

d	2	12	8	-10	0	5
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8.

soln,

Let us introduce ~~two~~³ slack variable s_1 , ~~s_2~~ and s_3 . Then
normal form or standard form of given LPP is

$$Z - 5x_1 - 4x_2 + 0 \cdot s_1 + 0 \cdot s_2 + 0 \cdot s_3 = 0$$

$$x_1 + x_2 + \frac{s_1}{2} = 20$$

$$2x_1 + x_2 + s_2 = 35$$

$$-3x_1 + x_2 + s_3 = 12$$

Initial feasible solution table

Z	x_1	x_2	s_1	s_2	s_3	b	Min +ve ratio
0	-5	-4	0	0	0	0	$0/-5 = 0$
0	1	1	0	0	0	20	$20/1 = 20$
0	-3	1	0	0	1	12	$12/-3 = -4$

Apply, $R_1 \rightarrow 2R_1 + 5R_3$

$$R_2 \rightarrow 2R_2 - R_3$$

$$R_4 \rightarrow 2R_3 + 3R_4$$

Z	x_1	x_2	s_1	s_2	s_3	b	Min +ve ratio
0	0	-3 (Z.O)	5	0	0	125	-58.33
0	0	2	-1	0	5	5	5
0	2	1	0	1	0	35	35
0	0	5	0	2	3	106	21.2

x_2 is pivot column

R_2 is pivot row

x_1 is pivot element

Apply

$$R_1 \rightarrow R_1 + 3R_2$$

$$R_3 \rightarrow R_3 - R_2$$

$$R_4 \rightarrow R_4 - 5R_2$$

$$Z = 2x_1 + 5x_2$$

Z	x_1	x_2	x_3	b
2	0	0	6	2
0	0	1	-2	0
0	2	0	-2	0
0	0	20	-10	30
				81

Since there is no negative element in first row. So, it has optimal solution on equation

$$2x_2 = 190$$

$$\therefore x_2 = 95$$

$$2x_1 + 5x_2 \leftarrow 95$$

$$2x_1 + 5(95) \leftarrow 95$$

$$2x_1 = 30$$

$$2x_1 \leftarrow 30$$

$$\therefore x_1 = 15$$

$\therefore \text{Max } Z = 95 \text{ at } (15, 5)$

4.

soln
Let us introduce ~~the~~³ slack variable s_1, s_2 and s_3 .
The normal form or standard form of given LPP is

$$Z - 6x_1 - 12x_2 + 0 \cdot s_1 + 0 \cdot s_2 + s_3 = 0$$

$$x_1 + s_1 = 4$$

$$x_2 + s_2 = 4$$

$$6x_1 + 12x_2 + s_3 = 72$$

Initial feasible solution table

Z	x_1	x_2	s_1	s_2	s_3	b	min ratio
1	-6	-12	0	0	0	0	$-12/0 = 0$
0	1	0	1	0	0	4	$4/0 = 0$
0	0	(P.E)	0	1	0	4	$4/1 = 4 \leftarrow$
0	6	12	0	0	1	72	$72/12 = 6$

In first row the greatest negative element, -12 and minimum ratio is 4. R_2 is pivot row and 1 is pivot element

ai) Pivot on 2) next min
along no positive 1 from 2nd to 1, 02 row left

$$rf = 8$$

$$N = 18$$

$$P = 5K$$

$$\text{Apply} \rightarrow R_1 \rightarrow R_1 + 12R_3$$

$$R_4 \rightarrow R_4 - 12R_3$$

(1) 02

	x_1	x_2	s_1	s_2	s_3	b	Min + Max rate
Σ	-6	0	0	12	0	48	$48/6 = 8$
1	1	0	0	0	0	4	4
0	0	1	$= 18$	0	0	9	0
0	0	0	$= 12$	1	24	9	
0	6	0	0	12	1	24	

$$S_4 = S_2 + S_3 + S_4$$

n_1 = pivot column

R_2 = pivot row

i = pivot element

$$\text{Apply, } R_1 \rightarrow R_1 + 6R_2$$

$$R_4 \rightarrow R_4 - 6R_2$$

	x_1	x_2	s_1	s_2	s_3	b
1	0	0	6	12	0	72
0	1	0	0	0	0	4
0	0	0	-6	12	0	0

since there is no negative element in first row. so, it has optimal solution on equal

$$\therefore S = 72$$

$$\therefore n_1 = 4$$

$$\therefore n_2 = 4$$

2. soln

Let us introduce two slack variable s_1 and s_2 .
The normal form or standard form of given LPP is

$$\begin{aligned} Z - x_1 - 2x_2 - x_3 + 0.s_1 + 0.s_2 &= 0 \\ 4x_1 + 5x_2 + x_3 + s_1 &= 12 \\ 8x_1 + 5x_2 + 4x_3 + s_2 &= 12 \end{aligned}$$

Initial feasible solution table

Z	x_1	x_2	x_3	s_1	s_2	b	Min func ratio
1	-1	-1	-1	0	0	0	$0/-1 = 0$
0	4	5	1	0	0	12	$12/4 = 3$
0	(8)	5	4	0	1	12	$12/8 = 1.5$

In first row the greatest element is -1 so x_1 is pivot column. Min func ratio is 0 and 8 is pivot element.

$$\text{Apply, } R_1 = 8R_1 + R_3$$

$$R_2 \rightarrow 8R_2 - 4R_3$$

Z	x_1	x_2	x_3	s_1	s_2	b	Min func ratio
8	0	-3	-4	0	1	12	$12/-4 = -3$
0	0	20	8	-4	48	2.4	$2.4 \leftarrow$
0	8	5	4	0	1	12	2.4

$$0 = 8K \quad \dots$$

$$P.S. = 8K \dots$$

$$0 = 8K \quad \dots$$

$$\text{Apply, } R_1 = 20R_1 + 3R_2$$

$$R_3 \rightarrow 20R_3 - 5R_2$$

$$\begin{array}{ccccccc|c} & & & & & & & \\ 160 & 0 & 0 & -104 & 24 & 8 & 384 & -3.69 \\ 0 & 0 & 20 & -8 & 8 & -4 & 48 & -6 \\ 0 & 160 & 0 & 120 & -40 & 40 & 0 & 0 \end{array}$$

$\Sigma L = 22 + 8K + 24 \uparrow P.E (K)$

In first column, + row, the greatest negative element is -104 . 0 is pivot element and R_3 is pivot row.

$$\text{Apply, } R_1 = 120R_1 + 104R_3$$

$$R_2 = 120R_2 + 8R_3$$

$$\begin{array}{ccccccc|c} Z & n_1 & n_2 & n_3 & s_1 & s_2 & b \\ 19200 & 16640 & 23100 & 0 & -1280 & 5120 & 46080 \\ 0 & 160 & 0 & 120 & -40 & 40 & 0 \end{array}$$

Since there is no negative element in first row. so it has optimal solution on equating

$$19200 \bar{z} = 46080$$

$$8 \bar{z} = 2.4$$

$$\therefore n_1 = 0$$

$$\therefore 2400 n_2 = 5760$$

$$\therefore n_2 = 2.4$$

$$\therefore n_3 = 0$$

5. Soln,
Let us introduce 3 slack variables s_1, s_2 and s_3 , such that

$$\begin{array}{l} Z - x_1 - x_2 + 0 \cdot s_1 + 0 \cdot s_2 + 0 \cdot s_3 = 0 \\ 2x_1 + 3x_2 + s_1 = 130 \\ 3x_1 + 8x_2 + s_2 = 300 \\ 4x_1 + 2x_2 + s_3 = 140 \end{array}$$

Initial feasible solution table

	x_1	x_2	s_1	s_2	s_3	b	Min. Due ratio
1	-1	-1	0	0	0	0	0
0	2	3	1000	0	0	130	65
0	3	8	0	0	0	300	100
0	(4)	2	0	0	1	140	35 ←
	P.E						

In first row, the first negative element is -1 so pivot column is x_1 and pivot element is 4.

$$\text{Apply } R_1 = 4R_1 + R_2$$

$$R_2 = 4R_2 - 2R_4$$

$$R_3 = 4R_3 - 3R_4$$

	x_1	x_2	s_1	s_2	s_3	b	Min. Due ratio
4	0	-2	0	0	1	140	-70
0	0	(8)	4	0	-2	290	301 ←
0	0	26	0	4	-3	780	30
0	4	2	0	0	1	140	70

$$\text{Apply, } R_1 \rightarrow 8R_1 + 2R_2$$

$$R_2 \rightarrow 8R_3 - 2R_2$$

$$R_4 \rightarrow 8R_4 - 2R_2$$

$$Z = 8x_1 + 2x_2 + 12x_3 + S_1 - S_2 - S_3 \quad b$$

$$\begin{array}{cccccc|c} 32 & 0 & 0 & 8 & 0 & 4 & 1600 \\ 0 & 0 & 0 & 8 & 12 & -2 & 240 \\ 0 & 0 & 0 & 0 & 12 & 28 & 0 \\ 4 & 32 & 0 & -8 & 0 & 12 & 640 \end{array}$$

all elements above diagonal are positive

since there is no negative element in first row. so it has optimal solution on equation

$$32x_3 = 1600$$

$$-3 = 50$$

$$8x_1 = 640$$

$$8x_2 = 240$$

$$\therefore x_2 = 30$$

$$8x_1 = 640$$

$$8x_1 = 640$$

	x_1	x_2	x_3	S_1	S_2	S_3	Z
Op1	1	0	0	10	10	0	640
Op2	5	0	0	2	0	0	1000
Op3	8	1	0	0	0	0	1600
Op4	1	0	0	0	0	0	0

6.

Soln)

Here,

Let us introduce slack variables, x_3, x_4, x_5 such that

$$Z - 9x_1 - 5x_2 + 0.s_1 + 0.s_2 + 0.s_3 = 0$$

$$\begin{array}{l} x_1 + 3x_2 + s_1 = 18 \\ 0.08x_1 + x_2 + s_2 = 10 \\ 3x_1 + x_2 + s_3 = 24 \end{array}$$

Initial feasible solution is

in form $Z = x_1 + 3x_2 + s_1 + s_2 + s_3$ b Min the value
 given by $-9x_1 - 5x_2$ and to 0 w.r.t 0

$$\begin{array}{ccccccc} 0 & 1 & 3 & 1 & 0 & 0 & 18 \\ 0 & 1 & 1 & 0 & 0 & 1 & 10 \\ 0 & 3 & 1 & 0 & 0 & 1 & 24 \end{array}$$

$\uparrow P.E$ $S.P = 18$

In first row, the first negative entries is -9. So pivot $\frac{\text{element}}{3}$ is 3

Apply: $R_1 \rightarrow R_1 + 3R_3$ $R_2 \rightarrow 3R_2 - R_3$ $R_3: 3R_3 - R_4$

$$\begin{array}{ccccccc} Z & x_1 & x_2 & s_1 & s_2 & s_3 & b & \text{Min the value} \\ 1 & 0 & -20 & 0 & 0 & 30 & 720 & -36 \\ 0 & 0 & 8 & 3 & 0 & -1 & 30 & 375 \\ 0 & 0 & 3 & 0 & 3 & -1 & 6 & 3 \\ 0 & 3 & 1 & 0 & 0 & 1 & 24 & 24 \end{array}$$

Apply, $R_1 \rightarrow R_1 + 10R_3$

$R_2 \rightarrow R_2 - 4R_3$

$R_4 \rightarrow 2R_4 - R_3$

Z	x_1	x_2	$S_1 = S_2 + 10S_3$	S_2	S_3	b
1	0	0	0	30	20	780
0	0	0	3	-12	3	6
0	0	2	0	3	-1	6
0	6	0	0	0	3	42

Since there is no negative element in
1st row & so it has optimal solution on equating.

$$x_1 = 0, x_2 = 0, S_2 = 30, S_3 = 20, b = 780$$

$$x_1 = 0, x_2 = 0, S_2 = 30, S_3 = 20, b = 780$$

$$x_1 = 0, x_2 = 0, S_2 = 30, S_3 = 20, b = 780$$

$$\therefore 6x_1 = 42$$

$$x_1 = 7, x_2 = 0, S_2 = 30, S_3 = 20, b = 780$$

$$\therefore 2x_2 = 6$$

$$x_1 = 7, x_2 = 3, S_2 = 30, S_3 = 20, b = 780$$

	x_1	x_2	S_1	S_2	S_3	b
1	0	0	0	30	20	780
2	0	1	0	8	8	0
3	0	1	0	3	3	0
4	1	0	0	1	2	0

soln
let us introduce slack variables s_1, s_2 and s_3
such that

$$z = 5x_1 + 6x_2 - x_3 + 0 \cdot s_1 + 0 \cdot s_2 + 0 \cdot s_3 = 0$$

$$2 - 5x_1 - 6x_2 - x_3 + s_1 = 5$$

$$9x_1 + 3x_2 - 2x_3 + s_2 = 2$$

$$4x_1 + 2x_2 - x_3 + s_3 = 3$$

Initial feasible solution is

	x_1	x_2	x_3	s_1	s_2	s_3	b	Min ratio
z				0	0	0	0	0
R_1	-5	-6	-1	0	0	0	5	1.67
0	9	3	-2	1	0	0	0	1 ↲
0	4	8	2	0	1	0	2	-0.75
0	1	-4	1	0	0	1	3	

Apply $R_1 \rightarrow 2R_1 + 6R_3$ $R_4 \rightarrow 2R_4 + 4R_3$

$$R_2 \rightarrow 2R_2 - 3R_3$$

	x_1	x_2	x_3	s_1	s_2	s_3	b	Min ratio
z	14	0	-8	0	6	0	12	-1.5
0	6	0	2	2	2	0	4	-4
0	4	2	-1	0	1	0	2	-2
0	18	0	-2	0	2	4	16	-8

Hence, all minimum ratios are negative
so, it has an unbounded solution.

9.

soln,

to force introduce slack variable s_1 and s_2 , such that

$$Z - x_1 - 3x_2 + 0 \cdot s_1 + 0 \cdot s_2 = 0$$

$$0 = 2 \cdot 0 + 2 \cdot 0 + 1 \cdot 0 \quad x_1 - 3x_2 + s_1 = -6$$

$$3 = 1 \cdot 2 + 3 \cdot 1 + x_2 + s_2 = 6$$

$$S = 62 + 2R - 2R_b + 1R_p$$

Initial feasible solution is

Z	x_1	x_2	s_1	s_2	b	Min ratio
1	-1	-3	0	0	0	0
0	0	0	1	0	0	≤ 2
0	0	0	0	1	6	≤ 6
Z	0	0	1	s_1	∞	0

$$\text{Apply, } R_1 \rightarrow R_1 - R_2 \quad R_3 \rightarrow 3R_3 + R_2$$

Z	x_1	x_2	s_1	s_2	b	Min ratio
0	1	-3	0	-1	6	≤ 3
0	0	0	1	3	12	≤ 6
Z	0	0	1	s_1	∞	0

$$\text{Apply, } R_1 \rightarrow 4R_1 + 2R_3 \quad R_2 \rightarrow 4R_2 - R_3$$

Z	x_1	x_2	s_1	s_2	b	
4	1	0	0	-2	6	48
0	0	0	3	0	3	-36

In row first, there is no negative element.
so, if has optimal solution on equating.

$$\therefore Z = 48$$

$$Z = 2x_1 + 12x_2 \therefore Z = 12x_2$$

$$Z = 12x_2 + CR + NK$$

$$\therefore Z = 12x_2 + K^2 + NK$$

$$x_1 = 3$$

$$\therefore -12x_2 = -36$$

$$\therefore x_2 = 3$$

$\therefore \text{Max } Z = 12 \text{ at } (3, 3)$

		d	12	12	-K	K	\leq
		0	0	0	2-	8-	1
		2+	2	0	3+ 3'9 > ①	1-	0
		0)	0)	1	0	1	0

travers with max val, favit row 15

and mark kong bnd a in off row 1st - 3- 21

$$Z = 38 \leftarrow R_1 + R_2 \leftarrow R_1 : \text{pbb}$$

		d	12	12	-K	K	\leq
		P-	38	0	2	0	8-
		2-	2	0	1	1	1-
		+ 2	4	1	1-	0	0

↑
3.9

Ques 13. Soluties op ei groot, ferit wort n²
 soluties no n uitlos loopte en ti, or
 let us introduce two slack variables s_1 and s_2 .

$$Z = 3x_1 - 6x_2 + 0.s_1 + 0.s_2 = 0$$

$$-x_1 + x_2 + 0.s_1 = 6$$

$$x_1 + x_2 + s_2 = 10$$

Initial feasible solution is

$$(0,0) \text{ for } s_1 = 0 \text{ and } s_2 = 0$$

	x_1	x_2	s_1	s_2	b	Min tvo ratio
1	-3	-6	0	0	0	0
0	-1	(1) $\leftarrow P'E$	1	0	6	6 ←
0	1	1	0	1	10	10

In row first, the maxim negative element is -6. The min tvo ratio is 6 and pivot element is 1.

$$\text{Apply: } R_1 \rightarrow R_1 + 6R_2 \quad R_3 \rightarrow R_3 - R_2$$

	x_1	x_2	s_1	s_2	b	Min tvo ratio
1	-9	0	6	0	36	-4
0	-1	1	1	0	6	-6
0	(2)	0	-1	1	4	2 ←

Apply, $R_1 \rightarrow 2R_1 + 9R_3$

~~and, 2~~ $R_2 \rightarrow 2R_2 + R_3$

$$\begin{array}{rcl} 1 & 0 & 0 \\ 2 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 2 & 0 \end{array} \begin{array}{l} 2x_1 + 2x_2 + 8x_3 + 18x_4 = b \\ 2x_1 + 2x_2 + 3x_3 + 9x_4 = 108 \\ 0x_1 + 2x_2 + 8x_3 + 16x_4 = 16 \\ 0 & -1 & 1 & 4 \end{array}$$

since, there is no negative element in row 1, so it has optimal solution on equating

$$\begin{array}{rcl} 0 & 0 & 0 & 0 & 0 \\ 2 & 2 & 2 & 1 & 0 \\ 0 & 0 & 1 & 0 & 0 \end{array} \begin{array}{l} 2x_3 = 108 \\ \therefore x_3 = 54 \end{array}$$

or 2nd prns. taking $x_3 = 48$ it will $2x_2 = 16$ i.e
working 2nd LPP, $x_2 = 8$ molar
transports having 2nd prns

$$x_2 = 8, x_3 = 8, x_4 = 0$$

$$x_3 = 8, x_4 = 0$$

$$\begin{array}{rcl} d & c_2 & c_3 & c_4 & c_5 & \Sigma \\ 0 & 0 & 2 & 0 & 1 & 1 \\ 2 & 0 & 1 & 0 & 0 & 0 \\ 2 & 2 & 1 & 0 & 0 & 0 \end{array}$$

14. soln,
let us introduce two slack variable s_1 and s_2

$$Z - 5x_1 + 20x_2 + 0 \cdot s_1 + 0 \cdot s_2 = 0$$

$$-2x_1 + 10x_2 + s_1 = 5$$

$$2x_1 + 5x_2 + s_2 = 10$$

Initial feasible solution is

	x_1	x_2	s_1	s_2	b	Min ratio
1	-5	20	0	0	0	
0	-2	(10)	1	0	5	0.5
0	2	5	0	1	10	2.5

In first row, the first positive entry is 20.
so, column of x_2 is pivot column and R_2 is pivot row.
 10 is pivot element

$$\text{Apply, } R_1 \rightarrow R_1 - 2R_2$$

$$R_3 \rightarrow 2R_3 - R_2$$

Z	x_1	x_2	s_1	s_2	b
1	-1	0	-2	0	-10
0	-2	10	1	0	5
0	6	0	-1	2	15

since, there is no negative element in first row.
so, it has a optimal solution by equating

$$\text{primal CSE} + \text{NS} = z \text{ optimality condition}$$
$$0 \leq x_{11} \Rightarrow \delta = -10 \quad \text{and} \quad \delta > 0 \Rightarrow 10$$

$$\therefore x_1 = 0$$

maximize of dual var.

$$10x_2 = 5$$

$$\therefore x_2 = 0.5$$

$$\therefore \max(z) = -10 \text{ at } (x_1, x_2) = (0, 0.5)$$

$$N \leq CK -$$

$$0 \leq CK + R$$

Variables	CK	R
(1,0)	0	1
(0,1)	1	1

and Mairon look at it and say bad IP for

$$CER + CR = \sum n_i x_i$$

0	CK	R
0	1	1
0	1	1

$$S \leq C^T - CR$$

$$S \leq C^T + C$$

$$0 \leq C^T + C$$

15. i) Formulate LPP based on given conditions

a) Maximise $Z = 2x_1 + 3x_2$ subject to
 $x_1 + x_2 \leq 6$, $-x_1 + x_2 \leq 4$, $x_1, x_2 \geq 0$

\rightarrow soln,

we have to maximise

$$Z = 2x_1 + 3x_2$$

s.t

$$x_1 + x_2 \leq 6$$

$$-x_1 + x_2 \leq 4$$

$$x_1, x_2 \geq 0$$

x_1	x_2	constant
1	1	6 (y_1)
-1	1	4 (y_2)

Let y_1 and y_2 be the dual variables then

$$\text{Min } Z' = 6y_1 + 4y_2$$

~~subject to~~

y_1	y_2	c
1	-1	2
1	1	3

s.t

$$y_1 - y_2 \geq 2$$

$$y_1 + y_2 \geq 3$$

$$y_1, y_2 \geq 0$$

b.

Soln,

$$\text{Maximize } (Z) = x_1 - x_2 + 4x_3$$

$$\text{s.t. } 8x_1 + 1x_2 = (18) \text{ minimize}$$

$$x_1 + x_2 + x_3 \leq 9$$

$$8x_1 - 2x_2 + x_3 \geq 6, x_1, x_2, x_3 \geq 0$$

$$8x_1 - 2x_2 + x_3 = 6$$

Showing constraints in table

x_1	x_2	b	x_3	problem
1	1	9	(x_1)	
-1	-2	6	(x_2)	
8	8			

dual or (let y_1 and y_2 be dual)

$$y_1 \quad y_2 \quad g_3 \quad c$$

lower bound for boundary to = lower

$$1 \quad -2 \quad 1 \quad 6$$

$$1 \quad -1 \quad -4 \quad 18$$

$$\text{Minimize } (Z') = 9y_1 + 6y_2$$

+2

$$\text{s.t. } y_1 + y_2 + \geq 1$$

$$8y_1 - 8y_2 \geq -1$$

$$y_1 + y_2 \geq 4$$

$$0 \leq y_1, y_2$$

c. soln)

Maximize $Z = 3x_1 + 8x_2$ maximum

s.t. $x_1 + 2x_2 \leq 8$

$x_1 + 6x_2 \leq 12$

$x_1, x_2 \geq 0$ non-neg. condition

Showing constraints in table

(row)	x ₁	x ₂	b	(no)
1	1	2	8	
2	1	6	12	(row 1) is basis
3	3	8		

Dual = Let y₁ and y₂ and dual

$$\begin{array}{cccc} & & & \\ & 1 & 2 & 1 \\ y_1 - y_2 & & 1 & 1 \end{array}$$

Maximize $Z' = 8y_1 + 12y_2$ maximum

s.t.

$$y_1 + y_2 \geq 3$$

$$-2y_1 + 6y_2 \leq 8$$

$$y_1, y_2 \geq 0$$

d.

Soln,

$$\text{Minimize } (S) = 8x_1 + 9x_2 \text{ subject to}$$

$$\text{s.t. } x_1 + x_2 \geq 5$$

$$x_1 + 3x_2 \leq 21$$

$$x_1 \geq 0, x_2 \geq 0$$

Showing constraints in table

x_1	x_2	b	
1	1	5	(n ₀)
3	1	21	(n ₁)

Let y_1 and y_2 be dual

x_1	x_2	b	
1	3	8	
1	1	9	

$$\text{Max } (g^1) = 5y_1 + 21y_2$$

s.t

$$y_1 + 3y_2 \leq 8$$

$$y_1 + y_2 \leq 9$$

$$y_1, y_2 \geq 0$$

16.

and we also have make our constraint as like

a.

soln)

$$0 = 2 \cdot 0 + 1 \cdot 0 + 1 \cdot 2 - 1 \cdot 0 - 1 \cdot 2$$

$$0 = 1 \cdot 2 + 1 \cdot 0 + 1 \cdot 1$$

$$\text{minimize } z = 4n_1 + 3n_2$$

s.t.

$$n_1 + n_2 \geq 5$$

$$3n_1 + n_2 \geq 21$$

$$n_1 \geq 0, n_2 \geq 0$$

	d	c	b	
0	0	0		
e1P	1	1		
f	3	1		
			1	0

Showing constraints in table

AS-23 animals with n_1 , and n_2 per tank
 2 animals having 21 + long animals 10 (y_1) 21 & 18
 2 animals having 3 + long animals 10 (y_2)

Dual: Let y_1 and y_2 are dual variable

	d	$y_{1,2}$	y_3	c	b	
e1B	0	3	3	1	1	
e1P	10	1	1	9	1	0
			1	0	1	0

$$\max z' = 5y_1 + 21y_2$$

animal's nutrition s.t. on 21 want 18
 animal's pd nutrition long $y_1 + 3y_2 \leq 10$ y1, y2 - wot terit
 $y_1 + y_2 \leq 2$ $y_1, y_2 \geq 0$

$$e1B = 10 \therefore$$

$$e1N = 21 \therefore$$

$$P = 21 \therefore$$

Let us introduce two slack variable s_1 and s_2

$$z' - 5y_1 - 21y_2 + 0 \cdot s_1 + 0 \cdot s_2 = 0$$

$$y_1 + 3y_2 + s_1 = 4$$

$$y_1 + 4y_2 + s_2 = 8$$

z'	y_1	y_2	s_1	s_2	b	min ratio
1	-5	-21	0	0	0	
0	1	3	1	0	4	$4/3$
0	1	4	1	1	7	7

addit. row 2 to row 3
pivot element

In first row, the negative element is -21
 y_2 is pivot column and s_1 is pivot elements

$$\text{Applying } R_1 \rightarrow R_1 + 7R_2 \quad R_3 \rightarrow 3R_3 - R_2$$

z'	y_1	y_2	s_1	s_2	b
1	2	0	2	0	$28/3$
0	1	3	1	0	$4/3$
0	1	0	-1	3	$19 \cdot 33/3$

Since there is no negative element in first row. so it has optimal solution by equating.

$$\therefore \max(z) = 28/3$$

$$\therefore y_1 = 0$$

$$\therefore 3y_2 = 4/3$$

$$\therefore y_2 = 4/9$$

Again,

$$\therefore n_1 = 7$$

$\therefore n_1 = 7 \quad \text{if } f(x) + g(x) = \text{minimum}$

$$\therefore n_2 = 0$$

$\therefore n_2 = 0 \quad l \leq 2kx_0 + jkx_0$

$$l \leq kx_0 + jk$$

$$\therefore \min(z) = 4n_1 + 7n_2$$

$$= 4 \times 7 + 7 \times 0$$

$$= 28$$

$\therefore \text{Min value} = 28 \text{ at } (7, 0)$

(0, 0) 1 2 2

(1, 0) 2 3 1

3 2 1
8 1 2
5 8 6

$$l \leq kx_0 + jk = (18) \times 0 + 18$$

f.2

$$8 \geq 2l + jkx_0$$

$$51 \geq kx_0 + jkx_0$$

$$0 \leq jkx_0$$

12 oldvior vole oot subortii en tot
12 kno

b. soln

$$\min(z) = 8x_1 + 12x_2$$

s.t

$$2x_1 + 2x_2 \geq 1$$

$$x_1 + 3x_2 \geq 2$$

$$x_1, x_2 \geq 0 \text{ f.t. } z = 8x_1 + 12x_2 = (8) x_1 + (12) x_2$$

showing constraints in table

$$x_1 \text{ (obj)} x_2 \text{ to } b = \text{soln. min}$$

			(y ₀)
2	2	1	
1	3	2	(y ₁)

Let y₁ and y₂ are dual variable

y ₁	y ₂	c
2	1	8
2	3	12

$$\therefore \max(z') = y_1 + 2y_2$$

s.t

$$2y_1 + y_2 \leq 8$$

$$2y_1 + 3y_2 \leq 12$$

$$y_1, y_2 \geq 0$$

Let us introduce two slack variables s₁ and s₂.

Let's translate $3y_1 - y_2 + 0s_1 + 0s_2 = 0$
 Now substitute $2y_1 + y_2 + s_1 = 8$ ~~we don't~~
 $2y_1 + 3y_2 + s_2 = 12$
~~18 = 18~~

Table:

	y_1	y_2	s_1	s_2	b	Min ratio
1	-1	-2	0	0	0	0
0	2	1	1	0	8	8
0	2	3	0	1	12	4

~~In first row, the negative element is -2. y_2 is the pivot column and 8 is pivot element~~

Apply $R_1 \rightarrow 3R_1 + 2R_3$
 $R_2 \rightarrow 3R_2 - R_3$

	y_1	y_2	s_1	s_2	b
3	1	0	0	2	8
0	4	0	3	-1	20
0	0	3	0	1	4

Apply $R_1 \rightarrow R_1/3$

	y_1	y_2	s_1	s_2	b
1	$\frac{1}{3}$	0	0	$\frac{2}{3}$	$\frac{8}{3}$
0	4	0	3	-1	20
0	0	3	0	1	4

since there is no negative element in first row. so, it has a optimal solution is given

$$S_1 = \{2, 8, 4, 6, 10\}$$

$$\text{Max}(z') = 8/3$$

$$\therefore y_2 = 4/3 \quad \therefore y_1 = 0$$

Again,

$$\begin{array}{cccccc} d & 2 & 12 & 8 & 10 & \Sigma \\ 0 & 0 & 0 & 1 & 1 & 1 \\ 8 & 8 & n_1 = 0 & 1 & 8 & 0 \\ P & S_1 & n_2 = 2/3 & 8 & 6 & 0 \end{array}$$

$$\text{min } z' = 8n_1 + 12n_2$$

$$\text{substituting } z' \text{ in } \Sigma \text{ b.p. rule} = 8 \times 0 + 12 \times 2/3, \quad \Sigma - 2/3$$

$$= 8 \quad \text{flag} \\ 8 - 8 + 2$$

$$\begin{array}{cccccc} d & 2 & 12 & 8 & 10 & \Sigma \\ 8 & 2 & 0 & 0 & 1 & 1 \\ 0 & 1 & 8 & 0 & P & 0 \\ P & 1 & 0 & 8 & 0 & 0 \end{array}$$

$$8/10 \leftarrow 1 \quad \text{flag}$$

$$\begin{array}{cccccc} d & 2 & 12 & 8 & 10 & \Sigma \\ 8/8 & 8/8 & 0 & 0 & 8/10 & 1 \\ 0 & 1 & 8 & 0 & P & 0 \\ P & 1 & 0 & 8 & 0 & 0 \end{array}$$

$$C.P = 8x_1 + 2x_2 + 12x_3 + 5x_4 - 108 - 150$$

solv

$$\text{Min } Z = x_1 + 8x_2 + 5x_3$$

s.t

$$x_1 + x_2 + x_3 \geq 8$$

$$-x_1 + 2x_2 + x_3 \geq 2$$

$$x_1, x_2, x_3 \geq 0$$

out aim d x_2 x_2 x_3 b

Showing constraints in table

x_1	x_2	x_3	b
1	0	0	18
8	8	0	y_1

x_1	x_2	x_3	b
2	1	0	8 (y_1)
-1	2	1	2 (y_2)

• 8 - 21 terms \Rightarrow independent 8 more + 5 in 11
terms having diff in b - amplus having 21, 11

Let y_1 and y_2 are dual variable

$$\text{Max } Z' = 8y_1 + 2y_2 \quad \text{plqns}$$

s.t

$$y_1 - y_2 \leq 1$$

x_1	x_2	x_3	b
8	8	0	$y_1 + 2y_2 \leq 8$
1	1	0	$8y_1 + y_2 \leq 5$

f Let us introduce two slack variable s_1 , ~~and~~
 s_2 and s_3

$$8.9$$

$$3^1 - 8y_1 - 2y_2 + 0 \cdot s_1 + 0 \cdot s_2 + 0 \cdot s_3 = 0$$

$$y_1 - y_2 + s_1 = 1$$

$$2^1 \geq y_1 + 2y_2 + s_2 \leq 8 \text{ min}$$

$$y_1 + y_2 + s_3 \leq 5$$

$$8 \leq 2R + 2R + R$$

$$s_1, s_2, s_3 \geq 0$$

Table:

$$S \leq 2R + 2R + R$$

$$0 \leq 2R + 2R + R$$

3^1	y_1	y_2	s_1	s_1	s_2	s_3	b	Min +vo
1	-8	1	0	0	0	0	0	0
0	1	$\leftarrow P.E$	-1	1	0	0	1	1 ←
0	1	$2R$	$2R$	0	R	0	8	8
10	8	1	1	0	0	0	5	5
100	8	1	1	0	0	0	1	

In first row, the negative element is -8.

y_1 is pivot column and 1 is the pivot element

$$\text{Applying: } R_1 \rightarrow R_1 + 8R_2$$

$$R_3 \rightarrow R_3 + R_2 = (1 \ 8) \times M$$

$$R_4 \rightarrow R_4 - R_2$$

$$1 \geq 8 + R - R$$

3^1	y_1	y_2	s_1	s_2	s_3	b	Min +vo
1	0	2	-10	8	0	0	8
0	1	-1	1	0	0	1	-1

3^1	y_1	y_2	s_1	s_2	s_3	b	Min +vo
1	0	2	-10	8	0	0	-0.8
0	1	-1	1	0	0	1	-1

3^1	y_1	y_2	s_1	s_2	s_3	b	Min +vo
1	0	2	-10	8	0	0	-0.8
0	1	-1	1	0	0	1	-1

3^1	y_1	y_2	s_1	s_2	s_3	b	Min +vo
1	0	2	-10	8	0	0	-0.8
0	1	-1	1	0	0	1	-1

3^1	y_1	y_2	s_1	s_2	s_3	b	Min +vo
1	0	2	-10	8	0	0	-0.8
0	1	-1	1	0	0	1	-1

3^1	y_1	y_2	s_1	s_2	s_3	b	Min +vo
1	0	2	-10	8	0	0	-0.8
0	1	-1	1	0	0	1	-1

$\uparrow P.E$

Apply $R_1 \rightarrow R_1 + 5R_4$, $R_2 \rightarrow 2R_2 + R_4$, $R_3 \rightarrow 2R_3 - 3R_4$

z^1	y_1	y_2	s_1	s_2	s_3	C
1	0	0	3	0	5	28
0	2	0	1	0	1	6
0	0	0	1	2	-3	2
0	0	2	-1	0	1	4

$$\text{Max}(z^1) = 28$$

$$2y_1 = 6 \quad \therefore 2y_2 = 4$$

$$\therefore y_1 = 3 \quad \therefore y_2 = 2$$

$$\therefore x_1 = 3 \quad x_2 = 0 \quad x_3 = 5$$

$$\begin{aligned} \therefore \text{Min}(z) &= 3 + 0 + 5 \times 5 \\ &= 28 \end{aligned}$$