Home Work

① Using VAM's Method

50	30	220	1
90	45	170	3
250	200	50	4
4	2	2	

Sol:-

$\Sigma a_i = 1+3+4 = 8$

$\Sigma b_j = 4+2+2 = 8$

Step 1

50	30	220	1	(20)
90	45	170	3	(45)
250	200	2) 50	$\cancel{4}$ 2	(150) *
4	2	2		
(40)	(15)	(120)		

$x_{33} = \{2, 4\}$

$= 2$

Step 2

50	30		1	(20)
90	45		3	(45)
250	2) 200		2	(50) *
4	$\cancel{2}$			
(40)	(15)			

$x_{32} = \{2, 2\}$

$= 2$

Step 3

50	1	(50)	
3) 90	3	(90)	*
4			
(90)			

$x_{21} = \{4, 3\}$

$= 3$

Step 4

1) 50	1
1	

Step 5

1) 50	30	220	1
3) 90	45	170	3
4) 250	2) 200	2) 50	4
4	2	2	

$m + n - 1$

$3 + 3 - 1$

$6 - 1 = 5$

$\Rightarrow (1 \times 50) + (3 \times 90) + (2 \times 200) + (2 \times 50) + (250 \times 4)$

$= 4 \rightarrow 0$

$\boxed{\text{Ans} = 820}$

② Using VAM's Method.

9	12	9	6	9	10	5
7	3	7	7	5	5	6
6	5	9	11	3	11	2
6	8	11	12	2	10	9
4	4	6	2	4	2	

Sol:-

$\Sigma a_i = 5+6+2+9$

$= 22$

$\Sigma b_j = 4+4+6+2+4+2$

$= 22$

$\boxed{\Sigma a_i = \Sigma b_j}$

step 1

9	12	9	6	9	$\cancel{10}$	5	(3)
7	3	7	7	5	2 $\cancel{5}$	6 =4	(2)
6	5	9	11	3	$\cancel{11}$	2	(2)
6	8	11	12	2	$\cancel{10}$	9	(4)
4	4	6	2	4	2		
(1)	(2)	(2)	(1)	(1)	(5)		

$$x_{26} = \min\{6, 2\}$$

$$= 2$$

step 2

$$\begin{matrix} 9 & 12 & 9 & 6 & 9 \\ 7 & 3 & 7 & 7 & 5 \\ 6 & 5 & 9 & 11 & 3 \\ 6 & 8 & 11 & 12 & 2 \end{matrix}$$

③ Using VAM's Method

20	28	32	55	70	50
48	36	40	44	25	100
35	55	22	45	48	150
100	70	50	40	40	

Sol:-

$\sum a_i = 150 + 100 + 50 = 300$

$\sum b_j = 100 + 70 + 50 + 40 + 40 = 300$

$\sum a_i = \sum b_j$

step 1

20	28	32	55	70	50	(8)
48	36	40	44	40) 25	100-40 =60	(11)
35	55	22	45	48	150	(13)
100	70	50	40	40		
(15)	(8)	(10)	(1)	(23)		

$x_{25} = \min\{100, 40\}$

$= 40$

step 2

50) 20	28	32	55	50	(8)
48	36	40	44	60	(4)
35	55	22	45	150	(13)
100-50 =50	70	50	40		
(15)	(8)	(10)	(1)		

$x_{11} = \{50, 100\}$

$= 50$

Step 3

48	60) ~~36~~	40	44	60	(4)
35	55	22	45	150	(13)
50	70-60 =10	50	40		
(13)	(19)	(18)	(1)		

$x_{22} = \{60, 70\}$

$= 60$

Step 4

35	10) ~~55~~	22	45	150-10 =140	(13)
50	10	50	40		
(35)	(55)	(22)	(45)		

$x_{32} = \min\{150, 10\}$

$= 10$

Step 5

35	22	40) ~~45~~	140-40 =100	(13)
(35) 50	(22) 50	(45) 40		

$x_{34} = \min\{40, 40\}$

$= 40$

Step 6

50) ~~35~~	22	100-50 =50	(13)
50	50		
(35)	(22)		

$x_{31} = \min\{100, 50\}$

$= 50$

Step 7

50) 22	50
50	

Step 8

50) 20	28	32	55	70	50
48	60) 36	40	44	40) 25	100
50) 35	10) 55	50) 22	40) 45	48	150
100	70	50	40	40	

$m + n - 1 = 0$

$3 + 5 - 1 = 0$

$8 - 1 = 7$

$\Rightarrow (50\times20)+(60\times36)+(40\times25)+(80\times85)+$ 1/16

$(10\times55)+(50\times22)+(40\times45).$

$\boxed{\text{[illegible]} = 9,360}$

Unbalanced tp Method using VAM's Method

(2)

	P	q	r	s	
K	95	80	70	60	70
L	75	65	60	50	40
M	70	45	50	40	90
N	60	40	40	30	30
	40	50	60	60	

Sol:-

$\Sigma a_i = 70+40+90+30$

$= 230$

$\Sigma b_j = 40+50+60+60$

$= 210$

$\boxed{\Sigma a_i \neq \Sigma b_j}$

Step 1

95	80	70	60	$^{20)}$0	70-20 $=50$	(60)	★
75	65	60	50	0	40	(50)	
70	45	50	40	0	90	(40)	
60	40	40	30	0	30	(30)	
40	50	60	60	20			
(10)	(5)	(10)	(10)				

$\Sigma a_i = 230$, $\Sigma b_j = 230$

$\boxed{\therefore \Sigma a_i = \Sigma b_j}$

$x_{15} = \min\{20, 70\}$

$= 20$

<u>step 2</u> :-

$\cancel{95}$	$\cancel{80}$	$\cancel{70}$	50) $\cancel{60}$	50	(10) *
75	65	60	50	40	(10)
70	45	50	40	90	(5)
60	40	40	30	30	(10)
40	50	60	60-50 =10		
(10)	(5)	(10)	(10)		

$x_{14} = \min\{50, 60\}$

$= 50$

<u>step 3</u> :-

75	65	60	50	40	(10)
70	45	50	40	90	(10)
30) 60	40	40	30	30	(10)
40-30 =10	50	60	10		
(10)	(5)	(10)	(10)		

$x_{41} = \min\{30, 40\}$

$= 30$

<u>step 4</u> :-

75	$\cancel{65}$	60	50	40	(10)
70	50) $\cancel{45}$	50	40	90-50 =40	(5)
10	50	60	10		
(5)	(20)	(10)	(10)		

$x_{32} = \min\{90, 50\}$

$= 50$

<u>step 5</u> :-

75	60	$\cancel{50}$	40	(10)
70	50	10) $\cancel{40}$	40-10 =30	(10)
10	60	10		
(5)	(10)	(10)		

$x_{34} = \min\{40, 10\}$

$= 10$

<u>step 6</u> :-

75	60	40	(5)
70	30) 50	30	(20)
10	60-30 =30		
(5)	(10)		

$x_{33} = \min\{30, 60\}$

$= 30$

step 7 :-

10) 75	60	40	(15)
10	30		
(75)	(60)		

$x_{21} = \min\{40, 10\}$

$= 10$

step 8 :-

30) 60	40-10 //
30	

step 9 :-

95	80	70	50) 60	20) 0	70
10) 75	65	30) 60	80	0	40
70	50) 45	30) 50	10) 40	0	90
30) 60	40	40	30	0	30
40	80	60	60		

$m + n - 1 =$

$4 + 5 - 1 =$

$9 - 1 = 8 //$

$= (50 \times 60) + (20 \times 0) + (10 \times 75) + (30 \times 60) + (50 \times 45) + (30 \times 50)$

$+ (10 \times 40) + (30 \times 60)$

$\boxed{\text{Ans} = 11,500 //}$

8/1/16

Modi Method

Transportation Algorithm

Step 1

Find the initial basic feasible solution by using of the three method discussed above

Step 2

Check the number of occubied cells if they are less than m+n-1 three degerar and we very small positive assignment if ε (=0) so that the number of occupied cells is exactly equal to m+n-1.

Step 3

Each occpied cell in the Current solution solve the system of equation $u_i + v_j = C_{ij}$ with some $u_i = 0$ (or) $v_j = 0$ the values of u_i and v_j in the Tp table.

Step 4

Compute the net evalutions.

$\Delta_{ij} = u_j + v_{ij} - u_{ij}$ for all unoccupied basic cells and the lower left of the Corresponding cells.

Step 5

Each Δ_{ij} if all $\Delta_{ij} \leq 0$ then the Current basic feasible solution. If an obtain one atleast one $\Delta_{ij} > 0$ selected the un occupied cell having the largest positive net evaluations to enter the basic.

Step 6

The un occupied cell (r,s) enter the basic allocated and unknown quantity. say identified a loop start and end at the sell (r,s) and ~~end~~ Conneded sum of the basic sells and end substract inter changing. The loop in choose away that the him requirements satisfied.

Step 7

A minimum value to a inchange away that the value of one basic variable. becomes 0 and 0 than basic variable one negative 0 whose allocated sell. has been reduced to 0.

Step 8

Return to step 3 and repeat the process untill and oppitimum basic feasible solution has been obtained

① Find the starting solution in the following transporation proplem in method.

	D_1	D_2	D_3	D_4	
	3	7	6	4	5
	2	4	3	2	2
	4	3	8	5	3
	3	3	2	2	

Sol:-

$\Sigma a_i = 5 + 2 + 5 = 10$

$\Sigma b_j = 3 + 3 + 2 + 2 = 10$

Step 1 :-

3	7	6	4	5	(1)
2	4	$\boxed{2}$ 3	2	2	(1)
4	3	8	5	3	(1)
3	3	2	2		
(1)	(1)	(3)	(2)		

★

$x_{23} = \min\{2, 2\}$

$= 2$

Step 2 :-

3	7	4	5	(1)
4	$\boxed{3}$ 3	5	3	(1)
3	3	2		
(1)	(2)	(1)		

★

$x_{32} = \min\{3, 3)$

$\boxed{= 3}$

Step 3 :-

3	$\boxed{2}$ 4	5	(1)
3	2		
(3)	(2)		

★

$x_{14} = \min\{2, 5\}$

$= 2.$

Step 4 :-

3/2	3
3	

3	7	6	4	5
2	4	3	2	2
4	3	8	5	3
3	3	2	2	

$u_1 = 4$

$u_2 = 2$

$u_3 = 5$

$v_1 = -1 \quad v_2 = 2 \quad v_3 = 1 \quad v_4 = 0$

$m+n-1 = 0$

$3+4-1 = 7-1$

$= 6$

$m+n-1 = 4$

$3+4-1 = 4$

$7-1 = 4$

$6 \neq 4$

Allocated cells :-

$C_{ij} = u_i + v_j$

$C_{14} = u_1 + v_4$

$4 = u_1 + 0$

$\boxed{u_1 = 4}$

$C_{24} = u_2 + v_3$

$3 = 2 + v_3$

$\boxed{u_2 = 2}$

Unallocated cells :-

$\Delta_{ij} = u_i + v_j - c_{ij}$

$\Delta_{12} = u_2 + v_2 - C_{12}$

$= 4 - 2 - 7$

$\boxed{\Delta_{12} = -5}$

$\Delta_{ij} = u_i + v_j - c_{ij}$

$= u_1 + v_2 - C_{13}$

$= 4 + 1 - 6$

$\boxed{\Delta_{13} = -1}$

$C_{34} = u_3 + v_4$

$5 = u_3 + 0$

$\boxed{u_3 = 5}$

$C_{23} = u_2 + v_3$

$3 = 2 + v_3$

$\boxed{v_3 = 2}$

$C_{32} = u_3 + v_2$

$3 = 5 + v_2$

$\boxed{v_2 = -2}$

$C_{11} = v_1 + u_1$

$3 = 4 + v_1$

$\boxed{v_1 = -1}$

$\Delta_{21} = u_2 + v_1 - C_{21}$

$= 2 - 1 - 2$

$\boxed{\Delta_{21} = -1}$

$\Delta_{31} = u_3 + v_1 - C_{31}$

$= 5 - 1 - 4$

$\boxed{\Delta_{31} = 0}$

$\Delta_{22} = v_2 + v_2 - C_{22}$

$= 2 - 2 - 4$

$\boxed{\Delta_{22} = -4}$

$\Delta_{33} = v_3 + u_3 - C_{33}$

$= 5 + 1 - 8$

$\boxed{\Delta_{33} = -2}$

$\Delta_{ij} < 0$ the current basic feasible solution is a obtain, it is possible to present a move compute form for computing the unknown u_i and v_j than evaluate the each unoccupied cells in a more convenient way by working the transportation table.

1	2	3	4
4	3	2	0
0	2	2	1

The optimum solution is $x_{12} = 6$, $x_{22} = 2$, $x_{24} = 6$, $x_{21} = 4$, $x_{32} = \epsilon$, $x_{33} = 2$

The transporation lost ossiate wish the optimum is

$\Rightarrow 3\times3 + 2\times4 + 2\times3 + 2\times\epsilon_1 + 3\times3 + 5\times\epsilon_2$

$\Rightarrow \epsilon_1 = 0$

$\Rightarrow 38 + 2\epsilon_1 + 5\epsilon_2$

$\Rightarrow 38$//.

(2) Optain an initial basic fecsiable solution to the following problem.

1	2	3	4	6
4	3	2	0	8
0	2	2	1	10
4	6	8	6	

Sol:-

$\Sigma ai = 6 + 8 + 10 = 24$

$\Sigma bj = 4 + 6 + 8 + 6 = 24$

step 1 :-

1	2	3	4	6	(1)
4	3	2	$\boxed{6}$ 0	8	(2) *
0	2	2	1	10	(1)
4	6	8	6		
(1)	(1)	(1)	(1)		

$x_{24} = \min\{8, 6\} = 6$

step 2

1	2	3	6	(1)
4	3	2	2	(1)
$\boxed{4}$ 0	2	2	10	(2) *
4	6	8		
(1)	(1)	(1)		

$x_{31} = \min\{10, 4\} = 4$

step 3

2	3	6	(1)
3	$\boxed{2}$ 2	2	(1) *
2	2	6	(0)
6	8		
(1)	(1)		

$x_{23} = \min\{8, 2\}$

$= 2$

Step 4

2	3	6	(1)
$\boxed{6}$ 2	2	6	(0)
6	6		
(0)	(1)		

$x_{33} = \min\{6, 6\}$

$= 6$

Step 5

$\boxed{6}$ 2	6
6	

Step 6

1	$\boxed{6}$ 2	3	4
4	3	$\boxed{2}$ 2	$\boxed{6}$ 0
$\boxed{0}$ 4	$\boxed{1}$ 2	$\boxed{6}$ 2	1

$u_1 = 0$

$u_2 = 0$

$u_3 = 0$

$v_1 = 0, \quad v_2 = 2, \quad v_3 = 2, \quad v_4 = 0$

(2)

$m + n - 1 =$

$3 + 4 - 1 =$

$7 - 1 = 6$ //

Allocated cells

$C_{ij} = u_i + v_j$

$C_{31} = u_3 + v_1$

$0 = 0 + v_1$

$\boxed{v_1 = 0}$

$C_{32} = u_3 + v_2$

$2 = 0 + v_2$

$\boxed{v_2 = 2}$

$C_{33} = u_2 + v_3$

$2 = 0 + 2$

$\boxed{v_3 = 2}$

$C_{23} = u_2 + v_3$

$2 = 2 - 2$

$\boxed{v_2 = 0}$

$C_{24} = v_2 + v_4$

$\boxed{v_4 = 0}$

$C_{12} = u_1 + v_2$

$2 = 2 - 2$

$\boxed{u_1 = 0}$

Unallocated cells.

$\Delta_{ij} = u_i + v_j - C_{ij}$

$\Delta_{11} = u_1 + v_1 - C_{11}$

$= 0 + 0 - 1$

$\boxed{\Delta_{11} = -1}$

$\Delta_{13} = u_1 + v_3 - C_{13}$

$= 0 + 2 - 3$

$\boxed{\Delta_{13} = -1}$

$\Delta_{14} = u_1 + v_1 - C_{14}$

$= 0 + 0 - 4$

$\boxed{\Delta_{14} = -4}$

$\Delta_{21} = u_2 + v_1 - C_{21}$

$= 0 + 0 - 4$

$\boxed{\Delta_{21} = -4}$

$\Delta_{22} = u_2 + v_2 - C_{22}$

$= 0 + 2 - 3$

$\boxed{\Delta_{22} = -1}$

$\Delta_{34} = u_3 + v_4 - C_{34}$

$= 0 + 0 - 1$

$\boxed{\Delta_{34} = -1}$

$\Delta ij \leq 0$ the Corrent basic feasible solution is a optain , it is possible to present a more compact from for compection the unknoo ui and vi than evaluate the each unallocated calls in a more conviaient way by working the transportation table.

1	2	3	4
4	3	2	0
0	2	2	1

The obtain solution is $x_{12} = 6$, $x_{22} = 2$

$x_{24} = 6$, $x_{21} = 4$, $x_{32} = \varepsilon$, $x_{33} = 2$

The transporation cost associate with the optimirimum is

$= 6\times2 + 2\times2 + 6\times0 + 4\times0 + \varepsilon\times2 + 2\times6$

$\varepsilon = 0$

$= 12 + 4 + 0 + 0 + 12$

$= 28$//

① Assignmant problem :-

18	26	17	11
13	28	14	26
38	19	18	15
19	26	24	10

Hoo should the takes be allocated one to a man so as to minimum the total Hours.

Sol :-

step1

7	15	6	0
0	15	1	13
23	4	3	0
9	16	14	0

step2

7	11	5	$\boxed{0}$
$\boxed{0}$	11	$\cancel{0}$	13
23	$\boxed{0}$	2	$\cancel{0}$
9	12	13	$\cancel{0}$

step 3

2	6	$\boxed{0}$	$\cancel{0}$
$\boxed{0}$	11	$\cancel{0}$	13
23	$\boxed{0}$	2	$\cancel{0}$
9	12	13	$\boxed{0}$

$= A \rightarrow G + B \rightarrow E + C \rightarrow F + D \rightarrow H$

$= 17 + 13 + 19 + 10$

$= 59$ //

(2)

8	7	6
5	7	8
6	8	7

using Assignment Problem.

Sol:-

step 1

2	1	0
0	2	3
0	2	1

step 2

2	$\boxed{0}$	$\cancel{0}$
$\boxed{0}$	1	3
$\cancel{0}$	1	1

step 3

2	$\boxed{0}$	$\cancel{0}$
$\boxed{0}$	1	3
$\cancel{0}$	$\cancel{0}$	$\boxed{0}$

$= A \rightarrow 2 + B \rightarrow 1 + C \rightarrow 3$

$= 7 + 5 + 7$

$= 19$ //

(3)

9	26	15	0
13	27	6	0
35	20	15	0
18	30	20	0

Sol:-

	1	2	3	4	
I	0	17	6	0	✓
II	7	21	0	0	✓
III	20	5	0	0	✓
IV	0	12	2	0	✓
	✓	×	✓	✓	

step 2

	1	2	3	4
I	$\boxed{0}$	12	6	$\cancel{0}$
II	7	16	$\boxed{0}$	$\cancel{0}$
III	20	$\boxed{0}$	$\cancel{0}$	$\cancel{0}$
IV	$\cancel{0}$	7	2	$\boxed{0}$

$= I \to 1 + II\ 3 + III \to 2 + IV \to 4$

$= 9 + 6 + 20 + 0$

$= 35$ //

29/1/25

①

-	5	2	0
4	7	5	6
5	8	4	3
3	6	6	2

using Assignment Problem.

Sol:-

step 1

m	5	2	0
0	3	1	2
2	5	1	0
1	4	4	0

step 2

m	2	1	$\boxed{0}$
$\boxed{0}$	$\cancel{0}$	$\cancel{0}$	2
2	2	$\boxed{0}$	$\cancel{0}$
1	1	3	$\cancel{0}$

step 3

m	2	1	$\boxed{0}$
$\boxed{0}$	$\cancel{0}$	$\cancel{0}$	2
2	2	$\boxed{0}$	$\cancel{0}$
$\cancel{0}$	$\boxed{0}$	2	0

= 1 → D + 2 → A + 3 → C + 4 → B

= 0 + 4 + 4 + 6

= 14

(2)

9	11	15	10	11
12	9	-	10	9
-	11	14	11	7
14	8	12	7	8
0	0	0	0	0

Using Assignment Problem.

Sol:-

0	2	6	1	2
3	0	m_1-9	1	0
m_2-7	4	7	2	0
7	1	5	0	1
0	0	0	0	0

= I → A + II → B + III → E + IV → D + V → C

= 9 + 9 + 7 + 7 + 0

= 32

Home Work.

Ans: 15

(1)

1	2	3	4
5	5	-	2
7	4	2	3
9	3	5	-
7	2	6	7

Unit - I

Linear Programming problem

A linear programming problem must have an objective which should be clearly identified and measurable in quantitative terms. It good been of profect maximisation, cost minimisation. The Relationship among the Variables representing objective must be linear.

2Mark

The Decision Variables :-

Refer to the activities that are one another for saving the Resource available all the decision Variable are consider as continous and non - negative operation Research (1940) mcclosky. county name United kingdom.

2Mark

※ Definition :- (OR) → Operations Research (1940, mcclosky, UK)

This new approach to Systematic and Scientific study of the operations of System was Called the operations Research (OR)

Applications of OR (8 Mark)

OR is mainly consold with the dechicks of applying scientific knowledge, baside the development of science. It provides and understanding which gives the manager new insides and Cabailidies to determind better solutions with grade speed in Recent years OR has Successfully entered many different areas of Research in defends Government service organisitions and industry. Sum applications of OR in the functional areas.

N:1 Finance

N:2 Marketing

N:3 physical distributions

N:4 explorations

N:5 Personal

N:6 Product

N:7 development

2/2/2020

Linear programming problem :-

(LPP - graphical Solutions)

Graphical Solution Method

Step1 :-

Identified the problem the Decision the variables, the objective and the restriction.

Step2 :-

Set up the mathematical formula of the problem.

Step3 :-

All the problem and identified the feasible region. The feasible region is the intersection of all the region represent by the Constraints the problem and the first only.

Step4 :-

The feasible region obtained in step3 may be bounded (or) unbounded compute the

Coordinate of all the corner points of the feasible region.

Step 5 :-

Find out the Values of objective functions. Each Corner point Determind in Step 4.

Step 6 :-

Select the Corner point that optimizes the Value of the objective function. It gives the optimum feasible solution.

அடிப்படை சாத்தியமான / ஏற்புடைய தீர்வு

feasible solutions (5 mark) 2005 - 2006

Any solutions to the general LPP which also satisfied the non-negative restrict of the problem, is called the feasible solution to the general LPP.

உகந்த தீர்வு :-

Optimum Solutions (2m)

Any feasible solution which optimize (minimize) or (maximize) the objective function of a general LPP is called optimum solution to general LPP.

Slack Variables (2m)

Let the constraince of a general LPP $\sum_{j=1} a_{ij}\ x_j \le b_i$; $i = 1, 2, 3 \ldots k$.

Then the non-negative variable x_{n+i} which satisfied.

$$\sum_{1=1} a_{ij}\ x_j + x_{n+i} = b_i \quad i = 1, 2, 3 \ldots k$$ are called slack Variables.

Surplus Variables (2m) (negative slack)

Let the Constrain of a general LPP $\sum_{j=1}^{n} a_{ij}\ x_j = b_j$ $\quad i = k+1, k+2, \ldots k$.

Or Then the non-negative Variables x_{n+i} which satisfied $\sum_{j=1}^{n} a_{ij} x_j - x = n+i\, b_i$

$i = n+1, n+2 \ldots l$ are called the Surplus Variables.

<u>The Canonical form</u> (Sm)

The general formulation of LPP in the previous section can always be put in the following form maximize,

$$\text{Max } z = c_1x_1 + c_2x_2 + \ldots + c_nx_n$$

$$a_{i1}x_1 + a_{i2}x_2 + \ldots + a_{in}x_{in} \leq b_i$$

$$x_1, x_2, \ldots x_n \geq 0$$

$$\text{where } i = 1, 2, \cdots m$$

this form of LPP is Called the Canonical form of the Characteristics of this form are,

① The objective function of the maximination type, $\min f(x) = -\max \{-f(x)\}$ for example the linear objective function min.

$z = c_1x_1 + c_2x_2 + \ldots c_nx_n$ is equivalent to $\max h = -z = -c_1x_1 - c_2x_2 \ldots c_nx_n$

$z = -h$.

② The linear Constrain ($\leq$ type).

$a_{i1}x_1 + a_{i2}x_2 + \ldots + a_{in}x_n \geq b_i$ is equivalent to

$$a_{i1}x_1 - a_{i2}x_2 - \ldots - a_{in}x_n \leq -1$$

The eqn may be replaced by two weak in equivalently in opposite direction.

$a_{i1}x_1 + a_{i2}x_2 + \ldots + a_{in}x_n = b_i$ is equivalent to

$$a_{i1}x_1 + a_{i2}x_2 + \ldots + a_{in}x_n \leq b_i$$

$$a_{i1}x_1 + a_{i2}x_2 + \ldots + a_{in}x_n \geq b_i$$

③ All the Variable also non-negative a Variable which ~~Variable~~ un-restricted in Sign

(+ve, −ve, (or) 0) the difference between to non-negative variable x_j is un-restricted can be replaced by $(x_j' - x_j'')$ both are non-negative that is $= (x_j' - x_j'')$

$$x_j' \geq 0, \quad x_j'' \geq 0$$

The standard form (2m)

① The general LPP in the form maximize and minimize $Z = c_1x_1 + c_2x_2 + \dots + c_nx_n$

Subject to,

$$a_{i1}x_1 + a_{i2}x_2 + \dots + a_{in}x_n \geq 0$$

$$i = 1, 2, \dots n$$

is cross standard from all the constrains are in the form of equation for the non-negative.

② Right hand side each constrain equation is non-negative max (a) mini $Z = cx$ sub to $Ax b$

$$x \geq 0.$$

① max $Z = x x_1 + 3x_2$

Sub to:

$$2x_1 + x_2 \leq 1000$$
$$x_1 + x_2 \leq 800$$
$$x_1 \leq 400$$
$$x_2 \leq 700$$
$$x_1 \geq 0$$
$$x_2 \geq 0$$

$2x_1 + x_2 = 1000$

$2(400) + x_2 = 1000 - 800$

$\boxed{x_2 = 200, \; (400, 200)}$

$2x_1 + x_2 = 1000$

$x_1 + x_2 = 800$

$x_1 = 200$

$\boxed{x_1 = 200}$

Sol:-

$$2x_1 + x_2 \leq 1000 \quad \text{—— ①}$$
$$x_1 + x_2 \leq 800 \quad \text{—— ②}$$

$2x_1 + x_2 = 1000 \rightarrow ①$

$x_1 = 0$ sub in $\rightarrow ①$

$① \Rightarrow 2(0) + x_2 = 1000$

$\boxed{x_2 = 1000}$ (0, 1000)

$x_2 = 0$ sub in eqn $\rightarrow ①$

$① \Rightarrow 2x_1 + 0 = 1000$

$2x_1 = 1000$

$x_1 = \frac{1000}{2}$

$\boxed{x_1 = 500}$ (500, 0)

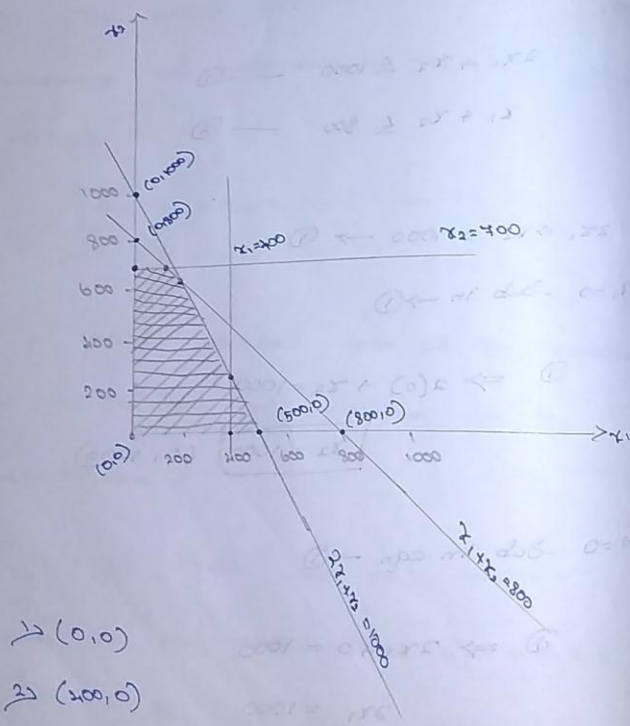
$x_1 + x_2 = 800$

$x_1 = 0$ sub in eqn ②

$x_2 = 800 \; (0, 800)$

$x_2 = 0 \Rightarrow$ sub in eqn ②

$x_1 = 800 \; (800, 0)$



1) (0,0)

2) (400,0)

3) $2x_1 + x_2 = 1000$

$800 + x_2 = 1000$

$x_2 = 200 \quad (400, 200)$

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4) $2x_1 + x_2 = 1000$

$x_1 + x_2 = 800$

(-) (-) (-)

$x_1 = 200$

$x_1 = 200$ sub in $x_1 + x_2 = 800$

$200 + x_2 = 800 - 200$

$x_2 = 600$

(200, 600)

5) $x_1 + x_2 = 800$

$x_2 = 700$

$x_1 + 700 = 800 - 700$

$\boxed{x_1 = 100}$

(100, 700)

6) (0, 700)

$\max Z = 4x_1 + 3x_2$

1) $(0,0) \Rightarrow \max z = 4(0) + 3(0) = 0$

2) $(400,0) \Rightarrow \max z = 4(400) + 3(0) = \underline{1600}$

3) $(400,200) \Rightarrow \max z = 4(400) + 3(200)$

$= 1600 + 600$

$= \underline{2200}$

4) $(200, 600) \Rightarrow \max Z = 4(200) + 3(600)$

$= 800 + 1800$

$= \underline{\underline{2600}}$

5) $(100, 700) \Rightarrow \max Z = 4(100) + 3(700) = \underline{\underline{2500}}$

6) $(0, 700) \Rightarrow \max Z = 4(0) + 3(700) = \underline{\underline{2100}}$.

$\therefore \max Z = 2600$

at point $(200, 600)$.

(2) $\max Z = 5x_1 + 3x_2$

sub to;

$x_1 + x_2 \le 6$

$2x_1 + 3x_2 \ge 3$

$0 \le x_1 \ge 3, \; 0 \le x_2 \ge 3$ using Graphical method.

Sol:-

$x_1 = 3 \to (3)$

$x_2 = 3 \to (4)$

$x_1 + x_2 = 6 \to (1)$

$2x_1 + 3x_2 = 3 \to (2)$

$x_1 + x_2 = 6$

$x_1 \Rightarrow 0 \Rightarrow x_2 = 6 \; (0, 6)$

$x_2 = 0 \Rightarrow x_1 = 6 \; (6, 0)$

$2x_1 + 3x_2 = 3$

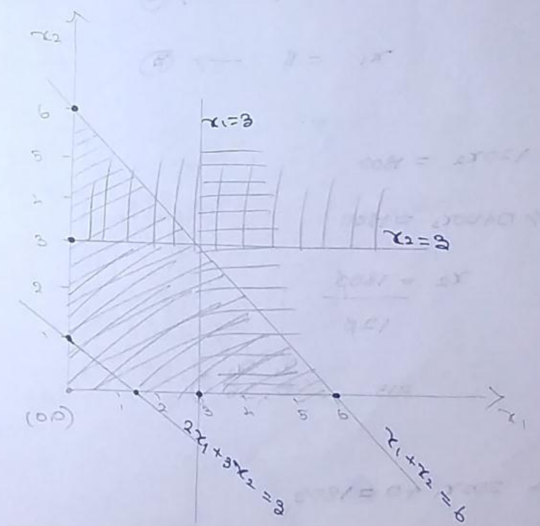
$x_1 = 0 \Rightarrow 3x_2 = 3$

$x_2 = 1 \quad (0, 1)$

$x_2 = 0 \Rightarrow 2x_1 = 3$

$x_1 = 3/2$

$x_1 = 1.5 \quad (1.5, 0)$



Ans:- That is Infeasible solution.

(3) $\max z = 8 \times 50x_1 + 80 \times 45 x_2$

Sub to :-

$8 \times 25x_1 + 8 \times 15x_2 \geq 1800$

$5x_1 + 3x_2 \geq 45$

$x_1 \leq 8$

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

using Grafical method.

sol:-

$8 \times 25x_1 + 8 \times 15x_2 = 1800$

$200x_1 + 120x_2 = 1800 \longrightarrow (1)$

$5x_1 + 3x_2 = 45 \longrightarrow (2)$

$x_1 = 8 \longrightarrow (3)$

$200x_1 + 120x_2 = 1800$

$x_1 = 0 \Rightarrow 0 + 120x_2 = 1800$

$x_2 = \frac{180\cancel{0}}{12\cancel{0}}$

$= 15 \quad \overset{x_1 \;\; x_2}{(0, 15)}$

$x_2 = 0 \Rightarrow 200x_1 + 0 = 1800$

$x_1 = \frac{18\cancel{00}}{2\cancel{00}}$

$= 9 \quad (9, 0)$

$5x_1 + 3x_2 = 45$

$x_1 = 0 \Rightarrow 0 + 3x_2 = 45$

$x_2 = \frac{45}{3}$

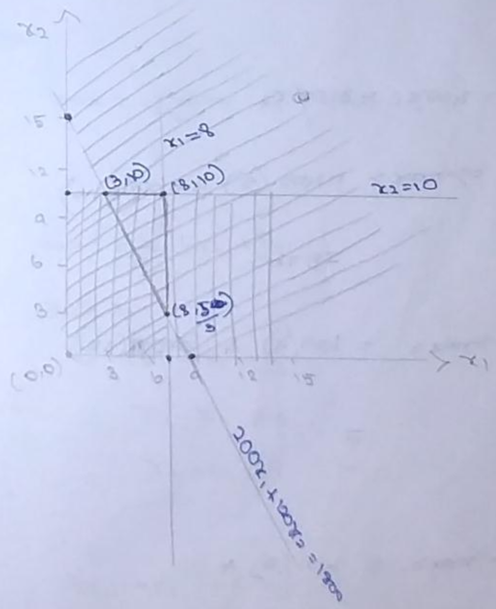
$= 15 \quad (0, 15)$

$x_2 = 0 \Rightarrow 5x_1 + 0 = 45$

$x_1 = \frac{\cancel{45}}{\cancel{5}}$

$= 9 \quad (9, 0)$

$x_1 = 8 \quad (8, 0)$



i) $5x_1 + 3x_2 = 45$

$x_1 = 8$

$5(8) + 3x_2 = 45$

$3x_2 = 45 - 40$

$3x_2 = 5$

$x_2 = 5/3$ (1.6) $\quad (8, 1.6)$

2) (8,10)

3) $5x_1 + 3x_2 = 45 \quad 5x_1 + 30 = 45$

$x_2 = 10 \quad 5x_1 = 15$

$x_1 = 15/5 = 3. \quad (3,10)$

$\max z = 400x_1 + 360x_2$

i) $(8, 1.6) \Rightarrow \max z = 400(8) + 360(1.6)$

$= 5760$

2) $(8,10) \Rightarrow \max z = 400(8) + 360(10)$

$=$

3) $(3,10) \Rightarrow \max z = 400(8) +$

$\max z = 400x_1 + 360x_2$

i) $(8, 5/3) = \max z = 400(8) + 360(5/3)$

$= 3200 + 360 \times 5/3$

$= 3800$

2) $(8,10) = \max z = 400(8) + 360(10)$

$= 6800$

3) $(3,10) \Rightarrow \max z = 400(3) + (360)(10)$

$= 4800$

Ans:-

$\max z = 6800$ at point (8,10)

(5) mini $z = 6x_1 + x_2$

sub to

$2x_1 + x_2 \geq 3$

$x_2 - x_1 \geq 0$

$x_1, x_2 \geq 0$

Sol:-

$2x_1 + x_2 = 3 \Rightarrow$ (1)

$x_2 - x_1 = 0 \Rightarrow$ (2)

$2x_1 + x_2 = 3$

$x_1 = 0 \Rightarrow x_2 = 3 \quad (0,3)$

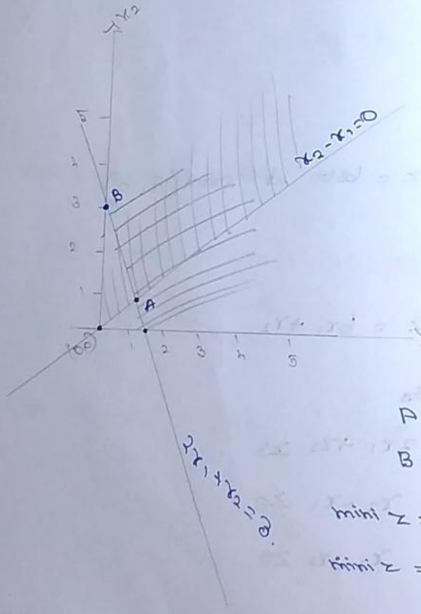
$x_2 = 0 \Rightarrow 2x_1 = 3$

$x_1 = \frac{3}{2} \quad (1.5, 0)$

$x_2 - x_1 = 0$

$x_1 = 0 \Rightarrow x_2 = 0 \quad (0,0)$

$x_2 = 0 \quad x_1 = 0 \quad (0,0)$



$A = (1,1)$

$B = (0,3)$

$\text{mini } z = 6(1) + (1) = 7$

$\text{mini } z = 0 + 3 = 3.$

Ans:- That is infeasible solution.

(4) solve Graphical method the following LPP $\max z = 3x_1 + 2x_2$.

Sub to:-

$-2x_1 + x_2 \le 1 \; ; \; x_1 \le 2$

$x_1 + x_2 \le 3 \; ; \; x_1, x_2 \ge 0.$

Sol:-

$-2x_1 + x_2 = 1 \rightarrow (1)$

$x_1 + x_2 = 3 \rightarrow (2)$

$x_1 = 2 \rightarrow (3)$

(1) $\Rightarrow$

$-2x_1 + x_2 = 1$

$x_1 = 0$

$\Rightarrow x_2 = 1 \quad (0,1)$

$x_2 = 0$

$\Rightarrow -2x_1 = 1$

$x_1 = -1/2 = -0.5 \quad (-0.5, 0)$

(2) $\Rightarrow$

$x_1 + x_2 = 3$

$x_1 = 0$

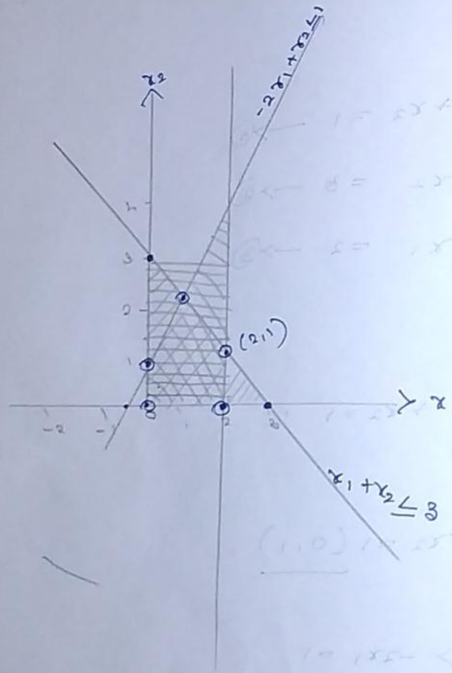
$\Rightarrow x_2 = 3 \quad (0,3)$

$x_2 = 0$

$\Rightarrow x_1 = 3$ $(3,0)$

(3) $\Rightarrow$

$x_1 = 2$ $(2,0)$



1> $(0,0)$

2> $(2,0)$

3> $x_1 + x_2 = 3$

$x_1 = 2$

$2 + x_2 = 3$

$x_2 = 1$ $(2,1)$

4> $-2x_1 + x_2 = 1$

$x_1 + x_2 = 3$

$(-)\quad(-)\quad(-)$

$-3x_1 = -2$

$x_1 = 2/3$

$\frac{2}{3} + x_2 = 3$

$x_2 = 3 - 2/3$

$x_2 = 7/3$

$(2/3, 7/3)$

5> $(0,1)$

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(7) The approximation mathematical formulation of the given LPP is.

$\min z = 2x_1 + 40x_2$

Sub to

$36x_1 + 6x_2 \geq 108$

$3x_1 + 12x_2 \geq 36$

$20x_1 + 10x_2 \geq 100$ and $x_1 \geq 0,\ x_2 \geq 0.$

Soln:

$36x_1 + 6x_2 = 108 \rightarrow (1)$

$3x_1 + 12x_2 = 36 \rightarrow (2)$

$20x_1 + 10x_2 = 100 \rightarrow (3)$

$36x_1 + 6x_2 = 108$

(1) $\Rightarrow$ $x_1 = 0$

$36(0) + 6(x_2) = 108$

$6x_2 = 108$

$x_2 = \frac{108}{6}$

$x_2 = 18$ $(0, 18)$

$x_2 = 0$

$36x_1 + 6(0) = 108$

$36x_1 = 108$

$x_1 = \frac{108}{36} = 3$ $(3, 0)$

$3x_1 + 12x_2 = 36$

(2) $\Rightarrow$ $x_1 = 0$

$3(0) + 12x_2 = 36$

$12x_2 = 36$

$x_2 = 36/12$

$x_2 = 3$ $(0, 3)$

$x_2 = 0$

$3x_1 + 12(0) = 36$

$3x_1 = 36$

$x_1 = 36/3 = 12$ $(12, 0)$

$20x_1 + 10x_2 = 100$

(3) $\Rightarrow$ $x_1 = 0$

$20(0) + 10x_2 = 100$

$10x_2 = 100$

$x_2 = \frac{100}{10}$

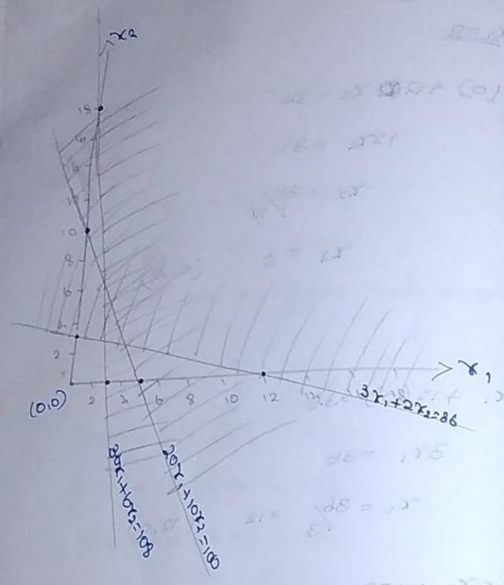
$x_2 = 10$ $(0, 10)$

$x_2 = 0$

$20x_1 + 10(0) = 100$

$x_1 = 100/20$

$x_1 = 5$ $(5, 0)$



That is unfeasible solution.

(8) Max $z = 2x_1 + 4x_2$

Sub to:-

$x_1 + 2x_2 \leq 5$

$x_1 + x_2 \leq 4$ and $x_1, x_2 \geq 0$

Sol:-

$x_1 + 2x_2 = 5 \longrightarrow$ (1)

$x_1 + x_2 = 4 \longrightarrow$ (2)

$x_1 + 2x_2 = 5$

$x_1 = 0$

$0 + 2x_2 = 5$

$x_2 = 5/2$

$x_2 = 2.5$ (0, 2.5)

$x_2 = 0$

$x_1 + 2(0) = 5$

$x_1 = 5$ (5, 0)

$x_1 + x_2 = 4$

$x_1 = 0$

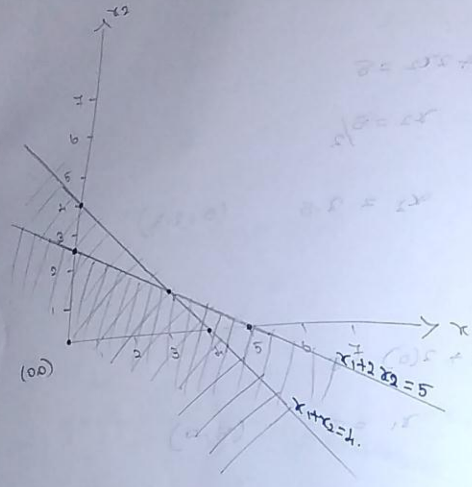
$0 + x_2 = 4$

$x_2 = 4$ (0, 4)

$x_2 = 0$

$x_1 + 0 = 4$

$x_1 = 4$ (4, 0)



i) (0,0)

ii) (4,0)

iii) $x_1 + 2x_2 = 5$

$x_1 + x_2 = 4$

(-) (-) (-)

$x_2 = 1$

$x_1 + x_2 = 4$

$x_1 = 4 - 1$

$= 3.$ (3,0)

iv) (0,2.5)

$\max z = 2x_1 + 4x_2$

(0,0)

$= 2(0) + 4(0)$

$= 0$

(2) => (4,0)

$= 2(4) + 4(0)$

$= 8$

(3) => (3,0)

$= 2(3) + 4(0)$

$= 6$

(4) => (0,2.5)

$= 2(0) + 4(2.5)$

$= 10$ //

Home Work

① max $z = 10x_1 + 6x_2$

Sub to :-

$5x_1 + 3x_2 \leq 30$

$x_1 + 2x_2 \leq 18$ and $x_1, x_2 \geq 0$

Sol:-

$5x_1 + 3x_2 = 30 \longrightarrow ①$

$x_1 + 2x_2 = 18 \longrightarrow ②$

$5x_1 + 3x_2 = 30$

$x_1 = 0$

$0 + 3x_2 = 30$

$x_2 = 30/3$

$x_2 = 10$ $(0, 10)$

$x_2 = 0$

$5x_1 + 0 = 30$

$5x_1 = 30$

$x_1 = 30/5$

$x_1 = 6$ $(6, 0)$

$x_1 + 2x_2 = 18$

$x_1 = 0$

$0 + 2x_2 = 18$

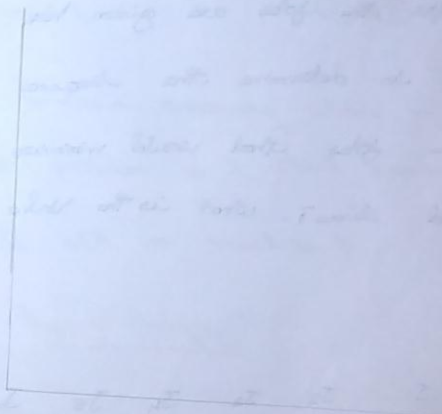
$x_2 = 18/2$

$x_2 = 9$ $(0, 9)$

$x_2 = 0$

$x_1 + 0 = 18$

$x_1 = 18$ $(18, 0)$



10/2/16 Unit IV

Sequencing Problem

Processing (n) jobs through 2 machines

Problem: 1

There are six jobs to perform each of which go throw two machines A and B in the order A, B. The processing (in hours) for the jobs are given here. You are required to determine the sequence for performing the jobs that would minimize the total elapsed time T. What is the value of T?

Job :	J_1	J_2	J_3	J_4	J_5	J_6
machine A :	1	3	8	5	6	3
machine B :	5	6	3	2	2	10

The smallest processing time in the given problem is 1 on machine A.

A

J_1					

B

The reduced set of processing times

Job :	J_2	J_3	J_4	J_5	J_6
mach A :	3	8	5	6	3
mach B :	6	3	2	2	10

The minimum processing time in this reduced problem is 2 which corresponds to J_4 and J_5 both on machine B.

A

J_1				J_4	J_5

B

Job :	J_2	J_3	J_6
mach A :	3	8	3
mach B :	6	3	10

The minimum processing time in this reduced problem is 3 which correspond to

J_2 and J_6 on machine A. and J_5 on machine B.

(1)

A					B
J_1	J_6	J_2	J_3	J_4	J_5

Jobs	Machine A		Machine B		idle time on B
	in	Out	in	Out	
J_1	0	1	1	6	1
J_6	1	4	6	16	–
J_2	4	7	16	22	–
J_3	7	15	22	25	–
J_4	15	20	25	27	–
J_5	20	26	27	29	–

From the above information,

we get $= 29$ hours.

Idle time of machine A $= (29-26) = 3$ hrs.

idle time on B $= 1$ hr.//

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(2)

Book	b_1	b_2	b_3	b_4	b_5	b_6
Printing time (hrs) :	30	120	50	20	90	100
Binding time (hrs) :	80	100	90	60	30	10

sol:-

A					B
b_4	b_1	b_3	b_2	b_5	b_6

The minimum elapsed time from the start of the first book to the completion of the last corresponding the optimal sequence is computed as shown in the following table:-

Book	Printing Machine		Binding machine		Idle time of
	Time in	Time Out	Time in	Time out	binding machine.
b4	0	20	20	80	20
b1	20	50	80	160	—
b3	50	100	160	280	—
b2	100	220	280	350	—
b5	220	310	350	380	—
b6	310	410	380	390	—

Idle time of Printing machine is

410 - 390 = 20 hrs.

T = 410 hrs

Binding machine = 390 hrs

Printing machine = 410 hrs.//

Idle time of binding machine } = 20 hrs.

(8) Job : J1 J2 J3 J4 J5

machine A : 5 1 9 3 10

machine B : 2 6 7 8 4

Sol:-

A | J2 | J4 | J3 | J5 | J1 | B

Job	Machine A		Machine B		Idle time of Job.
	Time in	Time Out	Time in	Time Out	
J2	0	1	1	7	1
J4	1+3	4	7	15	—
J3	4	13	15	22	—
J5	13	23	22	26	—
J1	23	28	26	28	—

Total hours = 28 hrs

machine B = 28 hrs

Idle time = 28 - 28

= 0

Processing n jobs through k machines :-

① Determine the optimal sequence of jobs that minimizes the total elapsed time based on the following information processing time on machines is given in hours and passing is not allowed.

job :	A	B	C	D	E	F	G
machine M_1 :	3	8	7	4	9	8	7
" M_2 :	4	3	2	5	1	4	3
" M_3 :	6	7	5	11	5	6	12

Sol :-

$G_i = M_1 + M_2 = A_i + B_i$

$H_i = M_2 + M_3 = B_i + C_i$

job :	A	B	C	D	E	F	G
G_i :	7	11	9	9	6	12	10
H_i :	10	10	7	16	6	6	15

G H

A	D	G	B	F	C	E

Jobs	Machine m_1		M_2		M_3		Idle Time
	in	Out	in	Out	in	Out	
~~A~~ A	0	3	3	7	7	14	7
~~B~~ D	3	7	7	14	14	25	0
~~C~~ G	7	14	14	22	25	34	0
~~D~~ B	14	22	22	30	37	44	0
~~E~~ F	22	30	30	34	44	50	0
~~F~~ C	30	37	34	46	50	55	0
~~G~~ E	37	46	46	47	55	60	2

Total Time = 60 hours

Idle time of

machine 3 : 7 hours

" 2 : 60-47

= 13 hours.

" 1 = 60-46.

= 14 hours.

2) job : 1 2 3 4 5 6

m.A : 4 13 6 3 10 12

m.B : 9 4 5 7 4 2

m.C : 14 15 10 13 9 14

Find Total Time,

idle time of mA, mB, mC,

n job 2 machine

① Job: J_1 J_2 J_3 J_4 J_5 J_6 J_7 J_8

m.A :	8	10	10	6	12	1	5	9
m:B	7	4	3	9	11	6	4	2

Find the total elapsed time, idle time of machine A & B.

Sol:-

J_6 J_4 J_5 J_1 J_2 J_7 J_3 J_8

Job	m.A In	m.A Out	m.B In	m.B Out	Idle time of m.B
J_6	0	1	1	7	1
J_4	1	7	7	16	0
J_5	7	19	19	30	3
J_1	19	27	30	37	0
J_2	27	37	37	41	0
J_7	37	42	42	46	1
J_3	42	52	52	55	6
J_8	52	61	61	63	6
					17

Idle time of machine A $= 0 + (1-1) + (7-7) + (19-19) + (27-27) + (37-37) + (42-42) + (52-52) + (63-61)$

$= 2$ hrs.

Total elapsed time $T = 63$ hrs.

Idle time of machine B is $= 17$ hrs.

n job through 3 machine

② Job: 1 2 3 4 5 6

m (A) :	4	13	6	3	10	12
m (B) :	9	7	5	7	4	2
m (C) :	14	15	10	13	9	14

Find total elapsed time & Idle time of m(A), m(B), m(C)

Sol:-

$G_i = t_{1j} + t_{2j}$

$H_i = t_{2j} + t_{3j}$

Job	$G = A_i + B_i$	$H = B_i + C_i$
J_1	13	23
J_2	20	22
J_3	11	15
J_4	10	20
J_5	14	12
J_6	12	16

G

J_4	J_3	J_1	J_6	J_2	J_5

H

Job	m(A)		m(B)		m(C)		Idle time of m(C)
	In	Out	In	Out	In	Out	
J_4	0	3	3	10	10	23	10
J_3	3	9	10	15	23	33	0
J_1	9	13	15	24	33	47	0
J_6	13	25	25	27	47	61	0
J_2	25	38	38	45	61	76	0
J_5	38	48	48	52	76	85	0
							10 hrs

~~Idle time T = 10 hrs.~~

~~Idle time M = 2 + (3-3) + (9-9) + 4~~

Total elapsed time T = 85 hrs.

Idle time of m.(C) = 10 hrs

$= 10 + (23-23) + (33-33) + (47-47) + (61-61) + (76-76)$

Idle time of m.(B) $= 3 + (10-10) + (15-15) + (25-24) + (38-27) + (48-45) + (85-52)$

= 51 hrs.

9/8/16 Processing any job s through m machines

① Job : 1 2 3 4

m(A) : 9 8 7 10

m(B) : 7 8 6 5

m(C) : 4 6 7 5

m(D) : 5 7 8 4

m(E) : 11 12 10 8

Sol:-

mini $A_i = 7$

maxi $B_i = 8$

maxi $C_i = 7$

maxi $D_i = 8$

maxi $E_i \geq$ (maxi B_i and D_i)

$12 \geq (8, 8)$

We can solve this problem considers the following tables jobs.

Job	$X = A_i + B_i + C_i + D_i$	$Y = B_i + C_i + D_i + E_i$
1)	28	27
2)	29	33
3)	28	31
4)	24	22

x | 1 | 3 | 2 | 4 | y

Job	m(A)		m(B)		m(C)		m(D)		m(E)		Idle time of m(E)
	I	O	I	O	I	O	I	O	I	O	
1)	0	9	9	16	16	20	20	25	25	36	
3)	9	16	16	22	22	29	29	37	37	47	
2)	16	24	24	32	32	38	38	45	47	59	
4)	24	34	34	39	39	44	45	49	59	67	

Total elapsed time = 67 hrs.

Idle time of m(E) = 26 hrs.

" m(D) = 20 + 4 + 1 + 0 + (67 - 49)

= 43 hrs.

" of m(C) = 16 + 2 + 3 + 1 (67 - 42)

= 45 hrs.

" of m(B) = 41 hrs.

" of m(A) = 33 hrs.

(2)

Job :	1	2	3	4
m(A) :	58	30	28	64
m(B) :	14	10	12	16
m(C) :	14	18	16	12
m(D) :	48	32	44	42

Sol:

mini A_i = 28

maxi B_i = 16

maxi C_i = 18

maxi D_i ≥ 48

~~maxi E_i~~

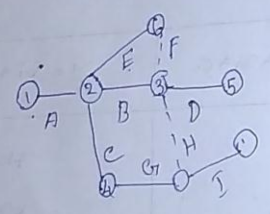
We can solve this problem consider the following table jobs.

Job	$X = A_i + B_i + C_i$	$Y = B_i + C_i + D_i$
1)	86	76
2)	58	60
3)	56	72
4)	92	70

x y

3	2	1	4

Job	m(A)		m(B)		m(C)		m(D)		Idle time of m(D)
	I	O	I	O	I	O	I	O	



11/3/16

UNIT - V

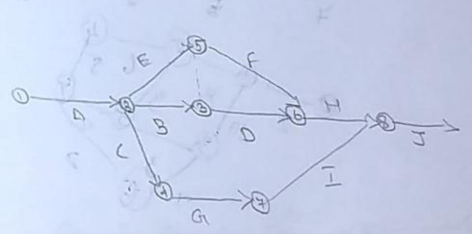
CPM - Critical path Method.

① Draw a Network diagram for the following data.

Activity :	A	B	C	D	E	F
Preceding activities :	-	A	A	B	A	B, E

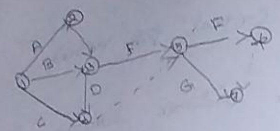
G	H	I	J
C	D, F	G	H, I

Sol:-



② Draw a Network diagram for the following data:-

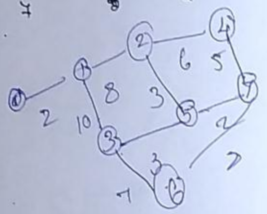
Activity :	A	B	C	D	E	F	G
Preceding Activity :	-	-	-	A,B	A,B	C,D,E	C,A,B

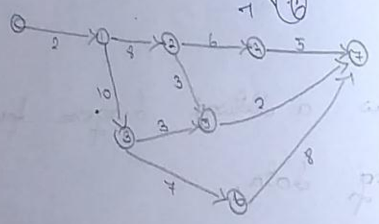


(3) Draw a network diagram for the following data:

Activity	0-1	1-2	1-3	2-4	2-5	3-5	3-6	4-7	5-7	6-7
days	2	8	10	6	3	3	7	5	2	8

Sol:-

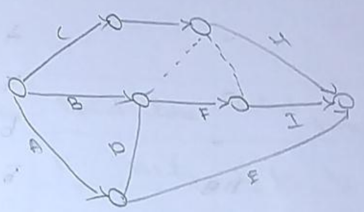




(4) Activity : A B C D E F G H I

P.A : - - - A A B.D C B.G F.G.

Sol:-

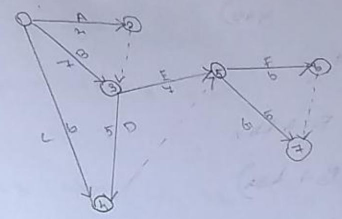


1) A Small project of 7 activities for which data are given.

Activity	Preceding Activity	Activity duration.
A	–	4
B	–	7
C	–	6
D	A,B	5
E	A,B	7
F	C,D,E	6
G	C,D,E	5

i) Draw the network and find the project completion time.

ii) Calculate total float for each of the activities and highlight the critical path.



Activity (i,j)	duration t_{ij}	Earliest time E_i	$E_i + t_{ij}$	Latest time $L_j - t_{ij}$	L_j	Total float
1-2	4	0	4	3	7	3
1-3	7	0	7	0	7	0
1-4	6	0	6	8	14	8
3-4	5	7	12	9	14	2
3-5	7	7	14	7	14	0
5-6	6	14	20	14	20	0
5-7	5	14	19	15	20	1

$(L_j + E_i) - t_{ij}$

Forward calculations.

$E_1 = 0$

$E_2 = E_1 + t_{12} = 0 + 4 = 4$

$E_3 = \max(E_1 + t_{13},$
$E_2 + E_{23})$

$= max(0+7, 7+0)$

$= 7$

$E_4 = max(E_1 + t_{14}, E_3 + t_{34})$

$max(0+6, 7+5) = 12$

$E_5 = max(E_3 + t_{35}, E_4 + t_{45})$

$max(7+7, 12+0) = 14$

$E_6 = E_5 + t_{56} = 14+5 = 19$

$E_7 = max(E_5 + t_{57}, E_6 + t_{67})$

$= max(14+6, 19+0) = 20$

Backward calculations:-

$L_7 = 20$

$L_6 = L_7 - t_{67}$

$= 20 - 0 = 20.$

$L_5 = min(L_6 - t_{56}, L_7 - t_{57})$

$= min(20-6, 20-5)$

$= min(14, 15)$

$L_5 = 14$

$L_4 = L_5 - t_{45} = 14 - 0$

$= 14.$

$L_3 = min(L_4 - t_{34}, L_5 - t_{35})$

$= '' (14-5, 14-7)$

$= min(9, 7)$

$L_3 = 7$

$L_2 = L_3 - t_{23}$

$= 7 - 0$

$= 7$

$L_1 = min\{L_2 - t_{12}, L_3 - t_{13}, L_4 - t_{14}\}$

$= min\{7-4, 7-7, 14-6\}$

$= 0.$

$\therefore$ The Critical path $= 1 \to 3 \to 5 \to 6 \to 7$

(2) Activity : 1-2 1-3 2-4 3-4 3-5 4-9

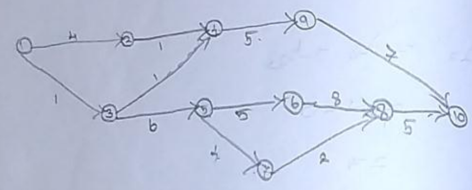
time : 4 1 1 1 6 5

5-6 5-7 6-8 7-8 8-10 7-10

5 4 8 2 5 7

i) Draw a Network

ii) Find the CP.



Forward Calculations:-

Set $E_1 = 0$

$E_2 = E_1 + t_{12}$

$= 0 + 4$

$E_2 = 4$

$E_3 = E_1 + t_{13}$

$= 0 + 1$

$E_3 = E_1 + t_{13}$

$= 0 + 1$

$E_3 = 1$

$E_4 = \max(E_2 + t_{24}, E_3 + t_{34})$

$= \max(4+1, 1+1)$

$E_4 = 5$

$E_5 = E_3 + t_{35}$

$= 1 + 6$

$= 7$

$E_6 = E_5 + t_{56}$

$= 7 + 5$

$= 12$

$E_7 = E_5 + t_{57}$

$= 7 + 4$

$= 11$

$E_8 = \max(E_6 + t_{68}, E_7 + t_{78})$

$= \max(12+8, 11+2)$

$E_8 = 20$

$E_9 = E_4 + t_{49}$

$= 5 + 5$

$= 10$

$E_{10} = \max(E_8 + t_{810}, E_9 + t_{910})$

$= \max(20+5, 10+7)$

$E_{10} = 25$

Backward calculations :-

$L_{10} = E_{10} = 25$

$L_9 = L_{10} - t_{910}$

$= 25 - 7$

$L_9 = 18$

$L_8 = L_{10} - t_{810}$

$= 25 - 5$

$= 20$

$L_7 = L_8 - t_{78}$

$= 20 - 2$

$= 18$

$L_6 = L_8 - t_{68}$

$= 20 - 8$

$= 12$

$L_5 = \min(L_6 - t_{56}, L_7 - t_{57})$

$= \min(12 - 5, \ 18, 4)$

$= 7$

$L_4 = L_9 - t_{49}$

$= 18 - 5$

$= 13.$

$L_3 = \min(L_4 - t_{34}, \ L_5 - t_{35})$

$= \min(13 - 1, \ 7 - 6)$

$= 1$

$L_2 = L_4 - t_{24}$

$= 13 - 1$

$= 12$

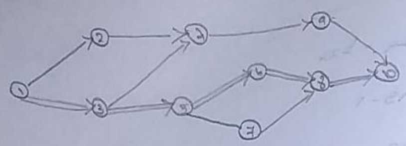
$L_1 = \min(L_2 - t_{12}, \ L_3 - t_{13})$

$= \min(12 - 4, \ 1 - 1)$

$= 0.$

Activities (ij)	Duration t_{ij}	Earliest Time E_i	$E_i + t_{ij}$	Latest time $L_i - t_{ij}$	L_i	Total float $L_j - E_i + t_{ij}$
1-2	4	0	4	8	12	8
1-3	1	0	1	0	1	0
2-4	1	4	5	12	13	8
3-4	1	1	2	12	13	11
3-5	6	1	7	1	7	0
4-9	5	5	10	13	18	8
5-6	5	7	11	8	12	1
5-7	4	7	15	10	18	3
6-8	8	12	13	19	20	7
7-8	2	11	13	18	20	7
8-10	5	20	25	20	25	0
7-10	7	10	17	18	25	8

∴ The CP is 1-3, 3-8, 5-6, 6-8, 8-10 //



<u>Home Work</u>

(1)

Activitys :	0-1	1-2	1-3	2-4	2-5	3-5	3-6	4-7	5-7	6-7
Time :	2	8	10	6	3	3	7	5	2	8

24/8/

(1)

A < D, E

B, D < F

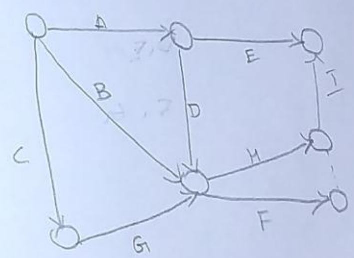
C < G

B, G < H

F, H < I

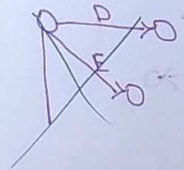
Draw a Diagram.

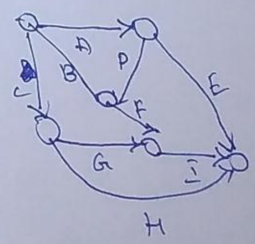
Sol:-



(2) A<D, A<E, B<F, D<F, ~~G~~ C<G, C<H, F<I, G<I.

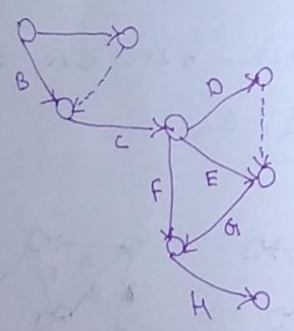
Sol:-





3) | Activity | Preceding Activity |
|---|---|
| A | – |
| B | – |
| C | A, B |
| D | C |
| E | C |
| F | C |
| G | D, E |
| H | F, G |

Sol:-



4) | Activity | Preceding Activity |
|---|---|
| A | – |
| B | – |
| C | A |
| D | A |
| E | A |
| F | B, C |
| G | D |
| H | E, F, G |

Sol:-

Unit - V

Simplex Method.

① Min $z = x_2 - 3x_3 + 2x_5$

Sub to : $3x_2 - x_3 + 2x_5 \le 7$ → less than

$-2x_2 + 4x_3 \le 12$

$-4x_2 + 3x_3 + 8x_5 \le 10$; $x_2, x_3, x_5 \ge 0$

Sol:-

step : 1

$3x_2 - x_3 + 2x_5 + s_1 = 7$

$-2x_2 + 4x_3 + 0x_5 + s_2 = 12$

$-4x_2 + 3x_3 + 8x_5 + s_3 = 10$

step : 2

$AX = B$

$$\begin{bmatrix} 3 & -1 & 2 & 1 & 0 & 0 \\ -2 & 4 & 0 & 0 & 1 & 0 \\ -4 & 3 & 8 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x_2 \\ x_3 \\ x_5 \\ s_1 \\ s_2 \\ s_3 \end{bmatrix} = \begin{bmatrix} 7 \\ 12 \\ 10 \end{bmatrix}$$

step 3

$0\times3 + 0\times-2 + \ldots = x - 4 = 0 - (\ldots)$ $= 1$

$0\times-1 + 0\times4 + 0\times3$ $= 0 - 3$ $= -3$

initial iteration

		C_j	-1	3	-2	0	0	0	
C_B	Y_B	X_B	x_2	x_3	x_5	s_1	s_2	s_3	
0	s_1	7	3	-1	2	1	0	0	$7/-1 = -7$
0	s_2	12	-2	4	0	0	1	0	$12/4 = 3$ →
0	s_3	10	-4	3	8	0	0	1	$10/3 = 3.33$
$z_j - c_j$		$z=0$	1	-3	2	0	0	0	

↑

step 4

$3 + 1/2$ $\frac{6-3}{6}$ $= \frac{3}{6}$ $= \frac{1}{2}$

		C_j	-1	3	-2	0	0	0
C_B	Y_B	X_B	x_2	x_3	x_5	s_1	s_2	s_3
0	s_1	10	5/2	0	2	1	1/4	0
3	x_3	3	-1/2	1	0	0	1/4	0
0	s_3	1	-5/2	0	8	0	-3/4	1
$z_j - c_j$ ⇒		$z=9$	-1/2	0	2	0	3/4	0

step 5

$-4 + 15$ / $z = 11$

		C_j	-1	3	-2	0	0	0
C_B	Y_B	X_B	x_2	x_3	x_5	s_1	s_2	s_3
-1	x_2	4	1	0	4/5	2/5	1/10	0
3	x_3	5	0	1	2/5	1/5	3/10	0
0	s_3	11	0	0	10	1	-1/2	1
$z_j - c_j$		$z=11$	0	0	12/5	1/5	3/10	0

Ans:-

$$\min z = -\max z$$

$$= -11 \text{ with}$$

$$x_2 = 4 \,;\ x_3 = 5 \ \& \ x_5 = 0.$$

(2) $\max z = 3x_1 + 2x_2$

Sub to:

$$-2x_1 + x_2 \le 1$$

$$x_1 \le 2$$

$$x_1 + x_2 \le 3$$

Sol:-

Step1

$$-2x_1 + x_2 + s_1 = 1$$

$$x_1 + 0x_2 + s_2 = 2$$

$$x_1 + x_2 + s_3 = 3.$$

Date.

Step2

$$A X = B$$

$$\begin{bmatrix} -2 & 1 & 1 & 0 & 0 \\ 1 & 0 & 0 & 1 & 0 \\ 1 & 1 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ s_1 \\ s_2 \\ s_3 \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix}$$

Step3

	C_j		3	2	0	0	0	
C_B	Y_B	X_B	x_1	x_2	s_1	s_2	s_3	
0	s_1	1	-2	1	1	0	0	$1/-2 = -0.5$
0	s_2	2	1	0	0	1	0	$2/1 = 2$
0	s_3	3	1	1	0	0	1	$3/1 = 3$
$Z_j - C_j$		$Z = 0$	-3	-2	0	0	0	

$0 \times -2 = 0$

$0 \times 1 = 0$

$0 \times 1 = 0$

step 4

C_B	Y_B	X_B	x_1	x_2	s_1	s_2	s_3
		C_j	3	2	0	0	0
0	s_1	5	0	0	1	2	0
3	x_1	2	1	0	0	1	0
0	s_3	1	0	1	0	-1	1
$z_i - c_j$		$z=6$	0	-2	0	3	0

step 5

C_B	Y_B	X_B	x_1	x_2	s_1	s_2	s_3
0	s_1	4	0	0	1	3	-1
3	x_1	2	1	0	0	1	0
2	x_2	1	0	1	0	-1	1
$z_j - c_j$		$z=8$	0	0	0	1	2

max $z = 8$.

$x_1 = 2$ $\quad$ $3x_1 + 2x_2$

$x_2 = 1$ $\quad$ $3(2) + 2(1)$

$6+2 = 8$ //.

step 1

1	2	3	4	6
4	3	2	0	8
0	2	2	1	10
4	6	8	6	

Σbj

Σbi

$\Sigma ai = 24$

$\Sigma bj = 24$

$\Sigma ai = \Sigma bj$

step 2.

1	2	3	4	6
4	3	2	0	8
4/0	2	2	1	10 - 4
4	6	8	6	

so x_{31} = min (10, 4) 4

2	3	4	6
3	2	6/0	8 - 6 = 2
2	2	1	4
6	8	6	

2	3	6
3	2	2
4/2	2	4
6-4	8	

VAM method :-

~~11~~ (200)	13	17	14	250 (3)
16	18	14	10	300 (4)
21	24	13	10	400 (3)
200	225	275	250	
(5)	(5)	(1)	(0)	

200 = 50

*

n11 = min {250, 200} = 200

step 2 :

~~13~~ (50)	~~17~~	~~14~~	(1) 250
18	14	10	(4) 300
24	13	10	(3) 400
(5)	(1)	(0)	

50 = 175 ~~225~~ 275 250

n12 = min

~~17~~ (150)	10

150 (0)

(0)

~~18~~ (175)	14	10	(4) 300 - 175 = 125
~~24~~	13	10	(3) 400
(6)	(1)	(0)	

*

175 275 250

~~14~~ (125)	10	125 (4)
13	10	400 (3)
275	250	
(1)	(0)	

275 - 125 = 150

275
125
150

Assignment

8	7	6
5	7	8
6	8	7

2	1	0
0	2	3
0	2	1

2	1	0
0	2	3
0	2	1

2	$\boxed{0}$	~~0~~
$\boxed{0}$	2	3
~~0~~	1	$\boxed{0}$

W.R

1	2	3	4	6
4	3	2	0	8
0	2	2	1	10
4	6	8	6	

Σai

Σbj

step 1:

$\Sigma ai = 6, 8, 10 = 24$

$\Sigma bj\ 4, 6, 8, 10 = 24$

$\Sigma ai = \Sigma bj$

4 / 1	2 / 2	3	3
4	4 / 3	4 / 2	0
0	2	4 / 2	6 / 1

$m+n-1 = 0$

$\cancel{7-6} = 6$

$3+4 =$

$7-1 = 6$

$1\times4 \quad 2\times2 \quad 4\times3 \quad 4\times2$

$4\times2 \quad 6\times1$

$2+4+12+8+8+6$

$= 42$

1×4

step 1

4 / 1	2	3	4	$6-4=2$
4	3	2	0	8
0	2	2	1	10
4	6	8	6	

$x_{11} = m(6, 4) =$

$= 4$

2 / 2	3	4	2
3	2	0	8
2	2	1	10

$4 = 2 - 6\ 8\ 6$

$x_{12}\ (6, 2) =$

$= 2$

4 / 3	2	0	$8-4$
2	2	1	10
4	8	6	

$x_{22} = min(8, 4)$

$= 4$

4 / 2	0	4
2	1	10
$4=8$	6	

4 / 2	1	$10-6$
4	6	

1	6
6	

2eM.

1	2	3	4	6
4	3	2	0	8
0	2	2	1	10
4	6	8	6	

$24\ \Sigma ai$

$24\ \Sigma bj$

$\Sigma ai = 6, 8, 10 = 24$

$\Sigma bj = 4, 6, 8, 6 = 24$

$\Sigma ai = \Sigma bj$

step 1:-

1	2	3	$\cancel{4}$	6
4	3	2	6 / 0	$8-6=2$
0	2	2	$\cancel{1}$	10
4	6	8	6	

$x\ 4, 2\ (8, 6)$

$= 6$

6 / $\cancel{2}$	$\cancel{3}$	6
3	2	2
2	2	6

$2 = 6 - 8 \quad 6$

$6 - 4 = 6$

step 2

$\cancel{1}$	2	3	6
$\cancel{4}$	3	2	2
4 / 0	$\cancel{2}$	$\cancel{2}$	$10-4=6$
4	8	6	

$\cancel{3}$	2	$2-0$
4 / $\cancel{2}$	2	6
$\cancel{2}$	6	

$= 64.$

$x_1 + x_2 = 8 \longrightarrow (1)$

$3x_1 + 4x_2 = 3 \longrightarrow (2)$

$6x_1 + 7x_2 = 5 \longrightarrow (3)$

$x_1 + x_2 = 0 \longrightarrow (4)$

$x_1 = 0$ sub in (1)

$0 + x_2 = 8$

$x_2 = 8$

$\boxed{(0, 8)}$

$x_2 = 0$

18	26	17	11
13	28	14	26
38	19	18	15
19	26	24	10

26
11
15

28
13
15

26
13
13

38
15
23

7	15	65	$\boxed{0}$
$\boxed{0}$	15	40	13
23	4	32	$\cancel{0}$
9	16	14	$\cancel{0}$

7	15	6	0
0	15	1	13
23	14	3	0
9	16	14	0

7	11	5	$\boxed{0}$
$\boxed{0}$	11	$\cancel{0}$	13
23	$\boxed{0}$	2	$\cancel{0}$
9	12	13	$\cancel{0}$

7	11	3	$\boxed{0}$
$\boxed{0}$	11	$\cancel{0}$	13
23	$\boxed{0}$	$\cancel{0}$	$\cancel{0}$
9	12	11	$\cancel{0}$

2
25
19
19
63

	E	F	G	H
A	7	11	3	$\boxed{0}$
B	$\cancel{0}$	11	$\boxed{0}$	13
C	23	$\boxed{0}$	$\cancel{0}$	$\cancel{0}$
D	$\boxed{0}$	3	2	$\cancel{0}$

$A \to H + B \to G \; C \to F + D \to E$

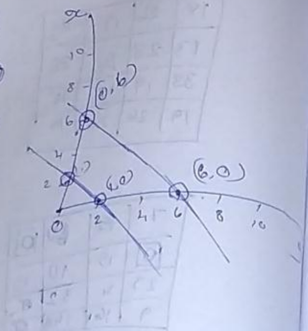
$= 11 + 14 + 19 + 19$

$= 63$ /.

$x_1 + x_2 = 6 \longrightarrow (1)$

$2x_1 + 3x_2 = 3 \longrightarrow (2)$

$x_1 + x_2 = 0 \Longrightarrow (3)$



$x_1 = 0$ sub $\Rightarrow$ (1)

$0 + x_2 = 6$

$x_2 = 6$

$(0,6)$

$\boxed{x_1 = 0 \; ; \; x_2 = 6}$

$x_2 = 0$ sub $\Rightarrow$ (1)

$x_1 + 0 = 6$

$x_1 = 6$

$\boxed{x_1 = 6 \; ; \; x_2 = 0}$

$2x_1 + 3x_2 = 3$

$x_1 = 0$ sub $\Rightarrow$ (2)

$0 + 3x_2 = 3$

$x_2 = 3/3 = 1$

$\boxed{x_1 = 0 \quad x_2 = 1}$

$2x_1 + 3x_2 = 3$

$x_2 = 0$ sub (2)

$2x_1 + 0 = 3$

$= 3/2$

$= 1$

$\boxed{x_1 = 1 \quad x_2 = 0}$

6	1	9	3	70 (2)
11	5	2	8	55 (3)
10	12	4	7	70 (3)
85	35	50	45	
(4)	(4)	(2)	(4)	

70 ~~6~~	~~1~~	~~9~~	~~3~~	70
11	5	2	8	55
10	12	4	7	70
15 - 85	35	50	45	

11	35 ~~5~~	2	8	~~55~~ (3)
10	~~12~~	4	7	70 (3)
15	35	50	45	
(1)	(7)	(2)	(1)	

35 20

11	8	55 (3)
10	7	70 (3)
15	45	
(1)	(1)	

11	50 ~~2~~	8	5 55 (6)
10	~~4~~	7	70 (3)
15	~~50~~	45	
		(1)	

11	8	5 (3)
10	7	70 (3)
15 (1)	45 (1)	

~~11~~	5 ~~8~~	5
10	~~7~~	70
15	45	

20 ~~4~~ 20

50

35
35
20

15 ~~11~~	~~2~~	~~8~~	(6) 15
~~10~~	4	7	(3) 20
15	50	45	
(1)	(2)	(1)	

4	20 ~~7~~	20 (3)
50	25-5	
(4)	(7)	

45
20
25

4	20
50	45 $\boxed{25}$
(4)	(7)

20 (3)

$\boxed{4}$ 2

50

$\boxed{10}$

Job	G = $M_1 + M_2$	B = $M_2 + M_3$
J_1	7	10
J_2	11	10
J_3	9	7
J_4	9	16
J_5	10	6
J_6	12	10
J_7	10	15

G | J_1 | J_4 | J_7 | J_6 | J_2 | J_3 | J_5 | B

	J_1	J_2	J_3	J_4	J_5	J_6	J_7
A	7	11	9	9	10	12	10
B	10	10	7	16	6	10	15

Job	M.A		M.B		idle time
	input	out	in	out	
J_1	0	7	7	17	
J_4	7	16	17	33	
J_6	16	28	33		
J_2	28	39			
J_3	39	48			
J_5	48	$\boxed{58}$			

Job	G = $A_i + B_i$	B = $B_i + C_i$
J_1	13	23
J_2	20	22
J_3	11	15
J_4	10	20
J_5	14	13
J_6	14	16

A | J_4 | J_3 | J_1 | J_6 | J_2 | J_5 | B

Job	M.A		M.B		M.C		Idle time
J_4	0	3	3	10	10	23	76
J_3	3	9	10	15	23	33	–
J_1	9	13	15	24	33	47	–
J_6	13	25	24	26	47	62	–
J_2	25	38	26	33	61	76	–
J_5	38	48	33	35	76	85	–

Idle time = 10 hrs

E =

total time = 85

$$\begin{array}{r} 85 \\ -76 \\ \hline 9 \end{array}$$

Machin B : $(10-10) + (15-15) + (24-24)$
$(26-26) + (33-33) + (85-76)$

In 1642 at the age of eighteen
French m. mathamatician Blaise
Pascal.

(1)

	M_1	M_2	M_3	M_4
J_1	5	7	11	6
J_2	8	5	9	6
J_3	4	7	10	7
J_4	10	4	8	3

Sol

$$\begin{bmatrix} 0 & 2 & 6 & 1 \\ 3 & 0 & 4 & 3 \\ 0 & 3 & 6 & 3 \\ 7 & 1 & 5 & 0 \end{bmatrix}$$

$$\begin{bmatrix} \boxed{0} & 2 & 2 & 1 \\ 3 & \boxed{0} & 0 & 3 \\ 0 & 3 & 2 & 3 \\ 7 & 1 & 1 & \boxed{0} \end{bmatrix}$$

$J_1 \to M_1 + J_2 \to M_2 + J_3 \to M_3 + J_4 \to M_4$

5 + 5 + 10 + 8

28

(2)

	I	II	III	IV	V
A	10	5	13	15	16
B	3	9	18	3	6
C	10	7	2	2	2
D	5	11	9	7	12
E	7	9	10	4	12

Sol

$A \to \text{II} + B \to \text{I} + C \to \text{III}$

$D \to \text{IV} + E \to \text{V}$

5 + 3 + 2 + 7 + 12

24

(3)

	1	2	3	4	5	6
A	12	10	15	22	18	8
B	10	18	25	15	16	12
C	11	10	3	8	5	9
D	6	14	10	13	13	12
E	8	12	11	7	13	10

Sol

$$\begin{matrix} 4 & 0 & 7 & 14 & 10 & 0 \\ 0 & 6 & 15 & 5 & 6 & 2 \\ 8 & 5 & 0 & 5 & 2 & 6 \\ 0 & 6 & 4 & 7 & 7 & 6 \\ 1 & 3 & 4 & 0 & 6 & 3 \end{matrix}$$

$A \to 2 + B \to 5 + C \to 3 + D \to 1$
$E \to 4$

10 + 16 + 3 + 6 + 7

42

(16)

	1	2	3	4	5
A	25	55	60	45	30
B	45	65	55	35	40
C	10	35	45	55	65
D	40	30	70	40	60
E	55	45	40	55	10

$\boxed{0}$ 30 35 20 5
10 30 20 $\boxed{0}$ 5
$\cancel{0}$ 25 35 45 55
10 $\boxed{0}$ 40 10 30
45 35 30 45 $\boxed{0}$

$\boxed{0}$ 30 15 20 5
10 30 $\cancel{\boxed{0}}$ $\boxed{\cancel{0}}$ 5
$\cancel{0}$ 25 15 45 35
10 $\boxed{0}$ 20 10 30
45 35 10 45 $\boxed{0}$

$\boxed{0}$ 30 $\cancel{0}$ 20 5
10 20 $\boxed{0}$ $\cancel{0}$ 5
$\cancel{0}$ 25 5 45 35
10 $\boxed{0}$ 10 10 30
45 35 0 45 $\boxed{0}$

OR

April - 2013

PART - A 10 x 2 = 20

1. Write any two applications of OR.
2. What are the methods for driving the solution to an OR model?
3. Define slack Variable
4. Define feasible ~~vor~~ solution.
5. When does degeneracy happen in transportation problem?
6. What is the objective of the assignment problem.
7. What is no passing rule in Sequencing algorithm?
8. What is Gantt chart?
9. Define interference float.
10. Define optimistic time.

PART - B 5 x 5 = 25

11. a) Explain the applications of OR.
(OR)

b) Solve graphically the following LPP.

maximize $z = 3x_1 + 2x_2$

sub to : $-2x_1 + x_2 \le 1$

$x_1 \le 2$

$x_1 + x_2 \le 3$, $x_1, x_2 \ge 0$.

12) a) Obtain all the basic solution to the following system linear eqn.

$x_1 + 2x_2 + x_3 = 4$

$2x_1 + x_2 + 5x_3 = 5$.

b) Use simplex method to solve the following LPP.

maximize $z = 3x_1 + 2x_2$

subject to $x_1 + x_2 \le 4$, $x_1 - x_2 \le 2$,

$x_1, x_2 \ge 0$.

13) a) Obtain an IBFS to the following transportation problem using matrix minima corner rule.

	D_1	D_2	D_3	D_4	
O_1	1	2	3	4	6
O_2	4	3	2	0	8
O_3	0	2	2	1	10
Demand	4	6	8	6	

(or)

b) Solve the following assignment problem.

$$\begin{array}{c|cccc} & A & B & C & D \\ 1 & 18 & 24 & 28 & 32 \\ 2 & 8 & 13 & 17 & 19 \\ 3 & 10 & 15 & 19 & 22 \end{array}$$

14) a) Explain problems with 2 jobs and R machine.

(or)

b) Determine the optimal sequence, minimum total elapsed time and idle time of machine A and B for which the times (in hours) are as follows.

Job :	J_1	J_2	J_3	J_4	J_5	J_6
machine A	1	3	8	5	6	3
B	5	6	3	2	2	10

(15) a) Construct the network diagram comprising activities B, C .. Q and N such that the following constraints are satisfied.

$B < E, F$; $C < G, L$; $E, G < H$; $L, H < I$;

$L < M$; $H, M < N$; $H < J$;

$I, J < P$; $P < Q$. (or)

b) Discuss the advantages of PERT / CPM.

PART-C

(16) Explain the uses and limitation of OR.

17) Use two phase simplex method to maximize $Z = 5x_1 - 4x_2 + 3x_3$

sub to :

$$2x_1 + x_2 - 6x_3 = 20 .$$
$$6x_1 + 5x_2 + 10x_3 \le 76$$
$$8x_1 - 3x_2 + 6x_3 \le 50$$
$$x_1 , x_2 , x_3 \ge 0 ,$$

(18) Solve the following assignment problem.

$$\begin{array}{c|c} & \begin{array}{cccc} E & F & G & H \end{array} \\ \begin{array}{c} A \\ B \\ C \\ D \end{array} & \begin{bmatrix} 18 & 26 & 17 & 11 \\ 13 & 28 & 14 & 26 \\ 38 & 19 & 18 & 15 \\ 19 & 26 & 24 & 10 \end{bmatrix} \end{array}$$

(19) Determine the optimal sequence of jobs that minimizes as the total elapsed time based on the following information processing time on machine is given in hours and passing is not allowed :

	job	A	B	C	D	E	F	G
machine	M_1	3	8	7	4	9	8	7
	M_2	4	3	2	5	1	4	3
	M_3	6	7	5	11	5	6	12.

20) A small project is composed of 7 activities whose time estimates are listed in the following taple.

Activity Estimated duration,

i	j	optimistic	most likely	pessimistic
1	2	1 ~~8~~	1	7
1	3	1 ~~4~~	4	7
1	4	2 ~~7~~	2	8
2	5	1 ~~8~~	1	1
3	5	2 ~~8~~	5	14
4	6	2	5	18
5	6	3	6	15