There

		1	• 1	,	4	
Q4.	Factory.	MI	W2 0	EWE	My	Factory cap.
	,F.L	20	56.	34	19	90
	F2	1-	19	57	20	1500
	F3	33	21	56.	1	1368
	Wavehouse Requirement	20	1120	33	2850	

Find initial basic feasible solution using Least Cost Method. For a cell the convention used is y = cost y = cost y = cost

The problem is an unbalanced transportation problem where demand > supply.

Here deman total demand = 4023. total supply = 2958

Excess demand = 1065. For with transportation we add a dummy row with transportation cell is at y

cost 6) .		1		2 is
IW1	W2 1	W3	W4	. Supply	allocation
F1 20	56	34	19	90	y is cost
$\frac{1}{\sqrt{20}}$	19.	57	20	1500.	
F3 33	21	56	1	1368	
Des Fall 0	1065	0	0	1065	
- la	0 551120	33	2850	4023,	2000

Smallest transportation cost 18 00. We can select any one cell say FdW2. We allocate. min (1065, 1120) and Fd 7000 is removed.

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	BWI	Ms	W3	414	Supply	
E1	\$20	56	34	19	90	
F2	1483	19	57	20		14.
F3	133	21	56	1500	1368	
Fa	10	lore?	0	0	10.	
Demand	20	55	83	2850		

min cost is 1. select #3W4. Allocate
min (1368, 2850) = 1368

Step-3

	W1	W2	W3	WH.	Supply
FT	20	56	34	19	90.
F2	20/1	19	57	20	1500
F3	33	21	56	1363 1	0
Fat	0	1015	0	0	0
Deman	1 21	55	33	148	2

Step-4 Allocate min (20, 1500) = 20.

		7 -		1,000	
	wi	W2	W3	Wy	supply
FI	20	56	34	90119	90
F2	20 1	19	57	20	1480
_F3	33	, / 21	156	1362	-0-
Fd	10	10821	-0-	0	0_
Dema	nd 2000	D E	35 33	148	32.

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Min cost = 19, Select FIW4.

allocate min (90,1482) = 90.

step-5

Demand 0 55 33 1392	F1 20 F2 20 F3 35	W2 55 55 9 1065	W3 -34 57 57	W4 90 90 90 90 90 90 90 9	54py 0- 1480
	Danand		33	139	2

min. cost = 19. select F2W2. Allocate min (55, 1480) = 55.

5tep-6

						-
		1 21	W2	W3	W4)	Supply
	FL	20	46	34	94 19	0
^	F2	20 1	55 9	57	1392	1425
	F3	33	1	56	1368	0
	Fa	0	1085	10	10	10
	Dena	nd 0.	. 6	3	3 \ 139:	2
	Jeanso	1 (0				

min. cost = 20. select. F2W4. Allocate min. (1425, 1392) 2 1392.

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Step-7

	WI	W2 \	W3	W4	Supply
FI	20	5	34	901	0
F2	20	1551 1A	57	20	33
F3	3/3	121	56	1388	0-
Fd	10	LOES	o la	10	0
Denar	4 6	0	33	, 0	

min cost = 57. select F2W2. Allocate 33.

Step-8

	nh	N2	W3		Supply
51	20	56	34	901	0
F2	2.0	151 19	21157	13911 210	0-
F3	93	21	56	3.68	-
Fq		ias	D	0	10
Daman	1	10	0	0	0

. 10 Initial feasible solution

			A STATE OF THE PARTY OF THE PAR		
	MI	W2	Wa	NY	Supply
	20	5%	34	19	90
13	1 1	5119	331 57	20	1500
	33	21	56	T	1368
Commission of Control of Control	0	0	0	0	1065
-1	20	1120	33	2850	
		2b 1 33	20 5% 20 1 SI 19 33 21 10 0	20 56 34 20 1 51 9 32 57 33 21 56 0 0 0	20 56 34 901 19 20 20 33 21 56 1 0 0 0 0

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Initial factors as cost = $90\times19 + 20\times1+ 55\times19 + 33\times57$ + $1392\times20+1368\times1+1065\times0$ = 33864,

number of allocated cells = 7.

Number of rows = 4 = n

Number of columns = 4 = m.

1. No of allocated cells = n+m-1

, Solution is non-degenerate.

(a) Solve using MODI method.

Assign li for rows and y' for columns.

Cej =
$$u_1^2 + v_2^2$$
 v_1
 v_2
 v_3
 v_4
 v_5
 v_6
 v_7
 v_7
 v_7
 v_7
 v_8
 v_8

 $C_{14} = U_1 + V_2 + = 19$ $C_{24} = U_3 + V_4 = 1$ $C_{21} = U_2 + V_1 = 1$ $C_{22} = U_2 + V_2 = 19$ $C_{23} = U_2 + V_3 = 57$ $C_{24} = U_2 + V_4 = 1000 + 20$

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putting
$$u_2 = 0$$
. We get $\frac{Roll : 801818000028}{19-20}$ $\frac{1}{2}$ $\frac{1}{2$

1	. 1	1	1	4	Rol	1:0016105	01020
Lib	WI	Na	Wa.	Will Su	6ply -		
4=1 (=1	20 50	5.6	34 3	19/	40		
Clo =0 F2	30] ([8]	119 8	3 57	30 I	500		
U3=-19 F3	33	21	56	1368	368		
us -19 Fa	10	crel	(4)0	0	1065		
	VI	V2=19	-	5 N > 50			
V.		1120	0.0	2850			
Demand.	20	()					

minimum allocated value = 33. Subtract 33 if (-) else add 33.

	WI	W2	\ W	3	W4	supply
F	20	56	3	25 1-	101 101	90
F2	20	38/19	1	57.	20.	1500
F3	33	2	,	56	1308	1368
F2	10.	1032	0 33	<u> </u>	0	1065
Dem	and 2	0 113	20	33	285	0

Again calculate lis Vj.

$$C_{4} = U_{4} + V_{4} = 0$$

$$C_{21} = U_{2} + V_{1} = 1$$

$$C_{22} = U_{2} + V_{2} = 1$$

$$C_{24} = U_{2} + V_{4} = 20$$

$$C_{34} = U_{3} + V_{4} = 1$$

$$C_{43} = U_{4} + V_{3} = 0$$

$$C_{43} = U_{4} + V_{3} = 0$$

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put
$$u_2 = 0$$
.
 $v_1 = 1$ $u_4 = -v_2 = -49$
 $v_2 = 19$ $u_3 = 1 - v_4 = -19$
 $v_4 = 20$ $v_4 = 190 - v_4 = 20$. $v_4 = 190 - v_4 = 190 - 1$.
 $v_3 = 1 - v_1 = 0$.

$$U_1 = -1$$
 $V_1 = 1$
 $U_2 = 0$ $V_2 = 19$
 $U_3 = -19$ $V_3 = -19$
 $U_4 = -19$ $V_4 = 20$.

 $d_{11} = c_{11} - (u_1 + v_1) = 20$ $d_{12} = c_{12} - (u_1 + v_2) = 56 - (-1 + 19) = 38$ $d_{13} = c_{13} - (u_1 + v_3) = 34 - (-1 + 19) = 16$ $d_{13} = c_{23} - (u_2 + v_3) = 57 - (0 + 19) = 38$ $d_{31} = c_{31} - (u_3 + v_1) = 33 - (-19 + 1) = 51$ $d_{32} = c_{32} - (u_3 + v_2) = 21 - (-19 + 19) = 21$ $d_{33} = c_{33} - (u_3 + v_3) = 56 - (-19 + 19) = 56$ $d_{41} = c_{41} - (u_4 + v_1) = 0 - (-19 + 1) = 18$ $d_{41} = c_{41} - (u_4 + v_1) = 0 - (-19 + 1) = 18$ $d_{41} = c_{41} - (u_4 + v_1) = 0 - (-19 + 10) = -1$ $d_{41} = c_{41} - c_{42} - c_{43} + c_{44} = 0$ $d_{41} = c_{41} - c_{43} + c_{44} + c_{44} = 0$ $d_{41} = c_{41} - c_{42} + c_{43} = 0$ $d_{41} = c_{41} - c_{42} + c_{43} = 0$ $d_{41} = c_{41} - c_{42} + c_{43} = 0$ $d_{41} = c_{41} - c_{42} + c_{43} = 0$ $d_{41} = c_{41} - c_{42} + c_{43} = 0$ $d_{41} = c_{41} - c_{42} + c_{43} = 0$ $d_{41} = c_{41} - c_{42} + c_{43} = 0$ $d_{41} = c_{41} - c_{42} + c_{43} = 0$ $d_{41} = c_{41} - c_{42} + c_{43} = 0$ $d_{41} = c_{41} - c_{42} + c_{43} = 0$ $d_{41} = c_{41} - c_{42} + c_{43} = 0$ $d_{41} = c_{41} - c_{42} + c_{43} = 0$ $d_{41} = c_{41} - c_{42} + c_{43} = 0$ $d_{41} = c_{41} - c_{42} + c_{43} = 0$ $d_{41} = c_{41} - c_{42} + c_{43} = 0$ $d_{41} = c_{42} - c_{43} - c_{43} + c_{43} = 0$ $d_{41} = c_{41} - c_{42} + c_{43} = 0$ $d_{41} = c_{41} - c_{42} + c_{43} = 0$ $d_{41} = c_{41} - c_{42} + c_{43} = 0$ $d_{41} = c_{41} - c_{42} + c_{43} = 0$ $d_{41} = c_{41} - c_{42} + c_{43} = 0$ $d_{41} = c_{41} - c_{42} + c_{43} = 0$ $d_{41} = c_{41} - c_{42} + c_{43} = 0$ $d_{41} = c_{41} - c_{42} + c_{43} = 0$ $d_{41} = c_{41} - c_{42} + c_{43} = 0$ $d_{41} = c_{41} - c_{42} + c_{43} = 0$ $d_{41} = c_{41} - c_{42} + c_{43} = 0$ $d_{41} = c_{41} - c_{42} + c_{43} = 0$ $d_{41} = c_{41} - c_{42} + c_{43} = 0$ $d_{41} = c_{41} - c_{42} + c_{43} = 0$ $d_{41} = c_{42} - c_{43} - c_{43} = 0$ $d_{41} = c_{42} - c_{43} - c_{43} = 0$ $d_{41} = c_{42} - c_{43} - c_{43} = 0$ $d_{41} = c_{42} - c_{43} - c_{43} = 0$ $d_{42} = c_{43} - c_{43} - c_{44} - c_{44} = 0$ d_{43}

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1		WI	W2	W3		
\dagger	Fi	20	56	1 34	901	Supply
+	F ₂	20	88	57	1392	90
\	F3	33	(H) 19		1268	1500
	Fa	10	10:2	56	T1	1368
	1	-	1-20	. 0	(+) 0	1065
	Demai	nd 20	(1121	33	2850	·

min allocated value among all -ve position = 1032.

		WI	W2	W3	W4	Supply
	FI	20	56	34	901 19	90
-	F2	20/1	19	57	360 20	1500
	F-3	33	, 21	56	1368	1368
	Fd	0	- 0	33	1032 D	1065
1	Dema	nd 2	0 1120	33	2850	

$$C_{14} = U_1 + V_4 = 19$$
 $C_{24} = U_2 + V_1 = 1$.

 $C_{22} = U_2 + V_2 = 19$.

 $C_{24} = U_2 + V_3 = 20$
 $C_{24} = U_3 + V_4 = 1$.

 $C_{34} = U_3 + V_4 = 1$.

 $C_{44} = U_4 + V_3 = 0$.

 $C_{44} = U_4 + V_4 = 0$.

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Put
$$v_4 = 0$$
.
 $u_1 = 19$ $v_1 = 1 - u_2 = -19$
 $u_2 = 20$ $v_2 = 19 - u_2 = -1$
 $u_3 = 1$ $v_3 = -u_4 = 0$
 $u_4 = 0$ $v_4 = 1 - u_3 = 0$

Find dij.

 $d_{11} = G_{11} - (u_{1} + v_{1}) = 20 - (19 - 19) = 20.$ $d_{12} = G_{12} - (u_{1} + v_{2}) = 56 - (19 - 1) = 38$ $d_{13} = G_{13} - (u_{1} + v_{3}) = 34 - (19 + 0) = 15$ $d_{13} = G_{23} - (u_{2} + v_{3}) = 57 - (20 + 0) = 37$ $d_{21} = G_{21} - (u_{3} + v_{1}) = 33 - (1 - 19) = 51$ $d_{22} = G_{22} - (u_{3} + v_{2}) = 21 - (16 - 1) = 21$ $d_{33} = G_{33} - (u_{3} + v_{3}) = 56 - (1 + 0) = 55$ $d_{41} = G_{41} - (u_{4} + v_{1}) = 0 - (0 - 19) = 19$ $d_{42} = G_{42} - (u_{4} + v_{2}) = 0 - (0 - 19) = 19$

... all dij >> 0 ... The solution obtained is optimal.

min total cost = 1920000 90 × 19 + 20 × 1+55 × 19 + 33 × 57 + 1392 × 20+ 1368 × 1 + 1065 × 0 = 31578.

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b) Solved using stepping stone method.

Initial feasible solution:
only lowest -ve cost path is shown in diagram.

٤	WI	W2	W3	W4	Supply
FI	20	56.	34	90 19	90
F2	20]	55 (f)	33	1392 20.	1500.
F3	33	21	56	1368]	1368
Fd	. 6	1062	(1)	0	1065
Deman	d 20	1120	33	2850.	

Now for every unoccupied cell we have to construct closed path of

unoccupied	Path	east
FIWI	FIWI -> FIWY -> F2WY -> F2WI	20-19+20-1=20
	FIW2 -> FIWY -> F2W4 -> F2W2	56-19+20-19=38
FIW2	FIW3 > FIW4 -> F2W4>F2W3	34-19+20-57=-22
FIW3		20 120 1251
F3WI	F3WI > F3W4 > F2W4 F2W	33-1+20-1=51-
1 m	$F3W2 \rightarrow F3W4 \rightarrow F2W4 \rightarrow F2W2$	
F3W2		
F3W3	F3W3 -> F3W4 -> F2W4 -> F2W	3 56-1+20-57
	Fawl > Faw2 > F2w2 > F2w	
FdWI	F2W2 F2W3	6-0+19-57=-38
FdW3	Fa W3 -> Fa W2 -> F2 W3	10-0+19-20=-1
Fa W4	Fawy > Faw2 > Faw2 > Faw	1-2
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t and the state of	III.	020
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	Rou . Colo	
	- 0	

B

Lowest -re value is -38 minimum allocated value on -ve path is 33. New allocation.

		1.1.			
	WI	W2	W/3	WH	Supply
FI	20	5%	34	901	90.
F2	20 1	88 (4)	57	1392 20	1500
F3	33	21	576	1368	1368
Fd	0-0	1632) 33	CHO D	1065
Demand	20	1121	33	2859	
Demand	J	17000		-	

Again find closed paths.

11000		34/11-
unoccupied cell		ebst.
PMI	FIWI -> FIWY -> F2WY -> F2WI	20-19+20-1=20
FAW2	FIW2 -> FIW4 -> F2W4 -> F2W	$\begin{array}{cccccccccccccccccccccccccccccccccccc$
EI M3	FIW3 \longrightarrow FIW4 \rightarrow F2W4 \rightarrow F2W \longrightarrow FaW2 \rightarrow FaW3 \rightarrow FIW3	WA STATE OF
F2W3	F2W2 -> F2W2 -> FaW2 -> FaW2	
F3W1.	F3W1 -> F3W4 -> F2W4 -> F2h	11 33-1420-1=51
F3 W2	F3W2 -> F3W4 -> F2W4 -> F2	w2 21-14-20-19=21.
F3W3	F3W3> F3W4> F2W4 -> F3	$2W2 \left 56 - 1 + 20 - 19 + 0^{-0} \right = 56$
EWI	FAW2 > FAW2 > FAW2 > FAW	0-0419-1=18
Fal W4	EW4 -> FW2 -> FZW2 -> FZW2	0.00
	Carlo	Anwian Chakratos'

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powest -ve value is -1 ... Not optimal.

min allocated value of -ve path is 1032.

New allocation.

	W)	W2_	W3	W4	Supply
FI	.20	56	34.	10	90.
F-2	201	19	57	20	1500
F3	33	21	56	TOTAL	1368
Fd	0	0	0	0	108
Demond	20	1120	33	2850	

Again find closed paths.

Again fen	4 000	
Unoccupied		Cost.
cell!	FIW1 -> FIW4 -> F2W4 -> F2W1	20-19+20-1=20
FIMI		56-19+20-19=38.
FIW2	FIW2 -> FIW4 ->F2W4->F2W2	34-19+0-0=15
FIW3	FIW3 -> FIW4 -> RAFW4 -> FUW3	25.20
	F2W3 -> F2W4 -> F2W4 -> F2W3	57-20+0-0=37
F2W3	F2W4 →F2h	11 33-1+20-1=51.
F3WI	F2WY → F2W3	2 21-1+20-19=21.
F3W2	F3W2 -> F3W4->F3W4->F3W4->F3W3	56-1+0-0=55
f3w3.		0-0+20-1=19
FaWI	Fawl > Faw4 > Faw4 > Faw1	
	Faw2 -> Fawy -> F2W4 -> F2W2	0-0-4-20
EW2	Ta	

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Since there is no gain in the allocation optimal.

Final allocation

	NI	W2	W3	W	4	Supply
FI	20	56	34	010	19	90.
1=2 21	-	120]	57	360	20	1500.
F3	33	21	33	103	1-1	1368
Fall	0	0	0	,	0	1065
Demon	20	1120	33	3 6	2850	

Total min toansportation cost = 90×19+ 20×1+1120×19+ 360×20 +1368×1+ 33×0+1032×0 = 31578.

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