Q.1
The Capacities of the three power plants are 25, 40, 30 million kWh

Max. demands of three cities are 30, 35, & 25 million KWH

(Price per million kWh is given.)

Now, let x_{ij} be the qty of electricity supplied from the plant j ($j = 1,2,3$) to city i ($i = 1,2,3$)
C_{ij} is the corresponding per unit price of transferring from j plant to i city.

∴ Initial Transportation Problem is

	C_1	C_2	C_3	Capacity
P_1	600	700	400	25
P_2	320	300	350	40
P_3	500	480	450	30
Dem.	30	35	25	

Now, for August there is a 20 % increase in demand at each of the three cities C_1, C_2, C_3.

Now, the extra electricity can be purchased from another network at a premium rate of $1000 per million kWh

↳ This network is not linked to City 3

So, now our problem becomes

Min $Z = \sum \sum c_{ij}$

	C_1	C_2	C_3	Capacity
P_1	600	700	400	25
P_2	320	300	350	40
P_3	500	480	450	30
P_4	$1000	1000	NA	13
Dem.	30	35	25	

Our demand increased by 20%
∴ Demands are 30, 35, 25

Now
Supply = Demand
& ∴ Plant 4 has to supply 13 million kWh electricity

Now, we have used trial & error method to find initial basic sol^n as the other methods were assigning some value to NA.

So, Initial Basic Sol^n Using Trial & Error is :

	C_1	C_2	C_3	
P_1	600 23	700 2	400	25
P_2	320	300 40	350	40
P_3	500	480	450 30	30
P_4	1000 13	1000	NA	
	36	42	30	

Now, the allocations are 5 < m+n-1 (6)
↳ ∴ Degeneracy

∴ Let $X_{13} = \epsilon \simeq 0$, Now UV Method

	$v_1 = 600$ C_1	$v_2 = 700$ C_2	$v_3 = 400$ C_3	
P_1	600 23	700 2 − θ	400 ε + θ	$u_1 = 0$
P_2	320 (120)	300 40	350	$u_2 = -400$
P_3	500 −150	480 θ −270	450 (30) − θ	$u_3 = 50$
P_4	1000 13	1000 −100	NA	$u_4 = 400$

Max. value θ can take is 2

$\therefore \theta = 2$

		$v_1 = 600$	$v_2 = 430$	$v_3 = 400$
		C_1	C_2	C_3
$u_1 = 0$	P_1	600 $23 - \theta$	700 (270)	400 $2 + \theta$
$u_2 = -130$	P_2	320 (−150)	300 40	350 (80)
$u_3 = 50$	P_3	500 (−150) θ	480 2	450 $28 - \theta$
$u_4 = 400$	P_4	1000 13	1000 (170)	NA

Now, after again applying UV we get :

Max. value θ can take is 23

$\therefore \theta = 23$

		$v_1 = 450$	$v_2 = 430$	$v_3 = 400$
		C_1	C_2	C_3
$u_1 = 0$	P_1	600 (150)	700 (270)	400 25
$u_2 = -130$	P_2	320 (0)	300 40	350 (80)
$u_3 = 50$	P_3	500 23	480 2	450 5
$u_4 = 550$	P_4	1000 13	1000 (20)	NA

No, −ve values

$\therefore$ This is our optimized Sol^n

∴ Our Optimal Distribution plan for the utility Company is

	C_1	C_2	C_3	
P_1	600	700	400	→ Per unit cost
	[illegible]	0	25	→ no. of units
P_2	320	300	350	
	0	40	0	
P_3	500	480	450	
	23	2	5	
P_4	1000	1000	NA	
	13	0	NA	

Cost for supplying electricity

$$= 400 \times 25 + 300 \times 40 + 500 \times 23 + 480 \times 2 + 450 \times 5 + \underbrace{1000 \times 13}_{\text{External source}} = \$49710$$

Cost of purchasing additional power by the three cities are:

City 1 = \$13000

City 2 = \$0

City 3 = \$0

(d)

For 10% Loss

Capacity will be = 22.5 , 36.0, 27.0, & 11.7

$$\text{Cost} = \frac{22.5 \times 40 + 135 \times 36.0 + 27.0 \times 30 + 100 \times 225 + 145 \times 45 + 75 \times 45}{10}$$

$= \$ 55,305$

Q.2

Departure date from dallas	Return date
Monday, June 3	Friday, June 7
Monday, June 10	Wednesday, June 12
Monday, June 17	Friday, June 21
Tuesday, June 25	Friday, June 28

Let Dallas be D
& Atlanta be A

	A_7	A_{12}	A_{21}	A_{28}
D_3	400	300	300	280
D_{10}	300	400	300	300
D_{17}	300	300	400	300
D_{25}	300	300	300	400

Now,
the same can be written as

	A_7	A_{12}	A_{21}	A_{28}
D_3	120	20	20	0
D_{10}	0	100	0	0
D_{17}	0	0	100	0
D_{25}	0	0	0	100

Now, doing row & column operation by assigning zero, by making square on it & cancelling the column.

	A_7	A_{12}	A_{21}	A_{28}
D_3	120	20	20	0
D_{10}	0	100	0	0
D_{17}	0	0	100	0
D_{25}	0	0	0	100

Optimal sol^n is when no. of squared zero = no. of row / column

$D_3 - A_{28} = 280$

$D_{10} - A_{21} = 300$

$D_{17} - A_{12} = 300$

$D_{25} - A_{21} = 300$

Q.3

No. of Machines available in the 4 categories are 25, 30, 20 & 30

Task Type

Machine Category	1	2	3	4	5
1	10	2	3	15	9
2	5	10	15	2	4
3	5	5	14	7	15
4	20	15	13	-	8
5	-	-	-	-	-

Making zero { By subtracting lowest value from each row }

	1	2	3	4	5
1	8	0	1	13	7
2	3	8	13	0	12
3	10	0	9	2	10
4	12	7	5	-	0
5	-	-	-	-	-

Now, subtract smallest value from each column to make min. one zero in each column

	1	2	3	4	5
1	5	0	0	13	7
2	0	8	12	0	2
3	7	0	8	2	10
4	9	7	4	-	0
5	-	-	-	-	-

Here, we have drawn a line to show which row or column has min. zero.

If no. of line = no. of columns or rows then we can proceed further

	1	2	3	4	5
1	5	$\cancel{0}$	$\boxed{0}$	13	7
2	$\cancel{0}$	8	12	$\boxed{0}$	2
3	7	$\boxed{0}$	8	2	10
4	9	7	4	–	$\boxed{0}$
5	–	–	–	–	–

Task assigned to machines are:

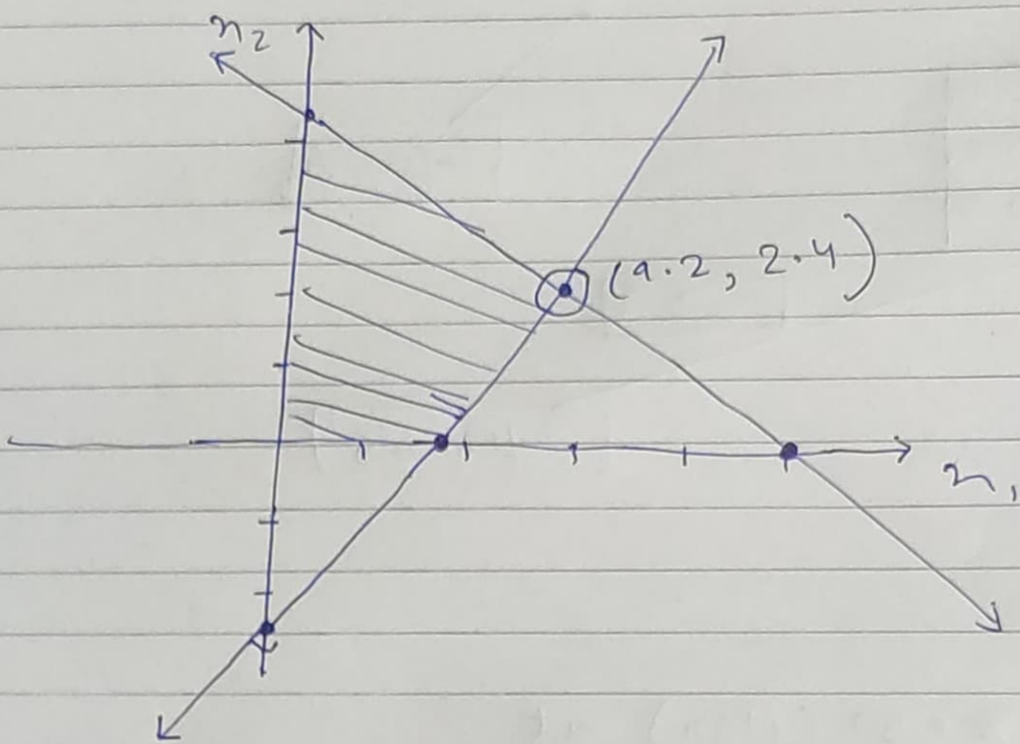
Machine 1 $\longrightarrow$ Task 3
Machine 2 $\longrightarrow$ Task 4
Machine 3 $\longrightarrow$ Task 2
Machine 4 $\longrightarrow$ Task 5

Min. Cost $= 10 \times 2 + 15 \times 3 + 25 \times 5 + 5 \times 2$
$+ 20 \times 7 + 5 \times 20 + 5 \times 13$
$+ 20 \times 8$
$= \$605$

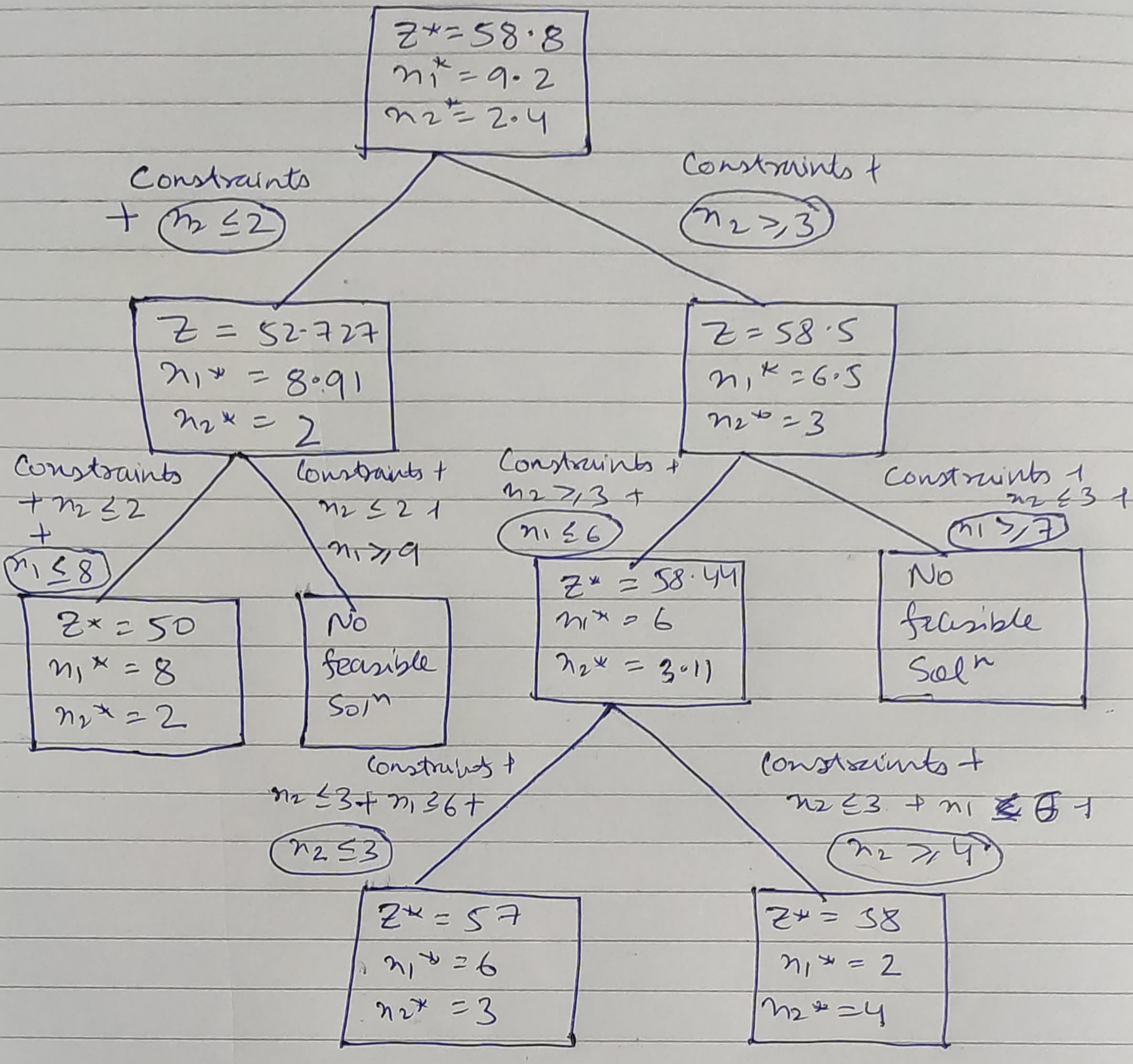
Q.4 Maximize $Z = 3x_1 + 13x_2$

subject to

$$2x_1 + 9x_2 \leq 40$$
$$11x_1 - 8x_2 \leq 82$$
$$x_1, x_2 \geq 0 \quad \& \text{ integers}$$



Now, Branch & Bound Method



Here Constraints are $2x_1 + 9x_2 \le 40$ &

$11x_1 - 8x_2 \le 82$

$\therefore$ Max $z = 58$ at

$x_1 = 2$

$x_2 = 4$