Q1.

Jobs

Mens	1	2	3	4	5
I	8	4	2	7	1
II	0	9	5	5	4
III	3	8	9	2	6
IV	4	3	1	0	3
V	9	5	8	9	5

Conditions

1. No. of Rows = No. of columns
2. Matrix is minimization matrix

STEP 1: ROW MINIMA

	J_1	J_2	J_3	J_4	J_5
M_1	7	3	1	6	0
M_2	0	9	5	5	4
M_3	1	6	7	0	4
M_4	4	3	1	0	3
M_5	4	0	3	4	0

STEP 2: COLUMN MINIMA

	J_1	J_2	J_3	J_4	J_5
M_1	7	3	0	6	0
M_2	0	9	4	5	4
M_3	1	6	6	0	4
M_4	4	3	0	0	3
M_5	4	0	2	4	0

STEP 3: OPTIMALITY TEST

	J_1	J_2	J_3	J_4	J_5	
M_1	7	3	0	6	0	1
M_2	0	9	4	5	4	
M_3	1	6	6	0	4	
M_4	4	3	0	0	3	2
M_5	4	0	2	4	0	3
	4			5		

STEP 4: ASSIGNMENT

	J_1	J_2	J_3	J_4	J_5
M_1	7	3	0	6	$\boxed{0}$
M_2	$\boxed{0}$	9	4	5	4
M_3	1	6	6	$\boxed{0}$	4
M_4	4	3	$\boxed{0}$	0	3
M_5	4	$\boxed{0}$	2	4	0

Optimal solution

No. of vertical and Horizontal line = Order of Matrix

5 = 5

STEP 5: CALCULATION OF MINIMUM TIME

MEN	JOB	TIME
M_1	J_5	1
M_2	J_1	0
M_3	J_4	2
M_4	J_3	1
M_5	J_2	5

TOTAL = 9 hrs.

Q2.

		Jobs					
		1	2	3	4	5	6
Mens	I	5	0	6	8	7	4
	II	5	2	3	0	6	7
	III	3	4	4	3	5	2
	IV	3	9	7	2	7	6
	V	9	8	7	8	4	5
	VI	1	8	7	4	2	3

Conditions

1. No. of rows ~~and~~ = No. of columns
2. Matrix is minimize matrix

STEP1: ROW MINIMA

	J_1	J_2	J_3	J_4	J_5	J_6
M_1	5	0	6	8	7	4
M_2	5	2	3	0	6	7
M_3	1	2	2	1	3	0
M_4	1	7	5	0	5	4
M_5	5	4	3	4	0	1
M_6	0	7	6	3	1	2

STEP2: COLUMN MINIMA

	J_1	J_2	J_3	J_4	J_5	J_6
M_1	5	0	4	8	7	4
M_2	5	2	1	0	6	7
M_3	1	2	0	1	3	0
M_4	1	7	3	0	5	4
M_5	5	4	1	4	0	1
M_6	0	7	4	3	1	2

STEP3: OPTIMALITY TEST

	J_1	J_2	J_3	J_4	J_5	J_6	
M_1	5	0	4	8	7	4	3
M_2	5	2	1	0	6	7	
M_3	1	2	0	1	3	0	1
M_4	1	7	3	0	5	4	
M_5	5	4	1	4	0	1	4
M_6	0	7	4	3	1	2	5
				2			

Non-optimal solution

STEP4: OPTIMALITY TEST

	J_1	J_2	J_3	J_4	J_5	J_6	
M_1	5	0	4	9	7	4	
M_2	4	1	0	0	6	6	1
M_3	1	2	0	2	3	0	2
M_4	0	6	2	0	4	3	3
M_5	5	4	1	5	0	1	
M_6	0	7	4	4	1	2	
	4	5			6		

Optimal solution

STEP5: ASSIGNMENT

	J_1	J_2	J_3	J_4	J_5	J_6
M_1	5	$\boxed{0}$	4	9	7	4
M_2	4	1	$\boxed{0}$	0	6	6
M_3	1	2	0	2	3	$\boxed{0}$
M_4	0	6	2	$\boxed{0}$	4	3
M_5	5	4	1	5	$\boxed{0}$	1
M_6	$\boxed{0}$	7	4	4	1	2

STEP6: CACULATION OF MINIMUM TIME

Men	Job	Time
M_1	J_2	0
M_2	J_3	3
M_3	J_6	2
M_4	J_4	2
M_5	J_5	4
M_6	J_1	1
TOTAL		12 Hrs.

Row & column = Order of matrix

Q3.

	D1	D2	D3	D4	Av.
O1	23	27	16	18	30
O2	12	17	20	51	40
O3	22	28	12	32	53
Req.	22	35	25	41	–

Conditions

1. It is a minimum matrix
2. Total Availability = Total Requirement
   123 = 123

PART I : VOGEL'S METHOD

	D1	D2	D3	D4	Ava.	P1	P2	P3	P4	P5
O1	23	27	16	18 $\boxed{30}$	30	2	–	–	–	–
O2	12 $\boxed{5}$	17 $\boxed{35}$	20	51	40	5	5	5	8	12
O3	22 $\boxed{17}$	28	12 $\boxed{25}$	32 $\boxed{11}$	53	10	10	10	10 ←	22 ←
Req.	22	35	25	41						
P1	10	10	4	14↑						
P2	10	11	8	19↑						
P3	10	11↑	8	–						
P4	10	–	8	–						
P5	10	–	–	–						

Feasibility Test

- $m+n-1$ = No. of allocation
  $3+4-1 = 6$
  Above solution is feasible.

PART II : OPTIMALITY TEST (MODI APPROACH)

Table 1 : $u_i + v_j$ Table

	D1	D2	D3	D4	u_i
O1	8	13	-2	18	14
O2	12	17	2	22	-10
O3	22	27	12	32	0
v_j	22	27	12	32	

Table 2 : Δ_{ij} Table

	D1	D2	D3	D4
O1	15	14	8	
O2			18	29
O3		1		

optimal solution

CALCULATION OF MIN. TRAN. COST

O	D	Unit	Cost	Total
O1	D4	30	18	540
O2	D1	5	12	60
O2	D2	35	17	595
O3	D1	17	22	374
O3	D3	25	12	300
O3	D4	11	32	352
			TOTAL	2221

Q5.

	W1	W2	W3	Requirement
A	5	7	8	70
B	4	4	6	30
C	6	7	7	50
Availability	65	42	43	

Conditions

1 Requirement = Availability

2 Matrix should be minimize

Part I : Vogel's Method

	W1	W2	W3	Req.	P1	P2	P3
A	5 [65]	7 [5]	8	70	2	2	1
B	4	4 [30]	6	30	0	–	–
C	6	7 [7]	7 [43]	50	1	1	0
Ava.	65	42	43				
P1	1	3↑	1				
P2	1	0	1				
P3	–	0	1↑				

Feasibility Test

$m+n-1$ = No. of Allocation

5 = 5

Above solution is feasible

Part II Optimality Test (MODI APPROACH)

Table 1 : u_i+v_j Table

	W1	W2	W3	u_i
A	5	7	7	7
B	2	4	4	4
C	5	7	7	7
v_j	-2	0	0	

Table 2 : Δ_{ij} Table

	W1	W2	W3
A			1
B	2		2
C	1		

Optimal solution

CACULATION OF MIN. TRANSPORT COST

CUSTOMER	WAREHOUSE	COST	Q	TOTAL
A	W1	5	65	325
A	W2	7	5	35
B	W2	4	30	120
C	W2	7	7	49
C	W3	7	43	301
		TOTAL		830

Q6.

	A	B	Max.
M_1	2	6	24
M_2	6	2	24
Profit	5	2	
No. of unit	x	y	

$Z = 5x + 2y$

STC

$2x + 6y \leq 24$

$6x + 2y < 24.$

Converting tranquilities into equalities

$\text{Max } Z = 5x + 2y + 0S_1 + 0S_2$

$2x + 6y + S_1 = 24$

$6x + 2y + S_2 = 24$

For intial solution

$x = y = 0 \qquad S_1 = 24 \qquad S_2 = 24.$

I Simplex Method Table

		CJ	5	2	0	0	Min.
CB	VB	SV	x	y	S_1	S_2	Ratio
0	S_1	24	2	6	1	0	12
0	S_2	24	$\boxed{6}$ Kn	2	0	1	4 ← KR
		ZJ	0	0	0	0	
		NCR	5 ↑ Kc	2	0	0	

II Simplex Table.

		CJ	5	2	0	0	Min.
CB	VB	SV	x	y	S_1	S_2	Ratio
0	S_1	16	0	$\boxed{16/3}$ Kn	1	$-1/3$	3 ← KR
5	x	4	1	$1/3$	0	$1/6$	12
		ZJ	5	$5/3$	0	$-5/6$	
		NCR	0	$1/3$ ↑ Kc	0	$-5/6$	

III Simplex Table

		C_J	5	2	0	0
C_B	VB	SV	x	y	S_1	S_2
2	y	3	0	1	3/16	-1/16
5	x	3	1	0	-1/16	7/48
		Z_J	5	2	1/6	29/48
		NER	0	0	-1/6	-29/49

Since all the value of NER are zero or negative so above solution is optimal where $x = 3$ $y = 3$

$$\text{Max } Z = 5x + 2y$$
$$= 5 \times 3 + 2 \times 3$$
$$= 21$$

Q7 Purchase Price = Rs 500
PVF @ 5%
Resale value = Nil
Running cost each year increases by 100

YEAR	RUNNING COST	PVF @ 5%	DISCOUNTED RUNNING COST	CUMULATIVE DISC. RUNNING COST	TOTAL COST	CUMULATIVE PVF	WEIGHTED AVERAGE
1	0	1	0	0	500	1	500
2	100	0.952	95.2	95.2	595.2	1.952	304.91
3	200	0.907	181.4	276.6	776.6	2.859	271.6
4	300	0.863	258.9	535.6	1036.6	3.722	278.5
5	400	0.822	328.8	864.4	1364.4	4.544	300.2
6	500	0.784	391.5	1255.9	1755.9	5.328	329.5
7	600	0.746	447.6	1703.5	2203.5	6.074	362.7

Q8

Month	Survival	Failure	Probability
0	100	0	0
1	97	3	0.03
2	90	10	0.10
3	70	30	0.30
4	30	70	0.70
5	15	85	0.85
6	0	100	1.00

STEP 1 : PROBABILITY OF FAILURE OF BULB In i^{th} week

$P_0 = 0$

$P_1 = 0 - 0.03 = 0.03$

$P_2 = 0.10 - 0.03 = 0.07$

$P_3 = 0.30 - 0.10 = 0.20$

$P_4 = 0.70 - 0.30 = 0.40$

$P_5 = 0.85 - 0.70 = 0.15$

$P_6 = 1 - 0.85 = 0.15$

STEP 2 : NO. OF BULB REPLACED IN i^{th} week

$N_0 = 10{,}000$

$N_1 = (10000 \times 0.03) = 300$

$N_2 = (10000 \times 0.07) + (300 \times 0.03) = 709$

$N_3 = (10000 \times 0.20) + (300 \times 0.07) + (709 \times 0.03) = 2042$

$N_4 = (10000 \times 0.40) + (300 \times 0.20) + (709 \times 0.07) + (2042 \times 0.03) = 4171$

$N_5 = (10000 \times 0.15) + (300 \times 0.40) + (709 \times 0.20) + (2042 \times 0.07) + (4171 \times 0.03) = 2030$

$N_6 = (10000 \times 0.15) + (300 \times 0.15) + (709 \times 0.40) + (2042 \times 0.20) + (4171 \times 0.07) + (2030 \times 0.03) = 2590$

STEP 3: EXPECTED LIFE

$\Rightarrow 1\times0.03 + 2\times0.07 + 3\times0.20 + 4\times0.40 + 5\times0.15 + 6\times0.15$

$= 4.02$ week

STEP 4: EXPECTED NO. OF RESISTOR REPLACED

$= \frac{10000}{4.02} = 248.8$

STEP 5: AVERAGE COST OF INDIVIDUAL REPLACEMENT

$= 248.8 \times 1 = 248.8$

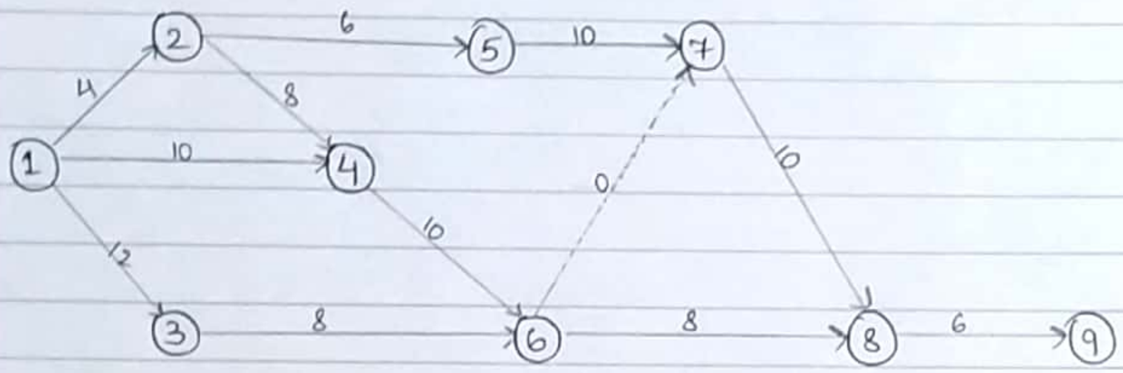
STEP 6: GROUP REPLACEMENT PERIOD

Month	No. of Replaced	Cumulative	Indiviual	G.P Cost	Total	Average
1	300	300	300	3500	3800	3800
2	709	1009	1009	3500	4509	2254.5
3	2042	3051	3051	3500	6551	2183.6
4	4171	7222	7222	3500	10722	2680.5
5	2030	9252	9252	3500	12752	2550.4
6	2590	11842	11842	3500	15342	2557

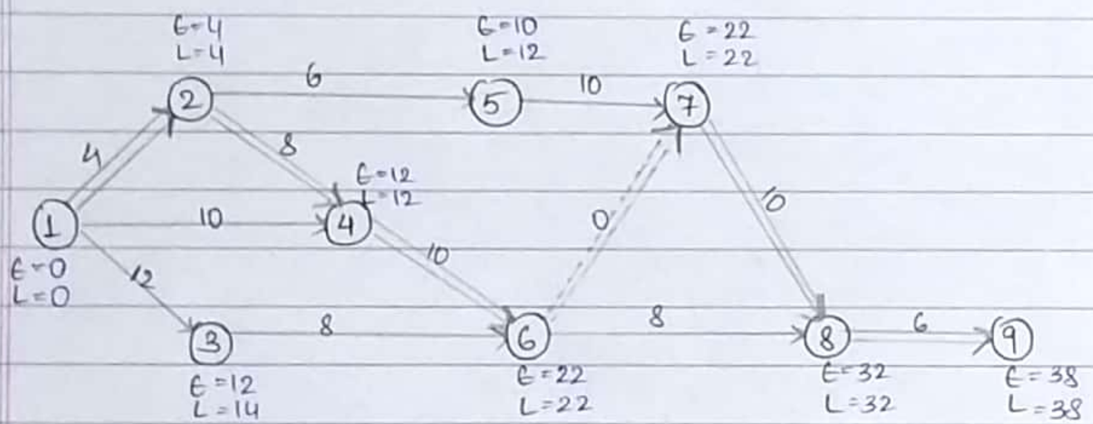
Resistor should be replaced after 3rd week

Q9

ACTIVITY	DURATION	ACTIVITY	DURATION
1-2	4	4-6	10
1-3	12	5-7	10
1-4	10	6-7	0
2-4	8	6-8	8
2-5	6	7-8	10
3-6	8	8-9	6



Critical Path = 1 - 2 - 4 - 6 - 7 - 8 - 9
Project length = 38 days



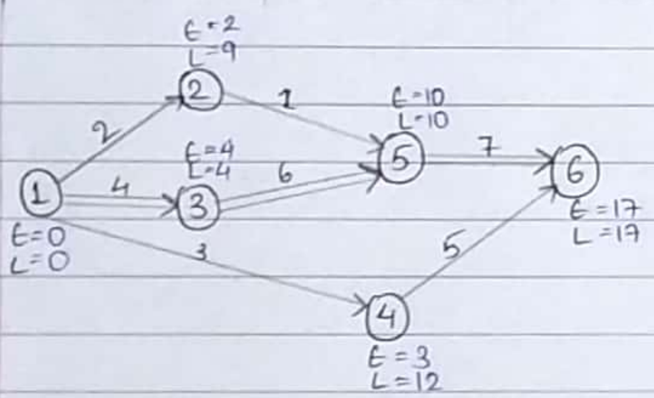
CACULATION

ACTIVITY	DURATION	ES	EF	LS	LF	TF	FF	IF
1-2	4	0	4	0	4	0	0	0
1-3	12	0	12	2	14	2	0	0
1-4	10	0	10	2	12	2	2	2
2-4	8	4	12	4	12	0	0	0
2-5	6	4	10	6	12	2	0	0
3-6	8	12	20	14	22	2	2	0
4-6	10	12	22	12	22	0	0	0
5-7	10	10	20	12	22	2	2	0
6-7	0	22	22	22	22	0	0	0
6-8	8	22	30	24	32	2	2	2
7-8	10	22	32	22	32	0	0	0
8-9	6	32	38	32	38	0	0	0

ES = Earliest Start time
EF = Earliest Finish time
LS = Latest start time
LF = Latest Finish time
TF = Total Float
FF = Free Float
IF = Independent Float

Q10.

ACTIVITY	ESTIMATED DURATION IN WEEK			Expected Time
	OPTIMISTIC	MOST LIKELY	PESSIMISTIC	
1 - 2	1	1	7	2
1 - 3	1	4	7	4
1 - 4	2	2	8	3
2 - 5	1	1	1	1
3 - 5	2	5	14	6
4 - 6	2	5	8	5
5 - 6	3	6	15	7



Critical Path
= 1 - 3 - 5 - 6

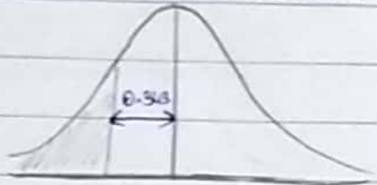
Project length
= 17 weeks.

Activity	Variance	Standard Deviation
1 - 2	1	
1 - 3	1	1
1 - 4	1	
2 - 5	0	
3 - 5	4	4
4 - 6	1	
5 - 6	4	4
		9

Standard Deviation
$= \sqrt{V}$
$= \sqrt{9} = 3$

(i) At least 3 week earlier than expected $\quad t_{cp} = 17 \quad t = 14 \quad \sigma_{cp} = 3$

$$|z| = \frac{t - t_{cp}}{\sigma_{cp}} = \frac{3}{3} = 1$$



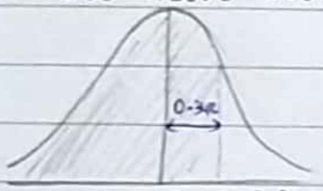
$z = 1 \quad z = 0$

$t = 14 \quad t_{cp} = 17$

Probability $= 0.50 - 0.3413 = 0.1512$

(ii) No more than 3 week later than expected $\quad t_{cp} = 17 \quad t = 20 \quad \sigma_{cp} = 3$

$$|z| = \frac{20 - 17}{3} = 1$$



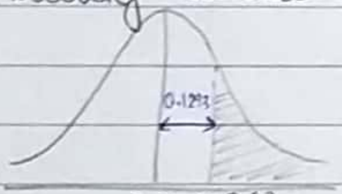
$z = 0 \quad z = 1$

$t_{cp} = 17 \quad t = 20$

Probability $= 0.50 + 0.3413$
$= 0.8413$

(iii) If the project due date is 18 week, what is probability of not meeting the due date $\quad t_{cp} = 17 \quad t = 18 \quad \sigma_{cp} = 3$

$$|z| = \frac{18 - 17}{3} = 0.33$$



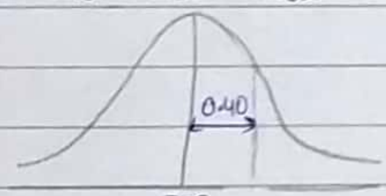
$z = 0 \quad z = 0.33$

$t_{cp} = 17 \quad t = 18$

Required Probability
$= 0.50 - 0.1293 = 0.3703$

(iv) What due date has about 90% chance of being met.

$t_{cp} = 17 \quad \sigma_{cp} = 3$



$z = 0$

$t_{cp} = 17$

0.40 nearest to 0.3997 $\quad z = 1.28$

$$1.28 = \frac{x - 17}{3} \qquad x = 20.84$$

within 20.84 week the project complete 90%