

**M. E. Mechanical Engineering - First Year - First Semester Examination 2024****Industrial Operations Research****Time: Three hours****Answer any five questions.****Full Marks: 100**

1. (a) What is linear programming? Define feasible solution, basic feasible solution and optimal solution in linear programming.

(b) Solve the following LPP using the simplex method:

$$\text{Minimize } Z = 2500x + 3000y$$

$$\text{Subject to: } x \geq 30$$

$$y \geq 20$$

$$x + y \geq 60$$

$$\text{with: } x, y \geq 0$$

[6+ 14]

2. A project is broken down into the following activities along with their times (days) and precedence relationships.

Activity	A	B	C	D	E	F	G	H	I
Immediate predecessor(s)	-	A	A	A	B	C, D	D, F	D	E, G, H
Time (days)	3	2	4	4	6	6	2	3	3

i. Draw the network based on AOA.

ii. Find the critical path and project duration based on forward pass and backward pass computation.

iii. Which would you shorten, if you have the option of shortening any or all of B, C, D, and G each of two days to reduce the project duration as much as possible?

iv. What is the new critical path and earliest completion time?

[5 + 4 + 8 + 3]

3. A project work consists of six major jobs for which an equal number of contractors have submitted tenders. The tender amount quoted (in lakhs of Rupees) is given in the matrix:

Contractor	Job					
	a	b	c	d	e	f
1	9	5	13	15	16	14
2	3	9	18	13	7	10
3	10	7	2	2	2	5
4	7	12	9	7	12	7
5	7	9	10	4	11	5
6	12	8	16	3	18	8

Find the assignment that minimizes the total cost of the project when each contractor has to be assigned to one job. Name the method you use to solve it.

[20]

4. (a) Two manufacturers A and B are competing with each other in a restricted market. Over the years, A's customers have exhibited a high degree of loyalty as measured by the fact that customers are using A's product 70 percent of the time. In addition, former customers purchasing the product from B have switched back to A's product 40 percent of the time. Construct the state transition matrix. Calculate the probability of a customer purchasing A's product at the end of the second period. What will be the distribution of customers at equilibrium?

[ Turn over

(b) In an election campaign, the strategies adopted by the ruling party and the opposition party along with payoffs (ruling party's per cent share in votes polled) are given below.

Ruling party's strategies	Opposition party's strategies		
	A	B	C
A	55	40	35
B	70	70	55
C	75	55	65

Assuming a zero-sum game, find the optimum strategies for both parties and the expected payoff to the ruling party. [10 + 10]

5. The unit costs of transportation along different paths are shown in the following table.

Destination Source	A	B	C	D	Supply
X	3	1	7	4	300
Y	2	6	5	9	400
Z	8	3	3	2	500
Demand	250	350	400	200	

(a) Solve the problem using Vogel's Approximation Method (VAM).

(b) Apply the MODI method to obtain an improved solution compared to that given by the North-West corner rule for the above problem.

(c) Explain the degeneracy in transportation problems. [5+12+3]

6. (a) State four major reasons for using simulation in optimization problems.

(b) For a company, the number of trucks arriving with the corresponding probability is given in the following table.

No. of trucks arriving	0	1	2	3	4	5
Probability	0.13	0.30	0.30	0.15	0.10	0.02

Using Monte Carlo simulation, simulate the waiting time process of 7 days with a known service rate (i) 2 per day, and (ii) 3 per day. Use the following random numbers for the above solution. 2,6,14,26,87,23,76,56,15,28,90,54,27,84. [4 + 16]

7. Consider the following payoff matrix.

		States of Nature				
Strategy		S1	S2	S3	S4	S5
	A1	15	10	0	-6	17
	A2	3	14	8	9	2
	A3	1	5	14	20	-3
	A4	7	19	10	2	0

No probabilities are known for the occurrence of the nature of states. Compare the solutions obtained by each of the following criteria. (i) pessimistic, (ii) optimistic, and (iii) Hurwicz ( $\alpha = 0.6$ )

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