MCC/24/M.SC/SEM-IV/MTM/1

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M.SC. Semester-IV Examination, 2026

(MATHEMATICS)

PAPER: MTM 407A

(OPTIMIZATION (METHODS USING MATLAB and LINGO)) (PRACTICAL)

Full Marks: 25 **Time: 2 Hours**

GROUP-A

Answer any **ONE** question from the following: 1×06=06

1. Write the code in LINGO and then to solve the following Geometric programming problem.
$$Minimize\ f(x) = 7x_1x_2^{-1} + 7x_2x_3^{-2} + 5x_1^{-3}x_2x_3 + x_1x_2x_3$$
$$x_1, x_2, x_3 \geq 0.$$
2. Write the code in LINGO and then to find the Nash equilibrium strategy and Nash equibrium outcome of the following bi-matrix game $A = \begin{bmatrix} 1 & 0 \\ 2 & -1 \end{bmatrix}$ *and* $B = \begin{bmatrix} 3 & 2 \\ 0 & 1 \end{bmatrix}$.
3. Write the code in LINGO and then to solve the following Stochastic Programming Problem.
A manufacturing firm produces two machines' parts using lathes, milling machines and grinding machines. The machining times available per week on different machines and the profit on machine part are given below. The machining times required on different machines for each part are not known precisely (as they vary from worker to worker) but are known to follow normal distribution with mean and standard deviations as indicated in the following table:

Type of Machine	Machining time required per piece (minutes)				Maximum time available per week (minutes)
	Part I		Part II		
	Mean	Standard deviation	Mean	Standard deviation	
Lathes	$\bar{a}_{11} = 10$	$\sigma_{a11} = 6$	$\bar{a}_{12} = 4$	$\sigma_{a12} = 4$	$b_1 = 2500$
Milling Machines	$\bar{a}_{21} = 4$	$\sigma_{a21} = 6$	$\bar{a}_{22} = 10$	$\sigma_{a22} = 7$	$b_2 = 2000$
Grinding Machines	$\bar{a}_{31} = 1$	$\sigma_{a31} = 2$	$\bar{a}_{32} = 1.5$	$\sigma_{a32} = 3$	$b_3 = 450$
Profit per unit (Rs.)	$c_1 = 50$		$c_2 = 100$		

Determine the number of machine parts I and II to be manufactured per week to maximize the profit without exceeding the available machining times more than once in 100 weeks.

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4. Write the code in LINGO and then to solve the following LPP using simplex method.

$$Max\ z = 1200x_1 + 1300x_2 + 1300x_3 + 1200x_4 + 899x_5 + 999x_6 + 899x_7 + 1099x_8$$
$$Subject\ to, 12x_1 + 13x_2 + 13x_3 + 12x_4 + 9x_5 + 10x_6 + 9x_7 + 11x_8 \le 39$$
$$x_1 + x_2 + x_3 + x_4 + 0x_5 + x_6 + x_7 + x_8 \le 3$$
$$x_1 + x_2 + x_3 + x_4 + x_5 + 0x_6 + x_7 + x_8 \le 3$$
$$x_1 + x_2 + x_3 + x_4 + x_5 + x_6 + 0x_7 + x_8 \le 3$$
$$x_1 + x_2 + x_3 + x_4 + x_5 + x_6 + x_7 + 0x_8 \le 3$$
$$0 \le x_i \le 1\ for\ 1,2,\ldots,8.$$

5. Write the code in LINGO and then to solve the following Goal Programming problem.

$$Min\ z = P_1(2d_2^- + 3d_3^-) + P_2 d_1^-$$
$$Subject\ to\ 20x_1 + 10x_2 \le 60$$
$$10x_1 + 10x_2 \le 40$$
$$30x_1 + 60x_2 + d_1^- - d_1^+ = 600$$
$$x_1 + d_2^- - d_2^+ = 4$$
$$x_2 + d_3^- - d_3^+ = 4$$
$$x_1, x_2, d_i^-, d_i^+ \ge 0, i = 1,2,3.$$

6. Write the code in LINGO and then to solve the following QPP using Wolfe's modified simplex method.

$$Max\ z = 10x_1 + 3x_2 - 0.001x_1^2 - 0.005x_2^2 - 100$$
$$\text{Subject to. } 2x_1 + 3x_2 \le 2500$$
$$x_1 + 2x_2 \le 1500$$
$$x_1, x_2 \ge 0.$$

7. Write the code in LINGO and then to solve the following fuzzy LPP using simplex method.

$$Max\ z = \tilde{2}x_1 + \tilde{3}x_2 - \tilde{1}x_3$$
$$Subject\ to, 2x_1 + 5x_2 - x_3 \le 5$$
$$x_1 + x_2 + 2x_3 = \tilde{6}$$
$$2x_1 - x_2 + 3x_3 = 7$$
$$x_1, x_2 \ge 0.$$

Here, $\tilde{2}, \tilde{3}$ and $\tilde{1}, \tilde{6}$ are symmetric triangular fuzzy numbers with spread 2.

Group-B

Answer any <u>One</u> question from the following: **1×09=09**

8. Write the code in MATLAB and then to solve the following goal programming problem:

$$Min\ Z = P_1 u_1 + P_2(u_2 + O_2) + P_3 u_3$$
$$Subject\ to, 8x_1 + 6x_2 + u_1 - O_1 = 36$$
$$x_1 - 2x_2 + u_2 - O_2 = 0$$
$$2x_1 + 4x_2 + u_3 = 20$$
$$3x_1 + 4x_2 + u_4 = 24$$
$$x_1, x_2, u_1, u_2, u_3, u_4, O_1, O_2 \ge 0.$$

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9. Write the code in MATLAB and then to solve the following Geometric Programming Problem.

$$Minimize\ f(x) = 5x_1 x_2^{-1} x_3^2 + x_1^{-2} x_2^{-1} + 10x_2^2 + 2x_1^{-1} x_2 x_3^{-2}$$
$$x_1, x_2, x_3 > 0.$$

10. Write the code in MATLAB to solve the following Stochastic Programming Problem.

A manufacturing firm produces two machines parts using lathes, milling machines and grinding Write a program in MATLAB to solve machines. The machining times required on different machines for each part and the profit on machine part are given below. If the machining times available on different machines are probabilistic (normally distributed) with parameters as given in the following table, find the number of machine parts I and II to be manufactured per week to maximize the profit. The constraint have to be satisfied with a probability of at least 0.99.

Type of Machine	Machining time required per piece(minutes)		Maximum time available per week (minutes)	
	Mean	Standard Deviation	Mean	Standard Deviation
Lathes	$a_{11} = 10$	$a_{12} = 5$	$b_1 = 2500$	$\sigma_{b1} = 500$
Milling Machines	$a_{21} = 4$	$a_{22} = 10$	$b_2 = 2000$	$\sigma_{b2} = 400$
Grinding Machines	$a_{31} = 1$	$a_{32} = 1.5$	$b_3 = 450$	$\sigma_{b3} = 50$
Profit per unit (Rs.)	$c_1 = 50$		$c_2 = 100$	

11. Write the code in MATLAB to solve the following QPP using Wolfe's modified simplex method.

$$Max\ Z = 2x_1 + 3x_2 - x_1^2$$
$$\text{Subject to. } 2x_1 + 3x_2 \le 6$$
$$2x_1 + x_2 \le 4$$
$$x_1, x_2 \ge 0.$$

12. Write the code in MATLAB and then to solve the following fuzzy LPP.

$$Max\ z = \tilde{3}x_1 + \tilde{4}x_2$$
$$Subject\ to, x_1 + x_2 \le 10$$
$$2x_1 + 3x_2 \le \widetilde{18}$$
$$x_1 \le 8$$
$$x_2 \le 6$$
$$x_1, x_2 \ge 0$$

Here, $\tilde{3}, \tilde{4}$ and $\widetilde{18}$ are symmetric triangular fuzzy numbers with spread 1.5.

13. Write the code in MATLAB to solve the following Stochastic Programming Problem.

A manufacturing firm produces two machines parts using lathes, milling machines and grinding machines. The machining times available per week on different machines and the machine times required on different machines for each part are given below. Assuming that the profit per unit of each of the machine parts I and II

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is a normally distributed random variable, find the number of machine parts to be manufactured per week to maximize the profit. The mean value and standard deviation of profit are Rs. 50 and 20 per unit for part I and Rs. 100 and 50 per unit for part II.

Type of Machine	Machining time required per piece(minutes)		Maximum time available per week (minutes)
	Part I	Part II	
Lathes	$a_{11} = 10$	$a_{12} = 5$	$b_1 = 2500$
Milling Machines	$a_{21} = 4$	$a_{22} = 10$	$b_2 = 2000$
Grinding Machines	$a_{31} = 1$	$a_{32} = 1.5$	$b_3 = 450$

14. Write the code in MATLAB and then to find the Nash equilibrium strategy and Nash equilibrium outcome of the following bi-matrix game.

$$A = \begin{bmatrix} 8 & 0 \\ 30 & 2 \end{bmatrix} \quad B = \begin{bmatrix} 8 & 30 \\ 0 & 2 \end{bmatrix}$$

15. Write the code in MATLAB and then to solve the following LPP.

$$Max\ Z = 61x_1 + 209x_2 + 324x_3 + 33x_4 + 276x_5 + 285x_6 + 250x_7 + 100x_8 + 12x_9 + 282x_{10}$$

Subject t constraints

$$16x_1 + 25x_2 + 22x_3 + 4x_4 + 9x_5 + 8x_6 + 11x_7 + 29x_8 + 20x_9 + 22x_{10} \leq 18$$
$$5x_1 + 22x_2 + 15x_3 + 30x_4 + 24x_5 + 15x_6 + 14x_7 + 28x_8 + 31x_9 + 25x_{10} \leq 53$$
$$22x_1 + 17x_2 + 9x_3 + 32x_4 + 26x_5 + 20x_6 + 16x_7 + 16x_8 + 26x_9 + 24x_{10} \leq 50$$
$$32x_1 + 30x_2 + 10x_3 + 30x_4 + 7x_5 + 29x_6 + 15x_7 + x_8 + 2x_9 + 23x_{10} \leq 4$$
$$14x_1 + 9x_2 + 32x_3 + 22x_4 + 30x_5 + 18x_6 + 18x_7 + 32x_8 + 15x_9 + x_{10} \leq 40$$
$$12x_1 + 4x_2 + 30x_3 + 11x_4 + 23x_5 + 29x_6 + 8x_7 + 2x_8 + 23x_{10} \leq 31$$
$$22x_1 + 23x_2 + 26x_3 + 13x_4 + 6x_5 + 13x_6 + 32x_7 + 11x_8 + 8x_9 + 5x_{10} \leq 39$$

$0 \leq X \leq U$ where $U^T = (0.125, 0.133, 0.04, 0.133, 0.571, 0.138, 0.266, 0.62, 0.21, 0.153)$

Laboratory Note Book: **05**
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