FIFTH SEMESTER UG DEGREE EXAMINATION, NOVEMBER 2025

(CBCSS-UG)

(Regular/Supplementary/Improvement)

CC20UMTS5D03 – LINEAR MATHEMATICAL MODELS

(Mathematics – Open Course)

(2019 Admission onwards)

Time: 2 Hours   Maximum: 60 Marks

Credit: 3

Section A

Answer *all* questions. Each question carries 2 marks.

1. Find the slope of the line through the pair of points $(2, -4)$ and $(6, -6)$.

2. Find the equation of the line passing through the point $(4, 7)$ and perpendicular to the line $y = x$.

3. Write the augmented matrix for the following system. **(Do not solve)**.
$$3x + 4y - z = 20, \qquad 3y - 4z = 2, \qquad 3x + 6y - 2z = 15.$$

4. Compute $\begin{bmatrix} 2 & -2 \\ 1 & -1 \end{bmatrix} \left(\begin{bmatrix} 4 & 3 \\ 1 & 2 \end{bmatrix} + \begin{bmatrix} 7 & 0 \\ -1 & 5 \end{bmatrix} \right)$

5. State the Corner Point Theorem.

6. Define Standard Maximum form of an L.P.P.

7. Write the Theorem of Duality.

8. Do the transformation $R_2 \rightarrow R_2 - 2R_1$ for the matrix,
$$A = \begin{pmatrix} 1 & 0 & 5 & 1 & 0 & 0 \\ 0 & 1 & -4 & -2 & 1 & 0 \\ 3 & 4 & 0 & 0 & 0 & 1 \end{pmatrix}.$$

9. Convert each inequality into an equation by adding slack variable.

   (a) $x_1 + 2x_2 \leq 6$ (b) $8x_1 + 16x_2 + 15x_3 \leq 250$

10. Find the transpose of the following matrix

    (a) $\begin{bmatrix} 1 & 2 \\ 5 & 6 \end{bmatrix}$ (b) $\begin{bmatrix} 6 & 8 & 9 \\ 2 & 6 & 0 \\ 11 & 34 & 56 \end{bmatrix}$

11. Write the system of linear equation of the two unknowns whose augmented matrix is given by $\begin{bmatrix} 4 & -4 & 10 \\ 15 & 2 & 19 \end{bmatrix}$.

12. Graph the feasible region for the given system of inequalities. Tell whether the region is bounded or unbounded. $-x - 2y < 5, \ 2x - y < 4$

(Ceiling: 20 Marks)

Section B

Answer *all* questions. Each question carries 5 marks.

13. Using Echelon Method to solve the following system of equation

$$3x + 10y = 115, \qquad 11x + 4y = 95$$

14. Formulate the following situation to a linear programming problem **(Do not solve).**

    Andrew Crowley plans to start a new business called River Explorers, which will rent canoes and kayaks to people to travel 10 miles down the Clarion River in Cook Forest State Park. He has $45,000 to purchase new boats. He can buy the canoes for $600 each and the kayaks for $750 each. His facility can hold up to 65 boats. The canoes will rent for $25 a day, and the kayaks will rent for $30 a day. How many canoes and how many kayaks should he buy to earn the most revenue if all boats can be rented each day?

15. Solve the following system of linear equations using the idea of inverse of the coefficient matrix

$$2x + 5y = 15, \qquad x + 4y = 9$$

16. Use slopes to show that the square with vertices at $(-2,5), (4,5), (4,-1), (-2,-1)$ has diagonals that are perpendicular.

17. Using Gauss-Jordan Method to solve the following system of equation

$$3x - 4y = 1 \text{ and } 5x + 2y = 19$$

18. Write the initial table for the following linear programming problem

    Maximize $Z = 10x + 14y + 12z$

    Subject to: $12x - 2y - 34z \leq 110$

    $13x + 22y + 12z \leq 101$

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    $x \geq 0, \; y \geq 0$

19. Consider the following L.P.P

    Maximize $Z = 5x + 4y - 10z$

    Subject to: $2x - 5y \geq 14, \; 11x + 4y \geq 5, \; -3x + 8y \geq 2, \; x \geq 0, \; y \geq 0$

    (a) Write the dual.

    (b) Find dual of the dual.

    (c) Identify the relation between dual and dual of the dual.

(Ceiling: 30 Marks)

Section C

Answer any *one* question. The question carries 10 marks.

20. Solve the following linear programming problem.

    Minimize $Z = 2x + 4y$

    Subject to: $x + 2y \geq 10, \; 3x + y \geq 10, \; x \geq 0, \; y \geq 0$

21. Consider the following matrix, $A = \begin{bmatrix} 2 & 1 & 1 \\ 1 & 2 & 1 \\ 1 & 1 & 1 \end{bmatrix}$

    (a) Is A is invertible? Justify?

    (b) If A is invertible, find the inverse of A a using row row operations.

(1 × 10 = 10 Marks)

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