

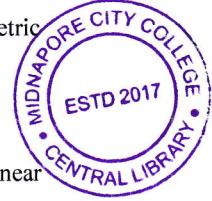
PG CBCS
M.SC. Semester-IV Examination, 2022
MATHEMATICS
PAPER: MTM 404B
(NONLINEAR OPTIMIZATION)

Full Marks: 40**Time: 2 Hours**

The figures in the right-hand margin indicate full marks.
 Candidates are required to give their answers in their own words as far as practicable.

GROUP-A**1. Answer any four questions of the following: 4×2=8**

- a) Define posynomial and polynomial in connection with geometric programming problem with example.
- b) Define bi-matrix game with example.
- c) Write the advantages of geometric programming problem.
- d) Define Pareto optimal solution in a multi-objective non-linear programming problem.
- e) State Kuhn-Tucker stationary point necessary optimality theorem.
- f) What are the basic differences between the necessary criteria and sufficient criteria of Fritz-John saddle point problem.

**GROUP-B****2. Answer any four questions of the following: 4×4=16**

- a) Prove that all strategically equivalent bi-matrix game have the same Nash equilibrium.
- b) Derive the Kuhn-tucker condition for quadratic programming problem.
- c) Find the minimum value of $f(X)$ by geometric programming

$$\text{Min } f(X) = 7x_1x_2^{-1} + 3x_2x_3^{-2} + 5x_1^{-3}x_2x_3 + x_1x_2x_3.$$
- d) State and Prove weak duality theorem in connection with duality in non-linear programming.
- e) Let θ be a numerical differentiable function on an open convex set $\Gamma \subset \mathbb{R}^n$. θ is convex if and only if $\theta(x^2) - \theta(x^1) \geq \nabla\theta(x^1)(x^2 - x^1)$ for each $x^1, x^2 \in \Gamma$. Prove it.

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- f) Write the relationship among the solutions of minimization Problem (MP), local minimization problem (LMP), the Fritz-John stationary point problem (FJP), the Fritz-John saddle point problem (FJSP), the Kuhn-Tucker saddle point problem.

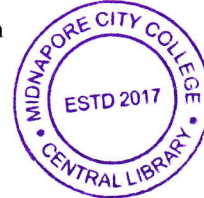
GROUP-C**3. Answer any two questions of the following:****8×2=16**

- a) How do you solve the following geometric programming problem?

Find $X = \begin{Bmatrix} x_1 \\ x_2 \\ \vdots \\ x_n \end{Bmatrix}$ that minimizes the objective function

$$f(x) = \sum_{j=1}^N U_j(x) = \sum_{j=1}^N (c_j \prod_{i=1}^n x_i^{a_{ij}})$$

$$c_j > 0, x_i > 0, a_{ij} \text{ are real numbers, } \forall i, j.$$



- b) Using the chance-constrained programming technique to find an equivalent deterministic LPP of the following stochastic programming problem.

$$\text{Minimize } F(x) = \sum_{j=1}^n c_j x_j$$

$$\text{subject to } P\left[\sum_{j=1}^n a_{ij} x_j \leq b_i\right] \geq p_i$$

$$x_j \geq 0, i, j = 1, 2, \dots, n$$

When b_i is a random variable and p_i is a specified probability.

- c) Solve the quadratic programming problem using Wolfe's method

$$\text{Maximize } z = 2x_1 + 3x_2 - 2x_1^2$$

$$\text{subject to } x_1 + 4x_2 \leq 4$$

$$x_1 + x_2 \leq 2$$

$$x_1, x_2 \geq 0$$
