

## M.Sc. (A.I.&amp; M.L.) Sem.-2 Examination

## Numerical Optimization

June-2025

Date ; 25/6/2025, Wednesday

Time : 3.00 Hours]

[Max.Marks : 100

- Q-1 Answer the following. (Any Two) [30]
- Using Fibonacci search method, find the minimum for the function  $f(x) = x^2 - 2.6x + 2$  in the interval  $[-2,3]$ . Perform 6 iterations.
  - Use the Golden Section Method to minimize  $f(x) = (x - 3)^2 + 2$  within the range  $[1, 4]$ .
  - Write an algorithm of Unrestricted Search Method with fixed step size. Explain its graphical interpretation.
- Q-2 Answer the following. (Any Three) [15]
- Determine if the function  $f(x, y) = x^2 + y^2 - 4x + 2y$  is convex.
  - Explain the difference between single-variable and multivariable optimization problems.
  - Compute the gradient of  $f(x, y) = 3x^2 + 2xy + y^2$ .
  - Explain Exhaustive Search technique for minimization problem.
- Q-3 Attempt any FIVE out of SIX: [05]
- Draw a flowchart of the optimal design procedure.
  - State Taylor's Theorem for functions of two variables.
  - Define: Critical Point
  - What is the difference between constrained and unconstrained optimization?
  - State any two techniques based on Region of Elimination.
  - Mention one difference between Fibonacci and Golden Section methods.
- Q-4 Answer the following. (Any Two) [30]
- Using Heeke-Jeeves method, find the minimum for the function  $f(x_1, x_2) = x_1 - x_2 + 2x_1x_2 + x_2^2 + 2x_1^2$ . starting from the point  $x_1 = (0,0)^T$ . Take  $\Delta x_1 = \Delta x_2 = 0.8$
  - Using Steepest Descent method, determine Minimize  $f(x_1, x_2) = x_1 - x_2 + 2x_1^2 + 2x_1 x_2 + x_2^2$  starting from the point  $x_1 = (0,0)$
  - Determine the optimal value of the objective function by applying the Kuhn-Tucker conditions:  $Max Z = x^3 - 3x^2 + 2x - 1$   
Subject to constraints are:  $-x \leq 2$  and  $x \leq 4$

- Q-5 Answer the following. (**Any Three**) [15]
- A company is planning to spend \$10,000 on advertising. It costs \$3,000 per minute to advertise on television and \$1,000 per minute to advertise on radio. If the firm buys  $x$  minutes of television advertising and  $y$  minutes of radio advertising, then its revenue in thousands of dollars is given by  $f(x, y) = -2x^2 - y^2 + xy + 8x + 3y$ . How can the firm maximize its revenue using Lagrangian Multiplier technique?
  - Given the function  $f(x, y) = x^2 + y^2 + 4x - 6y + 13$ . Find the point of minimum, Check convexity, Compute the Hessian matrix.
  - Explain an algorithm of Interior penalty function method.
  - Use Newton's Method for one step to minimize  $f(x) = x^3 - 2x^2 + x$ , starting at  $x_0 = 1$ .
- Q-6 Attempt any **FIVE** out of **SIX**: [05]
- Write down the shape of simplex in different dimension.
  - Define the Hessian matrix.
  - Describe a basic structure of a Genetic Algorithm.
  - Define constrained optimization.
  - Write down the penalty function in Interior penalty function.
  - State Pattern move used in Hooke-Jeeves Search Method.

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