Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

M.E -III[rd] SEMESTER–EXAMINATION – MAY- 2012

Subject code: 730801 Date: 08/05/2012

Subject Name: Engineering Optimization

Time: 10:30 am – 01:00 pm Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** What is Engineering Optimization? Explain the requirements for the application of Optimization Methods in Engineering. **07**

(b) Formulate the problem for minimum weight design of a helical spring under axial load as a geometric programming problem. Consider constraints on the shear stress, natural frequency, and buckling of the spring. **07**

Q.2 **(a)** Explain MATLAB Functions for Solving Optimization Problems in MATLAB Optimization Toolbox. **07**

(b) Minimize $f(x) = (100 - x)^2$ over the bounded interval $60 \leq x \leq 150$ using Golden Section Method. **07**

OR

(b) Minimize $f(x_1,x_2) = x_1 - x_2 + 2x_1^2 + 2x_1x_2 + x_2^2$ by taking starting point as $X_1 = \{0\ 0\}^T$ using Newton's Method. **07**

Q.3 **(a)** Why Stochastic programming is needed in Engineering Optimization? Explain stochastic linear programming method in detail. **07**

(b) Minimize **07**

$$f(Y) = \tfrac{1}{2}(y_1^2 + y_2^2 + y_3^2 + y_4^2)$$

subject to

$$g_1(Y) = y_1 + 2y_2 + 3y_3 + 5y_4 - 10 = 0$$
$$g_2(Y) = y_1 + 2y_2 + 5y_3 + 6y_4 - 15 = 0$$

OR

Q.3 **(a)** What is Genetic Algorithm? Explain Representation of Design Variable, Objective function, Constraints and Genetic Operator in GA. **07**

(b) Find the dimensions of a rectangular prism-type box that has the largest volume when the sum of its length, width, and height is limited to a maximum value of 60 in. and its length is restricted to a maximum value of 36 in. **07**

Q.4 **(a)** Define gradient of a function? Explain Steepest Decent Method for Unconstraint Optimization. **07**

(b) Minimize **07**

$$f = x_1x_2^2x3^{-1} + 2x_1^{-1}x_2^{-3}x_4 + 10x_1x_3$$

Subject to

$$3x_1^{-1}x_3x_4^{-2} + 4x_3x_4 \leq 1$$

$$5x_1x_2 \leq 1$$

Using Geometric Programming.

OR

Q.4 **(a)** Explain Quadratic Interpolation Method of Optimization in detail. **07**

(b) Write a MATLAB Program to find the solution to **07**

Minimize

$$f(X) = x_1^3 - 6x_1^2 + 11x_1 + x_3$$

Subject to

$$x_1^2 + x_2^2 + x_3^2 \leq 0$$

$$4 - x_1^2 - x_2^2 - x_3^2 \leq 0$$

$$x_3 - 5 \leq 0$$

$$x_i \leq 0 \text{ , } i = 1,2,3$$

starting from the initial point $\mathbf{X}_1 = \{0.1\ 0.1\ 3.0\}^T$

Q.5 **(a)** Explain Kuhn-Tucker theorem with necessary and sufficient Conditions in Classical Optimization Techniques. **07**

(b) Find the maximum of the function **07**

$$f(\mathbf{X}) = 2x_1 + x_2 + 10$$

subject to

$$g(\mathbf{X}) = x_1 + 2x_2^2 = 3$$

Using the Lagrange multiplier method. Also find the effect of changing the right-hand side of the constraint on the optimum value of f.

OR

Q.5 **(a)** Explain the interpretations of the Lagrange Multipliers in Classical Optimization Techniques. **07**

(b) Minimize **07**

$$f = x_1^2 + 2x_2^2 + 3x_3^2$$

subject to

$$x_1 - x_2 - 2x_3 \leq 12$$

$$x_1 + 2x_2 - 3x_3 \leq 8$$

Using Kuhn-Tucker Conditions.

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