Seat No.: __________ Enrolment No.______________

# GUJARAT TECHNOLOGICAL UNIVERSITY

## ME Semester –IV Examination Dec. - 2011

**Subject code: 741501** **Date: 07/12/2011**

**Subject Name: Structural 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)** Define (i) Local minima (ii) Global minima (iii) Saddle Point. Find whether local minima lies at (4/3, -2/3) for the function **07**

$$f(x_1, x_2) = x_1^2 + x_2^2 - 2x_1 + x_1x_2 + 1$$

**(b)** Determine whether function given below is concave or convex or neither **07**

$f(x_1,x_2,x_3) = 2x_1^2 + 2x_2^2 + 4x_3^2 + 2x_1x_2 + 4x_2x_3$

**Q.2** **(a)** Design a pin jointed steel frame shown in fig.1 for minimum weight. The horizontal deflection is limited to 5mm and vertical deflection is limited to 4mm. The allowable stress in each member is limited to 125MPa **07**

**(b)** Using Lagrange's multiplier method, **07**

$$\text{Maximize } f(x) = 3x_1^2 + x_2^2 + 2x_1x_2 + 6x_1 + 2x_2$$

subjected to $2x_1 - x_2 = 4$

**OR**

**(b)** Find out minimum weight of portal frame shown in fig .2 by assuming weight as a linear function of plastic moment capacity. The beam and column have plastic moment capacity $M_b$ and $M_c$ respectively. **07**

**Q.3** **(a)** Analyze and design the portal frame made up of square cross sections shown in fig .3 for minimum volume, if permissible horizontal sway of joints in given frame is 6mm and allowable bending stress in members is 165 MPa. **07**

**(b)** Derive Kuhn Tucker's condition to maximize **07**

$$f(x_1, x_2) = x_1^2 + x_2^2$$

subjected to $g = (x_1 - 3)^3 - x_2^2 \geq 0$

**OR**

**Q.3** **(a)** Minimize the function **07**

$$Z = x_1^2 - 10x_1 + x_2^2 - 6x_2 + x_3^2 - 4x_3$$

subjected to $g_1 = x_1 + x_2 + x_3 = 7$ & $g_2 = x_1, x_2, x_3 \geq 0$ using Lagrange's multiplier method.

**(b)** Minimize the function **07**

$Z = 3x_1 + 5x_2 + 4x_3$ subjected to

$2x_1 + 3x_2 \leq 8$

$2x_2 + 5x_3 \leq 10$

$3x_1 + 2x_2 + 4x_3 \leq 15$

$x_1, x_2, x_3 \geq 0$

Use simplex method.

**Q.4** **(a)** Solve following linear programming problem using graphical method **07**

Minimize $Z = 10x_1 + 5x_2$ subjected to

$x_1 + x_2 \leq 20$

$2x_1 + x_2 \geq 15$
$x_1 + 3x_2 \geq 30$
$x_1, x_2 \geq 0$

**(b)** Solve the following using Kuhn Tucker's conditions **07**
Minimize $Z = 10x_1 + 4x_2 - 2x_1^2 - x_2^2$
subjected to $g_1 = 2x_1 + x_2 \leq 5$ & $g_2 = x_1, x_2 \geq 0$

**OR**

**Q.4** **(a)** Minimize $f(x) = 5x_1^2 + 4x_2^2 + 8x_1x_2 - 6x_1$ using any method with starting point at origin. **07**

**(b)** Use simplex method to minimize **07**
$Z = 5x_1 + 3x_2 + x_3$ subjected to
$2x_1 + x_2 + x_3 \leq 3$
$-x_1 + 2x_3 \leq 4$
$x_1, x_2, x_3 \geq 0$

**Q.5** **(a)** Minimize the function given below using graphical method **07**
$Z = 5x_1 - x_2$ subjected to
$x_1 + x_2 \geq 2$
$x_1 + 2x_2 \leq 2$
$2x_1 + x_2 \leq 2$
$x_1, x_2 \geq 0$

**(b)** Define (i) Basic, feasible and optimal solution (ii) Primal and dual problem (iii) Quasi-Newton method **07**

**OR**

**Q.5** **(a)** Minimize $f(x) = 50 + (1 - x_1)^2 + (2.71 - x_2)^2$ using Fletcher - Reeves method with starting point at (0, 0.5). **07**

**(b)** Explain the following, **07**
(i) Linear and non linear programming
(ii) Application of optimization in structural engineering
(iii) Steepest descent method

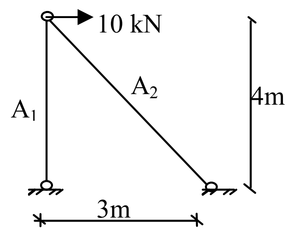


**Fig 1**

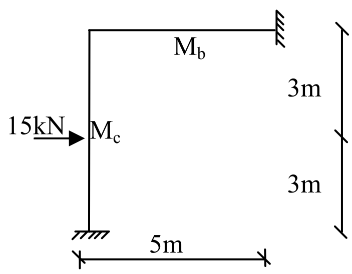


**Fig 2**

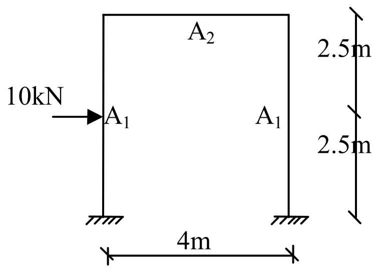


**Fig 3**

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