Seat No.: _____ Enrolment No.______

GUJARAT TECHNOLOGICAL UNIVERSITY

M. E. Sem – IV Examination May 2011

Subject code: 741501

Subject: Structural Optimization

Date:16/05/2011 **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 do you understand by term "Saddle Point"? Determine saddle points for function **07**

$$f(x_1, x_2) = x_1^3 + x_2^3 + 2x_1^2 + 4x_2^2 + 6$$

(b) What do you understand by concavity or convexity of the function? Determine whether function given below is concave or convex **07**

$$f(x_1,x_2,x_3) = 4x_1^2 + 3x_2^2 + 5x_3^2 + 6x_1x_2 + x_1x_3 - 3x_1 - 2x_2 + 15$$

Q.2 **(a)** Design a pin jointed steel frame shown in fig.1 for minimum weight. The horizontal deflection is limited to 3mm and vertical deflection is limited to 5mm. The allowable stress in each member is limited to 150MPa **07**

(b) Design the portal frame shown in fig .2 for minimum cost, if permissible horizontal sway in frame is 6mm and bending stress in members is 120 MPa. **07**

OR

(b) Analyze and design the portal frame shown in fig .3 for minimum volume, if permissible horizontal sway of joints in given frame is 5mm and allowable bending stress in members is 150 MPa. **07**

Q.3 **(a)** Using Lagrange's multiplier method, find the minimum and maximum function **07**

$$f(x) = x_1^2 + x_2^2 + x_3^2$$

subjected to

$$g_1(x) = \frac{x_1^2}{4} + \frac{x_2^2}{5} + \frac{x_3^2}{25} - 1 \text{ and}$$

$$g_2(x) = x_1 + x_2 - x_3$$

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

$f(x_1, x_2) = 3x_1^2 - 2x_2$ subjected to

$$2x_1 + x_2 = 4$$
$$x_1^2 + x_2^2 \leq 19.4$$
$$x_1 \geq 0$$

OR

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

$f(x,y) = k\,x^{-1}\,y^{-2}$ subjected to

$g(x,y) = x^2 + y^2 - a^2$ using Lagrange's multiplier method.

(b) Solve the following using Kuhn Tucker's conditions **07**

Minimize $Z = x_1^2 + 2x_2^2 + 3x_3^2$ subjected to

$$g_1 = x_1 - x_2 - 2x_3 \leq 12$$
$$g_2 = x_1 + 2x_2 - 3x_3 \leq 8$$

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

Minimize $Z = 20x_1 + 10x_2$ subjected to

$x_1 + 2x_2 \leq 40$
$3x_1 + x_2 \geq 30$
$4x_1 + 3x_2 \geq 60$
$x_1, x_2 \geq 0$

(b) Minimize the function **07**

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

$x_1 + x_2 + x_3 \leq 120$
$x_1 + 2x_2 + 3x_3 \leq 150$
$x_1 + x_2 \leq 90$
$x_1, x_2, x_3 \geq 0$

Use simplex method.

OR

Q.4 **(a)** Minimize the function given below using graphical method **07**

$Z = 3x_1 + 2x_2$ subjected to

$8x_1 + x_2 \geq 8$
$2x_1 + x_2 \geq 6$
$x_1 + 3x_2 \geq 6$
$x_1 + 6x_2 \geq 8$
$x_1, x_2 \geq 0$

(b) Use simplex method to minimize **07**

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

$2x_1 + 3x_2 \leq 8$
$2x_2 + 5x_3 \leq 10$
$3x_1 + 2x_2 + 4x_3 \leq 15$
$x_1, x_2, x_3 \geq 0$

Q.5 **(a)** Minimize $f(x) = 4x_1^2 + 3x_2^2 - 5x_1x_2 - 8x_1$ using Quasi-Newton method with starting point at origin. **07**

(b) Enlist unconstrained non-linear programming methods and explain any two in details. **07**

OR

Q.5 **(a)** Minimize $f(x) = x_1 - x_2 + 2x_1^2 + 2x_1x_2 + x_2^2$ using Fletcher - Reeves method with starting point at origin. **08**

(b) Explain the following, **06**

(i) Dynamic programming
(ii) Significance of structural optimization
(iii)Davidon-Fletcher-Powell method

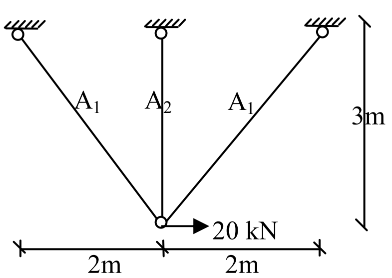

Fig. 1

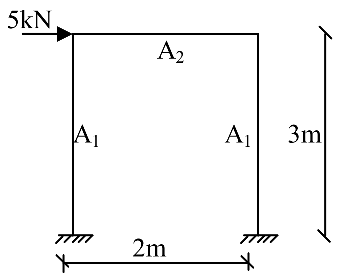

Fig. 2

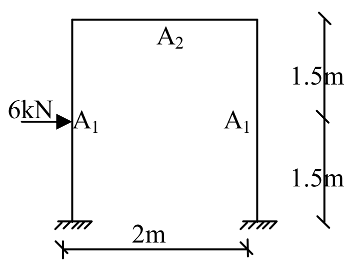

Fig. 3

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