Seat No.: _____ *Enrolment No._____*

GUJARAT TECHNOLOGICAL UNIVERSITY

M.E Sem-I Examination January 2010

Subject code: 710903 **Subject Name: Engineering optimization**
Date: 25 / 01 / 2010 **Time: 12.00 – 2.30 pm.**

Total Marks: 60

Instructions:

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

Q.1 **(a)** If a crank is at the angle θ from a dead center with $\theta = \omega t$,where ω is the angular velocity and t is time, the distance of piston from the end of its stroke (x)is given by , **06**

$$x = r(1-\cos\theta) + \frac{r^2}{4l}(1-\cos 2\theta)$$

where r is the length of the crank and l is the length of the connecting rod. For $r = 1$ and $l = 5$, find (a) the angular position of the crank at which the piston moves with maximum velocity and (b) the distance of the piston from the end of its stroke at that instant.

(b) Define the following type of problems: **03**

(i) Quadratic programming problem
(ii) Integer programming problem
(iii) Stochastic programming problem

(c) What is gradient vector? State the properties of gradient vector. **03**

Q.2 **(a)** Minimize $f = x_1^2 + 2x_2^2 + 3x_3^2$ subject to the constants: **06**

$g_1 = x_1 - x_2 - 2x_3 \le 12$

$g_2 = x_1 + 2x_2 - 3x_3 \le 8$

Using Kuhn-Tucker conditions.

(b) Minimize the objective function $f(x) = x^3 - 3x + 2$ using quadratic interpolation method, choose $x_1 = 0$, $x_2 = 2$, $x_3 = 3$ connect to an interval accuracy 0.1 **06**

OR

(b) Find the extreme points of the function **06**
$f(x, y) = x^3 + 3xy^2 - 15x^2 - 15y^2 + 72x$.

Q.3 **(a)** Minimize $f(x) = x^2 - \sin x$ [0, 1] correct to an interval accuracy of 0.1, using golden section method. **06**

(b) Find the dimensions of a rectangle box of maximum capacity when the surface area is $216\,m^2$. **06**

OR

Q.3 **(a)** Use the method of Lagrange's multipliers and check for points that satisfy the necessary and sufficient conditions for the problem: **06**

Minimize $f = x^2 + y^2 + z^2$

Subject to $x + y + z = 3$

(b) Find the minimum of the function $f = x^3 - 2x + 10$ by the Newton's method with the starting value of $x_0 = 1$.Carry out at least 5 iterations. **06**

Q.4 **(a)** Using Fibonacci methods find an approximate minimum of the function $f(x) = 2x^2 - 3x + 2$ with an accuracy of 0.1 with starting interval [0, 1] and choose $\delta = 0.01, N = 5$. **06**

(b) Perform three iterations ,using conjugate gradient method, for minimizing the function $f(x) = x_1^2 + 2x_2^2 - 4x_1 - 2x_1x_2$ with the starting point $x_0 = (1,1)^T$. **06**

OR

Q.4 **(a)** Minimize $f(x_1, x_2) = x_1 + x_2 + 2x_1^2 + 2x_1x_2 + x_2^2$ starting from the point $x_1 = (0,0)^T$ using steepest descent method. **06**

(b) Minimize $f(x_1, x_2) = x_1 - x_2 + 2x_1^2 + 2x_1x_2 + x_2^2$ using variable metric method. **06**

Q.5 **(a)** Analyze the function $f(x) = 12x^5 - 45x^4 + 40x^3 + 5$ and classify the stationary points as maxima, minima and points of inflection. **06**

(b) Determine whether the function is convex ,concave or neither $f = 4x_1^2 + 3x_2^2 + 5x_3^2 + 6x_1x_2 + x_1x_3 - 3x_1 - 2x_2 + 5$ **06**

OR

Q.5 **(a)** Find the point on the surface $xyz = 1$ in the positive octangle which is nearest to the origin using interior penalty method. **06**

(b) (i) Minimize $f = \frac{2}{x_1x_2} + \frac{3}{2x_2^2} + 2x_1x_2^2$ using geometric programming techniques. **06**

(ii) Describe briefly simulated annealing and geometric algorithm.

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