Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME – SEMESTER II (NEW) – • EXAMINATION – SUMMER 2016

Subject Code: 2721602 **Date: 24/05/2016**

Subject Name: Chemical Process Optimization

Time:10:30 am to 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)** Explain the concept of optimization and give examples of application of optimization in chemical industries. **07**

(b) A length of wire is to cut in two parts. One portion is to be bent into the form of a circle, and the other into the form of a square. Determine the ratio in which the wire must be cut, so that the sum of the areas enclosed by the circle and square is the least. **07**

Q.2 **(a)** Minimize the function $f = x_1 - x_2 + 2x_1^2 + 2x_1x_2 + x_2^2$ using Simplex method. Take the points defining the initial Simplex as $X_1 = [4,4]$, $X_2 = [5,4]$ and $X_3 = [4,5]$. Assume Ŭ= 1, ɓ = 0.5 and ɔ = 2. **10**

(b) Write short note on scanning and bracketing techniques in optimization. **04**

OR

(b) Find the values of x and z (both > 0) analytically that maximize the function: **04**

$$Y = -x^2 + 10x + xz \text{ ï } z^2 + 7z + 2$$

Q.3 **(a)** The total annual cost ($) of operating a pump and motor C in a particular piece of equipment is a function of x, the size (horsepower) of the motor, namely **07**

$$C = 300 + x + 4000/x$$

Find the motor size that minimizes the total annual cost.

Use Newtonôs method. Take an initial guess at x = 10. How many iterations it took to converge? Solve the equation analytically and determine actual solution. State the advantages and disadvantages of Newtonôs method.

(b) For a two-stage adiabatic compressor where the gas is cooled to the inlet gas temperature between stages, the theoretical work is given by: **07**

$$W = \frac{kp_1V_1}{k-1}\left[\left(\frac{p_2}{p_1}\right)^{(k-1)/k} - 2 + \left(\frac{p_3}{p_2}\right)^{(k-1)/k}\right]$$

where, $k = C_P/C_V$, p_1 = inlet pressure, p_2 = intermediate stage pressure, p_3 = outlet pressure, V_1 = inlet volume. We wish to optimize the intermediate pressure p_2 so that the work is a minimum. Show that if p_1 = 1 atm and p_3 = 4 atm, optimum p_2 = 2 atm.

OR

Q.3 **(a)** Minimize the function $f = 4x_1^2 + 3x_2^2 - 5x_1x_2$ ï $8x_1$ using Powellôs method. Take starting point [0,0]. **08**

(b) Minimize the function $f = 4x_1^2 + x_2^2 - 2x_1x_2$ starting from [1,1] using Newtonôs method. **06**

Q.4 **(a)** Determine the process of finding the optimum L/D ratio of a cylindrical storage vessel. Compare the result with design thumb rule of 3. State the assumptions clearly. **10**

(b) Find the dual of the following LPP: **04**

Minimize $Z = 11x_1 + 12x_2$

subject to:

$2x_1 + 3x_2$ Ò12

$5x_1 + 4x_2$ Ó20

$x_1 + 5x_2$ Ò15

$3x_1 - x_2$ Ó10

x_1 , x_2 Ó0

OR

Q.4 **(a)** Solve the following Linear Programming problem using Simplex method **10**

Maximize $Z = x_1 + 2x_2 + x_3$

subject to:

$2x_1 + x_2 - x_3$ Ò2

$- 2x_1 + x_2 - 5x_3$ Ó- 6

$4x_1 + x_2 + x_3$ Ò6

x_1 , x_2 , x_3 Ó0

(b) Write a short note on Box complex method. **04**

Q.5 **(a)** Explain particle swarm optimization technique in detail. **07**

(b) Find the dimensions of a cylindrical closed vessel made up of sheet metal to maximize its volume such that the total surface area is 24´. Use Lagrangeôs multiplier technique to solve the problem. **07**

OR

Q.5 **(a)** Explain multi objective optimization and its application in chemical engineering. **07**

(b) Minimize $f = - 4x_1 + x_1^2 + 2x_2^2 - 2x_1x_2$ **07**

subject to:

$2x_1 + x_2$ Ò6

$x_1 - 4x_2$ Ò0

x_1 , x_2 Ó0

Formulate the problem to solve by quadratic programming technique.