Seat No.: ________ Enrolment No.___________

GUJARAT TECHNOLOGICAL UNIVERSITY

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

Subject Code: 2723010 **Date: 27/05/2016**

Subject Name: Advance 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)** A liquid phase, isothermal, reversible first order, exothermic reaction **07**

$$A \underset{k_2}{\overset{k_1}{\rightleftarrows}} B$$

is to be carried out in a CSTR. The reactor space time is to be held constant at space time τ. The feed is pure A. Optimum temp which will maximize conversion of A is the one which will maximize $k_1\tau / 1+k_2\tau$.

If the reaction temperature is between 400-500 ˚K and $E_1/R = 10000$, $E_2/R = 20000$, $k_1^0 = e^{25}$, $k_2^0 = e^{30}$, $\tau = 1$ min find the optimum temperature within ± 1 ˚K using Fibonacci Search Technique.

(b) Write necessary any sufficient conditions for an extreme value of single variable objective function and find out stationary point for **07**

$$y = 1 + 8x + 2x^2 - 10/3\,x^3 - 1/4\,x^4 + 4/5\,x^5 - 1/6\,x^6$$

Q.2 **(a)** Find the minimum of the Linear function **09**

$$y = -3x_1 + x_2 + x_3$$

Subject to the Linear restrictions

$$x_1 - 2x_2 + x_3 \le 11$$

$$-4x_1 + x_2 + 2x_3 \ge 3$$

$$2x_1 - x_3 + 1 = 0$$

with $x_1 \ge 0$, $x_2 \ge 0$, and $x_3 \ge 0$

(b) Explain golden section search for sigle variable optimization and derive working equations for it. **05**

OR

(b) Find the optimum solution to the following LP by inspection **05**

Minimize $y = x_1 - 3x_2 + 2x_3$

Subject to the Linear restrictions

$$-2 \le x_1 \le 3$$

$$0 \le x_2 \le 4$$

$$2 \le x_3 \le 5$$

Q.3 **(a)** Find the optimum solution to the following: **07**

Maximize $y = x_1^2 + x_2 x_3 - x_3^3$

Subject to the restriction

$-2x_1 + 3x_2 + x_3 \le 3$

$x_1, x_2, x_3 \in \{0,1\}$

(b) The cost of purchase and installation of a steam pipe lagging may be represented as $c_1 = ax + b$ and the cost of heat loss from the piping may be given as $c_2 = c/x + d$, both c_1, and c_2 are expressed on same basis. a, b, c and d are all known constants, and x is the insulation thickness. Then the total cost y of the lagging system is the sum of these two costs, $y = ax + b + c/x + d$. This is a continuous convex function of single variable *x*. Find out the minimum cost of operation. **07**

OR

Q.3 **(a)** Solve the following by the branch and bound algorithm **07**

Maximize $y = 21x_1 + 11x_2$

Subject to the restriction

$7x_1 + 4x_2 + x_3 = 13$;

x_1, x_2, x_3 are non-negative integers.

(b) Search for minimum of the objective function $y = x_1^2 + 3x_2^2 + 5x_3^2$, starting from the base point (2, -1, 1). **07**

Q.4 **(a)** Find the minimum of the objective function using sequential simplex method. **08**

$y = x_1^2 + x_2^2 + 4x_3^2 + x_4^2$

Carry out eight cycles of vertex rejection and regeneration.

(b) Define a suitable search region and a feasible initial base point for the complex method of search in minimizing $y = x_1^3 - 2x_1x_2 + x_2^4$ subject to the restrictions that $x_1^2 + 2x_2^2 - 4 \le 0$. **06**

Setup a complex method of search and carryout two cycles of search.

OR

Q.4 **(a)** A log has the form of a frustum of cone 30 feet long, the diameters of its ends being 2 feet and 1 foot. A beam of square section is to be cut from the log. Find the length if the volume is maximum. **06**

(b) Find the global minimum and maximum of the function $y = x_2 - x_1^2$ if it is subject to the restriction that $1 - x_1^2 - x_2^2 = 0$ using the penalty function method. **08**

Q.5 **(a)** Using the Hooke-Jeeves search technique, seek the minimum of the objective function $y = 8x_1^2 + 4x_1x_2 + 5x_2^2$ starting from the point (-4,-4). **07**

(b) List the first four search directions for Powell's method to minimize $f(x) = x_1^2 + \exp(x_1^2 + x_2^2)$, staring at the point (2, 2). **07**

OR

Q.5 **(a)** An open top box is to be made out of a piece of cardboard measuring 2m X 3m by cutting off equal surfaces from the corners and turning up the side. Find dimensions of the box for maximum volume. **06**

(b) Find the maximum of $y = 6x_1x_2^{-1} + x_2x_1^{-2}$ subject to $h(x) = x_1x_2 - 2 = 0$; $g(x) = x_1 + x_2 \ge 1$; using direct successive QP from the initial point (2,1). **08**

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