

GUJARAT TECHNOLOGICAL UNIVERSITY**BE- SEMESTER-VII (NEW) EXAMINATION – WINTER 2024****Subject Code:3170513****Date:19-11-2024****Subject Name: Process Modelling, Simulation and 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.
4. Simple and non-programmable scientific calculators are allowed.

		MARKS
Q.1	(a) Determine whether the function is convex or concave. $f(x) = 2x_1^2 - 3x_1x_2 + 2x_2^2$	03
	(b) A box with a square base and open top is required to construct having volume of 1000 cm^3 . Find the dimensions that require the least material (assume uniform thickness of material) to construct the box.	04
	(c) Write the steps for solving optimization problems. Also list the common obstacles faced while solve optimization problems.	07
Q.2	(a) Briefly explain the fundamental laws used in model building of chemical engineering systems.	03
	(b) Explain Random search and grid search method for unconstrained multivariable optimization.	04
	(c) Develop a model for a batch reactor where a series reaction $A \rightarrow B \rightarrow C$ takes place inside the reactor and B is the desirable product. The batch reactor consists of a jacket for heating and cooling purposes. Make other suitable assumptions wherever necessary.	07
	OR	
	(c) Find the extreme points of the function and classify them. $f(x) = x_1^3 + x_2^3 + 2x_1^2 + 4x_2^2 + 6$	07
Q.3	(a) Differentiate between steady state and dynamic simulation.	03
	(b) Show the advantages and disadvantages of region elimination methods.	04
	(c) List the applications of optimization in chemical process and plants. Explain any one in detail.	07
	OR	
Q.3	(a) Minimize the quadratic function $f = x^2 - x$ by Newton method. Use the range -3 to +3.	03
	(b) Determine the optimum L/D ratio for a cylindrical storage vessel. List the necessary assumptions.	04
	(c) Minimize the function $f = 4x^3 + x^2 - 7x + 14$ in the interval 0 and 1 using (i) Bisection method and (ii) Golden section method. Compare the methods.	07
Q.4	(a) Compare linear model and non-linear model with example.	03
	(b) Differentiate between design mode and analysis mode in process simulation with the help of a diagram.	04

- (c) Solve the following Linear Programming problem using Simplex method 07

$$\text{Maximize } Z = x_1 + 2x_2 + x_3$$

subject to:

$$2x_1 + x_2 - x_3 \leq 2$$

$$-2x_1 + x_2 - 5x_3 \geq -6$$

$$4x_1 + x_2 + x_3 \leq 6$$

$$x_1, x_2, x_3 \geq 0.$$

OR

- Q.4 (a)** Minimize the function $f = 4x_1^2 + x_2^2 - 2x_1x_2$ using Newton's method. Take starting point [1, 1]. 07

- (b)** Solve the following non-linear function with constraints using Lagrange multiplier method. 07

$$\begin{aligned} \text{Minimize:} \quad & f(x,y) = k x^{-1} y^{-2} \\ \text{subject to:} \quad & g(x,y) = x^2 + y^2 = a^2 \end{aligned}$$

- Q.5 (a)** Describe the role of optimization in shell and tube heat exchanger design. 03

- (b)** Discuss the salient features of basic tearing algorithm with a flowchart. 04

- (c)** Develop a model for a series of isothermal, variable hold-up CSTRs in which a first order reaction $A \rightarrow B$ is taking place. State the assumptions clearly. 07

OR

- Q.5 (a)** Derive relation for solute to be extracted in a steady state two stages solvent extraction unit. Using this relation develop relation for 'N' stages. 07

- (b)** List the process simulators used in chemical engineering. Discuss the common features of process simulators. 07
