Seat No./Enrollment No.: _____

GUJARAT TECHNOLOGICAL UNIVERSITY
BACHELOR OF ENGINEERING – SEMESTER 7 – EXAMINATION – SUMMER 2026

Subject Code: 3170513 **Date: 20/05/2026**

Subject Name: Process Modelling, Simulation and Optimization

Time: 02:30 PM TO 05:00 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.**

Q.1 **(a)** List the various professional simulators used in chemical engineering. **03**

(b) Describe briefly the fundamental laws used in mathematical models of chemical engineering systems. **04**

(c) Explain the steps for solving optimization problems. Enlist the general obstacles faced while solving optimization problems. **07**

Q.2 **(a)** Define: black-box model, white box model, gray model. **03**

(b) Differentiate between design mode and analysis mode in process simulation with a diagram. **04**

(c) Discuss the role of optimization in design and operation of binary distillation column with a focus on optimum reflux ratio. **07**

OR

Q.2 **(c)** A closed cylindrical vessel can hold 20π m^3 of liquid. The material for the top and bottom costs \$10 per m^2 and material for the side costs \$8 per m^2. Find the radius and height of the most economical vessel. **07**

Q.3 **(a)** Find the values of x and z (both > 0) that maximize the function: **03**

$U = -x^2 + 10x + xz - z^2 + 8z + 2$

(b) Minimize $f(x) = x^2 - x$ by Newtons method and Secant method. Use the starting point in the range of -3 to +3. Compare the methods. **04**

(c) Minimize the function $f(x) = x^2 + \frac{54}{x}$ between the interval [2, 5] using (i) Bisection search method, (ii) Golden section search method. Compare the methods. **07**

OR

Q.3 **(a)** List the application of optimization in chemical engineering. **03**

(b) Find the extreme points of the function and classify them. **04**

$f(x) = {x_1}^3 + {x_2}^3 + 2{x_1}^2 + 4{x_2}^2 + 6$

(c) Solve the following Linear Programming Problem by Simplex method. **07**

Maximize $Z = 5x_1 + 3x_2$

subject to:

$x_1 + x_2 \leq 2$

$5x_1 + 2x_2 \leq 10$

$3x_1 + 8x_2 \leq 12$

$x_1, x_2 \geq 0$

Q.4 **(a)** Elaborate the process to build a model. **03**

(b) Derive the model equations for two heated tanks. **04**

(c) An oven is tested for heating and the following set of time and temperature data is collected. Fit the data to the equation, $T = a + bt$ where *a* and *b* are constants. **07**

t in min	1	2	3	4	5
T in ^{0}C	12.5	21.4	31.8	42.1	53.5

OR

Q.4 **(a)** Explain Random search method for multivariable optimization and its importance. **03**

(b) Minimize the function $f(x) = 8{x_1}^2 + 5{x_2}^2 + 4x_1x_2$ using Newtons method. Take starting point X_0 = [10,10]. **04**

(c) Develop a model for batch reactor. State the assumptions clearly. **07**

Q.5 **(a)** Differentiate between steady state versus dynamic simulation. **03**

(b) Explain equation solving approach with an example. **04**

(c) Develop a model for mixing tank. State the assumptions. **07**

OR

Q.5 **(a)** Write short note on decomposition of networks. **03**

(b) Minimize $f(x) = 4{x_1}^2 + 5{x_2}^2$ subject to $2x_1 + 3x_2 = 6$ using Lagrange multiplier method. **04**

(c) Write about partition and tearing applied to process flow sheeting. Explain any tearing algorithm with a flowchart. Write the steps clearly. **07**

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