Seat No.: ________ Enrolment No.

GUJARAT TECHNOLOGICAL UNIVERSITY

BE- SEMESTER–VIII (NEW) EXAMINATION – WINTER 2020

Subject Code: 2180503 **Date: 28/01/2021**

Subject Name: Process Modeling , Simulation & Optimization

Time: 02:00 PM TO 04:00 PM **Total Marks: 56**

Instructions:

1. **Attempt any FOUR questions out of EIGHT questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Differentiate between deterministic and stochastic models. **03**

(b) Describe any one chemical process simulator and its salient features. **04**

(c) Develop the equations for the series of isothermal, variable holdup CSTRs. List all the assumptions with their justifications. **07**

Q.2 **(a)** Minimize f(x) = $4x_1^2 + 5x_2^2$ subject to $2x_1 + 3x_2 - 6 = 0$ using Lagrange multipliers method. **03**

(b) Determine the optimum L/D ratio for a cylindrical storage vessel. Compare it with the thumb rule L/D = 3. List the necessary assumptions. **04**

(c) What is Optimization? List the six general steps for the analysis and solution of optimization problems. **07**

Q.3 **(a)** Explain the uses of mathematical models. **03**

(b) Compare different methods used for economic analyses. **04**

(c) The analysis of labor costs involved in the fabrication of heat exchangers can be used to predict the cost of a new exchanger of the same class. Let the cost be expressed as a linear equation. **07**

$C = \beta_1 + \beta_2 A + \beta_3 N$

Where β_1, β_2, and β_3 are constants, N = number of tubes, A = shell surface area. Estimate the values of the constants β_1, β_2 and β_3 from the data in following table.

Labor cost ($)	310	300	275	250	220	200	190	150	140	100
Area (A)	120	130	108	110	84	90	80	55	64	50
No. of tubes (N)	550	600	520	420	400	300	230	120	190	100

Q.4 **(a)** List various equations for the chemical kinetics used in process modeling. **03**

(b) Describe in detail the principles of formulation of mathematical models. **04**

(c) Discuss the optimization of a pipe diameter. **07**

Q.5 **(a)** Minimize $f = (x - 1)^4$ by Newton's method, starting at $x_0 = -1.5$. **03**

(b) Develop the model equations for a single component vaporizer **04**

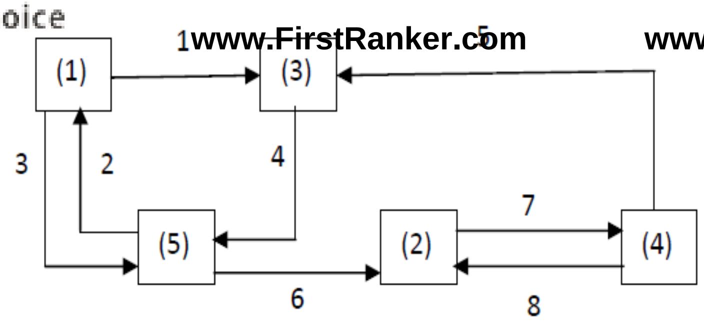
(c) Explain black-box model, white-box model, and gray model. **07**

Q.6 **(a)** Mention the conditions to be satisfied for extremum of the function of a single variable and find extremum for $f(x) = x^4$. **03**

(b) For the digraph given below: **04**

i) develop a signal flow graph.

ii) find the streams that are to be teared (i.e. cut set) using any algorithm. Write the important steps.



(c) Explain the fundamental laws of physics and chemistry with their application to simple chemical systems. **07**

Q.7 (a) Differentiate between equation oriented model and modular based model. **03**

(b) A chemical process is represented by the following set of equations: **04**

$f_1(x_3, x_4) = 0$; $f_2(x_5, x_2) = 0$; $f_3(x_6) = 0$;

$f_4(x_6, x_1) = 0$; $f_5(x_3, x_2) = 0$; $f_6(x_4, x_5, x_1) = 0$

Determine Associated incidence matrix, digraph of the process and associated adjacency matrix.

(c) A refinery has two crude oils that have the yields shown in the following table. Because of equipment and storage limitations, production of gasoline, kerosene, and fuel oil must be limited as also shown in this table. There are no plant limitations on the production of other products such as gas oils. The profit on processing crude #1 is \$l.00/bbl and on crude #2 it is \$0.70/bbl. Find the approximate optimum daily feed rates of the two crudes to this plant via a graphical method. **07**

	Volume % Yields		Maximum allowable Product rate (bbl/day)
	Crude #1	Crude #2	
Gasoline	70	31	6,000
Kerosene	6	9	2,400
Fuel oil	24	60	12,000

Q.8 (a) A cylindrical container is designed to hold 20π m^3 of liquid. The material for the top and bottom costs \$10 per m^2 and material for the sides costs \$8 per m^2. Find the radius (r) of the base and height (h) of the most economical container. **03**

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

(c) Classify the methods to solve unconstrained multivariable problems. **07**

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