Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VII (NEW) EXAMINATION – WINTER 2021

Subject Code:3170513 Date:17/12/2021

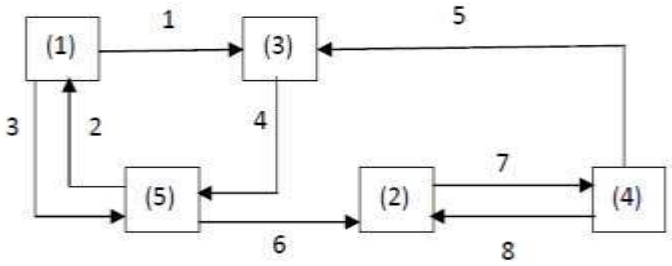
Subject Name:Process Modelling, Simulation and Optimization

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.**

Q.1	**(a)**	List the applications of optimization in chemical process engineering.	**03**
	(b)	List out various professional process simulator and explain any one in brief.	**04**
	(c)	Discuss essential feature of optimization problem.	**07**
Q.2	**(a)**	Compare lumped parameter model and distributed parameter model.	**03**
	(b)	A poster is to contain 300 cm^2 of printed matter with margins of 6cm at the top and bottom and 4cm at each side. Find the overall dimensions that minimize the total area of the poster.	**04**
	(c)	Explain basic tearing algorithm.	**07**
		OR	
	(c)	For the digraph given below: i) Develop a signal flow graph. ii) Find the streams that are to be teared (i.e. cut set) using Kehat and Shacham Algorithm.	**07**



Q.3	**(a)**	Define: simulation, optimization and modelling.	**03**
	(b)	Explain partitioning with suitable example.	**04**
	(c)	Describe classification of mathematical modelling based on state of the process.	**07**
		OR	
Q.3	**(a)**	Define continuity of function and convexity.	**03**
	(b)	Explain importance of modelling for simulation and optimization.	**04**
	(c)	Explain Simultaneous modular approach in simulation.	**07**
Q.4	**(a)**	Explain black box model.	**03**
	(b)	Explain Lagrange multiplier and the Kuhn-Tucker conditions.	**04**
	(c)	Determine the mathematical model for isothermal CSTR with constant hold-up.	**07**
		OR	
Q.4	**(a)**	Show the advantages and disadvantages of Newton's method.	**03**
	(b)	Determine the Hessian matrix of the function f(x) $= 2x_1^2 - 3x_1x_2 + 2x_2^2$	**04**
	(c)	List the methods for unconstrained multivariable optimization problems. Explain any one in brief.	**07**

Q.5 **(a)** Minimize the function f(x) $=x^2 - x$ using quadratic interpolation three point bracketing the minimum (-1.7,-0.1, 1.5) are used to start the search for the minimum of f(x). **03**

(b) List the various equations of chemical kinetics used in process modelling. **04**

(c) Minimize function f(x) $=x^4 - x + 1$ using Newton's method for starting point x=3 show five iterations. **07**

OR

Q.5 **(a)** Minimize the quadratic function f(x) $=x^2 - x$ using quasi Newton method start with x= -3 and x= 3. **03**

(b) Discuss the degree of freedom analysis with suitable example. **04**

(c) Solve the following linear programming problem using simplex method **07**

Maximize Z= $12\ x_1 + \ 16\ x_2$

Subject to $10\ x_1 + \ 20\ x_2 \leq 120$

$8\ x_1 + \ 8\ x_2 \leq 80$

$x_1, x_2 \geq 0$

Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VII (NEW) EXAMINATION – SUMMER 2022

Subject Code:3170513 Date:14/06/2022

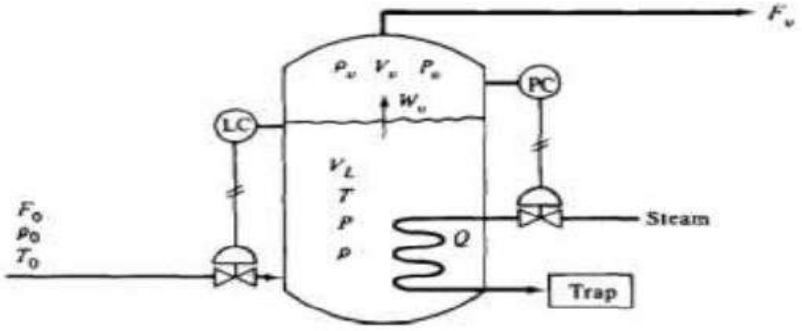
Subject Name:Process Modelling, Simulation and Optimization

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.**

			MARKS
Q.1	**(a)**	List out the important model building steps for a process.	**03**
	(b)	Write the various equations of motion for process modeling.	**04**
	(c)	Explain the six steps for solving optimization problems. List the general obstacles to solve optimization problems.	**07**
Q.2	**(a)**	Explain the uses of mathematical models.	**03**
	(b)	Minimize f(x) = $4{X_1}^2 + 5{X_2}^2$ subject to $2X_1 + 3X_2 - 6 = 0$ using Lagrange Multipliers method.	**04**
	(c)	Explain black-box model, white-box model, and gray model.	**07**
		OR	
	(c)	What is linear Programming Problem? State the linear programming in standard form and write down its application in chemical industries.	**07**
Q.3	**(a)**	Differentiate between deterministic and stochastic models.	**03**
	(b)	List various equations for the chemical kinetics used in process modeling.	**04**
	(c)	What are the necessity and sufficiency conditions for the optimization problems? Give examples of Optimization applied to Chemical Industries.	**07**
		OR	
Q.3	**(a)**	Maximize f(x) = $1 - 8x + 2x^2 - \frac{10}{3}x^3 + \frac{1}{4}x^4 + \frac{4}{5}x^5 - \frac{1}{6}x^6$ By Newton's method (two iterations will suffice). Start at $\boldsymbol{x}$ = -2. Hint: $f'(x) = (1+x)^2(2-x)^3$	**03**
	(b)	Compare linear model and non linear model.	**04**
	(c)	Explain partitioning and tearing with example.	**07**
Q.4	**(a)**	Show the advantages and disadvantages of Newton's Method.	**03**
	(b)	A box with a square base and open top is design to hold 1000 cm^3 of material. Find the dimensions that require the least material (assume uniform thickness of material) to construct box.	**04**
	(c)	Consider the vapourizer sketched in the figure.	**07**



Liquefied petroleum gas (LPG) is fed into a pressurized tank to hold the liquid level in the tank. We will assume that LPG is a pure component: propane. The liquid in the tank is assumed perfectly mixed. Heat is added at a rate Q to hold the desired pressure in the tank by vapourizing the liquid at a rate Wv (mass per time). Heat losses and the mass of the tank walls are assumed negligible. Gas is drawn off the top of the tank at a volumetric flow rate Fv. Fv is the forcing function or load disturbance. Derive the model equations for the system for steady state model and liquid and vapour dynamics model.

OR

Q.4	**(a)**	List out essential features of optimization	**03**
	(b)	List the applications of optimization in chemical engineering.	**04**
	(c)	Write down various professional simulation packages and explain features of any one shortly.	**07**
Q.5	**(a)**	Develop the model equations for a single component vaporizer.	**03**
	(b)	Explain Simplex algorithm for linear programming.	**04**
	(c)	Maximize following function using Simplex method; f = $x_1 + 3x_2$ subject to $-x_1 + x_2 + x_3 = 1$ $x_1 + x_2 + x_4 = 2$ $x_i \geq 0$ where i= 1,2,3,4 where x_1, x_2, x_3, x_4 are slack variables.	**07**

OR

Q.5	**(a)**	Derive the model equations for two heated tanks.	**03**
	(b)	Determine convexity or concavity for the following function, f(x) = $2X_1^2 - 3X_1X_2 + 2X_2^2$	**04**
	(c)	Discuss the optimization recovery of waste Heat.	**07**

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