Enrolment No./Seat No_____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE- SEMESTER–VIII (NEW) EXAMINATION – WINTER 2024

Subject Code:2180503 Date:19-11-2024

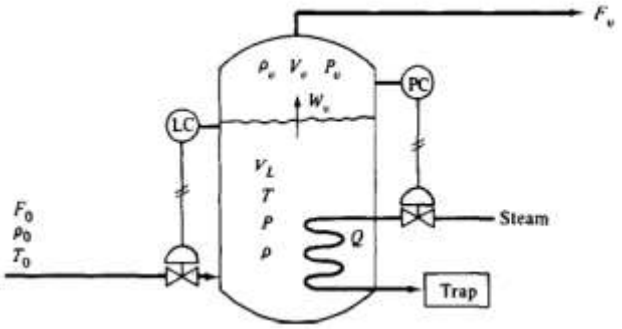
Subject Name: Process Modeling, Simulation & Optimization

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)**	Explain the uses of mathematical models.	**03**
	(b)	Describe in brief the transport equations used for modeling.	**04**
	(c)	Explain partitioning and tearing with examples.	**07**
Q.2	**(a)**	Explain the following terms for optimization: feasible solution, feasible region and optimum solution.	**03**
	(b)	Derive the mathematical model for the isothermal CSTR with constant hold up.	**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

	(c)	Derive a mathematical model for the batch distillation with holdup.	**07**
Q.3	**(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)	Explaini) digraph, and ii) signal flow graph, with diagram.	**04**
	(c)	Explain the fundamental laws of physics and chemistry with their application to simple chemical systems.	**07**

OR

Q.3	**(a)**	Minimize the quadratic function: $f(x) = x^2 – x$ using quasi-newton method.	**03**
	(b)	Describe in detail the principles of formulation of mathematical models.	**04**
	(c)	Explain scope and hierarchy of optimization.	**07**

Q.4 **(a)** Discuss classification of the methods to solve unconstrained multivariable problems. **03**

(b) Explain fitting of vapour-liquid equilibrium data by non-linear regression. **04**

(c) Minimize $f(x) = x^4 - x + 1$ using Newton's method for a starting point of x=0.6 (Show 3 iterations, use four decimal point accuracy). **07**

OR

Q.4 **(a)** Explain the differences between steady state and dynamic simulation. **03**

(b) Define the different measures of profitability/economic performance along with their significance. **04**

(c) Fit the exponential curve $y = ae^{bx}$ to following data: **07**

x	2	4	6	8
y	25	38	56	84

Q.5 **(a)** Explain sequential modular approach for simulation with proper examples. **03**

(b) Discuss the necessity and sufficiency conditions for the optimization problems. **04**

(c) Derive the model equations for the two heated tanks. Draw a neat sketch and list out all assumptions. **07**

OR

Q.5 **(a)** Discuss the degree of freedom analysis with suitable example. **03**

(b) Explain random search and grid search method for unconstrained multivariable optimization. **04**

(c) A box with a square base and open top is to hold 1000 cm^3. Calculate the dimensions that require the least material (assume uniform thickness of material) to construct the box. **07**

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