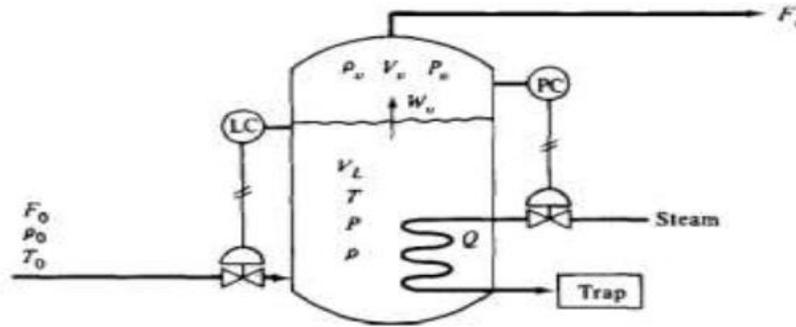


**GUJARAT TECHNOLOGICAL UNIVERSITY****BE - SEMESTER-VII (NEW) EXAMINATION – SUMMER 2022****Subject Code:3170513****Date:14/06/2022****Subject Name:Process Modelling, Simulation and Optimization****Time:02:30 PM TO 05:00 PM****Total Marks: 70****Instructions:**

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



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  $W_v$  (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  $F_v$ .  $F_v$  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; **07**

$$f = x_1 + 3x_2$$

subject to

$$-x_1 + x_2 + x_3 = 1$$

$$x_1 + x_2 + x_4 = 2$$

$$x_i \geq 0 \text{ where } i=1,2,3,4$$

where  $x_1, x_2, x_3, x_4$  are slack variables.

**OR**

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

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