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B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

February / March 2023 Semester End Main Examinations

Programme: B.E. **Semester: V**
Branch: Chemical Engineering **Duration: 3 hrs.**
Course Code: 19CH5DELB2 **Max Marks: 100**
Course: Optimization of Chemical Processes **Date: 01.03.2023**

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

UNIT - I

1 a) Apply concept of optimization to find the optimal length to diameter ratio (L/D) of a pressure vessel that minimizes capital cost of the vessel. **06**

b) Explain six steps of optimization with an example. **06**

c) Elucidate scope and hierarchy of optimization. **08**

UNIT - II

2 a) Analyze for convexity and concavity of the following functions. **08**

$$f(x) = 11x^2 - 3x + 45$$

$$f(x) = -9x^3 + 13x^2 - 6x + 28$$

$$f(x, y) = x^2 + 3xy + 4y^2 + x - 4y - 39$$

b) Find the optimal solution for the following unconstrained optimization problems using Newton's method. **06**

$$f(x) = 2x^2 - 3x + 1$$

c) Check for continuity of the given below functions and their first derivative. **06**

$$f(x) = \frac{1}{17x} + 11x$$

$$f(x) = \ln(2x) + 5x^2$$

UNIT - III

3 a) Solve the following constrained optimization problem applying Simplex method. **10**

$$Maximize \quad 10x_1 + 15x_2 + 20x_3$$

$$Subject\ to$$

$$2x_1 + 4x_2 + 6x_3 \leq 24$$

$$3x_1 + 9x_2 + 6x_3 \leq 30$$

$$x_1, x_2 and\ x_3 \geq 0$$

b) Solve the following constrained optimization problem using Simplex method. **10**

$$Minimize \quad 3x_1 + 2.5x_2$$

$$Subject\ to$$

$$2x_1 + 4x_2 \geq 40$$

$$3x_1 + 2x_2 \geq 50$$

$$x_1, x_2 \geq 0$$

UNIT - IV

4 a) Explain the steps involved in optimization of flow rates in a liquid-liquid extraction column. **10**

b) Derive the objective function and constrained equations for optimal design and operation of a conventional staged distillation column. **10**

OR

5 a) Elucidate the steps involved in optimization of a shell and tube heat exchanger design. **10**

b) Develop the objective function of optimal recovery of waste heat and find the optimal temperature of working fluid. **10**

UNIT - V

6 a) Apply material balance and energy balance to develop a model for optimal design of ammonia reactor. List the assumptions made. **10**

b) Find the optimal diameter of pipe in a flow system for turbulent flow. **10**
Assume friction factor $f = 0.046Re^{-0.2}$

OR

7 a) Find the optimal inter-stage pressure of a gas compression system for minimum work. **10**

b) Summarize and explain the relevant equations involved in economic operation of a fixed bed filter. **10**

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