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

Autonomous Institute Affiliated to VTU

January / February 2025 Semester End Main Examinations

Programme: B.E. **Semester: V**

Branch: Chemical Engineering **Duration: 3 hrs.**

Course Code: 23CH5PELA3 / 22CH5PELA3 **Max Marks: 100**

Course: Optimization of Chemical Processes

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	*CO*	*PO*	Marks
1	a	List the application of optimization in different chemical processes.	*CO1*	*PO2*	**06**
	b	A poster contains 300 cm^2 of printed matter with margins of 6 cm at the top and bottom and 4 cm at each side. Find the overall dimensions that minimize the total area of the poster.	*CO1*	*PO2*	**06**
	c	Company was proposed with two plans to supply water for an industry. Plan A requires a pipeline costing $160,000 with annual operation and recurring costs of $2200, and an estimated life of 30 years with no salvage. Plan B requires a flume costing $34,000 with a life of 10 years, a salvage value of $5600, and annual operation and recurring cost of $4500 plus a ditch costing $58,000, with a life of 30 years and annual costs for maintenance of $2500. Using an interest rate of 12 percent, compare the net present values of the two alternatives and explain the best plan.	*CO1*	*PO2*	**08**
		OR			
2	a)	Apply the concept of optimization to find the optimal length to diameter ratio (L/D) of a pressure vessel that minimizes capital cost of the vessel.	*CO1*	*PO2*	**08**
	b)	Explain the six steps of optimization with an example.	*CO1*	*PO2*	**06**
	c)	Elucidate the scope of optimization.	*CO1*	*PO2*	**06**
		UNIT - II			
3	a)	Analysis following functions list below to check if its continuous or not. Show the range of x for which the functions are continuous. i. $f(x) = \frac{1}{x}$ ii. $f(x) = \ln(x)$	*CO2*	*PO7*	**10**

		b)	Explain the Newton's and quasi newtons method to optimize one dimensional function. List all the relevant equations applied in both the methods.	*CO2*	*PO7*	**10**
			OR			
	4	a)	Evaluate the given objective functions are convex or concave in nature i. $f(x_1,x_2) = (x_1-x_2)^2+ x_2^2$ ii. $f(x_1,x_2, x_2) = x_1^2+ x_2^{2+} x_3^2$ iii. $f(x_1,x_2) = e^{x1}+ e^{x2}$	*CO2*	*PO7*	**10**
		b)	Laboratory filtration study is to be carried out at constant rate. The filtration time is expressed as $$t_f = \beta \times \left[\frac{\Delta P_c \times A^2}{\mu M^2 C}\right] \times x_C \times e^{(-ax_C+b)}$$ Where, t_f= time to build the filter cake, min; $\beta = 3.2\times10^{-8}$ kg/m^2 C=0.01 kg/kg of filtrate, a=3.643, b=2.680 and x_C is the mass fraction solids in the dry cake. Evaluate the max time for filtration as a function of x_C by Newtons method.	*CO2*	*PO7*	**10**
			UNIT - III			
	5	a)	Solve the function given below using geometry of linear program method. Plot the given constraints and located the optimized maximum value of the given function. Maximize: $f = x_1 + 3x_2$ Subjected to three constraints: Constraint 1: $-x_1 + x_2 \leq 1$ Constraints 2: $x_1 + x_2 \leq 2$; and Constraint 3: $x_1 \& x_2 \geq 0$.	*CO3*	*PO2*	**10**
		b)	Solve the following constrained optimization problem applying Simplex method. $$Maximize \quad x_1 + 2x_2 + x_3$$ $$Subject\ to$$ $$2x_1 + x_2 - x_3 \leq 2$$ $$2x_1 - x_2 + 5x_3 \leq 6$$ $$4x_1 + x_2 + x_3 \leq 6$$ $$x_1, x_2 and\ x_3 \geq 0$$	*CO3*	*PO2*	**10**
			OR			
	6	a)	Solve the following constrained optimization problem applying simplex method Minimize $f = 3x_1+x_2-x_3$ Subjected to $x_1-2x_2+x_3 \leq 11$ $4x_1-x_2-2x_3 \leq 3$ $-2x_1-0x_2+x_3 \leq 1$ $x_1, x_2, x_3 \geq 0$	*CO3*	*PO2*	**10**

		b)	Consider the linear program and plot the geometry of the linear program based on the objective function and constraints given to find optimal value to maximize the function Maximize $f = x_1+2x_2$ *Subjected to* $-x_1-3x_2 \leq 10$ $x_1+x_2 \leq 6$ $x_1, x_2 \geq 0$	*CO3*	*PO2*	**10**
			UNIT - IV			
	7	a)	Explain the steps involved in Optimization of flow rates in a Liquid-Liquid Extraction column. List the objective function considering a suitable economical model and all relevant equations as constraints.	*CO4*	*PO6*	**10**
		b)	Formulate an objective function and constrained equations for optimal design and operation of a conventional staged distillation column by applying suitable material and energy balance. List all the assumptions in detail.	*CO4*	*PO6*	**10**
			OR			
	8	a)	Formulate the objective function and the constraints equations to optimize the heat transfer area required for a shell and tube heat exchanger. List all the assumptions made to optimize the shell and tube heat exchanger.	*CO4*	*PO6*	**10**
		b)	Develop objective function of optimal recovery of waste heat and find the optimal temperature of working fluid. Data given: U = f (working fluid and operating temp), C_A = cost per unit area of the heat exchanger, r = annual capital investment, C_b = annual capital cost for boilers, C_{op} = operating cost, η = overall system efficiency, t = operating time in hrs, Δw = power from the boiler, and C_H = value of the power ($/ kW. h).	*CO4*	*PO6*	**10**
			UNIT - V			
	9	a)	Consider a Haber process for synthesis ammonia. The temperature at which the reaction rate is a maximum decrease as the conversion increases. Apply the energy balance and mass balance for each component considering suitable reaction in the ammonia reactor to optimize the reactor design.	*CO4*	*PO6*	**10**
		b)	Find the optimal inter-stage pressure of a gas compression system for minimum work.	*CO4*	*PO6*	**10**
			OR			
	10	a)	Find optimal diameter of pipe in a flow system for turbulent flow. Assume friction factor $f = 0.046Re^{-0.2}$	*CO4*	*PO6*	**10**
		b)	Illustrate the material and energy balances applied to optimize the gas transmission line for gas-oil processing industry.	*CO4*	*PO6*	**10**

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