Ref. No.: Ex/Che/PC/H/T/412/2025

B.E. CHEMICAL ENGINEERING FOURTH YEAR FIRST SEMESTER - 2025

OPTIMIZATION METHODS IN CHEMICAL ENGINEERING(HONS.)

Time: 3 Hrs. Full Marks: 100

Answer any _four_ questions

Assume any missing data

CO	Question	Marks
CO1	1. A. What is objective function related to optimization problem? B. Consider a vertical cylindrical tank of diameter D and height H. Draw a schematic of the system. Discuss how an optimization problem may be framed for minimum cost of construction of the tank? C. Mathematically derive the objective function for fabrication cost of the tank of given volume V, considering different fabrication cost per unit area for flat and curved surfaces. D. Find out the optimum aspect ratio of the tank of given volume for minimum cost. E. A polymer user company has 6kg of PP resin and 24 hours of free time in which two products A and B are to be made. Each product A requires 2kgs of PP and 7hrs of time while each product B requires 1kg of PP and 8hrs of time. The prices of the products are decided to be Rs.120 and Rs.80 respectively. How many each product should be made to maximize the sale revenue? F. Maximize $z = -x_1 - x_2 - x_3$ subjected to $x_1^2 + x_2 - 3 = 0$, $x_1 + 3x_2 + 2x_3 - 7 = 0$. Also determine whether function is concave or not.	**2+3+4+4+2+10**
CO2 & CO4	2. A. The total annual cost of operating a pump and motor (C) in a particular piece of equipment is a function of x, the size (horsepower) of the motor is $$C = \$500 + \$0.9x + \frac{\$0.03}{x}(150{,}000)$$ Find the motor size that minimizes the total annual cost. B. Maximize $f(x_1, x_2) = \pi x_1^2 x_2$ subject to $2\pi x_1^2 + 2\pi x_1 x_2 - A_0$ where $A_0 = 6\pi$	**10+15**
CO3	3. Compare two region elimination method, the golden section search and Fibonacci search method in terms of the obtained interval after 5 functions evaluations for the minimization of the function below in the interval (0,5). $$f(x) = x^2 + {}^{54}/_{x}$$	**25**

[Turn over

CO4	4. i) A chemical plant makes three products E, F, G and utilizes three raw materials (A, B, C) in limited supply. Each of three products is produced in a separate process (process 1, 2 and 3). The available A, B, C do not have to be totally consumed.	**10+15**

Process Data available:

Process 1: A+B→E   Process 2: A+B→F   Process 3: 3A+2B+C→G

Process	Product	Reactant Required (Kg/kg product)	Processing cost (product) (Rs/kg)	Selling price (product) (Rs/kg)
1	E	2/3 A, 1/3 B	1.5	4.0
2	F	2/3 A, 1/3 B	0.5	3.3
3	G	½ A, 1/6 B, 1/3 C	1.0	3.8

Raw material	Max. available (kg/day)	Cost (Rs/kg)
A	40000	1.5
B	30000	2.0
C	25000	2.5

Formulate the objective function to maximise the total operating profit/day in Rs. /day.

ii) Maximise $f(x) = \left(\frac{x}{2}\right) for\ x \le 2, f(x) = -x + 3\ for\ x > 2$ in interval (0,3) by Fibonacci method using n=6

CO3	5. Maximise $z = 5x_1 + 4x_2$ subject to $6x_1 + 4x_2 \le 24$. When $x_1 + 2x_2 \le 6$, $-x_1 + x_2 \le 1, x_2 \le 2, x_1, x_2 \ge 0$	**25**
CO3	6. Perform three iterations of the cubic search method to minimize the function and compare with the results obtained from successive quadratic estimation method, $f(x) = (x^2 - 1)^3 - (2x - 5)^4$	**25**