Ref. No. : Ex/Che/PC/H/T/412/2024

B.E. CHEMICAL ENGINEERING FOURTH YEAR FIRST SEMESTER - 2024
OPTIMIZATION METHODS IN CHEMICAL ENGINEERING (HONS.)

Time: 3 hrs **Full Marks: 100**

Answer any four questions etc.

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 needed to 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 products should be made to maximize the sale revenue?
   (f) Maximize $z = 5x_1 + 4x_2$, subject to $6x_1 + 4x_2 \leq 24$. Where $x_1 + 2x_2 \leq 6$, $-x_1 + x_2 \leq 1$, $x_2 \leq 2$, $x_1, x_2 \geq 0$.
   (g) Consider a function $f(x) = 2x_1^2 + 5x_2^2 + 5x_3^2 + 6x_1x_2 + x_1x_3 + 2x_2x_3 - 3x_1 - 2x_2 + 15$. Find out whether it is concave or convex.

   2+3+4+4+2+5+5

2. (a) A manufacturing firm produces two products, A and B, using two limited resources. The maximum number of resources 1 and 2 available per day are 1000 and 200 units, respectively. The production of 1unit of product A requires 1 unit of resource 1 and 0.2 unit of resource 2, and the production of 1 unit of product B requires 0.5 unit resource 1 and 0.5 unit of resource 2. The unit costs of resources 1 and 2 are given by the relations $(0.375 - 0.00005u_i)$ and$(0.75 - 0.000u_i)$, respectively, where $u_i$denotes the number of units of resources i used (i=1,2). The selling price per unit of products A and B, P_A and P_B, are given by

$$P_A = 2.00 - 0.0005x_A - 0.00015x_B$$
$$P_B = 3.50 - 0.0002x_A - 0.0015x_B$$

   Where x_A and x_B indicates the number of units of products A and B sold. Formulate the problem of maximising the profit if the firm can sell all the units it manufactures.

   (b) Minimise $f(x) = 0.65 - [0.75/(1 + x^2)] - 0.65x \tan^{-1}(1/x)$ in the interval [0, 3] by the Fibonacci method using n=6. 12+13

3. (a) Find the maximum of $f = x(1.507 - x)$ in interval (0, 1.0) within 10% of the exact value.
   (b) Maximise $f(x_1, x_2) = \pi x_1^2 x_2$ subject to $2\pi x_1^2 + 2\pi x_1 x_2 - A_0 = 0$ where$A_0 = 24\pi$. 12+13

4. Maximise $z = 5x_1 + 4x_2$ subject to $3x_1 + 2x_2 \leq 12$. Given that, $x_1 + 2x_2 \leq 6$, $-x_1 + x_2 \leq 1$, $x_2 \leq 2$, $x_1, x_2 \geq 0$. 25

5. Maximise $z = x_1 + 3x_2$ subject to $-x_1 + x_2 + x_3 = 1, x_1 + x_2 + x_4 = 2$. $x_1 \geq 0$, i=1,.....4. where x_3, x_4 are slack variables. Solve for the maximum using the simplex method. 25