Ref. No. : Ex/ChE/T/325/2018(Old)

B.E. CHEMICAL ENGINEERING THIRD YEAR SECOND SEMESTER (Old) - 2018

OPTIMIZATION METHODS

Time: Three hours **Full Marks: 100**

Answer any FIVE questions
Assume any missing data
Notations have usual significance
All parts of a question should be answered together and sequentially

1(a) What is objective function related to optimization problem?
(b) Consider a vertical cylindrical tank of diameter D and Height H. Draw a neat 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 costs 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) In the formulation of objective function mention necessary conditions for the tank dimensions.

2+3+8+7+1=20

2(a) Consider the following series reaction taking place in a PFR:

$$A \xrightarrow{K1} B \xrightarrow{K2} C$$

Assume B is the desired product.
Write Model equations for concentration distributions of A, B, and C with respect to time.
(b) Explain the problem in the light of optimization problem.
(c) Write required objective function for maximization of production of B.
(d) What are necessary and sufficient conditions for maxima?
(e) Find out the expression for maximum production of B and time to reach the maxima.

3+3+2+2+10=20

3(a) Consider two coaxial cylinders. The outer cylinder of diameter 16 cm and the clearance between two cylinders is 0.025 cm. The outer cylinder is rotating at a tangential speed of 12 m/s. Both cylinders and the fluid contained between them are at a temperature of 30°C. Due to rotation of the outer cylinder viscous heat is generated in the fluid.
Clearly state proper assumptions in order to derive differential equations for velocity profile and temperature profile.
(b) Solve the problem for temperature distribution in the fluid.
(c) Identify the object function.
(d) Calculate maximum temperature in the fluid
Thermo physical properties: ρ=1200 kg/m^3, k=0.13kJ/s.m.°C, μ=0.1kg/m.s

2+12+2+4=20

4. A chemical company produces two products as per following reactions.

$A + B \rightarrow P1$ (1)
$A + B \rightarrow P2$ (2)

Raw materials A and B have limited supply of 36 kg and 14 kg per day. Reaction – 1 takes 3 kg of A and 1 kg of B, to produce 1 kg of P1. Reaction – 2 takes 2 kg of A and 1 kg of B to produce 1 kg of P2. The profit of the company from selling these products is Rs. 14 per kg of A and Rs. 11 per kg of B. Solve for maximum profit and corresponding daily production rate of P1 and P2.

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5. A company has 4 warehouses from each of which a particular product is to be transported to five different locations. Transportation cost matrix, requirement and capacity are given in the following table. Find out basic feasible solution for this transportation problem after

(a) Clearly write algorithm for the solution.
(b) Find a basic feasible solution based on data given.

Origin/destination	D1	D2	D3	D4	D5	Capacity
O1	12	4	9	5	9	55
O2	8	1	6	6	7	45
O3	1	12	4	7	7	30
O4	10	15	6	9	1	50
Requirement	40	20	50	30	40	

10+10=20

6. Consider the following objective function.

$$f(x) = x^2 + \frac{54}{x}$$

(a) Apply exhaustive search method to obtain minimization of the above function within the range of 2.5 and 3.5. Write all algorithmic steps clearly.
(b) Write the steps of interval having method to obtain minima of the above objective function. Calculate up to 3 iterations.

10+10=20

7. Cost of a stirrer is Rs. 6100=00. Its scrape value is Rs. 100=00.Maintainance cost is given in the following table. Predict a suitable replacement policy of the stirrer.

Year	1	2	3	4	5	6	7	8
Maintenance cost(Rs.)	100	250	400	600	900	1250	1600	2000

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8. What is Artificial Neural Network (ANN). How it is used for optimization problems. Write the steps of Vanilla back propagation Algorithm to train weights of three layer-ANN.

5+2+13=20