BACHELOR OF ENGINEERING IN CHEMICAL ENGINEERING EXAMINATION, 2019

(3rd Year, 2nd Semester)

OPTIMIZATION METHODS FOR CHEMICAL ENGINEERING

Time : Three hours Full Marks : 100

Answer any five questions.

All questions carry equal marks
Assume any missing data
Symbols have usual meaning

1. Consider two co-axial horizontal cylinders whose outer cylinder has a diameter of 20 cm and the clearance between the cylinders is 0.025 cm. the outer cylinder is rotating with speed of 15 m /s. The intervening space between the cylinders is filled with highly viscous lubricant of property: density = 1200 kg/m^3, viscosity = 0.1kg/m.sec, thermal conductivity = 0.13kJ/m.sec.K, and both cylinders are at temperature 30°C. Assume viscous heat is generated in the fluid due to high shear stress. Derive the expression for temperature profile in the fluid and find maximum temperature and position of maximum temperature in the lubricant.

2. In a thermal power plant both high and low pressure steam are produced and sold to the market. The objective function for total revenue earning is given by,

$y = 1.86x_1+1.56x_2$, where x_1 and x_2 are production rate of high and low pressure steam respectively.

With constraints:

$$x_1 + x_2 \leq 2.6$$
$$x_1 + 4x_2 \leq 7.2$$
$$4x_1 + 3x_2 \leq 9.6$$

Apply linear programming method to find out production rate of high and low pressure steam to maximize the revenue.

3. Minimize the following function using exhaustive search method, and find the minimum value of the function bound by x=0 and x=5. Number of intervals may be taken as 10. Clearly write all steps of the algorithm. Discuss how degree of accuracy of the solution depends on number of intervals.

$F(x) = X^2 + 54/X$

4. Consider transportation of single commodity from n- number of origins to m- number of destinations. Discuss north-west corner rule to obtain a feasible solution for total cost of transportation of material. Apply the algorithm to the cost matrix given for a feasible solution to the problem.

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	

5. What type of optimization problem may be solved by Geometric programming? Give one example of unconstrained and one constrained Geometric programming problem. Explain degree of difficulty in geometric programming. What value of degree of difficulty is suitable for obtaining optimized solution by geometric programming? Find degree of difficulty for the given objective function.

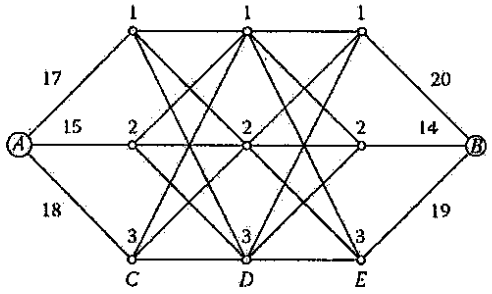
$$U = 550 + 105x_1 + \frac{120,000}{x_1^3} - 10x_1^{1.4}$$

For a metal rolling process, cost function is principally depends on water mass flow rate $\dot{m}$. The cost function is given by

$$C = 3.5\dot{m}^{1.4} + \frac{14.8}{\dot{m}^{2.2}}$$

Determine the minimum cost and corresponding mass flow rate of water using geometric programming.

6. Use dynamic programming to find minimum transportation cost for going from A to B. The cost matrix are given herewith.



A–1	A–2	A–3	1–B	2–B	3–B
19	20	17	18	16	21

and

1–1	1–2	1–3	2–1	2–2	2–3	3–1	3–2	3–3
12	15	19	15	13	17	18	18	16

7. Write the heuristics for distillation sequencing. In a chemical plant a mixture of 35 mol % A , 45mol% B and 20 mol %C is to be fractionated in a two stage distillation unit. The second distillation column receives feed from either top or bottom product of previous unit. What would be the better sequencing of distillation columns? Clearly state the assumptions needed and draw the schematics for column sequencing arrangement. What is meant by direct and indirect sequencing techniques? According to the given data find the better sequencing arrangement. Give reason for your answer.

Component	Boiling Point °C
A	40.7
B	60.2
C	76.8