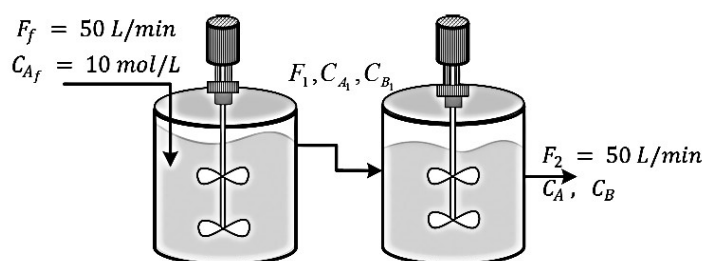


INSTRUCTIONS:

1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
4. Before attempting the question paper, be sure that you have got the correct question paper.
5. Tables/Data handbook/Graph paper etc. to be supplied to the candidates in the examination hall.

- Q.1 (a) Consider the two CSTRs as shown in the figure below. The following reaction is taking place in both reactors: $A \rightarrow B$ [5] CO 1 BL 321
The rate of reaction is first order: $-r_A = kC_A$, $k = 0.64 \text{ min}^{-1}$



The inlet and exit volumetric flow rates are fixed at 50 L/min, volume of each reactor is 100 L, and the inlet concentration of component A to the first tank is 10 mol/L. Develop the mathematical models for the systems that describe the concentration profile in the two tanks. Make suitable assumptions.

- Q.1 (b) Find all the minimum/maximum of [5] 4 3

$$f(x_1, x_2, x_3) = x_1 + x_1x_2 + 2x_2 + 3x_3 - x_1^2 - 2x_2^2 - x_3^2$$
- Q.2 Solve the Linear Programming Problem using Simplex Method. [10] 5 3

$$\text{Maximize, } Z = 6x_1 + 5x_2$$

$$\text{Subject to: } x_1 + x_2 \leq 5; 3x_1 + 2x_2 \leq 12; x_1, x_2 \geq 0$$
- Q.3 (a) Write the algorithm for Golden Section Search Method for a minimization problem with a single variable unimodal function. [4] 3 2
- Q.3 (b) Minimize the function, [6] 3 3

$$f(x) = x^2 + \frac{30}{x}$$

Using Newton's Method. Perform three iterations with the initial point as 2.

- Q.4 (a) Minimize the function, [5] 4 3

$$f(x) = (x_1^2 + x_2 - 11)^2 + (x_2^2 + x_1 - 7)^2$$
 With the initial point (1,1) and with scale factor, $\alpha = 0.5$, using Simplex Pattern Search method. Perform only three iterations.

Q.4 (b) Minimize the function,

[5] 4 3

$$f(x) = x_1 - x_2 + 2x_1^2 + 2x_1x_2 + x_2^2$$

With the initial point, (1,1), using Cauchy's Steepest Descent Method. Perform only two iterations.

Q.5 (a) Write the criterion for concavity and convexity of a multivariable function.

[3] 2 2

Q.5 (b) You have been hired as a production manager in a Fortune 500 company. The company primarily manufactures four products, which it supplies to the aerospace firm ISRO. Each of the products must pass through the following departments before they are shipped: wiring, drilling, assembly, and inspection. The time requirements in each department (in hours) for each unit produced and its corresponding profit value are given in the table:

[7] 2 3

PRODUCT	DEPARTMENT				PROFIT PER UNIT
	WIRING	DRILLING	ASSEMBLY	INSPECTION	
A	0.5	3	2	0.5	Rs. 9
B	1.5	1	4	1.0	Rs. 12
C	1.5	2	1	0.5	Rs. 15
D	1.0	3	2	0.5	Rs. 11

The production time available in each department each month and the minimum monthly production requirement to fulfill contracts are as follows:

DEPARTMENT	WIRING	DRILLING	ASSEMBLY	INSPECTION
CAPACITY (IN HOURS)	1500	2350	2600	1200

PRODUCT	A	B	C	D
MINIMUM PRODUCTION LEVEL	150	100	300	400

As a production manager, it is your responsibility to specify production levels for each product for the coming month which will maximize the profit. Formulate the optimization problem.

:::::20/11/2024:::::M