B.E. Chemical Engineering Second Year Second Semester Examination 2025

Numerical Analysis for Chemical Engineers

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

Use a separate Answer-Script for each part

PART – I (50 marks)

Answer any five questions

All question carry equal marks

1. The heat transfer coefficient (h) is related to the velocity (u) of a fluid flowing through a pipe by $h = au^b$. Determine the values of a and b from the following data.

u, m/s	0.305	0.914	1.524	2.134	2.743
h, W/m^2 K	852	2100	3208	4258	5224

2. Find the Newton's divided difference interpolating polynomial for the function $f(x)$ using the following data and, hence find $f(3)$.

x	1	2	4	6
$y = f(x)$	-26	12	256	844

3. Find the polynomial f (x) by using Lagrange's formula and hence find f(3) for

x	0	1	2	5
$f(x)$	2	3	12	147

4. Use the following table and find tan(0.12) and tan(0.26).

X	0.10	0.15	0.20	0.25	0.30
tan(X)	0.1003	0.1511	0.2027	0.2553	0.3073

5. Consider the following data table to find $f'(2.2)$.

x	1.4	1.6	1.8	2.0	2.2
$f(x)$	4.0552	4.953	6.0496	7.3891	9.025

6. Compute the integral integration, $I = \int_0^1 \frac{dx}{x^2 + 6x + 10}$ using both Trapezium and Simpson's 1/3 rules, taking $h = 0.2$.

Ref. No. : Ex/Che/PC/B/T/221/2025

Part II
(50 Marks)

Use Separate Answer scripts for each part

All questions carry equal marks

(Answer Q.6 and Q.7 and any <u>three</u> from the rest)

1. (a) Use the Gauss-Siedel method to solve the following system (perform three iterations),

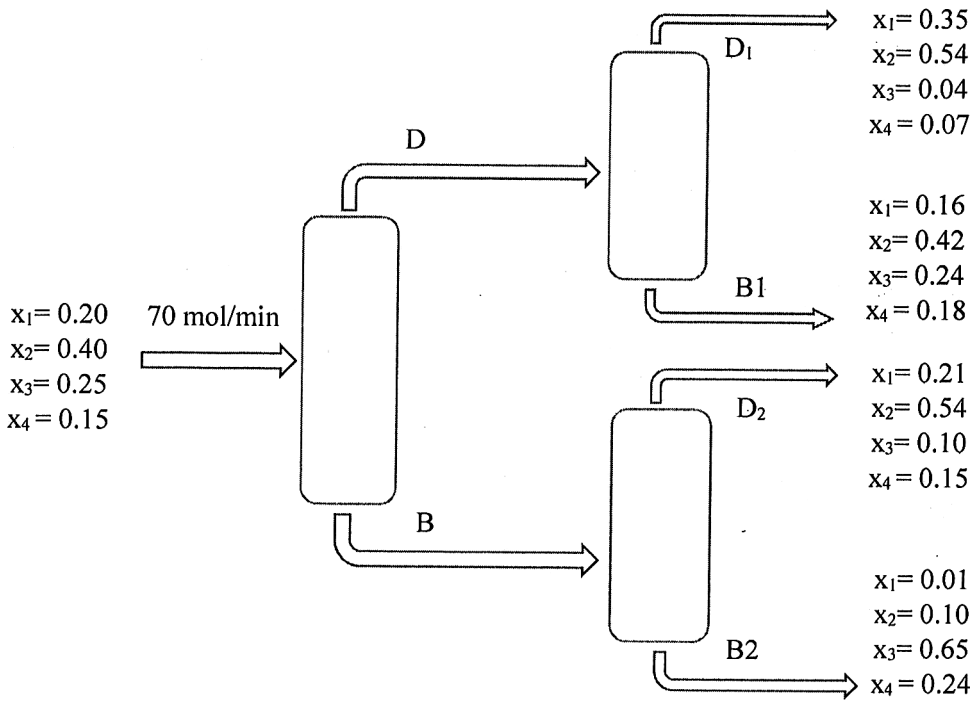
$$\begin{bmatrix} 2 & -1 & 0 \\ -1 & 2 & -1 \\ 0 & -1 & 2 \end{bmatrix} \begin{Bmatrix} x_1 \\ x_2 \\ x_3 \end{Bmatrix} = \begin{Bmatrix} 123.87 \\ 3.96 \\ 14 \end{Bmatrix}.$$

(b) Using SOR with $w = 1.5$. Do three iterations and compare with Gauss-Seidel values.

2. (a) What do you mean by truncation error? If the exponential function can be truncated as $e^x \approx 1 + x + \frac{x^2}{2!} + \frac{x^3}{3!}$,then find the truncation error for $e^{0.2}$.

(b) Is the matrix A= $\begin{pmatrix} 0 & 4 & 3 \\ 2 & 0 & -1 \\ 3 & 2 & 0 \end{pmatrix}$ can be decomposed by LU method?

3. Benzene (1) toluene (2), styrene (3) and xylene (4) are to be separated in the sequence of distillation coloumns shown in the figure below. Determine molar flow rates of streams D_1, B_1, D_2 and B_2. The composition of the feed stream and necessary details are mentioned in the figure. Also determine the molar flow rates and compositions of streams B and D. The molar flow rate of the feed stream is 70 mol/min.



4. Use Thomas algorithm to obtain the solution.

$$\begin{bmatrix} 2 & -1 & 0 \\ -1 & 2 & -1 \\ 0 & -1 & 2 \end{bmatrix} \begin{Bmatrix} x_1 \\ x_2 \\ x_3 \end{Bmatrix} = \begin{Bmatrix} 124 \\ 4 \\ 14 \end{Bmatrix}$$

5. Solve the following system of equations using Gauss Elimination with partial pivoting.

$$-5x_1 + 12x_3 = 60$$
$$4x_1 - x_2 - x_3 = -2$$
$$x_1 - 2x_2 + 12x_3 = -86$$

6. Find y (4.4) by modified Euler's method, by considering $h = 0.2$ from the differential equation

$$\frac{dy}{dx} = \frac{2-y^2}{5x} \text{ and } y(4) = 1$$

7. Compute y (0.4) by 4th order Runge-Kutta method by considering $h = 0.2$, correct up to four decimal places from the equation

$$\frac{dy}{dx} = xy \text{ and } y(0) = 2$$