B.E. CHEMICAL ENGINEERING SECOND YEAR SECOND SEMESTER EXAMINATION, 2022

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. Use the method of Linear Least Square to find the values of a and b by fitting a curve as $y = ab^x$ to the following data:

x	1	2	3	4	5	6
y	151	100	61	50	20	8

2. Consider the following data table to find an interpolating polynomial using Newton's divided difference formula. Use this polynomial to estimate $f(1.5)$ and $f(4.5)$.

x	0	1	2	4	5	6
$f(x)$	1	14	15	5	6	19

3. Find Lagrange's interpolation polynomial through the following set of data points and also find $f(5)$ using interpolation polynomial.

x	1	2	7	8
$f(x)$	4	5	5	4

4. Consider the following data table to find an interpolating polynomial using Newton's forward difference formula. Also find $f'(2)$.

x	2	4	6	8	10	12
$f(x)$	5.7	16.0	29.4	45.3	63.2	83.1

5. Consider the following data table to find $f'(3.0)$.

x	0.5	1.0	1.5	2.0	2.5	3.0
$f(x)$	-0.347	0.000	0.608	1.386	2.291	3.296

6. Find $\int_0^{2.0} 5e^{x^3} dx$, taking $h = 0.2$ using **Trapezoidal** and **Simpson's 1/3rd rules**.

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PART-II (50 marks)
Answer any *five*
All question carries equal marks

1. The following equations represent the free-falling of three parachutists at a velocity of 5 m/s (g=9.8m/s^2).

$$m_1 g - T - c_1 v = m_1 a$$
$$m_1 g + T - c_2 v - R = m_2 a$$
$$m_3 g - c_3 v + R = m_3 a$$

Express the equations in matrix form using the given information and calculate 'T' and 'a' using Gauss elimination rounding to four significant digits.

Parachutists	Mass, m (kg)	Drag Coefficient, c (kg/s)
1	70	10
2	60	14
3	40	17

2. Three masses are suspended vertically by a series of identical strings where mass 1 is at the top and mass 3 is at the bottom. If g = 9.81 m/s^2, m_1 = 2 kg, m_2 = 3 kg, m_3 = 2.5 kg, and the k's = 10 kg/s^2, Solve for the displacements x.

3. The following system of equations is designed to determine concentrations (the c's in g/m^3) in a series of coupled reactors as a function of the amount of mass input to each reactor (the right-hand sides in g/day),

$$15c_1 - 3c_2 - c_3 = 3300$$
$$-3c_1 + 18c_2 - 6c_3 = 1200$$
$$-4c_1 - c_2 + 12c_3 = 2400$$

4. Consider the ODE $\begin{bmatrix} y_1' \\ y_2' \end{bmatrix} = \begin{bmatrix} -100 & 0 \\ 2 & -1 \end{bmatrix} \begin{bmatrix} y_1 \\ y_2 \end{bmatrix}$ with $y_0 = [2 \quad 1]^T$. Use explicit Euler technique with h=0.02 to obtain y (t_1=0.02).

5. Solve the differential equation with y (0) =10, y (10) = 6 and Δx =2,

$$\frac{d^2y}{dx^2} + 2\frac{dy}{dx} - \frac{y}{2} - 2.5 = 0$$

6. Use Thomas algorithm to obtain the solution.

$$\begin{bmatrix} 2.04 & -1 & 0 & 0 \\ -1 & 2.04 & -1 & 0 \\ 0 & -1 & 2.04 & -1 \\ 0 & 0 & -1 & 2.04 \end{bmatrix} \begin{bmatrix} T1 \\ T2 \\ T3 \\ T4 \end{bmatrix} = \begin{bmatrix} 40.8 \\ 0.8 \\ 0.8 \\ 200.8 \end{bmatrix}$$

7. Solve $\frac{dy}{dt} = ye^{-4}$ with y = 1 at t = 0 and compute y at t = 2 using 4th order Adams-Bashforth method (h=0.5).