Ref. No. : Ex/ChE/T/214/2019

B.E. CHEMICAL ENGINEERING SECOND YEAR FIRST SEMESTER – 2019

NUMERICAL METHODS

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

Use a separate answer-script for each part

PART-I (50 marks)

Answer Q.1 and any *four* from the rest

All question carry equal marks

1. Fit a curve for the equation $r = \frac{kC_A}{C_A+S}$ and estimate the constants k and S

C_A	0.01	0.02	0.05	0.1	0.2	0.35
r	0.014	0.0292	0.0705	0.1333	0.24	0.3652

Find the value of r when C_A tends to infinity [8+2]

2. Solve the following system and simultaneously obtain inverse of the coefficient matrix by using suitable method

$$\begin{bmatrix} 1 & -1 & 2 \\ 2 & -2 & 3 \\ 1 & 1 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} -8 \\ -20 \\ -2 \end{bmatrix}$$

3. If the relation between friction factor (f) and the Reynolds number (Re) can be expressed by the following relationship:

$$\frac{1}{\sqrt{f}} = -0.40 + 4.0log_{10}(Re\sqrt{f})$$

Calculate f for $Re = 10^5$ using Newton-Raphson with $f^{(1)} = 0.01$.Terminate after three iterations.

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

$$m_1g - T - c_1v = m_1a$$
$$m_1g + T - c_2v - R = m_2a$$
$$m_3g - c_3v + R = m_3a$$

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

5. Consider the following system of equation:

$$\begin{bmatrix} 1 & -a \\ -a & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} b_1 \\ b_2 \end{bmatrix}$$

a) For which value of 'a' Gauss Seidel and Jacobi method converges?

b) For a=0.6, find the value of the relaxation parameter for which the spectral radius of iteration minimizes?

6. Find the root of the equation $\cos x - xe^x = 0$ within the range [0, 1]. Perform four iterations rounding to four significant digits.

PART – II (50 marks)

Use a separate Answer-Script for each part

Answer any FIVE questions

All question carry equal marks

1. The following table gives pressure of a steam at a given temperature. Using Newton's interpolating formula, compute pressure for a temperature of 145°C.

Temperature, °C	140	150	160	170	180	190
Pressure, kgf/cm^2	3.685	4.854	6.302	8.076	10.225	12.524

2. Find the Newton's divided difference interpolating polynomial for the function $f(x)$ using the following data and, hence find $f(4)$.

x	0	1	2	5	8
$y = f(x)$	2	3	15	125	420

3. Find the value of $f(10)$ by Lagrange's formula for the following data

x	2	4	8	15
$y = f(x)$	2	12	55	250

4. Compute the integral Integration $I = \sqrt{\frac{2}{\pi}} \int_0^1 e^{-x^2/2}\, dx$ using Simpson's 1/3 rule, taking $h = 0.125$.

5. Find $y(0.2)$ using Runge Kutta of order four by solving the differential equation $y' = -\left(xy^2 + y\right)$, $y(0) = 1$ with step size of 0.1.

6. Solve the following boundary value problem using central finite difference technique with $h = 0.25$.

$$y'' = \left(1 + x^2\right) y, \qquad -1 \le x \le 1$$
$$y(-1) = y(1) = 1$$

Show the unknown linear equations in tridiagonal matrix form and **do not solve the matrix.**