Ref. No.: Ex/PG/ChE/PE/T/115B/2025

**M.E. CHEMICAL ENGINEERING FIRST YEAR FIRST SEMESTER EXAM 2025**

**NUMERICAL METHODS**

Time : Three hours Full Marks : 100

Answer any four questions
Assume any missing information

Question 1:

(a) Determine whether the matrix given below is well conditioned

$$\begin{bmatrix} 25 & 24 & 10 \\ 66 & 78 & 87 \\ 92 & -73 & -80 \end{bmatrix}$$

(b) Obtain the rank of the matrix

$$\begin{bmatrix} 1 & -1 & 2 \\ 2 & -2 & 3 \\ 1 & 1 & 1 \end{bmatrix} \quad \begin{bmatrix} 1 & -1 & 2 & -8 \\ 2 & -2 & 3 & -20 \\ 1 & 1 & 1 & -2 \end{bmatrix}$$ (12 + 13)

Question 2:

Solve using Gauss Siedel technique with successive over relaxation using $w = 1.5$

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

Use $\boldsymbol{x}^{(1)} = [-9 \;\; 4 \;\; 6]^T$

Do two iterations. (25)

Question 3:

1. Obtain the value of the integral $\int_{-2}^{2} \frac{dx}{2x+5} dx$
   (a) by Gauss formulae using the Gauss-Legendre quadrature with N =3. Compare with exact solution.

   The roots of the polynomial are 0 (0.8888), $\sqrt{3/5}$ (0.5555) $-\sqrt{3/5}$ (0.5555) The values in the bracket are the corresponding weightage.

   (b) Obtain the value of the integral $\int_{-2}^{2} \frac{dx}{2x+5} dx$ using Simpson's rule.

(13+12)

Question 4:

$$\frac{dy}{dx} = x^2 + y^2 - 2 \qquad y(x = 0) = 1$$

Taking step size of 0.1 obtain the value of $y(x = 0.4)$ using 4th order Adams Bashford technique

$$y_{n+1} = y_n + \frac{h}{24}[55f(y_n) - 59f(y_{n-1}) + 37f(y_{n-2}) - 0f(y_{n-3})] \qquad (25)$$

Question 5:

The 1-D flow of a fluid between two flat plates spaced h apart with one plate at rest and the other starting to move at t = 0 with velocity $u_o$ is described by

$$\frac{\partial u}{\partial t} = \left(\frac{v}{h^2}\right)\frac{\partial^2 u}{\partial x^2}$$

$$u(x, 0) = 0, u(0, t) = 1, u(1, t) = 0$$

Where *u* is the dimensionless velocity and *x* is the dimensionless position. Set up Finite difference equation and solve for $\frac{v}{h^2} = 5$. Take *h* = 0.05 and obtained two internal points. Obtain the value of *u* at t = 0.1 sec. (25)