

MA635P-Scientific Programming Laboratory

Lab Exercise-9 (30 Marks)

Deadline: 10 March 2026, 4:00 PM

1. Create an algorithm for Forward Substitution and count the number of operations required. [2.5]
2. Create an algorithm for Backward Substitution and count the number of operations required. [2.5]
3. Create an algorithm for LU Decomposition to decompose $A = LU$ and count the number of operations required. [2.5]
4. Create an algorithm for Gaussian Elimination and count the exact number of operations required to solve the linear system. [2.5]
5. Write a Python code for the developed Forward Substitution Method and solve the following linear system [3]

$$\begin{pmatrix} 6 & 0 & 0 & 0 \\ 12 & -8 & 0 & 0 \\ 3 & -24 & 9 & 0 \\ -6 & 4 & 18 & -18 \end{pmatrix} \begin{pmatrix} y_1 \\ y_2 \\ y_3 \\ y_4 \end{pmatrix} = \begin{pmatrix} 16 \\ 26 \\ -19 \\ -34 \end{pmatrix}$$

6. Write a Python code for the developed Backward Substitution Method and solve the following linear system [3]

$$\begin{pmatrix} 1 & -1/3 & 1/3 & 2/3 \\ 0 & 1/2 & -1/4 & -1/4 \\ 0 & 0 & 2/9 & -5/9 \\ 0 & 0 & 0 & 1/6 \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{pmatrix} = \begin{pmatrix} 8/3 \\ 3/4 \\ -1 \\ 1/6 \end{pmatrix}$$

7. Write a Python code for the developed LU Decomposition with $l_{ii} = a_{ii}$ and solve the following linear system. Repeat this exercise by assuming $l_{ii} = 1$ and then $u_{ii} = 1$. [5]

$$\begin{pmatrix} 6 & -2 & 2 & 4 \\ 12 & -8 & 6 & 10 \\ 3 & -13 & 9 & 3 \\ -6 & 4 & 1 & -18 \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{pmatrix} = \begin{pmatrix} 16 \\ 26 \\ -19 \\ -34 \end{pmatrix}$$

8. Write a Python code for the developed Gaussian Elimination Algorithm and solve the above linear system [5]
9. For a given n , LU Decomposition and Gaussian Elimination Algorithm, print the number of days or years required to solve the linear system. [4]