

**Multiple-Choice Test – LU Decomposition Method**  
**Autar Kaw**

1. The  $[L][U]$  decomposition method is computationally more efficient than Naïve Gauss elimination for solving
- (A) a single set of simultaneous linear equations.
  - (B) multiple sets of simultaneous linear equations with different coefficient matrices and the same right hand side vectors.
  - (C) multiple sets of simultaneous linear equations with the same coefficient matrix and different right hand side vectors.
  - (D) less than ten simultaneous linear equations.
2. The lower triangular matrix  $[L]$  in the  $[L][U]$  decomposition of the matrix given below

$$\begin{bmatrix} 25 & 5 & 4 \\ 10 & 8 & 16 \\ 8 & 12 & 22 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ \ell_{21} & 1 & 0 \\ \ell_{31} & \ell_{32} & 1 \end{bmatrix} \begin{bmatrix} u_{11} & u_{12} & u_{13} \\ 0 & u_{22} & u_{23} \\ 0 & 0 & u_{33} \end{bmatrix}$$

is

- (A)  $\begin{bmatrix} 1 & 0 & 0 \\ 0.40000 & 1 & 0 \\ 0.32000 & 1.7333 & 1 \end{bmatrix}$
- (B)  $\begin{bmatrix} 25 & 5 & 4 \\ 0 & 6 & 14.400 \\ 0 & 0 & -4.2400 \end{bmatrix}$
- (C)  $\begin{bmatrix} 1 & 0 & 0 \\ 10 & 1 & 0 \\ 8 & 12 & 0 \end{bmatrix}$
- (D)  $\begin{bmatrix} 1 & 0 & 0 \\ 0.40000 & 1 & 0 \\ 0.32000 & 1.5000 & 1 \end{bmatrix}$



3. The upper triangular matrix  $[U]$  in the  $[L][U]$  decomposition of the matrix given below

$$\begin{bmatrix} 25 & 5 & 4 \\ 0 & 8 & 16 \\ 0 & 12 & 22 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ \ell_{21} & 1 & 0 \\ \ell_{31} & \ell_{32} & 1 \end{bmatrix} \begin{bmatrix} u_{11} & u_{12} & u_{13} \\ 0 & u_{22} & u_{23} \\ 0 & 0 & u_{33} \end{bmatrix}$$

is

(A)  $\begin{bmatrix} 1 & 0 & 0 \\ 0.40000 & 1 & 0 \\ 0.32000 & 1.7333 & 1 \end{bmatrix}$

(B)  $\begin{bmatrix} 25 & 5 & 4 \\ 0 & 6 & 14.400 \\ 0 & 0 & -4.2400 \end{bmatrix}$

(C)  $\begin{bmatrix} 25 & 5 & 4 \\ 0 & 8 & 16 \\ 0 & 0 & -2 \end{bmatrix}$

(D)  $\begin{bmatrix} 1 & 0.2000 & 0.16000 \\ 0 & 1 & 2.4000 \\ 0 & 0 & -4.240 \end{bmatrix}$

4. For a given  $2000 \times 2000$  matrix  $[A]$ , assume that it takes about 15 seconds to find the inverse of  $[A]$  by the use of the  $[L][U]$  decomposition method, that is, finding

Source URL: <http://numericalmethods.eng.usf.edu/>

Saylor URL: <http://www.saylor.org/courses/me205/>

Attributed to: University of South Florida: Holistic Numerical Methods Institute

Saylor.org



the  $[L][U]$  once, and then doing forward substitution and back substitution 2000 times using the 2000 columns of the identity matrix as the right hand side vector. The approximate time, in seconds, that it will take to find the inverse if found by repeated use of the Naive Gauss elimination method, that is, doing forward elimination and back substitution 2000 times by using the 2000 columns of the identity matrix as the right hand side vector is most nearly

- (A) 300
- (B) 1500
- (C) 7500
- (D) 30000

Source URL: <http://numericalmethods.eng.usf.edu/>  
Saylor URL: <http://www.saylor.org/courses/me205/>

Attributed to: University of South Florida: Holistic Numerical Methods Institute



Saylor.org

Page 3 of 6

5. The algorithm for solving a set of  $n$  equations  $[A][X] = [C]$ , where  $[A] = [L][U]$  involves solving  $[L][Z] = [C]$  by forward substitution. The algorithm to solve  $[L][Z] = [C]$  is given by

(A)  $z_1 = c_1 / l_{11}$

for  $i$  from 2 to  $n$  do

sum = 0

for  $j$  from 1 to  $i$  do

sum = sum +  $l_{ij} * z_j$

end do

$z_i = (c_i - \text{sum}) / l_{ii}$

end do

(B)  $z_1 = c_1 / l_{11}$

for  $i$  from 2 to  $n$  do

sum = 0

for  $j$  from 1 to  $(i-1)$  do

sum = sum +  $l_{ij} * z_j$

end do

$z_i = (c_i - \text{sum}) / l_{ii}$

end do

(C)  $z_1 = c_1 / l_{11}$

for  $i$  from 2 to  $n$  do

for  $j$  from 1 to  $(i-1)$  do



sum = sum +  $l_{ij} * z_j$

end do

$z_i = (c_i - sum) / l_{ii}$

end do

(D) for  $i$  from 2 to  $n$  do

sum = 0

for  $j$  from 1 to  $(i-1)$  do

sum = sum +  $l_{ij} * z_j$

end do

$z_i = (c_i - sum) / l_{ii}$

end do

Source URL: <http://numericalmethods.eng.usf.edu/>

Saylor URL: <http://www.saylor.org/courses/me205/>

Attributed to: University of South Florida: Holistic Numerical Methods Institute



Saylor.org

Page 5 of 6

6. To solve boundary value problems, the finite difference method is used resulting in simultaneous linear equations with tridiagonal coefficient matrices. These are solved using the specialized  $[L][U]$  decomposition method. The set of equations in matrix form with a tridiagonal coefficient matrix for

$$\frac{d^2 y}{dx^2} = 6x - 0.5x^2, \quad y(0) = 0, \quad y(12) = 0$$

using the finite difference method with a second order accurate central divided difference method and a step size of  $h = 4$  is

$$\begin{array}{l}
 \text{(A)} \quad \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0.0625 & 0.125 & 0.0625 & 0 \\ 0 & 0.0625 & 0.125 & 0.0625 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} y_1 \\ y_2 \\ y_3 \\ y_4 \end{bmatrix} = \begin{bmatrix} 0 \\ 16.0 \\ 16.0 \\ 0 \end{bmatrix} \\
 \text{(B)} \quad \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0.0625 & -0.125 & 0.0625 & 0 \\ 0 & 0.0625 & -0.125 & 0.0625 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} y_1 \\ y_2 \\ y_3 \\ y_4 \end{bmatrix} = \begin{bmatrix} 0 \\ 16.0 \\ 16.0 \\ 0 \end{bmatrix} \\
 \text{(C)} \quad \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \\ 0.0625 & -0.125 & 0.0625 & 0 \\ 0 & 0.0625 & -0.125 & 0.0625 \end{bmatrix} \begin{bmatrix} y_1 \\ y_2 \\ y_3 \\ y_4 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 16.0 \\ 16.0 \end{bmatrix} \\
 \text{(D)} \quad \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \\ 0.0625 & 0.125 & 0.0625 & 0 \\ 0 & 0.0625 & 0.125 & 0.0625 \end{bmatrix} \begin{bmatrix} y_1 \\ y_2 \\ y_3 \\ y_4 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 16.0 \\ 16.0 \end{bmatrix}
 \end{array}$$

