Choose from the following three options.

**OPTION 1:**

**Lab Objectives:**
To find the eigenvectors and eigenvalues for a 3x3 matrix.

**Description of Lab:**
Your program will ask the user to enter a 3x3 matrix. It will then compute the eigenvalues (real and complex) and eigenvectors (real and complex) for that matrix.

**Requirements:** The program should...
(Use your code from programming assignment 7 for items 1 through 4)
1. Ask the user to enter a real valued 3x3 matrix.
2. Find the determinant of the matrix $A - \lambda I$.
3. From (2), find the coefficients, $a_i$, $i = 0,1,2,3$ of the characteristic equation $a_3\lambda^3 + a_2\lambda^2 + a_1\lambda + a_0 = 0$.
4. Find the solutions (real and/or complex) for $a_3\lambda^3 + a_2\lambda^2 + a_1\lambda + a_0 = 0$.
5. For each of the eigenvalues found
   a. Find the matrix $A - \lambda I$.
   b. Reduce it (modify your code from programming assignment 2 to handle complex values).
   c. Output the solution matrix (you need not output the eigenvectors themselves).
6. Your output should be detailed, indicating both the original matrix, listing the eigenvectors and corresponding solution matrix.

**What to Turn In:**
1. A printout of your original code
2. A printout of the results for the following sample data inputs:
   a. $A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$
   b. $A = \begin{bmatrix} 1 & 3 & 2 \\ 4 & 1 & 0 \\ 1 & 2 & 1 \end{bmatrix}$
   c. $A = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$
   d. $A = \begin{bmatrix} 5 & -5 & -5 \\ -1 & 4 & 2 \\ 3 & -5 & -3 \end{bmatrix}$
   e. $A = \begin{bmatrix} 0 & -4 & -1 \\ 0 & 2 & 3 \\ 5 & 1 & 3 \end{bmatrix}$
3. Please be sure to label your pages at the top (i.e. “Original Code page 1 of 2” and “Run page 1 of 1”, etc).
4. Include a cover sheet, with “Program Assignment 8”, your name, and date.
OPTION 2:

Lab Objectives:
To find the eigenvectors and eigenvalues for a 3x3 matrix.

Description of Lab:
Your program will ask the user to enter a 3x3 matrix. It will then compute the eigenvalues (real and complex) and eigenvectors (for real eigenvalues) for that matrix.

Requirements: The program should…
(Use your code from programming assignment 7 for items 1 through 4)
1. Ask the user to enter a real valued 3x3 matrix.
2. Find the determinant of the matrix \(A - \lambda I\).
3. From (2), find the coefficients, \(a_i\) \(i = 0,1,2,3\) of the characteristic equation \(a_3\lambda^3 + a_2\lambda^2 + a_1\lambda + a_0\)
4. Find the solutions (real and/or complex) for \(a_3\lambda^3 + a_2\lambda^2 + a_1\lambda + a_0 = 0\).
5. For each of real-valued eigenvalues found
   d. Find the matrix \(A - \lambda I\).
   e. Reduce it (modify your code from programming assignment 2 to handle complex values).
   f. Output the solution matrix (you need not output the eigenvectors themselves).
6. For each of the complex-valued eigenvalues found, provide the user a message indicating the corresponding eigenvectors will not be found.
7. Your output should be detailed, indicating both the original matrix, listing the eigenvectors and corresponding solution matrix.

What to Turn In:
1. A printout of your original code
2. A printout of the results for the following sample data inputs:
   a. \(A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}\)
   b. \(A = \begin{bmatrix} 1 & 3 & 2 \\ 4 & 1 & 0 \\ 1 & 2 & 1 \end{bmatrix}\)
   c. \(A = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}\)
   d. \(A = \begin{bmatrix} 5 & -5 & -5 \\ -1 & 4 & 2 \\ 3 & -5 & -3 \end{bmatrix}\)
   e. \(A = \begin{bmatrix} 0 & -4 & -1 \\ 0 & 2 & 3 \\ 5 & 1 & 3 \end{bmatrix}\)
3. Please be sure to label your pages at the top
   (i.e. “Original Code page 1 of 2” and “Run page 1 of 1”, etc).
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OPTION 3:

Lab Objectives:
To use Cramer’s Rule to find the solution for $A\tilde{x} = \tilde{b}$. If you do this lab, you may not use any part for Program 9.

Description of Lab:
Your program will ask the user to enter a square matrix (no more than 10x10) and corresponding solution vector. It will then find the solution (if possible) using Cramer’s Rule.

Requirements: The program should…
1. Ask the user to enter a real valued square matrix (you may cap this at a 10x10).
2. Ask the user to enter a corresponding solution vector $\tilde{b}$, and the dimension of this vector should be checked.
3. Find the determinant of $A$ and each $B_i$.
4. Find the solution vector $\tilde{x}$.
5. Check your solution by comparing $A\tilde{x}$ with $\tilde{b}$, output success (or an error).

What to Turn In:
1. A printout of your original code
2. A printout of the results for the following sample data inputs:
   a. $A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$ $\tilde{b} = \begin{bmatrix} -6 \\ 5 \end{bmatrix}$
   b. $A = \begin{bmatrix} 1 & 3 & 2 \\ 4 & 1 & 0 \\ 1 & 2 & 1 \end{bmatrix}$ $\tilde{b} = \begin{bmatrix} -1 \\ 6 \\ 8 \end{bmatrix}$
   c. $A = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$ $\tilde{b} = \begin{bmatrix} 2 \\ 4 \\ 6 \end{bmatrix}$
   d. $A = \begin{bmatrix} 5 & -5 & -5 \\ -1 & 4 & 2 \\ 3 & -5 & -3 \end{bmatrix}$ $\tilde{b} = \begin{bmatrix} -5 \\ 5 \\ -5 \end{bmatrix}$
   e. $A = \begin{bmatrix} 0 & -4 & -1 \\ 0 & 2 & 3 \\ 5 & 1 & 3 \end{bmatrix}$ $\tilde{b} = \begin{bmatrix} -12 \\ 16 \\ 13 \end{bmatrix}$
3. Please be sure to label your pages at the top (i.e. “Original Code page 1 of 2” and “Run page 1 of 1”, etc).
4. Include a cover sheet, with “Program Assignment 8”, your name, and date.