CS 2300 Program 3
Due 4 Nov 19

Administrative:

1. Put your information (name, class, etc) in a header comment block.
2. Please comment appropriately. We are not looking for "production quality" comments but the grader should be able to follow your code. This is particularly important if you code doesn't work properly.

Description of the Assignment:

For this assignment, you will be given files that contains that contains the contents of an *n x n* system matrix and corresponding files containing *n x 1* product vector. Using Gaussian elimination, find the solution to the system.

Given the system matrix, *A,* and the product vector, $\vec{v}$, find $\vec{x}$:

$$A\vec{x} = \vec{v}$$

We will provide input files for this project. The contents of the input file are formatted as follows:

System matrices:
n [n^2 floating point numbers in row-major order]

Product vectors:
n [n floating point numbers]

For example:

sysMat1:
3 6.3 8.3 -4.4 8.1 2.6 0.9 -7.5 -8.0 9.2 <eof>

prodVec1:
3 -38.77 -49.30 93.79

Or:

$$\begin{bmatrix} 6.3 & 8.3 & -4.4 \\ 8.1 & 2.6 & 0.9 \\ -7.5 & -8.0 & 9.2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} -38.77 \\ -49.30 \\ 39.79 \end{bmatrix}$$

Solving for this system results in

$$\vec{x} = \begin{bmatrix} -9.3 \\ 7.0 \\ 8.7 \end{bmatrix}$$

To solve this system, use Gaussian elimination with pivoting. For the example above, the following steps should be followed:

$$\begin{bmatrix} 8.1 & 2.6 & 0.9 \\ 6.3 & 8.3 & -4.4 \\ -7.5 & -8.0 & 9.2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} -38.77 \\ -49.30 \\ 39.79 \end{bmatrix}$$

First, build an n x n+1 matrix by adding the product vector as the last column. For the example, this would be:

6.3000	8.3000	-4.4000	-38.7700
8.1000	2.6000	0.9000	-49.3000
-7.5000	-8.0000	9.2000	93.7900

First, pivot based on the first column (move the row with the largest absolute value to the top). In this case swap the first and second rows:

8.1000	2.6000	0.9000	-49.3000
6.3000	8.3000	-4.4000	-38.7700
-7.5000	-8.0000	9.2000	93.7900

Second, zero the element at (2,1) by multiplying the first row by 6.3, the second row by -8.1 and adding them to create the new second row:

8.1000	2.6000	0.9000	-49.3000
0	-50.8500	41.3100	3.4470
-7.5000	-8.0000	9.2000	93.7900

Third, multiply the first row by -7.5 and the third row by -8.1 and add to create the new third row:

8.1000	2.6000	0.9000	-49.3000
0.0000	-50.8500	41.3100	3.4470
0.0000	45.3000	-81.2700	-389.9490

Fourth, now consider pivoting on column 2 for rows 2 and 3. As the largest (absolute value) in column 2 for rows 2 and 3, there is no need to switch rows 2 and 3.

Fifth, multiply row 3 by -50.85, row 2 by -45.3 and add to form row 3:

1.0e+04 *

0.0008	0.0003	0.0001	-0.0049
0.0000	-0.0051	0.0041	0.0003
0.0000	0.0000	-0.2261	-1.9673

The A-matrix is in upper triangular form. Now solve for x_3, by noticing that

$$-2261x_3 = -19673$$
$$x_3 = 8.7$$

Solve for x_2 by substituting x_3 on the second row:

$$-50.85x_2 + 41.31(8.7) = 3.45$$
$$x_2 = 7.0$$

Finally, back substitute into row 1:

$$8.1000\ x_1 + 2.6000\ x_2 + 0.9000\ x_3 = -49.3000$$

$$x_1 = -9.3$$

For this assignment, use Gaussian elimination to solve for the *n x 1* solution vector.

Your solver should print, at a minimum:

1. The original system matrix (A augmented with $\vec{v}$)
2. The modified system matrix as each column is "zeroed."
3. The solution vector, $\vec{x}$

For example, the output for the example above might be:

The system matrix:

6.3000	8.3000	-4.4000	-38.7700
8.1000	2.6000	0.9000	-49.3000
-7.5000	-8.0000	9.2000	93.7900

Column 1:

8.1000	2.6000	0.9000	-49.3000
0.0000	-50.8500	41.3100	3.4470
0.0000	45.3000	-81.2700	-389.9490

Column 2:
1.0e+04 *
0.0008 0.0003 0.0001 -0.0049
0.0000 -0.0051 0.0041 0.0003
0.0000 0.0000 -0.2261 -1.9673

Solution vector:

-9.3
 7.0
 8.7