1. Find all solutions to the nonsingular system $\begin{cases} x_1 - 4x_2 = -10 \\ \frac{1}{2}x_1 - x_2 = -2 \end{cases}$
   (a) Describe the Matrix Form, the Row Picture geometrically.
   (b) the Column Picture geometrically. Do linear combinations "give" whole plane? What is the nullspace?

2. Find all solutions to the singular system $\begin{cases} x_1 + x_2 = 5 \\ 3x_1 + 3x_2 = 16 \end{cases}$
   (a) Describe the Matrix Form, the Row Picture geometrically.
   (b) the Column Picture geometrically. Do linear combinations "give" whole plane? What is the nullspace?

3. Find all solutions to the singular system $\begin{cases} x_1 + x_2 = 5 \\ 3x_1 + 3x_2 = 15 \end{cases}$
   (a) Describe the Matrix Form, the Row Picture geometrically.
   (b) the Column Picture geometrically. Do linear combinations "give" whole plane? What is the nullspace?

4. Find all solutions to the "almost" singular system $\begin{cases} 1.0001x_1 + x_2 = 2.0001 \\ 3x_1 + 3x_2 = 6 \end{cases}$
   (a) Verify $(1,1)$ is the only solution. Yet, $(2,0)$ is "almost" a solution and far from $(1,1)$. Explain. (This is no problem in linear algebra. It is a huge problem in numerical linear algebra.)
   (b) the Column Picture geometrically. Do linear combinations "give" whole plane? What is the nullspace?

5. (a) Find $\|x\|_1, \|x\|_2$, and $\|x\|_\infty$ when $x = \begin{bmatrix} 2.1 \\ -3 \\ 1.5 \end{bmatrix}$.
   (b) Find $\|A\|_1$, and $\|A\|_\infty$ when $A = \begin{bmatrix} 1 & 5 & 1 \\ -1 & 3 & -3 \\ 1 & -7 & 0 \end{bmatrix}$.

6. Find all the eigenvalues of each of the following square matrices A. Then find a basis for each eigenspace and diagonalize A by factoring $A = X\Lambda X^{-1}$, if possible.
   (a) $A = \begin{bmatrix} 7 & 8 \\ 0 & 9 \end{bmatrix}$
   (b) $A = \begin{bmatrix} 6 & 3 \\ 2 & 7 \end{bmatrix}$
   (c) $A = \begin{bmatrix} 4 & 5 \\ -2 & -2 \end{bmatrix}$

7. (a) Decompose $A = \begin{bmatrix} 1 & -1 \\ 2 & 4 \end{bmatrix}$ as $A = X\Lambda X^{-1}$.
   (b) Decompose the symmetric matrix $A = \begin{bmatrix} 3 & 4 \\ 4 & -3 \end{bmatrix}$ as $A = Q\Lambda Q^T$ when Q is orthogonal. Verify that Q is orthogonal.
   (c) Find the SVD of $A = \begin{bmatrix} 1 & 1 & 0 \\ 0 & 1 & 1 \end{bmatrix}$.

8. TEXTBOOK EXERCISES: 1, 2, 4b, 9, 10a, 11.