1. **a)** Find the standard matrix $A$ for $\text{proj}_W$, where $W = \text{Span}\left\{ \begin{pmatrix} 1 \\ 1 \\ -1 \end{pmatrix}, \begin{pmatrix} 3 \\ -1 \\ 2 \end{pmatrix} \right\}$.

**b)** Find the standard matrix $B$ for $\text{proj}_L$, where $L = \text{Span}\left\{ \begin{pmatrix} 1 \\ 1 \\ -1 \end{pmatrix} \right\}$.

c) Answer the following questions without doing any calculations:

(1) What are $A^2$ and $B^2$?

(2) What are $A^{-1}$ and $B^{-1}$?

(3) What are $AB$ and $BA$?

(4) Is $A$ or $B$ diagonalizable?

(5) What are the eigenvalues of $A$ and $B$? What are their algebraic multiplicities?

(6) Is $A$ similar to $B$?
2. a) Find the distance from $e_1$ to $W = \text{Span}\left\{ \begin{pmatrix} 1 \\ 0 \\ -1 \end{pmatrix}, \begin{pmatrix} 1 \\ 1 \end{pmatrix} \right\}$.

b) Find the least squares solution $\tilde{x}$ to $Ax = e_1$, where $A = \begin{pmatrix} 1 & 1 \\ 0 & 1 \\ -1 & 1 \end{pmatrix}$.

3. Let $A = \begin{pmatrix} 1 & 6 & 4 \\ -1 & -2 & 20 \\ 1 & 2 & -14 \\ 1 & 6 & 10 \end{pmatrix}$.

a) Find an orthogonal basis for $\text{Col}A$.

b) Find an orthonormal basis for $\text{Col}A$.

c) Find a $QR$ decomposition for $A$. 
4.  Consider the four points \((0, 0), (1, 8), (3, 8), \) and \((4, 20)\).
   a) Find the best fit line \(y = Ax + B\) through these points.

   b) Find the best fit parabola \(y = Ax^2 + Bx + C\) through these points.

   c) Find the best fit cubic \(y = Ax^3 + Bx^2 + Cx + D\) through these points.