1. (a) (15 pts.) Give an example of an orthonormal basis in $R^2$.
   (b) (15 pts.) Expand the vector $v = (5, 6)$ with respect to your orthonormal basis of part (a). In
   other words, let $e_1, e_2$ denote the orthonormal basis that you have found in part (a). Next write
   \[ (5, 6) = \alpha_1 e_1 + \alpha_2 e_2. \]  
   Then find $\alpha_1$ and $\alpha_2$

2. Find the projection of the vector $b = (0, 3, 0)$ onto the line of the vector $a = (2, 2, -1)$. In other words, find a scalar $\gamma$ such that the vector $b - \gamma a$ is orthogonal to $a$. (Then the projection is $\gamma a$.)

3. Let the matrix $A$ be given by,
   \[ A = \begin{bmatrix} 2 & 1 & 3 \\ 4 & -6 & -2 \\ -2 & 7 & 5 \end{bmatrix}. \]
   (a) (15 pts.) Find a basis for the column space of $A$
   (b) (15 pts.) Find an orthonormal basis for the column space of $A$

4. Let $A$ be a given $3 \times 3$ matrix. Prove that the column space of $A$ is orthogonal to the nullspace of $A$. (You might recall that this is a special case of the Second Fundamental Theorem of Linear Algebra of our text.)

5. Let the function $y(x)$ be equal to 1 for $-\pi < x < 0$ and equal to $-1$ for $0 < x < \pi$. Find the first three Fourier coefficients of the function $y$. In other words, write
   \[ y(x) = a_0 + a_1 \cos x + b_1 \sin x + a_2 \cos x + ... \]  
   Then find $a_0, a_1$ and $b_1$.

**GOOD LUCK**