Let $\vec{\mathbf{u_1}} = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix}$, $\vec{\mathbf{u_2}} = \begin{bmatrix} -2 \\ 1 \\ 1 \end{bmatrix}$, $\vec{\mathbf{u_3}} = \begin{bmatrix} 0 \\ -1 \\ 1 \end{bmatrix}$, and $\vec{\mathbf{y}} = \begin{bmatrix} -1 \\ 2 \\ 3 \end{bmatrix}$.

1. Verify that $\{\vec{\mathbf{u_1}}, \vec{\mathbf{u_2}}, \vec{\mathbf{u_3}}\}$ is an orthogonal basis for $\mathbb{R}^3$.
2. Find $\hat{y_1}$, the orthogonal projection of $\vec{\mathbf{y}}$ onto $\vec{\mathbf{u_1}}$.
3. Find $\hat{y_2}$, the orthogonal projection of $\vec{\mathbf{y}}$ onto $\vec{\mathbf{u_2}}$.
4. Find $\hat{y_3}$, the orthogonal projection of $\vec{\mathbf{y}}$ onto $\vec{\mathbf{u_3}}$.
5. Verify that $\vec{\mathbf{y}} = \hat{y_1} + \hat{y_2} + \hat{y_3}$.