Show all work. Unjustified answer yields no credit. No calculators!

Let $\mathbf{u} = (1, 1, -1, -1)^T, \mathbf{v} = (3, 0, -2, -3)^T, \mathbf{w} = (4, 5, 1, 0)^T$.

1. (4 pts) Show that $\mathbf{u}_1 = \mathbf{u}, \mathbf{u}_2 = (1, -2, 0, -1)^T$ is an orthogonal basis in $\mathbf{U} = \text{span}(\mathbf{u}, \mathbf{v})$.

2. (5 pts) Find the orthogonal projection of $\mathbf{w}$ on $\mathbf{U}$. (You can use the results of 1, even if you did not do it.)

3. (1 pts) Find the distance of $\mathbf{w}$ to $\mathbf{U}$.