# Orthogonality Computations

**Problem 1.** Let

$$A = \begin{pmatrix} 3 & 4 \\ -3 & -4 \\ 1 & 1 \\ -2 & 0 \end{pmatrix}.$$

a. Use the Rank Theorem and Theorem 3 on page 381 to compute $\dim((\operatorname{Col} A)^{\perp})$ *without any row reduction.*

b. Find a basis for $(\operatorname{Col} A)^{\perp}$. Use this to verify your computation in part (a).

**Problem 2.** Let

$$\mathbf{u} = \begin{pmatrix} 3 \\ 2 \\ 4 \end{pmatrix}.$$

a. Find a basis for $(\operatorname{Span}\{\mathbf{u}\})^{\perp}$.

b. Choose a nonzero vector $\mathbf{v}$ in $(\operatorname{Span}\{\mathbf{u}\})^{\perp}$ (there are many possibilities). Find a basis for $(\operatorname{Span}\{\mathbf{u}, \mathbf{v}\})^{\perp}$.

c. Choose a nonzero vector $\mathbf{w}$ in $(\operatorname{Span}\{\mathbf{u}, \mathbf{v}\})^{\perp}$ (there are many possibilities). Show that $\mathbf{u}$, $\mathbf{v}$ and $\mathbf{w}$ are linearly independent.