

Let  $\mathbf{u}_1 = \begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix}$ ,  $\mathbf{u}_2 = \begin{bmatrix} 3 \\ 0 \\ 1 \end{bmatrix}$ , and  $\mathbf{u}_3 = \begin{bmatrix} 1 \\ -1 \\ -1 \end{bmatrix}$

1. Find a vector  $\mathbf{x} \in \mathbb{R}^3$  that is orthogonal to  $\mathbf{u}_1$ .
2. Find a vector  $\mathbf{y} \in \mathbb{R}^3$  that is orthogonal to both  $\mathbf{u}_1$  and  $\mathbf{u}_2$ .
3. Find all vectors  $\mathbf{z} \in \mathbb{R}^3$  that are orthogonal to  $\mathbf{u}_1$ ,  $\mathbf{u}_2$ , and  $\mathbf{u}_3$ .
4. Let  $A$  be the matrix formed by putting  $\mathbf{u}_1$ ,  $\mathbf{u}_2$ ,  $\mathbf{u}_3$  in the rows of  $A$ 
  - (a) How are the vectors  $\mathbf{z}$  from #3 related to  $\text{row}(A)$ ?
  - (b) In which fundamental subspace of  $A$  do the vectors  $\mathbf{z}$  from #3 lie?