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**Quiz for November 5, 2009**

Let  $T : \mathbb{R}^2 \rightarrow \mathbb{R}^3$  be a linear transformation with  $T(e_1) = u_1$  and  $T(e_2) = u_2$ , where

$$e_1 = \begin{bmatrix} 1 \\ 0 \end{bmatrix}, \quad e_2 = \begin{bmatrix} 0 \\ 1 \end{bmatrix}, \quad u_1 = \begin{bmatrix} 1 \\ 0 \\ -1 \end{bmatrix}, \quad \text{and} \quad u_2 = \begin{bmatrix} 2 \\ 1 \\ 0 \end{bmatrix}.$$

Find  $T\left(\begin{bmatrix} 3 \\ 2 \end{bmatrix}\right)$ . Explain what you are doing.

**ANSWER:** We see that  $\begin{bmatrix} 3 \\ 2 \end{bmatrix} = 3e_1 + 2e_2$ . The function  $T$  is a linear transformation so,

$$\begin{aligned} T\left(\begin{bmatrix} 3 \\ 2 \end{bmatrix}\right) &= T(3e_1 + 2e_2) = T(3e_1) + T(2e_2) = 3T(e_1) + 2T(e_2) = 3u_1 + 2u_2 \\ &= 3 \begin{bmatrix} 1 \\ 0 \\ -1 \end{bmatrix} + 2 \begin{bmatrix} 2 \\ 1 \\ 0 \end{bmatrix} = \boxed{\begin{bmatrix} 7 \\ 2 \\ -3 \end{bmatrix}}. \end{aligned}$$