Name: ______________________________

Directions: Show all work. No credit for answers without work.

1. **[3 parts, 1 point each]** True/False. Justify your answers.

   (a) There is a vector $\mathbf{u} \in \mathbb{R}^n$ such that for each vector $\mathbf{v} \in \mathbb{R}^n$, we have $\mathbf{u} \in \text{Span}\{\mathbf{v}\}$.

   (b) If $\mathbf{u}$ and $\mathbf{v}$ are both linear combinations of the vectors $\mathbf{a}_1, \ldots, \mathbf{a}_p$, then so is $\mathbf{u} + \mathbf{v}$.

   (c) For all vectors $\mathbf{u}$ and $\mathbf{v}$, we have that $\text{Span}\{\mathbf{u}\} = \text{Span}\{\mathbf{v}\}$ implies $\mathbf{u} = \mathbf{v}$.

2. **[1 point]** Determine if $\mathbf{b}$ is in the span of $\mathbf{a_1}, \mathbf{a_2}, \mathbf{a_3}$ where $\mathbf{a_1} = \begin{bmatrix} -1 \\ -3 \\ 2 \end{bmatrix}$, $\mathbf{a_2} = \begin{bmatrix} 1 \\ 4 \\ 5 \end{bmatrix}$, $\mathbf{a_3} = \begin{bmatrix} 1 \\ 6 \\ 19 \end{bmatrix}$, and $\mathbf{b} = \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix}$.

3. **[2 parts, 3 points each]** Given A and $\mathbf{b}$ below, solve for $\mathbf{x}$ in the matrix equation $A\mathbf{x} = \mathbf{b}$.

   (a) $A = \begin{bmatrix} 5 & 3 & -1 \\ 0 & 1 & -2 \\ -2 & 1 & 1 \end{bmatrix}$, $\mathbf{b} = \begin{bmatrix} 31 \\ -8 \\ -15 \end{bmatrix}$.

   (b) $A = \begin{bmatrix} 2 & -1 & 2 \\ 1 & 0 & 2 \\ 3 & -1 & -1 \\ 4 & 1 & 0 \end{bmatrix}$, $\mathbf{b} = \begin{bmatrix} 23 \\ 13 \\ 11 \\ 5 \end{bmatrix}$.