(2) Is $\left\{\begin{bmatrix}1\\2\\0\end{bmatrix}, \begin{bmatrix}3\\5\\3\end{bmatrix}, \begin{bmatrix}0\\1\\2\end{bmatrix}\right\}$ a basis for $\mathbb{R}^3$?

Yes. These are three linearly independent vectors, so their spanning set is $\mathbb{R}^3$.

$$\begin{bmatrix}1 & 3 & 0\\ 2 & 5 & 1\\ 0 & 3 & 2\end{bmatrix} \sim \begin{bmatrix}1 & 3 & 0\\ 0 & +1 & -1\\ 0 & 0 & 5\end{bmatrix}$$

$$\sim \begin{bmatrix}1 & 0 & 0\\ 0 & 1 & 0\\ 0 & 0 & 1\end{bmatrix}$$

✓