For the true statements, give a short proof. For the false statements, give a reason or a counterexample.

A) If $A$ is a $3 \times 3$ matrix whose characteristic polynomial has a double root, then $A$ is not diagonalizable.

B) If $T : \mathbb{R}^2 \rightarrow \mathbb{R}^2$ and there is a non-zero vector $x$ that satisfies $T^2(x) = 4x$, then $T(x) = \pm 2x$.

C) Every $3 \times 3$ matrix has at least one eigenvalue $\lambda \in \mathbb{R}$.

D) If $\lambda$ is an eigenvalue of $(A - sI)^{-1}$, where $s \in \mathbb{R}$, then $s + \frac{1}{\lambda}$ is an eigenvalue of $A$.

E) The eigenvalues of $\begin{pmatrix} a & b \\ b & a \end{pmatrix}$ are $\lambda = a + b$ and $\lambda = a - b$.

F) If the linear mapping $T : \mathbb{R}^3 \rightarrow \mathbb{R}^3$ has eigenvalues $\lambda = 1, 2$, and $x_1, x_2$ are linearly independent eigenvectors for $\lambda = 1$, while $y$ is an eigenvector for $\lambda = 2$, then $E = \{x_1, x_2, y\}$ is linearly independent.

G) If $A$ is an $n \times n$ matrix with linearly independent rows, then $\det(A) = 0$.

H) Let $V$ be a vector space of dimension $n$ and $T : V \rightarrow V$ be linear. If $[T]_\alpha = I_n$ (the $n \times n$ identity matrix) with respect to some basis $\alpha$ for $V$, then $T$ is the identity mapping.