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1. Recall that an $n \times n$ idempotent matrix $\mathbf{A}$ always satisfies the requirement that $\mathbf{A}^2 = \mathbf{A}$.

   (a) (2 points) Show that $|\mathbf{A}| = 0$ or $|\mathbf{A}| = 1$.

   (b) (1 point) Give a simple example of an idempotent matrix such that $|\mathbf{A}| = 0$.

2. (4 points) Let $\mathbf{B}$ be a square matrix of order n such that $\mathbf{B}^2 = 2\mathbf{B}$. Find a value k such that $\mathbf{I} + k\mathbf{B}$ is the inverse of $\mathbf{I} + \mathbf{B}$.

3. (3 points) Without calculating the inverse itself, why would $\mathbf{A} = \begin{pmatrix} 3 & 0 & 0 \\ 0 & 2 & 0 \\ 2 & -1 & 1 \end{pmatrix}$ have an inverse?