Name:

1. $\boxed{\text{T}}$ $\boxed{\text{F}}$ The xy-plane and the yz-plane are perpendicular to each other as vector spaces.

2. $\boxed{\text{T}}$ $\boxed{\text{F}}$ The xy-plane and the z-axis are perpendicular to each other as vector spaces.

3. $\boxed{\text{T}}$ $\boxed{\text{F}}$ The zero vector is perpendicular to any vector.

4. $A^T A$ is invertible if and only if A has _____ .