Step-1

Consider a matrix A and vector z. If $Az = 0$, then $A^H Az = 0$. Multiply by z^H to prove that $Az = 0$.

$$z^H A^H Az = 0$$
$$(Az)^H Az = 0$$
$$\|Az\|^2 = 0$$

This shows that length is zero. Or it can be said as $\boxed{Az = 0}$.

Step-2

From the above calculations it can be said that the null space of A and $A^H A$ are same. Matrix $A^H A$ will be an invertible Hermitian matrix when the null space of matrix A contains only vector $\boxed{z = \{0\}}$.