1)

Part 1

Since P is a projection matrix we know that $P^2 = P$

We also know that the eigenvalues of P & P^2 are related.

P's eigenvalue is λ then λ^2 will be the eigenvalue for P^2

Then we have $P = P^2$

$$\lambda^2 = \lambda \Rightarrow \lambda^2 - \lambda = 0$$

The roots of this equation are 0 & 1

Part 2

Since H is a Householder matrix it is orthogonal and symmetric then $H = H^{-1}$

Thus the eigenvalues of a matrix & the inverse are related.

So if eigenvalue of A is λ then A^{-1} is $\frac{1}{\lambda}$

$$\lambda = \frac{1}{\lambda} \Rightarrow \lambda^2 - 1 = 0$$

Roots of this equation are -1 & 1