Hint for problem 3.
It can be shown (Book by Nielsen and Chuang, p. 174) that any unitary operator \( U \) can be written as

\[
U = e^{i\chi} R_z(\phi) R_y(\theta) R_z(\psi)
\]

where \( R_z \), \( R_y \) are the rotation matrices defined in class.

\[
R_y(\theta) = \begin{bmatrix}
\cos \frac{\theta}{2} & -\sin \frac{\theta}{2} \\
\sin \frac{\theta}{2} & \cos \frac{\theta}{2}
\end{bmatrix}
\]

\[
R_z(\psi) = \begin{bmatrix}
e^{-i\psi/2} & 0 \\
0 & e^{i\psi/2}
\end{bmatrix}
\]

\( H \) is unitary, your problem is to find \( \chi, \beta, \theta, \phi \) in the expression above so that

\[
H = U (\chi, \beta, \theta, \phi, \psi)
\]