Randomness and Quantum Computers

$$U(q)=\begin{pmatrix}\cos q & -\sin q\\ \sin q & \cos q\end{pmatrix}$$

$$U(q)\begin{pmatrix}w_0\\ w_1\end{pmatrix}=\begin{pmatrix}\cos q & -\sin q\\ \sin q & \cos q\end{pmatrix}\begin{pmatrix}w_0\\ w_1\end{pmatrix}=\begin{pmatrix}w_0\cos q-w_1\sin q\\ w_0\sin q+w_1\cos q\end{pmatrix}$$

In particular,

$$U(\frac{p}{4})|0>=U(\frac{p}{4})\begin{pmatrix}1\\ 0\end{pmatrix}$$
$$=\begin{pmatrix}1/\sqrt{2} & -1/\sqrt{2}\\ 1/\sqrt{2} & 1/\sqrt{2}\end{pmatrix}\begin{pmatrix}1\\ 0\end{pmatrix}=\begin{pmatrix}1/\sqrt{2}\\ 1/\sqrt{2}\end{pmatrix}$$
$$=\frac{1}{\sqrt{2}}|0>+\frac{1}{\sqrt{2}}|1>$$