Exercise 4.3

The rotation operator about the $\hat{z}$ axis is given by

$$R_z(\theta) = \cos\frac{\theta}{2}\, I - i \sin\frac{\theta}{2} Z = \begin{pmatrix} e^{-i\theta/2} & 0 \\ 0 & e^{i\theta/2} \end{pmatrix} \tag{1}$$

When $\theta = \pi/4$, the rotation operator is then

$$R_z(\pi/4) = \begin{pmatrix} e^{-i\pi/8} & 0 \\ 0 & e^{i\pi/8} \end{pmatrix} \tag{2}$$

The T gate is given by

$$T = e^{i\pi/8} \begin{pmatrix} e^{-i\pi/8} & 0 \\ 0 & e^{i\pi/8} \end{pmatrix} \tag{3}$$

Compare eq. (2) and eq. (3), we conclude that, up to a global phase, the $\pi/8$ gate satisfies $T = R_z(\pi/4)$.