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Homework 2

3.

- $|1><0|$
$$= \binom{0}{1} \cdot (1^* \quad 0^*)$$
$$= \begin{pmatrix} 0(1^*) & 0(0) \\ 1(1^*) & 1(0) \end{pmatrix}$$
$$= \begin{pmatrix} 0 & 0 \\ 1 & 0 \end{pmatrix}$$

- $<1|1>$
$$= (0^* \quad 1^*) \cdot \binom{0}{1}$$
$$= 0^*(0) + 1^*(1)$$
$$= 1$$

- $|1> \otimes |1>$
$$= \binom{0}{1} \otimes \binom{0}{1}$$
$$= \begin{pmatrix} 0 \binom{0}{1} \\ 1 \binom{0}{1} \end{pmatrix}$$
$$= \begin{pmatrix} 0 \\ 0 \\ 0 \\ 1 \end{pmatrix}$$

- $<1|H|0>$
$$= (0^* \quad 1^*) \cdot \begin{pmatrix} \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \\ \frac{1}{\sqrt{2}} & \frac{-1}{\sqrt{2}} \end{pmatrix} \binom{1}{0}$$
$$= (0^* \quad 1^*) \cdot \begin{pmatrix} \frac{1}{\sqrt{2}} \\ \frac{1}{\sqrt{2}} \end{pmatrix}$$
$$= 0^* \left(\frac{1}{\sqrt{2}}\right) + 1^* \left(\frac{1}{\sqrt{2}}\right)$$
$$= \frac{1}{\sqrt{2}}$$

- $Z \otimes H$

$$= \begin{pmatrix} 1 & 0 \\ 0 & \text{-}1 \end{pmatrix} \otimes \begin{pmatrix} \dfrac{1}{\sqrt{2}} & \dfrac{1}{\sqrt{2}} \\ \dfrac{1}{\sqrt{2}} & \dfrac{\text{-}1}{\sqrt{2}} \end{pmatrix}$$

$$= \begin{pmatrix} 1\begin{pmatrix} \dfrac{1}{\sqrt{2}} & \dfrac{1}{\sqrt{2}} \\ \dfrac{1}{\sqrt{2}} & \dfrac{\text{-}1}{\sqrt{2}} \end{pmatrix} & 0\begin{pmatrix} \dfrac{1}{\sqrt{2}} & \dfrac{1}{\sqrt{2}} \\ \dfrac{1}{\sqrt{2}} & \dfrac{\text{-}1}{\sqrt{2}} \end{pmatrix} \\ 0\begin{pmatrix} \dfrac{1}{\sqrt{2}} & \dfrac{1}{\sqrt{2}} \\ \dfrac{1}{\sqrt{2}} & \dfrac{\text{-}1}{\sqrt{2}} \end{pmatrix} & \text{-}1\begin{pmatrix} \dfrac{1}{\sqrt{2}} & \dfrac{1}{\sqrt{2}} \\ \dfrac{1}{\sqrt{2}} & \dfrac{\text{-}1}{\sqrt{2}} \end{pmatrix} \end{pmatrix}$$

$$= \begin{pmatrix} \dfrac{1}{\sqrt{2}} & \dfrac{1}{\sqrt{2}} & 0 & 0 \\ \dfrac{1}{\sqrt{2}} & \dfrac{\text{-}1}{\sqrt{2}} & 0 & 0 \\ 0 & 0 & \dfrac{1}{\sqrt{2}} & \dfrac{1}{\sqrt{2}} \\ 0 & 0 & \dfrac{1}{\sqrt{2}} & \dfrac{\text{-}1}{\sqrt{2}} \end{pmatrix}$$