Access Jupyter notebook file in here, best run using jupyter notebook or using VSCode

1. $\begin{bmatrix} 0 \\ 1 \end{bmatrix} \otimes \begin{bmatrix} 1 \\ 0 \end{bmatrix}$

$$\begin{bmatrix} 0 \begin{pmatrix} 1 \\ 0 \end{pmatrix} \\ 1 \begin{pmatrix} 1 \\ 0 \end{pmatrix} \end{bmatrix}$$

$$\begin{bmatrix} 0 \\ 0 \\ 1 \\ 0 \end{bmatrix}$$

$$\mathrm{Phi = np.array([0],[0],[1],[0])}$$

2. $|\Phi\rangle = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 1 & 0 \end{bmatrix} |\Psi\rangle$

$|\Phi\rangle = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} 0 \\ 0 \\ 1 \\ 0 \end{bmatrix}$

$= \begin{bmatrix} 0 \\ 0 \\ 0 \\ 1 \end{bmatrix}$

$$\mathrm{Phi = np.array([0],[0],[0],[1])}$$

3. $|\Psi\rangle = \left(\left(\left(\begin{bmatrix} 1 \\ 0 \end{bmatrix} \otimes \begin{bmatrix} 1 \\ 0 \end{bmatrix} \right) \otimes \begin{bmatrix} 0 \\ 1 \end{bmatrix} \right) \otimes \begin{bmatrix} 1 \\ 0 \end{bmatrix} \right.$

$= \left(\begin{bmatrix} 1 \begin{pmatrix} 1 \\ 0 \end{pmatrix} \\ 0 \begin{pmatrix} 1 \\ 0 \end{pmatrix} \end{bmatrix} \otimes \begin{bmatrix} 0 \\ 1 \end{bmatrix} \right) \otimes \begin{bmatrix} 1 \\ 0 \end{bmatrix}$

$= \left(\begin{bmatrix} 1 \\ 0 \\ 0 \\ 0 \end{bmatrix} \otimes \begin{bmatrix} 0 \\ 1 \end{bmatrix} \right) \otimes \begin{bmatrix} 1 \\ 0 \end{bmatrix}$

$= \left(\begin{bmatrix} 1 \begin{pmatrix} 0 \\ 1 \end{pmatrix} \\ 0 \begin{pmatrix} 0 \\ 1 \end{pmatrix} \\ 0 \begin{pmatrix} 0 \\ 1 \end{pmatrix} \\ 0 \begin{pmatrix} 0 \\ 1 \end{pmatrix} \end{bmatrix} \right) \otimes \begin{bmatrix} 1 \\ 0 \end{bmatrix}$

$$= \begin{bmatrix} 0 \\ 1 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} \otimes \begin{bmatrix} 1 \\ 0 \end{bmatrix}$$

$$= \begin{bmatrix} 0 \\ 0 \\ 1 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

```
Phi = np.array([0],[0],[1],[0],[0],[0],[0]
,[0],[0],[0],[0],[0],[0],[0],[0],[0])
```

4. $U = \left(\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \otimes \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \right) \otimes \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 1 & 0 \end{bmatrix}$

```
Phi = np.array([[0],[0],[0],[1],[0],[0],[0],
[0],[0],[0],[0],[0],[0],[0],[0],[0]])
```

5. $NP - Hard$

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