Quiz - 4

Instructions

- The following questions **may have more than one correct answers**.
- There is no negative marking for wrong answers.
- Correct answers are worth one point. Partially correct answers are worth half a point.
- i is the imaginary number, $i^2 = -1$.

Questions

1. The quantum state that encodes the sequence $\vec{\mathbf{X}} = \begin{bmatrix} 1 & 1 & \sqrt{2} & 2 \end{bmatrix}$, has a normalization factor of _____ and is _____.

   a. $\frac{1}{8}$ and 'entangled'.
   b. $\frac{1}{8}$ and 'not entangled'.
   c. $\frac{1}{\sqrt{8}}$ and 'not entangled'.
   d. $\frac{1}{\sqrt{8}}$ and 'entangled'.

2. Given the quantum state representing a sequence of integers is given as:

$$\left|\vec{\mathbf{X}}\right\rangle = \frac{1}{2\sqrt{2}}\left[|00\rangle + |01\rangle - \sqrt{3}\,|10\rangle + \sqrt{3}\,|11\rangle\right]$$

   What are the allowed values of the second and third elements of the sequence?

   a. 1 and -3.
   b. 1 and -6.
   c. -3 and 9.
   d. -1 and -3.

3. For a sequence of length $N = 8$, what is the fourth row of the Fourier basis change matrix?

   a. $\begin{bmatrix} 1 & \frac{1+i}{\sqrt{2}} & i & \frac{-1+i}{\sqrt{2}} & -1 & -\frac{1+i}{\sqrt{2}} & -i & \frac{1-i}{\sqrt{2}} \end{bmatrix}$
   b. $\begin{bmatrix} 1 & -\frac{1+i}{\sqrt{2}} & i & \frac{1-i}{\sqrt{2}} & -1 & \frac{1+i}{\sqrt{2}} & -i & \frac{-1+i}{\sqrt{2}} \end{bmatrix}$

c. $\begin{bmatrix}1 & i & -1 & -i & 1 & i & -1 & -i\end{bmatrix}$

d. $\begin{bmatrix}1 & \frac{-1+i}{\sqrt{2}} & -i & \frac{1+i}{\sqrt{2}} & -1 & \frac{1-i}{\sqrt{2}} & i & -\frac{1+i}{\sqrt{2}}\end{bmatrix}$

4. The quantum state that encodes the sequence $\vec{\mathbf{X}} = \begin{bmatrix}1 & \frac{1+i}{\sqrt{2}} & i & \frac{i-1}{\sqrt{2}}\end{bmatrix}$ is?

a. $\frac{|0\rangle+|1\rangle}{\sqrt{2}} \otimes \frac{|0\rangle+e^{i\frac{\pi}{4}}|1\rangle}{\sqrt{2}}$

b. $\frac{|0\rangle+i|1\rangle}{\sqrt{2}} \otimes \frac{|0\rangle+e^{i\frac{\pi}{4}}|1\rangle}{\sqrt{2}}$

c. $\frac{|0\rangle+i|1\rangle}{\sqrt{2}} \otimes \frac{|0\rangle+|1\rangle}{\sqrt{2}}$

d. $\frac{|0\rangle-|1\rangle}{\sqrt{2}} \otimes \frac{|0\rangle+e^{i\frac{\pi}{4}}|1\rangle}{\sqrt{2}}$

5. To perform the Quantum Fourier Transform on a sequence of length 8, what is the smallest controlled rotation angle that needs to be performed?

a. $\frac{\pi}{4}$

b. $\frac{\pi}{2}$

c. $\frac{\pi}{6}$

d. $\frac{\pi}{16}$

6. Consider the sequence $\vec{\mathbf{X}} = \begin{bmatrix}0 & 1 & 0 & 0\end{bmatrix}$, which of the following are the valid results of the Fourier transform on this sequence?

a. $\begin{bmatrix}1 & i & -1 & -i\end{bmatrix}$

b. $\begin{bmatrix}1 & 1 & 1 & 1\end{bmatrix}$

c. $\begin{bmatrix}1 & -1 & 1 & -1\end{bmatrix}$

d. $\begin{bmatrix}1 & -i & -1 & i\end{bmatrix}$

7. Application of the Fourier transform on the quantum state quantum state $|\psi\rangle = \begin{pmatrix}0\\1\\0\\0\\0\\0\\0\\0\end{pmatrix}$ yields

which of the following states?

a. $q_0 = |+\rangle$, $q_1 = |i\rangle$ and $q_2 = \frac{|0\rangle+i|1\rangle}{\sqrt{2}}$

b. $q_0 = |+\rangle$, $q_1 = |-i\rangle$ and $q_2 = \frac{|0\rangle+e^{i\frac{\pi}{4}}|1\rangle}{\sqrt{2}}$

c. $q_0 = |-\rangle$, $q_1 = |i\rangle$ and $q_2 = \frac{|0\rangle+e^{i\frac{\pi}{4}}|1\rangle}{\sqrt{2}}$

d. $q_0 = |-\rangle$, $q_1 = |-i\rangle$ and $q_2 = \frac{|0\rangle+e^{i\frac{\pi}{4}}|1\rangle}{\sqrt{2}}$

8. The Hadamard gate acts as the Fourier transform for a sequence of what length?

    a. 0

    b. 2

    c. 1

    d. 4

9. What is the outcome of the Fourier transform on a non-constant sequence of length 2?

    a. $|1\rangle$

    b. $|0\rangle$

    c. $|+\rangle$

    d. insufficient data provided.

10. When using the Fourier transform on the the state $|01\rangle$, without the swap operation, yields which of the following outputs?

    a. $|+\rangle\,|+\rangle$

    b. $|-\rangle\,|-\rangle$

    c. $|+\rangle\,|-\rangle$

    d. $|-\rangle\,|+\rangle$