Quiz - 1 [rerun]

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' represents the imaginary number, $i^2 = -1$.
- $\mathbb{C}$ is the set of all complex numbers. $\mathbb{R}$ is the set of all real numbers.

Questions

1. The state vector of a single qubit system belongs to which of the following spaces?

   a. $\mathbb{C} \times \mathbb{C}$
   b. $\mathbb{C}^2 \times \mathbb{C}^2$
   c. $\mathbb{R}^3$
   d. $\mathbb{C}$

2. The norm of a single qubit state vector is _____.

   a. n
   b. 2^n
   c. 1
   d. 0

3. Which of the following is/are valid state vector(s) of a quantum bit?

   a. $\frac{1}{9}|0\rangle + \frac{2\sqrt{10}}{9}|1\rangle$
   b. $|1\rangle$
   c. $\sqrt{\frac{2}{3}}|0\rangle + \sqrt{\frac{1}{3}}|1\rangle$
   d. $\frac{2}{3}|0\rangle + \frac{1}{3}|1\rangle$

4. Which of the following is/are valid single qubit transformation(s)?

   a. $\begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}$

   b. $\begin{pmatrix} \frac{1}{\sqrt{2}} & 0 \\ 0 & \frac{1}{\sqrt{2}} \end{pmatrix}$

   c. $\begin{pmatrix} 0 & \frac{1+i}{\sqrt{2}} \\ \frac{1-i}{\sqrt{2}} & 0 \end{pmatrix}$

   d. $\begin{pmatrix} 1 & 0 \\ 0 & e^{i\phi} \end{pmatrix}$

5. A single qubit state vector is of the form

$$|\psi\rangle = \frac{\sqrt{3}}{2}|0\rangle + x|1\rangle$$

   Which of the following is an allowed value of x?

   a. $\frac{1}{2}$

   b. $\frac{1}{\sqrt{2}}$

   c. $\frac{1}{2\sqrt{2}} + i\frac{1}{2\sqrt{2}}$

   d. None of the above

6. If a qubit in the state, $|\psi\rangle = \frac{1}{\sqrt{2}}(|0\rangle + i|1\rangle)$ is measured in the Hadamard basis. What is the probability that the resultant state is $|+\rangle$?

   a. 1

   b. 0.25

   c. 0

   d. 0.5

7. The action of a Unitary transformation U, on the single qubit standard basis is given by:

$$U|0\rangle = \frac{2\sqrt{2}}{3}|0\rangle + \frac{i}{3}|1\rangle$$
$$U|1\rangle = x|0\rangle + \frac{2\sqrt{2}}{3}|1\rangle$$

   What is the value of x?

   a. $\frac{1}{3}$

   b. $-\frac{i}{3}$

   c. $\frac{i}{3}$

   d. $-\frac{1}{3}$

8. Given two state vectors,

$$|\psi\rangle = \frac{1}{\sqrt{2}}|0\rangle + x|1\rangle$$

and

$$|\phi\rangle = \frac{|0\rangle - |1\rangle}{\sqrt{2}}$$

such that, $\langle\phi|\psi\rangle = -\frac{i}{\sqrt{2}}$. What is the value of x?

a. $\frac{1}{\sqrt{2}}$
b. $\frac{1-i}{\sqrt{2}}$
c. $\frac{1+i}{\sqrt{2}}$
d. $\frac{i}{\sqrt{2}}$

9. The number of allowed single qubit bases is _____.

a. 1
b. ∞
c. 2
d. none of the above.

10. Which of the following vectors form an orthonormal basis?

a. $\{|0\rangle, |+\rangle\}$
b. $\{|-\rangle, |1\rangle\}$
c. $\left\{\frac{|0\rangle+|1\rangle}{\sqrt{2}}, \frac{|0\rangle+i|1\rangle}{\sqrt{2}}\right\}$
d. none of the above.