

Quiz - 1

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. $\frac{3}{4} |0\rangle + \frac{1}{4} |1\rangle$
 - b. $|1\rangle$
 - c. $\sqrt{\frac{2}{3}} |0\rangle + \sqrt{\frac{1}{3}} |1\rangle$
 - d. $\frac{1}{3} |0\rangle + \sqrt{\frac{8}{9}} |1\rangle$

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

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

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

Which of the following is an allowed value of x ?

- a. $\frac{1}{4}$
 - 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, $\langle\phi|\psi\rangle = \frac{i}{2}$. What is the value of x ?

- a. $\frac{1}{\sqrt{2}}$
 - b. $\frac{1-i}{\sqrt{2}}$
 - c. $\frac{1-i}{2}$
 - d. $\frac{i}{\sqrt{2}}$
9. The number of vectors in a single qubit basis 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.