
QUANTUM STATES FOR TWO QUBIT SYSTEMS

Question 1

We define a state $|\psi\rangle = \alpha |00\rangle + \beta |01\rangle + \gamma |10\rangle + \delta |11\rangle$ to be a 2-qubit quantum state if $|\alpha|^2 + |\beta|^2 + |\gamma|^2 + |\delta|^2 = 1$. Which of the following equations describe a 2-qubit quantum state?

(a) Example: $\frac{1}{2} |00\rangle + \frac{1}{2} |01\rangle + \frac{1}{2} |10\rangle + \frac{1}{2} |11\rangle$

$$\alpha = \frac{1}{2}, \beta = \frac{1}{2}, \gamma = \frac{1}{2}, \delta = \frac{1}{2}$$

$$\alpha^2 + \beta^2 + \gamma^2 + \delta^2 = \left(\frac{1}{2}\right)^2 + \left(\frac{1}{2}\right)^2 + \left(\frac{1}{2}\right)^2 + \left(\frac{1}{2}\right)^2 = 1$$

Since $\alpha^2 + \beta^2 + \gamma^2 + \delta^2 = 1$, $|\psi\rangle$ is a valid quantum state.

$$(b) |\psi\rangle = |00\rangle$$

$$(c) |\psi\rangle = |00\rangle + |01\rangle + |10\rangle + |11\rangle$$

$$(d) |\psi\rangle = \frac{3}{5} |00\rangle + \frac{4}{5} |01\rangle$$

$$(e) |\psi\rangle = \frac{\sqrt{7}}{5} |00\rangle + \frac{\sqrt{7}}{\sqrt{5}} |01\rangle + \frac{3}{5} |10\rangle + \frac{\sqrt{2}}{5} |11\rangle$$