PHYS 512

Assignment – 02 $\langle Quantum|Computing\rangle$

Due Sunday Sep 7 – 11:59 pm (NO late submission)

Submit the solutions of Question 1, 2, 4, and 8 (You are strongly encouraged to solve all of them)

Please clearly write down your ID and PHYS 512 - Assignment – 01 on the submitted solution

Q.1 Concept of Photon [6]

A 500 W street lamp is at a distance to 1.0 km from and an observer. If observer's eye lens is of 5 mm in diameter find the number photons hitting his retina per second. (assume: lamp is producing light equally in all directions of wave length 600 nm, there is no absorption of light by atmosphere, and light obeys the inverse square law)

Q.2 Normalization [6]

Verify each of the following state is normalized, if the state is NOT normalized, normalized the state (show all the steps of verification and normalization)

i) $|\varphi\rangle = \frac{1}{\sqrt{6}}|0110\rangle + \frac{2}{\sqrt{3}}|1111\rangle + \frac{1}{\sqrt{6}}|0101\rangle$

ii) $|\Psi\rangle = \frac{1}{\sqrt{6}}|11\rangle + \frac{\sqrt{2}}{\sqrt{3}}|00\rangle + \frac{1}{\sqrt{6}}|01\rangle$

ii) $|\Upsilon\rangle = \frac{3i\,|0\rangle+4|1\rangle}{5}$

Q.3 Change of Basis [6]

Quantum state $|+\rangle, and\ |-\rangle$ is given in terms in terms of $|0\rangle\ and\ |1\rangle$

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

Express the states $|0\rangle\ and\ |1\rangle$ in terms of $|+\rangle\ and\ |-\rangle$

Q.4 Probability of measuring a state [6]

In each of the following quantum state

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

$$|\emptyset\rangle = \frac{1+i}{\sqrt{3}}|0\rangle - \sqrt{\frac{1}{3}}|1\rangle$$

a) What is the probability that we find the qubit in state $|0\rangle$

b) What is the probability that we find the qubit in state $|1\rangle$

Q.5 Entangled States [5]

For given entangled state $|\psi\rangle$

$$|\psi\rangle = \left(\frac{1}{4} + \frac{i}{4}\right)|01\rangle + \frac{\sqrt{7}}{2\sqrt{2}}|10\rangle$$

(a) What is the probability of finding the first qubit in state $|1\rangle$?

(b) If you measure, the first qubit is state$|1\rangle$ what is/are the possible states of second qubit

(c) Replace the factor $\left(\frac{1}{4} + \frac{i}{4}\right)$ with new number (fraction/real/complex) in state$|\psi\rangle$ such the probability of finding the state $|01\rangle$ remains the same.