DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
M.Tech. (Computer Science and Engineering)
Mid Semester Exam

SUBJECT: CSE 5115 Quantum Computing

Time: 10.00 AM-11.30 AM   Date:10-10-2024   MAX.MARKS: 30

Note: Answer All Questions

1A. Which of the following are allowed qubit states? (2M)

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

1B. A qubit is prepared in state $|\psi\rangle = \frac{1}{\sqrt{3}}|0\rangle - \sqrt{\frac{2}{3}}|1\rangle$. It is then measured. What is P(1)? The resulting qubit is measured a second time. What are P(0) and P(1) for the second measurement, given that the first measurement gave result $|1\rangle$? (3M)

1C. Determine which of the following are Unitary or not. Justify your answer. (5M)

$$(a)\begin{bmatrix} 1 & i \\ -i & -1 \end{bmatrix}, (b)\begin{bmatrix} 1 & 1 \\ -1 & -1 \end{bmatrix}, (c)\frac{1}{\sqrt{2}}\begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix}$$

2A. Determine whether the following state is entangled or not? Justify your answer. (3M)

$$|\psi\rangle = \frac{1}{2}\left(|00\rangle - |01\rangle + |10\rangle - |11\rangle\right)$$

2B. With neat diagram, explain Bloch sphere. (2 M)

2C. Define Y gate. Design quantum circuit for Controlled Y gate and give its matrix representation. (5M)

3A. Define CCNOT gate. Design quantum circuit for CCNOT gate and give its matrix representation. Implement OR gate using CCNOT gate. (5M)

3B. Alice wishes to exchange a private encryption key with Bob using the QKD protocol. She generates a binary string 101,011,0101, and encode using H H I H I H II I II I. What is the quantum state that she transmits to Bob? Alice sends the state to Bob, who decodes using II I II II I I II I II II. They both reveal their choice of encoding. What is the string they retain? (3M)

3C. Design quantum circuit for teleportation protocol. (2M)