MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL
(A constituent unit of MAHE, Manipal)

SCHOOL OF COMPUTER ENGINEERING

I Sem M.Tech. (Computer Science and Engineering)

Mid Semester Exam

SUBJECT: CSS 5104 Quantum Computing

Time: 2.15 PM-3.45 PM **Date: 16-09-2025** **MAX.MARKS: 30**

Note: Answer All Questions

1A. Define "braket" of two vectors $|v\rangle and |w\rangle$. If

$|v\rangle = \frac{2i}{\sqrt{5}}|0\rangle + \frac{1}{\sqrt{5}}|1\rangle and |w\rangle = \frac{2}{\sqrt{5}}|0\rangle - \frac{i}{\sqrt{5}}|1\rangle$, compute $\langle v|w\rangle$. (3M)

1B. Let $|v\rangle = \begin{bmatrix} v_1 \\ v_2 \end{bmatrix} and |w\rangle = \begin{bmatrix} w_1 \\ w_2 \end{bmatrix}$ compute $v \otimes w$. Let $|\psi\rangle = \frac{1}{\sqrt{2}}(|00\rangle + |11\rangle)$, compute P(00) and P(11). Let H and I are Hadamard and Identity gates respectively, evaluate $|\psi_1\rangle = (H \otimes I)|\psi\rangle$. (5M)

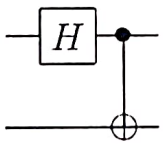
1C. With neat diagram, explain Bloch sphere. (2M)

2A. Imagine we can define a unitary operator U that can copy the qubit states $|0\rangle and |1\rangle : U(|0\rangle|0\rangle) = |0\rangle|0\rangle and U(|1\rangle|0\rangle) = |1\rangle|1\rangle$. Can U be used to copy $|\psi\rangle = \frac{1}{\sqrt{2}}(|0\rangle + |1\rangle)$ Verify using an explicit calculation. (4M)

2B. Define Z gate and give its bracket representation. (3M)

2C. State No-Cloning Theorem. With quantum circuit, show that the unknown quantum state $|\psi\rangle = a|0\rangle + b|1\rangle$ cannot be copied using CNOT gate. (3M)

3A. Define Bell state. Consider the following quantum circuit:



Compute the outputs for the inputs: $|00\rangle, |01\rangle, |10\rangle and |11\rangle$. (5M)

3B. With circuit diagram, implement SWAP operation using CNOT gate. (2M)

3C. Define CCNOT gate. Design its quantum circuit and matrix representation. With quantum circuit implement OR gate using CCNOT gate. (3M)