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Bengaluru

Mid Term Examinations - October 2026

Date: 05/10/2026 **Time:** 09:30 AM - 11:00 AM

Course Code: IST3414 **Course Name:** Quantum Computing and AI

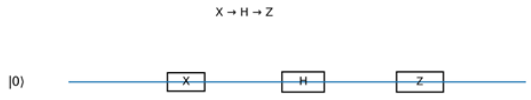
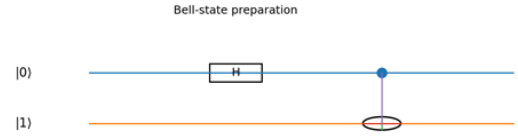
Semester: Fifth Semester **Max. Marks:** 50 **Weightage:** 50%

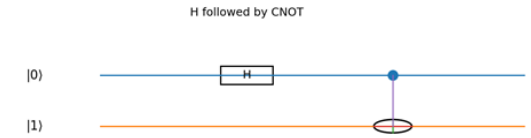
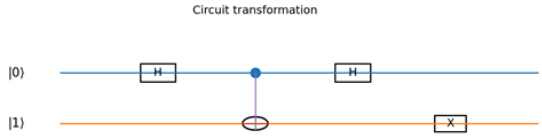
CO - Levels	CO1	CO2
Marks	46	44

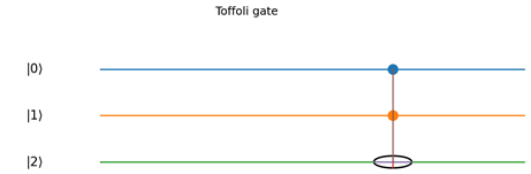
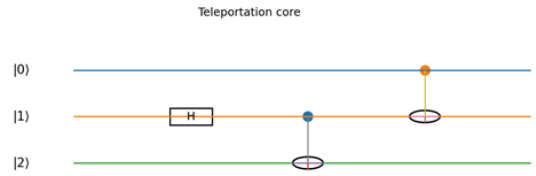
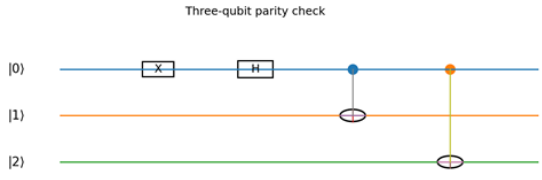
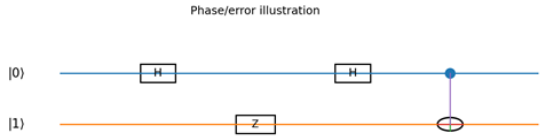
PART A: Answer Following Questions. 10 M

Q.N.	Questions	M	CO	BT
1	What is the normalization condition for $\|\psi\rangle=\alpha\|0\rangle+\beta\|1\rangle$?	2	CO1	BT1
2	Define a qubit register.	2	CO1	BT1
3	State two standard difference between classical bits and qubits.	2	CO1	BT1
4	What is the matrix representation of the Pauli-X, Y, and Z- gate?	2	CO2	BT2
5	State the no-cloning theorem in one sentence.	2	CO2	BT2

PART B : Answer Any 1 Following Questions. 10 M

Q.N.	Questions	M	CO	BT
6	(a) Starting from |0>., apply H and then Z as shown by the single-qubit circuit. Write the state after each gate and calculate the final measurement probabilities.  (b) A qubit has state $\|\psi\rangle=(1/\sqrt{2})\|0\rangle+i(1/\sqrt{2})\|1\rangle$. Compute its density matrix and Bloch coordinates. 	10	CO1	BT3

7	(a) For $\|\Phi^+\rangle=(\|00\rangle+\|11\rangle)/\sqrt{2}$, calculate $\langle Z\otimes Z\rangle$ and $\langle X\otimes X\rangle$ and interpret the results.  (b)Using tensor products, derive the 4×4 matrix of CNOT from its action on $\|00\rangle$, $\|01\rangle$, $\|10\rangle$, $\|11\rangle$. Verify its unitarity. 	10	CO1	BT3

PART C: Answer Any 1 Following Questions. 10 M				
Q.N.	**Questions**	**M**	**CO**	**BT**
8	(a) For the Toffoli circuit, calculate the output for |111> and |101>. Represent the transformation as a reversible mapping.  (b) For teleportation, derive the four possible receiver states conditioned on Alice's two measurement outcomes and specify the corresponding Pauli correction operators. 	10	CO2	BT4
9	(a) Consider the three-qubit repetition code. Encode $\|1\rangle$ as $\|111\rangle$, assume an X error occurs on q_2, and use parity checks to identify and correct the error mathematically.  (b) Show that CNOT is its own inverse by applying the shown circuit twice to an arbitrary basis state $\|ab\rangle$. 	10	CO2	BT4

PART D: Answer Any 1 Following Questions. 10 M				
Q.N.	**Questions**	**M**	**CO**	**BT**
10	Explain all five postulates of quantum mechanics relevant to quantum computing. Discuss how each postulate influences the design of quantum algorithms and quantum circuits.	10	CO1	BT2

11	Describe the steps involved in designing a quantum circuit for a given problem. Explain the challenges involved in circuit depth, gate count, and error accumulation in practical quantum systems.	10	CO1	BT2

PART E: Answer Any 1 Following Questions. 10 M				
Q.N.	**Questions**	**M**	**CO**	**BT**
12	Design a quantum circuit to transform the input state $\|00\rangle$ into $\|\psi\rangle = (\|00\rangle - \|01\rangle + \|10\rangle - \|11\rangle)/2$. Explain the role of each gate used in the circuit.	10	CO2	BT4
13	State and prove No Cloning Theorem. Discuss its advantages.	10	CO2	BT4