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PRESIDENCY UNIVERSITY

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Bengaluru

Mid Term Examinations - October 2026

Date: 06/10/2026 **Time:** 09:30 AM - 11:00 AM

Course Code: PHY3001 **Course Name:** Principles of Quantum Mechanics and Quantum Computing

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

CO - Levels	CO1	CO2	CO3	CO5
Marks	48	70	22	40

PART A: Answer Following Questions. 10 M

Q.N.	Questions	M	CO	BT
1	Write any two characteristics of matter waves.	2	CO1	BT2
2	Find the norm of the vector $\|A\rangle = \begin{bmatrix} 3 \\ 4i \end{bmatrix}$ and write the corresponding normalized vector.	2	CO1	BT3
3	State any two properties of a density matrix ρ.	2	CO2	BT2
4	For the state $\|\psi\rangle = \|0\rangle$, construct the density matrix ρ.	2	CO2	BT3
5	$\|\psi\rangle = \frac{1}{\sqrt{2}}(\|0\rangle + \|1\rangle)$ Apply the Pauli-Z gate to the given state above and write the output state.	2	CO3	BT3

PART B : Answer Any 1 Following Questions. 10 M

Q.N.	Questions	M	CO	BT
6	State the de Broglie hypothesis of matter waves. Derive the expression for its de Broglie wavelength in terms of its kinetic energy; further derive the expression for the de Broglie wavelength of an electron accelerated through a potential difference of V volts.	10	CO1	BT2
7	**a.** Explain the properties of bra–ket (Dirac) notation. How is a bra vector obtained from a ket vector? Illustrate with a suitable example. **b.** Two vectors are given by $\|A\rangle = \begin{bmatrix} 1+i \\ 2 \\ -i \end{bmatrix}, \quad \|B\rangle = \begin{bmatrix} 2 \\ i \\ 1 \end{bmatrix}.$ Find ⟨A|B⟩ and ⟨B|A⟩, and verify that ⟨A|B⟩ = ⟨B|A⟩* .	10	CO1	BT3

PART C: Answer Any 1 Following Questions. 10 M

Q.N.	Questions	M	CO	BT

8	**a.** Mention the differences between classical and quantum computers. **b.** Consider the two-qubit state $\|\psi\rangle = \frac{1}{\sqrt{2}}(\|00\rangle + \|11\rangle)$ Construct the density matrix ρ and check whether the given state is pure or mixed.	10	CO2	BT3
9	**a.** What is the expectation value of an observable? Write the expressions for the density matrix of a pure state and for a mixed state. **b.** Find the expectation value of σ_z using $\langle\psi\|\sigma_z\|\psi\rangle$, and verify the result using the density matrix method . Given $\|\psi\rangle = \frac{1}{\sqrt{2}}(\|0\rangle + \|1\rangle)$, $\sigma_Z = \begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix}$.	10	CO2	BT3

PART D: Answer Any 1 Following Questions. 10 M				
Q.N.	**Questions**	**M**	**CO**	**BT**
10	a. Explain in detail the S gate. b. $H = \frac{1}{\sqrt{2}}\begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix}$ Using the matrix H (i) show that H is unitary, and (ii) show that applying the Hadamard gate twice returns the original state, i.e. $HH\|0\rangle = \|0\rangle$.	10	CO3	BT3
11	Explain the SWAP and Taffoli gates.	10	CO3	BT3

PART E: Answer Any 1 Following Questions. 10 M				
Q.N.	**Questions**	**M**	**CO**	**BT**
12	Explain CNOT gate and the Fredkin gate with a circuit diagram, truth table, working and matrix representation.	10	CO5	BT3
13	Explain the Controlled-Z (CZ) gate with its circuit symbol and 4 × 4 matrix. Find the output of the CZ gate for the inputs $\|10\rangle$ and $\|11\rangle$, and compare its action with the CNOT gate.	10	CO5	BT3