



PRESIDENCY UNIVERSITY

BENGALURU

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Mid - Term Examinations - March 2026

Date: 12-03-2026

Time: 09:30am - 11.00am

School: SOCSE	Program: B.Tech		
Course Code: PHY3001	Course Name: Principles of Quantum Mechanics and quantum computing		
Semester: VI	Max Marks: 50	Weightage: 25%	

CO - Levels	CO1	CO2	CO3	CO4	CO5
Marks	36	34			20

Instructions:

- (i) Read all questions carefully and answer accordingly.
- (ii) Do not write anything on the question paper other than roll number.

Part A

Answer ALL the Questions. Each question carries 2marks.

5Q x 2M=10M

1	Define matter waves.	2 Marks	L2	CO1
2	Mention the number of basis states in a 3-qubit system ?	2 Marks	L3	CO2
3	State the conditions for matrix "A" is called Hermitian, Skew-Hermitian, and Unitary	2 Marks	L2	CO1
4	Explain the normalization and orthogonality conditions of quantum states using Dirac bra-ket notation.	2 Marks	L2	CO1
5	Mention the matrix representation for $ 00\rangle$ and $ 11\rangle$ quantum states.	2 Marks	L2	CO2

Part B

Answer the Questions.

Total Marks 40M

6.	a.	Derive the de Broglie wavelength of a free particle in terms kinetic energy and for an electron accelerated through a potential difference V.	5 Marks	L2	CO1
			5 Marks	L3	CO5

	b	Analyze the momentum of an electron and the de Broglie wavelength associated with it if its kinetic energy is 1.5 KeV.			
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Or

7.	a.	Explain the properties of Dirac notation with appropriate mathematical expressions.	5 Marks	L2	C01
	b.	<p>A qubit is in the state</p> $ \psi\rangle = \frac{1}{\sqrt{3}} 0\rangle + \sqrt{\frac{2}{3}} 1\rangle$ <p>(a) Verify whether the state is normalized. (b) Find the probability of measuring the qubit in state $1\rangle$.</p>	5 Marks	L3	C05

8.	a.	Explain the concept of a qubit and its properties. Discuss the technological limitations that have slowed down Moore's Law.	5 Marks	L2	C02
	b.	Analyze how the parameters θ and ϕ determine the position of a qubit state on the Bloch sphere. Explain their effect on measurement probabilities.	5 Marks	L4	C05

Or

9.	a.	Write the differences between classical and quantum computers.	5 Marks	L2	C02
	b.	Analyze the operation of the Toffoli (CCNOT) gate for different input combinations.	5 Marks	L4	C05

10.	a.	<p>Consider the vectors</p> $ u\rangle = \begin{bmatrix} 1 \\ i \\ -1 \end{bmatrix}, \quad v\rangle = \begin{bmatrix} i \\ 2 \\ 1+i \end{bmatrix}$ <p>Find the conjugate transpose $\langle u$. Calculate the inner product $\langle u v\rangle$. Determine the outer product $u\rangle\langle v$ and show that the result is a 3×3 matrix.</p>	10 Marks	L3	C01
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Or

11.	a.	<p>Suppose that $u_1\rangle, u_2\rangle, u_3\rangle$ is an orthonormal basis. In this basis let,</p> $ \psi\rangle = 2i u_1\rangle - 3 u_2\rangle + i u_3\rangle$ $ \phi\rangle = 3 u_1\rangle - 2 u_2\rangle + 4 u_3\rangle$ <p>(a) Find $\langle\psi$ and $\langle\phi$.</p> <p>(b) Compute the inner product $\langle\phi \psi\rangle$ and show that $\langle\phi \psi\rangle = \langle\psi \phi\rangle^*$.</p> <p>(c) Let $a = 3 + 3i$ and compute $a\psi\rangle$.</p> <p>(d) Find $\psi + \phi\rangle, \psi - \phi\rangle$.</p>	10 Marks	L3	CO1
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12.	a.	<p>Explain in detail the Pauli-X, Pauli-Y, and Pauli-Z gates with their matrix representation, symbolic form, outer product and truth table. Derive their effect on basis states $0\rangle, 1\rangle$ and $\alpha 0\rangle + \beta 1\rangle$.</p>	10 Marks	L2	CO2
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Or

13.	a.	<p>Explain the working of multiple-qubit gates CNOT, and Controlled-Z with their matrix representation, symbolic form, outer product and truth table.</p>	10 Marks	L2	CO2
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