Roll No.												

PRESIDENCY UNIVERSITY

BENGALURU

End - Term Examinations – May / June 2026

Date: 25-05-2026 **Time:** 01:00pm – 04:00pm

School: B .Tech CSE and Allied Courses	**Program**: B. Tech	
Course Code: PHY3001	**Course Name:** Principles of Quantum Mechanics and quantum computing	
Semester: VI	**Max Marks**: 100	**Weightage**: 50%

CO - Levels	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Marks	**12**	**16**	**24**	**26**	**22**

Instructions:

(i) Read all questions carefully and answer accordingly.

(ii) Do not write anything on the question paper other than roll number.

(iii) Given : Planck's constant $h = 6.625\times10^{-34}$ Js; Boltzmann's constant $k_B = 1.38\times10^{-23}$ J/K , Speed of light $c = 3\times10^{8}$ m/s, Mass of the electron $m = 9.1\times10^{-31}$ kg, Charge of the electron $e = 1.6\times10^{-19}$ C

Part A

Answer ALL the Questions. Each question carries 2marks. 10Q x 2M=20M

1.	Which basic quantum gate is used in building a SWAP operation, and how many such gates are required?	**2 Marks**	**L2**	**CO2**
2.	Explain the key differences between classical bits and quantum bits (qubits).	**2 Marks**	**L2**	**CO2**
3.	Explain any two applications of quantum computing.	**2 Marks**	**L2**	**CO2**
4.	List all three Pauli matrices.	**2 Marks**	**L2**	**CO1**
5.	State the condition for a unitary operator and check whether the T gate fulfills this condition.	**2 Marks**	**L2**	**CO5**
6.	What is quantum teleportation?	**2 Marks**	**L2**	**CO4**
7.	What is the main function of Grover's search algorithm?	**2 Marks**	**L2**	**CO4**
8.	What is the quantum advantage in Simon's algorithm?	**2 Marks**	**L2**	**CO4**
9.	In quantum parallelism, if the input state is $\|110\rangle$, what is the resulting output after applying the function?	**2 Marks**	**L2**	**CO3**

10.	What is quantum entanglement?	**2 Marks**	**L2**	**CO3**

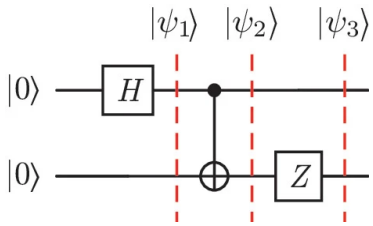
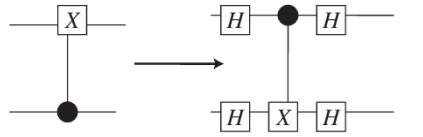
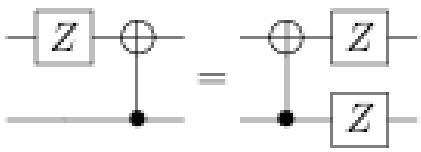
Part B

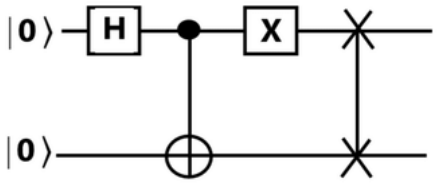
Answer the Questions. **Total Marks 80M**

11.	**a.**	Explain the concept of the wave function, including its properties and physical significance, and then discuss the properties of Dirac ket–bra notation.	**10 Marks**	**L2**	**CO1**
	b.	A three-qubit system is in the state $$\|\psi\rangle = \left(\frac{\sqrt{2}+i}{\sqrt{20}}\right)\|000\rangle + \frac{1}{\sqrt{2}}\|001\rangle + \frac{1}{\sqrt{10}}\|011\rangle + \frac{i}{2}\|111\rangle$$ Find the state |ψ⟩ is normalized or not. What is the probability that the system is found in the state |011> if all three qubits are measured? What is the probability that a measurement on the second qubit only gives |1>? What is the post measurement state of the system? Show that the post measurement state is normalized.	**10 Marks**	**L3**	**CO5**
		Or			
12.	**a.**	Derive the de Broglie wavelength of a free particle in terms kinetic energy and for an electron accelerated through a potential difference V. Compare the energy of a photon with that of a neutron when both are associated with a de Broglie wavelength of 1 Å. Given mass of neutron is 1.674×10^{-27} kg .	**10 Marks**	**L2**	**CO1**
	b.	Let three vectors be defined as $$\|A\rangle = \begin{pmatrix} 1+i \\ -2 \\ 3i \end{pmatrix}, \quad \|B\rangle = \begin{pmatrix} 2 \\ -1+i \\ 4 \end{pmatrix}, \quad \|C\rangle = \begin{pmatrix} -i \\ 3 \\ 2-i \end{pmatrix}$$ Answer the following: Find the norm of each vector |A⟩ and |B⟩. Compute the inner products ⟨A|B⟩ and ⟨B|C⟩. Check whether any two of the given vectors are orthogonal.	**10 Marks**	**L3**	**CO5**

13.	**a.**	Explain the Bloch sphere representation of a qubit, and represent the states |0⟩ and |1⟩ on the Bloch sphere. Further, illustrate any three superposition states and describe their positions on the Bloch sphere.	**10 Marks**	**L**	**CO2**
	b.	Prove trace of outer product is equal to inner product with example.	**10 Marks**	**L**	**CO5**

		Suppose that in some orthonormal basis $\{\|u_1\rangle, \|u_2\rangle, \|u_3\rangle\}$ an operator A acts as follows: $A\|u_1\rangle = 2\|u_1\rangle$ $A\|u_2\rangle = 3\|u_1\rangle - i\|u_3\rangle$ $A\|u_3\rangle = -\|u_2\rangle$ Write the matrix representation of the operator.			
		Or			
14.	**a.**	Explain the working of multiple-qubit gates **:** Swap gate, and Controlled-Z with their matrix representation, symbolic form, outer product form and truth table.	**10 Marks**	**L3**	**CO2**
	b.	Consider the two-qubit entangled state $\|\psi\rangle=1/\sqrt{2}(\|00\rangle+\|11\rangle)$. find state $\|\psi\rangle$ is pure or mixed state Construct the density matrix $\rho=\|\psi\rangle\langle\psi\|$. Obtain the reduced density matrix of the first qubit by performing a partial trace over the second qubit. Is the reduced density matrix a pure or mixed state? Justify your answer.	**10 Marks**	**L4**	**CO5**

15.	**a.**	Compare classical and quantum approaches for evaluating a function over multiple inputs. Using an example (2-qubit and 3 –qubit), explain how quantum parallelism provides computational advantage.	**10 Marks**	**L3**	**CO3**
	b.	Apply circuit operations and matrix representation of quantum gates to find the final output state of the given circuit. 	**10 Marks**	**L3**	**CO3**
		Or			
16.	**a.**	Show that the following circuits are equivalent:  	**10 Marks**	**L3**	**CO3**

	b.	Apply circuit operations and matrix representation of quantum gates to find the final output state of the given circuit. 	**10 Marks**	**L3**	**CO3**

17.	**a.**	Explain the concept of Quantum Teleportation with a neat quantum circuit, describe the steps involved.	**10 Marks**	**L4**	**CO4**
	b.	Explain the working of Superdense Coding with a quantum circuit. Compare Quantum Teleportation and Superdense Coding in terms of principle, resources, and applications.	**10 Marks**	**L4**	**CO4**
		Or			
18.	**a.**	State and prove the No-Cloning Theorem in quantum mechanics using: Linearity of quantum operations and Orthogonality condition of quantum states.	**10 Marks**	**L3**	**CO4**
	b.	Apply Simon's Algorithm to determine the hidden string "s " for a given function by explaining the problem definition, periodicity property $f(x)=f(x \oplus s)$ quantum circuit steps, measurement interpretation, method of obtaining s, and its advantage over classical complexity.	**10 Marks**	**L4**	**CO4**