K. K. Wagh Institute of Engineering Education & Research, Nashik

(An Autonomous Institute From A.Y. 2022-23)

WINTER-2025	
Exam Seat No.:	
Academic Year:2025-2026	Semester:V
Class:TY	Program:B.Tech
Branch Code:ADS/COM/CSD	Pattern:2023
Name of Course:Foundation of Quantum Computing	Course Code:2301381
Max. Marks:60	Duration:2.30 Hrs.

Instructions: Candidates should read carefully the instructions printed on the Question Paper and on the cover page of the Answer Book, which is provided for their use.

1. This question paper contains 2 page(s).
2. Answer to each new question is to be started on a new page.
3. Assume suitable data wherever required, but justify it.
4. Draw the neat labelled diagrams, wherever necessary.
5. The last columns indicates the Course Outcome and level of Blooms Taxonomy of the Question/sub-question.

		Marks	CO
Question No. 1			
1a)	Write short note on difference between classical and Quantum computing systems in terms of information representation, processing mechanism and computational power?	(6)	CO1
Question No. 2			
2a)	What is ‘Ket’ and ‘Bra’ and How quantum state is represented using this Bra Ket notation, how one can calculate the probability that system will collapse into either |0> or |1>?	(6)	CO2
Question No. 3			
3a)	What is a qubit? Explain the mathematical representation of quantum states using ket notation, probability amplitudes, and normalization.	(8)	CO3
	OR		
3b)	What is Qubit? How it differs from classical bit in terms of state representation, information and measurement?	(8)	CO3
3c)	Explain how Hadamard gate converts a |0> and |1> qubits into superposition state i.e. H |0> = |+> and H|1> = |-> ?	(8)	CO3
	OR		
3d)	Verify H(H|0>) = H(|+>) = |0> showing H^2 = Identity ? also Apply Hadamard gate to quantum state Ψ = 1/sqrt(3) |0> + sqrt(2/3) |1> ?	(8)	CO3
Question No. 4			
4a)	Calculate the inner and outer product of following states	(8)	CO4

$$|\phi\rangle = \begin{bmatrix} 1 \\ i \end{bmatrix}, \quad |\psi\rangle = \begin{bmatrix} 2 \\ 3i \end{bmatrix}$$

OR

4b)	Explain working of X, Y and Z-gate operating on qubit |0> also draw Bloch diagram before and after operations of these gates? Also Prove that The Z gate is its own inverse. Therefore, applying Z Gate to the same Qubit twice will result in the original state of the Qubit.	(8)	CO4
4c)	S Gate is applied on a Qubit in the state $\Psi = \|+\rangle$ and the resulting state of the Qubit is $\Psi = \|i\rangle$? Also prove that T Gate is applied on a Qubit in the state $\Psi = \|+\rangle$ and the resulting state of the Qubit is $\Psi = 1/\sqrt{2}\ \|0\rangle + (i+1)/2\ \|1\rangle$	(8)	CO4

OR

4d)	Explain with example working of Rx and Rz gates on qubit |0> and |1>, also show corresponding Bloch sphere diagrams?	(8)	CO4

Question No. 5

5a)	Explain with example how to convert digital gate to a reversible one?	(8)	CO5

OR

5b)	Write a short note on Deutsch Algorithm and explain how quantum approach is significant over classical one?	(8)	CO5
5c)	Define quantum coherence and de-coherence. Why is it essential for quantum computing? Give one example of a quantum operation that relies on coherence.	(8)	CO5

OR

5d)	With a neat diagram of the quantum circuit, describe the working steps of Deutsch's Algorithm. Why is it considered faster than a classical algorithm?	(8)	CO5

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