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Printed Page:-4 **Subject Code:- BCSMC0301**

Roll. No:

NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY, GREATER NOIDA
(An Autonomous Institute Affiliated to AKTU, Lucknow)
B.Tech
SEM: III - THEORY EXAMINATION (2025 - 2026)
Subject: Introduction to Quantum Computing

Time: 3 Hours **Max. Marks: 100**

General Instructions:

IMP: *Verify that you have received the question paper with the correct course, code, branch etc.*

1. *This Question paper comprises of* ***three Sections -A, B, & C.*** *It consists of Multiple Choice Questions (MCQ's) & Subjective type questions.*

2. *Maximum marks for each question are indicated on right -hand side of each question.*

3. *Illustrate your answers with neat sketches wherever necessary.*

4. *Assume suitable data if necessary.*

5. *Preferably, write the answers in sequential order.*

6. *No sheet should be left blank. Any written material after a blank sheet will not be evaluated/checked.*

SECTION-A 20

1. Attempt all parts:-

1-a. What is an algorithm? (CO1,K1) 1

(a) A puzzle
(b) Step-by-step problem solution
(c) Programming language
(d) Software

1-b. Complexity of an algorithm is estimated for: (CO1, K1) 1

(a) Time
(b) Space
(c) Both Time and Space
(d) Neither

1-c. Neuromorphic computing is inspired by the structure of the _____. (CO2, K2) 1

(a) Brain
(b) Neuron
(c) Heart
(d) None of the mentioned

1-d. The limitation of classical computing models is primarily due to _____ constraints. (CO2, K3) 1

(a) Physical
(b) Economic
(c) Mathematical
(d) None of the mentioned

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1-e. Two qubits are said to be entangled if their joint state cannot be written as a _____ product (CO3, K2). 1

(a) Sum
(b) Tensor
(c) Scalar
(d) Diagonal

1-f. The state $\Phi+\rangle = (00\rangle + 11\rangle)/\sqrt{2}$ is an example of a _____ state (CO3, K1). 1

(a) Mixed
(b) Product
(c) Entangled
(d) Local

1-g. States $+\rangle$ and $-\rangle$ are found on the Bloch sphere at _____. (CO4, K2) 1

(a) Poles
(b) Y axis
(c) Equator
(d) Origin

1-h. The radius of the Bloch sphere is always _____. (CO4, K2) 1

(a) 0
(b) 1
(c) π
(d) ∞

1-i. Quantum simulation is key in advancing _____. (CO5, K2) 1

(a) Hardware
(b) Chemistry
(c) Finance
(d) Material science

1-j. Quantum key distribution ensures _____. (CO5, K2) 1

(a) Secure communication
(b) Superposition
(c) Interference
(d) Speedup

2. Attempt all parts:-

2.a. Write the difference between primary and secondary memory. (CO1. K3) 2

2.b. What is transistor scaling? (CO2, K2) 2

2.c. How are measurement probabilities calculated for a qubit? (CO3, K3) 2

2.d. Write a Qiskit code snippet to implement a CNOT gate on two qubits. (CO4, K3) 2

2.e. Give one example of a practical problem where quantum advantage is sought. (CO5, K2) 2

SECTION-B 30

3. Attempt all parts:-

3.a. Answer any one of the following:-

3.a.(i)	Discuss the structure and function of the ALU. (CO1, K2)	6
3.a.(ii)	Write a note on system buses and their types. (CO1, K2)	6

3.b. Answer any one of the following:-

3.b.(i)	What motivates researchers to look for new computational models? (CO2, K3)	6
3.b.(ii)	Explain why P vs NP is considered an important open problem. (CO2, K3)	6

3.c. Answer any one of the following:-

3.c.(i)	Consider a qubit in the state $\psi\rangle = 1/\sqrt{2}\ (0\rangle + 1\rangle)$. Calculate the probabilities of measuring 0 and 1. (CO3, K4)	6
3.c.(ii)	Explain the significance of normalization in quantum state representation. (CO3, K3)	6

3.d. Answer any one of the following:-

3.d.(i)	Compare classical and quantum gates with examples and matrix representations. (CO4, K4)	6
3.d.(ii)	Explain why understanding quantum gates is essential for quantum programming and algorithm design. (CO4, K3)	6

3.e. Answer any one of the following:-

3.e.(i)	Why is achieving quantum advantage considered more meaningful for industry applications than quantum supremacy? (CO5, K4)	6
3.e.(ii)	Explain the problem of decoherence in quantum computing. (CO5, K3)	6

SECTION-C 50

4. Answer any one of the following:-

4-a.	Describe the algorithm to perform binary search and analyze its time complexity. (CO1, K4)	10
4-b.	Discuss the differences between deterministic and non-deterministic machines in the context of P and NP problems . (CO1, K4)	10

5. Answer any one of the following:-

5-a.	Describe the motivation for developing new computational models beyond the classical Turing model. (CO2, K3)	10
5-b.	Illustrate the limitations of Moore's Law with respect to transistor scaling and fabrication technology. (CO2, K3)	10

6. Answer any one of the following:-

6-a.	Discuss the role of entanglement in quantum teleportation. (CO3, K4)	10
6-b.	Explain the importance of tensor products in multi-qubit representation. (CO3, K4)	10

7. Answer any one of the following:-

7-a.	Design a two-qubit circuit using H and CNOT gates that prepares the four Bell states from the initial state $\|00\rangle$. Explain the role of each gate step-by-step and show the resulting states mathematically. (CO4, K4)	10
7-b.	What is the Bloch sphere representation of a single qubit? Explain how an	10

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arbitrary pure qubit state can be mapped to a point on the Bloch sphere and discuss how the X, Y, and Z gates correspond to rotations on this sphere. (CO4, K4)

8. Answer any <u>one</u> of the following:-

8-a.	What are the main physical platforms used for quantum hardware, and what challenges do they face? (CO5, K4)	10
8-b.	Evaluate the importance of scalability in the development of quantum hardware. (CO5, K4)	10