BRAINWARE UNIVERSITY

Term End Examination 2025-2026
Programme – M.Tech.(CSE)-AIML-2025
Course Name – Quantum Computing
Course Code - MTA20503
(Semester II)

Full Marks : 60 **Time : 2:30 Hours**

[The figure in the margin indicates full marks. Candidates are required to give their answers in their own words as far as practicable.]

Group-A

(Multiple Choice Type Question) 1 x 15=15

1. *Choose the correct alternative from the following :*

(i) A valid qubit state must satisfy

a) $|\alpha| + |\beta| = 1$ b) $|\alpha|^2 + |\beta|^2 = 1$
c) $\alpha = \beta$ d) $\alpha\beta = 0$

(ii) Entanglement in quantum systems is identified by

a) Separable state description b) Independent measurements
c) Non-factorizable joint states d) Classical correlation

(iii) Quantum computing exploits which fundamental principle to represent multiple states simultaneously

a) Determinism b) Superposition
c) Irreversibility d) Locality

(iv) Grover's algorithm achieves quadratic speedup through

a) Classical parallelism b) Amplitude amplification
c) Tensor decomposition d) Eigenvalue inversion

(v) Quantum Phase Estimation in Shor's algorithm is used to

a) Estimate modular periodicity b) Reduce qubit noise
c) Sort outputs d) Measure amplitudes

(vi) Grover's oracle operation performs

a) Amplitude damping b) Phase inversion of marked states
c) Tensor expansion d) State measurement

(vii) Depolarizing noise causes a qubit state to

a) Collapse deterministically b) Relax to $|0\rangle$
c) Randomly flip with equal probability d) Lose phase only

(viii) The surface code is primarily valued for its

a) Classical decoding b) Minimal qubit count
c) Simple encoding d) High threshold error rate

(ix) The threshold theorem states that

a) Decoherence can be ignored
b) Classical simulation is impossible
c) Arbitrarily long computation is possible below an error rate
d) Quantum computers are noise-free

(x) BB84 protocol achieves secure key distribution by leveraging

a) Quantum no-cloning principle
b) Trusted third parties
c) Symmetric encryption
d) Classical secrecy assumptions

(xi) Entanglement-based cryptography detects intrusion through

a) Packet loss
b) Correlation inconsistency
c) Increased error rates
d) Key mismatch

(xii) Intercept-resend attacks introduce detectable anomalies because

a) Quantum states collapse on measurement
b) Channels are noisy
c) Authentication is missing
d) Encryption fails

(xiii) Quantum neural networks are typically implemented using

a) Classical convolution layers
b) Support vector machines
c) Decision trees
d) Parameterized quantum circuits

(xiv) Quantum supremacy experiments often use

a) Database search
b) Random circuit sampling
c) Fourier transforms
d) Factorization circuits

(xv) Quantum advantage in optimization with QAOA depends on

a) Classical post-processing
b) Encryption strength
c) Hardware cost
d) Quality of variational parameters

Group-B

(Short Answer Type Questions) 3 x 5=15

2. Summarize the role of basis reconciliation in BB84 key generation. (3)
3. Evaluate the limitations of QKD over long-distance fiber channels. (3)
4. Identify the number of physical qubits used in the Shor code. (3)
5. Demonstrate the action of the Quantum Fourier Transform (QFT) on a computational basis state $|j\rangle$ for $N=2^n$. (3)
6. Construct a workflow for using quantum simulation in molecular energy estimation. (3)

OR

Formulate a hybrid approach combining quantum kernels with classical classifiers. (3)

Group-C

(Long Answer Type Questions) 5 x 6=30

7. Develop a mitigation strategy against photon-number-splitting attacks in QKD systems. (5)
8. Justify the importance of fault-tolerant gates in deep quantum circuits. (5)
9. Explain the creation and properties of the Bell state $|\Phi^+\rangle$ using quantum gates. (5)
10. Defend the statement that large-scale quantum computers pose an existential threat to RSA-based cryptography. (5)
11. Demonstrate the working of QAOA for solving optimization problems with layered circuits. (5)
12. Design a quantum neural network architecture suitable for NISQ devices. (5)

OR

Construct an evaluation strategy to verify claims of quantum supremacy. (5)

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