COURSE CONTENT

QUANTUM COMPUTING								
III Semester: CSE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
2435827	**Professional Core courses**	3	0	0	3	40	60	100
Contact Classes: 45	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 45**		
Prerequisites: **UG level course in quantum computing**								

Course Overview:

The Quantum Computing course introduces the mathematical foundations and physical principles underlying quantum computation, including linear algebra, quantum mechanics, and qubit implementation. It covers quantum gates, circuits, architectures, and major quantum algorithms such as Shor's and Grover's algorithms

Course Objectives:

1. To understand the fundamental principles and concepts of quantum computing and quantum mechanics.
2. To study the mathematical foundations required for quantum computing, including linear algebra, matrices, vectors, and complex numbers.
3. To learn the concepts of qubits, quantum gates, quantum circuits, and quantum architectures used in quantum systems.
4. To analyze and implement major quantum algorithms such as Deutsch, Shor's, Grover's, and Bernstein-Vazirani algorithms.
5. To explore the impact of quantum computing on modern cryptography, security systems, and advanced computational applications.

Course Outcomes: After Completion of the Course, Students should be able to

1. Evaluate the implications of IT Act 2000 and 2008 amendments in digital forensic practices.
2. Apply basic concepts of atomic structure, Hilbert spaces, and quantum states in problem-solving.
3. Evaluate different quantum architectures such as D-Wave and topological quantum computing for efficiency.
4. Analyze the logic and performance improvements of quantum algorithms over classical ones.
5. Apply knowledge of asymmetric algorithms such as RSA, Diffie-Hellman, and ECC.

UNIT - I

Introduction to Essential Linear Algebra: Some Basic Algebra, Matrix Math, Vectors and Vector Spaces, SetTheory.

Complex Numbers: Definition of Complex Numbers, Algebra of Complex Numbers, Complex Numbers Graphically, Vector Representations of Complex Numbers, Pauli Matrice, Transcendental Numbers.

UNIT - II

Basic Physics for Quantum Computing: The Journey to Quantum, Quantum Physics Essentials, Basic Atomic Structure, Hilbert Spaces, Uncertainty, Quantum States, Entanglement

Basic Quantum Theory: Further with Quantum Mechanics, Quantum Decoherence, Quantum Electrodynamics, Quantum Chromodynamics, Feynman Diagram Quantum Entanglement and QKD, Quantum Entanglement, Interpretation, QKE.

UNIT - III

Quantum Architecture: Further with Qubits, Quantum Gates, More with Gates, Quantum Circuits, TheD-Wave Quantum Architecture.

Quantum Hardware: Qubits, How Many Qubits Are Needed? Addressing Decoherence, Topological Quantum Computing, Quantum Essentials.

UNIT - IV

Quantum Algorithms: What Is an Algorithm? Deutsch's Algorithm, Deutsch-Jozsa Algorithm, Bernstein-Vazirani Algorithm, Simon's Algorithm, Shor's Algorithm, Grover's Algorithm.

UNIT - V

Current Asymmetric Algorithms: RSA, Diffie-Hellman, Elliptic Curve

The Impact of Quantum Computing on Cryptography: Asymmetric Cryptography, Specific Algorithms, Specific Applications

TEXT BOOKS:

1. Nielsen M. A., Quantum Computation and Quantum Information, Cambridge University Press
2. Dr. Chuck Easttom, Quantum Computing Fundamentals, Pearson

REFERENCE BOOKS:

1. Quantum Computing for Computer Scientists by Noson S. Yanofsky and Mirco A. Mannucci
2. Benenti G., Casati G. and Strini G., Principles of Quantum Computation and Information, Vol. Basic Concepts, Vol
3. Basic Tools and Special Topics, World Scientific. Pittenger A. O., An Introduction to Quantum Computing Algorithms.

ELECTRONIC RESOURCES:

1. **https://nptel.ac.in/courses/106/106/106106197**
2. **https://quantum-computing.ibm.com/**
3. **https://www.coursera.org/learn/quantum-computing**
4. **https://www.geeksforgeeks.org/quantum-computing/**

MATERIALS ONLINE:

1. Course template
2. Tutorial question bank
3. Tech talk and Concept Video topics
4. Open-ended experiments
5. Definitions and terminology
6. Assignments
7. Model question paper – I
8. Model question paper – II
9. Lecture notes
10. E-Learning Readiness Videos (ELRV)