QUANTUM COMPUTING

Subject Code: CS35122CS	Subject Type: DE (Elective-1)	Evaluation Scheme: MSE (30), TA (20), ESE (50)	L-T-P: 3-0-0 (3)

Pre-Requisites: Linear Algebra, Probability Theory, Matrix

Course Objective: The objective of the course is to provide the students an introduction to quantum computation. Much of the background material related to the algebra of complex vector space and quantum mechanics is covered within the course.

Course Outcomes: At the end of the course, the student will be able to

CO	Course Outcomes
CO-1	Introduction to various terminologies for quantum mechanics and quantum computation
CO-2	Introduction to Mathematical and Physics concepts required for quantum computing.
CO-3	Understanding of various Quantum Algorithms and cryptography principles
CO-4	Understanding of various Quantum machine learning principles and techniques.

Syllabus:

Unit 1: Introduction To Quantum Computation

Introduction to quantum computing. Quantum Bits, Bloch Sphere representation of a qubit, Multiple qubits, Linear operators and spectral decomposition, Operator functions and tensor products, Hilbert Spaces, Dirac's notation.

Unit 2: Background Mathematics and Physics

Probabilities and Measurements, Entanglement, Density Operators and Correlation, Basis of quantum mechanics, Measurements in Bases other than computational Basis, Quantum circuits: Single qubit gates, Multiple qubit gates, Design of quantum circuits.

Unit 3: Quantum Information and Cryptography

Comparison between classical and quantum information theory, Bell States, Quantum Teleportation, Quantum Cryptography, No cloning Theorem. Quantum Algorithms: Classical computation on quantum computers, Relationship between quantum and classical complexity classes, Deutsch's Algorithm, Deutsch-Jozsa Algorithm, Shor Factorization, Grover Search.

Unit 4: Quantum Machine Learning

Quantum data encodings: Basis, Angle, Amplitude encodings, Data representations, Quantum Fourier transformation, Quantum phase Estimation, Quantum Support Vector Machine, NISQ Devices, Quantum Approximate Optimization Algorithm (QAOA).

Learning Resources:

Text Books:

1. Michael A. Nielsen, Isaac L. Chuang, Quantum Computing and Quantum Information, Cambridge University Press.
2. Maria Schuld, Francesco Petruccione, Machine learning with Quantum Computers, Springer Nature.
3. Elías F. Combarro, Samuel González-Castillo, A Practical Guide to Quantum Machine Learning and Quantum Optimization, Packt Publishing.