Course code: Course Title	Course Structure			Pre-Requisite
SE433: Quantum Computing	**L**	**T**	**P**	**NIL**
	3	**1**	**0**	

Course Objective: The course explores quantum computation and quantum information covering aspects of quantum entanglement, quantum algorithms, quantum channels, quantum information theory.

S. NO	Course Outcomes (CO)
CO1	Understand the fundamental concepts of qubits, quantum gates, entanglement, and quantum circuit design
CO2	Analyze and evaluate quantum algorithms, including Shor's Algorithm and Quantum Fourier Transform.
CO3	Analyze quantum simulation techniques and the impact of hardware noise on simulation results.
CO4	Understand the fundamentals of quantum computing, quantum circuits, and probabilistic differences from classical computing.
CO5	Analyze quantum error correction techniques and their applications in cryptography, optimization, and machine learning.

S. NO	Contents	Contact Hours
UNIT 1	**Introduction to Quantum Computation:** Representing Qubit States, Single Qubit Gates, Multiple Qubits and Entangled States, More Circuit Identities, Design of Quantum Circuits, Measurements in Bases other than Computational Basis.	**8**
UNIT 2	**Quantum Algorithms:** Shor's Algorithm, Bernstein-Vazirani Algorithm, Quantum Fourier Transform, Quantum Phase Estimation, Variational Quantum Eigensolver (VQE), SWAP Test, Linear Combination of Unitaries (LCU).	**8**
UNIT 3	**Quantum Simulation of Many-Body Hamiltonian:** Encodings and Transformations (Jordan-Wigner transformation, Gray code encoding), Many-body Hamiltonian, VQE and suitable Ansatz, Simulation results in the presence of hardware noise.	**8**
UNIT 4	**Basics of Quantum Computing and Circuits:** Introduction to Hilbert Spaces (basic understanding), Quantum vs Classical probability (with simple examples), Basic Quantum Circuits (single and multi-qubit operations), Concept of Quantum Universality, Introduction to Grover's Algorithm.	**8**
UNIT 5	**Quantum Error Correction and Applications:** Need for Quantum Error Correction, Introduction to simple Quantum Error Correcting Codes, Stabilizer Codes (basic concepts), Real-world Applications of Quantum Computing (cryptography, optimization, and machine learning).	**10**
	TOTAL	**42**

REFERENCES		
S.No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1.	M. A. Nielsen, I. L. Chuang, "Quantum Computation and Quantum Information", Cambridge University Press.	**2010**
2.	D. J. Griffiths, "Introduction to Quantum Mechanics", Prentice Hall.	**2016**

3.	N. D. Mermin, “Quantum Computer Science: An Introduction”, Cambridge University Press.	**2007**
4.	R. M. Roth, “Introduction to Coding Theory”, Cambridge University Press.	**2006**