

GUJARAT TECHNOLOGICAL UNIVERSITY

M.E. Semester: I

M.E. Information Technology

Subject Name: **Quantum Computing & Algorithm Analysis**
(Major Elective-I)

Sr.No	Course content
1.	Qubit & Quantum States: The Qubit, Vector Spaces. Linear Combination Of Vectors, Uniqueness of a spanning set, basis & dimensions, inner Products, orthonormality, gram-schmidt ortho gonization, bra-ket formalism, the Cauchy-schwarz and triangle Inequalities.
2.	Matrices & Operators: Observables, The Pauli Operators, Outer Products, The Closure Relation, Representation of operators using matrices, outer products & matrix representation, matrix representation of operators in two dimensional spaces, Pauli Matrix, Hermitian unitary and normal operator, Eigen values & Eigen Vectors, Spectral Decomposition, Trace of an operator, important properties of Trace, Expectation Value of Operator, Projection Operator, Positive Operators, Commutator Algebra, Heisenberg uncertainty principle, polar decomposition & singular values, Postulates of Quantum Mechanics.
3.	Tensor Products: Representing Composite States in Quantum Mechanics, Computing inner products, Tensor products of column vectors, operators and tensor products of Matrices.
4.	Density Operator: Density Operator of Pure & Mix state, Key Properties, Characterizing Mixed State, Practical Trace & Reduce Density Operator, Density Operator & Bloch Vector.
5.	Quantum Measurement Theory : Distinguishing Quantum states & Measures, Projective Measurements, Measurement on Composite systems, Generalized Measurements, Positive Operator- Valued Measures.
6.	<u>Introduction</u> Mathematics for Algorithmic: <u>Sets</u> , <u>Functions and Relations</u> . Properties of Matrices, Solving systems of linear Equations, Linear programming, general linear programs, an overview of linear programming The Greedy Methods: Optimization problems, the greedy method, 0/1 knapsack problem, topological sorting, Single source shortest path, minimum cost spanning tree. Divide & Conquer: The method. Application: merge sort. Dynamic programming: The method, Application: 0/1 knapsack problem Skip lists and hashing. Priority Queues: Huffman Codes. Binary Search Trees: Binary search trees, indexed binary search trees, binary search tree operations and implementation. Graphs.

Reference Books:

- 1. Quantum Computing without Magic by Zdzisław Meglicki**
- 2. Quantum Computing Explained By DAVID McMAHON**
- 3. Quantum Computer Science By Marco Lanzagorta, Jeffrey Uhlmann**
- 4. An Introduction to Quantum Computing Phillip Kaye, Raymond Laflamme, Michele Mosca**
- 5. Introduction to Algorithms by Thomas H. Cormen, Leiserson, Rivest & Stein.**
- 6. Data Structures, Algorithms & Applications in C++ by Sartaj Sahni.**
- 7. Algorithm Design by Michael T. Goodrich.**