GANPAT UNIVERSITY

FACULTY OF ENGINEERING & TECHNOLOGY

Programme	Bachelor of Technology	Branch/Spec.	Computer Engineering / Information Technology
Semester	V	Version	2.0.0.0
Effective from Academic Year	2020-21	Effective for the batch Admitted in	July 2018
Subject code	2CEIT5PE3	Subject Name	Quantum Computing

Teaching scheme						Examination scheme (Marks)			
(Per week)	Lecture (DT)		Practical (Lab.)		Total		CE	SEE	Total
	L	TU	P	TW					
Credit	3	0	1	-	4	Theory	40	60	100
Hours	3	0	2	-	5	Practical	30	20	50

Pre-requisites:

Data Structure and Algorithm, Programming concepts

Objectives of the course:

1. To learn and understand the concept of Quantum Computing.
2. To learn and understand the concept of Qubits System.
3. To learn and understand the architecture of Quantum Computing.
4. Understanding of Quantum Logic gates and circuits.
5. Demonstrate the quantum computing algorithm by simulating it on a classical computer, and state some of the practical challenges in building a quantum computer.
6. Distinguish problems of different computational complexity and explain why certain problems are rendered tractable by quantum computation with reference to the relevant concepts in quantum theory.

Theory syllabus

Unit	Content	Hrs
1	**Introduction to Quantum Computing:** Motivation for Studying Quantum Computing, Major Players in The Industry (IBM, Microsoft, Rigetti, D-Wave Etc.), Origin Of Quantum Computing, Overview of Major Concepts in Quantum Computing - Qubits and Multi-Qubits States, Bra-Ket Notation, Bloch Sphere Representation, Quantum Superposition, Quantum Entanglement	06
2	**Math Foundation for Quantum Computing:** Matrix Algebra: Basis Vectors and Orthogonality, Inner Product and Hilbert Spaces, Matrices and Tensors, Unitary Operators and Projectors, Dirac Notation, Eigen Values and Eigen Vectors.	09
3	**Building Blocks for Quantum Program:** Architecture of Quantum Computing Platform, Details of Q-Bit System of Information Representation: Block Sphere, Multi-Qubits States, Quantum Superposition of Qubits (Valid and Invalid Superposition), Quantum Entanglement, Useful States From Quantum Algorithmic Perceptive E.G. Bell State, Operation on Qubits: Measuring and Transforming Using Gates, Quantum Logic Gates and Circuit: Pauli, Hadamard, Phase Shift, Controlled Gates, Ising, Deutsch, Swap etc, Programming Model for A Quantum Computing Program, Steps Performed on Classical Computer, Steps Performed on Quantum Computer, Moving Data Between Bits and Qubits.	08
4	**Quantum Algorithms:** Basic Techniques Exploited by Quantum Algorithms: Amplitude Amplification, Quantum Fourier Transform, Phase Kick-Back, Quantum Phase Estimation, Quantum Walks, Major	22

	Algorithms: Shor’s Algorithm, Grover’s Algorithm, Deutsch’s Algorithm, Deutsch -Jozsa Algorithm, Oss Toolkits For Implementing Quantum Program: Ibm Quantum Experience, Microsoft Q, Rigetti Pyquil (Qpu/Qvm).	
Practical Content		
Experiments/Practicals/Simulations would be carried out based on syllabus		
Text Books		
1	Quantum Computation and Quantum Information, M A Nielsen and I L Chuang.	
2	An Introduction to Quantum Computing, P Kaye, R Laflamme and M Mosca.	
Reference Books		
1	Pittenger A. O., An Introduction to Quantum Computing Algorithms	
2	David McMahon, “Quantum Computing Explained”, Wiley	
ICT/MOOCs Reference		
1	https://nptel.ac.in/courses/115101092/	
2	https://nptel.ac.in/courses/104104082/	
Course Outcomes:		
After successful completion of this course, student will be able to 1. Use the principles of quantum computing 2. Classify the problems that can be expected to be solved well by quantum computers. 3. Understand the basic quantum algorithms. 4. Understand the differences between classical and quantum computing.		