COURSE CONTENT

QUANTUM COMPUTING								
II Semester: CSE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
BCSE29	**Elective**	3	-	-	3	40	60	100
Contact Classes:48	**Total Tutorials: Nil**	**Total Practical Classes: Nil**				**Total Classes: 45**		
Prerequisites: Computer organization and Architecture, Advanced algorithms, Cryptography								

I. COURSE OVERVIEW:

Quantum computing is an evolving and complex field that merges concepts from quantum mechanics, computer science, and mathematics. Provide insights into specific quantum algorithms, their advantages over classical algorithms, and their applications in various domains such as cryptography, optimization, and machine learning.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The different quantum computing mechanics.
II. The indepth of quantum computation theory.
III. Quantum algorithms, and their advantages over classical algorithms.

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO1 Analyze the performance of data transmission between the systems using quantum computing algorithms.
CO2 Identify suitable technique to minimize complexity of different computational problems.
CO3 Apply quantum search algorithms of find quantum information for speeding up the solutions of NP-complete problems.
CO4 Apply three-qubit phase flip code & shor code to discretize and correct the errors.
CO5 Identify suitable cryptography algorithms to provide security for quantum information
CO6 Classify various encryption techniques of quantum mechanics to secure and transmit data.

IV. COURSE CONTENT:

MODULE-I: INTRODUCTION OF QUANTUM COMPUTING AND OVERVIEW (9)
History of quantum computation and quantum information, Quantum bits, Multiple qubits, Quantum computation, Single qubit gates, Multiple qubit gates, Measurements in bases other than the computational basis, Quantum circuits, Qubit copying circuit, Example: Bell states, Example: quantum teleportation. Quantum algorithms: Classical computations on a quantum computer, Quantum parallelism, Deutsch's algorithm, The Deutsch–Jozsa algorithm, and Quantum algorithms summarized.

MODULE-II: INTRODUCTION TO COMPUTER SCIENCE (9)
Models for computation, Turing machines, Circuits, The analysis of computational problems, How to quantify computational resources, Computational complexity, Decision problems and the complexity classes P and NP, A plethora of complexity classes, Energy and computation, and Perspectives on computer science.

MODULE-III: QUANTUM SEARCH ALGORITHMS (9)
The quantum search algorithm, Quantum search as a quantum simulation, Quantum counting, Speeding up the solution of NP-complete problems, Quantum search of an unstructured database, Optimality of the search algorithm, Black box algorithm limits.

MODULE-IV: QUANTUM ERROR-CORRECTION (9)
The three-qubit bit flip code, the Three-qubit phase flip code, The Shor code, the Theory of quantum error correction Discretization of the errors, Independent error models, Degenerate codes, The quantum Hamming bound.

MODULE-V: QUANTUM CRYPTOGRAPHY (9)
Private key cryptography, Privacy amplification and information reconciliation, Quantum key distribution, Privacy, and coherent information, and security of quantum key distribution.

V. TEXT BOOKS:

1. Nielsen and Chuang, Quantum Computation and Quantum Information, 10th Anniversary Edition, Cambridge University Press, 2010.

VI. REFERENCE BOOKS:

1. Scott Aaronson, "Quantum Computing since Democritus", Cambridge, 2013.
2. Riley Tipton Perry, "Quantum Computing from the Ground Up", World Scientific Publishing Ltd 2012.
3. V.K Sahni, Quantum Computing (with CD), TATA McGraw-Hill, 2007.

VII. WEB REFERENCES:

1. https://fivebooks.com/best-books/quantum-computing-chris-bernhardt/
2. https://philpapers.org/browse/quantum-computation
3. https://link.springer.com/referenceworkentry/10.1007/978-1-4020-8265-8_1230

VIII. E-Text Books:

1. https://www.fi.muni.cz/usr/gruska/qbook1.pdf
2. https://library.oapen.org/handle/20.500.12657/48236
3. https://freecomputerbooks.com/Quantum-Computing-for-the-Quantum-Curious.html

IX. MATERIALS ONLINE:

1. Course Outline Description
2. Tutorial question bank
3. Tech talk 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. PowerPoint presentation
11. E-Learning Readiness Videos (ELRV)