SEMESTER S6

QUANTUM COMPUTING

(Common to CS/CM/CR/AD/AM)

Course Code	PECST638	CIE Marks	40
Teaching Hours/Week (L:T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To give an understanding of quantum computing against classical computing.
2. To understand fundamental principles of quantum computing, quantum algorithms and quantum information.

SYLLABUS

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Module No.	Syllabus Description	Contact Hours
1	Review of Basics Concepts Review of linear algebra, Principles of quantum mechanics, Review of Information theory, Review of Theory of Computation. [Text 1 - Ch 1, 2; Text 2, Ch 11.1, 11.2]	9
2	Introduction to Quantum Information Qubit – Bloch sphere representation, Multiple qubit states, Quantum logic gates – single qubit and multi-qubit, Quantum circuits, Density matrix, Quantum entanglement. [Text 1 - Ch 3, 4; Text 2 - Ch 4]	9
3	Quantum Algorithms: - Simple Quantum Algorithms, Quantum Integral Transforms, Grover's Search Algorithm and Shor's Factorization Algorithm. [Text 1 - Ch 5,6,7,8]	9
4	Quantum Communication: - Von Neumann entropy, Holevo Bound, Data compression, Classical information over noisy quantum channels, Quantum information over noisy	9

	quantum channels, Quantum Key Distribution, Quantum Communication protocols [Text 2 - Ch 11.3, Ch 12.1 - 12.5]	

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

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Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course, students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain the concept of quantum computing against classical computing.	**K2**
CO2	Illustrate various quantum computing algorithms.	**K2**
CO3	Explain the latest quantum communication & protocols.	**K2**
CO4	Experiment with new algorithms and protocols for quantum computing.	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3									2
CO2	3	2	3									2
CO3	3	2	3									2
CO4	3	2	3									2

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

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Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Quantum Computing : From Linear Algebra to Physical Realizations	Mikio Nakahara Tetsuo Ohmi	CRC Press	1/e, 2008
2	Quantum Computation and Quantum Information	Michael A. Nielsen & Isaac L. Chuang	Cambridge University Press	1/e, 2010

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Quantum Computing for Programmers	Robert Hundt	Cambridge University Press	1/e, 2022
2	Quantum Computing for Everyone	Chris Bernhardt	MIT Press	1/e, 2020
3	An Introduction to Practical Quantum Key Distribution [paper]	Omar Amer Vaibhav Garg Walter O. Krawec	IEEE Aerospace and Electronic Systems Magazine	March 2021
4	Quantum communication [paper]	Nicolas Gisin & Rob Thew	Nature Photonics	March 2007

Video Links (NPTEL, SWAYAM…)	
No.	**Link ID**
1	https://archive.nptel.ac.in/courses/106/106/106106232/
2	https://archive.nptel.ac.in/noc/courses/noc19/SEM2/noc19-cy31/

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