Course Type	Course Code	Name of Course	L	T	P	Credit
DE	NECD523	Introduction to Quantum Communication	3	0	0	3

Course Objective
The objective of this course is to present the core mathematical concepts and theory behind the principles of Quantum Communication and discuss the working principle behind quantum communication systems as well as some fundamental limits of quantum communication through classical and quantum channels.
Learning Outcomes
Upon successful completion of this course, students will: • acquire a broad understanding of the mathematical concepts behind quantum communication and computing. • be able to recognize and design various quantum communication systems and modulation schemes • be prepared to venture into more advanced areas of quantum communication research.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	**Mathematical Tools:** Introduction to vector spaces, inner-product spaces, linear independence, basis, Finite dimensional Hilbert spaces, linear operators, projectors, Eigenvalue decomposition, Tensor products; Analysis and probability, limit, infimum, supremum, continuity, compact sets, convexity, dual function, probability distributions.	9	The student will have understanding of the basic mathematical tools used throughout quantum communication.
2	**Elements of Quantum Mechanics:** The notion of qubits, axioms of a closed quantum system, quantum dynamical systems, quantum measurements and POVM.	9	The student will be introduced to the most basic notion and theory of quantum mechanics as used in quantum communication
3	**Introduction to Quantum decision theory:** Analysis of a quantum communication system, introduction to the Helstrom decision theory of quantum binary communication systems, decision theory of K-ary Quantum communication systems, Holevo's theorem, constellation of quantum states.	8	The student will have a good understanding of the basic decision theory of quantum communication systems
4	**Introduction to Quantum communication systems:** Introduction to Glauber's representation of coherent quantum states, Quantum binary communication systems and different modulation schemes: OOK, BPSK, QAM, PSK, PPM, overview of quantum squeezed states.	8	The student will acquire a fundamental understanding of the physical quantum systems and their operating principles which can be used for quantum communication
5	**Introduction to Quantum Information Theory:** Notion of density operators, partial trace, reduced density operator, Schmidt rank, purification of mixed states, entanglement, quantum teleportation. Introduction to classical information theory: Shannon entropy, classical channels and channel coding. Notion of von-Neumann entropy, quantum channels, accessible information and Holevo bound, transmission through a noisy quantum channel. Introduction to Quantum Cryptography and Quantum Key Distribution.	8	The student will acquire a basic understanding of the different notions associated with quantum information theory and will learn a few of its applications in quantum cryptography and quantum key distribution
	Total	**42**	

Text Books:

1. "Quantum Communications", Gianfranco Cariolaro, Springer, 2015.
2. "Quantum Communication, Quantum Networks, and Quantum Sensing", Ivan B. Djordjevic, Academic Press, 2022.

Reference Books:

1. "Principles of Quantum Communication Theory: A Modern Approach", Sumeet Khatri, and Mark M. Wilde, 2021, Pre-release version, available freely at https://www.markwilde.com/teaching/2021-fall-qit/.
2. "Quantum Computation and Quantum Information", Michael Nielsen and Isaac Chuang, Cambridge University Press, 2010.