Quantum information theory is an active field of research at the intersection of mathematics, physics and computer science. In this introductory course, we focus on the mathematical side of the subject. We will start by introducing basic notions from probability theory and classical information theory, and then develop the mathematical foundation of quantum information theory including quantum states on Hilbert spaces, distance measures, the measurement formalism, quantum channels and their representations, no-go theorems, and entanglement. In the second part of the course, we will introduce the von Neumann entropy, study its basic properties, and discuss the Schumacher compression theorem giving this quantity an operational meaning. In the final part of the course, we will focus on the transmission of information over noisy quantum channels. We will study the classical and quantum capacity of quantum channels and discuss their basic properties.

After completing the course, the student will:

- Have good knowledge of the mathematical formalism of quantum information theory and will be able to formalize basic problems arising in quantum physics.
- Have knowledge of the basic features of quantum theory such as superposition, entanglement, and the no-cloning theorem.
- Be familiar with tensor products of Hilbert spaces and operators, and be able to compute entropies and distance measures between quantum states.
- Acquire ability to convert between Choi, Kraus, and Stinespring dilations of quantum channels.
- Be able to explain the notions of qubits, measurement, entanglement, and the basic protocols of quantum information theory such as quantum teleportation and superdense coding.
- Be able to explain quantum information theoretic tasks such as compression or information transmission.
- Know about the capacities of quantum channels, and their entropic characterizations.