CTP Graduate School Course, 2nd semester (2015)

# Introduction to Quantum Information & Quantum Foundations

Centre for Theoretical Physics, Jamia Millia Islamia

Tabish Qureshi
tabish@ctp-jamia.res.in

**Course Description:** This course is an elementary introduction to a new and frontier multi-disciplinary field of quantum information and quantum computing and the established and active area of foundations of quantum mechanics. The course will introduce the basic issues of interest in the foundational aspects of quantum mechanics, and how information can be presented in terms of qubits and how this information can be processed (computation) and transmitted.
**Prerequisite(s):** M.Sc. course in quantum mechanics

## Course Syllabus:

- Fundamental Issues in Quantum Mechanics

  Quantum states, Superposition principle, Entanglement of States, Quantum Measurement, Quantum Nonlocality, Complementarity, Measures of entanglement, Entropy of Entanglement, Concurrence, Quantum discord.

- Quantum Computation

  Classical computation: Circuit model, Complexity, Turing machines, Energy and Information, reversible computation. Quantum Gates: single qubit, multiple qubit gates, Controlled gates, Universal Gates, Measurement, Quantum algorithms, quantum circuits.

- Quantum Algorithms

  Deutsch Algorithm, Shor Algorithm, Grovers Algorithm

- Quantum Information Theory

  Quantum information, Quantum cryptography, quantum key distribution, BB84 and Ekert protocols, error-correction.

**Recommended Books:**

1. "Quantum Computation and Quantum Information", M A Nielsen and I L Chuang, (Cambrige University Press 2002) (Special Indian Edition: Foundation Books, Delhi)

2. "Introduction to Quantum Information Science", Vlatko Vedral (Oxford University Press 2006).

3. "The Quantum Challenge: Modern Research on the Foundations of Quantum Mechanics", George Greenstein, Arthur G. Zajonc (Narosa 2006).