Quantum computation and information - Indranil Chakravarty

Siddharth Bhat

Contents

Chapter 1

Lecture 1: Introduction

Taught in collaboration with MSR Redmond for the Q# bits.

Topics:

- Intro: Transition from Classical to Quantum: Stern Gerlash, Sequential Stern Gerlash, Rise of randomness.
- Foundations of Quantum Theory: States, Ensembles, Qubits, Pure and Mixed states, Multi qubit states, Tensor products, Unitary transforms, Spectral decomposition, SVD, Generalized measurements, Projective measurements, POVM, Evolution of quantum state, Krauss Representation.
- Quantum Entropy: Subadditivity of Entropy, Avani-Licb(?) Inequality, Quantum channel, Quantum channel capacity, Data compression, Benjamin Schumahur(?) theorem.
- Quantum Entanglement: EPR paradox, Schmidt decomposition, Purification of entanglement, Entanglement separability problem, Pure and mixed entangled states, Measures of Entanglement.
- Quantum information processing protocols: Teleportation, Superdense coding, Entanglement swapping.
- Impossible operations in quantum information theory: No cloning, No deleting, No partial erasure.
- Quantum Computation: Introduction to Quantum Computating, Pauli gates, Hadamard gates, Universal gates, Quantum algorithms (Shor, Grover search, machine learning and optimisation).
- Quantum programming: Programming quantum algorithms, Q# progtramming language, quantum subroutines.

Books:

- Quantum computation and Quantum information — Nielsen and Chuang.
- Preskill lecture notes.

Grading:

- Possibility of open book take-home open ended exam for the finals.
- Mid 1: 15%
- Mid 2: 15%
- End sem (open book?) : 30%
- Assignments: 15%
- Projects: 25%