COOPERATIVE PHENOMENA IN CLASSICAL & QUANTUM SYSTEMS(PHY690Q)

**Students are expected to complete a course on quantum mechanics (for example, at the level of Phy431) and a course on statistical mechanics (for example, at the level of phy412)**

Instructor: Amit Dutta

Module I: Basics of cooperative phenomena: Lectures **10**

Cooperative phenomena in spin and electronic systems and their implications in connection to phase transitions. Dynamics of phase transitions: coarsening, nucleation and spinodal decomposition.

Books: 1. Fetter and Walecka, Many-body physics

2. Chaikin and Lubensky

Module II: Cooperative Phenomena, superfluidity and super- and quantum coherence: Lectures **20**

Bose-Einstein condensation, A brief note on basic phenomenology of superfluidity and superconductivity, Landau theory of superconductivity and Abelian Higgs model, BCS theory, the macroscopic coherent state, Josepshon junctions and applications, flux qubit, charge qubits and connection to quantum information studies.

Books: 1. James F. Annett, Superconductivity, superfluids and condensates.
2. Tinkham, Superconductivity

Module III: Cooperative phenomena in quantum information and topology: Lectures **12**

Quantum phase transitions, geometrical aspects of quantum states (fidelity and loschmidt echo, etc.), global order parameters, topological phases in connection to quantum many body systems.

Books: 1.Issac Chuang and Michael Nielsen, Quantum computation and quantum information.
2. Dutta et al, Quantum phase transitions in transverse field spin models: from statistical physics to quantum information**,** Cambridge University Press (2015).
3. Shun-Qing Shen, Topological Insulators: Dirac Equation in Condensed Matters.