Phy 690T/S, SUPERCONDUCTIVITY AND APPLICATIONS

Instructor: Satyajit Banerjee, Dept. of Physics, IITK

1. **Objectives**: This PG level elective course will attempt to provide an overview of the vast field of superconductivity and its applications. It will discuss different aspects of superconductivity from both theoretical and experimental point of view. Seminal experiments associated with this phenomenon which led to its advancement will be discussed. The initial part of the course will discuss classical aspects of superconductors, followed by study of their thermodynamic and magnetic properties and electrodynamic response. An overview of the different types of modern superconductors discovered, will be presented and what are the new facets of superconductivity being thrown up with discovery of these new materials will be presented, like Pnictide superconductivity, superconductivity-magnetism coexistence, nematic phase in superconductors, topological superconductor. The course will discuss the BCS theory and develop the gap equation near Tc and discuss various thermodynamic quantities within the purview of the microscopic theory. Ginzburg Landau theory for superconductivity, abrikosov vortex state, pinning and vortex phases and phase transition in these phases, current voltage relationship of a type II superconductor in the presence of a magnetic field. Study of tunneling phenomenon in N-I-S or S-I-S junctions, Josephson effect - junctions and their applications (SQUID). Superconductivity and vortex physics at nanoscales and applications will be introduced through the course at relevant points in the course. There will be discussion of low temperature techniques. Also relevant discussions related to superconductor based devices will be presented.
2. **Prerequisites**: Condensed Matter physics, Quantum mechanics, Electrodynamics, Thermodynamics and Statistical mechanics.
3. **Books & References:**

Introduction to Superconductivity: A. C. Rose-Innes and E. H. Rhoderick

Introduction to Superconductivity: Michael Tinkham

Magnetic Flux structures in superconductors: R. P. Huebner

Theory of superconductivity: J. R. Schrieffer

Superconductivity Physics and Applications : Kristian Fossheim and Asle Sudbo

Superfluidity and Superconductivity: D. R. Tilley and J. Tilley