Course Handout

Phy 690S, Type II Superconductors Vortices & Applications

1. **Objectives**: This PG level elective course will attempt to summarize the vast field of superconductivity and its applications. It will discuss different aspects of superconductivity from both theoretical and experimental point of view. I will discuss seminal experiments associated with this phenomenon which led to its advancement. 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 aspects of modern superconductors along with the new facets of superconductivity , new materials, devices etc will be discussed. 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, associated Andreev reflection issues, Josephson effect - junctions and their applications (SQUID), Superconductivity and vortex physics at nanoscales and device applications and experiments related to superconductivity will be introduced ~~through~~and discussed throughout the course at relevant points in the course. Attempts wherever possible will be made to connect some of the physics with that of superfluidity. The course will also attempt to review some of the latest developments in superconductivity and its applications.

2. **Prerequisites**: Condensed Matter physics, Quantum mechanics (with familiarity with second quantization formalism -> needed to understand BCS theory), Electrodynamics, Thermodynamics and Statistical mechanics.
3. **Course Policies:** As per Institute Guidelines. The course evaluation will involve exams as well as involve term paper presentations. Participation in both is essential to acquire a grade for the course.
4. **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