



## Condensed Matter-II

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**Prerequisites:** Masters level Statistical Mechanics (e. g. PHY412) and Condensed Matter Physics (e. g. PHY543).

### Course Objective:

This course is an advanced course on Condensed Matter Physics that is supposed to provide some of the conceptual and technical machinery necessary to understand physical phenomena observed in Quantum Materials.

### Contents (28 lectures in total)

1. Overview and scope, Organizing principles in condensed matter, Second quantization, Coherent state path integrals and Green's functions. 3 lectures
2. Linear response theory: Fluctuation-dissipation theorem, Calculation of response functions. 3 lectures
3. Fermi liquid theory – Concept of quasiparticles, thermodynamics 3 lectures
4. Hartree-Fock theory (exchange and correlation effects); Screening and collective phenomena – Random-Phase Approximation. 4 lectures
5. Superconductivity – Basic phenomena, Electrodynamics of Superconductors. 2 lectures
6. Ginzburg-Landau theory of Superconductivity, Flux quantization and vortices. 2 lectures
7. Cooper problem, BCS theory, Functional integral formalism. 4 lectures
8. Josephson effect, Dynamics of Josephson junctions- RCSJ model 2 lectures
9. Gorkov theory, Derivation of BdG equations, Quasi-classical theory of transport in superconductors- Eilenberger equations and Usadel equations. 5 lectures

**Credits:** 3-0-0-0 (9)

**Evaluation:** 4 Assignments- 40%, Midsem exam- 30%, Final exam- 30%

### Recommended textbooks:

1. "Introduction to Many-Body Physics" by *Piers Coleman*.
2. "Advanced Solid State Physics" by *Philip Phillips*.
3. "Quantum Theory of the Electron Liquid" by *Giuliani and Vignale*.
4. "Theory of Nonequilibrium Superconductivity" by *Nikolai Kopin*.