Course Type	Course Code	Name of Course	L	T	P	Credit
DE	NPHD508	ADVANCED CONDENSED MATTER PHYSICS	3	0	0	3

Prerequisite: Mathematical Physics, Quantum Mechanics, condensed Matter Physics, Statistical Mechanics

Course Objective

The objective of the course is to introduce the basic theoretical background of condensed matter physics. To guide student to understand the underlying theories of advanced topics in condensed matter physics.

Learning Outcomes

Upon successful completion of this course, students will:

- be acquainted with the basic theoretical knowledge about second quantization and many-electron theory
- be able to know about localized disordered and correlated systems.
- be able to familiar with the advanced theories of superconductivity and quantum Hall effect.
- be acquainted with the basics of soft matter such as polymers, liquid crystal etc.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	Many electron theory: Introduction to many-electron wave function, Hartree-Fock theory, Second quantization formalism; Interactions of Electrons and Phonons with Photons, Exciton and Polaritons.	9	This topic covers the basic theory of many-electron system such as Hartree-Fock theory. They will also learn about dynamics of quasi-particles such as photons, phonons, excitons and polaritons.
2	Localization in Disordered Systems: Electron Localization, Anderson localization, Mott's Localization, Hopping Conductivity.	6	This unit will help student to get knowledge about localization phenomena in disordered system and their consequences giving rise to hopping conductivity.
3	Correlated Systems: Hubbard Model, Mott insulator, Kondo effect.	6	In this topic, students will learn about one of the key theories in condensed matter physics, the Hubbard model. They will also learn important phenomena such as Mott's insulators, Kondo effect and so on.
4	Theory of Superconductivity: Flux quantization, Macroscopic Quantum interference, Cooper Pairing, Energy gap, BCS theory; Ginzburg-Landau theory; Introduction to high temperature superconductors.	10	This topic will teach them detailed theories of superconductivity in cluding BCS and GL theories. Moreover, it will also provide an introductory section about High-Tc superconductivity.
5	Quantum Hall Effect: Integer quantum Hall effect, Introduction to fractional QHE.	5	This part will help to understand the Nobel prize winning advanced topics such as integer and fractional quantum Hall effect and their basic theories.
6	Introduction to Soft Matter: What is Soft Condensed Matter: Qualitative discussion of Colloids, Polymers, Gels, Liquid crystals	6	In this topic, students will learn about different phenomena of soft condensed matter physics including colloids, polymers, liquid crystals, etc.
	Total	**42**	

Textbooks:

1. Many-Particle Physics; G. D. Mahan, Springer, 2000
2. Introduction to Condensed Matter Physics, F. Duan, J. Guojun, World Scientific.
3. Advanced Condensed Matter Physics, L. M. Sander, Cambridge.

Reference Books:

1. Basic notions of Condensed Matter Physics, P.W. Anderson, Perseus Books
2. Physics of Condensed Matter, P. K. Mishra, Academic Press, 2012.
3. Condensed matter field theory, Altland and Simmons , Cambridge
4. Quantum field theory and condensed Matter, R. Shankar,
5. Quantum approach to condensed matter physics, Taylor and Heinonen, Cambridge.
6. Soft Condensed Matter: Jones; Oxford University Press; 2002.