


INTRODUCTION TO SOLID STATE PHYSICS

SATYAJIT BANERJEE
MANOJ K. HARBOLA
Department of
IIT Kanpur

TYPE OF COURSE : Rerun | Core | UG
COURSE DURATION : 12 weeks (26-Jul' 21 - 15-Oct' 21)
EXAM DATE : 24 Oct 2021

INTENDED AUDIENCE : Any Interested Learners

PRE-REQUISITES : Students who have familiar with basic knowledge in quantum mechanics, statistical mechanics, thermodynamics, electromagnetism and classical mechanics

COURSE OUTLINE :

The course deals with introducing concepts of condensed matter physics to advanced undergraduate and postgraduate students. The course will be pitched at the level of a first year course in MSc in Physics. For this course, an exposure to undergraduate level of: (a) quantum mechanics, (b) statistical and thermal physics and (c) electromagnetic theory, is expected for this course. It is hoped that through this course, the student will understand the quantum theory of solids which is used to describe the thermal and electrical properties of a solid. The student will explore the interaction of a solid with electromagnetic radiation like X-rays and how this can be used to understand the atomic crystal structure of the solid. During the course the student will be exposed to some experiments related to probing various properties of solid

ABOUT INSTRUCTOR :

Professor Satyajit Banerjee is in the department of physics at IIT Kanpur. Some of my other interests lie in investigating the equilibrium as well as non-equilibrium phases of vortex matter in superconductors, behavior of superconductivity and magnetism under extreme conditions viz., of strong confinement or high magnetic fields, hetero structures of superconducting and magnetic materials as well as the competition of these two phenomena in natural systems.

Professor Dr. Manoj Kumar Harbola He joined the Department in 2000. His chief interest lies in Electronic Structure of Atoms, Molecules and Solids using Density Functional Methods.

COURSE PLAN :

Week 1**:** Introduction to Drudes free electron theory of metals, electrical conductivity Ohms law and Hall effect

Week 2 : Introduction to Sommerfeld's model

Week 3 : Specific heat of an electron gas and the behaviour of thermal conductivity of a solid and relationship with electrical conductivity

Week 4 : Periodic Arrays of Atoms, Fundamental Types of Lattices, Index System for Crystal Planes

Week 5 : Direct Imaging of Atomic Structure, Diffraction of Waves by Crystals, Reciprocal lattice, Brillouin Zones

Week 6 : Vibrations of Crystals with Monatomic Basis, Acoustic and Optical modes

Week 7 : Two Atoms per Primitive Basis, Quantization of Elastic Waves, Phonon Momentum

Week 8 : Phonon contribution to heat capacity, Einstein and Debye theory of specific heat

Week 9 : Bloch Functions, Nearly Free Electron Model, Kronig-Penney Model

Week 10 : Wave Equation of Electron in a Periodic Potential,Band Gap

Week 11 : Equations of Motion, effective mass, concept of a hole, Intrinsic Carrier Concentration, Impurity Conductivity

Week 12 : Superconductivity