PHY623 First Course Hand-out

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This is designed to be the first introductory course on solid state physics. It introduces students to the physical properties of different types of solids and their explanation based on quantum theory. There will be 3 lectures (MTTh) per week and a tutorial on Friday. Regular assignments will be uploaded in the HelloIITK portal and selected problems will be discussed on Friday's tutorials. Students are encouraged to use the HelloIITK portal as a forum for discussion and posting doubts.

Evaluation: There will be a mid-sem and an end-sem exam. The break-up of marks is as follows:

b) Mid-sem: 40
c) End-sem: 60

It is highly probable that marks below 25% could be given F grades.

Course contents:

1. Free Electron Theory: Drude and Sommerfeld theory of free electrons in metals. Electrical conductivity, Hall Effect, electronic heat capacity. Wiedemann Franz law.

2. Bonding in solids: Ionic, covalent, van der Waals bonding; thermal expansion

3. Crystal Structure and Solids: Geometry of solids: lattices and unit cells. Crystal planes and X-ray diffraction. Reciprocal lattice and Brillouin zones.

4. Energy Bands of electrons in lattices: Bloch theorem. Motion of electron in periodic potential; nearly free electron theory of bands. Fermi surfaces of electrons. Tight binding theory of bands. Metal, semiconductors and insulators. Electronic structure of Graphene.

5. Lattice Vibrations and Phonons: Heat capacity of solids, lattice vibrations, phonon dispersion, optical and acoustic phonons. Thermal transport by phonons.

6. Electron transport in Solids: Motion of electrons in bands and effective mass of electrons and holes. Carrier conduction in metals and semiconductors. Physics of semiconductor devices.

7. Magnetism: Isolated magnetic moments, Hund's rule, Spin-orbit interaction and crystal field effects; Paramagnetism, diamagnetism. Exchange interaction, ferromagnetism, band model of ferromagnetism. Anti-ferromagnets. Spin-waves.

8. Superconductivity: Basic phenomenology, London's equations. Meissner effect and flux quantization. Type I and Type II superconductors; Instability of Fermi surface and Cooper pairing.

Policy: No make-up exam will be taken for the quiz or mid-sem. Marks for mid-sem exam could be prorated based on end-sem exam only if appropriate documents approved by the authorities are produced. Marks will NOT be prorated for absence during quiz. **Taking the end-sem exam is compulsory for awarding of grades.** 100% attendance in the lectures is mandatory. **Attendance of not less than 80% in the course is compulsory for appearing in the end-sem exam.**

Reference books:

No particular book will be followed. However the course material will be available in all standard introductory books on Solid state Physics. Few of them are listed below.

1) Introduction to Solid State Physics by C. Kittel
2) Solid State Physics, N. W. Ashcroft and N. D. Mermin
3) Solid State Physics by H. Ibach and Hans Luth
4) Magnetism in Condensed Matter by Stephen Blundell.
5) Condensed Matter Physics by Michael P. Marder