Paper-09

Solid State Physics and Atomic and Molecular Physics

Group A: Solid State Physics **[36 Lectures]**

Recapitulations of crystal structures, brief overview of quasi crystals and liquid crystals

[2L]

Band theory of solids: Bloch equation, empty band, nearly free electron (NFE) theory, band gap, tight binding approximation (TBA), Slater-Koster LCAO approach; effective mass of an electron in a band, concept of holes, classification of metal, semiconductor and insulator, 2D materials, Landau levels.

[8L]

Dielectric properties of solids: Complex dielectric constant and dielectric losses, relaxation time, classical theory of electronic polarization and optical absorption, ferroelectricity.

[4L]

Electronic & Thermal properties of solids: The Boltzmann transport equation and relaxation time, electrical and thermal conductivity of metals,

Wiedemann–Franz law, thermal expansion; Magnetoresistance and Hall effect.

[4L]

Magnetic properties of solids: Quantum theory of paramagnetism, spin para-magnetism – Pauli theory. Ferromagnetism: Stoner's criterion, Curie-Weiss law, Temperature dependence of saturation magnetization, Heisenberg's exchange interaction, Ferromagnetic domains, Magnetic anisotropy, Ferrimagnetism and Anti-ferromagnetism, Longitudinal and Transverse relaxation times, Hyperfine field.

[7L]

Imperfections in solids: Lattice imperfections, vacancies and interstitial defects, dislocations, colour-centres, photoconductivity, luminescence and phosphors, Order-disorder phenomena in binary alloys, Bragg-Williams theory, extra specific heat, superlattice.

[5L]

Superconductivity: Phenomenological description of superconductivity, Cooper pairs, BCS theory- expression for energy gap, Josephson effect (qualitative), high-T_c superconductors (qualitative).

[6L]

Reference Books:

1) Solid State Physics by N. W. Ashcroft & N. D. Mermin

2) Solid State Physics by H. Ibach & H. Löth

3) Introduction to Solids by L. V. Azaroff

4) Introduction to Superconductivity by M. Tinkham

5) Principles of the Theory of Solids by J. M. Ziman

Group B: Atomic & Molecular Physics [36 Lectures]

Quantum states of an electron in an atom, electron spin

[5L]

Relativistic corrections for energy levels of hydrogen atom, hyperfine structure, isotopic shift, width of spectral lines

[5L]

Interaction of hydrogen atom with EM-radiation: induced absorption and emission, transition rates, selection rules

[5L]

Spectrum of helium and alkali atom, LS and JJ couplings

[4L]

Electron spin resonance, nuclear magnetic resonance, chemical shift

[3L]

Molecular structure: molecular Hamiltonian, Born-Oppenheimer approximation, calculation of bond length and dissociation energy, solution of nuclear equation, molecular rotation, rigid and non-rigid rotator, centrifugal distortion, molecular vibration, harmonic oscillator approximation, anharmonicity, Interatomic potentials: Lennard-Jones, Morse potential.

[8L]

Molecular spectra: Franck-Condon principle, electronic, vibrational, rotational and Raman spectra of di-atomic molecules, selection rules.

[6L]

Reference Books:

1. Physics of Atoms and Molecules by B.H.Bransden and C.J.Joachain
2. Fundamentals of molecular spectroscopy by Colin N. Banwell and Elaine M. McCash
3. The Fundamentals of Atomic and Molecular Physics by Robert L Brooks
4. Basic Atomic and Molecular Spectroscopy by J Michael Hollas
5. Atomic and Molecular Spectroscopy: Basic Aspects and Practical Applications by Sune Svanberg
6. An Introduction to Atomic and Molecular Physics by Wolfgang Demtroder