JTL 201 Syllabus

Solid State Physics

Condensed Matter Systems. The Hamiltonian for the many-body problem. Difficulties associated with solving the many-body problem. Crystals and amorphous systems and liquids. The Born-Oppenheimer approximation.

Crystal Structure

Bravais lattices. Basis and crystal structure. Two- and three-dimensional lattice types. Simple crystal structures. Lattice vectors. Primitive and non-primitive unit cells. Miller Indices.

Reciprocal Lattice and X-Ray Diffraction.

Definition of the reciprocal lattice and its physical interpretation. Reciprocal lattice vectors. Fourier analysis. Noether's Theorem. Reciprocal lattices to various Bravais lattices. Brillouin zones. Irreducible Brillouin zone. Diffraction conditions. Bragg's Law. Laue equations. Ewald construction.Structure factor. Atomic form factor.

Free Electron Model

Classical and quantum mechanical treatment of free electrons. Free electrons in one, two and three dimensions. Density of states. Fermi-Dirac distribution. Sommerfeld model. Specific heat capacity – classical and quantum mechanical results. Electrical conductivity and Ohm's Law. Hall effect. Thermal conductivity. Wiedemann-Franz Law. Successes and failures of the Free Electron Model.

Band Theory

Empty lattice model for free electrons. Electrons in a periodic potential. Bloch's theorem. Metals and insulators. Peierls instability. Independent electron approximation. Tight binding approximation. Nearly free electron approximation. Successes and failures of the Independent electron approximation.

Crystal Vibrations and Phonons

Classical and quantum mechanical treatments of crystal vibrations. Normal modes. Dynamical matrix. Transverse and longitudinal modes. Acoustic and optical modes. Inelastic scattering by phonons. Raman scattering and neutron scattering. Phonon anharmonicity.