

List of topics 2020

Solid-state physics (Materials science MSc.)

1. Lattice structure of crystals

Elementary cell, translation vectors, Bravais lattice, Bragg-reflection, Reciprocal lattice, Brillouin-zone, Bondings: van-der-Waals, ionic, covalent

2. Phonons

Debye-frequency, specific heat of lattice vibration, phonon band structure of a 1D lattice model, acoustic and optical modes, sound velocity, equivalent wavenumbers

3. Quasi-free electron approximation

Bloch-theorem, dispersion relation of a free electron, empty-lattice approximation, weak potential, Fermi-energy, Fermi-Dirac distribution, Fermi-surface, metal or insulator?

4. Tight-binding approximation (Approximation with Bound Electrons)

Bloch-theorem, tight binding approximation of a 1D lattice, hopping integral, on-site energy, Fermi-energy, Fermi-Dirac distribution, Fermi-surface, metal or insulator?

5. Transport-phenomenon

Differential Ohm's law, Drude-Lorentz model, Hall-effect, Thermoelectricity (Peltier, Seebeck)

6. Semiconductors

Band structure of semiconductors, conductance and valence band, electron and hole mass, n-doped and p-doped semiconductors, conductivity vs. temperature plot for a n-doped semiconductor, density of states of the free electron gas in 1D, 2D and 3D

7. Electrons in magnetic field

Classical description, cyclotron frequency, cyclotron-mass, Hall-effect, Landau-levels,

8. Superconductors

Phase diagram of I and II-type superconductors, Meissner-effect, Thermodynamics of superconductors, London-equation, Cooper-pairs, SQUID