SMART NANOSTRUCTURES AND CONDENSED MATTER PHYSICS

ENTRY TEST FOR THE MASTER PROGRAM, YEAR 2020

CONTENT

1. Quantum mechanics

1.1. Wave function and its properties.

Momentum operator. Spherical functions. Hydrogen atom. Energy spectrum and wave functions.

1.10. *Particle scattering.*

Scattering amplitude, scattering cross section. Born approximation. Scattering at the Coulomb center, Rutherford formula.

1.11. *Angular momentum.*

The general formalism of angular momentum. Spin of the particles. Particles with spin 1/2, spinors. Spin operator, Pauli matrices.

1.12. *The principle of indistinguishability of identical particles.*

Symmetry of the wave function with respect to particle permutations. Bosons and fermions. Pauli principle.

2.7. Electronic band structure of crystals. Electrons in a periodic potential.
Schrödinger's equation for an electron in a periodic potential field. Fermi surface.

2.8. Electronic band structure of crystals. Electrons in a weak periodic potential.
The concept of perturbation theory in quantum mechanics. The periodic potential of the lattice as a perturbation. Allowed and forbidden zones of electronic states.

2.9. Drude theory of metals.
The main principles of Drude theory of metals. Static conductivity and Hall coefficient.

2.10.   Sommerfeld theory of metals.
Thermodynamic properties of free electron gas. Fermi-Dirac distribution function. Heat capacity in Sommerfeld theory of metals.

2.11.   General concepts of interatomic interactions. The forces of Van der Waals.
Van der Waals interaction from the classical and quantum points of view. The binding energy in the Van der Waals interaction.

2.12.   General concepts of interatomic interactions. Lennard-Jones potential.
Mutual repulsion of atoms. Lennard-Jones potential. Ion bond. Covalent bond.

Recommended books:

1. Griffiths, David (2005). Introduction to Quantum Mechanics (2nd ed.). Pearson Prentice Hall. ISBN 0131118927.
2. Cohen-Tannoudji, Claude; Diu, Bernard; Laloë, Franck (1977). Quantum Mechanics. Wiley. ISBN 978-0471164333.
3. Feynman, Richard P. (2005). The Feynman Lectures on Physics. 1, 3 (2nd ed.). Addison