



## COURSE DATASHEET

<b>Semester:</b>	2015/16/1
<b>Course:</b>	Solid state physics
<b>Code:</b>	VEMKFI2212A
<b>Responsible department:</b>	Institute of Physics and Mechatronics
<b>Department code:</b>	MKFI
<b>Responsible instructor:</b>	dr. Péter Gurin

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### Course objectives:

Description of the macroscopic properties of the solid and condensed matter, and the understanding the underlying microphysical processes. Acquirement of the theoretical basis essential for the structural study and design of solid materials.

### Course content:

1. Classical models for solid state matter: Drude's model. Electronic and heat transport, Hall effect, thermoelectric effect. 2. Sommerfeld's model. The weak point of the classical description, the importance of quantum effects. Quantum statistics. Thermodynamic properties of ideal Fermi and Bose gases. 3. Crystal lattice. Types of lattices, symmetries. Bravais lattices. Reciprocal lattice, Brillouin zones. Dislocations. 4. Mechanical properties of the lattice. Deformation and stress tensor. Hooke's law. Plastic deformation. The role of the dislocation. 5. Elastic waves in a continuum. Wave equation and its solution. Ultrasonic study of the elastic properties. 6. Oscillation of a crystal, phonons. Oscillations of a one dimensional lattice. Acoustic and optical branches. Interactions between electrons and phonons, Peierls transition. 7. Interaction of the lattice with radiation. Diffraction. Form factors. Study of the phonon spectrum by inelastic neutron scattering. Surface study methods: RBS. 8. Thermodynamic properties. Specific heat of the lattice and the electron gas. Expansion. 9. Basics of quantum mechanics. Representation of observables by operators. Eigenfunctions and eigenvalues. Schrödinger's equation. 10. Spin in external field. NMR. Theory of covalent bonding. The hydrogen molecule. Metallic bonding. 11. Electrons in periodic potential. Kronig-Penny's model. Bloch's theorem. Energy bands. Band structure of metals, insulators and semiconductors. Electrons and holes, effective mass. 12. Semiconductor materials and its applications. Intrinsic and doped semiconductors, diode, bipolar transistor, FET, IC. 13. Dielectric and optical properties of the matter. Polarization. Clausius-Mosotti relation. Frequency dependence of dielectric constant. Ferroelectric materials. Piezoelectric effect. 14. Magnetism. Paramagnetism and diamagnetism. Ferromagnetism and its microscopic origin. Ising, Heisenberg, Stoner and Hubbard models. Spin glasses. Superparamagnetism. Study of the magnetic properties by neutron scattering. 15. Superconductivity. Meissner effect. Outline of the theory: Cooper's pairs, BCS theory. Josephson's junction, SQUID. High Tc superconductors.

### Requirements, evaluation and grading:

exam



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### Required and recommended readings:

Charles Kittel: Bevezetés a szilárdtest fizikába. Muszaki Könyvkiadó (1965) Simonyi Károly: Elektronfizika. Tankönyvkiadó (1965) Ashcroft-Mermin: Solid State Physics. Holt, Rinehart and Winston Inc. (1976)