



COURSE UNIT (MODULE) DESCRIPTION

Course unit (module) title	Code
Solid state theory	

Lecturer(s)	Department(s) where the course unit (module) is delivered
Coordinator: prof. Darius Abramavičius	VU Fizikos fakultetas, Saulėtekio al. 9/III, Vilnius
Other(s):	

Study cycle	Type of the course unit (module)
second	optional

Mode of delivery	Period when the course unit (module) is delivered	Language(s) of instruction
auditorial	2 semester	Lithuanian-english

Requirements for students	
Prerequisites: statistical physics and thermodynamics, quantum mechanics	Additional requirements (if any):

Course (module) volume in credits	Total student's workload	Contact hours	Self-study hours
5	144	32	112

Purpose of the course unit (module): programme competences to be developed		
Student will be acquainted with crystalline materials, their electronic and thermal properties, with quasiparticles: electrons, holes, phonons, polarons, excitons, polaritons, plazmons, magnons.		
Learning outcomes of the course unit (module)	Teaching and learning methods	Assessment methods
Student will learn the concepts used by describing solid materials, learn the ways to analyze experiments of solid materials	Lectures, practices, seminars, laboratory work, self-studying.	Evaluation of problem solving, laboratory work and written exam
Students will acquire the basic knowledge for problem solving in solid state physics		

Content: breakdown of the topics	Contact hours							Self-study work: time and assignments	
	Lectures	Tutorials	Seminars	Exercises	Laboratory work	Internship/work placement	Contact hours	Self-study hours	Assignments
Translational symmetry. Bravais lattice. Primitive and Wigner–Seitz cells. Point symmetries and point groups. Reciprocal lattice. Brillouin zones.	2						2	9	Read literature on the topic
Microscopic model of solid state. Core and valence electrons. Drude model. Free electrons in free space. Density of states. Fermi surface.	2						2	9	Read literature on the topic
Statistical Physics. Bosons and Fermions. Density of states. Fermi-Dirac distribution. Fermi surface. Thermal phenomena.	2						2	9	Read literature on the topic
Schrödinger equation. Adiabatic approach. One electron approximation. Bloch theorem. Tight binding method, TBA. Weak periodic potential.	2						2	9	Read literature on the topic
Many-electron problem. Electron antisymmetry. Hartree-Fock theory.	2						2	9	Read literature on the topic
Electrons and holes. Wavepacket equation of motion. Bloch oscillations. Band structure of metals, dielectrics.	2						2	9	Read literature on the topic
Oscillations in the chain of atoms. Acoustic and optical oscillations. Quantum mechanical description of lattice oscillations, phonons. Einstein's model. Debye model.	2						2	9	Read literature on the topic
Non-adiabatic electron-phonon scattering. Microscopic model of the scattering. Quasiparticle scattering.	2						2	9	Read literature on the topic
Boltzmann's kinetic equation. Relaxation Time approach. Balance of quantum jumps. Energy relaxation time. The golden rule of quantum mechanics.	2		2				4	9	Read literature on the topic
Semiconductors. Homogeneous and non-homogenous. Statistics of charges. Impurities and defects. i n p type semiconductors	2		2				4	11	Read literature on the topic
General Relation of Electrodynamics. Dielectric function. Quantum-mechanical optical transitions. Interband jumps. Excitons. Polarotons. Plasmons. Nanoparticles.	2		2				4	11	Read literature on the topic
Magnetism, Ising, Heisenberg Models. Critical phenomena	2		2				4	11	Read literature on the topic
Total	24		8				32	112	

Assessment strategy	Weight, %	Deadline	Assessment criteria
Seminar presentations	50 %	During the semester	Excellence in problem solution and presentation.
Exam	50 %	Exam session	Perfect knowledge of the subject.

Final evaluation	Sum		
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Author	Year of publication	Title	Issue of a periodical or volume of a publication	Publishing place and house or web link
Compulsary reading				
N. W. Ashcroft, N. D. Mermin	1976	Solid state physics		Cengage Learnin
Papildoma literatūra				
Optional reading				
		Crystal program manual		https://tutorials.crystalsolutions.eu https://www.crystal.unito.it/include/manuals/crystal23.pdf