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<tr><td>NAME OF THE COURSE</td><td colspan="7">Solid State Physics</td></tr>
<tr><td>Code</td><td>PMP201</td><td>Year of study</td><td colspan="4">GU-1
GU-2</td></tr>
<tr><td>Course teacher</td><td>Ivica Aviani, PhD, Professor</td><td>Credits (ECTS)</td><td colspan="4">6,0</td></tr>
<tr><td rowspan="2">Associate teachers</td><td rowspan="2">Viktor Cikojević</td><td rowspan="2">Type of instruction (number of hours)</td><td>L</td><td>S</td><td>E</td><td>F</td></tr>
<tr><td>30</td><td>0</td><td>30</td><td>0</td></tr>
<tr><td>Status of the course</td><td>Compulsory</td><td>Percentage of application of e-learning</td><td colspan="4">20%</td></tr>
<tr><td colspan="7">COURSE DESCRIPTION</td></tr>
<tr><td>Course objectives</td><td colspan="6">To familiarize students with basic condensed matter physics concepts based on statistical and quantum mechanics cognitions using mainly semi-classical models. Comprehension of experimental occurrences in crystal structures based on microscopic physical models is expected as well as the ability to quantitatively describe and solve problems using adequate mathematical formalism.</td></tr>
<tr><td>Course enrolment requirements and entry competences required for the course</td><td colspan="6">Quantum Mechanics
Statistical Physics</td></tr>
<tr><td>Learning outcomes expected at the level of the course (4 to 10 learning outcomes)</td><td colspan="6">To describe basic crystallographic systems and symmetry operations.
To explain characteristics of interatomic bonds in crystals.
To analyze spectral functions of phonons and their contributions to heat capacity and thermal expansion.
To determine and discuss electronic heat capacity and temperature dependency.
To explain electronic properties of metals and connection between electron and heat conductivity.
To explain electron energy spectrum in periodical potential and electron and electron hole properties.
To analyze contributions to electric resistance of metals.
To explain electric properties of semiconductors.
To explain atomic magnetism and magnetism of matter.
To explain occurrence and properties of superconductivity.
To explain basic experimental techniques in physics of condensed matter.</td></tr>
<tr><td>Course content broken down in detail by weekly class schedule (syllabus)</td><td colspan="6">1st week: Introduction class (introducing students and lecturers, description of work methods, student obligations and evaluations of achievements, description of the solid-state physics research area, role of condensed matter physics in technology and civilization development, basic experimental methods).
2nd week: Crystals and crystal structures (types of crystals, crystal lattice, elementary cell, operations of symmetry, quasi-crystal, Bravais lattice).
3rd week: Crystal lattice and defects (crystal lattices, reciprocal lattice, direct and momentum space, diffraction of x rays, crystal defects, Schottky's defects, Frankel's defects, elemental excitations).
4th week: Interatomic bonds and cohesion energy (covalent bond, ionic bond, Van der Waals bond, hydrogen bond, metallic bond).
5th week: Oscillations of single-atom linear crystal lattice (wave equation, group velocity, Brillouin zone, wave number recounting).
6th week: Oscillations of two-atom linear crystal lattice (oscillations of crystal lattice with two atoms in the primitive cell, acoustic oscillations, optical oscillations)
7th week: Ionic crystals in electromagnetic field, dipole moment of the atom, polarizability of atoms and molecules.
8th week: Phonon contribution to heat capacity of crystals (acoustic and optical phonons, Debye and Einstein approximation, heat capacity of the</td></tr>
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	crystal cell, Dulong-Petit rule). Heat expansion of crystal. 9th week: Sommerfeld model of metals (types of metals and their properties, Drude and Sommerfeld model of metals, Fermi energy, density of electronic states, Sommerfeld expansion, heat capacity of electron gas). 10th week: Electron in the periodic potential (Schrödinger equation for electron in the periodic potential, Bloch theorem, electron energy bands, electron hole, effective mass, van Hove singularities). 11th week: Transport phenomena (Drude model of electric conductivity, Ohm's law, Joule's heat, Matthiessen's and Nordheim's rule, phonon contribution to electrical resistance, Hall effect, Heat conductivity, Wiedemann-Franz law). 12th week: Semiconductors (types of semiconductors, zone structure of semiconductors, doped semiconductors, electron and hole conductivity of semiconductors). 13th week: Atomic magnetism (spin and orbital magnetic moment, Hund's rules, atomic paramagnetism, magnetization for J=1/2, Brillouin function, Langeven atomic diamagnetism). 14th week: Magnetic properties of matter (paramagnetism and diamagnetism of free electrons, quantum theory of ferromagnetism, magnetic domains and hysteresis, Weiss theory of molecular field, antiferromagnetism, Curie – Weiss law). 15th week: Superconductivity (Meissner effect, isotopic effect, type 1 and type 2 superconductors, electron – phonon coupling, Cooper pairs, BCS theory, superconductivity gap, critical temperature, critical current, Josephson effect).
Format of instruction	☒ lectures ☐ seminars and workshops ☒ exercises ☐ on line in entirety ☒ partial e-learning ☐ field work ☐ independent assignments ☐ multimedia ☐ laboratory ☐ work with mentor ☒ homework assignments
Student responsibilities	Attendance of at least 50% of lectures and exercises. At least 50% of solved homework problems.

Screening student work *(name the proportion of ECTS credits for each activity so that the total number of ECTS credits is equal to the ECTS value of the course)*

Name	Ects	Name	Ects	Name	Ects
Class attendance	1.6	Research		Experimental work	
Oral exam	2.6	Report		Homework assignments	0.5
Seminar essay		Essay		Colloquia	0.9
Tests		Practical training			
Written exam	0.4	Project			

Grading and evaluating student work in class and at the final exam	Evaluation of student achievements and activities are graded as follows: • class attendance - up to 10 points • homework problem solving - up to 10 points • written exam - up to 30 points • oral exam - up to 50 points Written exam is consisted of problems (exercises) that need to be solved. This exam can be passed during the semester via two colloquia. In order to attend the oral exam, student must solve at least 50% of problems in the written exam and must fulfill all requirements to get the professor's signature. In order for student to pass the exam via colloquia, he or she must solve at least 50% of all problems from both colloquia. Oral exam is consisted of 5 questions from different content units. These questions are randomly selected from an initially known list of question. Grades are given according the following score ranges: • 89 - 100 points : excellent

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<tr><td></td><td>• 76 - 88 points: very good
• 63 - 75 points: good
• 50 - 62 points: sufficient</td></tr>
<tr><td>Required literature (available in the library and via other media)</td><td><table>
<tr><th>Title</th><th>Number of copies in the library</th><th>Availability via other media</th></tr>
<tr><td>C. Kittel, Introduction to Solid State Physics, 5th edition, John Wiley & Sons, Inc.,197</td><td>5</td><td></td></tr>
<tr><td>V. Šips, Uvod u fiziku čvrstog stanja, Školska knjiga Zagreb, 1991.</td><td>3</td><td></td></tr>
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<tr><td>Optional literature (at the time of submission of study programme proposal)</td><td>G.I.Epifanov, Solid State Physics, MIR Publishers, Moscow, 1979</td></tr>
<tr><td>Quality assurance methods that ensure the acquisition of exit competences</td><td>Evaluation of student achievements in accordance with expected outcomes
Lecturer's self-evaluation
Student feedback through questionnaires
In-institution and out-institution review</td></tr>
<tr><td>Other (as the proposer wishes to add)</td><td></td></tr>
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