NAME OF THE COURSE	Introduction to statistical physics					
Code	PMP114	Year of study	3 PD			
Course teacher	prof. dr. sc . Ivica Aviani	Credits (ECTS)	5			
Associate teachers		Type of instruction (number of hours)	L	S	E	F
			30	0	30	0
Status of the course	Mandatory	Percentage of application of e-learning	20			

COURSE DESCRIPTION

Course objectives	Introducing students with basic properties and description of many-particle systems through the concepts of thermodynamics and statistical physics in the thermodynamic limit, with the adoption of fundamental concepts such as entropy, thermodynamic potentials, fluctuations, and single-particle distributions. Qualitative understanding of the experimentally observed phenomena of microscopic physical models is expected, as well as the ability to quantitatively describe and solve problems by means of appropriate mathematical formalism.
Course enrolment requirements and entry competences required for the course	Passed courses: General Physics I and II, Mathematics I and II. Attended courses: General Physics III and IV, and Classical mechanics.
Learning outcomes expected at the level of the course (4 to 10 learning outcomes)	• Define and discuss thermodynamic laws. • Calculate thermodynamic quantities for simple thermodynamic systems. • Define and discuss basic concepts of statistical physics, and explain the connection with thermodynamics. • Explain Maxwell-Boltzmann distribution and the meaning of partition function. • Apply statistical mechanics to solve selected problems. • Define and discuss the basic concepts of quantum statistical physics. • Explain Fermi- Dirac and Bose- Einstein distributions, discuss the conditions of applicability and behavior in the classical limit. • Explain the basic ideas of classical and quantum descriptions of crystalline lattice vibrations and ideal gas. • Describe and discuss the model of black-body radiation.
Course content broken down in detail by weekly class schedule (syllabus)	*Thermodynamics - 3 weeks* 1. General characteristics of many-particle systems: Functions of state. Functions of process. Intermolecular collisions. Equilibrium of state. Temperature. Pressure. 2. Thermodynamic laws. Work and heat. Carnot cycle. Entropy. Reversibility. Heat capacity. 3. Conditions of thermodynamic equilibrium. Thermodynamic potentials. Systems with variable particle number. *Classical statistical physics - 6 weeks* 4. Basic concepts of probability and Statistics. Statistical behavior of many-particle systems. Maxwell's distribution. 5. The most probable distribution: Boltzmann's distribution. Lagrange multipliers. 6. Explanation of second law of thermodynamics. Entropy. Thermal properties of ideal gas. The law of equipartition of energy. 7. Phase space. Average values of physical quantity. Partition function, Free energy. 8. Classical harmonic oscillator. 9. Heat capacity of crystal lattice and ideal gas. *Quantum statistical physics - 6 weeks* 10. Quantization of energy levels. Identical particles. Symmetry of wave functions. Explanation of the third law of thermodynamics. Limits of classical statistics. 11. Quantum harmonic oscillator. Partition function. 12. Black-body radiation: Planck distribution. Photons. Rayleigh-Jeans formula. Stefan-Boltzmann law, Wien's law.

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<tr><td></td><td colspan="6">13. Vibrations of atoms in crystals: Einstein and Debye model. Phonons.
14. Bose-Einstein and Fermi- Dirac distribution.
15. Density of the state. Degenerate fermion systems.</td></tr>
<tr><td>Format of instruction</td><td colspan="3">☒ lectures
☐ seminars and workshops
☒ exercises
☐ on line in entirety
☒ partial e-learning
☐ field work</td><td colspan="3">☒ independent assignments
☒ multimedia
☐ laboratory
☐ work with mentor
☐ (other)</td></tr>
<tr><td>Student responsibilities</td><td colspan="6"></td></tr>
<tr><td rowspan="5">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)</td><td>Class attendance</td><td>1.5</td><td>Research</td><td></td><td>Practical training</td><td></td></tr>
<tr><td>Experimental work</td><td></td><td>Report</td><td></td><td>Home works</td><td>0.5</td></tr>
<tr><td>Essay</td><td></td><td>Seminar essay</td><td></td><td>(Other)</td><td></td></tr>
<tr><td>Tests</td><td>1.0</td><td>Oral exam</td><td>2.0</td><td>(Other)</td><td></td></tr>
<tr><td>Written exam</td><td></td><td>Project</td><td></td><td>(Other)</td><td></td></tr>
<tr><td>Grading and evaluating student work in class and at the final exam</td><td colspan="6">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 fulfil 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 three 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
• 76 - 88 points: very good
• 63 - 75 points: good
• 50 - 62 points: enough</td></tr>
<tr><td rowspan="9">Required literature (available in the library and via other media)</td><td colspan="4">Title</td><td>Number of copies in the library</td><td>Availability via other media</td></tr>
<tr><td colspan="4">V. Šips, Uvod u statističku fiziku, Školska knjiga Zagreb, 1990.</td><td></td><td></td></tr>
<tr><td colspan="4">F. Reif, Statistical Physics (Berkeley Physics Course, Vol.5), McGraw Hill, 1967.</td><td></td><td></td></tr>
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<tr><td>Optional literature (at the time of submission of study programme proposal)</td><td colspan="6">1. The principles of statistical mechanics, R. C. Tolman, Oxford press, 1938.
2. Theoretical Concepts in Physics, M. Longair, Cambridge University Press, 2006.
3. Thermodynamics and an Introduction to Thermostatistics, H. B. Callen, Wiley, 1985.
3. Feynman, The Feynman Lectures on Physics, (sections 39-46), 1963.
4. Selected research papers and lectures.</td></tr>
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Quality assurance methods that ensure the acquisition of exit competences	• Evaluation of student achievements in accordance with expected outcomes. • Lecturer's self-evaluation. • Student feedback through questionnaires. • In-institution and out-institution review.
Other (as the proposer wishes to add)	