Faculty of Science and Mathematics / PHYSICS / MOLECULAR PHYSICS AND THERMODYNAMICS

Course:	MOLECULAR PHYSICS AND THERMODYNAMICS			
Course ID	**Course status**	**Semester**	**ECTS credits**	**Lessons** (Lessons+Exercises+Laboratory)
10108	Mandatory	2	7	3+3+0
Programs	PHYSICS			
Prerequisites				
Aims	Acquiring knowledge about thermal phenomena, processes and laws, as well as about the basic relations and principles of the molecular-kinetic theory of gases and thermodynamics.			
Learning outcomes	After successful completion of the course students should be able to: understand basic concept of heat transfer and interpret different heat transfer mechanisms (conduction, convection, radiation); explain “behavior“ of molecules and relevant distributions, demonstrate knowledge of the ideal gas model, derive the van der Waals equation and apply it to a real gas; use thermodynamic terminology correctly, derive and discuss the first and second laws of thermodynamics, analyze basic thermodynamic cycles, distinguish between thermodynamic potentials, understand the concept of thermodynamic equilibrium; develop a simple physical model applicable to solving a given problem from the molecular-kinetic theory and thermodynamics; describe in general phenomena at the boundary of different phases, phase transitions and phase diagram.			
Lecturer / Teaching assistant	Prof Dr Nevenka Antović, Dr Krsto Ivanović			
Methodology	Lectures, exercises, consultations, homework.			
Plan and program of work				
Preparing week	Preparation and registration of the semester			
I week lectures	Thermal and molecular properties of matter. Temperature and temperature scales. Thermal expansion.			
I week exercises	Temperature scales. Thermal expansion.			
II week lectures	Thermal stress. Quantity of heat. Heat transfer.			
II week exercises	Thermal stress. Quantity of heat. Heat transfer (conduction).			
III week lectures	Specific heats. Basics of calorimetry. Kinetic theory of gases – basic relations.			
III week exercises	Heat transfer (convection, radiation). Specific heats.			
IV week lectures	Ideal gas – equation of state, processes, work. Internal energy and degrees of freedom.			
IV week exercises	Basic relations of the kinetic theory of gases. Ideal gas – equation of state.			
V week lectures	Mean free path. Maxwell and Boltzmann distribution.			
V week exercises	Ideal gas – processes, work; mean free path; Maxwell and Boltzmann distribution.			
VI week lectures	Midterm exam I			
VI week exercises	Midterm exam I			
VII week lectures	Real gas – equation of state, internal energy. Joule-Thomson effect.			
VII week exercises	Van der Waals equation; real gas – internal energy.			
VIII week lectures	Viscosity, thermal conductivity and diffusion of gases. Properties of ultra-dilute gases.			
VIII week exercises	Viscosity, thermal conductivity and diffusion of gases.			
IX week lectures	Thermodynamic system; state. Thermodynamic process. Laws of thermodynamics.			
IX week exercises	Laws of thermodynamics.			
X week lectures	Heat engine; refrigerator. Carnot and other cycles. Clausius inequality.			
X week exercises	Thermodynamic cycles.			
XI week lectures	Entropy. Nernst theorem. Thermodynamic potentials.			
XI week exercises	Thermodynamic cycles. Entropy. TS-diagram.			
XII week lectures	Surface tension; force. Phenomena at the boundary between phases. Capillarity.			
XII week exercises	Midterm exam II			

XIII week lectures	Phase transitions. Evaporation and condensation. Ideal and real isotherms; critical point.
XIII week exercises	Surface tension; capillary action.
XIV week lectures	Metastable states of vapor and liquid. Clausius-Clapeyron equation.
XIV week exercises	Evaporation and condensation. Clausius-Clapeyron equation.
XV week lectures	Melting and crystallization. Equilibrium conditions between phases. Triple point – phase diagram.
XV week exercises	Melting and crystallization. Phase diagram.
Student workload	Weekly: 7 x 40/30 = 9 h and 20 min; total: 7 x 30 = 210 h

Per week	**Per semester**
7 credits x 40/30=9 hours and 20 minuts 3 sat(a) theoretical classes 0 sat(a) practical classes 3 excercises **3 hour(s) i 20 minuts** of independent work, including consultations	Classes and final exam: **9 hour(s) i 20 minuts x 16 =149 hour(s) i 20 minuts** Necessary preparation before the beginning of the semester (administration, registration, certification): **9 hour(s) i 20 minuts x 2 =18 hour(s) i 40 minuts** Total workload for the subject: **7 x 30=210 hour(s)** Additional work for exam preparation in the preparing exam period, including taking the remedial exam from 0 to 30 hours (remaining time from the first two items to the total load for the item) **42 hour(s) i 0 minuts** Workload structure: **149 hour(s) i 20 minuts (cources), 18 hour(s) i 40 minuts (preparation), 42 hour(s) i 0 minuts (additional work)**
Student obligations	Attending classes (lectures and exercises) regularly; doing homework assignments and taking midterm exams.
Consultations	As needed.
Literature	D. Halliday, R. Resnick, J. Walker, Fundamentals of Physics, John Wiley&Sons, 2005; B. Žižić, Kurs opšte fizike – Molekularna fizika, termodinamika, mehanički talasi. IRO Građevinska knjiga, Beograd, 1988; I. Irodov, Zbirka zadataka iz opšte fizike, Zavod za udžbenike i nastavna sredstva, Podgorica, 2000; G. Dimić, M. Mitrinović, Zbirka zadataka iz fizike (kurs D), Naša knjiga, Beograd, 2000.
Examination methods	Regular attendance: 5 points; homework: 5 points (5 x 1); midterm exams: 40 points (2 x 20); final exam: 50 points. In order to pass the course, students have to achieve at least 50 points.
Special remarks	
Comment	

Grade:	F	E	D	C	B	A
Number of points	less than 50 points	greater than or equal to 50 points and less than 60 points	greater than or equal to 60 points and less than 70 points	greater than or equal to 70 points and less than 80 points	greater than or equal to 80 points and less than 90 points	greater than or equal to 90 points