Fundamentals of physics II - Thermodynamics - course description

General information

Course name	Fundamentals of physics II - Thermodynamics
Course ID	13.2-WF-FizP-FP-II-T-S17
Faculty	Faculty of Physics and Astronomy
Field of study	WFiA - oferta ERASMUS
Education profile	-
Level of studies	Erasmus programme
Beginning semester	winter term 2023/2024

Course information

Semester	2
ECTS credits to win	5
Course type	obligatory
Teaching language	english
Author of syllabus	• dr hab. Maria Przybylska, prof. UZ

Classes forms

The class form	Hours per semester (full-time)	Hours per week (full-time)	Hours per semester (part-time)	Hours per week (part-time)	Form of assignment
Lecture	30	2	-	-	Exam
Class	30	2	-	-	Credit with grade

Aim of the course

The aim of the course is to acquire the student's ability to understand and describe the physical phenomena of thermodynamics and the basics of statistical physics. In addition, students will become acquainted with the development of physics research concepts and methods. The lecture is enriched with demonstrations of physical laws and their applications.

Prerequisites

Knowledge of mathematics and physics at the secondary school level, finished course “Fundamentals of physics I'

Scope

- Basis notions of thermodynamics: work, heat, internal energy

- The zeroth law of thermodynamics: measure of temperature, temperature's scales

- Specific heat and material properties: thermal expansions of fluids and solids, heat capacity, specific heat, latent (hidden) heat

- Heat and work: the first law of thermodynamics, thermodynamic processes

- Heat transfer modes: thermal conductivity, convection, radiation

- Model of ideal gas: assumptions of this model, equation of state for an ideal gas, thermodynamic processes for ideal gases

- Models of real gases: van der Waals state equation

- Kinetic theory of gasses: relation of pressure and temperature to the average value of the square of the velocity of molecules, Maxwell distribution of velocities, mean free path

- The second law of thermodynamics: entropy, thermal engines, Carnot's engines, efficiency coefficient

- The third law of thermodynamics: reversible and irreversible processes; systems: open, closed and isolated; absolute zero temperature; cooling and obtaining very low temperatures

- Elements of phase transitions physics: fluctuations, phase diagrams, phase transitions of first kind and continuous transitions

- Elements of statistical physics: probability, microstates and macrostates, statistical sum, entropy, microcanonical and canonical ensembles, statistical definition of temperature; open systems, grand canonical ensemble, bosons and fermions, the Fermi-Dirac and the Bose-Einstein statistics, photon gas in the cavity and Planck's radiation law, the blackbody spectrum

Teaching methods

Conventional lecture illustrated with demonstrations of physical experiments

During classes students analyse and solve exercises illustrating the content of the lecture.

Learning outcomes and methods of theirs verification

Outcome description	Outcome symbols	Methods of verification	The class form

Outcome description	Outcome symbols	Methods of verification	The class form
Student knows basic ensembles: microcanonical, canonical and grand canonical, and is able to provide examples of their applications.		• an evaluation test • an exam - oral, descriptive, test and other	• Lecture • Class
The student can extend the model of an ideal gas to the model of a real gas		• an evaluation test • an exam - oral, descriptive, test and other	• Lecture • Class
Student is able to describe the first-order phase transition and continuous phase transition using a phase diagram.		• an evaluation test • an exam - oral, descriptive, test and other	• Lecture • Class
Students know, and can apply the principles of thermodynamics to the qualitative and quantitative analysis of simple problems. They can explain how a thermal engine and refrigerator work		• a discussion • an evaluation test • an exam - oral, descriptive, test and other	• Lecture • Class
The student can give the parameters defining the thermodynamic state of the system and define the functions of the state. The student can provide and describe the different forms of energy and its transfer.		• an evaluation test • an exam - oral, descriptive, test and other	• Lecture • Class
The student understands and can describe the phenomenological and statistical approach to the phenomena of thermodynamics		• an evaluation test • an exam - oral, descriptive, test and other	• Lecture • Class
Student understands a notion of the microstate and macrostate, and is able to determine their occurence probability.		• an evaluation test • an exam - oral, descriptive, test and other	• Lecture • Class
Student is able to define the entropy for an isolated system and to provide a statistical definition of the temperature.		• an evaluation test • an exam - oral, descriptive, test and other	• Lecture • Class

Assignment conditions

Lecture - obtaining a positive assessment of the final exam (written and oral). A positive evaluation requires at least 60% of the answers to the questions posed.

Classes - Positive pass of partial tests obtained on the base of more than 50% of the maximum number of points.

Before taking the exam a student must gain positive grade during the class.

Total score: average rating of the exam (50%) and grade from the class (50%).

Recommended reading

[1] A. K. Wróblewski, J. A. Zakrzewski, *Wstęp do fizyki*, (t. 2, cz. 2, roz. VI – Elementy termodynamiki, t. 1, roz. VII – Układy bardzo wielu cząstek), Wydawnictwo Naukowe PWN,, 1991 i 1984.

[2] R. Hołyst, A. Poniewierski, A. Ciach, *Termodynamika dla chemików, fizyków i inżynierów*, Wydawnictwo Uniwersytetu Kardynała Stefana Wyszyńskiego, Warszawa, 2005. Eng. translation R. Hołyst, A. Poniewierski, A. Ciach, Thermodynamics for chemists, physicists and engineer, Springer Science+Business Media Dordrecht 2012

[3] K. Huang, *Podstawy fizyki statystycznej*, Wydawnictwo Naukowe PWN, Warszawa 2006, Eng. translation K. Huang, Introduction to Statistical Physics, 2 ed, Chapman and Hall/CRC, 2009

[4] Slides and other materials provided by lecturer

Further reading

[1] D. Halliday, R. Resnick, J. Walker, Podstawy fizyki, tom 2, Wydawnictwo Naukowe PWN, Warszawa 2005.

[2] I. Anselm, *Podstawy fizyki statystycznej i termodynamiki,* Państwowe Wydawnictwo Naukowe, Warszawa 1990.

Notes

The lectures are supplemented by physical demonstrations conducted by Dr. S. Jerzyniak, MSc S. Kruk and Mr. H. Adamek

Modified by dr Marcin Kośmider (last modification: 06-02-2023 22:55)