Course title	**Properties of matter and thermal processes**
Course code	***Fizi 1023***
Scientific field	Physics
Scientific subfield	Properties of matter and thermal processes
Credit points	6
ECTS credits	9
Total contact hours *Number of hours for lectures* *Number of hours for seminars and practical assignments* *Number of hours for laboratory assignments* *Number of hours for course paper*	96 32 32 32 -

Course developer (-s)
Dr.paed., doc. Lolita Jonāne, DMF

Prerequisite knowledge (course title, part of the program where the course is learnt)
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Course abstract:
The course is intended for students of Bachelor study program "Physics". The course focuses on analysing questions of matter (physical body) as a thermodynamic system, its properties dependence on the atomic or molecular structure, particle motion and nature of interaction forces. The course deepens the existing knowledge and allows to learn new concepts and laws that characterize gases, liquids and fluids, solids and polymers, phase equilibrium and phase transitions. The course of study offers to explore thermodinamical phenomena.

Learning outcomes:

Students will:
- Use characterizing concepts and models of substance structure and properties of matter and thermal processes.
- Explain the properties of the substance and thermal processes' dependence on atomic structure of matter.
- Use the laws of thermodynamics in description and analysis of thermal processes.
- Demonstrate planning skills and carry out studies on the structure and properties of the matter and thermal processes, and to analyze and explain physical problems in nature and technology.
- Analyze, summarize and evaluate the theoretical knowledge and experimental skills and be able to apply them in physical content studies.
- Analyse and evaluate the evolution of thermodynamic knowledge, applicability and importance of physics in science and technology.

Course content:

1. Introduction. Kinetic theory of gas.
2. Distribution laws of gas molecules.
3. Laws of thermodynamics.
4. Real gas.
5. Transfer processes in gases.
6. Solutions and liquids.
7. Solids.
8. Phase balance and phase transition.

Course plan:

Lectures – 32 KS., Practical assignments– 32 KS., Laboratory assignments -32 KS.

Topics of lectures

1. Molecular - kinetic theory of gas. History and development of learning about matter

structure. Characteristics of matter.

2. Ideal gas. Gas pressure. Dalton's law. The basic equation of gas molecular-kinetic theory (MKT). Temperature concept in physics. Ideal gas law (Mendeleev - Klapeiron equation). Isoprocesses.
3. Distribution laws of gas molecules. Gas in field of forces. Boltzmann distribution. Experimental determination of Avogadro constant. Explanation of Brownian motion.
4. Equal distribution principle of energy by degrees of freedom. Maxwell's molecular distribution by velocity. experimental determination of molecular distribution.
5. Laws of thermodynamics. Thermodynamic system. Internal energy of thermodinamic system. Heat and work concept in thermodynamics. The first law of thermodynamics. Classical gas calorific theory. Adiabatic process. Heat and environmental problems..
6. The second law of thermodynamics. Types of processes. Cyclical processes and heat machines. Carnot cycle. Otto cycle. Diesel cycle.
7. Entropy. Static character of the second law of thermodynamics. Carnot's theorem. Nernst's theorem.
8. Real gas. Interaction forces and potential energy of real gas molecules. Van der Waals equation, its analysis. Substances in critical condition. Van der Waals isotherms.
9. Internal energy of real gas. Joule - Thomson effect. Gas liquefaction. Low temperatures. Gas liquefaction methods.
10. Transfer processes in gas. General characteristics of the transfer process. Diffusion. Viscosity. Thermal conductivity.
11. Vacuum, techniques of obtaining vacuum. Pumps.
12. Solutions and liquids. Substances in liquid state, their properties and structure. Thermal expansion of liquid. Surface tension of liquid. Free energy of surface. Laplace's formula. Wetting and non-wetting. Capillarity. Solutions. Osmotic pressure.
13. Solids. Substances crystalline state. Single crystals and polycrystalline. Crystalline lattice types. Defects in crystals. Thermal expansion of crystals.
14. Heat capacity of crystal. Dulong–Petit law.
15. Phase equilibrium and phase transitions. Phase concept. Phase transitions of type 1 and type 2 . Clapeyron - Clausius equation. Liquid and vapor equilibrium. Equilibrium diagram of a substance.
16. Saturated and unsaturated vapor. Air humidity. Water features and its role in nature.

Practical assignments/ seminars. .

1. Characteristics of substances and particles - amount of substance, molecular weight, molar mass.
2. Kinetic theory of gas. Pressure. Temperature.
3. Seminar. Laws of gas.
4. Distribution laws of gas molecules. Bolzmann's distribution.
5. Distribution laws of gas molecules.Maxwell's distribution.

6 Cyclical processes.

7. Carnot cycle. Otto cycle. Diesel cycle.
8. Test. Use of laws of thermodynamics.
9. Real gas
10. Transfer processes.
11. Vacuum.
12. Liquids.
13. Solids. Thermal expansion.
14. Phase transition.
15. Phase transition.
16. Test.

Laboratory assignments.

1. Determination of universal gas constant.
2. Determination of gass pressure thermal coeficient.
3. Determination of molar heath capacity c_p/c_v by Clement-Desormes' method.
4. Determination of specific heat of metals, using the cooling method.
5. Determination of viscosity coefficient.

6. Determination of liquid surface tension coefficient.
7. Determination of liquid specific heat capacity.
8. Defence of laboratory work.

Requirements for awarding credit points:

Differentiated test: Practical work / seminars - 20%, 5 test and 3 control assignments - 30% independent and laboratory work, calculations and defense - 50%.
Examination: overwiev of two topics from the course. The exam can be taken if the differentiated test has been assessed positively.

Compulsory reading:

1. Grabovskis R. *Fizika.* - Rīga: Zvaigzne, 1983. - 644 lpp.
2. *Fizika*. A.Valtera redakcijā. - R.: Zvaigzne, 1992. - 643 lpp.
3. Kručāns J. *Molekulārfizika*.- R.: Zvaigzne, 1975.
4. Zaķis J. *Mācība par vielu*. – R.: Zvaigzne, 1990.
5. Cutnell J.D, Johnson K.W. *Physics (5-th*) – New Jork: JohnWiley& Sons, 2001.
6. Jones E., Childers R. *Contemporary College Physics*.-USA: McGraw-Hall, 1999.
7. Hobsom A. Physics. *Concepts and Connections*.- New Jersey: Prentice-Hall, 1999.
8. Матвеев А. *Молекулярная физика* . М.: Высшая школа, 1987.
9. Кикоин А., Кикоин И. *Курс Физики. Теплота и молекулярная физика*. Том 2. – М.: Наука, 1875.

Further reading:

1. Beizīters L. *Molekulārfizikas uzdevumi: analīze un atrisinājumi*.-R.: Zvaigzne ABC.
2. Jansone M., Kalnača A., Blūms J., Ķiploka A., Klemenoks I., Medvins A., Knite M. *Uzdevumu krājums vispārīgajā fizikā*.- Rīga: RTU, 2000.
3. Jansons L., Zambrāns A. u.c. *Fizikas praktikums*. – Rīga: Zvaigzne, 1979.
4. Kokina A. *Laboratory assignments molekulārajā fizikā*.- Daugavpils, DPI, 1974.
5. Krūmiņš J. u.c. *Uzdevumu krājums vispārīgajā fizika*. – Rīga: Zvaigzne, 1979.
6. Krūmiņš J., Ertele B. *Fizikas uzdevumu risināšanas metodika*. - R.: Zvaigzne, 1980.
7. Krūmiņš J. Ertele B., Zambrāna A. *Fizikas uzdevumu risināšanas metodika*. – Rīga: Zvaigzne, 1979.

Periodics and other sources of information

1. Magzine Enerģētika un automatizācija
2. Materials today

Study programs and their sections (A, B, C, D) which this course belongs to:

BSP “Physics”, section A