| F010 | **General Physics IV** | L | S | P | ECTS |
|---|---|---|---|---|---|
| | | 4 | 1 | 2 | 7 |

**Course objective.** Understanding the basic physical concepts and relations connected with the structure of matter, kinetic theory of gases, thermodynamics, structure of atom, nuclear reactions, standard model of particles. Get prepared for advanced courses that require knowledge in named fields.

**Prerequisites.** Competences acquired in General Physics I, General Physics II, Differential and integral calculus.

**Course content.**

1. Structure of matter; amount of substance, mol, Brown's motion. Diffusion. Molecular forces. States of matter.
2. Kinetic theory of gases. Ideal gas law. Maxwell-Boltzmann distribution. Temperature. Thermometrics. Changes between states of matter. Humidity of air. Phase change graph, triple point of water.
3. Calorimetrics; heat measurements, heat capacity. Calorimeters. Boling point, melting point, heat of transformation. Dalton's law.
4. Real gases, Van der Waals equation.
5. Thermodynamics; internal energy, work. First law of thermodynamics. Gay-Lussac-Joule experiment. Mayer's relation. Entalpy. Adiabatic process. Second law of thermodynamics, perpetuum mobile. Reversible and irreversible processes.
6. Statistical theory of heat. Entropy. Carnot cycle. Efficiency of a Carnot engine. Clausius-Clapeyron equation. Engines. Thermodynamic temperature scale. Refrigerators. Heating pump.
7. Heat transport. Spectrum of black body radiation. Kirchhoff's law of radiation. Planck law of black body radiation. Stefan law of radiation.
8. Structure of atoms. Schrödinger wave equation. Heisenberg principle of uncertainty. Quantum numbers. The Pauli exclusion principle. Periodic table.
9. Atomic nucleus. Radioactivity. Radioactive decay law. Nuclear reactions; nuclear fission, nuclear fusion. Accelerators, Roentgen's radiation. Interactions of radiation with matters.
10. Radiation dosimetry. Radiation protection.
11. Particle physics; quarks. The standard model of cosmology.

**LEARNING OUTCOMES**

| No. | LEARNING OUTCOMES |
|---|---|
| 1. | Define and describe terms in the field of thermodynamics. |
| 2. | Determine the relationship between temperature and mean kinetic energy of molecules in kinetic-molecular theory. |
| 3. | Derive the equation of state of an ideal gas and explain the generalization to real gases (Van der Wals equation). |
| 4. | Describe the means of heat transfer and the change of states of matter. |
| 5. | Evaluate the ratio of heat capacities at constant volume and constant pressure. |
| 6. | Apply the laws of thermodynamics. |

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| 7. | Define Helmholtz free energy, enthalpy and Gibbs free energy as thermodynamic potentials. |
| 8. | Comment on the notion of ultraviolet catastrophe. |
| 9. | Comment on Bohr's postulates and the quantum mechanical approach to the structur of atoms. |
| 10. | Describe the fundamental forces in nature; describe the structure of matter. |
| 11. | Describe the nature and types of nuclear reactions (fission and fusion) and decays (alpha, beta, gamma decay). |
| 12. | Explain the impact of radiation on organisms. |
| 13. | Define basic concepts in the field of cosmology and elementary particles. |
| 14. | Interpret a graphical representation of the physical quantities and their mutual dependence. |
| 15. | Describe and interpret demonstration experiments in the above areas. |
| 16. | Evaluate the results obtained by solving tasks. |

**RELATING THE LEARNING OUTCOMES, ORGANIZATION OF THE EDUCATIONAL PROCESS AND ASSESSMENT OF THE LEARNING OUTCOMES**

| TEACHING ACTIVITY | ECTS | LEARNING OUTCOME ** | STUDENT ACTIVITY* | EVALUATION METHOD | POINTS | |
|---|---|---|---|---|---|---|
| | | | | | min | max |
| Class attendance | 0.5 | 1-16 | Class attendance | Evidence list (handwritten signature of the student) | 5 | 10 |
| Colloqium (midterm exams) | 2 | 1-16 | Expressions of definitions and physical laws. Performs mathematical expressions for certain physical quantities. Describing demonstration experiments performed in class. Solving numerical problems. | Written midterms (3 exams per semester). | 15 | 30 |
| Seminars | 1 | 1-16 | The research on a given topic and writing text seminars. Drawing up a presentation and | Rating of the written seminar (up to 5 points), and oral presentation | 5 | 10 |

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| | | | an oral presentation of the seminar. | score (up to 5 points). | | |
| Homework | 0.5 | 1-16 | Solving numerical problems. | Checking and discussions on the following exercises or consultation. | 5 | 10 |
| Final exam | 3 | 1-16 | Numerical exercises as written and oral assessment test understanding of physical laws. | Written and oral examination. | 20 | 40 |
| TOTAL | 7 | | | | 50 | 100 |

**Teaching methods and knowledge assessment.** Lectures (60 hours) with the use of Power Point presentations, interactive simulation, the performance of demonstration experiments, addressing selected sample assignments, individual and group work, discussions and tests to check knowledge. Numerical exercises instructed by an assistant (30 hours) with the lead of the assistant. Within the auditory exercises students receive additional tasks for the exercise, which are solved alone for the homework. Checking solutions and discussion on the tutorials. Student presentations and discussions of specific topics at the seminar (15 hours). Students have the opportunity to take the numerical problems and theories through three exams (colloquium) per semester. If for each area in each colloquium achieve more than 60% of the points are exempt from the written and oral examination. Other students take a written and oral exam.

**Can the course be taught in English**: Yes

**Basic literature:**


1. Cindro, N., Fizika 1, Školska knjiga, Zagreb, 1991.
2. http://www.fizika.unios.hr/of4
3. Kulišić, P., Mehanika i toplina, Školska knjiga, Zagreb, 2005.
4. Kulišić, P., Lopac, V., Elektromagnetske pojave i struktura tvari, Školska knjiga, Zagreb, 1991.
5. Kulišić, P., Bistričić, L., Horvat, D. et al., Riješeni zadaci iz mehanike i topline, Školska knjiga, Zagreb, 2007.


**Recommended literature:**


1. Paić, M., Toplina, Termodinamika, Energija, Liber, Zagreb, 1993.
2. Halliday, D., Resnick, R., Walker, J., Fundamentals of physics, John Wiley & Sons, Hoboken, 2003.
3. Young, H., Freedman, R., University Physics, with modern physics Addison-Wesley Publ., New York, 2008.
4. Giambattista, A i suradnici, College physics, McGraw Hill, 2007.
5. E. Babić, R. Krsnik i M. Očko. Zbirka riješenih zadataka iz fizike. Školska knjiga, Zagreb 2004.
6. P. Kulišić, L.Bistričić, D. Horvat, Z. Narančić, T. Petrović i D. Pevec, Riješeni zadaci iz mehanike i topline, Školska knjiga, Zagreb, 2002.