COURSE DESCRIPTION CARD - SYLLABUS

Course name
Thermodynamics [S2ETI1>Termodyn]

Course

Field of study
Education in Technology and Informatics

Year/Semester
1/1

Area of study (specialization)
–

Profile of study
general academic

Level of study
second-cycle

Course offered in
polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
30

Laboratory classes
0

Other (e.g. online)
0

Tutorials
15

Projects/seminars
0

Number of credit points

3,00

Coordinators

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Lecturers

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Prerequisites

Basic knowledge of experimental physics and mathematical analysis. The ability to solve simple physical problems based on knowledge and the ability to obtain information from the indicated sources. Understanding the need to expand your competencies, and readiness to cooperate as part of the team.

Course objective

1. Providing students with thermodynamic issues related to phenomena occurring in the world around us, for example, related to warming, and increasing entropy of the world. Getting acquainted with the principle of operation and construction of instruments for measuring thermodynamic parameters and thermal machines 2. Developing students" skills in solving basic thermodynamic problems, measuring thermodynamic parameters, and analyzing the results 3. Shaping students" teamwork skills

Course-related learning outcomes

Knowledge:

1. can define the basic thermodynamic parameters, theoretically describe the state of the system and its changes, define the basic thermodynamic functions; explain the processes of reaching the state of thermodynamic equilibrium; transport processes, formulate the principles of thermodynamics, explain the principles of operation of thermal machines. has ordered knowledge of microworld objects for gas, liquid, and solid phases [k2_w01].
2. knows and understands the methods of measuring thermodynamic quantities, can calculate the efficiency of thermal machines, estimate the heat flow and work performed in thermodynamic processes [k2_w06].

Skills:
1. can obtain information from the literature and apply it to solve thermodynamic problems. can use mathematics for simple problems of heat transport, work in processes, estimate the efficiency of selected thermal machines, can describe thermodynamic changes. can demonstrate the advantages of heat engines and heat pumps by determining the efficiency; entropy [k2_u04].
2. can identify the physical and technical problems related to heat transport and work in systems [k2_u09].
3. can select standard measuring devices for a specific task [k_u13].

Social competences:
1. can work on a designated task independently and cooperate in a team, assuming various roles in it; shows responsibility in this work. is aware and understands the importance of non-technical aspects and effects of engineering activities, including their impact on the environment [k2_k02].
2. understands the need and knows the possibilities of continuous training (first and second-degree studies, postgraduate studies), improving professional, personal, and social competencies [k2_k07].

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Learning outcomes presented above are verified as follows:
final written examination/oral examination at the end of the semester

Programme content

1. Hydrostatics - Hydrostatic pressure, Barometers, Manometers, Pascal"s law, Hydraulic press, Buoyancy and Floatage, Phenomena at Liquid Surfaces.
2. Fluid Dynamics - Euler Equation, Continuity Equation, Bernoulli Equation, Applications of the Bernoulli equation and the continuity equation, Viscosity and laminar flow, Poiseuille"s Law, Turbulence measurement, The Aerodynamical Buoyancy.
3. Thermodynamic system, thermodynamic process, Thermodynamic parameters and functions, The process of achieving thermodynamic equilibrium - 0 law of thermodynamics, Thermodynamic parameters: pressure, volume, temperature, system composition, Temperature measurement, Thermometer equation, thermometer accuracy. Scaling the thermometer. Absolute temperature scale. Gas thermometer. Liquid thermometer. Thermocouple and thermocouple. Resistance thermometer.
4.Thermal Expansion, Internal energy and Heat, Heat and work equivalence, Joule"s experiment, First law of thermodynamics, Phase Transformations, Phase diagrams, The heat of transformation, Heat balance.
5.Heat transfer mechanisms: conductivity, convection and radiation.
6. Thermal radiation and photons, Black body radiation, Planck"s formula, Wien"s law, Stefan-Boltzmann law, Thermovision, The body"s emission and absorption capacity, The use of the thermal energy of the sun.
7. Ideal ga - macroscopic considerations, Gas laws, Charles"s law, Gay-Lussac"s law, Boyle-Mariotte law, Ideal gas equation of state.
8. Assumptions of the kinetic-molecular theory, real gas equation of state, Van der Waals gas equation of state, RMS speed, Kinematic interpretation of pressure. Kinematic interpretation of temperature. The principle of energy equipartition. Maxwell-Boltzmann gas-particle velocity distribution. Thermodynamic definition of temperature.
9. Free path of gas molecules, Brownian motion, fluctuations, J. Perrin"s experiments with suspension, Mean free path length, Dalton"s law, Saturated steam pressure
10. The specific heat of an ideal gas, Thermal capacity. Cp, Cv of gases, the heat capacity of solids. Molar heat of solids, Dulong-Petit rule, Derivation of the Poisson equation, Polytrope equation.

11. Spontaneous, forced, and reversible processes, Entropy - macroscopic definition; transfer and generated entropy, Entropy - microscopic definition.
12. Carnot cycle; efficiency. Entropy in change. Steam engine, Otto, Diesel, Stirling, cyclic jet engine.
13. Second and third law of thermodynamics, Refrigerator and heat pump.
14. Definition of probability, types of events, product and sum of events, law of large numbers. Canonical and microcanonical distribution. Ideal gas equation based on statistical physics. Statistical definition of entropy. Thermodynamic definition of entropy and its relation to the phenomenological concept.

Teaching methods

Lecture supported by audiovisual means
Tutorial: solving of the mechanical problems on the blackboard, discussion

Bibliography

Basic
1. D.Halliday, R.Resnick, J.Walker, Fundamentals of Physics, 5th ed. John Wiley & Sons, 1999
2. W. Demtroeder, Mechanics and Thermodynamics , Springer International Publishing Switzerland 2017
3. https://openstax.org/details/books/fizyka-dla-szkół-wyższych-tom-2
4. W. Pudlik, Termodynamika, Wydawnictwo Politechniki Gdańskiej, Gdańsk 2021
5. M. Kamińska, A. Witkowski, J. Ginter, Wstęp do termodynamiki fenomenologicznej, Wydawnictwo Uniwersytetu Warszawskiego, Warszawa, 2005
Additional
1. K. Zalewski, Wykłady z termodynamiki fenomenologicznej i statystycznej, PWN, Warszawa, 1973
2. Danielewicz-Ferchmin, A.R. Ferchmin, Ciepło tom I i II, I. Wydawnictwo Naukowe UAM, Poznań, 2000
3. Fundamentalsof Physics Extended, vol 2, John Wiley & Sons 2014

Breakdown of average student's workload

	Hours	ECTS
Total workload	68	3,00
Classes requiring direct contact with the teacher	53	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	15	1,00