COURSE DESCRIPTION CARD - SYLLABUS

Course name

Technical Thermodynamics

Course

Field of study	Year/Semester
Technical Physics	2/3
Area of study (specialization)	Profile of study
	general academic
Level of study	Course offered in
First-cycle studies	polish
Form of study	Requirements
full-time	compulsory

Number of hours

Lecture	Laboratory classes	Other (e.g. online)
30		
Tutorials	Projects/seminars	
15		

Number of credit points

3

Lecturers

Responsible for the course/lecturer:	Responsible for the course/lecturer:
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Prerequisites

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

Course objective

1. Provide students with knowledge of thermodynamics concerning the phenomena occurring in the world around us, familiarization with the principle of operation and construction of measuring instruments and thermal machines.

2. Developing students' skills in solving basic thermodynamic problems and selecting the optimal measuring instruments for determining thermodynamic parameters and better assessing thermodynamic properties of systems.

3. Shaping students' teamwork skills.

Course-related learning outcomes

Knowledge

As a result of the conducted classes, the student:

1. Can define basic thermodynamic parameters, theoretically describe the state of the system and its transformations, define basic thermodynamic functions; explain the processes of reaching the state of thermodynamic equilibrium; transport processes, formulate the rules of thermodynamics, explain the principles of operation of thermal machines - [K1_W03].

2. Knows and understands the methods of measuring thermodynamic quantities, is able to calculate the efficiency of thermal machines, estimate the heat flow and work performed in thermodynamic processes - [K1_W09].

3. Has ordered knowledge of microworld objects for gas, liquid and solid phases - [K1_W11].

Skills

As a result of the course, the student should demonstrate skills in the following areas (the student will be able to):

1. Can obtain information from the literature and apply to solve thermodynamic problems - [K1_U02].

2. Is able to identify a physical and technical problem related to heat transport and work in systems - [K1_U14].

3. Can select standard measuring devices for a specific task - [K1_U14].

4. Can use mathematics for simple problems of heat transport, work in processes, estimate the efficiency of selected heat machines, can describe thermodynamic changes. Can demonstrate the advantages of heat engines and heat pumps by determining the efficiency, entropy - [K1_U01, K1_U14].

Social competences

As a result of the course, the student will acquire the competences listed below. Completing the course means that:

1. Can work on a designated task independently and work in a team, assuming different roles in it; shows responsibility in this work - [K1_K01].

2. Understands the need and knows the possibilities of continuous training (first and second cycle studies, postgraduate studies)? improving professional, personal and social competences - [K1_K03].

3. Is aware and understands the importance of non-technical aspects and effects of engineering activities, including its impact on the environment - [K1_K06].

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

eEffect	Form of evaluation	Evaluation criteria
W03, W09, W11	Assessment of individual oral presentation	50.1% -70.0% (3)
	with the use of a computer program	70.1% -90.0% (4)
	and assessment of responses to presentation questions	from 90.1% (5)
U01, U02, U14	Assessment of individual oral presentation	50.1% -70.0% (3)
	with the use of a computer program	70.1% -90.0% (4)
	and assessment of responses to presentation questions	from 90.1% (5)
K01, K03, K06	Assessment of individual oral presentation	50.1% -70.0% (3)
	with the use of a computer program	70.1% -90.0% (4)
	and assessment of responses to presentation questions	from 90.1% (5)

Programme content

Thermodynamic parameters and functions. Spontaneous, forced and reversible processes. The process of achieving thermodynamic equilibrium. Thermodynamic parameters: pressure, volume, temperature, system composition. Heat conductivity. Barometric formula. Barometers, manometers. 0 law of thermodynamics. Thermometer equation, thermometer accuracy. Scaling the thermometer. Absolute temperature scale. Gas thermometer. Liquid thermometer. Thermocouple and thermocouple. Resistance thermometer PT100. Calorimetry. Thermal capacity. Cp, Cv of gases, heat capacity of solids. Molar heat of solids, Dulong-Petit rule, Einstein and Debye models. Ideal gas equation of state. Gas transformations, volumetric work in transformations. Polytrope equation. Ideal and real gas equation of state. Heat and work, Joul's equivalent. Internal energy of gas. Internal energy (components of internal energy - classical and quantum description). First, second, third law of thermodynamics. Entropy; transfer and generated entropy. Thermal machines. Carnot cycle; efficiency. Entropy in change. Steam engine, Otto, Diesel, Stirling, cyclic jet engine. Refrigerator and heat pump. Transport phenomena (stationary states); diffusion, thermal conductivity, viscosity. Assumptions of the kinetic-molecular theory. Brownian motion, fluctuations. J. Perrin's experiments with suspension (evidence of the existence of atoms). Average Clearance. Time dependence of the mean free path (according to A. Einstein). Kinematic interpretation of pressure. Kinematic interpretation of temperature. The principle of energy equipartition. Maxwell-Boltzmann gas particle velocity distribution. Thermodynamic definition of temperature. 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

Exercises: problem solving, practical exercises, discussion

Bibliography

Basic

1. D. Halliday, R. Resnick, J. Walker, Podstawy Fizyki tom 2, PWN, Warszawa, 2011

2. M. Kamińska, A. Witkowski, J. Ginter, Wstęp do termodynamiki fenomenologicznej, Wydawnictwo Uniwersytetu Warszawskiego, Warszawa, 2005

3. K. Zalewski, Wykłady z termodynamiki fenomenologicznej i statystycznej, PWN, Warszawa, 1973

Additional

1. Danielewicz-Ferchmin, A.R. Ferchmin, Ciepło tom I i II, I. Wydawnictwo Naukowe UAM, Poznań, 2000

2. R. Hołyst, Ciach, Termodynamika dla chemików, fizyków i inżynierów, Wydawnictwo UKSW, Warszawa, 2005

3. A. Zagórski, Fizyka statystyczna, Oficyna Wydawnicza PW, Warszawa, 1994

Breakdown of average student's workload

	Hours	ECTS
Total workload	87	3
Classes requiring direct contact with the teacher	57	2
Student's own work (literature studies, preparation for laboratory classes/tutorials, preparation for tests/exam, project preparation) [1]	30	1

[1] delete or add other activities as appropriate