COURSE DESCRIPTION CARD - SYLLABUS

Course name
Technical Thermodynamics [S1FT2>TT]

Course

Field of study
Technical Physics

Year/Semester
2/3

Area of study (specialization)
–

Profile of study
general academic

Level of study
first-cycle

Course offered in
Polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
30

Laboratory classes
0

Other
0

Tutorials
15

Projects/seminars
0

Number of credit points

4,00

Coordinators

dr hab. Magdalena Elantkowska prof. PP
magdalena.elantkowska@put.poznan.pl

Lecturers

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 knowledge, and 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, and 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, 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
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
3. Has ordered knowledge of microworld objects for gas, liquid, and solid phases

Skills:
As a result of the course, the student should demonstrate skills in the following areas (student will be able to):
1. Can obtain information from the literature and apply it to solve thermodynamic problems
2. Can identify a physical and technical problem related to heat transport and work in systems
3. Can select standard measuring devices for a specific task
4. Can use mathematics for simple problems of heat transfer, 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, and entropy

Social competences:
As a result of the course, 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
2. Understands the need and knows the possibilities of continuous training (first and second cycle studies, postgraduate studies)? improving professional, personal and social competences
3. Is aware and understands the importance of non-technical aspects and effects of engineering activities, including its impact on the environment

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

The lecture first discusses issues in the field of fluid statics and dynamics, then introduces thermodynamic concepts, introduces subsequent laws of thermodynamics starting from zero and ending with the third, transfer mechanisms, phase transformations, kinetic theory of gases, reversible and irreversible transformations, macroscopic and statistical definition of entropy and discusses heat engines, ending with a nuclear power plant.

Course topics

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, Firstlaw 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. Ideal gas equation based on statistical physics. Statistical definition of entropy. Thermodynamic definition of entropy and its relation to the phenomenological concept.
15. Basics of operation of a nuclear power plant.
16. Thermodynamic potentials.

Teaching methods

Lecture supported by audiovisual means
Exercises: problem solving, practical exercises, 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	100	4,00
Classes requiring direct contact with the teacher	47	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	53	2,00