POZNAN UNIVERSITY OF TECHNOLOGY

EUROPEAN CREDIT TRANSFER AND ACCUMULATION SYSTEM (ECTS)

COURSE DESCRIPTION CARD - SYLLABUS

Course name
Applied thermodynamics [N1Energ2>TT1]

Course

Field of study
Power Engineering

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
part-time

Requirements
compulsory

Number of hours

Lecture
20

Laboratory classes
0

Other
0

Tutorials
10

Projects/seminars
0

Number of credit points

3,00

Coordinators

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Lecturers

Prerequisites

Student should have basic knowledge in mathematics (integration, differentiation) and in physics. Should be able to obtain information from the library and internet, should be ready to cooperate in a team.

Course objective

The purpose of the course is to acquaint the student with the basic laws of thermodynamics and with their practical application in energetics. The purpose of the subject is also to draw attention to the issue of ecology.

Course-related learning outcomes

Knowledge:
1. Student has advanced, established and in-depth knowledge of thermodynamics necessary to describe and analyze the operation of energy elements and systems, as well as the physical and chemical processes involved in the generation, storage and supply of energy.
2. Student has theoretically underpinned knowledge covering thermodynamics, including the knowledge necessary to understand complex methods and technologies for energy generation, storage and delivery, including in networks dominated by unstable sources.

3. Student knows and understands to an advanced degree the phenomena associated with the combustion and gasification of fuels, the chemical analysis of processes occurring in the power industry, and the impact of the parameters of energy carriers and operating factors on the efficiency of the process of energy generation, storage and delivery.

Skills:
1. Student is able to obtain information from the literature, databases and other sources and integrate the information obtained, interpret, evaluate, critically analyze and synthesize it in order to draw appropriate conclusions and formulate and issue opinions determining the conditions and technologies for the installation of power equipment and installations.
2. Student can work individually and as part of a team to develop measures to reduce the risk of emergencies related to the energy supply process, can develop emergency plans related to the possibility of danger to people, property and the environment, can develop and implement a schedule of work to ensure that deadlines are met.

Social competences:
1. Student is aware of the critical evaluation of his knowledge, recognizes its importance in solving cognitive and practical problems, as well as in decision-making in processes related to energy generation, storage and supply, both under normal working conditions and under changing circumstances and time pressure.
2. Student is aware of the need to initiate changes both in the work environment and for the public interest, related to the implementation of new technologies and technical and organizational solutions in the energy industry.
3. Student is aware of the responsibility for his own work and willingness to submit to the rules of teamwork and take responsibility for his professional role in jointly carried out activities for the improvement of safety and quality of work, improving the quality of manufactured products and services and tasks performed in the processes related to energy.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lecture: Knowledge acquired during the lecture is verified by a 80-minute exam. For a passing grade it is necessary to obtain 50% of the points from the exam.
Tutorials: the knowledge and skills acquired in the exercises are verified by an 80-minute colloquium. The colloquium consists of two or three problems. A score of 50% is required for a passing grade.

Programme content

Key concepts related to thermodynamics, such as thermodynamic system, state parameters, thermodynamic equilibrium, and the laws of thermodynamics, including the zeroth and first laws. Basic thermodynamic processes, heat cycles, heat transfer methods, and energy balance in closed and open systems, including the Carnot, Otto, Diesel, and Brayton cycles.

Course topics

Lecture: The most important definitions of thermodynamics (thermodynamic system, system state, state parameters, thermodynamic equilibrium, thermodynamic factor). The zero principle of thermodynamics. Physical parameters used in thermodynamics and their units. Relationships between state parameters. Equation of the state of a perfect gas. Mixtures of perfect gases. Analysis of basic thermodynamic transformations: isobar, isochore, isotherm, isentrope, and polytrope. Transformations in p-v, T-s, and h-s diagrams. Definition of useful work, technical work, change in internal energy, and enthalpy. First and second principles of thermodynamics. Energy balances for closed and open systems. Efficiency of the compression and expansion processes. Right- and left-handed circuits. Analysis of Carnot, Sabathe, Otto, Diesel, Brayton, and Joule circuits. Thermal efficiency of the circuit. Work of circulation. Basic modes of heat flow (conduction, convection, radiation). Fourier's, Newton's and Stefan-Boltzman's laws. Heat transfer through partitions. Heat flow in a cocurrent and countercurrent heat exchanger.
Tutorials: solving simple practical problems of the first principle of thermodynamics and thermodynamic transformations. Calculation of simple model circuits. Calculation of tasks in energy balances for thermodynamic systems. Solving tasks on heat flow through monolayer and multilayer walls.

Teaching methods

Lecture: multimedia presentation, examples and derivations of formulas presented on the board.
Tutorials: the problems are solved on the board.

Bibliography

Basic:
1. Pudlik, W., Termodynamika, Wydawnictwo Politechniki Gdańskiej, Gdańsk 2020
2. Wiśniewski, S., Wiśniewski, T., Wymiana ciepła, WNT, 2002.
3. Szargut, J. Termodynamika, PWN, Warszawa, 2000.
4. Walczak, J., Grzelczak., M., Termodynamika techniczna, Wydawnictwo PP, Poznań 2013.
5. Szargut, J., Guzik, A., Górniak, H., Zadania z termodynamiki Technicznej, Wyd. Politechniki Ślaskiej, Gliwice, 2011.
6. Sadłowska-Sałęga, A., Materiały pomocnicze do ćwiczeń z przedmiotu: Termodynamika techniczna.

Additional:
1.Cengel, Y., Boles, M.A., Thermodynamics, an engineering approach, Mc Graw Hill, 2008.
2. Incropera, F., DeWitt, D., Fundamentals of heat and mass transfer, Wiley, 2008.
3. Ghiaasiaan, M., Convective heat and mass transfer, Cambridge University Press, 2014.
4. Joachimiak M., Joachimiak D., Stabilization of boundary conditions obtained from the solution of the inverse problem during the cooling process in a furnace for thermochemical treatment, International Journal of Heat and Mass Transfer, 2024, vol. 224, pp. 1-12

Breakdown of average student's workload

	Hours	ECTS
Total workload	80	3,00
Classes requiring direct contact with the teacher	30	1,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	50	2,00