GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Thermodynamics, PG_00036982		
Field of study	Nanotechnology		
Date of commencement of studies	October 2024	Academic year of realisation of subject	2024/2025
Education level	second-cycle studies	Subject group	Specialty subject group Subject group related to scientific research in the field of study
Mode of study	Full-time studies	Mode of delivery	at the university
Year of study	1	Language of instruction	English
Semester of study	1	ECTS credits	3.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Department of Solid State Physics -> Faculty of Applied Physics and Mathematics		
Name and surname of lecturer (lecturers)	Subject supervisor	prof. dr hab. inż. Jarosław Rybicki	
	Teachers	prof. dr hab. inż. Jarosław Rybicki	

Lesson types and methods of instruction

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	30.0	15.0	0.0	0.0	0.0	45
E-learning hours included: 0.0						

Learning activity and number of study hours

Learning activity	Participation in didactic classes included in study plan	Participation in consultation hours	Self-study	SUM
Number of study hours	45	5.0	25.0	75

Subject objectives

The purpose of the subject is to familiarize students with the basics of phenomenological thermodynamics, in particular with 0-th, 1-st and 2-nd principle of thermodynamics. The principles will be illustrated with many various examples of applications.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_U06] can plan and conduct theoretical and numerical calculations, simulations of phenomena and processes, critically analyze their results, draw conclusions and formulate reasoned conclusions – within their specialization.	Ability to solve calculation problems and analyze thermodynamic processes	[SU3] Assessment of ability to use knowledge gained from the subject [SU2] Assessment of ability to analyse information
[K7_W04] has practical and theoretical knowledge of physical and chemical experimental methods of nanotechnology.	The course curriculum includes thermodynamics of magnetic and dielectric materials.	[SW1] Assessment of factual knowledge

Subject contents

LECTURE: Basic concepts. The 0-th law of thermodynamics. The first law of thermodynamics as the energy conservation principle. The second law of thermodynamics. Entropy. Thermodynamical potentials.Thermodynamics of photon gas, magnets, superconductors and dielectrics. Basic thermodynamics of chemical systems. Chemical potential. Mass action law. Gibbs phase rule.

EXERCISES: Properties of ideal, semi-ideal and real gases. Gas laws. Thermal and caloric equation of state. Thermodynamic processes of ideal gas. Thermodynamics gas cycles. Entropy. Equilibrium conditions. Thermodynamical potentials and their properties. Examples of applications of thermodynamics in materials science.

Prerequisites and co-requisites

Basic knowledge from course of physics and mathematics.

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Written test in problem solution	51.0%	50.0%
Written exam in theory	51.0%	50.0%

Recommended reading

Basic literature	1. K. Gumiński, Termodynamik, PWN 1982

	Supplementary literature	1. Mayhew R., Engineering thermodynamics/Work & Heat Transfer. J. Wiley & Sons Inc. 1993. USA.
	eResources addresses	Adresy na platformie eNauczanie:

Example issues/ example questions/ tasks being completed	Define the concepts of the thermodynamic system, thermodynamic phase, uniform and non-uniform phase. Define and discuss the concept of thermodynamic equilibrium. Define the concepts of the adiabatic boundary and diathermic boundary. Formulate the so-called zero principle of thermodynamics. Define the empirical temperature. Discuss in detail the concept of quasi-equilibrium processes. Explain their importance in thermodynamics. Formulate and discuss the postulate of existence of internal energy. Formulate the first principle of thermodynamics. Discuss the concepts of elementary work and heat. What is the relation of these values with infinitesimal changes in internal energy? Pay attention to the mathematical nature of the discussed small increments. Give the Plancks classic counterexample proving that constant heat Q_{el} is not a total differential. Define the concept of enthalpy. Formulate the first principle of thermodynamics with the help of enthalpy. Discuss the direct conclusions arising from the first principle of thermodynamics applied to isochoric processes in single-phase systems. Formulate and derive Hesss and Kirchhoff's laws for isochoric processes. Discuss the direct conclusions arising from the first principle of thermodynamics applied to isobaric processes in single-phase systems. Formulate and derive Hesss and Kirchhoff's laws for isobaric processes. Discuss the concept of specific heat at constant volume and at constant pressure. Derive the general relation between them and give its physical sense. Apply the obtained results to ideal gas. Discuss the equation of state for an ideal gas. What is the gas constant? What does its numerical value physically correspond to? Quote Carathéodory's theorem and explain its fundamental importance for the mathematical formalism of phenomenological thermodynamics. Formulate the postulate of existence of entropy and the integrating factor for DQ. What is the physical meaning of the integrating factor? Demonstrate that the entropy of nature does not change in reversible transformation. Demonstrate that the entropy of nature increases in irreversible transformation. Discuss the direct conclusions arising from the second principle of thermodynamics applied to isothermal processes (6 conclusions in total). Discuss the direct conclusions arising from the second principle of thermodynamics applied to isothermal-isochoric processes. Discuss the direct conclusions arising from the second principle of thermodynamics applied to isothermal-isobaric processes.

	Discuss the direct conclusions arising from the second principle of thermodynamics applied to isentropic and isentropic-isobaric processes. Discuss the conditions of thermodynamic equilibrium in light of the second principle of thermodynamics and define the thermodynamic potentials. Discuss the relation between the thermodynamic potentials U (V,S), H (S,p), F (V,T), G (p,T). Assuming that free enthalpy is known as a function of T and p, calculate S and V and also F, H and U. Assuming that free energy is known as a function of T and V, calculate S and p and also G, U and H. Define thermodynamic functions for chemical systems. Characterize the intensive and extensive qualities in general. Introduce the concept of chemical potential. Define the concept of chemical activity and Lewiss activity coefficients. Define the concepts of ideal, perfect ideal and non-ideal phases. Give examples. Discuss the three basic properties of perfect gas mixtures (Dalton's, Joule's and Plancks laws). Formulate, derive and discuss the Gibbs phase rule. Formulate a general law of equilibrium shifts in thermodynamic systems.
Work placement	Not applicable