GDAŃSK UNIVERSITY
OF TECHNOLOGY

Subject card

Subject name and code	Thermodynamics and statistical physics, PG_00064050		
Field of study	Technical Physics		
Date of commencement of studies	October 2025	Academic year of realisation of subject	2027/2028
Education level	first-cycle studies	Subject group	Optional 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	3	Language of instruction	Polish Polish
Semester of study	6	ECTS credits	5.0
Learning profile	general academic profile	Assessment form	exam
Conducting unit	Department of Atomic Physics and Luminescence -> Faculty of Applied Physics and Mathematics -> Faculties of Gdańsk University of Technology		
Name and surname of lecturer (lecturers)	Subject supervisor	dr Piotr Weber	
	Teachers		

Lesson types

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	30.0	30.0	0.0	0.0	0.0	60

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	60	5.0	60.0	125

Subject objectives

To familiarize students with the basics of classical and quantum statistical physics. To familiarize students with the derivation of the principles of phenomenological thermodynamics from the formalism of statistical physics. To familiarize students with the elements of the theory of stochastic processes

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K6_W02] has systematized knowledge of the basics of physics, including mechanics, thermodynamics, electricity and magnetism, optics, atomic and particle physics, solid-state physics, nuclear and elementary particle physics	The student correctly uses the terminology used in statistical physics. The student has knowledge of the various possible approaches to describing a system in statistical physics.	[SW1] Assessment of factual knowledge [SW2] Assessment of knowledge contained in presentation
[K6_U02] analyzes and solves simple scientific and technical problems, based on possessed knowledge, using analytical, numerical, simulation and experimental methods	The student is able to solve tasks and problems in the field of statistical physics and phenomenological thermodynamics.	[SU1] Assessment of task fulfilment [SU4] Assessment of ability to use methods and tools

Subject contents

Course content – lecture

The lecture consists of several thematic parts. The first part discusses the characteristics of macroscopic systems
in terms of equilibrium phenomenological thermodynamics (for systems with fixed or variable number of particles).
As part of this issue, the axioms of equilibrium phenomenological thermodynamics (principles of thermodynamics),
Maxwell's relations and the concept of chemical potential.are presented, In the next part, the basic concepts of probability theory are reminded. The third part concerns the concept of state: in classical mechanics, quantum mechanics and statistical physics. In this part the student learns the concept of statistical state in the classical approach
(for continuous and discrete systems) and quantum (the concept of density matrix is described). The methods of describing the evolution of statistical states are discussed (master equation for discrete systems, Chapman-Kolmogorov equation, master equation for continuous systems, Fokker-Planck equation, von Neumann equation). In the next part, the concept of entropy and its connections with information theory is presented. The next three parts present respectively: a micromanical ensemble, a canonical ensemble and a great canonical ensemble. The next parts discuss practical applications of statistical physics. The following are discussed: real gases (van der Waals equation, virial equation, Maxwell-Boltzmann distribution), quantum gases (quantum statistics), phase transitions, noise and their characteristics (stochastic processes), generalized Langevine quation and the fluctuation-dissipation theorem.

Course content – exercises

During the exercises:
- problems are solved to consolidate the knowledge and skills acquired during the lecture.
- Some specific topics are presented in the form of short comments and sample problems.

Prerequisites and co-requisites

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Tutorials	50.0%	30.0%
Lecture	50.0%	70.0%

Recommended reading

Basic literature	L. E. Reichl, "A Modern Course in Statistical Physics" W. Greiner, L. Neise, H. Stöcker, "Thermodynamics and Statistical Mechanics" F. Schwabl, "Statistical mechanics"
Supplementary literature	B. Ch. Eu, M. Al.-Ghoul "Chemical thermodynamics" P. Atkins, J de Paula, J. Keeler, "Physical chemistry"
eResources addresses	

Example issues/ example questions/ tasks being completed

- Explain the concept of a state function.
- State functions and the natural direction of physicochemical processes.
- Explain the concept of a statistical state.
- Describe how the concept of the density operator appears in statistical quantum mechanics.
- What does it mean for a stochastic process to be a Markov process?
- Derivate the Gibbs phase rule.
- Find a representative distribution for a macrostate generated by the mean value of a physical quantity.
- Present the reasoning leading to the master equation for a continuous random variable, assuming that it is a Markov process.

Practical activites within the subject

Not applicable

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