



Subject card

Subject name and code	Thermodynamics and statistical physics, PG_00037279						
Field of study	Technical Physics						
Date of commencement of studies	October 2023		Academic year of realisation of subject		2025/2026		
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		4.0		
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		dr Piotr Weber				
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		35.0	100
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 different possible approaches to the description of a system within statistical physics.		[SW1] Assessment of factual knowledge [SW2] Assessment of knowledge contained in presentation		
	[K6_U02] Can analyze and solve 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 microcanonical 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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