GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Thermodynamics and statistical physics, PG_00037279		
Field of study	Technical Physics		
Date of commencement of studies	October 2022	Academic year of realisation of subject	2024/2025
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
Semester of study	6	ECTS credits	4.0
Learning profile	general academic profile	Assessment form	exam
Conducting unit	Institute of Physics and Applied Computer Science -> Faculty of Applied Physics and Mathematics		
Name and surname of lecturer (lecturers)	Subject supervisor	dr Piotr Weber	
	Teachers	dr Piotr Weber	

Lesson types and methods of instruction

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

The aim of the lecture is:

- familiarize students with the basics of classical and quantum statistical physics
- familiarize students with deductions explaining the properties of macroscopic bodies (thermodynamic properties) from the formalism of statistical physics
- familiarize students with the elements of the theory of stochastic process

Learning outcomes

Course outcome	Subject outcome	Method of verification
K6_W02	Student has an ordered knowledge of the fundamental laws of physics	[SW2] Assessment of knowledge contained in presentation [SW1] Assessment of factual knowledge
K6_U02	Student can analyze standard problems in the field of statistical physics.	[SU3] Assessment of ability to use knowledge gained from the subject [SU1] Assessment of task fulfilment

Subject contents

The lecture consists of several topics in statistical physics and thermodynamics. There are presented 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), Thermodynamic state functions are discussed. The lecture 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). Equations of 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). The concept of entropy and its connections with information theory is presented. The idea of a statistical ensemble is presented: a microcanonical ensemble, a canonical ensemble and a great canonical ensemble. The lecture includes discussions on practical applications of statistical physics for: real gases (van der Waals equation, virial equation, Maxwell-Boltzmann distribution), quantum gases (quantum statistics) and phase transitions. The lecture also presents elements of the theory of random processes, (stochastic processes), generalized Langevine quation and the fluctuation-dissipation theorem.

<table>
<tr><td>Prerequisites and co-requisites</td><td colspan="3"></td></tr>
<tr><td>Assessment methods and criteria</td><td colspan="3"><table>
<tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr>
<tr><td>Lecture</td><td>50.0%</td><td>70.0%</td></tr>
<tr><td>Tutorials</td><td>50.0%</td><td>30.0%</td></tr>
</table></td></tr>
<tr><td rowspan="3">Recommended reading</td><td>Basic literature</td><td colspan="2">L. E. Reichl, "A Modern Course in Statistical Physics"

W. Greiner, L. Neise, H. Stöcker, "Thermodynamics and Statistical Mechanics"

F. Schwabl, "Statistical mechanics"</td></tr>
<tr><td>Supplementary literature</td><td colspan="2">B. Ch. Eu, M. Al.-Ghoul "Chemical thermodynamics"

P. Atkins, J de Paula, J. Keeler, "Physical chemistry"</td></tr>
<tr><td>eResources addresses</td><td colspan="2">Adresy na platformie eNauczanie:
Termodynamika i fizyka statystyczna - 2025 - Moodle ID: 43835
https://enauczanie.pg.edu.pl/moodle/course/view.php?id=43835
Thermodynamics and statistical physics - 2025 - Moodle ID: 43836
https://enauczanie.pg.edu.pl/moodle/course/view.php?id=43836</td></tr>
<tr><td>Example issues/ example questions/ tasks being completed</td><td colspan="3">• Describe the concept of statistical state.
• Describe the concept of a statistical ensemble
• What formula describes the evolution of the statistical state in the phase space? Provide this formula and explain the symbols used there.
• Give the mathematical form of the probability density for the canonical ensemble in classical statistical physics. Describe what systems this statistical ensemble can be applied
• Describe the stages of the Carnot cycle.
• Entropy in spontaneous physicochemical processes.</td></tr>
<tr><td>Work placement</td><td colspan="3">Not applicable</td></tr>
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