GHENT UNIVERSITY

Course Specifications

Valid as from the academic year 2024-2025

Statistical Physics (E021521)

Course size *(nominal values; actual values may depend on programme)*

Credits 3.0 **Study time 90 h**

Course offerings in academic year 2025-2026

A (semester 2)	Dutch	Gent

Lecturers in academic year 2025-2026

Vanduyfhuys, Louis	TW17	lecturer-in-charge
Ghysels, An	TW06	co-lecturer
Mehdipour, Ahmadreza	TW17	co-lecturer

Offered in the following programmes in 2025-2026	**crdts**	**offering**
Bachelor of Science in Engineering(main subject Biomedical Engineering)	3	A

Teaching languages

Dutch

Keywords

Statistical thermodynamics, ensembles, partition function, Boltzmann distribution, Fermi-Dirac and Bose-Einstein distribution

Position of the course

This course teaches the foundations of statistical physics for systems in equilibrium in order to make the bridge from the microscopic structure of matter towards its macroscopic thermodynamic behavior. Special attention is given towards the introduction of partition functions and the ensemble theory of Gibbs. The Boltzmann partition function, the classical Maxwell-Boltzmann distribution and the quantum Fermi-Dirac and Bose-Einstein statistics are derived. The course focuses on the physics of systems with many degrees of freedom and deriving their thermodynamic properties. Various applications from the field of solid state physics, physical chemistry and atomic and molecular physics are covered.

Contents

- Revision of the laws of thermodynamics and their statistical interpretation
- Macro- and microstate, isolated systems in equilibrium, systems in a heat bath, boltzmann partition function
- Theory of ensembles: phase space, the classical and quantum mechanical partition function, the ensemble concept (microcanonical, canonical, grand canonical), Gibbs and Boltzmann definition of entropy
- Statistical description of paramagnetics: canonical and micro-canonical description
- Specific heat of solids: Einstein theory, Debye theory
- The classical ideal gas: classical ideal gas and its criterium of existence, State equations, separation of degrees of freedom, translational, rotational, vibrational partition function, heat capacity
- Ideal quantum gases: Grand canonical distribution, Fermi-Dirac and Bose-Einstein distributions, Applications: electron gas

Initial competences

This course builds upon certain final competences from Physics I and Physics II.

Final competences

1 Master and apply the basic concepts of statistical physics.
2 Understand the relation between the macroscopic and microscopic description of

matter.

3 Derive statistical quantities such as partition functions for simple and complex systems and apply them to determine macroscopically observable quantities.

4 Understand the various statistical distribution functions and apply them to systems with many degrees of freedom.

Conditions for credit contract

Access to this course unit via a credit contract is determined after successful competences assessment

Conditions for exam contract

This course unit cannot be taken via an exam contract

Teaching methods

Seminar, Lecture

Study material

Type: Syllabus

Name: Statistical Physics
Indicative price: € 7
Optional: yes
Language : Dutch
Number of Pages : 220
Available on Ufora : No
Online Available : No
Available in the Library : No
Available through Student Association : No
Additional information: The course material for the course Statistical Physics consists of a syllabus and slides. The slides will be uploaded to Ufora during the academic year and we offer the opportunity to buy the syllabus.

Type: Slides

Name: Slides Statistical Physics
Indicative price: Free or paid by faculty
Optional: no
Language : Dutch
Available on Ufora : Yes
Online Available : Yes
Available in the Library : No
Available through Student Association : No

References

- Baierlein R., Thermal Physics, Cambridge University Press 1999 - ISBN 0-521-59082-5
- Kittel C., Kroemer H., Thermal Physics, W.H. Freeman 1980 - ISBN 0-7167-1088-9
- Mandl F., Statistical Physics, The Manchester Physics Series, 2nd edition, Wiley 1988 - ISBN 0-471-91533-5 (paperback)

Course content-related study coaching

Lecturer and assistants are available before and after lectures or by appointment

Assessment moments

end-of-term assessment

Examination methods in case of periodic assessment during the first examination period

Written assessment

Examination methods in case of periodic assessment during the second examination period

Written assessment

Examination methods in case of permanent assessment

Possibilities of retake in case of permanent assessment

not applicable

Extra information on the examination methods

- Written theory exam, closed book
- Written exercise exam, closed book
- A formulary is provided during the exam.

Calculation of the examination mark