GHENT UNIVERSITY

Course Specifications

From the academic year 2017-2018 up to and including the

Statistical Physics 1 (C002461)

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

Credits	6.0	Study time	180 h	Contact hrs	52.5 h

Course offerings and teaching methods in academic year 2018-2019

A (semester 1)	Dutch	lecture	30.0 h
		seminar: coached exercises	22.5 h

Lecturers in academic year 2018-2019

Ryckebusch, Jan	WE05	lecturer-in-charge

Offered in the following programmes in 2018-2019	crdts	offering
Bachelor of Science in Physics and Astronomy	6	A
Master of Science in Mathematics	6	A
Preparatory Course Master of Science in Physics and Astronomy	6	A

Teaching languages

Dutch

Keywords

Statistical physics, physics of systems with many degrees-of-freedom

Position of the course

This course aims at providing a formal development of the techniques adopted in statistical physics. In a next step, these techniques are applied to outline the statistical physics of interacting - and non-interacting systems, of quantum-mechanical phenomena at extremely low temperatures and the theory of critical phenomena (phase transitions). A profound knowledge of statistiscal physics is a prerequisite for studying astrophysics, condensed-matter physics and subatomic physics. One of the major objectives of the course is establishing the link between statistical physics and numerical simulation techniques.

Contents

- First, second and third law of themodynamics
- The canonical system (fluctuations, paramagnets, negative temperatures, defects in solids, systems of coupled and uncoupled harmonic oscillators, ensemble theory, introduction to information theory)
- Classical systems (ideal gases, real gases, cluster expansions, theory of liquids, molecular-dynamics technique)
- Quantum statistics (relation between spin and statistics, ideal quantum gas, ideal photon gas, density matrix)
- The grand-canonical system and the Gibbs partition function (chemical potential, grand-canonical partition function)
- The ideal Fermi gas (equation of state, ideal Fermi gas, white dwarfs, Pauli paramagnetism)
- The ideal Bose gas (equation of state, superfluidity, Bose-Einstein condensation)
- Critical phenomena (Ising system, order parameters, mean-field theory, Landau-Ginzburg theory, computer simulations, correlation functions, universality, Monte-Carlo techniques)

Initial competences

The development of the theory of statistical physics relies on concepts of Newtonian mechanics and quantum mechanics. A good working knowledge of thermal physics (at the level of an introductory course in thermodynamics), analysis, and algebra is essential.

Final competences

1 Master the basic techniques adopted in statistical physics for describing the physics of systems consisting of many degrees of freedom.
2 Acquaint the student with modelling and simulation techniques, as a powerful tool to learn about systems with many degrees-of-freedom.
3 To acquire insight into the link between the microscopic and macroscopic world.

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

Lecture, seminar: coached exercises

Extra information on the teaching methods

Theory : lectures with frequent use of computer simulations.
Problem sessions : small groups. The students communicate their solutions to the group.

Learning materials and price

Course material is made avaialble through the electronic learning system of the university.

References

F. Mandl "Statistical Physics" (John Wiley & Sons, 1998)
Ralph Baierlain "Thermal Physics" (Cambridge University Press, 1999)
Kerson Huang "Statistical Mechanics" (John Wiley & Sons, 1987)
Franz Schwabl "Statistical Mechanics" (Springer, Berlin, 2002)

Course content-related study coaching

The lecturer offers the possibility to discuss the course material with small groups of students. The electronic learning-environment is employed to discuss the course material with the students and to draw their attention to recent advances in statistical physics.

Evaluation methods

end-of-term evaluation

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

Written examination with open questions, open book examination, oral examination

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

Written examination with open questions, open book examination, oral examination

Examination methods in case of permanent evaluation

Possibilities of retake in case of permanent evaluation

not applicable

Extra information on the examination methods

Theory : oral and written exam
Problems : written exam (use of the course material is allowed)

Calculation of the examination mark

- 40% for the oral exam
- 40% for the open-book part of the written exam
- 20% for the closed-book part of the written exam