Faculty of Science

FYSB12, Physics: Basic Statistical Physics and Quantum Statistics, 7.5 credits

Fysik: Grundläggande statistisk fysik och kvantstatistik, 7,5 högskolepoäng

First Cycle / Grundnivå

Details of approval

The syllabus was approved by Study programmes board, Faculty of Science on 2015-10-15 and was last revised on 2015-10-15. The revised syllabus applies from 2016-01-01, spring semester 2016.

General Information

The course is an elective component of the Bachelor's programmes in science, and a compulsory component of a Bachelor of Science degree in Physics and of the Master of Science programme in Medical Physics.

Language of instruction: English

Main field of studies	*Depth of study relative to the degree requirements*
Physics	G2F, First cycle, has at least 60 credits in first-cycle course/s as entry requirements

Learning outcomes

The objective is that the students, on completion of the course, shall have acquired knowledge and skills within basic statistical physics and quantum statistics.

The learning outcomes listed below relate to the general outcomes in the Higher Education Ordinance (1993:100).

Knowledge and understanding

On completion of the course, the students shall be able to

1. account for the laws of thermodynamics and explain their implications
2. account for the concepts of equilibrium, entropy and statistical weight

3. describe different processes, especially circuit processes, and applications such as motors, refrigerators, heat pumps etc.,

4. account for the equipartition principle and describe how quantum mechanics corrects its predictions of heat capacities

5. provide an outline the ultraviolet catastrophe

6. account for the mechanism behind the pressure in degenerate fermion gases and provide examples in an area of physics or astronomy where this is significant.

Competence and skills

On completion of the course, the students shall be able to

7. from a probability distribution perspective, determine various expectation values of individual statistical variables and the sum of several independent variables

8. deduce and use the Boltzmann factor

9. be acquainted with the partition function for simple systems and characterise equilibrium in terms of the partition function

10. determine a system's degrees of freedom and use this as a basis for calculating a classical physics prediction for its heat capacity

11. calculate the efficiency of simple circuit processes and determine if a process is reversible or not

12. work with state densities and average number density for ideal, sparse gases and ideal fermion and boson gases

13. conduct, interpret and describe in writing experiments using e.g. vacuum systems or circuit processes

14. orally describe a phenomenon that is relevant to the course using a popular science approach

Judgement and approach

On completion of the course, the students shall be able to

15. assess experimental results

16. assess the applicability and limitations of physical models

Course content

The course covers basic statistical physics and quantum statistics, with a focus on systems in equilibrium without phase transitions.

In particular:

- basic statistics for several, independent variables
- the ideal gas law
- state variables, entropy, free energy
- the Boltzmann factor, canonical and grand canonical ensemble
- circuit processes, the laws of thermodynamics
- heat capacities, equipartition principle, the ultraviolet catastrophe
- identical particles, degenerate quantum gases
- diffusion?
- applications in astronomy, meteorology or other relevant areas of physics

Course design

The teaching consists of laboratory sessions, lectures, calculation exercises and written assignments. Compulsory participation is required in laboratory sessions and associated elements.

Assessment

The assessment is based on:

- compulsory laboratory sessions – assessment of learning outcomes 13 and 15 in particular
- project on popular science communication – assessment of learning outcome 14 in particular
- compulsory written assignments during the course – assessment of all learning outcomes
- a written or oral exam at the end of the course – assessment of all learning outcomes.

Subcourses that are part of this course can be found in an appendix at the end of this document.

Grades

Marking scale: Fail, Pass, Pass with distinction.
For a grade of Pass on the whole course, the students must have passed the reports and presentations of compulsory components and the exam.

Entry requirements

To be admitted to the course, students must meet the general entry requirements and have physics knowledge equivalent to FYSA01 General Physics, 30 credits, and FYSB11 Basic Quantum Mechanics, 7.5 credits, as well as mathematics knowledge equivalent to 45 credits, including the courses NUMA01 Computational Programming with Python, 7.5 credits, MATB22 Linear Algebra 2, 7.5 credits, and MATB21 Multivariable Analysis 1, 7.5 credits, or the equivalent.

Subcourses in FYSB12, Physics: Basic Statistical Physics and Quantum Statistics

Applies from V16

1501 Exam, 5,5 hp
Grading scale: Fail, Pass, Pass with distinction
1502 Laboratory exercises and Projects, 2,0 hp
Grading scale: Fail, Pass