Faculty of Science

FYST58, Physics: Atomic and Molecular Spectroscopy, 7.5 credits

Fysik: Atom- och molekylspektroskopi, 7,5 högskolepoäng

Second Cycle / Avancerad nivå

Details of approval

The syllabus was approved by Study programmes board, Faculty of Science on 2021-12-12 and was last revised on 2025-10-21 by The Education Board of Faculty of Science. The revised syllabus comes into effect 2025-10-21 and is valid from the autumn semester 2026.

General information

The course is an elective second cycle component of a Bachelor or Master's degree (120 credits).

Language of instruction: English

Main field of study	*Specialisation*
Physics	A1N, Second cycle, has only first-cycle course/s as entry requirements

Learning outcomes

The course intends to provide theoretical and practical knowledge of the many powerful methods, as modern atom and molecular spectroscopy offer respect both basic studies and practical applications.

Knowledge and understanding

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

- account for spectroscopic methods in different energy intervals
- describe the most common components in spectroscopic equipment for different energy intervals with special emphasis on optical methods and in particular laser spectroscopic methods
- describe what can be measured using spectroscopic techniques

- describe a consolidated image of quantum mechanics and atomic physics and its relation to classical physics.

Competence and skills

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

- carry out some practical work with optical components and lasers
- find and extract information from scientific literature and the internet and carry out smaller investigations
- make concise written and oral presentations of smaller projects which they have carried out.

Judgement and approach

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

- assess magnitudes for many physical phenomena
- assess which spectroscopic method that would be applicable in a given situation
- describe how spectroscopy can be used as a powerful tool within science and technology.

Course content

The aim of the course is to provide knowledge in modern atom and molecular spectroscopy with special emphasis on practical applications. Overview of atomic and molecular structure implying a specialisation especially regarding molecules.

Radiation and scattering processes: resonant radiation, Rayleigh-, Raman- and Mie-scattering.

Optical spectroscopy: sources of light, optical and spectrally dispersive devices and components and detectors and optical analytical methods.

Lasers: different types of lasers, single mode operation, high power lasers and peripheral equipment.

Laser spectroscopy: time-resolved spectroscopy and high-resolution Doppler-free techniques, orientation in ultrafast spectroscopy and cooling and interception of atoms and ions.

Laser spectroscopic applications: remote sensing of air and water pollutions, combustion and reactions diagnostics and medical applications.

Demonstrations: laser diagnostics including remote sensing and combustion diagnostics.

Laboratory work: fourier transform spectroscopy and flame emission, applied laser spectroscopy on atmospheric gases and doppler-free saturation spectroscopy.

Course design

The teaching consists of lectures, laboratory sessions, research lab visits, group work including written and oral presentations. Participation in laboratory sessions and project presentations is compulsory.

Assessment

The assessment is based on a written exam at the end of the course and through compulsory components (laboratory work, lab reports and written and oral project presentations).

Students who do not pass the regular exam are offered a new possibility at a scheduled re-exam period.

The examiner, in consultation with Disability Support Services, may deviate from the regular form of examination in order to provide a permanently disabled student with a form of examination equivalent to that of a student without a disability.

Grades

Grading scale includes the grades: Fail, Pass, Pass with distinction
For a grade of Pass on the whole course, the student must have
passed the examination, laboratory reports, project presentation and participated in all compulsory components.

Grading scale for laboratory work, lab reports and project is Fail, Pass, while the grading scale for the exam is Fail, Pass, Pass with distinction.

The final grade is determined by the grade of the exam.

Entry requirements

To be admitted to the course, students must have 135 credits in natural science studies, including 90 credits in Physics and 45 credits Mathematics, alternatively a Bachelor's Degree in Physics or equivalent.

In either case this includes knowledge corresponding to FYSA13 Introduction to University Physics with Optics, Waves and Quantum Physics, 7.5 credits, FYSB22 Basic Quantum Mechanics, 7.5 credits, and minimum one of the courses FYSB24 Atomic and Molecular Physics, 7.5 credits or FYSC23 Solid State Physics, 7.5 credits.

English 6/B

Further information

The course cannot be included in a degree together with FYST14 Physics: Atomic and Molecular Spectroscopy, 7.5 credits.

The course is to be studied together with FAFN25, Atomic and Molecular Spectroscopy, 7.5 credits, which is coordinated by LTH.

The examination time is coordinated with the exam scheme of LTH.