

Course syllabus

Advanced Optics and Lasers Avancerade laser- och optiksystem

FAFN10, 7.5 credits, A (Second Cycle)

Valid for: 2025/26

Faculty: Faculty of Engineering LTH

Decided by: PLED N

Date of Decision: 2025-04-10

Effective: 2025-05-05

General Information

Main field: Photonics **Depth of study relative to the degree requirements:** Second cycle, in-depth level of the course cannot be classified

Mandatory for: MFOT1

Elective for: E4, F4, F4-f, F4-kv

Language of instruction: The course will be given in English

Aim

The course aims at providing knowledge about basic as well as advanced techniques for manipulating and controlling laser light and laser pulses. This involves controlling intensity, frequency distribution, temporal profiles in order to design advanced optical systems for specialised tasks in industry as well as research.

Learning outcomes

Knowledge and understanding

For a passing grade the student must

- be able to account for the principles of acousto-optic and electro-optic effects and their technical applications,
- be able to account for how optical components and optical systems modifies ultrashort laser pulses,
- be able to account for transverse coherence and longitudinal coherence and describe technical applications where

- coherence is used,
- be able to describe the basic principles of non-linear interactions between light and matter,
- be able to carry out theoretical calculations of the efficiency for non-linear processes,
- be able to account for the basics of laser safety.

Competences and skills

For a passing grade the student must

- be able to qualitatively and quantitatively analyse advanced optical systems based on acousto-optical, electro-optical and non-linear optical effects,
- be able to design optical systems based on acousto-optical, electro-optical and non-linear optical effects for specific tasks,
- be able to calculate pulse shapes of ultrashort laser pulses following propagation through optical components and optical systems,
- be able to calculate coherence properties based on the spectrum, the size and distance of the light source,
- be able to tackle and solve more extensive and complex theoretical problems,
- be able to search for and integrate knowledge from extensive English reading lists.

Judgement and approach

For a passing grade the student must

- be able to assess and find optical methods to develop new advanced technological applications, methods and systems based on polarization, non-linear, optics, acousto-optics, electro-optics, coherence and ultrashort pulses.

Contents

The course covers the following topics:

-
- Light propagation in anisotropic materials,
- Acousto-optical effects and modulators,
- Electro-optical effects and modulators,
- Non-linear interaction between light and matter,
- Ultrafast optics, propagation of short laser pulses in dispersive non-linear media,
- Basic laser safety.

The teaching consists of lectures, two laboratory sessions (non-linear optics, ultrafast optics (titanium-sapphire laser)) including preparatory laser safety, group work and a project in optical design by means of a modern ray tracing program. Participation in laboratory sessions, projects and related teaching is compulsory. Study visit showing current research information is offered.

Examination details

Grading scale: TH - (U, 3, 4, 5) - (Fail, Three, Four, Five)

Assessment: The examination is based on laboratory sessions and project work and their related reports during the course and on a written examination at the end of the course. Before the laboratory exercises, the student shall complete a course with a test in basic laser safety.

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.

Modules

Code: 0123. **Name:** Written Examination.

Credits: 5.0. **Grading scale:** TH - (U, 3, 4, 5). **Assessment:** Written exam.

Code: 0223. **Name:** Project.

Credits: 1.0. **Grading scale:** UG - (U, G). **Assessment:** Passed project.

Code: 0323. **Name:** Laboratory Works.

Credits: 1.0. **Grading scale:** UG - (U, G). **Assessment:** Passed laboratory works.

Code: 0423. **Name:** Laser Safety.

Credits: 0.5. **Grading scale:** UG - (U, G). **Assessment:** Passed laser safety module

Admission

Assumed prior knowledge: Basic Physics, Mathematics and Optics.

The number of participants is limited to: No

Reading list

- B. E. A. Saleh and M. C. Teich,.
- Fundamentals of Photonics.
- Wiley Series in Pure and Applied Optics, John Wiley & sons, inc. 1991, ISBN 0-471-83965-5.

Contact

Course coordinator: Anne-Lise Viotti, anne-lise.viotti@fysik.lth.se

Course coordinator: Jörgen Larsson, jorgen.larsson@fysik.lth.se

Examinator: Jörgen Larsson, jorgen.larsson@fysik.lth.se

Course homepage: <https://canvas.education.lu.se/courses/12019>

Further information

The course is part of a series of three courses (FAFF01, FAFN01 and FAFN10). This course (FAFN10) can be taken first but it is an advantage to have passed the course FAFF01 Optics and optical design first. It is mandatory to attend the first lecture in order to be admitted to the course.