Modern Optics, 6.0 credits

Modern optik, 6.0 hp

Third-cycle education course

6FIFM93

Department of Physics, Chemistry and Biology

Valid from: Second half-year 2024

Approved by **Approved**

Registration number

Entry requirements

Entry requirement for studies on third-cycle education courses:

- second-cycle degree,
- 240 credits in required courses, including at least 60 second-cycle credits, or
- acquisition of equivalent knowledge in some other manner

Specific entry requirements for this course:
Bachelor level mathematics and physics. It is in particular recommended to have a good knowledge in electromagnetics, wave physics and optics.

Specific information

This course is overlapping with the course *6FIFMA0 Thin Film Optics and Polarized Light* (3 credits). Only one of the courses can be included in your degree.

Learning outcomes

The aim of the course is to give in-depth knowledge of optics.
After successful examination the student should be able to ...

- reproduce, explain, analyze, and use physical concepts, relations, and methods related to wave optics.
- reproduce, explain, analyze, and use physical concepts, relations, and methods related to materials optics.
- reproduce, explain, analyze, and use physical concepts, relations, and methods related to polarization optics.
- reproduce, explain, analyze, and use physical concepts, relations, and methods related to ray optics and particle optics.

Contents

The course aims to provide in-depth knowledge of several of the fields of optics. The purpose is also to be a link between basic optics courses and the content covered in more specialized optics courses and to disseminate knowledge in optics to prepare for industrial applications and to understand on an overall level the results of ongoing international optics research. The ambition is to describe the path from theory to application and at the same time provide models, methodology and tools that are practically useful. The studies include mathematical models for analysis to provide physical / mathematical tools that are useful for developing and describing the optical systems, methods and components that exist in different environments in society and that need further development. Basic theory is anchored in physics to provide an understanding of the optics relevant to current research. The course connects to real-world problems through application examples to show that it is a short step between academic studies and the knowledge, and methods used in industrial development and research. Theories and models are tested in laboratory work and calculation steps to illustrate their usefulness and limitations.
The course consists of four parts (I-IV) with subheadings according to,

I. Wave optics: -Coherence theory, -Fourier optics, -Near field optics.
II. Material optics: -Optical response, -Dispersion models, -Inhomogeneous materials, -Layered structures.
III. Polarization optics: -Polarized light, -Polarizing components, -Polarization methods.
IV. Ray optics and particle optics: -Variation analysis, -Transformation optics, -Photon optics, -Electron and neutron optics

The lectures begin with brief repetitions of basic optics and then develop further into the more advanced concepts. The course also places great emphasis on the optical properties of materials and in many cases, the theory is supplemented with application examples.
In the course, many concepts are covered including:
Coherence, Doppler shift, Gaussian rays, Fourier optics, laser optics, fiber optics and optical waveguides, dispersion models, Kramers / Kronig relationships, polarizing materials, heterogeneous media, effective media concepts, Jones formalism, Stokes/Mueller formalism, spectrophotometry, polarimetry, ellipsometry, matrix formalism for optical systems, and ray-tracking methods. Guest lecturers are often invited to give more insights into the optical research front.

Educational methods

Preparation tasks covering the basic parts are available before lectures. The lectures are instead focused on more advanced parts of the subjects. An interaction with the class during the lectures is wanted. The knowledge is deepened and applied through special problem-solving sessions, laboratory work and group assignments. Continuous examination is used to encourage active participation during the course.

Examination

Hand-in Problems and/or Group Assignments
Laboratory Work
Written Examination
Optional assignments may give bonus points on the written exam. Dates for examination and re-examination are scheduled according to the corresponding master-level course (Modern Optics, TFYA97).

Grading

Two-grade scale

Course literature

Arwin, Hans, (2021) *Thin Film Optics and Polarized Light* Caeruleus edition (7e).
ISBN:
Hecht, Eugene, (2017) *Optics*. Fifth edition (5e), Pearson.
ISBN: 9781292096933, 1292096934.
Nordling, Carl, Österman, Jonny, (2020) *Physics handbook : for science and engineering*. Ninth edition (9e), Studentlitteratur Lund.
ISBN: 9789144128061

General information

The course is also given as a master-level course with the code TFYA97.
If the course is withdrawn or is subject to major changes, examination according to this syllabus is normally offered on three occasions within/in close connection to the two following semesters.