Materials Optics

Programme course

6 credits

Materialoptik

TFYA04

Valid from: 2017 Spring semester

Determined by
Board of Studies for Electrical Engineering, Physics and Mathematics

Date determined
2017-01-25

Main field of study
Applied Physics, Physics

Course level
Second cycle

Advancement level
A1X

Course offered for
- Applied Physics and Electrical Engineering, M Sc in Engineering
- Physics and Nanoscience, Master's programme
- Materials Science and Nanotechnology, Master's programme
- Applied Physics and Electrical Engineering - International, M Sc in Engineering

Entry requirements
Note: Admission requirements for non-programme students usually also include admission requirements for the programme and threshold requirements for progression within the programme, or corresponding.

Prerequisites
Basic courses in linear algebra and complex numbers

Intended learning outcomes

The course objective is to give a physical background to linear optical properties of materials, to describe how they can be measured and analyzed with modern techniques and to give examples of how they can be utilized in devices and for understanding of advanced optical structures. Special emphasis will be on tools (often matrix-based) for analyzing complex structures found in devices as well as in nature. Application examples will be chosen both from solid state physics of device-related materials and from optical structures in nature, e.g. structural colors in insects, with the ambition to illustrate ongoing research and development in university and industry. More specifically the course treats determination and analysis of optically related materials properties like refractive index, optical band gaps, etc, as well as determination of microstructure like thicknesses of thin films and analysis of multilayered systems, materials composition, porosity, and more. The ambition is to provide knowledge in optics on a level sufficient to understand results from ongoing research in the corresponding areas and also to prepare for research. Goals:

- To learn about basic theory to provide understanding for the optics and physics behind linear optical properties.
- To learn about models for analysis to provide mathematical tools useful to understand and develop optical systems, methods and components found in various environments in society.
- To provide a connection to reality through examples from research to demonstrate that it can be a small step from university studies to knowledge and methodology used in research and development.
- To apply the knowledge and models in laboratory exercises and simulations to check usefulness and limitations of theories and models. In summary the goal is to describe the path from physics to application and during the trip provide models, tools and methodology useful in practice.

Course content

Among the included subjects for basic understanding of optics are:

- Relations between the microscopic properties (dipoles) and macroscopic properties (dielectric function) of materials
- Anisotropic and bianisotropic optical properties
- Spectral properties: absorption and dispersion, phonon spectroscopy
- Optical properties of composite materials and metamaterials
- Polarized light and depolarization: Jones formalism and Stokes/Mueller formalism
- Detailed understanding about surface optics
- Advanced multilayer optics including photonic crystals and structural colors.

Among the practical tools to be put in the tool box are:

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    - Models for parameterization of optical properties
    - Effective-media models for composite materials
    - Matrix models for polarized light
    - Methodology and matrix models for reflection and transmission of light at surfaces with and without layers
    - 4x4 matrix models for anisotropic layered materials
    - Optical measurement techniques: reflectance, ellipsometry, generalized and Mueller-matrix ellipsometry, surface plasmon resonance.
- A detailed course content is found on the course homepage.

Teaching and working methods

The course consists of lectures during which the most important theory is discussed. Some of the lectures are devoted to problem solving. External lectures are invited to give the course a wider perspective.

Examination

LAB1	Laborations	1 credits	U, G
TEN1	Written examination	5 credits	U, 3, 4, 5

At the exam it is allowed to bring the course literature Thin Film Optics and Polarized Light, H Arwin, with own notations in the book.

Grades

Four-grade scale, LiU, U, 3, 4, 5

Other information

Supplementary courses: Kursen kombineras gärna med kurser i Optoelektronik och Materiefysik

Department

Institutionen för fysik, kemi och biologi

Director of Studies or equivalent

Magnus Johansson

Examiner

Kenneth Järrendahl

Course website and other links

http://www.ifm.liu.se/undergrad/fysikgtu/coursepage.html?selection=all&sort=kk

Education components

Preliminary scheduled hours: 44 h
Recommended self-study hours: 116 h

Course literature

Thin Film Optics and Polarized Light (H Arwin) och särtryck.

Common rules

Regulations (apply to LiU in its entirety)

The university is a government agency whose operations are regulated by legislation and ordinances, which include the Higher Education Act and the Higher Education Ordinance. In addition to legislation and ordinances, operations are subject to several policy documents. The Linköping University rule book collects currently valid decisions of a regulatory nature taken by the university board, the vice-chancellor and faculty/department boards.

LiU's rule book for education at first-cycle and second-cycle levels is available at http://styrdokument.liu.se/Regelsamling/Innehall/Utbildning_pa_grund-_och_avancerad_niva.