SK2340 Fourier optics 6.0 credits

Fourieroptik

This is a translation of the Swedish, legally binding, course syllabus.

If the course is discontinued, students may request to be examined during the following two academic years

Establishment

Course syllabus for SK2340 valid from Autumn 2009

Grading scale

A, B, C, D, E, FX, F

Education cycle

Second cycle

Main field of study

Engineering Physics,Physics

Specific prerequisites

Knowledge of the physics of electromagnetic radiation (SK1120 Waves, 6 hp or corresponding) and in basic mathematics (vector analysis, integrals, differential equations).

Recommended previous knowledge:
Knowledge in optics (SK2300 Optical physics, 6 hp or equivalent) is of advantage, but not mandatory. Basic knowledge of programming in MATLAB is highly recommended, but maybe acquired during the course.

Language of instruction

The language of instruction is specified in the course offering information in the course catalogue.

Intended learning outcomes

The overall aim of the course is that you should be able to analyze optical problems with the help of the approximations made in Fourier optics and develop simple numerical simulations for your systems.

This means that you should be able to:

- Describe the mathematical characteristics of the two dimensional Fourier transform and explain their relevance for the analysis of linear optical systems
- Explain the basics of scalar diffraction theory
- Analyze different solution methods for the Helmholtz equation
- Apply the Fresnel and Fraunhofer approximation to calculate the diffraction patterns of standard optical components
- Reflect on the physical implications of diffraction and their influence on the resolution in optical imaging systems
- Develop and implement algorithms for numerical wavefield propagation

Course contents

The course will follow chapters 2-6 and 8-9 of the book with an additional part on wave-propagation methods:

- Analysis of two-dimensional signals and systems
- Foundations of scalar diffraction theory
- Fresnel and Fraunhofer diffraction
- Wave-optics analysis of coherent systems
- Frequency analysis of optical imaging systems
- Coherence
- Image processing
- Holography
- Numerical methods for wave-field propagation:
  - Fresnel-Kirchhoff diffraction formalism
  - Fresnel propagation
  - Fraunhofer propagation
  - Example for techniques beyond Fourier optics: Finite-difference method

The lectures will be given by the students on one or part of the above topics. The length of one lecture is two hours. The number of lectures and their specific content will be adjusted to the number of participants. Additionally, the students have to implement examples of the above mentioned numerical methods using the computer program MATLAB. The programs will be evaluated using a peer-review scheme.

Course literature

Joseph W. Goodman, Introduction to Fourier Optics, Third edition (2005), Roberts and Company publishers

One of the best books in optical physics, suitable both for self-study and reference. This book is required for the course. Additional literature will be provided to the student in form of copies from other books and scientific articles.

Examination

- INL1 - Assignments, 3.0 credits, grading scale: A, B, C, D, E, FX, F
- RED1 - Lecture, 3.0 credits, grading scale: A, B, C, D, E, FX, F

Based on recommendation from KTH's coordinator for disabilities, the examiner will decide how to adapt an examination for students with documented disability.

The examiner may apply another examination format when re-examining individual students.

The course grading is A-F. The examination consists of two parts:

Part 1: Lecture given by the students on one part of the course content (RED1, 3hp, grading A-F)

Part 2: Homework problems: Numerical simulations on wave propagation (INL1, 3hp, grading A-F)

To pass the course, you have to attend at least 80% of the lectures. If this is not possible, you will be given an extra written assignment about the content of the missed lectures.

Ethical approach

- All members of a group are responsible for the group's work.
- In any assessment, every student shall honestly disclose any help received and sources used.
- In an oral assessment, every student shall be able to present and answer questions about the entire assignment and solution.