KTH Engineering Sciences

Course PM
SK2340 (Master level) / SK3340 (PhD level), Fourier optics, 6 hp (ECTS)

Course responsible / examinator

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Language of instruction

English

Eligibility

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**.

Course objectives

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.

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

Course literature

Joseph W. Goodman, Introduction to Fourier Optics, Third edition (2005), Roberts and Company publishers. This is one of the best books in optical physics and suitable both for self-study and reference. **You have to buy the book for the course**, but it is worth the investment. Please do this well in advance of the course start.

Course organization

10 lectures, 2 hours each:

Lecture	Topics	Literature
1	Fourier transform, discrete Fourier transform, linear systems	FO chapter 2
2	Foundations of scalar diffraction theory 1	FO chapter 3
3	Foundations of scalar diffraction theory 2	FO chapter 3
4	Fresnel and Fraunhofer diffraction	FO chapter 4
5	Wave-optics analysis of a thin lens	FO chapter 5
6	Frequency analysis of optical imaging systems 1	FO chapter 6
7	Frequency analysis of optical imaging systems 2	FO chapter 6
8	Holography	FO chapter 9
9	Fourier optics recent application topic	Handout papers
10	Review FO chapter 2-6	

FO: Joseph W. Goodman, *Introduction to Fourier optics*

5 computer-based labs with MATLAB, 3 hours each:

Lab	Topics	Literature
1	Discrete Fourier transform in MATLAB	FO chapter 2
2	Fresnel-Kirchhoff diffraction integral	FO chapter 3
3	Wavefield propagation using Fresnel diffraction integral	FO chapter 4
4	Coherent and incoherent imaging	FO chapter 5,6
5	Advanced problem simulation	

Examination

LAB1 – Computer laboratory, 2.0 credits, grade scale: Pass/Fail.

To be passed, you need to attend at least 4 out of 5 lab exercises. If this is not possible, an extra hand-in task will be given to you.

TEN1 – Written exam, 4.0 credits, grade scale: A, B, C, D, E, FX, F, lowest passing grade E.

To pass the course you have to pass the lab and the written examination. The exam grade determines the overall course grade (A-E for SK2340, for SK3340 pass/fail only).

Course evaluation

You are strongly encouraged to participate in the anonymous course evaluation at the end of the course. The goal of the evaluation is to continuously improve the course. Further information will be given in time.