# SK2330 VT21-1 Optical Systems Design

The course consists of lectures, computer labs, practical lab and written exam. For SK3330 there are additional tasks.

Covid adaption: Due to Covid the situation is likely to change. The current plan is to run two lectures (out of 12) and one lab on campus and the rest of the activities on-line. The exam will be on-line, probably a home exam but possibly combined with an oral exam via zoom.

The course literature is a compendium written by Ove Axner. It can be bought at the student office (Kursexpeditionen) at level 5 in AnbaNova.

The teacher is Anna Burvall

## To pass the course

**To pass SK2330, you need to**

- Complete 5 computer labs and reports, on time.
- Complete one practical lab
- Pass the exam, which also sets the grade A-F.

**To pass the PhD course SK3330, you need to**

- present one of the home tasks to the class during lecture
- Complete 5 computer labs and reports, on time.
- Complete one practical lab
- Actively participate in lecture 12, completing a short lab on the disposable camera.
- Pass the exam, which also sets the grade A-F.

## Intended learning outcomes

After completing this course, the students should be able to

- Apply geometrical optics methods, such as lens formulas, graphical methods and ray-tracing, to analyze optical systems.
- Identify and calculate third-order Seidel and first-order chromatic aberrations, and apply standard design methods to minimize these aberrations.
- Describe tools (for example MTF, PDF, spot diagrams, or lists of aberration coefficients) for system evaluation, and apply these tools to judge the suitability of an optical system for a specific task.
- Use ray-tracing software to analyze and optimize optical systems.
- Discuss different approaches and methods of optical design.

## Lectures and course material

There are 12 lectures on the course. Below follows the plan for the course, along with suggested tasks. There are six extra tasks included: these will be solved during the next lecture, and you will learn a lot more from the if you do them yourself before the next lecture.

They are referred to as home tasks (HT) in the table below. Similarly A represents Axner's booklet, and H the Hecht book.

- **Lecture 1: Geometrical optics.**
  Reading: Hecht chap. 5 & 6, handout
  Suggested tasks: HT1, H 5.6 5.11 5.15 5.18

- **Lecture 2: Geometrical optics and raytracing**
  Reading: Hecht chap 5 & 6, Axner chap. 9.1, 9.5
  Suggested tasks: H 6.2 6.4 6.12

- **Lecture 3: Introduction to aberrations**
  Reading: Axner chap. 9, 10
  Suggested tasks: A 9.1, 9.6
  Lecture notes for self-studies

- **Lecture 4: Monochromatic aberrations**
  Reading: Axner chap. 10, 11
  Suggested tasks: HT2, A 10.2, 10.4, 10.10

- **Lecture 5: Monochrometic aberrations (cont.)**
  Reading: Axner chap. 11 (13)
  Suggested tasks: A 11.1, 11.2, 11.4

- **Lecture 6: Chromatic aberrations**
  Reading: Axner chap. 8
  Suggested tasks: HT3, A 8.2, 8.5, 8.6

- **Lecture 7: MTF and system characterization**
  Reading: Axner chap X or handout
  Suggested tasks: HT4

- **Lecture 8: Seidel sums**
  Reading: Axner chap. 12.1-12.5
  Suggested tasks: A 12.5

- **Lecture 9: Seidel sums (cont.) and aberration-free surfaces**
  Reading: Axner chap. 13 (13.4.2-3 low prior.,13.5 high prior)
  Suggested tasks: HT5, A 13.8

- **Lecture 10: Aberrations in thin lenses**
  Reading: Axner chap 12.6-12.9
  Suggested tasks: HT6, A 12.1, 12.2, 12.3, 13.1, 13.2, 13.5, 13.6

- **Lecture 11: Aberrations in systems**
  Reading: Axner chap 14, handout

- **Lecture 12: Disposable camera**
  Reading: Handout

# Lab and computer labs

## Laboratory task

One laboratory task should be completed. Students and assistant meet here and the go to the lab rooms. Please note that labs start at e.g. 8.00 or 13.00 sharp, not quarter past. At present, there is one lab session in the schedule. If it suits the students badly, we will change it. More sessions might be added if needed.

## Computer labs

5 computer tasks should be completed by the given hand-in dates. We will be using an optical design software called Synopsys, which can be downloaded from the manufacturer's homepage www.osdoptics.com (Länkar till en externa sida.). We can use the free version, which limits the number of surfaces to 12 but still allows optimization. The program is installed in the computer room RB33, but you can also download and install it on your own computer.

Rules for hand-in of computer labs. The labs are best handed in via canvas, but can also be given to the lecturer or assistant in paper form.

Due to low attendance during previous years, there will be no scheduled sessions in the computer room. Instead, there are 4 one-hour sessions scheduled directly before or after the lectures, often in the same room as the lecture for easy access. During these sessions you will receive assistance on the computer tasks. If you have a laptop, bring it. If not, put your files on a USB stick, so they can be uploaded to the laptop brought by the assistant.

Computer task 1 should be handed in by November 7.

Computer task 2 should be handed in by November 16.

Computer task 3 should be handed in by November 28.

Computer task 4 should be handed in by December 12.

Computer task 5 should be handed in by December 14.

Please note that the hand-in dates of the last two labs, which are the most advanced, are quite close together. Start early!

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## Examination

For SK2330, the examination consists of the lab, computer labs, and exam. The grade on the exam (A-F) is determines the grade on the course.

You need to sign up for the exam, following the rules and procedures of the SCI school. The exact date and time of the exam can be found in the schedule.

You may bring any materials to the exam, except those that can be used for communication with the outside world, and those where you can install commercial ray-tracing software. So no phones, computers or anything in between. But bring for example your book, notes and calculator. Don't forget a ruler, to draw ray diagrams, and something to eat or drink.

The grading is done by the number of credits on the exam: 0–8p F, 9–11p Fx, 12–14p D, 15–18p C, 19–21p B, 22–24p A.