Fys3280/4280

Semiconductor components

Introduction and background

Research and development in semiconductor physics has formed the basis of modern society. Fast and energy-efficient electrical components are being produced for an increasing number of applications, while the development in miniaturizing components has been almost exponential, with some component dimensions now only 3-5 nanometers. As a result, conventional silicon technology is reaching its physical limits and the famous Moore's Law is no longer valid. At the same time, new materials and components have developed to become central/critical for the production of environmentally friendly energy via solar and fuel cells and for new efficient solid-state light sources (Nobel Prize in Physics, 2014). Another exciting application of semiconductor materials is in detectors, such as the detection of high-energy elementary particles (e.g. the Higgs boson, Nobel Prize in 2013): In addition, a growing field of research nowadays is the use of point defects in semiconductors in quantum technology (Nobel Prize in Physics in 2022).

In this course we look at the behavior of "simple" semiconductor components such as diodes, solar cells and transistors and the corresponding physical processes. The introduction of the course emphasizes semiconductor materials and basic electrical and optical phenomena. We then continue with various components such as the diode, field effect transistors, the bipolar transistor and opto-electrical components such as solar cells, LEDs, photo- and particle detectors. The course also includes lab exercises where students make their own components in the cleanroom at UiO's Micro and Nanotechnology Laboratory (UiO/MiNaLab).

Content

The course extent is 10 study points with 38 hours of lecture, 24h of exercises/colloquium and 20h lab.

Lecturer and course responsible: Lasse Vines (lasse.vines@fys.uio.no)
Responsible for exercises: Oliver Moen-Duran (oliver.moen-duran@kjemi.uio.no)
Lab responsible: Viktor Bobal (viktor.bobal@fys.uio.no)

Course literature

Solid State Electronic Devices (7th edition), Ben G. Streetman and Sanjay Banerjee, Prentice-Hall, ISBN-13: 978-0-13-335603-8 el. ISBN-13: 9781292060552
For reading instructions, see page 3 to 5 in this document.

Eksaminasjon

Written examination on October 7 at 0900 (3 hours) in Hall 3D in Silurveien 2, (approx. 20% weight), individual lab report (approx. 20%) with deadline Sunday November 24, and final oral exam in week 49 or 50 (approx. 60%). Letter grade.
The course is defined by the course literature ("Streetman's book" and assignments) and material covered in lectures, exercises/colloquia and lab.

Plan for lectures

place: Kristian Birkelands aud.,

Mondays 1015 – 1200 (until week 41) , Thursdays 1015 – 1200

Note: There will be 4h lecture in the beginning. After the mid term exam we reduce the amount to 2h per week.

Date	hours	Chapter	Content
19/8	2	1,3	Course presentation, properties of semiconductors
22/8	2	3	Properties of semiconductors
26/8	2	3	Properties of semiconductors
29/8	2	3,4	Charge carriers, lifetime, drift and diffusion
2/9	2	4	Charge carriers, lifetime, drift and diffusion
5/9	2	4,5	Charge carriers, pn-junction
9/9	2	5	Pn-junction
12/9	2	5	Pn-junction
16/9	2	5	Pn-junction, Schottky diode
19/9	2	6	Field effect transistor; JFET and MESFET
23/9	2	6	Field effect transistor; MOSFET
26/9	2	6	Field effect transistor; MOSFET
30/9	2	1-5	Repetition Chap. 1-5
Week 41; mid term exam, no lectures			
17/10	2	6,7	Bipolar transistor
24/10	2	7	Bipolar transistor,
31/10	2	8	Optoelectronic components (Solar cells)
7/11	2	8	Optoelectronic components (detectors)
14/11	2	8	Optoelectronic components (LED, Lasers)
21/11	2	3,4,5,6,7,8	Repetition

Plan for exercises and colloquia

Place: Seminar room Ø358,

Fridays kl. 1015 - 1200

Date	hours	Chapter.	Topic
30/8	2	3	Properties of semiconductors
6/9	2	3,4	Charge carriers, lifetime, drift and diffusion
13/9	2	5	Pn-junction
20/9	2	5	Pn-junction, Schottky diode
27h/9	2	3-5	JFET and MESFET
4/10	2	3-5	Preparation for mid term exam; chap. 3-5
18/10	2	6	JFET, MESFET and MOSFET
25/10	2	6	MOSFET and Bipolar transistor
1/11	2	6,7	Bipolar transistor
8/11	2	7	Optocomponents
15/11	2	8	Optocomponents, lab assignments
22/11	2	8	Lab assignments

Lab excercises

Carried out in the Micro- and Nanotechnology Laboratory (MiNaLab), Gaustadalleen 23C, and starts in week 42 (14-18/10). A total of 5 lab exercises (1 lab per week) with 4 hours duration. Lab days are arranged before the midterm exam. Deadline for submission of lab report: 24.11.2022. The lab exercises are mandatory and each student writes their own report. Digital submission.

FYS2210 - READING INSTRUCTIONSD FOR "STREETMAN"

A: Very important, text mass and calculations should be well known
B: Important, must be read and can be included in examinations
C: Read as background information or assume familiarity from other courses

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