IH1611 Semiconductor Devices 7.5 credits

Halvledarkomponenter

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 IH1611 valid from Spring 2011

Grading scale

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

Education cycle

First cycle

Main field of study

Electrical Engineering,Technology

Specific prerequisites

Completed upper secondary education including documented proficiency in Swedish corresponding to Swedish B and English corresponding to English A. For students who received/will receive their final school grades after 31 December 2009, there is an additional entry requirement for mathematics as follows: documented proficiency in mathematics corresponding to Mathematics A. And the specific requirements of mathematics, physics and chemistry corresponding to Mathematics D, Physics B and Chemistry A.

Language of instruction

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

Intended learning outcomes

The student should after the course be able to describe the basic principles of the semiconductor devices; the pn diode, the MOS transistor and the bipolar transistor. Other objectives are that the student should know how to calculate the current in these devices and analyze and judge the validity of device models from a device physics point of view.

In detail this means that the student after the course should be able to

1. describe why the electrical conductivity is different for different materials
2. account for and calculate how the electrical conductivity varies with temperature, light and doping concentration for the semiconductors Si and GaAs
3. formulate the basic principles and give examples of process technology that is used for fabricating semiconductor devices
4. analyze and describe the charge distribution in the pn diode and the MOS transistor for different bias voltages
5. analyze how different physical phenomena influence the current in semiconductor devices
6. calculate the current in the pn diode, the MOS transistor and the bipolar transistor using simplified device models based on the physical phenomena that influence the current
7. exemplify how the simplified device models can be developed to more complex models that deviate less from experimental data
8. describe how a complex device model can be implemented in a computer simulation
9. analyze the validity and determine the complexity that is needed in a computer model of a semiconductor devices for a certain application.

Course contents

The course deals with basic semiconductor device physics involving energy bands, doping, drift and diffusion currents and carrier recombination. The principles of the pn junction are studied with a detailed description of space charge, built-in potential and current transport including modeling. The technologically important metal-insulator-semiconductor is analyzed to understand the free carrier channels that are used in MOS transistors. MOS transistors are described in detail with focus on modeling the current. The principles of the bipolar transistor are described, based on models for the current transport of the pn diode, and models for the bipolar transistor current are described. In the course it is also described how basic process technology such as diffusion and photolithography is used to fabricate pn diodes.

The course consists of laboratory exercises that give practical skills in process technology and device characterization using electrical measurements. To provide a special focus on problem solving the course also consists of compulsory student exercises. The students have to solve previously handed out examples in advance and show their solutions in front of the class at the student exercise.

Course literature

Modern Semiconductor Devices for Integrated Circuits, Chenming Calvin Hu, Förlag Pearson, År 2010, ISBN-13: 978-0-13-700668-7

ISBN-10:0-13-700668-3

Examination

- LAB1 - Laboratory Work, 1.5 credits, grading scale: P, F
- TEN1 - Examination, 6.0 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.

Other requirements for final grade

The course examination consists of a written exam and laboratory exercises. Passing the written exam is awarded with 6 student credits and passing the laboratory exercises is awarded with 1,5 student credits. Good solution attempts on a certain number of examples, handed out before the student exercises, are required to be allowed to write the exam. A good solution attempt is counted if the student is present in the compulsory student exercise and is prepared to show the exercise to the class.

The exam consists of eight exercises and at least half of the maximum points are required to pass.

To pass the exam, the student must be able to describe the function of the pn diode, the MOS transistor and the bipolar transistor and calculate the current in these devices.

To obtain a higher grade the student should be able to independently judge the validity of device models from a device physics point of view. To pass the laboratory exercises the student must perform active work, solve the laboratory exercises and write a thorough and well structured lab report that describes the work performed and the results.

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.