Semiconductor Technology

Programme course

12 credits

Halvledarteknik och tillverkning

TNE058

Valid from: 2017 Spring semester

Determined by
Board of Studies for Electrical Engineering, Physics and Mathematics

Date determined
2017-01-25

Main field of study
Electrical Engineering, Applied Physics

Course level
Second cycle

Advancement level
A1X

Course offered for
- Electronics Design Engineering, M Sc in Engineering

Entry requirements
Note: Admission requirements for non-programme students usually also include admission requirements for the programme and threshold requirements for progression within the programme, or corresponding.

Prerequisites
The students attending this course should have basic knowledge in physics and mathematics. The student should be able to solve system of equations, differential equations and have good knowledge in differential and integral calculus. Student should have basic knowledge in Newtonian mechanics and classical physics, electromagnetism, optics and wave. It is expected that the student have some knowledge from modern physics and can use Shrödinger equation on simple systems

Intended learning outcomes

The aim of the course is to present the fundamental principle of semiconductor devices and how models of devices can be created from this understanding. How the semiconductor devices are fabricated? Basic unit processes will be presented. The students get the basic knowledge that is necessary to understand, work and produce integrated circuits and optoelectronics. After this course the student should

- Describe manufacturing steps, lithography, oxidation, metallization, and etching.
- Integrate the manufacturing steps for manufacturing of bipolar transistors, MOSFET, CMOS and MEMS.
- Explain the terms, band gap, energy level, mobility, effective mass, charge generation and recombination, doping, drift, diffusion, equilibrium and steady state.
- •Apply relations between band gap, energy level, mobility, effective mass, charge generation and recombination, doping, drift, diffusion, conductivity, current density, temperature and illumination in semiconductors.
- Calculate and determine the material parameters (band gap, doping, level, carrier lifetime, diffusion length) from electrical characteristics of semiconductor devices.
- Design pn-junctions, Schottky diodes, bipolar transistor, MOSFET, and pn-solar cells having given characteristics.
- Design pn-junctions, Schottky diodes, bipolar transistor, and MOSFET.

Course content

Basic semiconductor physics, concept and mechanisms such as band diagram, valence- and conduction band, Fermi level, Fermi-Dirac statistics, band gap, effective mass, drift, diffusion, doping, intrinsic, extrinsic, electron-hole pair, charge generation and recombination, minority carriers, majority carriers etc. will be discussed thoroughly. Function and modelling of pn-junctions, contact potential, depletion region, and different break down mechanisms for pn-junctions will be explained. Functions and I-V characteristics of some other devices such as MOSFET and bipolar transistors will also be discussed. Basic unit processes such as ion implantation, diffusion, thermal oxidation, annealing, deposition processes such as evaporation, sputtering, CVD, epitaxial growth, fabrication processes such as optical and non-optical lithography, photoresist and etching will be introduced. The students should enter deeply into one of the subjects below and present their work for the whole class. Device isolation, Contacts and metallization, CMOS technology, GaAs technology, bipolar technology and MEMS. Laboratory assignment includes classical labs with diode and transistor measurements.

Teaching and working methods
Lectures and tutorial. Laboratory work, Weekly Home assignment , Student oral presentations. Mandatory attendance of some lectures and during student presentations.
The course runs over the entire autumn semester.

Examination
UPG2	Optional assignments	0 credits	U, G
DUG1	Midterm Short Exam	2 credits	U, G
UPG1	Assignment, Written and Oral Presentation	1 credits	U, G
LAB1	Laboratory work	1 credits	U, G
TEN1	Written Examination	8 credits	U, 3, 4, 5

Mandatory attendance during student presentations

Grades
Four-grade scale, LiU, U, 3, 4, 5

Other information
Supplementary courses: Solar Cell Technology, Power Electronics,and Charge Transport in Organic and Inorganic Materials, System Design.

Department
Institutionen för teknik och naturvetenskap

Director of Studies or equivalent
Adriana Serban

Examiner
Amir Baranzahi

Course website and other links
http://www2.itn.liu.se/utbildning/kurs/index.html?coursecode=TNE058

Education components
Preliminary scheduled hours: 108 h
Recommended self-study hours: 212 h

Course literature

Additional literature

Books

Jasprit Singh, (2004) *Semiconductor Devices, basic principles*
ISBN: 0-471-36245-X
Wiley & Sons
Sami Franssila, (2004) *Introduction to Microfabrication*
ISBN: 0470-85106-6
Wiley & Sons

Common rules

Regulations (apply to LiU in its entirety)

The university is a government agency whose operations are regulated by legislation and ordinances, which include the Higher Education Act and the Higher Education Ordinance. In addition to legislation and ordinances, operations are subject to several policy documents. The Linköping University rule book collects currently valid decisions of a regulatory nature taken by the university board, the vice-chancellor and faculty/department boards.

LiU's rule book for education at first-cycle and second-cycle levels is available at http://styrdokument.liu.se/Regelsamling/Innehall/Utbildning_pa_grund-_och_avancerad_niva.