KTH Information and Communication Technology

IH2653/IH3610 Simulation of Semiconductor Devices Fall 2019

This course gives an in-depth knowledge in simulation of device physics for advanced semiconductor devices for all application areas. The implementation of the semiconductor equations and the solution using the finite difference method, finite element method and finite volume method is explained.
After the course, the student should be able to

- *analyse boundary conditions*
- *analyse discretization in one and two dimensions*
- *analyse semiconductor device operation*
- *design geometries for physical problems*
- *use computer tools to solve simple problems*
- *use computer tools to solve partial differential equations*
- *use computer tools to simulate semiconductor devices*

Staff involved

Lectures and examination: Assoc. Prof. B Gunnar Malm, EECS/ELE, 08-790 4335, gunta@kth.se

Prerequisites

Basic semiconductor physics, semiconductor devices, electromagnetic field theory.

Literature

We will use a combination of lecture slides, lecture notes, book sections and program manual chapters.
For extra reading Selberherr - Analysis and Simulation of Semiconductor Devices, Springer (1984) is suggested (http://link.springer.com/book/10.1007/978-3-7091-8752-4).

Syllabus

- Basic numerical methods (repetition)
- Fundamentals of electromagnetism and its numerical analysis
- Transport phenomena and their numerical analysis, discretization in one and two dimensions
- The semiconductor equations
- Numerical solution of partial differential equations using the finite element method and the finite volume method
- Thermal and diffusion simulation
- Micromagnetic simulations
- Simulation on parallel computers and GPUs
- Numerical solution of partial differential equations using the finite element method and the finite volume method

These modules will not be covered Fall 2019 but material is available

- Kinetic transport models, including Monte Carlo simulation
- Circuit simulation
- Photonic/wave simulation

Requirements

The examination is through homework assignments from the parts covered during lectures and labs. The course is worth 7.5 hp (higher education credits, equivalent to 7.5 ECTS).
IH2653: (Undergraduate course) Grading: A-F. Each person should hand in a set of individual solutions, including text, figures and software code. You may ask other students for help, but extensive help should be acknowledged in the report.
IH3610: (PhD course) Grading: pass/fail (75 points). PhD students should solve all problems individually. The project should be based on one of your research tasks.
If you copy someone else's homework I may have to report you for plagiarism.

If you want more points to achieve a higher grade, an individual project can be selected, which includes simplified analysis and use of Comsol Multiphysics or nanoHUB. Either one of the project suggestions or a project of your choice can be analyzed/simulated. If you want to do a project based on your research this is also possible, as long as it includes analysis and simulation. Sign up for a project by December 16. There is both an individually scheduled 30 min oral presentation of your work, and a written report required.
Deadline for report: January 20, 2020.
Oral presentations should preferably be done in January 2020.

Lectures and Labs

Lectures are according to the schedule. The lectures will also repeat material on solution of differential equations, numerical methods, electromagnetic field theory and semiconductor physics. Lecture notes and other material will be available on the website.

Homework

There are 8 sets of homework problems to be solved for a maximum of 100 points. Some homework requires the use of Matlab, Comsol Multiphysics or nanoHUB, see below. Doing a project is optional.
Homework should be emailed to bellman@kth.se on the date below at 23.59 latest, with your name as filename. Very late homework will receive lower marks, and **homework received after January 21st 2019 may not be graded at all**. The problem texts are available on the website but parameters are assigned individually, see below. Preliminary grading below.

Points	Grade
≥ 90	A
≥ 80	B
≥ 70	C
≥ 60	D
≥ 50	E
< 50	Fx

* Depends on selected project. Make project selection by Fri 14/12.

Computer and Software requirements

- The Homework has parameters assigned individually based on a student id number course. Email bellman@kth.se to register for the course and to receive your SIN.
- You will need to install some software on a home computer or a laptop to do the ho MATLAB you also need Comsol Multiphysics (CMP), which is a general tool for s differential equations. MATLAB and Comsol Multiphysics can be downloaded fro www.comsol.se
- You need internet access to register and use http://www.nanohub.org (it is free). You will use some specialized semiconductor device simulation tools that require login.
- The course administration and material is in Canvas LMS.