IH2657/IH3609 Design of Nano Semiconductor Devices
Spring 2021

The course is about advanced nanometer scaled semiconductor devices for application areas such as very large-scale integrated circuits and for high-speed communications.

After the course, the student should be able to

- *analyse the operation of semiconductor devices*
- *analyse delay times from parasitics*
- *analyse scaling of MOSFETs*
- *design a scaled down device from a given device*
- *discuss semiconductor devices based on research articles*

With analyse is meant to derive relations and calculate from equations given in the textbook.

Staff involved
Lectures and examination: Professor Carl-Mikael Zetterling, EECS/EE/EES, 08-790 4344, bellman@kth.se
Lectures and labs: Professor Gunnar Malm, EECS/EE/EES, 08-790 4332, gunta@kth.se

Prerequisites
A basic course in semiconductor devices or semiconductor physics is required, for instance IH1611.

Literature
The main literature consists of the combination of Harry Veendrick, Nanometer CMOS ICs, 2ed, 2017 (available as E-book via KTHB) and research articles from IEEE and other peer-reviewed research journals. The articles are available from the Canvas LMS.

Syllabus
This course covers the most important device in silicon: nanometer sized MOSFETs for digital high speed operation. Sections: technology and device trends, physics of the MOS structure, MOSFET scaling theory, nanometer design, silicon-on-insulator (SOI), memory, low power design, and new techniques such as graphene, nanotubes and nanowires. Apart from the text book, research articles are studied, and the students select an article to present in English in a seminar.

Requirements
Homework assignments, computer labs, seminar presentation and an oral exam. Grading is based on the four tasks, and all four must be attempted for more than a passing grade. The course is worth 7.5 hp (higher education credits, equivalent to 7.5 ECTS). Each person should submit a set of individual solutions. The Lab exercise will be slightly individualized. **If I find copying between students or from internet sources in any of the assignments, all involved students will receive 0 points for that homework/lab/seminar part.**

IH2657: (Undergraduate course) Grading: A-F.
IH3609: (PhD course) Grading: pass/fail. For pass 75 points are required.

Plagiarism
Plagiarism (copying all or parts of someone else's work and submitting it as your own) normally leads to six week's suspension. Suspension means that you may not take exams nor have work corrected or gain access to KTH's computer halls. As a KTH teacher I am required to report all cases of plagiarism to the Disciplinary board of KTH for further judgement. Avoid being accused of plagiarism by writing in your own words rather than cut-and-pasting from references (with or without the intention to change it later). For more help, see:

http://refero.lnu.se/english/
http://plagiarism.arts.cornell.edu/tutorial/index.cfm
https://kth.instructure.com/courses/190/assignments/497?module_item_id=3041
http://urn.kb.se/resolve?urn=urn:nbn:se:kth:diva-83704

Lectures, Labs and Seminars

Lectures, Labs and Seminars will be given according to the schedule below (March 24th – May 21st), content is preliminary.

Activity	Day	Time	Place	Chapter	Content	Teacher
	Wed 24/3	13-15	Zoom		Introduction	CMZ
	Fri 26/3	10-12	Zoom	1	Basic principles	BGM
	Wed 31/3	13-15	Zoom	2	Scaling	CMZ
	Thu 1/4	10-12	Zoom	3	MOS manufacture	CMZ
	Wed 14/4	13-15	Zoom	4	CMOS circuits	CMZ
	Fri 16/4	10-12	Zoom		Simulation	BGM
	Mon 19/4	13-15	Zoom	5	Special circuits	BGM
	Wed 21/4	13-15	X		Cancelled	X
	Fri 23/4	10-12	Zoom	6	Memories	BGM
	Mon 26/4	10-12	Zoom		Spintronics	BGM
	Fri 30/4	10-12	Zoom	7	VLSI and ASIC	CMZ
LAB	Mon 3/5	15-17	Zoom	8	Low power	CMZ
	Wed 5/5	13-15	Zoom	9	Robustness	BGM
	Fri 7/5	10-12	Zoom	10	Testing etc	BGM
SEM1	Mon 10/5	10-12	Zoom	11	Roadmap	BGM
	Wed 12/5	13-15	Zoom		Spare	
SEM2	Mon 17/5	15-17	Zoom		Seminars	
SEM2	Wed 19/5	13-15	Zoom		Seminars	
SEM2	Fri 21/5	10-12	Zoom		Seminars	

Homework (including Labs and Seminars)

There are homework problems to be solved (25 points), a simulation lab report (25 points), a seminar task (25 points) and an oral exam (25 points) for a maximum of 100 points in total.
The labs requires the use of nanoHUB, see below. You will you use measurements from the MOSFETs made in IH2659 and compare the results with your simulations.
In preparation for the seminars, each student should do an information search for an article related to the course topics, dated **2020** or later, and present a summary of this in class (max 8 minutes + 4 minutes of questions).
After the seminars each student should write a summary of one other presentation during the same day.
All work should be submitted in the Canvas LMS on the date below at 23.59 latest. **(to be decided)**
Very late homework will receive lower marks, and **homework received after May 21st 2021 may not be graded at all**. The problem texts are available on the website. Preliminary grading below.

What	Points	Deadline	nanoHUB	Content
HW	25	Mondays		One exercise per chapter
LAB	25	Mon 3/5	Yes	Lab report
SEM1	5	Mon 10/5		Article selection
SEM2	10	Fri 21/5		Seminar presentation
SEM3	10	Mon 25/5		Seminar summary
EXAM	25	Mon 1/6		Oral exam, individually scheduled

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

* A grade > E requires that the student has some points for each area: homework, labs, seminars and exam.

Computer and other requirements

- For the Lab, bring a laptop. You need internet access to register and use www.nanohub.org (it is free). You will use the specialized device simulation tools ABACUS and Nano-CMOS which require login.
- To submit the homework in the Canvas LMS you need to be registered on the course for this semester.
- For the information searching you need a KTHB library card with pin code.