Course Syllabus

Instructor Contact:

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Course Content

This course begins with a substantive treatment of the fundamental behavior of semiconductor materials and moves on to the semiconductor diode, the bipolar transistor, and field-effect transistor devices. Building upon these concepts, their operations, biasing, small- and large-signal models are analyzed. Laboratory exercises are provided to reinforce the theory of operation of these devices.

Objectives

The primary objective of this course is to provide students with the fundamental physical and electronic properties of semiconductor materials and the operation principles of most common semiconductor devices used in electronic circuits. Starting from the solid structure of semiconductors, the course aims to examine the basic physical processes taking place in semiconductor devices and their relation to the performance parameters of device operation.

Recommended or required reading

Textbook: *Semiconductor Device Fundamentals*, R.F.Pierret (Addison Wesley, 1996)
Reference: *Modern Semiconductor Devices for Integrated Circuits*, C. Hu (Prentice Hall, 2009)

Course Outline (*dates are tentatively set to provide a rough estimate and may be subject to revision***)**

wk.1	27-Sep	Introduction, Solid State structure of semiconductors, and semiconductor terminology	Ch.1
wk.2		Band theory of semiconductors, Fermi Level and Fermi potential, determining electron and hole concentrations in the intrinsic and doped semiconductors	Ch.2
wk.3		Band theory of semiconductors, Fermi Level and Fermi potential, determining electron and hole concentrations in the intrinsic and doped semiconductors. Examples, practice problems.	Ch.2
wk.4		Concepts of drift, diffusion, recombination-generation of electrons and holes, Einstein's Relationship, Quasi-Fermi Levels, derivation of steady state minority carrier diffusion equations	Ch.3
Quiz 1 (25-Oct): covers lectures wk.1-4			
wk.5		Concepts of drift, diffusion, recombination-generation of electrons and holes, Einstein's Relationship, Quasi-Fermi Levels, derivation of steady state minority carrier diffusion equations.	Ch.3
wk.6		Concepts of drift, diffusion, recombination-generation of electrons and holes, Einstein's Relationship, Quasi-Fermi Levels, derivation of steady state minority carrier diffusion equations. Work Function, Metal-Semiconductor Junction, Ohmic and Schottky contact analysis	Ch.3, Ch.14-15

wk.7		Work Function, Metal-Semiconductor Junction, Ohmic and Schottky contact analysis.	Ch.14-15
wk.8		Electrostatic analysis of a p-n junction. Working principle, I-V derivation and small signal analysis of the ideal diode. Analysis of variations from the ideal case.	Ch.5-6
Midterm (15-Nov): covers lectures wk.1-7			
wk.9		Electrostatic analysis of a p-n junction. Working principle, I-V derivation and small signal analysis of the ideal diode. Analysis of variations from the ideal case.	Ch.5-6
wk.10		Analysis of the MOS structure. MOS terminology and the MOS capacitor	Ch.16
wk.11		Analysis of the MOS structure. MOS terminology and the MOS capacitor	Ch.16
Quiz 2 (15-Dec): covers lectures wk. 8-9			
wk.12		MOSFETs. Working principle, I-V derivation, small-signal model derivation for the enhancement type ideal MOSFET.	Ch.17
wk.13		MOSFETs. Working principle, I-V derivation, small-signal model derivation for the enhancement type ideal MOSFET.	Ch.17, 19
wk.14	27-Dec	Introduction to BJTs, working principle, biasing modes, circuit configurations.	Ch.10-11

Learning Outcomes

1. To understand the fundamental physical properties of semiconductors.
2. To learn the behavior of carriers in a semiconductor crystal in equilibrium, continuity equations, concept of minority-majority carriers, doping.
3. To learn the fundamental theory and the relationships for the analysis of semiconductor devices and be able to explain the operation of fundamental semiconductor devices including pn junctions, bipolar junction transistors and field effect transistors.
4. To learn energy band models and be able to draw energy band diagrams for semiconductor structures subject to various conditions.
5. Comprehensive understanding of the derivation of I-V relationships used in electronic circuit analysis of fundamental building blocks of semiconductor ICs.

Course Policies

Attendance and active participation to lectures and recitations are mandatory and will constitute part of the course grade. There will be unannounced short quizzes typically every lecture on material covered on that day which will count towards your attendance grade. If you miss a test and want to make it up, you must contact me and explain your excuse as soon as possible. If it is a health problem you must bring your doctor's report, which is given or checked by SU Health Center, as well. In case you are unable to visit me, you, a friend or a relative should somehow (e-mail, phone, etc.) let me know about the situation.

Grading Scheme

Final	40 %	1	**Quiz 1**	8 %	1
Midterm	30 %	1	**Quiz 2**	8 %	1
Attendance	9 %	9	**Homework**	5 %	4

Honor Code

Any form of cheating, copying will be strictly penalized and against the academic integrity statement of Sabanci University. As such, “We, as Sabancı University stakeholders, believe that the principle of academic integrity constitutes the most important component of any research, creative work and/or of the learning process. Academic integrity is the foremost of our responsibilities toward the world of knowledge, to the society in which we live, to each other, and to ourselves. Within this framework, therefore, we as Sabancı University faculty members, students, and administrators, declare that we will neither violate the principle of academic integrity nor allow others to do so.”