UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

SYLLABUS DEL CORSO

Physics and Technology of Electronic Devices

2526-2-FSM01Q029

Aims

The course will provide theoretical and practical understanding of the physics and technology of modern semiconductor devices. Starting from pure electronic devices, including diodes and transistors, the course will extend to opto-electronic devices, LEDs, lasers and photodetectors, and finally to functional semiconductor electrodes for bio- and ion sensing, solar hydrogen generation and photofuel cells. In addition to the lectures the course includes two laboratory activities dedicated to the characterization and simulation of mainly electronic devices.
At the end of the course the students will acquire a solid knowledge and understanding of basic semiconductor physics concepts applied to specific electronic, optoelectronic and photoelectrochemical device functionalities. The students will be able to evaluate the limits of current device architectures and fabrication technologies. The students will develop efficient problem solving strategies and strengthen continued learning skills by collectively treating dedicated exercises.

Contents

The physics and applications of conventional electronic devices, of opto-electronic devices and of emerging devices based on functional electrodes for photoelectrochemical devices.

Detailed program

LECTURES

1. p-n junctions

2. Metal-semiconductor junctions
3. Bipolar transistors
4. Field-effect transistors
5. Heterojunction devices
6. LEDs and lasers
7. Photodetectors and solar cells
8. Bio- and ion sensors
9. Solar hydrogen and photofuel cells

LABORATORY

1. Introduction to the experimental techniques and set-ups
2. Semiconductor-metal contacts: ohmic and Schottky contacts. Zener diode
3. BJT: I-V
4. MOS: C-V (doping profile, defects, high-k -EOT)
5. MOSFET: I-V, C-V
6. Introduction to TCAD
7. Surviving to Linux
8. Building up the device: SSE
9. Practice: Zener diode / MOSFET / Bipolar
10. Hints on discretization
11. Meshing the device: SSE/SNMESH
12. Practice: Zener diode / MOSFET / Bipolar
13. Solving the device: SDevice 3h
14. Visualizing results: SVisual 1h
15. Practice: simulated device characterization

Prerequisites

Solid State Physics and Physics of Semiconductors.

Teaching form

The course comprises lectures in the classroom and a laboratory part dedicated to electrical characterization and simulation.
In particular:
a) 16 two-hour lectures, in person, Delivered Didactics
b) 4 four-hour practical classes (lab), in person, Interactive Teaching

Textbook and teaching resource

- M. Shur, Physics of Semiconductor Devices, Prentice Hall
- D. Neaman, Semiconductor Physics and Devices, McGraw Hill
- S.M. Sze, Physics of Semiconductor devices, J. Wiley
- Notes from the teachers
- Slides of the lectures on the e-learning platform

Semester

Ist Semester

Assessment method

In an oral exam students must demonstrate that they are familar with the fundamental principles of the various semiconductor devices and the underlying physics and how the functions of these devices can be simulated and experimentally analyzed. The exam consists of two or three questions on different topics of the course which have to be discussed based on schematic drawings, equations and numerical data. The student may choose the first topic and must submit the lab activity report at least five days before the exam. Proficiency in qualitative and quantitative aspects of device functioning will be evaluated, considering the physical understanding and related theoretical formalism. The experimental part will be assessed by discussing the final laboratory report.

Office hours

On request

Sustainable Development Goals

QUALITY EDUCATION | AFFORDABLE AND CLEAN ENERGY | INDUSTRY, INNOVATION AND INFRASTRUCTURE