Nanoelectronic Devices 2014/2015

Code: 43430
ECTS Credits: 6

Degree	Type	Year	Semester
4314939 Advanced Nanoscience and Nanotechnology	OT	0	1

Contact

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Use of languages

Principal working language: anglès (eng)

Some groups entirely in English: No

Some groups entirely in Catalan: Yes

Some groups entirely in Spanish: No

Teachers

Xavier Oriols Pladevall

Pedro Carlos Feijoo Guerro

David Jiménez Jiménez

Enrique Alberto Miranda

Prerequisites

Some basic knowledge about electron devices is very convenient.

Objectives and Contextualisation

1) Obtain a general vision about the state-of-the-art in nanoelectronics mainly from the anallysis of the International Technology reoadmap for Semiconductors. This will include the understanding of the most important technological barriers, the research goals and the main evolution trends.

2) To know the main techniques for the fabrication of electron devices, with the goal of establishing a link to their performance.

3) To adquire a broad view of the main techniques for the simulation of nanoelectronic devices, being able to determine which method is mots adequate for each particular situation.

4) Get some understanding of the principles of operation of the main nanoelectronic devices, including devices for logic and memory.

Skills

- Analyse the benefits of nanotechnology products, within one's specialisation, and understand their origins at a basic level
- Continue the learning process, to a large extent autonomously
- Critically analyze the principles of operation and expected benefits of electronic devices operating at the nanoscale (nano-electronics specialty)

- Identify and distinguish the synthesis/manufacture techniques for nanomaterials and nanodevices typically adopted in one's specialisation.
- Show expertise in using scientific terminology and explaining research results in the context of scientific production, in order to understand and interact effectively with other professionals.

Learning outcomes

1. Choose the most appropriate simulation/modelling method for a nanoelectronic device on the basis of its physical characteristics and operational principle.
2. Continue the learning process, to a large extent autonomously
3. Describe the current state of nanoelectronic technologies and the directions in which they are moving, in accordance with the International Technology Roadmap for Semiconductors.
4. Describe the operational principles of emerging devices, and their main advantages and limitations.
5. Describe the operational principles of what are currently the main logic and memory devices.
6. Know the principles behind the techniques used for making the most important nanoelectronic devices.
7. Show expertise in using scientific terminology and explaining research results in the context of scientific production, in order to understand and interact effectively with other professionals.

Content

- Historical evolution of microelectronics and nanoelectonics. State-of-the-art of CMOS technology, tredns and alternatives in the frontiers of their dimensional scaling. International Technology Roadmap for Semiconductors.

- Devices fabrication technology. An introduction to optical, electron beam and local probe lithography, molecular beam epitaxy, Chemical Vapor Deposition, atomic layer deposition, pulsed laser deposition.

- Simulation and multiscale modelling of electornic transport in nanoelectronic devices. Firt principles simulations. Semiclassical models. Classical and quantum Monte Carlo simulation. Landauer transmission approach. Compat modelling. Noise at the mesoscale.

- Nanoelectronic devices for logic and memory applications. Advanced field-effect transistors. Beyond CMOS devices. Voloatile and non-volatile memories. Ionic and magnetic devices for storage-class memories.

Methodology

We will combine class lectures with autonomous homework, including the reading of research papers, solution of excercises, the critical reading of ITRS documents and oral presentations by the students.

Activities

Title	Hours	ECTS	Learning outcomes
Type: Directed			
Autonomous works and report writting	65	2.6	4, 5, 3, 7, 1, 2
Lessons	30	1.2	6, 4, 5, 3, 1
Oral presentation	6	0.24	7, 2
Reading of research papers and other scientific documents	30	1.2	2
Use of TCAD tools for electron devices	15	0.6	2

Evaluation

We will combine the final exam with active participation in class and careful preparation of homework reports

Evaluation activities

Title	Weighting	Hours	ECTS	Learning outcomes
Attendance and participacion in class	25	0	0	6, 4, 5, 3, 7, 2
Final exam	40	4	0.16	6, 4, 5, 3, 7, 1, 2
Homework report	35	0	0	4, 5, 3, 7, 1, 2

Bibliography

1) International Technology Roadmap for Semiconductors

2) Electrical Transport in Nanoscale Systems Hardcover , Cambridge 2008 by Massimiliano Di Ventra

3) Transport in Nanostructures, Cambridge 1997 by David K. Ferry, Stephen Marshall Goodnick

4) Y. Taur and T. H. Ning, Fundamentals of Modern VLSI devices, Cambrigde University Press 2009