Course guide
2301201 - MITP - Microelectronic Technologies and Processes

Last modified: 29/05/2025

Unit in charge: Barcelona School of Telecommunications Engineering
Teaching unit: 1022 - UAB - (ANG) pendent.

Degree: MASTER'S DEGREE IN SEMICONDUCTOR ENGINEERING AND MICROELECTRONIC DESIGN (Syllabus 2024). (Compulsory subject).

Academic year: 2025 **ECTS Credits:** 6.0 **Languages:** English

LECTURER

Coordinating lecturer: JOAN BAUSELLS ROIGÉ

Others: Primer quadrimestre:
JOAN BAUSELLS ROIGÉ - 11, 13
SALVADOR HIDALGO VILLENA - 11, 13
FRANCESC PÉREZ MURANO - 11, 13
FRANCESC TORRES CANALS - 11, 13

PRIOR SKILLS

Basic concepts at the level of a bachelor's degree of physics, chemistry, and mathematics, and specifically of solid-state physics and electron devices.

LEARNING RESULTS

Knowledges:
KT01. Identify semiconductor devices, technological processes, the most appropriate microelectronic design tools, and relationships between these elements in order to integrate a given product or system into microelectronic technologies.
KT02. Describe the current state of scientific research and microelectronic industrial technology worldwide and their economic, social and environmental impact.
KT03. Describe the physical principles underlying current semiconductor devices in relation to their application, as well as their emerging trends, modelling and characterisation techniques.
KT07. Identify gender stereotypes and roles and how they may impact professional practice.
KT04. Identify and describe the different manufacturing and characterisation processes in microelectronics and their applicability according to the functional and cost requirements of the final integrated product.

Skills:
ST01. Design integrated devices, circuits and systems for new products according to their applications, taking into account sustainability and energy efficiency requirements.
ST02. Apply the manufacturing techniques and processes and design, simulation and characterisation tools of semiconductor engineering and microelectronic design to provide a solution to a specific integrated system proposal.
ST03. Critically analyse the principles, values and procedures that govern the practice of the profession.
ST04. Select appropriate sources of information from the scientific and technical literature, using appropriate channels, and integrate this information, demonstrating the ability to synthesise information, analyse alternatives and engage in critical debate.
ST05. Communicate the results of one's work, the conclusions reached and the knowledge and reasoning underlying them clearly, concisely and unambiguously to specialist and non-specialist audiences, both orally and in written technical and/or scientific documents.
ST06. Plan the different activities involved in successfully carrying out an assigned task within a team, managing time and resources appropriately.
ST07. Work as part of a heterogeneous team that includes supervisors and specialist and non-specialist members.

Competences:
CT01. Design new devices and integrated systems that require the use of manufacturing techniques specific to microelectronic technologies or the use of microelectronic design tools.
CT02. Apply sustainability criteria to projects based on integrated microelectronic products.
CT03. Apply the processes of semiconductor engineering and microelectronic design to fields in diverse areas of science or engineering where integrated systems are required.
CT04. Generate questions and hypotheses, propose methodologies to address new research and innovation challenges, and demonstrate originality in approaching and solving problems requiring integrated solutions in microelectronic technologies.

TEACHING METHODOLOGY

Theory classes (large group) where the contents of the subject matter are presented, combined with classes on exercises and problems solving. There is also a practical part consisting of 5 computer laboratory sessions, where simulations of manufacturing processes are carried out, including their integration.

LEARNING OBJECTIVES OF THE SUBJECT

1. Acquire knowledge on the individual technological processes that are used in microelectronics.
2. Learn the basic parameters that control each one of the individual processes in microelectronics technology.
3. Be able to evaluate the result of performing a technological process.
4. Be able to analyse the process sequence that has been used for the fabrication of a microelectronic device.
5. Acquire the skills to understand and apply the design rules of the standard fabrication processes (e.g. by commercial foundries) in microelectronics technology.
6. Acquire the competence to design a sequence of process steps for the fabrication of a specific microstructure or device.

STUDY LOAD

Type	Hours	Percentage
Hours large group	38,0	25.33
Hours small group	10,0	6.67
Self study	102,0	68.00

Total learning time: 150 h

CONTENTS

Module 1. Introduction to semiconductor manufacturing technologies

Description:
1. Introduction to microelectronics technologies
Concept of planar technology. Evolution of microelectronics technology.
2. Basic concepts on semiconductors and devices
Review of basic concepts of semiconductor physics: energy bands, carrier concentration and doping, carrier transport. Basic structures of semiconductor devices: planar MOSFET, FDSOI, FinFET.

Full-or-part-time: 5h 30m
Theory classes: 5h 30m

Module 2. Processes for microelectronics fabrication

Description:
Description of the individual processes that are used for microelectronics fabrication.
3. Cleaning and oxidation
Wafer cleaning. Dry and wet oxidation of silicon.
4. Impurity doping of semiconductors
Thermal pre-deposition. Thermal diffusion. Ion implantation.
5. Thin film deposition techniques
5.1. Chemical Vapour Deposition: Low-pressure CVD, Plasma-Enhanced CVD, Atomic Layer Deposition.
5.2. Physical Vapour Deposition: Evaporation, sputtering.
6. Lithography
6.1. Optical lithography
6.2. Electron beam lithography. Mask making.
7. Etching
7.1. Wet chemical etching: Isotropic and anisotropic techniques.
7.2. Dry etching: Reactive Ion Etching, Deep reactive ion etching.
7.3. Chemical Mechanical Polishing

Full-or-part-time: 20h 30m
Theory classes: 20h 30m

Module 3. Process integration

Description:
Integration of sequences of process steps (process flows) for the fabrication of specific microstructures or devices. Introduction to the simulation of processes. Introduction to Process Design Kits, which act as a bridge between manufacturing technologies and circuit design.
8. Integration examples
8.1. General concepts of process integration.
8.2. Process modules for CMOS technology.
8.3. Integration of processes for Micro Electro Mechanical Systems (MEMS) fabrication.
8.4. Technologies for advanced nodes: FinFET.
9. Technology-related CAD tools
9.1. Introduction to Technology Computer-Aided Design for process simulation.
9.2. Introduction to Process Design Kits (PDK).

Full-or-part-time: 12h
Theory classes: 12h

Simulation laboratory

Description:
Practical sessions of process simulation with Technology Computer-Aided Design (TCAD) software tools. Five sessions of 2 hours.

Full-or-part-time: 10h
Laboratory classes: 10h

GRADING SYSTEM

Final written examination (50 %), proposed exercises/problems (30%), reports corresponding to laboratory sessions (20%).

BIBLIOGRAPHY

Basic:
- May, G.S.; Sze, S.M. Fundamentals of semiconductor fabrication. New York: Wiley, 2004. ISBN 0471232793.
- Sze, S.M.; Lee, M.-K. Semiconductor devices, physics and technology. 3a ed. int. stud. ed. Singapore: Wiley, 2013. ISBN 9788126556755.
- Campbell, S.A. Fabrication engineering at the micro- and nanoscale. 4th ed. Oxford: Oxford University Press, 2013. ISBN 9780199861224.
- Franssila, S. Introduction to microfabrication [on line]. 2a ed. Chichester, West Sussex, England: John Wiley & Sons, 2010 [Consultation: 31/07/2024]. Available on: https://onlinelibrary-wiley-com.recursos.biblioteca.upc.edu/doi/book/10.1002/9781119990413. ISBN 9781119990413.
- Doering, R.; Nishi, Y. Handbook of semiconductor manufacturing technology. 2a ed. Boca Raton: CRC Press, 2008. ISBN 9781574446753.