Course guide
2301212 - MS - Microsensors

Last modified: 22/04/2024

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). (Optional subject).

Academic year: 2024 **ECTS Credits:** 4.0 **Languages:** English

LECTURER

Coordinating lecturer: Gabriel Abadal

Others: Núria Barniol, Francesc Torres, Jaume Esteve, Toni Baldi

PRIOR SKILLS

Advanced knowledge of physics and maths

TEACHING METHODOLOGY

Theory: Oral exposition of the fundamentals concepts.
Laboratory: Hands-on specific tools for MEMS design and analysis. Finite elements simulations

LEARNING OBJECTIVES OF THE SUBJECT

1. To give a global vision of microsensors and MEMS technologies. Terminology and basic concepts.
2. To state the basic equations for the analysis and design of the fundamental mechanical structures.
2. To describe the phenomenology and transduction principles which are the bases of the MEMS structures operation in microsensors.
4. To identify the most relevant examples of state-of-the-art applications of microsensors.
5. To apply the simulation techniques for the analysis and design of microsensors.

STUDY LOAD

Type	Hours	Percentage
Hours large group	18,0	18.00
Hours small group	12,0	12.00
Self study	70,0	70.00

Total learning time: 100 h

CONTENTS

1. Introduction to microsensors

Description:
basic concepts, MEMS, typologies, and applications

Full-or-part-time: 2h
Theory classes: 2h

2. Basic mechanical structures for MEMS systems

Description:
beams and membranes. Elasticity theory. Static and dynamic performance.

Full-or-part-time: 4h
Theory classes: 4h

3. Transducers

Description:
materials, mechanisms and devices. Piezoresistive, piezoelectric, electrostatic, electromagnetic, optical, thermal.

Full-or-part-time: 4h
Theory classes: 4h

4. Microsensors and microactuators

Description:
a. Inertial: accelerometers, gyroscopes, magnetometers, IMUs.
b. Ambient: temperature, pressure, gas, humidity, VOC, particles.
c. Acoustics: microphones, microspeakers, SAW, BAW, PMUTs.
d. Biosensors: chemical sensors, electrochemical sensors.

Full-or-part-time: 8h
Theory classes: 8h

Lab sessions

Description:
Development of a MEMS microsensor to address a specific functionality, including design, simulation (mechanics and transduction), fabrication process proposal to demonstrate its viability.
a. Conceptualization of the proposal and basic design of the solution.
b. FEM simulation of the structure. Modelling and simulation of transducing elements. FEM simulation tools. Simulations domains: mechanical, electromagnetic, thermal, optical, fluidic, acoustic. Modelling and simulation at the system level.
c. Characterization at LAB of a fabricated microsensor.

Specific objectives:
Microsensors course aims to provide a wide overview of the microsensors and MEMS technology, from the most basic concepts of elasticity theory and main transducing mechanisms to their more advanced applications in the fields of physical sensors, ambient sensors and biosensors, through the discussion of state-of-the-art examples

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

GRADING SYSTEM

Examination: course work (reports/exposition of laboratory work, exercises/problems) (60%) + written exam (40%).

BIBLIOGRAPHY

Basic:

- Senturia, S.D. Microsystems design [on line]. New York: Springer, 2001 [Consultation: 14/06/2024]. Available on: https://link-springer-com.recursos.biblioteca.upc.edu/book/10.1007/b117574. ISBN 9780306476013.
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- Göpel, W.; Hesse, J.; Zemel, J.N. Sensors: a comprehensive survey: vol.7: mechanical sensors. Weinheim ; New York: F.R.G. ; VCH, 1993. ISBN 9783527267736.
- Baltes, H.; Göpel, W.; Hesse, J. Sensors update. Wiley-VCH, 1996. ISBN 9783527294336.
- Kaajakari, V. Practical MEMS. 2nd ed. Small Gear Publishing, 2024. ISBN 9780982299111.
- Vigna, B.; Ferrari, P.; Villa, F.F.; Lasalandra, E.; Zerbini, S. (eds). Silicon sensors and actuators: the Feynman roadmap [on line]. Switzerland: Springer, 2023 [Consultation: 14/06/2024]. Available on: https://link-springer-com.recursos.biblioteca.upc.edu/book/10.1007/978-3-030-80135-9. ISBN 9783030801359.