MICRO-534

Advanced MEMS & microsystems

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Cursus	Sem.	Type
Microtechnics	MA2, MA4	Obl.
Microtechnics	MA2, MA4	Opt.

Language of teaching	English
Credits	3
Session	Summer
Semester	Spring
Exam	Oral
Workload	90h
Weeks	14
Hours	**3 weekly**
Courses	3 weekly
Number of positions	

Summary

In depth analysis of the operation principles and technology of advanced micro- and nanosystems. Familiarisation to their implementation into products and their applications.

Content

Introduction: MEMS history, overview of the different types of MEMS and microsystems. Smart systems and 3D architectures. Current state of the art and trends at the academic and industrial levels. Market players and forecasts.
Transducing principles review: Detection (capacitive, piezoresistive, thermal) and actuation (thermal, electromagnetic, electrostatic, piezoelectric) principles of common MEMS devices.
MEMS Sensors: Introduction to motion sensors, 3D accelerometers, gyroscopes, pressure sensors, microphones, resonators, CMOS integration, multi-parametric sensor devices.
MEMS Actuators and Optical MEMS: Electrostatic and magnetic actuators; MOEMS in Consumer Electronics and Mobile (Micromirrors and Arrays, Scanners, Projectors, Displays, MEMS Spectrometers and Optical Filters); MOEMS in Telecommunications (Optical Switches, Tunable Lasers, Filters and Variable Optical Attenuators).
MEMS Gas Sensors: capacitive, resistive, catalytic, FET, optical, silicon micromachined vapor and gas sensing devices, micro-analytical instruments for gas detection.
RF-MEMS: RF resonators for filters, frequency sources, time reference, and sensors.
NEMS: Introduction to Nano electro mechanical systems with particular emphasis on physical, chemical and biological sensors.
Packaging: Die level vs. wafer level, packaging techniques, hermetic packaging, Through Silicon Vias (TSVs), 3D-integration.
Power MEMS: Overview of micro power sources, batteries and solar cells vs. MEMS based devices, energy harvesting (thermal, mechanical and chemical).
Polymeric and Printed Microsystems: Polymeric MEMS on rigid and soft substrates. Printing technologies and printed sensors.
Industrial Seminars: Presenting the manufacturing and/or the implementation of MEMS devices into products

Keywords

MEMS/NEMS, Microsystems, Sensors and Actuators, Motion sensors, Actuators, Resonators, RF, Power, Optical, Polymer, Packaging.

Learning Prerequisites

Recommended courses

Sensors, Materials and Technology of Microfabrication I&II

Learning Outcomes

By the end of the course, the student must be able to:

- Explain the operation principles of advanced micro- and nanosystems
- Describe the technology implemented in advanced micro- and nanosystems
- Apply a concept of a micro- and nano-device into a real device considering the scaling laws and boundary conditions involved
- Present the basics of implementation of MEMS into products
- List the trends in the sensor and MEMS field

Transversal skills

- Plan and carry out activities in a way which makes optimal use of available time and other resources.
- Assess one's own level of skill acquisition, and plan their on-going learning goals.
- Access and evaluate appropriate sources of information.

Teaching methods

Lectures, exercises, case studies, and seminars from the industry.

Expected student activities

Attendance at lectures and seminars
Reading written material
Solving the exercises

Assessment methods

Oral Examination at the end of the course
Oral presentation during the course
Reports on Industrial Seminars

Resources

Bibliography

- Stephen Senturia (Editor in chief), MEMS Reference Shelf, Springer, 2010 and later.
- Advanced Micro & NanoSystems, Wiley-VCH book series, 10 volumes, 2004 and later.
- Thomas B. Jones, Nenad G. Nenadic, Electromechanics and MEMS, Cambridge University Press, 2013.
- Gregory T.A. Kovacs, Micromachined Transducers Sourcebook, McGraw-Hill, 1998, 911 pp.
- Marc Madou, Fundamentals of Microfabrication and Nanotechnology, 3rd Edition, CRC Press, 2011.
- Manouchehr E. Motamedi, MOEMS : Micro-opto-electro-mechanical systems, 2005.

Ressources en bibliothèque

- MEMS Reference Shelf / Senturia
- Micromachined Transducers Sourcebook / Kovacs
- Fundamentals of Microfabrication and Nanotechnology / Madou
- MOEMS:Micro-opto-electro-mechanical systems / Motamedi
- Electromechanics and MEMS / Jones
- Advanced Micro & NanoSystems
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