MICRO-534

Advanced MEMS & microsystems

Briand Danick

Cursus	Sem.	Type
Microengineering minor	E	Opt.
Microtechnics	MA2, MA4	Opt.
Robotics	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 and scaling laws: Detection (capacitive, piezoresistive, thermal) and actuation (thermal, electromagnetic, electrostatic, piezoelectric) principles of common MEMS devices. Scaling laws of main transducing principles.
MEMS Sensors: Introduction to motion sensors, 3D accelerometers, gyroscopes, pressure sensors, CMOS integration, multi-parametric sensor devices.
Actuators and Optical MEMS: Electrostatic and magnetic actuators; MOEMS in Consumer Electronics and Mobile (Micromirrors and Arrays, Scanners, Projectors, Displays)
Acoustic and Ultrasonic MEMS: Microphones, ultrasonic transducers, microspeakers, finger print sensors, piezoelectric MEMS
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.
Thermal and Gas Sensors: Thermal flow sensors and accelerometers, capacitive, resistive, catalytic, FET, optical, and vapor/gas sensing devices.
Packaging: Die level vs. wafer level, packaging techniques, hermetic packaging, Through Silicon Vias (TSVs), 3D-integration.
Power MEMS: Overview of micro power sources, MEMS based energy harvesting devices
Industrial Seminars: Presenting the manufacturing and/or the implementation of MEMS devices into products

Keywords

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

Learning Prerequisites

Recommended courses

Sensors, Microfabrication Technologies, Physics of Semiconductors Devices

Learning Outcomes

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

- Explain the design and 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 sensors and MEMS field
- Report on the recent practices in the industry related to 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 (80%)
Oral Presentation during the course (10%)
Reports on Industrial seminars (evaluation is the average of the four best results) (10% of the grade)

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

- Micromachined Transducers Sourcebook / Kovacs
- Fundamentals of Microfabrication and Nanotechnology / Madou
- Advanced Micro & NanoSystems. Série de titres en ligne
- MEMS Reference Shelf / Senturia (ed). Série de titres en ligne
- MOEMS:Micro-opto-electro-mechanical systems / Motamedi
- Electromechanics and MEMS / Jones

Références suggérées par la bibliothèque

- Franssila, Introduction to microfabrication

Moodle Link

- https://go.epfl.ch/MICRO-534