**MICRO-504**

**Photonic micro- and nanosystems**

<table>
<thead>
<tr>
<th>Cursus</th>
<th>Sem.</th>
<th>Type</th>
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<tbody>
<tr>
<td>Génie électrique et électronique</td>
<td>MA2, MA4</td>
<td>Opt.</td>
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<tr>
<td>Microtechnique</td>
<td>MA2, MA4</td>
<td>Opt.</td>
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<tr>
<td>Photonics minor</td>
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<td>Opt.</td>
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**Language**: English  
**Credits**: 2  
**Session**: Summer  
**Semester**: Spring  
**Exam**: Oral  
**Workload**: 60h  
**Weeks**: 14  
**Hours**: 2 weekly  
**Number of positions**: 

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**Remarque**

pas donnée en 2018-19

**Summary**

This course aims at providing engineering and design guidelines for selected Photonic Micro- and Nanosystems. In particular, Optical MEMS and Integrated Photonics are reviewed. Standard fabrication processes and related design approaches are introduced and product aspects are discussed.

**Content**

- **Introduction**: Course Overview, Definitions, Review of Relevant Optics, MEMS/NEMS Fabrication Technologies.
- **Micromirrors**: Reflective Coatings, Distributed Bragg Reflectors, High Contrast Gratings; Piston and Tilting Micromirrors; Mechanical and Optical Design Constraints; Scanning and Projection Systems based on Micromirrors; Design Tradeoffs (Tilt Angle, Size, Speed, Resolvable Spots, Loss Mechanisms). Micromirror Imperfections.
- **Spatial Light Modulators**: Technologies, Amplitude and Phase Modulation, Performance and Applications; Deformable Mirrors; Liquid Crystal, MEMS, Grating Light Valve (GLV), Magneto-Optic, Optical Phased Arrays.
- **Photonic Switches**: Telecommunication Applications, Definition of Key Performance Figures, 2D Switches, Optical Cross Connects, Integrated Photonic Switches.
- **Tunable Lasers**: Tuning Mechanisms and Configurations, Design and Performance (Power, Tuning Range, Linewidth, Response Time).
- **Microspectrometers**: Dispersive Systems, Gratings, FTIR, Fabry Pérot Filters, Hyperspectral Imagers.
- **Silicon Photonics**: Platforms and ‘Standard’ Fabrication Processes, Passive Components (Waveguides, Transitions, Interferometers, Resonators, Filters, …), Active Components (Sources, Modulators, Detectors), Optical I/O (Grating Couplers, Edge Couplers, Direct Source Coupling).
- **Integrated Photonic Systems**: Promise of Integration; Transceivers and LIDAR-on-Chip System Examples.
- **Photonic System Packaging**: Assembly Strategies, Interfaces: Optical, Electrical, Thermal, Mechanical.

**Keywords**

Optical MEMS, MOEMS, Silicon Photonics, Microspectrometers, Spatial Light Modulators.

**Learning Prerequisites**

**Required courses**
• Micro-331 – Technologie des Microstructures I (or equivalent)

Recommended courses
• Micro-321, 322 – Ingénierie Optique (or equivalent)
• Micro-330 – Capteurs
• Micro-431 – Microstructures Technology II

Important concepts to start the course
• Microfabrication Techniques
• Optics Basics

Learning Outcomes
By the end of the course, the student must be able to:
• Explain the working principle of the discussed photonic micro- and nanosystems
• Analyze a given photonic microsystem with respect to its design constraints
• Discuss potential fabrication processes for a given photonic microsystem
• Propose a design for a photonic microsystem
• Assess / Evaluate design tradeoffs for miniaturized optical systems
• Propose a design for a silicon photonic integrated circuit

Teaching methods
The lecture will be given ex cathedra. Exercises and design examples will be discussed for selected systems. Short experiments will demonstrate selected particularities of spatial light modulators. A selection of scientific papers will be distributed and discussed.

Expected student activities
Attend lectures, read the course material, participate actively during discussions.

Assessment methods
Oral examination at the end of the course.

Resources
Bibliography
• Fundamentals of Photonics by B.E.A. Saleh & M.C. Teich, 2007, Wiley
• Photonic Microsystems by O. Solgaard, 2009, Springer (MEMS Reference Shelf)
• MOEMS Micro-Opto-Electro-Mechanical Systems by M. E. Motamedi, 2005, SPIE
• Silicon Photonics by L. Chrostowsky & M. Hochberg, 2015, Cambridge
• Spatial Light Modulator Technology by U. Efron, 1995, CRC Press

Ressources en bibliothèque
• Fundamentals of Photonics / Saleh
• Spatial Light Modulator Technology / Efron
Notes/Handbook
Lecture powerpoint slides will be available to download via moodle before each class.

Moodle Link