MG2816
Micro-Electro-Mechanical Systems (MEMS)

Professor: Denis Aubry

Language of instruction: French – **Number of hours**: 36 – **ECTS**: 3

Prerequisites: MG1100 or equivalent. Basic knowledge in Continuum Mechanics, Solids and Fluids

Period: S8 Elective 10 February to June IN28IE3, SEP8IE3

Course Objectives

In many technological areas, the miniaturization of systems is a major industrial issue. Micro-Electromechanical-Systems (MEMS) are often preferred to purely electronic systems for applications of measurement and control because they offer signicant advantages in terms of energy consumption (low insertion losses and insulation), reliability, fast response time. They are used in a variety of industrial applications such as automobiles, aeronautics, medicine, biology, telecommunications (ABS, smart phones, micro-switches, sensors, actuators).

Our objective is to present the operating principles, industrial applications, and fabrication processes for selected MEMS. In these examples, the main *multiphysics coupling mechanisms* will be described: vibrations, flow-structure interactions, thermal and electrical interactions. Numerical simulations of these coupling mechanisms will be presented through *intensive use of a multiphysics software*.

On completion of the course, students should be able to

- MEMS technology: applications, micromachining, design process and principles
- Design of sensors, actuators, gyroscopes, switch, micromotor
- Mutiphysics problems solving including: mechanics, temperature, fluids, electric and magnetic fields
- Applied skills with a multiphysics finite element software

Course Contents

- Interest and use of MEMS
- Main fabrication processes
- Multiphysics coupling: vibrations of microsystems, distortion by ohmic or capacitve effects, piezo-electric effects, microflow-structure coupling and fluid dampening in thin films
- Numerical simulations of real MEMS

Course Organization

Lectures: 12 hr, Tutorials: 12 hr, Project : 9 hr, Exam: oral presentation

Teaching Material and Textbooks

- Minhang Bao, Analysis and Design Principles of MEMS devices, Elsevier, 2005
- J. A. Pelesko, D. H. Bernstein, Modeling MEMS and NEMS, Chapman Hall/CRC, 2003

Evaluation

Written report and oral defense of the project