# Soft microrobotics

**Lecturer**
Pierre LAMBERT (Coordinator)

**Course mnemonic**
MECA-H501

**ECTS credits**
5 credits

**Language(s) of instruction**
English

**Course period**
Academic year

**Campus**
Solbosch

## Course content

This course presents some of the recent advances in soft/wet microrobotics, namely:

- Active materials and design methodologies to produce soft actuators and tunable stiffness mechanisms
- Compliant mechanisms for microrobotics (mainly produced in elastic metal by electro-discharge machining or glass for femtosecond laser machining), used to measure microforces or to provide kinematics in precision mechanics and MEMS applications
- Surface tension effects and capillary forces enhancing adhesion, sealing, actuation, or self-centering in microsystems

Additionally, two methodologies are also introduced:

- Scaling laws in micro-engineering (dimensional analysis, similitude laws)
- Design of experiments, to organize experimental campaigns in many parameters problems

## Objectives (and/or specific learning outcomes)

The goal of the course is to give an overview of the ongoing research in the field, to offer student the opportunity to become familiar with the scientific literature, and to apply one of the course topics in their own master thesis or in one of the research questions of the department

## Pre-requisits and co-requisits

### Required knowledge and skills

The course is based on previous courses of mechanical engineering: mechanics, materials strength, kinematics, and dynamics of machines.

## Teaching method and learning activities

- 24h theory: theoretical course and seminars based on ongoing research in the department
- 24h practical work: introduction to the software Design Expert used in design of experiments, exercises on scaling laws, and individual work applying the course to your master thesis or to a research question of the department. Examples of past works: design of an electrostatic actuator (coupling of electrostatics and compliant mechanisms), design and assembly of a lateral capillary forces [http://www.springerlink.com/content/j85q5h5576nr3164/?MUD=MP] test bed, to characterize industrial micro-assembly processes, design and assembly of a forces measurement device to characterize granular adhesion in soil mechanics, characterization of silicone-ethanol actuators...
- 12h personal work

### Contribution to the teaching profile

Develop a scientific methodology mixing rigor and creativity, develop structured scientific approaches, with tools and languages appropriate for sciences and engineering sciences.

### References, bibliography and recommended reading


- T. Szirtes, Applied Dimensional Analysis and Modelling [http://www.amazon.com/Applied-Dimensional-Analysis-Modeling-Edition/dp/0123706203]
- N. Chaillet, M. Hafez and P. Lambert, Actuators for Microrobotics, in Microrobotics for Micromanipulation [http://www.amazon.com/Microrobotics-Micromanipulation-ISTE-Nicolas-Chaillet/dp/1848211864]
- L. Howell, Compliant mechanisms [http://books.google.be/books/about/Compliant_Mechanisms.html?id=tiiSOuhslfgC&redir_esc=y]
- S. Henein, Conception des guidages flexibles [http://books.google.be/books/about/Conception_des_guidages_flexibles.html?id=0z9pu7uC8MAC&redir_esc=y]
- M.P. Koster, Constructieprincipes [http://www.bol.com/nl/p/constructieprincipes/1001004005902416]
- P. Lambert, Capillary Forces in Microassembly [http://www.amazon.com/Capillary-Forces-Microassembly-Experiments-Microtechnology/dp/0387710884]

- D. Montgomery, Design and Analysis of Experiments [https://www.wiley.com/en-us/Design+and+Analysis+of+Experiments%2C+10th+Edition-p-9781119492443]
- H. Koshima, Mechanically Responsive Materials for Soft Robotics [https://onlinelibrary.wiley.com/doi/book/10.1002/9783527822201]

### Course notes

Université virtuelle

## Other information

### Place(s) of teaching

Solbosch

### Contact(s)

Pierre LAMBERT, TIPs, http://plambert.ulb.be

## Evaluation method(s)

Other

### Evaluation method(s) (additional information)

Oral examination (75%) + written project report (25%)

### Determination of the mark (including the weighting of partial marks)

Oral examination (75%) + written project report (25%)

### Main language(s) of evaluation

English and French

## Programmes

### Programmes proposing this course at the Brussels School of Engineering

MA-IRCB | Master of science in Biomedical Engineering | finalité Professional/unit 2, MA-IREM | Master of science in Electromechanical Engineering | finalité Professional/unit 2 and MS-NATE | Specialized Master in Nanotechnology | unit U