

# AS-74.4340 Special Course in Control Engineering, summer 2013

## **Topic: Surface tension effects in microsystems, 2-3 ECTS**

Lecturer: Prof. Pierre LAMBERT, Universite Libre de Bruxelles

Lecture room: TUAS building, AS3. First lecture: 20.08.2013 at 10:00.

### **Introduction**

This course will be based on a new book to be published this summer.

Pierre LAMBERT, Surface Tension in Microsystems: Engineering Below the Capillary Length, Springer, ISBN 978-3-642-37551-4

<http://www.springer.com/materials/mechanics/book/978-3-642-37551-4>

- Summarizes most recent developments and research results in surface tension for emerging industrial products
- Provides an original and comprehensive study of surface tension forces and torques including modeling, simulation, experimental set ups
- Contains many case studies including gripping, actuation, capillary filling, sealing, self-assembly, adhesion for better understanding

This course describes how surface tension effects can be used by engineers to provide mechanical functions in miniaturized products (<1 mm). Even if precursors of this field such as Jurin or Laplace already date back to the 18th century, describing surface tension effects from a mechanical perspective is very recent.

It provides a comprehensive approach to various applications, such as capillary adhesion (axial force), centering force in packaging and micro-assembly (lateral force) and recent developments such as a capillary motor (torque).

It devises how surface tension can be used to provide mechanical functions such as actuation (bubble-actuated compliant table), sealing and tightness, energy harvesting, nanodispensing.

**Content Level** » Research

**Keywords** » axial capillary forces - bubble-actuated compliant table - capillary adhesion - capillary forces - capillary forces and adhesion - capillary micro motor - capillary torque - lateral capillary forces - modelling capillary forces - packaging of microdevices - surface tension book

## Detailed content

### 20.08: 10:00-12:00 **Surface tension effects and capillary forces I** / Introduction and applications

Surface energy, surface tension, contact angle, Gibbs equation, curvature, Laplace equation, forces Handling and micromanipulation, self-assembly, capillary condensation, actuation, microfluidics, micro-optics

### 21.08: 10:00-12h00 **Surface tension effects and capillary forces II** / Models and measures

Energetic method (towards Surface Evolver), Laplace equation based models, geometrical models, lateral stiffness of menisci

### 22.08: 10:00-12:00 **Surface tension effects and capillary forces III** / Exercises

### 26.08: 14:00-16:00 **Dimensional analysis I** / PI-theorem and dimensional matrix

### 27.08: 10:00-12:00 **Dimensional analysis I** / Scaling laws and exercises

### 28.08: 10:00-12:00 **Design of experiments I** / Introduction (T-test, ANOVA, factorial designs)

### 29.08: 10:00-12:00 **Design of experiments II** / Exercises (paper exercises and/or design expert)

## Home work (tentative):

- Write a Matlab code to compute meniscus shape and capillary forces between two parallel plates
- Write a personal report on surface tension effects in your research

## Contact information:

Course assistant: Ville Liimatainen, AS, email: [ville.liimainen@aalto.fi](mailto:ville.liimainen@aalto.fi)

Host professor: Quan Zhou, AS, email: [quan.zhou@aalto.fi](mailto:quan.zhou@aalto.fi)