EPFL

MICRO-718

Theoretical Microfluidics

Gijs Martinus, Lehnert Thomas

Cursus	Sem.	Type
Microsystèmes et microélectronique		Opt.

Language	English
Credits	1
Session	
Exam	Oral
Workload	30h
Hours	**14**
Lecture	14
Number of positions	**25**

Frequency

Every 2 years

Remark

May 10 to 12, 2021 - Online

Summary

Navier-Stokes equations and basic flow solutions / Hydraulic resistance and compliance / Diffusion and mixing on the microscale / Capillary effects and droplets -- Electrohydrodynamics and Electroosmosis / Nanofluidics Dielectrophoresis / Magnetophoresis.

Content

Liquid flows on the microscale often do not behave as we would expect intuitively from our macroscopic point of view. The goal of this course is to provide an insight into specific fluidic phenomena that appear on the scale of typical lab-on-a-chip devices. The course intends to give a more theoretical introduction of fundamental formulas and equations. Nevertheless a range of selected devices/applications will be shown to exemplify specific microfluidic properties. Using the Navier-Stokes equation we will first derive solutions for some basic microfluidic situations, with specific focus on pressure-driven flows. The impact of liquid/channel wall interfaces (capillary forces) on the solution transport in microchannels will be discussed. Analysing the convection-diffusion equation will allow to understand issues related to diffusion and mixing encountered in many lab-on-a-chip applications. In the last part of the course the physical background of liquid transport by electrical fields on the micro- and nanoscale will be explained in detail (electroosmosis). We will also derive the formulas governing the manipulation of cells or particles by electric (dielectrophoresis) and magnetic forces in microfluidic devices.

Keywords

Microfluidics, lab-on-a-chip, Navier-Stokes equation, electroosmosis

Learning Prerequisites

Important concepts to start the course

Basic knowledge in physics and lab-on-a-chip technologies/applications

Learning Outcomes

- Explain basic concepts and main equations related to (micro-)fluidic (e.g. Navier-Stokes eqns, Stokes eqns, etc).
- Apply these concepts to simple fluidic model situations.

Resources

EPFL

Bibliography

Henrik Bruus, **Theoretical Microfluidics**, Oxford University Press, 2008 (Reprint 2010), ISBN 978-0-19-923509-4.

Websites

- lmis2.epfl