ME 141C *MicroElectroMechanical Systems*

Introduction to Microfluidics & BioMEMS
Spring 07

Instructor

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This class focuses on the physics of fluid mechanics that occurs at the micro / nanoscale, and is applicable to MEMS and BioMEMS. Particular emphasis is place on using finite element software (Femlab) to simulate multi-physics problems associated with microfluidics, and can be extended to a wide variety of engineering problems.

Prequisite: ME 152A/B (or equivalent), ME 141A (can be waived by instructor)

TA:

Topics

I. Introduction / Background
II. Microscale Fluid Mechanics Theory
III. Electrokinetic Phenomena
IV. Experimental Flow Characterization
V. Microfluidics for Life Sciences

Grading

Home Work (4 – 5)	50%
Research Report	50%

Recommended Texts (on reserve at the library)

Microfluidics for Biotechnology (2005), Jean Berthier & Pascal Silberzan, Artech House, Boston, ISBN 1580539610.
Fundamentals and Applications of Microfluidics, (2002), Nam-Trung Nguyen & Steven T. Wereley, Artech House, Boston.
AC Electrokinetic: Colloids and Nanoparticles (Microtechnologies and Microsystems) by Hywel Morgan, Nicolas G. Green_ ISBN 0 86380 255 9
Fundamentals of Microfabrication, Marc Madou, CRC Press, 1997.
DNA Simplified II: The Illustrated Hitchhiker's Guide to DNA, Daniel H. Farkas, AACC Press, 1999.
Analysis of Transport Phenomena, Bill Dean Oxford University Press, 1998.
Chemiophisiohydrodynamics, Robert Probstein.
Nano: The Emerging Science of Nanotechnology, Ed Regis, Little, Brown, & Co. 1995.

Outline

I. Introduction / Background (Notes)
- Overview of MEMS Applications
- MEMS Market Trends
- Scaling Laws

II. Microscale Fluid Mechanics Theory
- Governing Equations
- Elementary Solutions
- Surface dominated physics
- Electrokinetic & electrothermal effects
- Surface reaction kinetics

III. Electrokinetic Phenomena
- Maxwell's Equations & Electrostatics
- Electrophoresis
- Electro-osmosis
- Dielectrophoresis (DEP)
- Electrothermal Flow
- Electrokinetic Instabilities

IV. Experimental Flow Characterization
- Introduction to micron-resolution Particle Image Velocimetry
- Slip flow boundary conditions
- Analysis of AC Electrokinetic phenomena
- Mixing in microchannels

V. Microfluidics for Life Sciences
- Microarray Technology for high throughput screening
- Sandwich Immunoassay Devices
- DNA Sequencing and Analysis Devices
- Micro Total Analysis Systems
- Proteomics
- Single Molecule Detection

Academic Goals

1. Understand physics associated with microscale fluid mechanics
    a. Electrokinetics & electrothermal effects
    b. Surface-dominated effects
    c. Chemical kinetics
    d. Particle dynamics
2. Gain knowledge in the field of BioMEMS
    a. Optical techniques for molecular diagnostics
    b. Single molecule detection
    c. Microfluidics & biotechnology
3. Understand and apply computational tools to solve advanced problems
    a. Femlab (finite element software, runs with Matlab)
    b. Research Tool
    c. Design Tool
4. Gain experience in conducting and presenting research projects
    a. Research Project
    b. Homework