Fall 2014

MAE 4301-002 / ME 5390-001
Introduction to Micro and Nanofluidics

(Tentative Syllabus subject to change)

Instructor

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Schedule

MWF 11:00 – 11:50 am, NH 109

Office hours

MW 2:00 – 5:00 pm or by appointment

Course Description

As going down to micro scales, the basic hypothesis in the macro scale fluid mechanics may not be applicable in such scales. The objectives of this course are: to identify dominant forces and their effects in micro scale fluid systems that are different from those in the macro scales; to understand the fundamentals of micro fluidic phenomena; to discuss various microfluidic applications in research and commercial levels; and to explore new possible microfluidic applications in the emerging fields. Topics include overview of microfluidics, scaling laws, violation limit of the Navier-Stokes equations, surface force, surface tension, electrowetting, electrokinetics, dielectrophoresis, and soft lithography. Letter grading.

Subjects

- Introduction, overview, and applications
- Scaling issues
- Low Re flows
- Intermolecular forces
- Kinetic theory of gases
- Interface and surface sciences
- Active control of interfacial phenomena
- Electrohydrodynamics and Electrokinetics (electrocapillary, electroosmosis, electrophoresis, dielectrophoresis etc) and applications
- Microfabrications (soft lithography)
- Micropumps and valves
- Flow through porous medium and applications
- Multi-phase flow (if time allows)
- Term project presentations

Assignments and Tests

- There will be several homework assignments that are normally due one week after given. Late homework will not be accepted.
- Two take-home tests (one midterm and one final exam) will be given. The exact dates and times will be specified and announced later.
- The term project includes oral presentation and submission of a term paper. The topic should be chosen by students and informed to the instructor. With regard to the term project, more detailed instruction will be given during the term.

Grading

Homework 20%, Midterm Exam 20%, Final Exam 20%, and Term Project 40% (term paper 20% and oral presentation 20%).

Textbook

No textbook required but relevant references on each subject will be specified.

Term Project Topics

1. Low Reynolds number flow in microdevices
2. Micro and nanofluidic phenomena in separation processes
3. Mixing in microfluidics
4. Heat transfer in microfluidic channel (or microscale confined space)
5. Biomimetic micro and nanofluidics (micro and nanofluidic device or models learned from the nature)
6. Active control of interfacial energy
7. Microfluidic phenomena in petroleum (or other energy source) processes
8. Microfluidic devices for developing (underdeveloped) countries
9. Motion by wettability control
10. Particulate flows or dispersion
11. Acoustic fluidics
12. Optofluidics
13. Magnetic fluidics
14. Others