

ME265: Physicochemical Hydrodynamics Spring 2011 – Revised Syllabus

Instructor: Prof. Chuan-Hua Chen (chuanhua.chen@duke.edu)

Lecture: TuTh 2:50-4:05pm (Teer 211)

Office Hour: W 2-4pm (Hudson 178)

References

- R.F. Probstein, *Physicochemical Hydrodynamics*, 2nd Ed., Wiley, 1994.
- P.G. de Gennes, F. Brochard-Wyart and D. Quere, *Capillarity and Wetting Phenomena*, Springer, 2004.
- R.J. Hunter, *Foundations of Colloid Science*, 2nd Ed., Oxford, 2001.
- J.R. Melcher, *Continuum Electromechanics*, MIT Press, 1981.

Overview

Physicochemical hydrodynamics is a multidisciplinary subject dealing with transport and interfacial phenomena coupled with physical and chemical processes. This course introduces the fundamental principles of physicochemical hydrodynamics, with an emphasis on scaling analysis. The overarching goal is for the students to develop physical intuition and scaling tools to single out the dominant physicochemical process in a complex system.

Each student is required to finish a course project to apply the fundamentals of physicochemical hydrodynamics to practical engineering systems. To get the most benefit out of the course project, students are advised to

- Design a project that bridges the sub-disciplines in the course;
- Work in a team and regularly consult with the instructor; and
- Conduct both experimental and theoretical research.

Arrangements can be made for the students to use the instructor's lab for the course project. Example projects include:

- The wetting and/or splashing of a charged jet on a counter electrode.
- The interaction between charged drops and superhydrophobic surfaces.

Grading

The final grade will be based upon four problem sets and a course project:

- Homework 40%
- Project 60%

No late homework or project report will be accepted.

Schedule

<u>Week</u>	<u>Topics</u>
Jan 13	Introduction to physicochemical hydrodynamics
Jan 18, 20	Viscous flow / Scaling analysis
Jan 25, 27	Microscopic interpretation of flow properties
Feb 1, 3	Brownian motion / Molecular diffusion Homework #1
Feb 8, 10	Electrostatics / Electrodynamics
Feb 15, 17	Transport of charge species
Feb 22, 24	Double layer / Electrokinetics Homework #2
Mar 1, 3	Introduction to capillarity and wetting <i>Project abstract due</i>
Mar 15, 17	Electrified interfaces <i>Midterm project presentations (in class)</i>
Mar 22, 24	Taylor cone-jets
Mar 29, 31	Capillary length / Contact angle hysteresis Homework #3
Apr 5, 7	Capillary jet and stability / Thermodynamics of interfaces
Apr 12, 14	Wetting and long-range forces / Superhydrophobicity Homework #4
Apr 19	<i>Final project presentations (in class)</i>
May 2	<i>Final project report (10-page maximum, due 5pm)</i>