BMEN 5321 Microfluidics in Biology in Medicine

Fall 2014

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Course Description and Goals

The application of microfluidics in biology and medicine has exploded in the last decade, and this technology is now an important part of the bio/biomedical engineering toolkit. The primary objectives for this course are to learn fundamentals of transport mechanisms in microfluidic systems and to expose students to the range of applications for microfluidics in biology and medicine. Students will learn to use finite element methods to design and analyze microfluidic systems, and students will be exposed to microfabrication methods relevant to microfluidics devices.

Teaching Methods

The course will use multiple formats. Some classes will mix traditional lecture with group discussion and problem solving. Other classes will involve group discussion of a relevant study from the literature. Several classes will be devoted to hands-on demonstrations of microfabrication and microfluidics. I strongly encourage you to ask questions in class. Framing questions is part of the learning process

Expectations

You can expect me to:

- Plan the course AND alter that plan as needed. I believe the best curriculum comes from the student. That means that we will take advantage of unforeseen events that capture our interest, and then juggle the class topics as necessary.
- Give you feedback.
- Bring my expertise into the classroom. This includes many years of formal study, professional experience and development, and stories from real life.
- Be open about options. I think it's great when students bring ideas of how to form a class session or perhaps request a topic.
- Treat you, as adult learners, with the related style of respect.

Here is what I expect from you:

- Participation in class, which includes both speaking up and listening.
- Effort to make this class your own. In other words, what will you do to foster your learning?
- Completion of assignments – including the reading.
- Willingness to challenge what you hear, even from me.

Assignments and Grading

Homework: 30%
Mid-Term Exam: 30%
Final Project: 30%
Class Participation: 10%

Homework, consisting of 2-5 problems, will be assigned weekly during most of the course. The Mid-Term Exam will focus on fundamentals of transport mechanisms that will be covered in the course. For the final projects I will ask students to work in small groups to analyze an application area of microfluidics. This will involve surveying the literature, analyzing the engineering and design criteria for a specific application, and presenting your analysis to the class in the form of a full 1 hour lecture.

Text and Resources

There is no official text for the class, although I will take a significant amount of material on microfluidic transport phenomena from two sources: *Micro- and Nanoscale Fluid Mechanics* by Brian Kirby and *Theoretical Microfluidics* by Henrick Bruus. If you're a book collector, feel free to purchase either or both of these, as they are excellent texts. If you'd prefer to save a few pennies, much of Dr. Kirby's book can be found online:

http://www.kirbyresearch.com/index.cfm/wrap/textbook/microfluidicsnanofluidics.html

Dr. Kirby's lectures on this subject are also posted throughout the online textbook and are an excellent resource. The original lecture notes on which Dr. Bruus' book is based are posted on the course website on Moodle and can be downloaded free. Any papers or other resources that are relevant to our discussions will be posted on the course website as well.

Tentative Course Schedule: (May change to accommodate guest presenters & student needs)

Unit	Date(s)	Topics or Activities
	Sept 3	Introduction and Course Overview
1	Sept 5 - 10	Transport Phenomena, Laminar Flow
2	Sept 12 – 17	Convection-Diffusion, Laminar flow patterning
3	Sept 19	Capillary Flows
4	Sept 24	Device Fabrication (lecture)
4	Sept 26	NFC Tour
4	Oct 1	Device Fabrication (hands-on)
5	Oct 3 – 8	DC Electrokinetics, Electro-osmosis
6	Oct 10 – 17	Finite Element Modeling in COMSOL
7	Oct 22	Microvalves & Micropumps
8	Oct 24	Dielectrophoresis
9	Oct 29 – 31	Inertial Microfluidics & Mixing
10	Nov 5	Microfluidic Droplets
11	Nov 7	Cell Sorting
11	Nov 12 – 14	Applications
12	Nov 19	Paper Microfluidics
13	Nov 21 – Dec 10	Project Presentations