

Fall 9-6-2016

Microfluidic Devices in Biotechnology

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BME510/I7700: Microfluidic Devices in Biotechnology



BME 510: Fundamentals of modern microfluidic devices with applications to biomedical measurements, e.g., electrophoretic systems, flow cytometers, and immunoassays. Review of fundamental properties of microfluidic systems including the effects of fluid mechanics, heat transfer, and electromagnetic phenomena on biological systems. Critical overview of design, manufacture, and operation of micrometer scale systems that use photolithographic and surface treatment techniques for device development.

Lectures: Mondays 11:00AM-12:15PM ST-402
Wednesdays (10 Labs) 11:00AM-2:50PM ST-481/ASRC

Instructors: Professor M. Vazquez vaZqueZ@ccny.cuny.edu
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Office Hours: Tuesdays from 3PM-4PM, and by appointment as necessary.

Pre/Co-Requisites: All students must have completed an undergraduate fluid mechanics or transport course (e.g. ME356 or ChE341) as well as an undergraduate wet laboratory course (e.g. BME310) NO EXCEPTIONS.

Readings: Assignments uploaded onto blackboard.com must be read prior to lectures.

Lateness: Students are expected to attend every lecture in a prompt fashion. *Please silence electronic devices during each class.* Students who must use a cell phone for emergency purposes are asked to please do so outside of the classroom.

Participation: Class participation in lecture counts! Ask questions and be ready to discuss questions posed in class. Students don't always have to know the right answer, but should be prepared to guess intelligently. Each student should ask and answer multiple questions every lecture.

Lecture Format: Each lecture will generally follow the format shown below:

Administrative Items	5 min
Technical Lecture	40 min
Group Problem Solving	15 min
Discussion	15 min

Exams and HW: One midterm examination and one practical examination will be administered during this course. No makeup exams will be permitted unless the student can document an emergency. Five homework sets will be assigned throughout the semester. Assignments are due at the beginning of class.

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Laboratories & Presentation:

The course will incorporate a micro-manufacturing laboratory component required of all students. Labs will be conducted during 10 dedicated class times as shown on the syllabus. One comprehensive presentation and prototype of a microfluidic system must be presented and submitted as part of the course.

Grade Distribution:

Homework Sets (5 of 5)	25%
Midterm Exam	20%
Practical Exam (ASRC)	20%
Poster Presentation	25%
Class Participation/Effort	10%
	<hr/>
	100%

Academic Integrity:

Students are welcomed and encouraged to discuss homework problems, lecture material, laboratory exercises/reports, and technical analysis with all of their classmates, as well as proofread each other's documents. Students Cannot: (1) Use data from another group without explicit instructor permission; (2) Copy (even in part) text from another report (including previous years); (3) Collaborate during examinations. Students who copy OR allow their work to be copied will be de-registered from the course and subject to investigation by the Grove School of Engineering (GSOE).

Course Outcomes: Upon course completion, students will demonstrate abilities to:

1. Successfully analyze a contemporary microfluidic flow problem by considering the underlying transport phenomena and dimensional constraints.
2. Develop and evaluate microscale designs that address bioengineering challenges and spatial constraints including consideration of manufacture, materials, and operation.
3. Micromanufacture microscale devices used for engineering analysis and/or system throughput.

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<u>Lec</u>	<u>Date</u>	<u>Topics Discussed</u>	<u>Due</u>
1	08.29.16(M)	Introduction and Course Overview	In-Class Diagnostic
2	08.31.16(W)	Review of Math/ Fluid Mechanics	
3	09.07.16(W)	Review of Heat Transfer/Thermodynamics	
4	09.12.16(M)	Overview of Clean Room Spaces and Lab Safety	HW 1 (Analysis)
5	09.14.16(W)	Overview of Key Microfabrication processes Photolithography (Technical Lecture)	
6	09.19.16(M)	Surface Bonding/Micromolding (Technical Lecture)	
7	09.21.16(W)	CCNY Lab 1 (Photolithography/micromolding)	HW 2 (Protocols)
8	09.26.16(M)	Discussion of Results from CCNY Lab 1	
9	09.28.16(W)	ASRC Lab Safety and Orientation	
10	10.05.16(W)	ASRC Lab 1A (Photolithography)	
11	10.06.16(TH)	Etching (Technical Lecture)	
12	10.17.16(M)	ASRC Lab 1B (Bonding/Planar Etching)	HW 3 (Protocols)
13	10.19.16(W)	CCNY Lab 2 (Chemical Etching and DRIE) Midterm Review	
14	10.24.16(M)	In-Class Exam	MIDTERM
15	10.26.16(W)	ASRC Lab 2 (Chemical Etch, DRIE)	
16	10.31.16(M)	Physical Vapor Deposition (Technical Lecture)	
17	11.02.16(W)	Chemical Vapor Deposition (Technical Lecture)	HW 4 (Analysis)
18	11.07.16(M)	CCNY Lab 3 (CVD Demo)	
19	11.09.16(W)	ASRC Lab 3 (CVD)	
20	11.14.16(M)	Imaging of Devices (Technical Lecture)	
21	11.16.16(W)	Microfluidic Designs (Technical Lecture)	
22	11.21.16(M)	Micro Flows/Actuation/Valving (Technical Lecture)	HW 5 (Design)
23	11.23.16(W)	ASRC Lab 4 (Comprehensive)	
24	11.28.16(M)	ASRC Lab 5 (Comprehensive)	Practical Exam
25	11.30.16(M)	<u>Open Lab</u> : Prototype Design and Microfabrication	
26	12.05.16(M)	<u>Open Lab</u> : Prototype Design and Microfabrication	
27	12.07.16(W)	PROJECT PRESENTATIONS	PPTs
28	12.12.16(M)	Review/Recap of Course	



Lecture 1: August 29, 2016

A. Course Logistics

1. Syllabus Handout (bb.com upload)

B. In Class

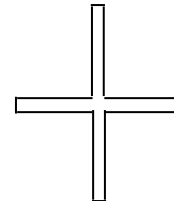
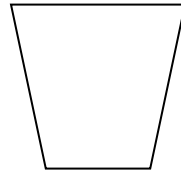
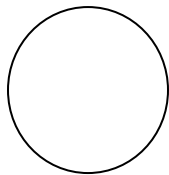
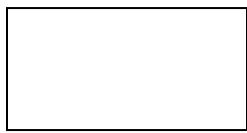
- Scale
- Geometry
- Continuum

C. Group Problems

1. Identify the following symbols with units and definitions

- | | |
|--------|---|
| a. F | f. g |
| b. Q | g. h |
| c. W | i. P |
| d. T | j. $\underline{u} \underline{v}$ |
| e. R | h. $\underline{u} \times \underline{v}$ |

2. Identify (and justify!) what you would use as the characteristic length of the following geometries.



3. A packed-bed microreactor has a depth of $200\mu\text{m}$ and cross-section of $500\mu\text{m}$ by $500\mu\text{m}$. The chamber is loosely packed with $10\text{-}\mu\text{m}$ -diameter microspheres that occupy 40% of the chamber volume. Estimate the number of spheres and the ratio between the reacting surface and chamber volume.

D. Look Forward

Review of Mathematics and Fluid Mechanics