

Microfluidics and Microscale Analysis in Materials and Biology

CHEM-ENG 590E – Spring 2018

COURSE DESCRIPTION AND OBJECTIVES

This course is intended to provide undergraduate and graduate students with a clear overview of microfluidics, microchemical systems, and microscale analysis. Following an introduction to the basic concepts of microfluidic device fabrication and operation, students will research and present on microscale technology relevant to a specific application in materials or biology. In parallel, students will apply this knowledge for the hands-on development of a microscale technology relevant to a topic of their interest. Students are encouraged to work on technologies that would benefit their own areas of research.

During the first two weeks, students in teams of 2-3 will select a relevant scientific challenge, such as high-throughput combinatorial screening, cell culture, nanoparticle synthesis, sensing, etc. Students are encouraged to choose topics that are relevant to their own field of research and to use this course as a basis for developing microfluidic technology for use in their own work. As the course progresses, students will research the current state of the field in their area of interest while exploring the basics of microfluidic design and fabrication through a series of laboratory modules. These modules will utilize computer-aided design, 3D printing and/or photolithography. Students will then build on this foundation to design and optimize a microfluidic device relevant to their topic and present the results to the class.

In tandem with their design project, students will first present a lecture on their general scientific topic, providing an overview of current research in the field. Each team will also prepare a series of progress reports on status of their project over the course of the semester. At the end of the semester, each team will be asked to give a formal presentation on their project and will prepare a written report. These reports will be compiled into an annual “journal issue” for the class.

At the end of this course students should:

1. Understand the basic principles involved in microfluidic and microscale analysis systems.
2. Be familiar with simple, droplet-based, multilayer, and paper microfluidics.
3. Be able to use Adobe Illustrator to design, and standard methods such as soft lithography and 3D printing to fabricate microfluidic devices.
4. Understand how microfluidics and microscale analysis systems are used in applications ranging from materials to biology.
5. Develop proficient oral presentation skills.
6. Develop proficient technical writing skills.
7. Be familiar with the scientific literature related to microfluidics and its applications.
8. Be prepared to use the principles and tools learned in this class to solve problems not covered in detail as part of this course and to continue learning related material as needed in the future.

INSTRUCTORS

The instructor for the course is Prof. Sarah Perry. Office hours will be scheduled for the purpose of discussing any concerns or questions that may arise, and you are encouraged to take advantage of them.

Sarah Perry
N563 Life Sciences Laboratory
Telephone: (413) 545-6252
perrys@engin.umass.edu
Office Hours: By Appointment

TEACHING ASSISTANT

We are fortunate to have an excellent chemical engineering graduate student as a TA for this course. Shuo will assist with grading homework assignments/papers and will help students with the course material and projects. You will be able to contact Shuo via email and during office hours. Please make use of the TA in this course. He is eager to help and is very knowledgeable about the material.

Shuo Sui, ssui@umass.edu, LSL N560D, Office Hours: By Appointment

UNDERGRADUATE TEACHING ASSISTANTS

We are also fortunate to have an undergraduate TA this semester. Eric took this class last year and will be available to assist with design projects and other course material.

Eric Ying eying@umass.edu, Office Hours: By Appointment

COURSE LOGISTICS

Lectures are scheduled for Tuesdays and Thursdays from 10:00-11:15am in LSL N410. Class attendance is critical. Attendance and participation will be factored into your final grade (see Grading section).

COMMUNICATION

There will be times when changes in the course schedule are necessary, and these changes will be announced during class time and posted on the class Moodle site. Additionally, you are welcome (and encouraged) to send an email to the instructor at any time.

COURSE MATERIALS

This course requires Adobe Illustrator software. The full Adobe Creative Suite is available free of charge for university-owned computers, and for a minor fee through the OIT website at <http://www.umass.edu/it/software/adobe-campus-agreement>.

Additional materials will be provided via the Moodle site throughout the semester.

SAFETY TRAINING

Laboratory Safety Training (<https://ehs.umass.edu/lab-safety-training>), Fire Safety Training (<https://ehs.umass.edu/fire-safety-training>), and Biological Safety Training (<https://ehs.umass.edu/biological-safety-training-4>) are required for participation in this class. You must complete these courses before participating in hands-on activities. Students are also expected to bring their own laboratory safety glasses to the lab.

ASSIGNMENTS

Readings: It is critical that you keep up with the reading assignments, as class lectures will give overviews of the reading with an additional focus on recent advances in the field of bioengineering. Readings come from current literature (research papers) and the online wiki textbook.

Homework: Reading, homework, and project milestones will be assigned regularly and must be submitted electronically via Moodle. You are encouraged to discuss the course material and the assignments with other students, but each of you is responsible for working out your own solutions.

Wiki Pages: Each class member will research one topical area of microfluidics or microscale systems, a publicly available wiki page on their topic using the NSF-funded openwetware.org website for the course (<http://openwetware.org/wiki/CHEM-ENG590E>), that will ultimately be used in the development of an openly accessible online wiki "textbook."

Late homework will not be accepted. If, for medical reasons, you will be unable to hand in the homework on the due date, please make special arrangements with the instructor **before** the due date. For all other planned absences, please complete the assignment **before** it is due.

TEAM DESIGN PROJECT

You will be expected to participate in a semester-long project in which teams of 2-3 students will research a particular type of microfluidic technology and its utility for a particular application. Students will design, fabricate, test, and then optimize a device relevant to their topic. A variety of projects are available each semester, many of which have been sponsored by various labs on campus. Students may also propose their own project.

Team Presentation: Each team will prepare a lecture on the topic of their design project during the course of the semester. This talk should cover the relevant literature related to their topic, including both the scientific motivation and related efforts in the field of microfluidics.

Final Report: Each team will prepare a final written report, in the style of a *Lab on a Chip* manuscript, providing relevant background information, a materials and methods section, results/discussion, and future outlook. These “articles” will be compiled into a “journal issue” for the class.

Final Presentation: Each team will present on their design project at an end-of-semester event that will be attended by project sponsors and is open to the public.

EXAMINATIONS

There are no examinations in this class.

GRADING

Numerical grades will be assigned for each homework assignment, presentation, wiki textbook page, project, and final report. Your final grade will be computed based on your performance in all aspects of the course with weights as follows:

Homework	20%
Wiki “Textbook” Page	20%
Design Project Topical Lecture	20%
Design Project Final Presentation	20%
Design Project Final Report	20%

Letter grades in the course will be assigned based on the following grade breakdown. Final grades in the course may be curved, as necessary.

Numerical Grade	Letter Grade
93.00 – 100.0	A
90.00 – 92.99	A-
87.00 – 89.99	B+
83.00 – 86.99	B
80.00 – 82.99	B-
77.00 – 79.99	C+
73.00 – 76.99	C
70.00 – 72.99	C-
67.00 – 69.99	D+
60.00 – 66.99	D
0.00 – 59.99	F

In borderline cases, your grade may be raised if you are close to a cutoff point for the class and if justified by your attendance and participation in class. Therefore it is important that you both attend and participate in all class periods.

ACCOMMODATION STATEMENT

The University of Massachusetts Amherst is committed to providing an equal educational opportunity for all students. If you have a documented physical, psychological, or learning disability on file with Disability Services (DS), you may be eligible for reasonable academic accommodations to help you succeed in this course. If you have a documented disability that requires an accommodation, please notify me within the first two weeks of the semester so that we may make appropriate arrangements.

DIVERSITY

We are all members of an academic community with a shared responsibility to cultivate a climate where all students/individuals are valued and where both they and their ideas are treated with respect. The diversity of the participants in this course is a valuable source of ideas, problem solving strategies, and engineering creativity. If you feel that your contribution is not being valued for any reason, please speak with me privately. You may also speak with Dr. Paula Rees, Assistant Dean for Diversity (rees@umass.edu, 413-545-6324, Marston 128), submit a comment to the box on the door of Marston 128, or submit an anonymous comment online <http://tinyurl.com/UMassEngineerClimate>.

ACADEMIC HONESTY

Since the integrity of the academic enterprise of any institution of higher education requires honesty in scholarship and research, academic honesty is required of all students at the University of Massachusetts Amherst. Academic dishonesty is prohibited in all programs of the University. Academic dishonesty includes but is not limited to: cheating, fabrication, plagiarism, and facilitating dishonesty. Appropriate sanctions may be imposed on any student who has committed an act of academic dishonesty. Instructors should take reasonable steps to address academic misconduct. Any person who has reason to believe that a student has committed academic dishonesty should bring such information to the attention of the appropriate course instructor as soon as possible. Instances of academic dishonesty not related to a specific course should be brought to the attention of the appropriate department Head or Chair. Since students are expected to be familiar with this policy and the commonly accepted standards of academic integrity, ignorance of such standards is not normally sufficient evidence of lack of intent (http://www.umass.edu/dean_students/codeofconduct/acadhonesty/).