

# Microfluidics and Microscale Analysis in Materials and Biology

## CHEM-ENG 535 – Spring 2020 (3 credits)

### 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](mailto:perrys@engin.umass.edu)  
Office Hours: By Appointment

## TEACHING ASSISTANT

We are fortunate to have an excellent chemical engineering graduate student support for this course. Sarthak will assist with grading homework assignments/papers and will help students with the course material and projects. You are encouraged to contact Sarthak via email, he is eager to help.

**Sarthak Saha**, [ssaha@umass.edu](mailto:ssaha@umass.edu), LSL N560D, Office Hours: By Appointment

## UNDERGRADUATE TEACHING ASSISTANTS

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

**Josh McGee** [jemcgee@umass.edu](mailto:jemcgee@umass.edu), Office Hours: By Appointment

## COURSE LOGISTICS

Lectures are scheduled for Tuesdays and Thursdays from 10:00-11:15am in LGRT 201. Class attendance is critical. Attendance and participation will be factored into your final grade (see Grading section). We also have lab space available in GSMN 54.

## 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 microfluidics. 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. Assignments are due by 11:55pm on Sundays, unless otherwise specified.

**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.

## HEALTH AND WELLBEING

Success in this course and the College of Engineering depends heavily on your personal health and wellbeing. **Recognize** that stress is an expected part of the college experience, and it often can be compounded by unexpected setbacks or life changes outside the classroom. I strongly encourage you to **reframe** challenges as an unavoidable pathway to success. **Reflect** on your role in taking care of yourself throughout the term, before the demands of exams and projects reach their peak. Please feel free to **reach out** to me about any difficulty you may be having that may impact your performance in your courses or campus life as soon as it occurs and before it becomes too overwhelming. I encourage you to contact support services on campus that stand ready to assist you. Within the College, you may reach out to your academic advisor, the Office of Student Affairs (126 Marston) or the Office of Community Equity and Inclusion (128 Marcus). You can learn about the confidential mental health services available on campus by calling the Center for Counseling and Psychological Health (CCPH) at (413) 545-2337 or visiting their website at [umass.edu/counseling](http://umass.edu/counseling). There are many other resources on campus for students facing personal, financial or life challenges to find support, stay in school, and graduate. See a comprehensive list at [umass.studentlife/single-stop](http://umass.studentlife/single-stop). Help is always available. Please reach out for support finding the resources you need.

## DISABILITY ACCOMMODATION AND INCLUSIVE LEARNING STATEMENT

Your success in this class is important to me. We all learn differently and bring different strengths and needs to the class. The University of Massachusetts Amherst is committed to making reasonable, effective and appropriate accommodations to meet the needs of students with disabilities and help create a barrier-free campus. If you have a qualifying disability and require accommodations while participating in this course, please work with Disability Services to have an accommodation letter sent to me in a timely manner. If you have a disability but are not yet affiliated with Disability Services, please register with Disability Services (161 Whitmore Administration building; phone (413) 545-0892). Information on services and materials for registering are also available on their website [www.umass.edu/disability](http://www.umass.edu/disability). *It is incumbent upon you contact me during the first few weeks of the semester, or shortly following registration with Disability Services, to ensure that your accommodations are being sufficiently met, including extra time and note-taking access, as applicable.* Finally, beyond disability accommodations, if there are aspects of the course that prevent you from learning or make you feel excluded, please let me know as soon as possible. Together we'll develop strategies to meet both your needs and the requirements of the course.

## 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](mailto: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

Although many of the assignments for this class involve discussion with your classmates, you alone are responsible for individual assignments (most homework assignments and the individual paper). The exams require independent thinking and, therefore, individual efforts on homework assignments will be good practice for you.

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/](http://www.umass.edu/dean_students/codeofconduct/acadhonesty/)).

### **INCLUSIVITY**

The diversity of the participants of this course is a valuable source of ideas, problem solving strategies, and engineering creativity. If you feel that your contribution is not being valued or respected for any reason, please speak with me privately. If you wish to communicate with someone else in the College, speak with Assistant Dean Dr. Paula Rees ([rees@umass.edu](mailto:rees@umass.edu), (413) 545-6324, 128b Marcus Hall). You may also submit anonymously through the College of Engineering Climate Concerns and Suggestions online form (<https://tinyurl.com/UMassEngineerClimate>) and/or the Positive and Negative Classroom Experience online form (<https://tinyurl.com/UMassEngineerClassroom>). 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.

### **PRONOUNS AND NAMES**

Everyone has the right to be addressed by the name and pronouns that they use for themselves. Students can indicate their preferred/chosen first name and pronouns on SPIRE, which appear on class rosters. Please let me know what name and pronouns I should use for you if they are not on the roster. A student's chosen name and pronouns are to be respected at all times in the classroom. To learn more, read the Intro Handout on Pronouns:

[https://www.umass.edu/stonewall/sites/default/files/pronouns\\_intro.pdf](https://www.umass.edu/stonewall/sites/default/files/pronouns_intro.pdf)

### **TITLE IX**

Any conduct that has the purpose or effect of unreasonably interfering with an individual's performance by creating an intimidating, hostile, or sexually offensive educational, academic, residential, or working environment is considered sexual harassment. Faculty have the responsibility to inform students of the resources and reporting options relevant to reporting an incident of sexual assault, sexual harassment, relationship violence or stalking for all genders. You may go to the Title IX webpage at <http://www.umass.edu/titleix/> and the Sexual & Relationship Violence Resource Guide at ([https://www.umass.edu/titleix/sites/default/files/documents/sexual\\_violence\\_resource\\_guide-fall2019.pdf](https://www.umass.edu/titleix/sites/default/files/documents/sexual_violence_resource_guide-fall2019.pdf)) to find more information about resources and reporting options. Please reach out to me if you would like assistance connecting with any of these resources/options. You may also contact William Brady, the Interim Title IX Coordinator by email at [wdb Brady@umass.edu](mailto:wdb Brady@umass.edu) or by phone at (413) 545-6204 if they have any questions or want to make a report, file a complaint, find out about resources and/or academic support.