Department of Electrical & Computer Engineering and Department of Biology
Concordia University

MICROFLUIDICS FOR SYNTHETIC BIOLOGY

FALL 2021

>> Course Outline <<

➢ Course Instructor

Steve Shih (Dept. of ECE and Biology)
Physical Offices: EV 16.189 (SGW); GE 330.15 (Loyola)
Office Hours: Email for appointment
E-mail Address: steve.shih[at]concordia.ca
Personal website: shihmicrolab.ca
Website for course: Moodle

➢ Lectures

Lectures will take place **in-person** SGW Hall Building (Downtown) Room 1011 on Monday 2:45-5:30pm. **Note: Medical masks must be always worn inside the lecture room.**

➢ Office Hours

Given these unprecendented times, Steve and the TAs are only available for online meetings. Please email them for an appointment.

We are also starting a *Slack* channel (you will receive an email to join using the email registered MyConcordia) which will allow you to ask any immediate questions and to receive answers and feedback. This channel is where announcements will be made (as well as on Moodle). To download Slack, please go to https://slack.com/intl/en-ca/ (it is free).

➢ Brief Description & Objectives

This course is an interdisciplinary course with 2.5 class hours of lectures scheduled every week. This course is to learn two fields: microfluidics and synthetic biology. In the first part of the course, students will learn the advancements in the study of microfluidic components as a tool and a device. They will learn fabrication techniques for different paradigms of microfluidics, advantages and disadvantages of each paradigm and how they can be applied to study chemical and biochemical analysis. Some hands-on experience for creating some simple devices will be introduced. Fluid flow and characteristics would be discussed. The second part of the course will introduce the fundamentals of synthetic biology which will include learning about biological parts and their properties, network structure and pathway engineering, how synthetic networks be created experimentally, manipulating DNA and measuring responses, basic behavior of genetic circuits, and how to build complex networks. The end of the course, students will learn to integrate both fields and to understand the economic potential in the industry. ALL students will be asked to complete a lab and project in which they will present (oral and written) at the end of the course.

- **Midterm and Exam**

There will be NO midterm or final exam for this course.

- **Course plan (tentative plan)**

Date	Topic	Notes
Week 1 (Sept. 13th)	Microfluidic introduction – fluid mechanics, resistance, and mixing	Purchase an Arduino Kit for constructing a colormetric sensor
Week 2 (Sept. 20th)	Microfluidic paradigms – Channel and Droplet-in-Channel **(video demo)**	Assign groups and papers for critique
Week 3 (Sept. 27th)	Digital microfluidics and Basic Biology **(video demo)**	
Week 4 (Oct. 4th)	Biology and Fabrication Techniques **(video demo)**	**Test #1**
Week 5 (Oct. 11th)	NO CLASS – Thanksgiving	Make up on Tuesday Dec. 7th
Week 6 (Oct. 18th)	Building a colorimetric sensor using Arduino	TAs will lead the lab
Week 7 (Oct. 25th)	Synthetic Biology Basics #1	Arduino lab due today before start of class – submit online only
Week 8 (Nov. 1st)	Paper critique presentations	TAs will lead discussion
Week 9 (Nov. 8th)	Synthetic Biology Basics #2	
Week 10 (Nov. 15th)	Microfluidic Applications and DNA Assembly	
Week 11 (Nov. 22nd)	Microfluidics and synthetic biology – combining both paradigms	**Test #2**
Week 12 (Nov. 29th)	Guest Speaker: Laurent Potvin-Trottier (Synthetic biology oscillators)	
Week 13 (Dec. 6th)	Transformation laboratory presentation/Project Presentations	See transformation lab handout for deadlines.
Week 13 (Dec. 7th)	Project Presentations	Project report and final presentation due on **Dec 6th via email by 8pm EST**. No hard copies.

- **Textbook & Papers**

There are no required textbooks – notes and papers that we discuss in class will be sufficient.

Here are some recommended books:

"BioBuilder: Synthetic Biology in the Lab" by Karen Ingram (online version on website)

"Theoretical Microfluidics" by Henrik Bruus (online version on website)

"Micro-drops and Digital Microfluidics" by Jean Berthier (book available in bookstore)

Best resources are the papers/publications that we will discuss in class. All the slides used in the lectures and discussed research papers will be made available to you on the website. You are expected to attend every lecture, participate in it, and make your own notes.

- **Tests**

There are **two** tests in the course. Tests will cover all previous lecture material. For example, if a test is given in lecture #4, it will cover everything from lecture #1-3. We will have them at the beginning of lecture.

- **Paper Critique Presentations**

You will pair up with a partner and present a critique on a paper that will be assigned. The objective is to critically analyze the paper (i.e., what is novel regarding their paper, did they perform the experiments correctly, do they have the right controls? What can be improved?).

- **Laboratory**

There will be two labs in this course: (a) Designing a colorimetric sensor using Arduino and (b) Automating transformation using microfluidics. See additional handouts for more details.

- **Project**

See additional handout on Moodle.

- **Graduate Attributes**

All engineers/biologists must be able to analyze data and draw valid conclusions from it. Many of the tools that you learn in this course will be aimed toward that. This course emphasizes and develops the following CEAB (Canadian Engineering Accreditation Board) graduate attributes and indicators:

Attribute	Indicator	Level of knowledge	Evaluation method
Investigation	Background and Hypothesis Formulation	Introductory	Group project
	Designing Experiments	Introductory	Group project
	Conducting Experiments and Collection of Data	Intermediate	Group project
	Analysis and Interpretation of Data	Intermediate	Group project
A knowledge base for engineering	Knowledge-base of mathematics	Advanced	Tests/Project
	Knowledge base in a specific domain	Advanced	Tests/Project

- **Grade Breakdown**

10 % Paper Critique Report/Presentation
15 % Two Tests (Oct 4th and Nov. 22nd)
25 % Laboratory (Colormetric Sensor and DNA assembly/transformation)
50 % Project

➢ A SUPPLEMENTARY NOTE ABOUT EXPECTATIONS OF PROFESSIONALISM

In addition to preparing students for the technical requirements of a career in Engineering, we sincerely feel that our program at Concordia University also prepares students for a wide variety of non-technical elements Engineering careers require. An aspect of this non-technical training is the maintaining of clear expectations of professionalism in the classroom, tutorials, and laboratories. We expect that students treat one another, their TAs, lab demonstrators, specialists, and professors with respect and act honestly. It is imperative that students do not talk or make other noise during lectures, when the teaching assistants are presenting material in tutorials, or when lab demonstrators and staff are addressing lab sections.

Another important component of professionalism is academic integrity. The copying of labs and assignments is not permitted, and will be dealt with seriously. Please review Concordia's guide to academic integrity:

https://www.concordia.ca/students/academic-integrity.html

➢ A NOTE ON PLAGIARISM:

The following is taken from the website of the office of Provost.

The most common offense under the Academic Code of Conduct is plagiarism which the Code defines as "the presentation of the work of another person as one's own or without proper acknowledgement." This could be material copied word for word from books, journals, internet sites, professor's course notes, etc. It could be material that is paraphrased but closely resembles the original source. It could be the work of a fellow student, for example, an answer on a quiz, data for a lab report, a paper or assignment completed by another student. It might be a paper purchased through one of the many available sources. Plagiarism does not refer to words alone - it can also refer to copying images, graphs, tables, and ideas. "Presentation" is not limited to written work. It also includes oral presentations, computer assignments and artistic works. Finally, if you translate the work of another person into French or English and do not cite the source, this is also plagiarism.

In Simple Words:
Do not copy, paraphrase or translate anything from anywhere without declaring where you obtained it from!