Faculty of Engineering

Department of Mechanical Engineering

COURSE OUTLINE

MECH 580 A04, MECH/BME 452 A01 – Microfluidics for Biomedical and Energy Applications

Term – Summer 2022 (202205)

Instructor	**Office Hours**
Dr. Karolina Papera Valente	Days: M,R
Phone:	Time: 14:30-15:50PM
E-mail: kvalente@uvic.ca	Location: ECS 124

LECTURE DATE(S)

Section/CRN	Days	Time	Location
BME 452 A01/ CRN: 30065	M, R	2:30pm-3:50pm	ECS 124
MECH 452 A01/CRN: 30610	M, R	2:30pm-3:50pm	ECS 124
MECH 580 A04/CRN: 30638	M, R	2:30pm-3:50pm	ECS 124

TA Name	**E-mail**	**Office**
TBD	TBD	TBD

Optional Texts	
Title: Fundamentals and Applications of Microfluidics	Introduction to BioMEMS
Author: Ngyen, N.T., Wereley, S.T.	Folch, A.
Publisher/Year: Artech House, 2002	CRC Press, 2012

LECTURES AND OFFICE HOURS

Lectures will be in person, and course material will be posted on BrightSpace. Lectures will be on Mondays and Thursdays, from 2:30 pm to 3:50 pm (ECS124).

Office hours will be conducted in person on Thursdays from 4 pm to 5 pm (EOW331)

COURSE OBJECTIVES:

"Microfluidics for Biomedical and Energy Applications" is an interdisciplinary senior and graduate level course, which introduces the students to the design and development of miniaturized systems for a wide range of biomedical applications from medical diagnostics to drug discovery and regenerative medicine as well as energy applications from fluid sample analysis (e.g. oil analysis) to CO2 transport in microporous media). The main focus is to understand the fundamentals and basic concepts underlying the heat and mass transport in micro scales, microfabrication strategies, and flow control in microfluidic systems. This course will cover the following topics: 1) Transport phenomena in microscale; 2) Fundamentals of microfabrication techniques for microfluidic devices; 3) Flow control in microfluidic systems; 4) Recent advances in designing microscale diagnostics and analytical systems; 5) A brief overview of the applications of microfluidic systems in biology and the concept of organ-on-chip; and 6) A brief overview of the use of microscale technologies for energy applications. The course is highly interactive, emphasizing teamwork, student presentation, and class discussion.

LEARNING OUTCOMES: At the end of this course, students will be able to:

1. Explain the scaling laws in microscales.
2. Understand the heat and mass transfer in microscales.

3. Understand and analyze the hydrodynamic of pressure –driven flows in microchannels.
4. Understand and analyze wettability, surface tension, and capillary flow in microchannels.
5. Understand and analyze flow through porous structures.
6. Understand and analyze electrokinetic flow in microchannels.
7. Explain different microfabrication strategies and their advantages and drawbacks.
8. Describe flow control approaches in microfluidic systems.
9. Explain different applications of microfluidic systems for analytical chemistry and diagnostics.
10. Explain the applications of microfluidics in cell culture, three-dimensional tissue modeling, organs-on-chip, and disease modelling.
11. Explain the use of microfluidic systems for energy applications.

Weight & Date(s) of Assessments:	**Weight**	**Date**
Assignments: 1	5%	06.01
2	5%	06.15
3	5%	06.29
4	5%	07.06
5	5%	07.20
6	5%	08.03
Mid-term	30%	06.30 from 6 pm to 8 pm
Project	40%	End of Term

ASSIGNMENTS

Assignment #1: Transport phenomena in microscales
Assignment #2: Fabrication techniques for microfluidics
Assignment #3: Flow control in microfluidics
Assignment #4: Lab-on-chip
Assignment #5: Cells-on-chip
Assignment #6: Microfluidics for energy

PROJECTS:

There will be a major project on the following topics:

- Organ-On-Chip
- Microfluidic devices for drug discovery
- Tissue engineering and disease modeling
- Point of care diagnostics
- Microfluidics for CO2 management
- Microfluidics and optics for bioenergy
- Your own topic

Students will submit a report, give presentations in the class, provide feedback to their peers. The report is 40% and presentation is 60% of the final project grade.
For the projects, undergraduate students will be evaluated as a group while the graduate students will be evaluated individually.

NOTE:

The final grade obtained from the above marking scheme for the purpose of GPA calculation will be based on the percentage-to-grade point conversion table as listed in the current Undergraduate Calendar.

NOTES ON WORK COMPELETION

Failure to complete and submit all assignments will result in a grade of N.

COURSE LECTURE NOTES

Unless otherwise noted, all course materials supplied to students in this course are intended for use in this course only. These materials are NOT to be re-circulated digitally, whether by email or by uploading or copying to websites, or to others not enrolled in this course. Violation of this policy may in some cases constitute a breach of academic integrity as defined in the UVic Calendar.

COURSE SCHEDULE

Module	Topics	Week
#0	Introductory concepts	1
#1	Transport phenomena in microscales	2
#1/#2	Fabrication techniques for microfluidics	3
#2	Fabrication techniques for microfluidics	4
#2/#3	Flow control in microfluidics	5
#3	Flow control in microfluidics	6
#4	Lab-on-chip	7
#4	Lab-on-chip	8
#5	Cell-on-chip	9
#5	Cell-on-chip	10
#6	Microfluidics for energy	11

General Information

Note to Students: Students who have issues with the conduct of the course should discuss them with the instructor first. If these discussions do not resolve the issue, then students should feel free to contact the Chair of the Department by email or the Assistant to the Chair to set up an appointment.

Centre for Accessible Learning (CAL) https://www.uvic.ca/services/cal/

Accommodation of Religious Observance (AC1210) Read it here

Discrimination and Harassment Policy (GV0205) Read it here

Sexualized Violence Prevention and Response at UVic:
UVic takes sexualized violence seriously, and has raised the bar for what is considered acceptable behaviour. We encourage students to learn more about how the university defines sexualized violence and its overall approach

by visiting https://www.uvic.ca/sexualizedviolence/. If you or someone you know has been impacted by sexualized violence and needs information, advice, and/or support please contact the sexualized violence resource office in Equity and Human Rights (EQHR). Whether or not you have been directly impacted, if you want to take part in the important prevention work taking place on campus, you can also reach out:
Where: Sexualized violence resource office in EQHR; Sedgewick C119
Phone: 250.721.8021
Email: svpcoordinator@uvic.ca
Web: https://www.uvic.ca/sexualizedviolence/

Office of the Ombudsperson:
The Office of the Ombudsperson is an independent and impartial resource to assist with the fair resolution of student issues. A confidential consultation can help you understand your rights and responsibilities. The Ombudsperson can also clarify information, help navigate procedures, assist with problem-solving, facilitate communication, provide feedback on an appeal, investigate and make recommendations.
Phone: 250-721-8357
Email: ombuddy@uvic.ca
Web: https://uvicombudsperson.ca/

Electronic devices in labs and lectures: No unauthorized audio or video recording of lectures is permitted.

Electronic devices in midterms and exams: Calculators are only permitted for examinations and tests if explicitly authorized and the type of calculator permitted may be restricted. No other electronic devices (e.g. cell phones, pagers, PDA, etc.) may be used during examinations or tests unless explicitly authorized.

Faculty of Engineering, University of Victoria Standards for Professional Behavior
It is the responsibility of all members of the Faculty of Engineering, students, staff, and faculty, to adhere to and promote standards of professional behavior that support an effective learning environment that prepares graduates for careers as professionals...
You are advised to read the Faculty of Engineering document *Standards for Professional Behavior* which contains important information regarding conduct in courses, labs, and in the general use of facilities.

Engineering Students' Society
The Engineering Students' Society (ESS) serves all students registered in an Engineering degree program. For information on ESS activities, events and services navigate to http://www.engr.uvic.ca/~ess

Grading System
The University of Victoria follows a percentage grading system in which the instructor will submit grades in percentages. The University will use the following Senate approved standardized grading scale to assign letter grades. Both the percentage mark and the letter grade will be recorded on the academic record and transcripts. Read the policy here

Course Experience Survey (CES)
We value your feedback on this course. Towards the end of term you will have the opportunity to complete a confidential course experience survey (CES) regarding your learning experience. The survey is vital to providing feedback to me regarding the course and my teaching, as well as to help the department improve the overall

program for students in the future. When it is time for you to complete the survey, you will receive an email inviting you to do so. If you do not receive an email invitation, you can go directly to the http://ces.uvic.ca

You will need to use your UVic NetLink ID to access the survey, which can be done on your laptop, tablet or mobile device. I will remind you closer to the time, but please be thinking about this important activity, especially the following three questions, during the course.

- What strengths did your instructor demonstrate that helped you learn in this course?
- Please provide specific suggestions as to how the instructor could have helped you learn more effectively.
- Please provide specific suggestions as to how this course could be improved.

Attendance
Students are expected to attend all classes in which they are enrolled. An academic unit may require a student to withdraw from a course if the student is registered in another course that occurs at the same time...
An Instructor may refuse a student admission to a lecture, laboratory, online course discussion or learning activity, tutorial or other learning activity set out in the course outline because of lateness, misconduct, inattention or failure to meet the responsibilities of the course set out in the course outline. Students who neglect their academic work may be assigned a final grade of N or debarred from final examinations.
Students who do not attend classes must not assume that they have been dropped from the course by an academic unit or an instructor. Courses that are not formally dropped will be given a failing grade, students may be required to withdraw and will be required to pay the tuition fee for the course. Read the policy here

Academic Integrity
Academic integrity is intellectual honesty and responsibility for academic work that you submit individual or group work. It involves commitment to the values of honesty, trust, and responsibility. It is expected that students will respect these ethical values in all activities related to learning, teaching, research, and service. Therefore, plagiarism and other acts against academic integrity are serious academic offences.

The responsibility of the institution Instructors and academic units have the responsibility to ensure that standards of academic honesty are met. By doing so, the institution recognizes students for their hard work and assures them that other students do not have an unfair advantage through cheating on essays, exams, and projects.

The responsibility of the student Plagiarism sometimes occurs due to a misunderstanding regarding the rules of academic integrity, but it is the responsibility of the student to know them. If you are unsure about the standards for citations or for referencing your sources, ask your instructor. Depending on the severity of the case, penalties include a warning, a failing grade, a record on the student's transcript, or a suspension.
It is your responsibility to understand the University's policy on Academic Integrity

Equality
This course aims to provide equal opportunities and access for all students to enjoy the benefits and privileges of the class and its curriculum and to meet the syllabus requirements. Reasonable and appropriate accommodation will be made available to students with documented disabilities (physical, mental, learning) in order to give them the opportunity to successfully meet the essential requirements of the course. The accommodation will not alter academic standards or learning outcomes, although the student may be allowed to demonstrate knowledge and skills in a different way. It is not necessary for you to reveal your disability and/or confidential medical information to the course instructor. If you believe that you may require accommodation, the course instructor can provide you with information about confidential resources on

campus that can assist you in arranging for appropriate accommodation. Alternatively, you may want to contact the Centre for Accessible Learning (formerly the Resource Centre for Students with a Disability) located in the Campus Services Building.

The University of Victoria is committed to promoting, providing, and protecting a positive, and supportive and safe learning and working environment for all its members.