

**Department of Electrical and Computer Engineering****ECED6240/Credit Hours:3****Complementary Metal-Oxide-Semiconductor – MicroElectroMechanical Systems (CMOS-MEMS)**

Fall 2024/2025

Lectures (Thursday 9-12 am C365)**Course Website:** mems.ece.dal.ca/eced6240.php**Instructor:** Yuan Ma**Office:** Sexton Campus C314**Office Phone:** 902 494 6129**Office Hours:** by appointment**Email:** Yuan.Ma@Dal.Ca**Course Website:** mems.ece.dal.ca/eced6240.php**Course Description**

This course includes an introduction to MicroElectroMechanical Systems (MEMS) with a focus on integration of MEMS with CMOS technology. Design principles, techniques and micro-fabrication process are covered. Electrical and mechanical concepts of MEMS characterization are introduced. Contemporary computer aided design and analysis tools such as L-Edit, COMSOL and ANSYS are introduced. Students will work on a project to design, simulate, and implement a MEMS system for selected applications.

Course Learning Outcomes

Upon completion of this course, students should be able to:

- Understand basic MEMS working principles and micro-fabrication processes;
- Use design MEMS design techniques and design rules to design basic MEMS structures;
- Calibrate simple MEMS devices;
- Use CAD tools efficiently for design, analysis and implementation of basic sensors and actuators.

Reference Text(s)

Foundations of MEMS, by C. Liu, Pearson;

CMOS-MEMS, edited by H. Baltes et al.

Course Schedule

The first half of the term will focus on the basics of instrumentation and MEMS. The seco

Week/Module Class Dates	Focus Topic	Lab Activities	Readings
1	Introduction to CMOS and MEMS	Video- Silicon Run	Ch 1, Baltes, Liu
2	Electrical and mechanical concepts	-----	Ch 3, Liu
3	Bulk / surface micromachining	MUMPS process tutorial	Ch 2, 10 Liu
4	MEMS actuation principles	-----	Ch 4-9, Liu
5	Sensing and actuation	L-EDIT tutorial	Ch 9, Liu
6	MEMS calibration methods	COMSOL tutorial	Ch 2-5 Baltes
7	Optical interferometer	Veeco tutorial	Ch 5-6 Liu
8	Advanced topics: Optical MEMS	ES micromirror tutorial	Ch 15, Liu
9	Study Break	-----	-----
10	Project - Design	L-EDIT	----

Week/Module Class Dates	Focus Topic	Lab Activities	Readings
11	Project – Simulation	COMSOL	----
12	Project - Presentation	Presentation	----

Course Assessments

Components of your grade include assignments, labs, and a project.

Assignments (30%): Brightspace submission of three written assignments will be required. Assignments and due dates will be posted on the course website. No late assignments will be accepted.

Labs (30%): There will be two labs in this course. One focuses on the design of MEMS, and the other is for the finite element analysis of MEMS. Each lab may take a few lab sessions to finish. Details regarding the labs will be posted on the course website.

Project (40%): Two types of projects can be carried out by each student or a group of two students depending on the scale of the difficulty. - Design projects: You can use LEdit, or MEMS Pro or other microelectronics design and simulation tools to develop a CMOS – MEMS application. The project should cover the design objectives, design approaches, performance simulation and final CMOS – MEMS fabrication layout. - Literature review project: Certain research topics in CMOS – MEMS with an in-depth literature search and review into chosen topics in CMOS – MEMS research areas with a detailed report can be a great project. The review must be thorough and high quality.

Project deliverables: Each group submit a report with necessary appendix of program files, plots, design diagrams, and layout for fabrication if possible. Deadline: The project is due on December 8th, 2024.

University Statements

<https://dalus.sharepoint.com/sites/acad/eng/SitePages/Course-Syllabus-Appendix.aspx>

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Dalhousie Engineering Student Oath

I, as one who is preparing to enter the profession of engineering, promise to conduct myself in an honorable and ethical manner, and, as such, I will not cheat, plagiarize or be involved in any other academically dishonest activities. I shall uphold the values of truth, honesty and trustworthiness. I shall study diligently so that I will be able to safeguard human life, to protect the welfare of society and the environment, and to uphold the reputation of the profession. In all this I shall be concerned for the well-being of others, and not just myself.