

**UNIVERSITY OF TORONTO**  
**DEPARTMENT OF MECHANICAL AND INDUSTRIAL ENGINEERING**

*MIE506*

*MEMS Design and Microfabrication*

*2025*

**SYLLABUS**

**Time and Location:**

***Lectures (Starting from Jan. 6)***

*Lectures - Wednesday, 6:00-9:00pm, BA B024*

***Design Tutorials (Starting from Jan, 6)***

*Friday, 10:00-11:00am, SF 3202*

***Labs (Starting from Jan, 6)***

*PRA 0102 Tuesday, 3:00-6:00pm, MY 350*

*PRA 0101 Friday, 3:00-6:00pm, MY 420*

**Instructor:**

Dr. Maher Bakri-Kassem

E-mail: maher.bakrikassem@utoronto.ca

Office hours: TBA

**Tutorial and Lab TAs:**

Hosseinali Omranpourshahreza (ali.omranpourshahreza@mail.utoronto.ca) (Lab TA)

Office location and hours: TBA

Mohammad Mahdi Rastegardoost (m.rastegardoost@mail.utoronto.ca) (Tutorial/Project TA)

Office location and hours: TBA

**Course Description:**

This course will present the fundamental basis of microelectromechanical systems (MEMS). Topics will include: micromachining/microfabrication techniques, micro sensing and actuation principles and design, MEMS modeling and simulation, and device characterization and packaging. Students will be required to complete three MEMS design projects, including design modeling, simulation, microfabrication process design, and photolithographic mask layout.

*Lectures:* in-depth discussions will be given on selected topics: (1) micromachining/microfabrication techniques; (2) electrostatic and electrothermal microactuation; and (3) capacitive, thermal, and piezoresistive sensing.

*CAD design tutorials:* the instructor and TAs will teach detailed design tutorials through design examples. Students will gain the capability of using MEMS CAD software (e.g., ANSYS) and will complete three design projects under the guidance of the instructor and TAs.

*Cleanroom microfabrication lab sessions:* students will gain knowledge of microfabrication and testing through online resources.

### **Learning Objectives:**

Upon completion of MIE506, each student will have demonstrated the ability to:

1. Understand micromachining and microfabrication techniques, sensing and transduction mechanisms of MEMS devices and systems.
2. Design and analyze various MEMS actuators and sensors through theoretical calculations, and FEA simulations.
3. Apply technical knowledge and engineering tools (ANSYS) for the development of MEMS devices.
4. Perform modeling of MEMS devices to integrate MEMS devices within other circuits.
5. Gain microfabrication knowledge.

**Course Web Site:** <https://q.utoronto.ca/courses/330319>

### **Grading:**

25% Three design Projects (simulation and calculation)

25% Midterm (1-page single-sided info sheet allowed)

Wed.. Feb. 26<sup>th</sup>, 2025 @ 6:00-8:00pm

10% Lab attendance, reports and quizzes

5% Homework

35% Final exam (1-page single-sided info sheet allowed)

### **Required Textbook:**

▪ **Foundations of MEMS**, by C. Liu, Pearson/Prentice Hall, Second Edition, 2012. (ISBN: 978-0-13-249736-7)

**Schedule:** (subject to changes during semester)

Week 1	Introduction
Week 2	Introduction to microfabrication
Week 3	Bulk micromachining
Week 4	Surface micromachining
Week 5	Electrothermal actuation
Week 6	Electrothermal actuation
Week 7	Electrostatic actuation
Week 8	Midterm exam
Week 9	Electrostatic actuation
Week 10	Capacitive sensing
Week 11	Piezoresistive sensing
Week 12	Device packaging and characterization
Week 13	Review