



**AME 455: Introduction to MEMS**

**Units: 3**

**Term: Spring 2024**

**Day-Time: M/W 10:00-11:20 am**

**Section: 28861R**

**Location: DMC 101**

**Instructor: Hangbo Zhao**

**Office: OHE 430S**

**Contact Info: [hangbozh@usc.edu](mailto:hangbozh@usc.edu)**

**TA: Jaemin Seo ([jaemin.seo@usc.edu](mailto:jaemin.seo@usc.edu))**

**Office Hours: TBD**

## Course Description

This course introduces students to the multi-disciplinary, and exciting field of microelectromechanical systems (MEMS). Topics covered in this course include scaling laws involved in MEMS, material properties, structural mechanics, basic sensing and actuation principles, fabrication and device integration, typical MEMS devices and applications, and latest developments in the field.

## Learning Objectives

This course aims at providing a comprehensive understanding of science and technology of MEMS, with an emphasis on the underlying mechanics, structures, electrostatics, and dynamics in the design and fabrication of MEMS for real-world applications. After completing this course, students should be able to:

- (a) Understand fundamental principles of sensing and actuation and corresponding scaling laws in MEMS
- (b) Gain a comprehensive perspective of various fabrication processes and materials used in microfabrication
- (c) Understand the principle, design, and fabrication techniques of leading exemplary devices in the MEMS industry
- (d) Design basic MEMS devices using relevant mechanical/electrical/fluidic engineering principles

**Prerequisite(s):** background in undergraduate-level mechanics of materials and structures is necessary.

## Course Notes

Letter grade.

## Technological Proficiency and Hardware/Software Required

N/A.

## Required Readings and Supplementary Materials

There is no required textbook for this course. The following textbooks are helpful resources:

- “Foundations of MEMS”, Chang Liu (ISBN: 978-0132497367)
- “Fundamentals of Microelectromechanical Systems (MEMS)”, Eun Sok Kim (ISBN: 978-1264257584)
- “Microsystem Design”, Stephen D. Senturia (ISBN: 978-0792372462)
- “Fundamental of Microfabrication”, Marc Madou (ISBN: 978-0849308260)
- “The MEMS Handbook”, Mohamed Gad-el-Hak (ISBN: 978-0849300776)

## Grading Breakdown and Policy

Homework	35%
Midterm	35%
Final project	30%

## Assignment Submission Policy

- There will be a total of 5 homework assignments.
- No late homework submission will be accepted.
- Discussion of homework assignments with your classmates is encouraged, but each student is required to submit their own solutions.
- Final project: students will form small teams to study and present on a topic from a list of MEMS topics. More details will be announced later.

## Use of AI Generators Policy

Since creating, analytical, and critical thinking skills are part of the learning outcomes of this course, all assignments should be prepared by the student working individually or in groups. Students may not have another person or entity complete any substantive portion of the assignment. Using AI-generated tools is prohibited in this course, will be identified as plagiarism, and will be reported to the Office of Academic Integrity.

## Tentative Course Schedule

Date	Topics	HW assigned	Deliverable/ Due dates
Mon 1/8	Course overview, introduction of MEMS		
Wed 1/10	Scaling laws: I		
Mon 1/15	<b>MLK Day, no lecture</b>		
Wed 1/17	Scaling laws: II	HW 1	
Mon 1/22	Mechanics of materials for MEMS		
Wed 1/24	Mechanics of MEMS structures		HW 1 due
Mon 1/29	Electrostatic sensing and actuation: I		
Wed 1/31	Electrostatic sensing and actuation: II	HW 2	
Mon 2/5	Electrostatic sensing and actuation: III		
Wed 2/7	Microfabrication: I		
Mon 2/12	Microfabrication: II		HW 2 due
Wed 2/14	Microfabrication: III	HW 3	
Mon 2/19	<b>President's Day, no lecture</b>		
Wed 2/21	Microfabrication: IV		
Mon 2/26	USC Cleanroom tour (tentative)		
Wed 2/28	Review session		HW 3 due
Mon 3/4	<b>Midterm exam</b>		
Wed 3/6	Piezoelectric sensing and actuation: I		
3/10-3/17	<b>Spring Recess, no lectures</b>		
Mon 3/18	Piezoelectric sensing and actuation: II	HW 4	
Wed 3/20	Thermal sensing and actuation		
Mon 3/25	Piezoresistivity I		
Wed 3/27	Piezoresistivity II		HW 4 due
Mon 4/1	Soft lithography and microfluidics	HW 5	
Wed 4/3	Optical and RF MEMS		
Mon 4/8	MEMS device case study I		
Wed 4/10	MEMS device case study II		HW 5 due
Mon 4/15	Emerging MEMS technologies		
Wed 4/17	<b>Final project presentation I</b>		
Mon 4/22	<b>Final project presentation II</b>		
Wed 4/24	<b>Final project presentation III</b>		

## Statement on Academic Conduct and Support Systems

### Academic Integrity:

The University of Southern California is a learning community committed to developing successful scholars and researchers dedicated to the pursuit of knowledge and the dissemination of ideas. Academic misconduct, which includes any act of dishonesty in the production or submission of academic work, compromises the integrity of the person who commits the act and can impugn the perceived integrity of the entire university community. It stands in opposition to the university's mission to research, educate, and contribute productively to our community and the world.

All students are expected to submit assignments that represent their own original work, and that have been prepared specifically for the course or section for which they have been submitted. You may not submit work written by others or "recycle" work prepared for other courses without obtaining written permission from the instructor(s).

Other violations of academic integrity include, but are not limited to, cheating, plagiarism, fabrication (e.g., falsifying data), collusion, knowingly assisting others in acts of academic dishonesty, and any act that gains or is intended to gain an unfair academic advantage.

The impact of academic dishonesty is far-reaching and is considered a serious offense against the university. All incidences of academic misconduct will be reported to the Office of Academic Integrity and could result in outcomes such as failure on the assignment, failure in the course, suspension, or even expulsion from the university.

For more information about academic integrity see [the student handbook](#) or the [Office of Academic Integrity's website](#), and university policies on [Research and Scholarship Misconduct](#).

Please ask your instructor if you are unsure what constitutes unauthorized assistance on an exam or assignment, or what information requires citation and/or attribution.

### Students and Disability Accommodations:

USC welcomes students with disabilities into all of the University's educational programs. [The Office of Student Accessibility Services](#) (OSAS) is responsible for the determination of appropriate accommodations for students who encounter disability-related barriers. Once a student has completed the OSAS process (registration, initial appointment, and submitted documentation) and accommodations are determined to be reasonable and appropriate, a Letter of Accommodation (LOA) will be available to generate for each course. The LOA must be given to each course instructor by the student and followed up with a discussion. This should be done as early in the semester as possible as accommodations are not retroactive. More information can be found at [osas.usc.edu](http://osas.usc.edu). You may contact OSAS at (213) 740-0776 or via email at [osasfrontdesk@usc.edu](mailto:osasfrontdesk@usc.edu).

### Support Systems:

[Counseling and Mental Health](#) - (213) 740-9355 – 24/7 on call

Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

[988 Suicide and Crisis Lifeline](#) - 988 for both calls and text messages – 24/7 on call

The 988 Suicide and Crisis Lifeline (formerly known as the National Suicide Prevention Lifeline) provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week, across the United States. The Lifeline is comprised of a national network of over 200 local crisis centers, combining custom local care and resources with national standards and best practices. The new, shorter phone number makes it easier

for people to remember and access mental health crisis services (though the previous 1 (800) 273-8255 number will continue to function indefinitely) and represents a continued commitment to those in crisis.

[Relationship and Sexual Violence Prevention Services \(RSVP\)](#) - (213) 740-9355(WELL) – 24/7 on call

Free and confidential therapy services, workshops, and training for situations related to gender- and power-based harm (including sexual assault, intimate partner violence, and stalking).

[Office for Equity, Equal Opportunity, and Title IX \(EEO-TIX\)](#) - (213) 740-5086

Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants.

[Reporting Incidents of Bias or Harassment](#) - (213) 740-5086 or (213) 821-8298

Avenue to report incidents of bias, hate crimes, and microaggressions to the Office for Equity, Equal Opportunity, and Title for appropriate investigation, supportive measures, and response.

[The Office of Student Accessibility Services \(OSAS\)](#) - (213) 740-0776

OSAS ensures equal access for students with disabilities through providing academic accommodations and auxiliary aids in accordance with federal laws and university policy.

[USC Campus Support and Intervention](#) - (213) 740-0411

Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

[Diversity, Equity and Inclusion](#) - (213) 740-2101

Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

[USC Emergency](#) - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call

Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

[USC Department of Public Safety](#) - UPC: (213) 740-6000, HSC: (323) 442-1200 – 24/7 on call

Non-emergency assistance or information.

[Office of the Ombuds](#) - (213) 821-9556 (UPC) / (323-442-0382 (HSC)

A safe and confidential place to share your USC-related issues with a University Ombuds who will work with you to explore options or paths to manage your concern.

[Occupational Therapy Faculty Practice](#) - (323) 442-2850 or [otfp@med.usc.edu](mailto:otfp@med.usc.edu)

Confidential Lifestyle Redesign services for USC students to support health promoting habits and routines that enhance quality of life and academic performance.