**Mechanics of MEMS (ME 586)**

**Fall 2025, MW 10-11:50, 2043 LuMEB**

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Office hrs: Tu, 5:10-6:0 pm, 2210D MEL

MEMS/NEMS (Micro/Nano Electro Mechanical Systems) is an evolving field and is highly interdisciplinary in nature. This course will examine a few fundamental issues related to MEMS/NEMS materials, forces and dynamics. These issues derive their attributes from the small size scale - whether it is the dimension of MEMS/NEMS, or the proximity between neighboring entities, or the characteristic length of the micro structure of materials - and hence they are shared by a large class of micro/nano systems irrespective of their applications. The goal of the course is to provide fundamental understanding of the micro/nano systems necessary for their advanced design and analysis.

There is no textbook for this course, but several books and articles will be referred.

Grading will be based on home-works (25%), two exams (25% each), and a final project (25%).

**Topics:**

Overview of sensors and actuators:

* early small mechanical systems to modern small structures

MEMS/NEMS materials:

 - Overview of fabrication processes and materials

Scaling laws:

 - electrostatics, magnetics, fluidics

Thin films for MEMS/NEMS

 - Kinetics of growth and etching, Silicon dioxide: a case study

 - Mechanical behavior of thin films:

 • residual/intrinsic stress

 • strength - a size effect

 • Experimental studies of thin films using MEMS instruments

Surface forces and stability of MEMS/NEMS

 - Surface tension

 - Electrostatic force

 - Stiction, a case study

**Exam 1**

Dynamics of MEMS/NEMS

 - Linear motion

 - Non-linear motion due to large deformation/non-linear elasto-electric fields

 - Duffing behavior in MEMS/NEMS

 - Mathieu behavior in MEMS/NEMS

 - Chaotic systems

 - Tunable dynamical systems

Failure and reliability of MEMS/NEMS

 - Fatigue and fracture of Poly crystalline Si at micro scale

Design considerations

Student project presentations

**Exam 2**