

BME 680 BIOMEMS – Design and Applications

Textbook:

Biomedical Microsystems, Ellis Meng, CRC Press, 2011.

ISBN 978-1-2-4200-5122-3

References:

Micromachined Transducers Sourcebook, Gregory Kovacs,

ISBN 0072907223

Journals:

**Lab on a chip, Sensors and Actuators, Journal of Micromechanics and
Microengineering**

Handouts:

Handouts will be distributed throughout the course

Instructor:

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Office Hours: TBA

Grading:

Exam 1: 25%

Final Exam: 35%

Project: 25% (Ansys - fluid and structure)

HW: 15%

Course Description:

The emphasis of this course will be on applications and design of MEMS (MicroElectricalMechanicalSystems) devices for Biological and related applications. We will begin with a 3 week introduction to common MEMS fabrication techniques and processes and look at how silicon is used as a platform for many MEMS devices. We will study how membranes and cantilevers are used for sensing and actuation and how geometry affects their sensitivity and structural response. The course will conclude with an introduction to microfluidics and its application to biotechnology. Additional topics covered are chemical and biological transducers. Example applications and case studies directly related to the biotech industry will be used throughout the course. A recurring theme will be the integration of the separate subjects for Lab-on-a-Chip technology. Assignments will include a mix of engineering design and literature review. Basic knowledge in mechanics and instrumentation is preferred. Students should be familiar with the concepts of stress and strain.

Prerequisites

Engineering background.

Week 1, 2, 3:

Intro to MEMS
Microfabrication

Week 4, 5:

Mechanical Transducers: Cantilevers, membranes, spring constants, measuring deflections (Mach-Zehnder spectrometer), static, dynamic (frequency shift),

Week 6,7:

stress, strain, Electrostatics, pull-in, piezoelectric (PZT)

EXAM 1 (Midterm)

Week 8, 9:

Chemical and biological transducers, ISFET (Ion Sensitive Field Effect Transistors)

Week 10, 11, 12, 13:

Microfluidics and Biotechnology, soft lithography
Microflows, shear, pressure, flow rate, single and two phase flows, mixing, separation, surface tension, microdrops, Electrophoresis (DNA, proteins, cells), electro-osmotic flow, micropumps

Week 14:

Intro to ANSYS, Using ANSYS for structure and fluid MEMS problems

Week 15:

ANSYS, Project

EXAM 2 (Final Exam)

HW Assignments:

HW 1: Pressure Sensor Mask Design

HW 2: Pressure Sensor Design (Membranes)

HW 3: MicroCantilevers: Deflection and stress measurement

HW 4a: Literature Search/Abstract Review - ISFET Biosensors

HW 4b: ISFET Biosensor Fabrication sequence

HW 5: Microfluidic Y-channel flow calculations

HW 6: Flow Metering Devices in microchannels (Surface Tension Calculations)

ANSYS PROJECT:

Part A: Cantilever Design- maximum stress, deflection, resonant frequency

Part B: Microfluidic Channel - Pressure, Streamlines, Velocity profile