EE 5141 Introduction to Microsystem Technology
Spring 2007

Instructor
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Office hours: Mons 1:30-2:30pm, Weds 2:00-3:00pm, or by appointment.

Teaching Assistant
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Lectures and Labs
Lectures: MWF 11:15-12:05 a.m., ME 102
Lab Sessions: Tuesday and Friday, 12:20-2:15 p.m., EE/CS 1-165

Course Website
http://iml.umn.edu/courses/ee5141

Textbook
Required: C. Liu, Foundations of MEMS, Prentice Hall, 2006.
Suggested references:
(1) G. T.A. Kovacs, Micromachined Transducers Sourcebook, McGraw-Hill, 1998.
(2) S. Senturia, Microsystem Design, Kluwer Academic Publishers, 2001

Prerequisite by Topic
Knowledge of the physical sciences and biology (Freshman physics, chemistry and biology)
Understanding of electronics and devices (EE 2101, EE3161)
Microfabrication technology (EE5171) – suggested but not essential

Course Objectives
This course is designed to provide an introduction to microsystem technology that includes an overview of micromachining and MEMS fabrication technologies followed by basic sensing and actuation principles of microsensors and actuators. This course covers the review of fundamentals in bulk and surface micromachining technologies and their applications to interface the real world. Basic physics and principle of operations in different signal domains and materials will be discussed in detail from electrostatic, thermal, piezoelectric and magnetic sensing and actuations to microfluidics and biomedical applications. Packaging and signal integrity in system's point of view will be discussed. Other applications in RF, optical and medical devices will be briefly introduced in addition to the recent advancement of nanotechnologies which can be integrated in MEMS platforms. The lab sessions will emphasize basic principles and technologies and provide an exposure to solid-state micromachining and other MEMS fabrication technologies by building a couple of interesting MEMS devices.

Literature Review Project

In this project you will choose a topic which you will study extensively through literature/web search and reading articles. At the end of the class you will present what you have studied and submit the final report. The format of presentation and final report will be given by the instructor. If you need some help to find a topic, you can talk to the instructor.

Laboratory Sessions

The laboratory is the integral part of the course. You will be divided into a group of 5-7 and carry out a variety of MEMS fabrication processes. In this semester, you will fabricate not only some basic bulk micromachining structures but also will make a polymer microfludic devices for bead sorting and manipulation. The laboratory reports will be required from individual students. The report format and contents will be specified by the lab TA. Participation in the lab is mandatory. The lab sessions will be graded by the lab participation and lab reports.

Grading

Homework	10%
Midterm Exam	25%
Final Exam	25%
Project	15%
Lab Sessions	25%

Exam Dates

Midterm	Fri, Mar 9
Final	Fri, May 11

Course Schedule (Tentative)

Week	Contents
1. (1/17, 19)	Introduction
2. (1/22, 24, 26)	Introductory review of microfabrication
3. (1/29, 31, 2/02)	Bulk micromachining
4. (2/05, 07, 09)	Surface micromachining
5. (2/12, 14, 16)	Wafer bonding/LIGA/Packaging
6. (2/19, 21, 23)	Polymer Processes
7. (2/26, 28, 3/02)	Microfluidics and BioMEMS
8. (3/09)	Midterm exam (3/09)
9. (3/12 - 16)	*Spring Break*
10. (3/19, 21, 23)	Essential electrical and mechanical concepts
11. (3/26, 28, 30)	Electrostatic sending and actuation
12. (4/02, 04, 06)	Thermal sensing and actuation
13. (4/09, 11, 13)	Piezoelectric sensing and actuation
14. (4/16, 18, 20)	Magnetic sensing and actuation
15. (4/23, 25, 27)	RF MEMS/Optical MEMS/Biomedical applications
16. (4/30, 5/02, 04)	Project presentation
17. (5/11)	Final exam

Lab Sessions Schedule (Tentative)

Covering Contents

(1) Silicon anisotropic silicon wet etch
- Photolithography
- Silicon nitride deposition; LPCVD
- Silicon nitride dry etch: STS Etcher
- Silicon anisotropic wet etching in KOH
- Measurement

(2) Microfluidic Devices (Bead Manipulation/ Magnetic sorting)
- Metal deposition
- Lift-off lithography
- Fabrication of SU-8 Molding
- PDMS Replica Process
- Bonding / Measurement
- DEP (Dielectrophoresis) manipulation/Magnetic sorting

Process		Week
Introduction		1
Silicon Wet Etch	Cleaning	2
	Si_3N_4 Deposition	
	Photolithography	
	Si_3N_4 Dry Etch	3
	Photoresist Strip	
	KOH Wet Etch	
	Measurement	4
Microfluidic Channels and Bead Manipulation	Cleaning	5
	SiO_2 Deposition	
	Photolithography	
	Metal Deposition	6
	Lift-Off	
	Photolithography : SU-8	7
	PDMS Process	8
	Bonding	9
	Experiment	
Magnetic Sorting	Cleaning	10
	Photolithography	
	Metal Deposition	
	Lift-Off	
	Photolithography : SU-8	11
	PDMS Process	
	Bonding	
	Experiment	12