

Fundamentals of Microfabrication

BIOEN 6421; ELEN 5221; MEEN 5960 and 6960

Class Time: Tuesday and Thursday 2:00-2:50 PM in EMCB 110
Lab sessions to be determined. Will be held in Microfabrication Teaching Lab

Instructor: Dr. Bruce Gale
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Office Hours: 3-5 PM Daily
Other times by appointment

Text: *Fundamentals of Microfabrication*, Mark Madou, CRC Press, ISBN: 0-8493-9451-1

Supplemental Texts: Microsystem Design, Stephen D. Senturia, Kluwer Academic Press, 2000.
Other relevant microfabrication texts.

Class Web Page: <http://www.eng.utah.edu/~gale/>

Objectives

1. To gain an understanding of standard microfabrication techniques and the issues surrounding them.
2. To know the major classes, components, and applications of microsystems and to demonstrate an understanding of the fundamental principles behind the operation of these systems
3. To understand the unique requirements, environments, and applications of microsystems.
4. To apply knowledge of microfabrication techniques and applications to the design and manufacturing of a microsystem.
5. To practice microfabrication techniques in a laboratory setting.
6. To make the study of microsystems enjoyable

Grading

Grading will be curved with students above the median receiving an "A", students below the median and above one standard deviation below the median receiving a "B". 1 to 2 standard deviations below the median will receive a "C", 2 to 3 standard deviations below will receive a "D", and anything lower will receive an "F".

Exam 1	15%
Exam 2	15%
Final Exam	20%
Poster and Poster Presentation	10%
Design Project Written Report	15%
Lab Notebooks	20%
Quizzes, Homework and Attendance	5%

Quizzes and Homework

Quizzes will be held randomly and may or may not be announced in class. On weeks that an exam is being held, no quiz will take place. Quizzes can only be made up under extenuating circumstances approved by the instructor. Homework will be assigned occasionally during the course of the quarter to assist students in preparing for exams and to ensure understanding of the presented material. Homework assignments will be due in class and distributed on the course web page.

Design Project

Each graduate student and team of three undergraduate students will be required to complete a design project focused around a microsystem. The project must be approved by the instructor or his designee by March 5. The project will be expected to include the following sections addressed in the poster: problem definition, literature search, motivation or rationale, implementation methods considered (brainstorming), "customer" requirements, functional specifications, modeling and scaling effects, fabrication methodology, mask or CAD layout, packaging, testing methodology/plan, results and discussion, conclusions, and references. Each of these sections will be due on a specific date in the quarter to allow some feedback on the progress of the project. On the last day of class, a poster session will be held where each individual/group will present their work to the public. The graded posters and their presentation will constitute of the poster grade. The written report will be turned in on the poster presentation day

and graded by the instructor. The reports must be typed and easily readable with proper grammar and English. Each poster and paper will be graded on the following: clarity, organization, uniqueness of design, feasibility of design, mask layout, background (introduction), comprehensiveness, depth of presentation, modeling, packaging, testing, and fabrication procedure. The course instructor will be assisted in grading posters and projects by the TAs assigned to the course.

Schedule

All topics listed in this outline will be covered in class. The schedule **is subject to change** and changes to the published schedule will be announced in class and on the web page. Additional assignments may be made if deemed necessary by the instructor.

Class	Date	Topic	Lab
1	Jan. 3	Introduction to MEMS; Preview of Course, Course Policies	
2	Jan. 8	Chemicals in Microfabrication	Lab Safety and Facilities Tour
3	Jan. 10	Clean Rooms and Vacuum Systems	
4	Jan. 15	Basic Lithography	Cleaning and Photolithography; Masks
5	Jan. 17	Mask Layout and Design	
6	Jan. 22	Materials Science for MEMS, Crystallography	CVD and Diffusion
7	Jan. 24	CVD Processes and Thermal Oxidation and Diffusion	
8	Jan. 29	Dry Etching	Dry Etching
9	Jan. 31	Exam 1 Lectures 1-8	
10	Feb. 28	Wet Etching and Bulk Micromachining	
11	Mar. 5	Physical Vapor Deposition: Sputtering, Evaporation,	Wet Etching
12	Mar. 7	No Class PARALYMPIC OPENING CEREMONY	
13	Mar. 12	Electroplating and Micromolding	Metallization
14	Mar. 14	Beam Processing, Mechanical Micromachining and Other Techniques	
15	Mar. 19	Plastic Molding Processes: LIGA, Hot Embossing, Injection Molding, PDMS	Bonding
16	Mar. 21	Wafer Bonding and Basic MEMS Packaging	
17	Mar. 26	Integration with Microelectronics; Packaging of Optical and Fluidic Systems	Packaging
18	Mar. 28	MEMS CAD and Simulation Programs	
19	Apr. 2	Basic Measurement and Characterization of MEMS systems	Characterization and Metrology
20	Apr. 4	Exam 2 Lectures 10-19	
21	Apr. 9	Optical Microsystems	Individual Projects
22	Apr. 11	Electrical and Magnetic Microsystems	
23	Apr. 16	Mechanical Microsystems	Individual Projects
24	Apr. 18	Chemical Microsystems	
25	Apr. 23	Microfluidic Systems	Individual Projects
26	Apr. 25	Biomedical Microsystems	
27	Apr. 30	Introduction to Nanotechnology	Individual Projects
28	May 2	Poster Session DESIGN PROJECT DUE	
29	May 8	Final Exam Comprehensive 1-3 PM	

General Class Policies

1. Last day to drop classes is January 12.
2. Code of student rights and responsibilities, see spring schedule.
3. Student records, scores, exams and homework are confidential
4. Course evaluations on the last day of class.
5. Attendance: Failure to attend more than 50% of presented lectures will result in failure of the class unless extenuating circumstances exist.
6. Cheating and Shared Work: Cheating on in-class assignments and exams will result in a zero on that assignment. Shared work on take home assignments will result in a shared grade.
7. The University of Utah seeks to provide equal access to its programs, services and activities for people with disabilities. If you will need accommodations in this class, reasonable prior notice needs to be given to the instructor and to the Center for Disability Services, 162 Olpin Union Building, 581-5020 (V/TDD) to make arrangements for accommodations. All written information in this course can be made available in alternative format with prior notification.