BME-451: Fundamentals of Biomedical Microdevices

FALL 2005

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DRB-159
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Course Description

Introduction to biomedical microdevices with emphasis on biomedical microelectromechanical systems (bioMEMS) and microtechnologies. Principles for measurement of small-scale biological phenomena and clinical applications.

Prerequisites EE 202L

Textbook None. Reading material will be posted to course website or handed out in class.

Class Schedule and Grading Policy

There will be two lectures per week (TTH 11:00a-12:20p) held in KAP163.
The final grade will be based on the following:

(1) Homework (50%)

Regular homework sets will be assigned on a weekly basis for the 1st half of the course (approx. 7 HW sets). Homework sets are due in class at the beginning of class on Tuesdays.

Collaboration is permitted on HW, however copying is not. Each student is responsible for fully understanding the work they submit.

(2) Final Project (50%)

Students will work in teams of 2 or 3 (depending on class size) to research special topics in bioMEMS. Each team will consist of all undergraduate or graduate student members. Mixed teams will not be allowed. Topics suitable for the final project will be covered in class.

Several final project milestones will be assigned as homework during the 2nd half of the course. These milestones will be used in the calculation of your final project grade (10%).

A jointly written final paper consisting of a comprehensive review of the selected topic will account for 25% of the final grade. Final papers must be submitted in class on Nov. 22, 2005. *Plagiarism will be severely punished and result in a "zero" grade for written portion of the final project.*

The remaining 15% of the grade will be determined by the joint presentation prepared using Microsoft Powerpoint. Presentations will be given to the rest of the class during the final exam date (Dec. 13, 2005, 8-10am).

Emphasis will be placed on critical thinking and the ability of students to analyze the viability of bioMEMS designs.

(3) Notes on Grading:

Undergraduate and graduate students will be graded on separate scales. Graduate students will be held to a higher grading standard.

Final project grades will be determined by considering individual and team contributions.

Course Objectives

Students will be exposed to the concept of miniaturization, the materials and methods for microfabrication of biomedical microdevices, transduction and sensing principles, and applications of bioMEMS. Through classroom lectures and homework sets, students will develop critical thinking skills as they apply to microengineering design, biocompatibility, and system integration and packaging. Students will also obtain an understanding of the fundamental mechanisms (electrical, mechanical, optical, and chemical) used in biomedical applications. Through group projects students will become well-versed in new advances in biosensing and bioMEMS applications. This introductory course will prepare students for advanced MEMS courses including BME-551, EE-607, and EE-608L. The following courses are recommended for those interested in MEMS: AME-455, 537; BME-551; EE-438L, 504L, 607, 608L; MASC-439, 514L, 534.

Course Topics and Outline

This following is a tentative course outline. The topics will be covered as time allows.

Introduction and Overview
- Why miniaturization? Dimensions and scaling challenges in bioMEMS

BioMEMS Materials
- From silicon to polymers, the need for biocompatibility

Microfabrication for BioMEMS Part A
- Introduction to micropatterning, micromachining, and micromolding with consideration given to device/system design

Microfabrication for BioMEMS Part B
- Surface and bulk micromachining, etching and thin film processes

System Integration
- Bonding, assembly, packaging, and other microfabrication techniques

Biosignal Transduction Mechanisms
- Challenges of biosensing, principles: mechanical, thermal, optical, acoustic, electrochemical, conductometric, potentiometric, amperometric

BioSensors
- Examples and applications of biosensors

Cell Manipulation
- Governing forces and manipulation strategies

Microfluidics
- Introduction to microfluidics, properties of biological fluids in microchannels, devices

Lab-on-a-Chip
- Microanalytical systems in chemistry and biology

MEMS Implants and Bioelectric Interfaces
- Implantable microelectrodes, shunts, etc.

Microengineering in Biotechnology
- PCR, microarray technology, optical detection

What's next? Frontiers in BioMEMS
- Nanolithography, biomimetic nanodevices, nanotubes
- Case Studies and Speakers from Companies/Academia
- Commercialized devices, in depth look at specific topics in biomedical microdevices

Course Bibliography

Reading will be selected from the following texts:

Fundamentals and Applications of Microfluidics, N.T. Nguyen & S.Wereley (**on reserve in SEL**)
Fundamentals of Microfabrication, M. Madou (**on reserve in SEL**)
Micromachined Transducers Sourcebook, Gregory T.A. Kovacs (**on reserve in SEL**)
Microsystem Technology in Chemistry and Life Science, A. Manz & H. Becker (on Blackboard)

You are not required to purchase these books for the class. In addition to these books, select journal articles and conference papers will be provided to supplement the course reader and lecture notes.

Statement for Students with Disabilities

Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to me (or to the TA) as early in the semester as possible. DSP is located in STU 301 and is open 8:30 a.m. – 5:00 p.m., Monday through Friday. The phone number for DSP is (213) 740-0776.

Disclaimer

Taking this course **will not** guarantee or prepare you for a MEMS job in industry. MEMS is a tool and not a replacement for firm grounding in engineering fundamentals.