ME 555/MS 555 **MEMS: Fabrication and Materials** **Fall 2013**

Instructor
Xin Zhang, Professor
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Lectures: Mon, Wed 2-4 PM at PHO 901
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(Otherwise, quick questions by email; additional meetings by appointment)

ME 555/MS 555 — MEMS: Fabrication and Materials
This course will explore the world of microelectromechanical systems (MEMS) and NEMS. This requires an awareness of design, fabrication, and materials issues involved in micro/nanosystems. We will go over this through a combination of lectures, case studies, and individual homework assignments. The course will cover fabrication technologies, material properties, structural mechanics, basic sensing and actuation principles, packaging, and MEMS markets and applications. The course will emphasize the fabrication and materials of micro/nanosystems. This is not because the other parts aren't important. Instead, it is because with fabrication and materials expertise there is something concrete you can do that will always help. When we exam special topics and case studies, a lot of these other pieces will be put together.

Course Schedule: 4 lec hr/wk

Status in the Curriculum: Graduate Students and Senior Undergraduates

Textbooks: There is no standard textbook. We will use a combination of materials from books, web sites, monographs, journal papers, and conference proceedings. Two major reference books are: (1) *Microsystem Design*, Stephen D. Senturia, Kluwer Academic Publishers, 2001, and (2) *Fundamentals of Microfabrication*, Marc J. Madou, CRC Press LLC, 2002.

Coordinator: Xin Zhang, Professor of Mechanical Engineering

Prerequisites by topic: None

Goals: To explore the world of microelectromechanical systems (MEMS) by emphasizing the state-of-the-art science and technology in fabrication and materials of MEMS.

Computer Usage: PPT for project presentation.

Course Learning Outcomes:

As an outcome of completing this course, student will:

i. Be introduced to the field of micro/nanosystems
ii. Grain a knowledge of basic approaches for micro/nanosystem design
iii. Gain a knowledge of state-of-the-art lithography techniques for micro/nanosystems
iv. Learn new materials, science and technology for micro/nanosystem applications
v. Understand materials science for micro/nanosystem applications
vi. Understand state-of-the-art micromachining and packaging technologies

vii. Develop experience on micro/nanosystems for photonics and optical applications
viii. Develop experience on micro/nanosystems for power and energy applications
ix. Development experience on micro/nanosystems for clinical/biomedical applications
x. Have a good vision to the future of micro/nanotechnology

Topics (approximate time spent topic varied from 0.5 to 1.5 weeks)

1. Introduction to MEMS
2. Lithography and Soft Lithography
3. Materials and Material Properties
4. Basic Micro/Nanofabrication Techniques
5. Bulk Micromachining
   a. Dry Bulk Micromachining
   b. Wet Bulk Micromachining
6. Surface Micromachining
7. Wafer Bonding and Packaging
8. MEMS Design and High-Volume Manufacturing
9. Fundamentals:
   a. Electronics
   b. Structures and Elasticity
   c. Fluids and Mass Transport in Liquids
10. Structures and Devices
    a. Mechanical Sensors
    b. Mechanical Actuators
    c. Microfluidic Devices
    d. Optical/Photonic Microsystems
    e. Biological Transducers
11. Invited Lectures
12. Presentations by Students
    a. Case Study Presentations
    b. Preliminary/Midterm Presentations
    c. Final Presentations

Contribution of Course to Meeting the Professional Component:
Engineering topics: 100%

Grading: Quiz -10%, Assignments -10%, Case Study (I) -10%, Case Study (II) -10%, Case Study (III) -10%, Preliminary -10%, Midterm -15%, Final -25%.

- **Assignments:** Individual work assignments
- **Quizzes:** Consist of both in-class and take-home questions
- **Case Studies:** One-to-one teach-and-learn mini group studies followed by presentations
- **Preliminary/Midterm Projects:** Literature reviews, reports and presentations
- **Final Projects:** Case studies, experiments, reports, and presentations