**Department of Electrical and Computer Engineering**
**Fall 2005**

# ECE-215
# Introduction to MEMS

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**This is the first Course on MicroElectroMechanical Systems (MEMS). The students will learn the basic principles of designing, simulation, and fabricating MEMS.**

## Texts:

**In addition to class notes which are given every week, the following texts are recommended:**

1. **G. Kovacs: Micromachined Transducers Sourcebook, McGraw-Hill 1998**
2. **S. Senturia: Microsystems Design, Kluwer publications, 2001**

## Course Requirement:

**Students are required to design MEMS device, using CAD tools, and simulate the design and realize the layout of the design in the chosen technology. The students will report on their project through final project report and oral presentation. TWO students are the maximum number of students that are allowed to work on one project. Students are encouraged to design novel devices, which could be fabricated through MEMS foundries. The fabricated device may be measured in the laboratory and may be published in the literature. The proposed MEMS devices are not limited to specific area. Students are required to submit a Proposal of their chosen project by October 18 (written TWO pages). Final Project Oral and written presentation is due on Dec. 6, 2005.**

# Course Outline and Schedule

## September 6, 2005: Introduction to MEMS and Their Applications

Introduction to the field of Micromachined sensors and actuators .List of Course requirement. Introduction to the field and overview of the market and important applications will be discussed. Technology scaling issues. Classes of MEMS. Introducing various MEMS Computer resources at GWU.

## September 13, 2005: Overview of IC Fabrication Technology

Overview of standard IC processing. CMOS technology fabricating steps
Familiarization with layout CAD tools, different layers and their notation.
Introduction to Bulk Fabrications of MEMS.

CAD tools at GWU. Start learning the Coventor Ware tutorials.
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## September 20, 2005: Bulk Micromachining

Bulk micromachining is introduced that include wet and dry etch, isotropic and anisotropy etching procedures. Other techniques for bulk micromachining will be discussed. Examples of the design
Introduction to the design procedures for MEMS devices. Modeling and analytical descriptions of MEMS devices, solution of the system equations will be discussed. Use of other CAD tools will be introduced.

Continue read Coventor Tutorial. Demo of MEMS CAD tools

## September 27, 2005: Introduction to Surface Micromachining

Micromachined terms, general properties of common semiconductors are discussed. Various techniques for surface micromachining will be discussed that include Thin-Film

processes, electrodeposition, and sacrificial processes. List of Foundries of MEMS. Technology we will use.

**Assignment #1**

## October 4, 2005: Mechanics of Materials and Energy Convergence

Introduction to Material Properties. Examples of energy conversion methods. Discussions of Elasticity, piezoelectricity, and piezoresisitive properties. Examples of devices will be discussed.

## October 11, 2005: Examples of Mechanical Microsystems

Selective examples of the design of mechanical transducers, and of mechanical sensors Will be introduced Mechanical resonators, accelerometers

**Assignment #2**

**DISCUSS with the Instructor ideas for projects**

## October 18, 2005: Examples of Mechanical Microsystems (cont.)

Selective examples of the design of mechanical transducers, and of mechanical sensors will be introduced. Introduction to mechanical actuation, static actuators. Comb Derive design, RF-Switch

**PROJECT PROPOSAL IS DUE**
**START project design**

## October 25, 2005: Electrostatic Actuation and Capacitive position sensing

Examples of capacitive sensing, circuits' requirement for integration. Process Integration.

## November 1, 2005: Example of Thermal Microsystems

Selective examples of temperature sensors and their design will be introduced. Thermal Microsystems will be discussed. Thermopiles devices.

**Assignment #3**

## November 8, 2005: Examples of Smart Sensors

Integrated circuits with MEMS devices. Noise issues. Brief introduction to BioMEMS, and Microfluidic.

Selective examples of temperature sensors and their design will be discussed.

## November 15, 2005: Integration Packaging and Assembly

Problems with process Integrations. MEMS devices packaging and assembly. Examples

## November 22, 2005:

**PROJECT REVIEW (Working with individual Groups)**

## November 29, 2005:

**PROJECT REVIEW (Working with individual Groups)**

**December 6, 2005: Projects Are DUE**

**Oral presentation each student will present his/her project to the Class. Final Project Report is Due**

**Final Exam will be posted**

**Grading: 50% Project**
**30% Final Exam**
**20% Assignments**

## Exam is Open Book and Open Notes.