

# **EEL5225 Principles of MEMS Transducers**

**Fall 2003 Semester**  
(9<sup>th</sup> Period, MWF, LAR 239)

**Goals:** *To analyze and design MEMS transducers utilizing principles of sensing and actuation, properties of materials available for fabrication, microfabrication technologies, and understanding of circuit and system issues, packaging, calibration, and test.*

**Textbook:** Stephen D. Senturia, *Microsystem Design* (Kluwer Academic Publishers, Boston, 2001)

**Instructor:** Dr. Huikai Xie, Department of Electrical & Computer Engineering; 221 Benton Hall; Tel: 846-0441; E-mail: hxxie@ece.ufl.edu

**Prerequisites:** This course is intended for graduate and upper-level undergraduate students with any engineering or physics background. Prerequisites by topic: 1) Differential and integral calculus; 2) Introductory circuit theory; and 3) Statics.

## **Topics**

### **1. Introduction and Orientation**

- Overview of MEMS
- Sensors and actuators technologies

### **2. Fabrication Technology**

- Review of standard IC fabrication technologies - diode, BJT, CMOS
- MEMS fabrication technologies - bulk micromachining, surface micromachining, and CMOS micromachining; bonding technologies

### **3. Mechanical Behavior**

- Mechanics: stress, strain, bending, beam-mass systems
- Lumped-element modeling of static behavior of elementary beams, membranes and plates
- Effects of residual stress and stress gradients
- Dynamics, normal modes, damping

### **4. Transduction Principles**

Capacitive, inductive, magnetic, optical, piezoresistive, and piezoelectric methods

### **5. Pressure Sensors and Accelerometers**

Case studies based on the MEMS literature.

### **6. Resonant Sensors and Drive Circuits**

Principles of resonant sensors and drive electronics; RF MEMS

### **7. Optical MEMS**

MEMS mirrors and gratings for optical displays, switching and imaging

**Grading:** 30% Homework, 30% Test, 40% Design Project, no Final Exam

## **Computer Usage:**

Layout of masks and FEM simulation using **Coventorware**, circuit simulation using **P-SPICE**, and dynamics calculation using **Matlab**, Mathcad, or Mathematica.