

EEL5225 Principles of MEMS Transducers

Fall 2009 Semester
(4th Period, MWF, LAR 330)

1. Catalog Description (including credit hours): Introduction to principles of micro-electro-mechanical devices and systems. 3 credits.
2. Pre-requisites: Basic semiconductor theory (EEL 3396), differential and integral calculus, introductory circuit theory, statics and dynamics, or with permission of the instructor.
3. Course Objectives: To introduce MEMS transducers through exploration of sensing/actuation mechanisms, materials, and microfabrication technologies and to model multi-energy-domain systems using lumped-element models.
4. Contribution of course to meeting the professional component (ABET only): N/A
5. Relationship of course to program outcomes (ABET only): N/A
6. Instructor: Dr. Huikai Xie
 - Office location: 221 Benton Hall
 - Telephone: 846-0441
 - E-mail address: hkx@ufl.edu
 - Web site: <https://lss.at.ufl.edu/>
 - Office hours: 4:30 – 5:30 pm, MW
7. Teaching Assistant: NONE
8. Meeting Times: 4th Period (10:40-11:30 am), MWF
9. Class/laboratory schedule:
 - Three lectures per week and 50 minutes for each lecture.
10. Meeting Location: 330 Larsen Hall
11. Material and Supply Fees: None
12. Textbooks and Software Required
 - Stephen D. Senturia, *Microsystem Design*, Kluwer Academic Publishers: Boston, 2001.
 - MATLAB, MathCAD, Excel, or equivalent may be needed for homework.
13. Recommended Reading
 - Books:
 - R. S. Muller, et. al., Editors, *Microsensors*, IEEE Press, 1991
 - W. Trimmer, Editor, *Micromechanics and MEMS*, IEEE Press, 1997
 - G. Kovacs, *Micromachined Transducers Sourcebook*, McGraw-Hill, 1998
 - N. Maluf, *An Introduction to Microelectromechanical Systems Engineering*, Artech House, 2000.

- M. Madou, *Fundamentals of Microfabrication*, 2nd Ed., CRC Press, 2002.
- J. A. Pelesko and D. H. Bernstein, *Modeling of MEMS and NEMS*, Chapman & Hall/CRC, 2003.
- R.C. Jaeger, *Introduction to Microelectronic Fabrication*, 2nd ed., Prentice Hall, 2002.
- Primary Journals:
 - *J. Microelectromechanical Systems* (IEEE/ASME)
 - *J. Micromechanics and Microengineering* (IoP)
 - *Sensors and Actuators* (Elsevier)

14. Course Outline (provide topics covered by week or by class period)

Introduction and Orientation

- Overview of MEMS
- Transducer Basics

Fabrication Technology

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

Transduction Principles

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

Modeling

- Mechanics: stress, strain, bending, beam-mass systems
- Lumped-element modeling (LEM)
- Linear system dynamics

Domain Specifics

- Mechanics
- Thermodynamics
- Fluidics
- Acoustics
- Optics
- MEMS interface electronics

15. Grading

- | | |
|-----------------------|-----|
| ▪ Homework | 30% |
| ▪ Exams/Mini-projects | 40% |
| ▪ Final exam | 30% |

16. Grading Scale

> 90 A; 85-89 B+; 80-84 B; 75-79 C+; 70-74 C; 65-69 D+; 60-64 D; and <60 E.

17. Make-up Exam Policy: No make-up exam

18. Honesty Policy – All students admitted to the University of Florida have signed a statement of academic honesty committing themselves to be honest in all academic work and understanding that failure to comply with this commitment will result in disciplinary action.

This statement is a reminder to uphold your obligation as a UF student and to be honest in all work submitted and exams taken in this course and all others.

19. **Accommodation for Students with Disabilities** – Students Requesting classroom accommodation must first register with the Dean of Students Office. That office will provide the student with documentation that he/she must provide to the course instructor when requesting accommodation.
20. **UF Counseling Services** – Resources are available on-campus for students having personal problems or lacking clear career and academic goals. The resources include:
 - University Counseling Center, 301 Peabody Hall, 392-1575, Personal and Career Counseling.
 - SHCC mental Health, Student Health Care Center, 392-1171, Personal and Counseling.
 - Center for Sexual Assault/Abuse Recovery and Education (CARE), Student Health Care Center, 392-1161, sexual assault counseling.
 - Career Resource Center, Reitz Union, 392-1601, career development assistance and counseling.
21. **Software Use** – All faculty, staff and student of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.