ECE 4370/6370 Spring 2020
Microelectromechanical Systems (MEMS)

Instructor: Pingshan Wang, 301 EIB (Fluor Daniel Engineering Innovation Building)
Tel: 656-2117, pwang@clemson.edu

Class Time: TTH 2:00 pm-3:15 pm

Where: Riggs Hall 219

GA: Duye Ye

Office Hours: TTH 1:00 pm – 2:00 pm or by appointments

Textbooks: S. D. Senturia, *Microsystem Design*, Kluwer Academics, 2000.

Suggested books

N. Maluf, *An Introduction to Microelectromechanical Systems Engineering*, Artech House, 2000. (This book has a concise overview but lack of sufficient analytical treatment)

G. T. A. Kovacs, *Micromachined Transducers Sourcebook*, McGraw Hill, 1998. (This book has comprehensive coverage and is highly recommended for serious readers.)

Suggested reading materials

- R. Feyman, "There's plenty of room at the bottom", Caltech, Dec. 29, 1959
- J. Voldman, M. L. Gray and M. A. Schmidt, "Microfabrication in biology and medicine", Annu. Rev. Biomed. Eng. 1999, pp. 401-425.

Prerequisite: CH101, 102, PHYS 122, and Consent of instructor.

Course Description: Microelectromechanical systems (MEMS) have undergone steady growth in various applications in the last fifteen years, and can potentially bring forth new low-cost microsystems by integrating microelectronics with sensors, actuators and other micromachined structures. The objective of this course is to provide students an overview to MEMS design, technology, modeling, present industrial applications and future possibilities. The final project will involve cumulative design experience on microsystem design.

Class e-mail: You should check your e-mail daily since I will send out important information and reminders this way.

Topics

	Introduction	
	Bulk material properties in MEMS	Chaps. 1, 2, 3.1 and 3.2
	Overview of microfabrication in MEMS	Chaps 3.2 and 3.3
	Thin-film characteristics and special processes	Chaps 3.3 to 4.2
	Process and design integration in MEMS	Chaps 4.2, 4.3 and MUMPs manual
	Transducers by lumped models	Chaps 6.1 to 6.6
	Deformable solids by elasticity theory	Chaps 8.1 to 8.5
	Beam and plate deformation mechanics	Chaps 9.1 to 9.6
	Microfluidics: theory and principles	Chaps 13.1 to 13.3
	Microfluidics: electrokinetics	Chaps 13.4 to 13.6
3/20 – 3/24:	Spring break	
	Pressure sensor design	Chap. 18
	Accelerometer design	Chap. 19
	Optical and RF MEMS components	Chap. 20
	Glossary of other MEMS applications	Chaps 21 and 22
	Final project presentations	

Attendance Policy**:** It is in the student's best interest to attend all lectures. The roll will be taken in the first two lectures in accord with Clemson University policy. No other attendance enforcement will be imposed other than for quizzes.

Homework: Homework will comprise some textbook problems. It will be assigned on a regular basis. Normally, homework will be assigned at the first lecture of a topic (chapter) and will be due at the beginning of a new topic. Solutions to homework will be placed on CLE (*Blackboard*) after the due date. It is expected that your homework will represent your own work, although working in groups is allowed and even encouraged. *Late homework will not be accepted!*

Lab & Project: A design project will be assigned. The students are expected to design a selected MEMS device. The course instructor will work with a MEMS service company to fabricate the designed device. The designers are invited back to make measurements (probably after the course is over).

Graduate student (ECE 6370) will be responsible for executing a selected design project. The results will be presented briefly in class. This is part of the project assignment for graduate students.

Quizzes and Exams: There will be two exams. Each exam will cover about one-half the semester's work.

Disability Access: It is University policy to provide, on a flexible and individualized basis, reasonable accommodations to students who have disabilities. Students are encouraged to contact Student Disability Services to discuss their individual needs for accommodation. You should also discuss this with me.

Grading: Final grades will be determined by averaging the homework, quizzes, exams, simulation project, and final exam based on the following scale:

For 6370 students

Homework problems	30%+5%
Design projects	30%+5%
Project presentation	10%+5%
Midterm	10% +5%
Final exam	20%-20%
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Course Grade	100%

Grading Scale:

85 - 100	A
70 - 85	B
60 – 69	C
0 - 60	F

For 4370 students

Homework problems	40%+5%
Design projects	30%+10%
Midterm	10% +5%
Final exam	20% -20%
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Course Grade	100%

Grading Scale:

90 - 100	A
80 - 89	B
70 - 79	C
60 - 69	D
0 - 59	F

ANY ONE OF THESE "RULES" IS SUBJECT TO MODIFICATION WHERE CIRCUMSTANCES WARRANT SUCH.

Academic Integrity

"As members of the Clemson University community, we have inherited Thomas Green Clemson's vision of this institution as a 'high seminary of learning.' Fundamental to this vision is a mutual commitment to truthfulness, honor, and responsibility, without which we cannot earn the trust and respect of others. Furthermore, we recognize that academic dishonesty detracts

from the value of a Clemson degree. Therefore, we shall not tolerate lying, cheating, or stealing in any form."

"When, in the opinion of a faculty member, there is evidence that a student has committed an act of academic dishonesty, the faculty member shall make a formal written charge of academic dishonesty, including a description of the misconduct, to the Associate Dean for Curriculum in the Office of Undergraduate Studies. At the same time, the faculty member may, but is not required to, inform each involved student privately of the nature of the alleged charge."