Syllabus for ME5653
MicroElectroMechanical Systems (MEMS)
Fall, 2008

NYU·poly
POLYTECHNIC INSTITUTE OF NYU

Course Information

Instructor:	Dr. Maurizio Porfiri	
	Email: mporfiri@poly.edu	
	Office: RH504A	
	Phone: 718-260-3681	
	Office Hours: Tuesday 12:00-12:55	
Lecture:	Wednesday 6:00-8:30	RH604
Webpage:	My Poly	

Course Goals

This course presents the fundamentals of modeling and analysis of MEMS with a specialized focus on electrostatically actuated systems. Topics include fundamentals of solid mechanics, electrostatics, and analytical and numerical methods for analyzing multiphysics systems. Students will develop a basic knowledge of MEMS that is of sufficient depth to begin reading the subject literature.

Prerequisites

It is assumed that all students have a working familiarity with the basics of dynamics, mechanics of materials, electromagnetism, and ordinary differential equations. ME5003 (Applied Mathematics in Mechanical Engineering) is a highly recommended corequisite, although it is not required.

Required Text

Pelesko, J. A. and Bernstein, D. H. Modeling MEMS and NEMS, Chapman and Hall/CRC, 2003

References

Journal papers

1. Teresi, L. and Tiero, A., 1997: "On Variational Approaches to Plate Models", Meccanica, 32, 143-156
2. Batra, R. C., Porfiri, M., Spinello, D., 2007: "Review of modeling electrostatically actuated microelectromechanical systems", Smart Materials and Structures, 16(6), R23-R31
3. Batra, R. C., Porfiri, M., Spinello, D., 2008: "Vibrations of narrow microbeams predeformed by an electric field", Journal of Sound and Vibration, 309(3), 600-612

Books

Gurtin, M. An Introduction to Continuum Mechanics, Academic Press, 1982

Homework

Two homework will be assigned. Each homework assignment must be typed on a word-processor. Use of LaTeX is encouraged, although other word processing platforms are certainly acceptable. Students must hand-in their own work. Students are permitted to discuss homework questions with other students, although they are not permitted to discuss solutions except in general terms. No late homework will be accepted except for exceptional and documented circumstances. Solutions for all assigned problems will be provided, although not all assigned problems will necessarily be graded. Significant weight in grading will be placed on clarity of presentation.

The two homework assignments are due at the start of class on:

1. Wednesday, 8 October
2. Wednesday, 19 November

Exams

There will be only one mid-term. The exam will be administered in class and will test the student's comprehension and ability to apply material learned in class and through assignments. The test is open book and closed notes. Formula sheets prepared by students will not be allowed. During the exam, before beginning to solve assigned problems, students should briefly restate the problem and list the data given. Also, students should list the important concepts and formulae used to arrive at the final solution along with detailed work. Every page of every exam submission should have the student full name and section number. Illegible work and loose sheets will not be graded. Students must complete the exam on their own. If a student cannot attend an exam due to a medical condition, certified by a doctor, he/she must notify the instructor in advance. Unexcused absence from an exam will result in a grade of 0 for that exam.

Project

One project will be assigned to every student team comprising 2-3 students on November 5, 2008. Each project must be typed on a word-processor. Use of LaTeX is encouraged, although other word processing platforms are certainly acceptable. Students will present their projects during the last day of class and must turn their project to the instructor during that day.

Grading policy

Homework:	30%
Midterm Exam:	30%
Project:	40%

Extra credit

There are no opportunities for extra credit. The grading policy allows for a "bad score".

Class attendance and absences

There are no formal requirements for attendance, and there is no direct penalty for missing class. Students are strongly encouraged to attend class since some course material will only appear in lectures. Students that miss class are responsible for obtaining class notes from a classmate.

Honor system

The honor system is in strictly force for this course. It is assumed that all work submitted by a student is done so under the honor system code. **Homework questions may be discussed with students. Homework solutions may not be discussed.** The final exam must be completed individually.

ABET a-k criteria compliance

	a	b	c	d	e	f	g	h	i	j	k
ME5653	✓		✓	✓	✓	✓	✓		✓	✓	✓

(a) an ability to apply knowledge of mathematics, science, and engineering
(b) an ability to design and conduct experiments, as well as to analyze and interpret data
(c) an ability to design a system, component, or process to meet desired needs
(d) an ability to function on multi-disciplinary teams
(e) an ability to identify, formulate, and solve engineering problems
(f) an understanding of professional and ethical responsibility
(g) an ability to communicate effectively
(h) the broad education necessary to understand the impact of engineering solutions in a global and societal context
(i) a recognition of the need for, and an ability to engage in life-long learning
(j) a knowledge of contemporary issues
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Tentative Lecture Schedule

Lecture	Reading	Topic of the day
Lecture 1 9/3/08	PB Ch 1 and Ch 5 pp 138-148	Course overview, non-dimensionalization, and single degree of freedom systems
Lecture 2 9/10/08	PB Ch 5 pp 131-136 and Ch 2 pp 15-18	Elastic MEMS and kinematics of continua
Lecture 3 9/17/08	PB Ch 2 pp 23-25	Equilibrium equations, constitutive equations in linear elasticity, and Navier's equations
Lecture 4 9/24/08	PB Ch 2 pp 26-28 and Ch 5 pp 151-160	Strings and membranes
Lecture 5 10/1/08	None	Beam theory
Lecture 6 10/8/08	PB Ch 2	Variational calculus: Lagrange equations and an alternative way to look at strings, membranes, and plates
Lecture 7 10/15/08		**Midterm exam**
Lecture 8 10/22/08	Journal paper [1]	Plate theory
Lecture 9 10/29/08	PB Ch 5 pp 164-167	Plate problems
Lecture 10 11/5/08	PB Ch 2 pp 47-53 and Ch 2 pp 78-79	Fundamentals of electrodynamics and small is different
Lecture 11 11/12/08	PB Ch 7 pp 213-234	Analysis of single degree of freedom models for electrostatically actuated MEMS
Lecture 12 11/19/08	PB Ch 7 pp 235-250 and Journal paper [2]	Modeling electrostatically actuated micromembranes
Lecture 13 12/3/08	Journal paper [3]	Modeling and numerical analysis of electrostatically actuated microbeams and microplates
Lecture 14 12/10/08		**Projects**