EE C245 / ME C218 INTRODUCTION TO MEMS DESIGN FALL 2009

DETAILED COURSE SYLLABUS *(TENTATIVE)*

The following comprises a **tentative** syllabus describing the material to be covered in this course. Material to be covered for each dated lecture is indicated along with the corresponding sections of the required textbooks, where S = Senturia's "Microsystem Design" (i.e., required text), K = Kovacs' "Micromachined Transducers Sourcebook" (i.e., supplementary text), and J = Jaeger's "Introduction to Microelectronic Fabrication" (i.e., supplementary text).

Date		Lec #	Material to be Covered	Reading Assignment
Aug.	27	1	Administrative Information, MEMS Roadmaps, Benefits of Miniaturization	S: §1.1-1.4
Sept.	1	2	Benefits of Scaling I: faster speed (transistors, micromechanical resonators)	
	3	3	Benefits of Scaling II: lower power consumption (micro-ovens), higher sensitivity (gas sensors)	
	8	4	Fabrication Process Modules I: oxidation, film deposition, lithography	S: §3.1-3.2.3, §3.2.6, §3.3.1 J: §2.1, §2.3-2.5, §3.1-3.3, §3.6, §6.1-6.3
	10	5	Fabrication Process Modules II: etching, ion implantation, diffusion	S: §3.2.5, §3.3.4.1, §3.3.5-3.3.6 J: §2.2, §4.1-4.5, §5.1-5.5
	15	6	Surface Micromachining I: basic polysilicon process flow, release, sacrificial & structural material choices	S: §4.1-4.4 J: §11.4.1-11.4.2
	17	7	Surface Micromachining II: 2nd order issues, stiction, residual stress, electroplating, 3D out-of-plane MEMS	S: §8.3, §13.2.3 J: §11.4.3-11.4.4
	22	8	Surface Micromachining III: MUMPS, design rules, Summit	Handout
	24	9	Bulk Micromachining: wet etch-based, dissolved wafer process, SOI MEMS, Scream, Hexsil MEMS, sealed cavity deep RIE	S: §3.3.4.2-3.3.4.3 J: §11.2-11.3, §11.6
	29	10	Mechanics of Materials for MEMS I: stress, strain, material properties, measurement & characterization of mechanical parameters	S: §8.1-8.2, §8.4
Oct.	1	11	Mechanics of Materials for MEMS II: quality factor, beam bending	S: §7.2.2, §9.1-9.3
	6	12	Mechanics of Materials for MEMS III: practical stress, beam combos, stressed folded flexures	
	8	13	Energy Methods I: virtual work, energy formulations, tapered beam example	S: §10.1-10.3
	13	14	Energy Methods II: clamped-clamped beam example, large deflection analysis, estimating resonance frequency	S: §10.5
	15	15	Equivalent Circuits I: dynamic mass, stiffness, and damping, example: free-free beam, lumped mass-spring-damper circuit	S: §10.5.2, Handout
	20	16	Equivalent Circuits II: electromechanical analogies, lossless transducers	S: §5.1-5.6, Handout
	22	17	Lossless Transducers I: capacitive transducers, charge control, voltage control, spring suspended C, parallel-plate capacitive transducer, pull-in, linearization	S: §6.1-6.4
	27	18	Lossless Transducers II: electrical stiffness, comb drive, levitation	Handouts
	29		***Midterm Exam***	
Nov.	3	19	Equivalent Circuits III: input modeling, force-to-velocity relationship & circuit, intro. to gyroscopes	S: §6.6, §19.1-19.2, §21.1-21.2
	5	20	Equivalent Circuits IV: output modeling, input-to-output transconductance, complete equivalent circuit	Handout
	10	21	Sensing Circuits I: ideal op amps, velocity sensing, position sensing	S: §14.9, §14.11.2
	12	22	Sensing Circuits II: differential position sensing, MEMS/transistor integration	S: §19.1-19.4 J: §7.7, §9.3, §11.7
	17	23	Sensing Circuits III: non-ideal op amps, begin noise	S: §14.10-14.11, S: Chpt. 15
	19	24	Sensor Resolution I: noise sources, noise calculation, minimum detectable signal	S: §16.1, §16.3-16.6
	24	25	Sensor Resolution II: noise calculation examples	Class Notes
	26		***Thanksgiving—Holiday***	Handouts
Dec.	1	26	Sensor Resolution II: gyro example	
	3	27	MEMS-Transistor Integration: mixed, MEMS-first, MEMS-last	Handouts
	8		***Reading/Recitation/Review Day—No Lecture***	
			Final Exam: Saturday, Dec. 19,12:30-3:30 p.m. (Exam Group 20)	