

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.	28	1	Administrative Information, MEMS Roadmaps, Benefits of Miniaturization	S: Chpt. 1
	30	2	Benefits of Scaling, start Fabrication Process Modules I	S: Chpt. 1, 3, Handouts
Sept.	4	3	Fabrication Process Modules I: oxidation, film deposition, lithography	S: Chpt. 3, J: Chpt. 2, 3, 6
	6	4	Fabrication Process Modules II: etching, ion implantation, diffusion	S: Chpt. 3, J: Chpt. 2, 4, 5
	11	5	Surface Micromachining I: basic process flow, release, stiction, material choices, residual stress, stringers and planarization	S: Chpt. 3, J: Chpt. 11, Handouts
	13	6	Surface Micromachining II: MUMPS, Summit, electroplating, 3D out-of-plane	S: Chpt. 3, Handouts
	18	7	Bulk Micromachining: wet etch-based, dissolved wafer process, SOI MEMS, Scream, Hexsil MEMS, sealed cavity deep RIE	S: Chpt. 3, J: Chpt. 11, Handouts
	20	8	Process Integration: interleaved, MEMS-first, MEMS-last, bonded integration, wafer-to-wafer transfer, fluidic assembly	S: Chpt. 4, J: Chpt. 11, Handouts
	25	9	Mechanics of Materials for MEMS: stress, strain, material properties, measurement & characterization of mechanical parameters	S: Chpt. 8
	27	10	Microstructural Elements: bending moment and strain, flexural rigidity, residual stress, boundary conditions, spring combinations	S: Chpt. 9
Oct.	2	11	Energy Methods I: application to clamped-clamped beam under axial load	S: Chpt. 9, Handouts
	4	12	Energy Methods II: resonance frequency determination, free-free beam, disk, ring, lumped-element mechanical equivalent circuits	S: Chpt. 9
	9	13	Electrostatic Actuators I: charge control, voltage control, spring suspended C, pull-in voltage, linearization methods	S: Chpt. 6
	11	14	Electrostatic Actuators II: comb drive, levitation, equivalent circuits	Handouts
	16	15	Circuit Modeling of MEMS: resonator equivalent circuits, thermal circuits, fluidic circuits	S: Chpt. 5, Handouts
	18	16	Alternative Transduction Principles: piezoelectric, magnetomotive, thermal actuation, scaling comparisons	S: Chpt. 18, 21
	23	17	Signal Conditioning Circuits: op amp models & circuits, transistor-level design	S: Chpt. 19
	25		<b>Midterm Exam</b>	
	30	18	Electronic and Mechanical Noise: electronic noise sources, Brownian motion noise, circuit noise calculation procedure, SNR, dynamic range	S: Chpt. 16
Nov.	1	19	Capacitive Position Sensing: sensing configurations, divider, effect of parasitic capacitance, resolution, accelerometers & gyroscopes	S: Chpt. 15, 19
	6	20	Wireless Communication Basics: communication front-end block diagram, noise figure, focus on front-end filtering, importance of high $Q$	Handouts
	8	21	Micromechanical Circuits I: general filter topologies, insertion loss (noise figure), shape factor, design with k and q values, termination impedance,	Handouts
	13	22	Micromechanical Circuits II: resonator and couplers, circuit modeling of coupled resonators, systematic micromechanical filter design procedure	Handouts
	15	23	Micromechanical Circuits III: nonlinear functions (mixing), coupled arrays, oscillators, RF MEMS switches	Handouts
	20	24	Fluid Dynamics: viscosity, density, surface tension, continuity equation, Newton's second law, Navier-Stokes, flow types	S: Chpt. 13
	22	25	Microfluidics: Electrokinetics and Fabrication: electroosmosis, electrophoresis, fabrication methods (replication vs. direct)	S: Chpt. 13
	27		<b>Thanksgiving—Holiday</b>	
	29	27	Microfluidics for DNA Analysis: amplification, detection, separation, sequencing, scaling issues, survey of existing chips	Handouts
Dec.	4	28	Lab on a Chip: examples, proteomics, sub-unit examples: pumps, valves,	Handouts
	6	29	Scaling Revisited: A generalized treatment	Handouts
			<b>Final Exam: Saturday, Dec. 15, 8:00-11:00 a.m. (Exam Group 7)</b>	