ELEC 5820/6820 Final Exam Study Guide

I. Final Exam: Tuesday, Dec 8, 8:00am to 10:30 am

II. What does the test cover: Everything

III. Topics

1) Terms such as: MEMS, isotropic, anisotropic, undercut, mask, aspect ratio, Bosch process, native oxide, hydrophilic, hydrophobic, stiction, sacrificial layer, etc…
2) Miniaturization and scaling (surface effects, volume effects,…), Cleanroom class
3) Energy domains and example devices for each
4) How Si wafers are made (CZ and FZ)
5) Photolithography, grayscale lithography, liftoff patterning
6) Bulk and Surface Micromachining
7) Noise sources
8) Single crystal Si (FCC, Miller Indices and notation, crystal planes & characteristics, flats & wafer identification…)
9) Wet etching (3 etchants, etching features into (100) wafers, hillocks, mesas, …)
10) Plasma (definition, Paschen curve, sputtering)
11) Dry etching (plasma etching, ion milling, RIE, DRIE)
12) Wafer bonding (fusion, anodic, high temp, adhesive, eutectic, low temp, CMP)
13) SOI wafers (structure, materials, SIMOX)
14) Thin film deposition (sputtering, evaporation, LPCVD, PECVD, thermal oxidation, plating, spin-on)
15) Triple point drying, critical point drying
16) Device layout terms (kerf, light field, dark field, fiducial, etc.)
17) Find k (spring constant) from a structure design, suspension system designs, torsional spring
18) Find T(s) from plot of |T(jω)|, Damping sources, Capacitance calculations
19) Electrostatic actuators: PPA, GCA, CDA, series cap PPA stabilization
20) Electrostatic MEMS resonators, oscillation criterion, phase shift oscillator
21) Thermal sensing/actuation, bimorph, thermocouple, themistor, PTAT
22) Piezoelectric actuation/sensing, Magnetic actuation, SMA, thermal pump, flowFET
23) Inertial MEMS devices: accelerometer (Sensitivity), gyroscope, pressure sensor
24) RF MEMS, optical MEMS (MOEMS), energy scavenging

IV. How to study

a. Exams 1 and 2 (keys on class website)
b. Homework questions/problems (keys on class website)
c. Class notes (my notes are on the class website)
d. Text book

V. Likely test format

a. Problems, Short Answer, Matching, Identify/Label the drawing, Acronyms
b. A bonus problem (anything covered in class is fair game)

VI. Things to watch out for:

a. Units on answers and in the units asked for
b. Answer all parts of questions
c. Convert parameters to a common unit before calculating the answer AND show calculations

VII. Equation I will provide (as needed)

Actuator force equations, PPA pull in voltage, torsional spring, spring constant, capacitance, bimorph, CTE, {also any needed constants: G, ε0, etc.}

VIII. You need to know

T(s), relationships between k, c, m and ωn, fn, Q, ζ; magnitude/angle calc. for RC circuit

IX. Test Is Closed Book, Closed Notes, No Laptop/Notebook PC’s