INFORMATION ABOUT THE FINAL EXAM

Office Hours During RRR and Finals Week:

Prof. Nguyen will be traveling during all of RRR week, except Friday. Thus, over RRR week and Finals week, Prof. Nguyen and Kieran will hold office hours as follows:

Kieran: Monday, April 30, 3:30-5 p.m., 212 Cory
Kieran: Wednesday, May 2, 1-2 p.m., 293 Cory
Prof. Nguyen: Friday, May 5, 2-3 p.m., 574 Cory
Prof. Nguyen: Monday, May 7, 2-3 p.m., 574 Cory
Prof. Nguyen: Tuesday, May 8, 2:30-3:30 p.m., 574 Cory
Kieran: Monday, May 7, 3:30-5 p.m., 212 Cory
Kieran: Wednesday, May 9, 1-2 p.m., 367 Cory

Review Session:

Friday, May 4, 1-2 p.m. in 299 Cory

Date of Exam:

Exam Group 13: Thursday, May 10, 8-11 a.m. (sharp)

Place:

3109 Etcheverry

General Information:

The exam will be closed book, except you can have 2 two-sided 8.5″×11″ sheets of notes, and you can use a calculator. The exam sheets will provide enough space to put all your work on these sheets. You should show and include all your work on the exam sheets. The exam will consist of a few problems, each with a number of parts.

Material Coverage:

Reading in Senturia, class lecture notes, handouts, and homeworks. The exam is meant to include all material covered in the class, with stronger emphasis on material covered after the Midterm Exam. A summary of important topics that might appear on the Final Exam are as follows:

1. Basic MEMS fabrication process modules, including oxidation, film deposition, lithography, etching, ion implantation, and diffusion. You should especially have a good understanding of MEMS-centric etching and what influences selectivity and the degree of anisotropy.
2. Physics of stiction and bending/warping due to residual or thermal stresses and other phenomena. Be able to quantitatively determine whether a particular structure is warped or stuck down.

3. MEMS process flow design and layout. Be prepared to design your own process flow and layout for some arbitrary cross-section or 3D structure.
4. Surface micromachining, including its basic process flow, release issues (e.g., stiction), material choices, residual stress, stringers and methods for eliminating them.
5. Mechanics of materials for MEMS, including stress, strain, material properties, and on-chip measurement & characterization of mechanical properties.
6. Microstructural elements, including bending moment and strain, flexural rigidity, residual stress analysis, boundary conditions, and spring combinations. You should be familiar with beam bending equations and their application. You should also be able to derive properties for arbitrary connections of beams (i.e., springs).
7. Pros and cons of scaling, including understanding of thermal circuits and impact of scaling on surface-to-volume ratios.
8. Energy methods for determination of deflection functions and resonance frequencies.
9. Input/output transducer modeling, including energy methods and construction of equivalent circuits. Here, you should understand first and second order effects for both parallel-plate and comb-capacitive transducers, including electrical stiffness and levitation.
10. Micromechanical circuit analysis, including specification of the equivalent circuit for a micromechanical device with multiple ports and determination of the output variables (e.g., current, voltage, displacement, velocity) at the various ports when emplaced into a circuit of other elements (e.g., resistors, capacitors, etc.).
11. Sensing circuits, including topologies that minimize parasitics. Be able to analyze circuit topologies and make the right choice of which circuit to use to grab a desired output variable.
12. Gyroscope operation and scale factor. Be able to determine how scale factor changes with changes in a given environmental variable.
13. Sensor resolution and minimum detectable signal (MDS). Be able to do circuit analysis using noise sources and/or input-referred noise generators to determine their impact on the MDS.

Practice Material:

To give you some semblance of what to expect, the solutions to the Final Exams given over the last few years accompany this document. Note that the material coverage between previous years and this year differ slightly (e.g., some things were emphasized more than others), so might not be fully representative of what your exam might look like. However, it still gives you some sample problems on which to practice. And as always, practice is one of the best ways to do well on an engineering exam. In fact, a good way to study for this exam is to make up some of your own problems and solve them.