

## ELEC 5760/6760 Final Exam Study Guide

### I. Sensor and Fabrication Terminology

Know terms such as: transducer, measurand, sensor, actuator, SOI wafer and structure, Young's Modulus, MEMS, transmissibility, resistivity, bimorph, Wheatstone bridge, strain gauge, piezoresistor, stiction, types of damping, synchronous demodulation, 2-point/4-point resistance measurement, gauge factor (GF), types of pressure sensors, force feedback, sensitivity, TIA, PTAT, interferometer, spectrometer, analyte, etc...

### II. Sensor Structures

- a. Find  $k$  (spring constant) from a structure design
- b. Determine mass-spring displacement for an applied force
- c. Find  $T(s)$  from plot of  $|T(j\omega)|$  and vice-versa
- d. Know how to relate:  $m$ ,  $c$ ,  $k$ ,  $Q$ ,  $\zeta$ ,  $\omega_n$ ,  $f_n$ , displacement to a force

### III. Op Amp Circuit and Sensor Interface Circuit Analysis (homework problems)

### IV. Sensing Methods

- a. Conductivity
- b. Resistance (temperature effects, strain gauge, piezoresistor)
- c. Capacitance (calculating  $C_{nom}/max/min$ , interface circuits)
- d. Voltage
- e. Current
- f. Optical (the different methods)

### V. MEMS Actuators

- a. Electrostatic
  - (1) parallel plate actuator (PPA)
  - (2) comb drive actuator (CDA)
  - (3) gap closing actuator (GCA)
- b. Piezoelectric
- c. Thermal
- d. Shape Memory Alloy (SMA)
- e. Magnetic
- f. FlowFET

### VI. MEMS Sensors (terminology and analysis)

- a. Pressure Sensors (problems and terms)
- b. Accelerometers (problems and terms)
- c. Gyroscopes (problems and terms)
- d. Temperature Sensors (terms)
- e. Chemical Sensors (terms)

VII. Miscellaneous

- a. Voltage divider circuits
- b. Calculation of a transfer function from a block diagram

VIII. I will provide (AS NEEDED):

- a. Constants:  $\pi$ ,  $\epsilon_0$ , G, 1 atm in kPa
- b. Equations for: Gauge Factor, Resistivity as  $f(\text{Temp})$ , Resistance as  $f(\text{resistivity})$ , spring constant, ring oscillator frequency, phase delay cap interface circuit
- c. Lapace Transform table
- d. Equations for PE, KE, static pressure, actuators, accel/gyro as needed

IX. You need to know equations for:

- a. Ohms law
- b. Impedance of a capacitor
- c. Capacitance of a parallel plate capacitor
- d.  $T(s)$  as a function of  $m$ ,  $c$ ,  $k$ ,  $Q$ ,  $\zeta$ ,  $\omega_n$
- e. Relationships between  $m$ ,  $c$ ,  $k$ ,  $f_n$  and  $\zeta$ ,  $Q$ ,  $\omega_n$
- f. Unit conversions (pF to F,  $\Omega\text{-cm}$  to  $\Omega\text{-m}$ ,  $\mu\text{m}$  to  $\text{m}$ , etc...)
- g. Units for  $m$ ,  $k$ ,  $c$ ,  $Q$ ,  $\zeta$

X. Things to watch out for:

- a. Units on answers
- b. Answer all parts of questions
- c. Show calculations
- d. Convert parameters to a common unit before calculating the answer

XI. Guide to Studying

- a. Exams 1 and 2
- b. Homeworks
- c. Study guides for Exams 1 and 2
- d. Notes, handouts, PowerPoint presentation, lecture videos
- e. Sample tests (on class website)

**XII. Test Is Closed Book, Closed Notes, No Laptop/Notebook PC's**

Date: Tuesday, Dec. 10, 8:00 am to 10:00 am