Homework Assignment #5 ELEC 5760/6760 Due: Wednesday 2/20/13

1) A MEMS device consists of a proof mass attached to a frame with a suspension system. The bottom of the proof mass is 1mm by 1mm in size and serves as an electrode. Another electrode of the same size is located 2μm beneath it. If the proof mass can move up and down ±1μm from its nominal distance to the bottom electrodes, calculate the nominal, maximum and minimum capacitance between the two electrodes. Assume that the device is in a vacuum.

2) A certain MEMS capacitance has a rest (i.e. nominal) value of 3pF, a minimum value of 2pF and a maximum value of 5pF. Place it in a charge amplifier circuit that has an input voltage of 10V and a feedback capacitor (C2) of 10pF. Calculate the amplifier output voltage (at the end of the $\phi 2$ cycle) for the nominal, minimum and maximum capacitance values.

3) For the MEMS capacitance in (2) place it in a 5V "fast" CMOS ring oscillator circuit with both resistors being 100kΩ. What is the output frequency for C_{min}, C_{nom} and C_{max}?

4) If two MEMS capacitances from (2) are placed in a capacitive AC voltage divider to realize a differential capacitive sensor configuration, with the input voltage having an amplitude of 10V, what is the output voltage amplitude for each case?

5) If the MEMS capacitance from (2) is placed in a switched-capacitor circuit that is switched at 250KHz, what is the value of the equivalent resistance for the nominal, minimum and maximum capacitance values?

6) If the MEMS device in (2) is placed in an RC phase delay circuit, where R = 250 kΩ, what is the phase delay in μs for the nominal, minimum and maximum capacitance values?