NAME (please print) ______________________________ SID __________________

UNIVERSITY OF CALIFORNIA, BERKELEY
Electrical Engineering and Computer Sciences Department
EECS 145L Electronic Transducer Lab
MIDTERM #1 (100 points maximum)
October 8, 2008

(closed book, calculators OK, equation sheet provided)
(You will not receive full credit if you do not show your work)

**PROBLEM 1 (36 points)**

Briefly define the following terms:

**1.1** Electronic sensor

**1.2** Sensitivity of an electronic sensor

**1.3** Instrumentation amplifier

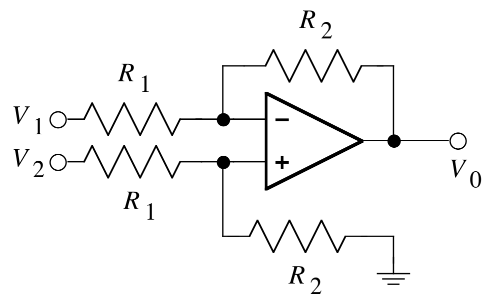
**1.4** Differential gain (of an amplifier with two inputs)

**1.5** Common mode gain (of an amplifier with two inputs)

**1.6** Johnson noise (of a resistor)

**PROBLEM 2 (30 points)**

**2.1** (15 points) Derive an equation for the output $V_0$ of the op-amp circuit shown below as a function of the input voltages $V_1$ and $V_2$ and the resistors $R_1$ and $R_2$. Assume that the op-amp has infinite open loop gain and infinite input impedances.




**2.2** (15 points) Using the equation derived in part 2.1, write an equation for the differential and common-mode gains as functions of the resistors $R_1$ and $R_2$.

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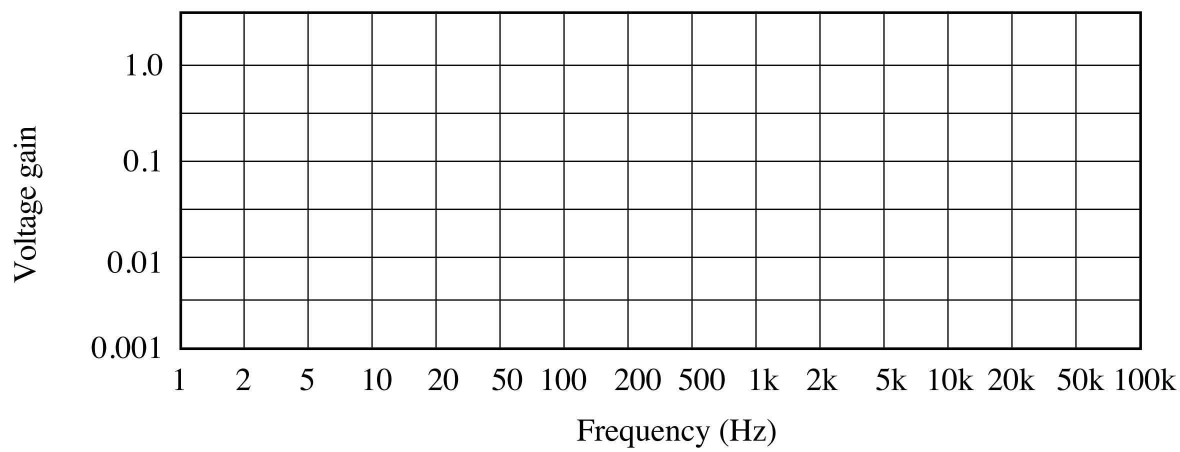
**PROBLEM 3 (34 points)**

Design an analog filter circuit that has the following properties

- Gain between 0.9 and 1.0 for frequencies between 100 Hz and 20 kHz
- Gain less than 0.001 for frequencies above 52 kHz
- Gain less than 0.01 at 60 Hz
- Gain less than 0.001 for frequencies below 2 Hz

**3.1** (10 points) Sketch the required gain vs. frequency below




**3.2** (24 points) Design a filtering circuit that meets the requirements above with the minimum complexity and cost. **For each filtering element, give type, corner frequency, and order number.** (Hint: see equation sheet for a table of $f/f_c$ vs. gain and order.) Do not give resistor and capacitor values.