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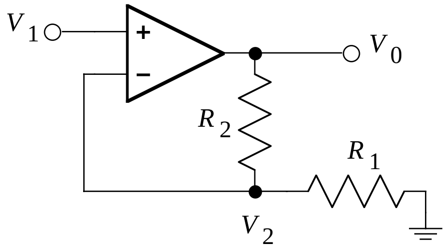
UNIVERSITY OF CALIFORNIA, BERKELEY
Electrical Engineering and Computer Sciences Department

EECS 145L Electronic Transducer Lab
MIDTERM #1 (100 points maximum)
October 2, 2000

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

PROBLEM 1 (30 points)

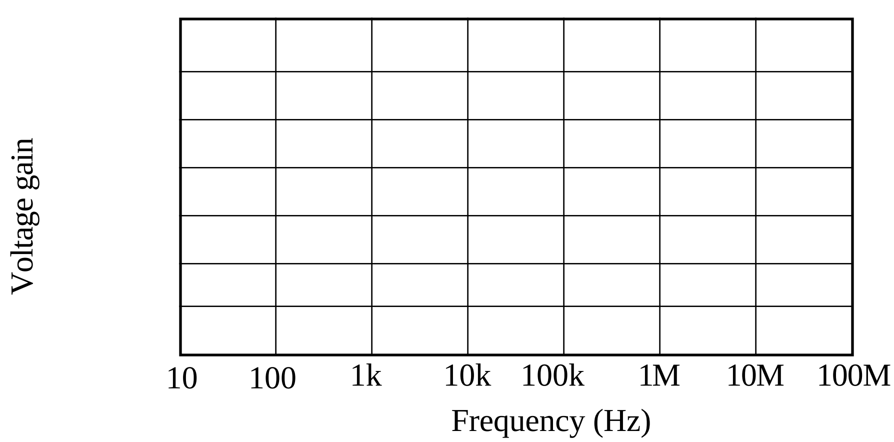
Consider the noninverting op-amp circuit shown below:



The op-amp has open loop gain $A = k/f$, $k = 10^7$ Hz and the input impedances are infinite.

1a (20 points) derive the equation for the voltage gain V_0/V_1 as a function of the resistor values R_1, R_2, and the frequency f.

1b (10 points) Write the gain equation for R_1 = 1 kW and R_2 = 99 kW and sketch the gain from f = 10 Hz to 100 MHz in the figure below.



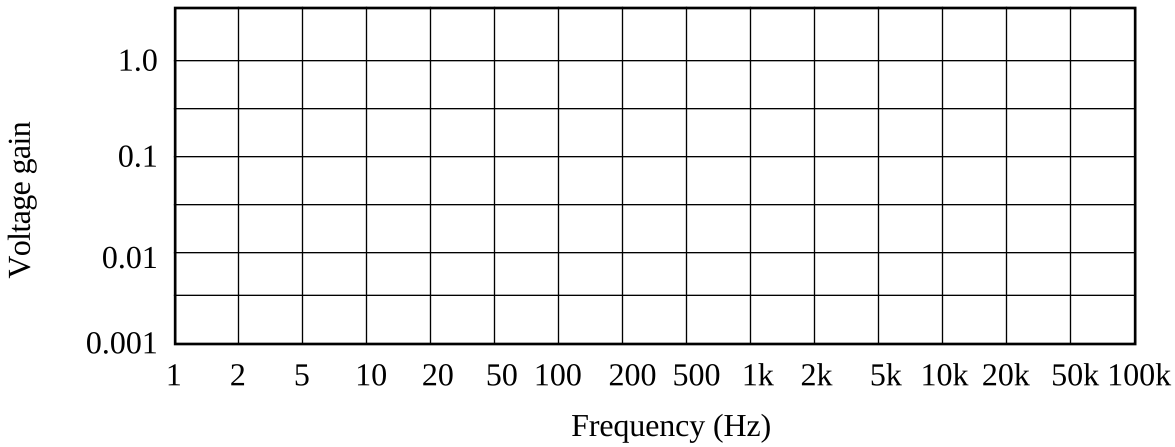
NAME (please print) ______________________________

PROBLEM 2 (35 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

2a (5 points) Sketch the required gain vs. frequency below



2b (30 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.

NAME (please print) ____________________

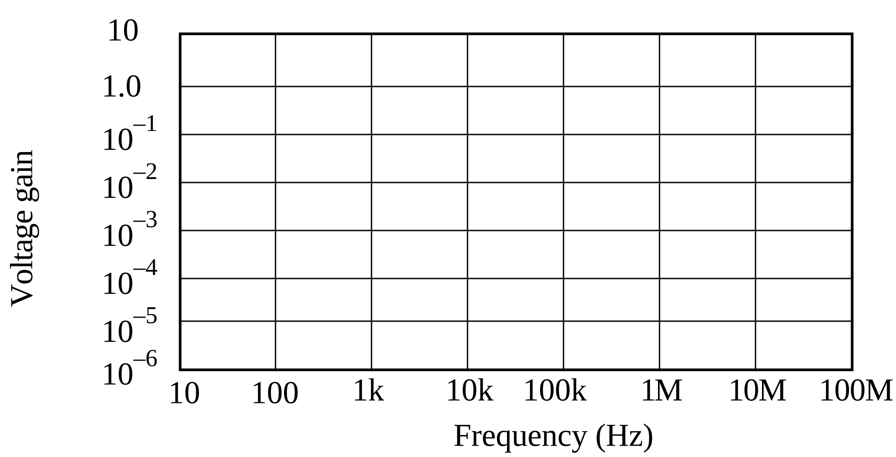
PROBLEM 3 (35 points)

You have been given an instrumentation amplifier and asked to measure and characterize its differential and common mode gains.

3a (10 points) How would you measure the common mode gain and differential gain as a function of frequency?

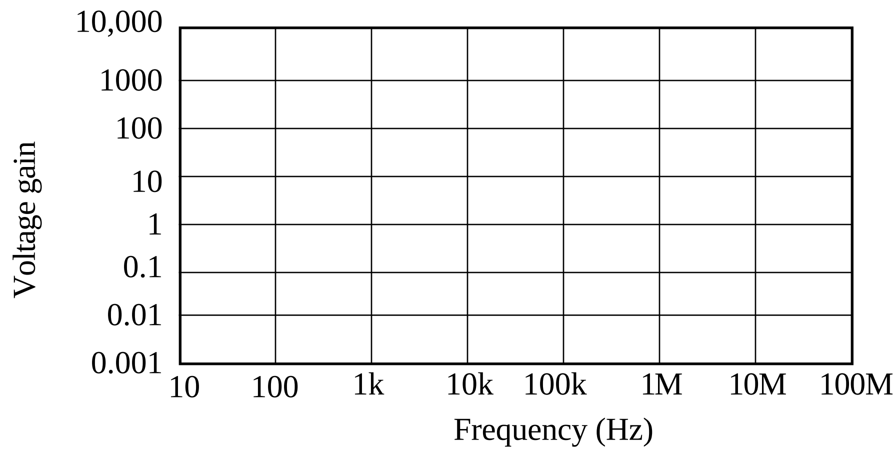
You find that the differential gain can be modeled as an ideal instrumentation amplifier with a differential gain of 1000 followed by a Butterworth low pass filter of order one with a corner frequency of 1 kHz. You also find that the common mode gain can be modeled as a Butterworth high pass filter with unity gain and a corner frequency of 10^6 Hz.

3b (10 points) Write an equation for the common mode gain as a function of frequency and sketch the function in the grid below:



NAME (please print) ______________________________

3a (10 points) Write an equation for the differential gain as a function of frequency and sketch the function in the grid below:



3a (5 points) Sketch the common mode rejection ratio (CMRR) as a function of frequency