NAME (please print) _____Student ID_____

UNIVERSITY OF CALIFORNIA, BERKELEY
Electrical Engineering and Computer Sciences Department

EECS 145L Electronic Transducer Lab
MIDTERM #1 (100 points maximum)
October 1, 2001

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

**PROBLEM 1 (15 points)**

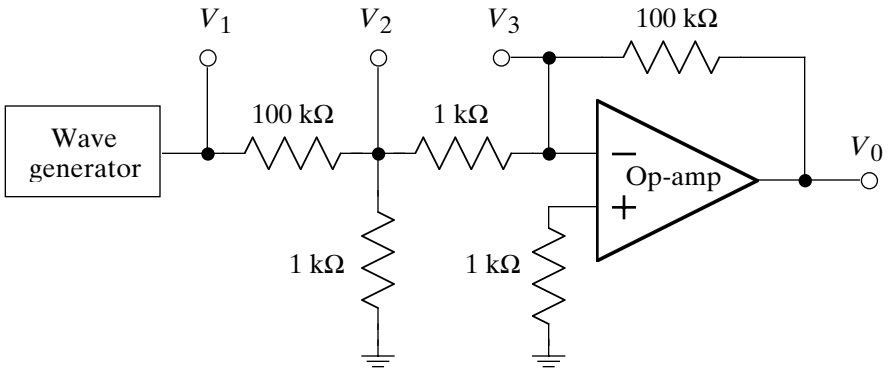
In the table below, fill in YES or NO in each of the 15 boxes

| | Op Amp | Inverting op-amp circuit amplifier | Non-inverting op-amp circuit amplifier | Differential op-amp circuit amplifier | Instrumentation amplifier |
|---|---|---|---|---|---|
| High $Z_{in}$ | | | | | |
| Differential input | | | | | |
| Defined gain over a frequency band | | | | | |

**PROBLEM 2 (40 points)**

In the circuit shown below, assume the following:

- The op-amp open-loop gain $A = 10^6$ Hz/$f$ for $f > 10$ Hz.
- Op-amp input currents are zero
- Output offset can be neglected
- The wave generator produces a pure sinewave of frequency $f$ and has zero output impedance



**2a** (20 points) Derive expressions for $V_0$, $V_3$, and $V_2$ as a function of input $V_1$, frequency $f$ and open-loop gain $A$.

**2b** (20 points) Evaluate the above expressions at $f$=10 Hz and 1 MHz. Note: To simplify the calculation, you can neglect small terms that change the answer by less than a few percent.

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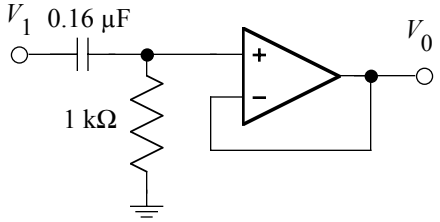
**PROBLEM 3 (25 points)**

Consider the high-pass one-pole filter circuit shown below.



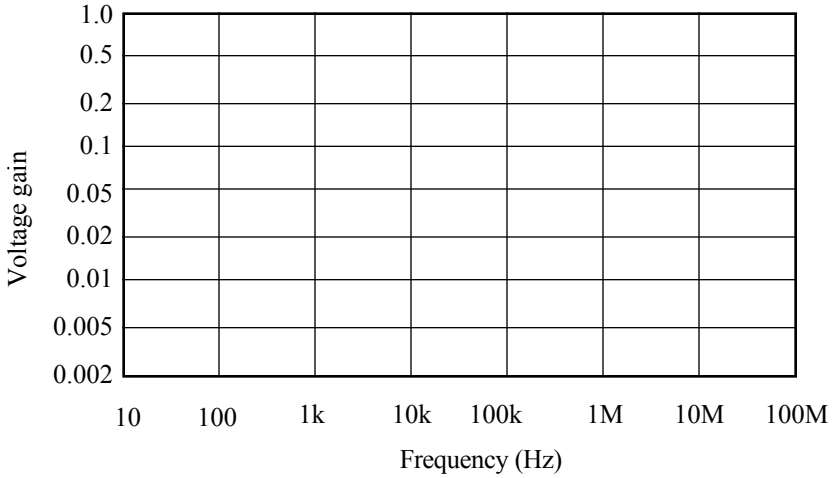

The op amp specifications are

- Infinite input impedance, no input leakage currents
- Above 10 Hz, the open-loop gain $A$ varies as 1/frequency and reaches unity gain at $10^6$ Hz

**3a** (5 points) What is the 3-dB lower corner frequency of the circuit?

**3b** (5 points) At what upper frequency does the gain drop to 0.5?

**3c** (20 points) Sketch the Bode gain plot below.



**PROBLEM 4 (20 points)**

Design a circuit that uses two op-amps to combine four inputs as follows:

$$V_0(t) = V_1(t) + V_2(t) - V_3(t) - V_4(t)$$

Sketch your circuit below: