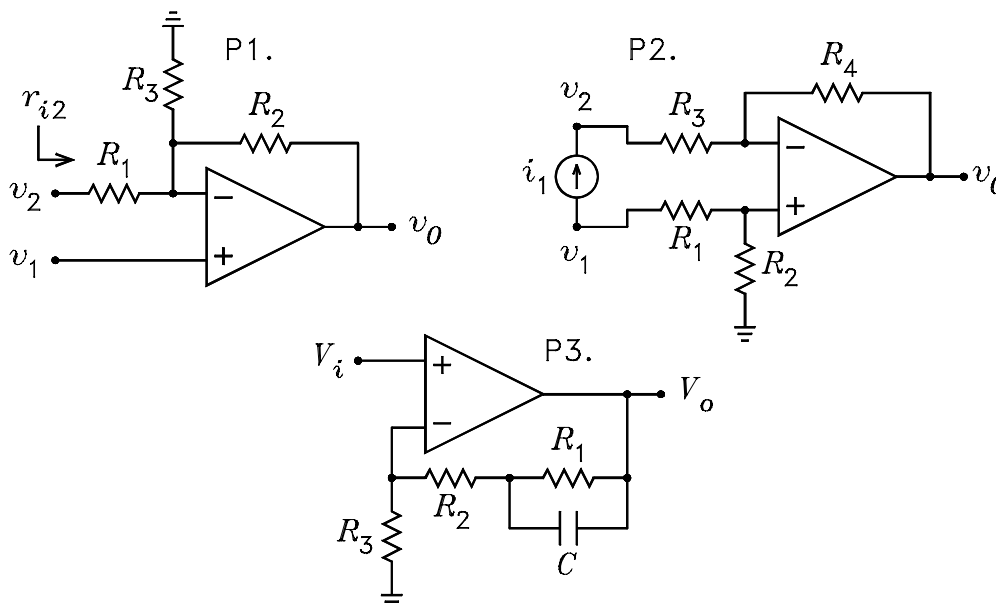Professor Leach                                    Name_____

**Instructions.** Print your name in the space above and on all quiz work sheets. Place a box around all answers. Write the word "over" if you continue your work on another page. Organize your work in an orderly fashion.

1. For the circuit in Figure P1

   (a) Solve for $v_O$.

   (b) Solve for $r_{in2}$ for the three cases: $v_1 = 0$, $v_1 = v_2$, and $v_1 = -v_2$.

2. For the circuit in Figure P2, it is given that $i_1 = 2$ mA, $R_1 = 1$ kΩ, $R_2 = 3$ kΩ, $R_3 = 2$ kΩ, and $R_4 = 5$ kΩ.

   (a) Solve for $v_O$.

   (b) Solve for $v_1$.

   (c) Solve for $v_2$.

3. Figure P3 shows a possible circuit for a preamplifier for a tape deck.

   (a) What is the gain at very low frequencies? What is the gain at very high frequencies? Use the gain information to sketch the expected shape of the Bode magnitude plot for the voltage gain. Label the asymptotic gains and sketch in a smooth curve for the expected actual gain.

   (b) Derive the transfer function for $V_o/V_i$. Put it into the form $K(1 + \tau_1 s)/(1 + \tau_2 s)$, where you must specify the equations for $K$, $\tau_1$, and $\tau_2$. To keep the equations simple, use the notation $R_a \| R_b$ to indicate parallel combinations of resistors.

   (c) For a pole frequency at 50 Hz and a zero frequency at 3180 Hz, what must be the values of $\tau_1$ and $\tau_2$?

   (d) To minimize dc offsets at the output, what would be the simplest modification to the circuit to obtain unity gain at zero frequency?
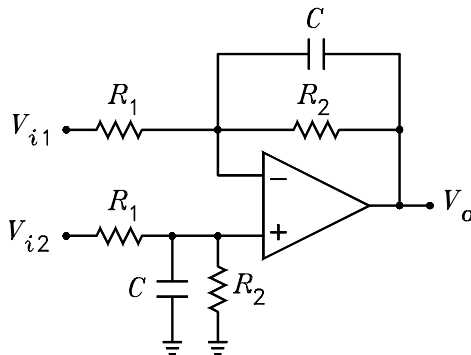


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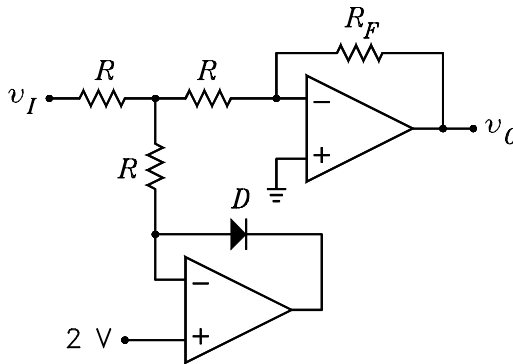Professor Leach                                                  Name_____

**Instructions.** Print your name in the space above and on all quiz work sheets. Place a box around all answers. Write the word "over" if you continue your work on another page. Do not write in the area where you staple the pages together.

4. A diff amp circuit is shown.



   (a) For $V_{i2} = 0$, solve for $V_o/V_{i1}$. Put the answer in standard time constant form, i.e. $V_o/V_{i1} = K(1 + \tau_1 s)/(1 + \tau_2 s)$, where you must specify $K$, $\tau_1$, and $\tau_2$.

   (b) For $V_{i1} = 0$, solve for $V_o/V_{i2}$. Put the answer in standard time constant form.

   (c) What is the condition on the resistors and capacitors for $V_o = A(s)(V_{i2} - V_{i1})$?

5. The diode in the circuit is ideal. The op amp saturation voltages are $\pm V_{SAT}$. Sketch the plot of $v_O$ versus $v_I$. Label all slopes and break points.



6. An op amp has a gain bandwidth product $f_x = 2$ MHz and a slew rate $SR = 5$ V/$\mu$s.

   (a) Calculate the bandwidth if the op amp is operated as a non-inverting amplifier with a voltage gain of 5.

   (b) Calculate the bandwidth if the op amp is operated as an inverting amplifier with a voltage gain of $-5$.

   (c) For $v_O(t) = 10\sin 2\pi ft$, what is the largest frequency $f$ for which the op amp will not slew?