ECE 2210 Homework 25

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rev, 11/29/05

May be handed with the final

Refer to the Operational Amplifier handout. Most of the problems below are design problems. The answer should be a schematic of a circuit showing the values of all the parts. Use resistor values in the 1 kΩ to 1 MΩ range. You **MUST** choose resistor values that are **DIFFERENT** than those in my answers.

1. Design a buffer circuit which will allow a sensor with a high source resistance to be connected to fairly low resistance load. You don't need any voltage gain, but it is important that the load does not interfere with the measurement.

2. Design an amplifier with a gain of 12. The output voltage must be in phase with the input voltage (no inversion is allowed).

3. Design an amplifier with a gain of 25. The output voltage may be 180° out of phase with the input voltage (inversion is allowed). Its input resistance should be ≥10 kΩ. That is, from the input's point of view, the amplifier should look like a 10 kΩ resistor hooked to ground, or larger.

4. Design an amplifier with two inputs where $v_o = -10v_1 - 4v_2$.

5. Design an amplifier with two inputs where $v_o = +10v_1 + 4v_2$. You may use more than one op-amp.

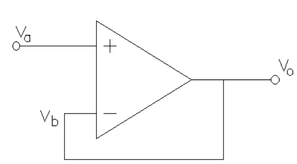
6. Design an amplifier with two inputs where $v_o = 12v_2 - 12v_1$.

7. Design a differentiator using an op-amp, a resistor, and an inductor. You do not need to show parts values, but you need to show that the circuit differentiate by showing a derivation similar to the ones in my handout.

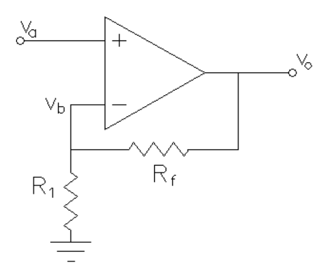
8. Design a comparator whose output will be high (about 8 or 9 V) when the input is greater than 5 V and whose output will be low (about 1 V or so) when the input is less than 5 V.

<u>Answers</u>

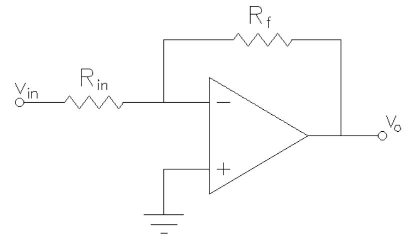
1.) Draw a voltage follower.



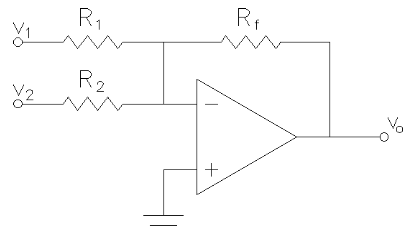
2.) Draw a noninverting amplifier. Choose an R_1 and an R_f which is 11 times bigger than R_1. Say R_1 = 10 kΩ and R_f = 110 kΩ.



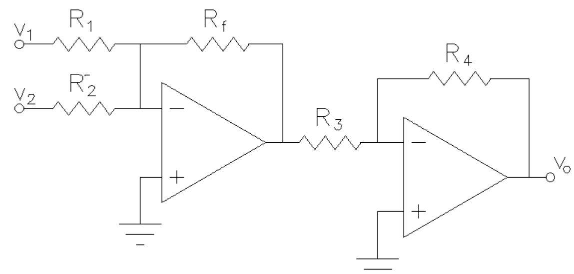
3.) Draw an inverting amplifier. Rin = 10 kΩ, Rf = 250 kΩ.



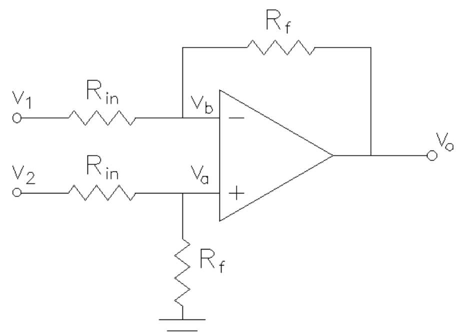
4.) Draw a two-input summer. Choose a value for R_f. Choose a value for R_1 which is $R_f/10$ and a value for R_2 which is $R_f/4$. Say 100 kΩ, 10 kΩ and 25 kΩ.



5.) Redraw the same circuit as problem 4, only now follow it with an inverting amp with a gain of 1. Say $R_3 = R_4 = 10$ kΩ for the second op-amp.



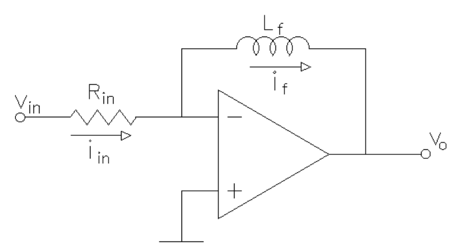
6.) Draw a differential amplifier. Choose an R_{in} value. Make R_f 12 times bigger than R_{in}. Say $R_{in} = 10$ kΩ and $R_f = 120$ kΩ.



7.)

$$i_{in} = \frac{v_{in}}{R_{in}} = i_L = -\frac{1}{L}\int v_o dt$$

$$v_o = -\frac{L}{R_{in}}\frac{dv_{in}}{dt}$$



8.) Just choose the two resistor values to be equal, so the voltage at the inverting input pin will be 5 V. Now, anytime the voltage on the noninverting pin is above 5 V the output will be high (~8 V) and anytime the voltage on the noninverting pin is below 5 V the output will be low (~2 V).