## Name \_\_\_\_\_

ECE 2210 HomeworkOA1Due: Tue 11/28/23A. Stolp, 11/28/01Refer to the Operational Amplifier handout.Most of the problems below are designproblems.The answer should be a schematic of a circuit showing the values of all theparts.Use resistor values in the 1 k $\Omega$  to 1 M $\Omega$  range.You MUST choose resistorvalues 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  $180^{\circ}$  out of phase with the input voltage (inversion is allowed). Its input resistance should be  $\ge 10 \text{ k}\Omega$ . That is, from the input's point of view, the amplifier should look like a 10 k $\Omega$  resistor hooked to ground, or larger.

4. Design an amplifier with two inputs where  $v_0 = -10v_1 - 4v_2$ .

5. Design an amplifier with two inputs where  $v_0 = +10v_1 + 4v_2$ . You may use more than one op-amp.

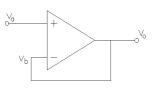
6. Design an amplifier with two inputs where  $v_0 = 12v_2 - 12v_1$ .

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 will differentiate by showing a derivation similar to the ones in my handout.

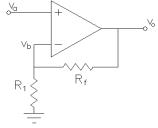
8. Design a comparator whose output will be high (about 8 or 9 V) when the input is greater than 5 V and whose output will be low (about 1 V or so) when the input is less than 5 V.

## <u>Answers</u>

1.) Draw a voltage follower.

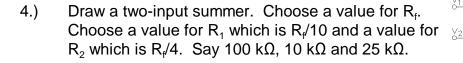


2.) Draw a noninverting amplifier. Choose an  $R_1$  and an  $R_f$  which is 11 times bigger than  $R_1$ . Say  $R_1 = 10 \text{ k}\Omega$  and  $R_f = 110 \text{ k}\Omega$ .



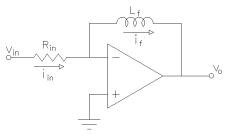
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3.) Draw an inverting amplifier. Rin = 10 k $\Omega$ , Rf = 250 k $\Omega$ .



- 5.) Redraw the same circuit as problem 4,  $\underbrace{\mathbb{V}_1}_{1}$  only now follow it with an inverting amp with a gain of 1. Say  $R_3 = R_4 = 10 \text{ k}\Omega$  for  $\underbrace{\mathbb{V}_2}_{1}$  the second op-amp.
- 6.) Draw a differential amplifier. Choose an  $R_{in}$  value. Make  $R_f$  12 times bigger than  $R_{in}$ . Say  $R_{in} \bigvee_{0-1} = 10 \text{ k}\Omega$  and  $R_f = 120 \text{ k}\Omega$ .
- 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 will differentiate by showing a derivation similar to the ones in my handout.

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



Rf

 $\mathbb{R}_4$ 

Rin

R<sub>1</sub>

 $\mathbb{R}_2$ 

R<sub>3</sub>

٧ь

R f

 $\mathsf{R}_{\mathsf{in}}$ 

R<sub>in</sub>

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).

