Name: SOLUTIONS (please print)

Signature: _____

ECE 3455
Quiz 3
February 27, 2008

Quiz duration: 30 minutes

1. You may have one 8 ½ x 11 in. "crib" sheet, written on both sides, during the quiz. You may have any calculator you choose, but no computers. No other notes or materials will be allowed.
2. Show all work necessary to complete the problem on these pages. A solution without the work shown will receive no credit.
3. Show units in intermediate and final results, and in figures.
4. If your work is sloppy or difficult to follow, points will be subtracted.

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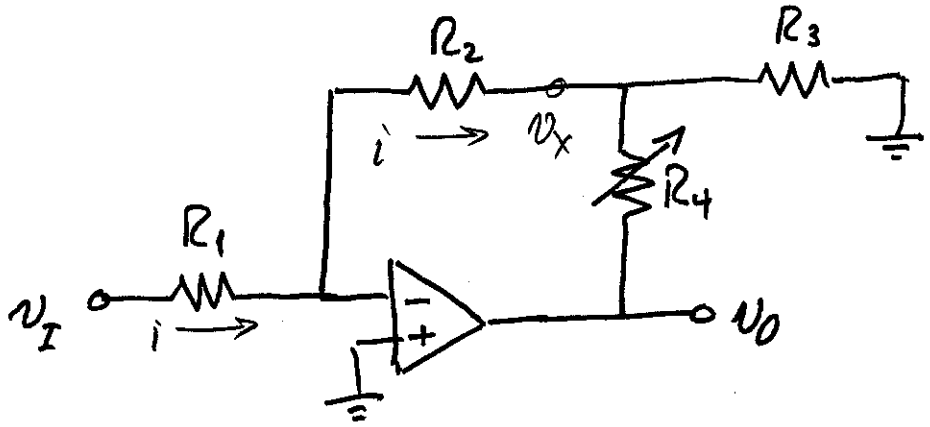
In the circuit shown, the op amp is ideal. Resistor R_4 is variable. Choose values for R_1, R_2, and R_3 ~~such that~~ and a range for R_4 so that:

a) the input resistance seen by the source v_I is 100 kΩ and
b) the gain v_O/v_I varies between -2 and -5.



First let's find v_O/v_I for arbitrary R's.

Define v_x and do a KCL:

$$\frac{v_x - v_O}{R_4} + \frac{v_x}{R_2} + \frac{v_x}{R_3} = 0$$

$$v_x\left(\frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4}\right) = \frac{v_O}{R_4}$$

But $i = v_I/R_1$ and $v_x = -iR_2 = -\frac{R_2}{R_1} v_I$. So...

$$-\frac{R_2}{R_1} R_4 \left(\frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4}\right) = \frac{v_O}{v_I}$$

$$\Rightarrow \quad \frac{v_O}{v_I} = -\frac{R_2}{R_1}\left(1 + \frac{R_4}{R_2} + \frac{R_4}{R_3}\right)$$

Now the input resistance is $R_1 = 100$ kΩ.

Room for Extra Work

We have a lot of choices now so let's choose $R_2 = R_3 = 100\ k\Omega$. Then

$$\frac{V_O}{V_I} = -\left(1 + \frac{2R_4}{100\ k\Omega}\right)$$

Clearly $R_4 = 50\ k\Omega$ gives $V_O/V_I = -2$ and

$R_4 = 200\ k\Omega$ gives $V_O/V_I = -5$.

So $R_1 = R_2 = R_3 = 100\ k\Omega$ and $50\ k\Omega \le R_4 \le 200\ k\Omega$ will give us what we want.