Name: _____ (please print)

Signature: _____

ECE 3455
Quiz #1
February 6, 2008

Quiz duration: 30 minutes

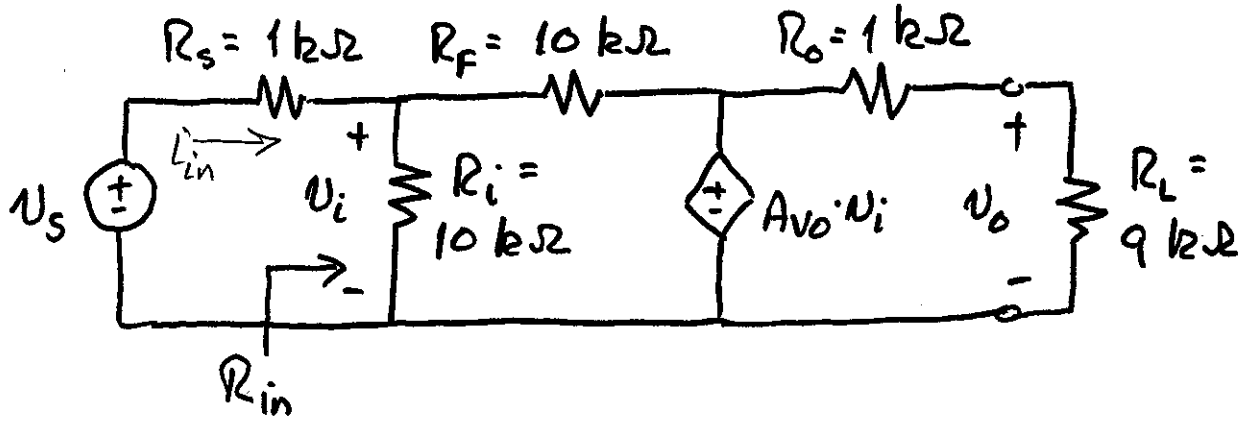
1. You may have one 8 ½ x 11 in. "crib" sheet, written on both sides, during the quiz. You may have any calculator you choose, but no computers. No other notes or materials will be allowed.
2. Show all work necessary to complete the problem on these pages. A solution without the work shown will receive 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.

_____/20

The figure below shows a source, amplifier, and load.

i. The input impedance R_{in} of this circuit can be varied if we vary A_{vo}. Given the resistances shown, what is the largest possible R_{in} that can be achieved by varying A_{vo}?

ii. What is the gain v_o/v_s for the value of A_{vo} obtained in part i)?



i) Input current here is

$$i_{in} = \frac{v_i}{R_i} + \frac{v_i - A_{vo} \cdot v_i}{R_F}$$

The highest R_{in} occurs for the lowest i_{in}. Let's see how small we can make i_{in}:

$$i_{in} = 0 \Rightarrow \frac{1}{R_i} = \frac{A_{vo} - 1}{R_F}$$

$$R_i = R_F \Rightarrow A_{vo} = 2 \Rightarrow R_{in} = \infty \text{ !}$$

ii)

$$\frac{v_i}{R_i} + \frac{v_i - v_s}{R_s} + \frac{v_i (1 - A_{vo})}{R_F} = 0$$

$$v_i \left(\frac{1}{R_i} + \frac{1}{R_s} + \frac{1 - A_{vo}}{R_F} \right) = \frac{v_s}{R_s}$$

Room for Extra Work

$$\therefore \quad v_i = \frac{v_s}{1 + \frac{R_s}{R_i} + \frac{R_s}{R_f}(1 - A_{vo})}$$

At the output

$$v_o = A_{vo} v_i \cdot \frac{R_L}{R_L + R_o}$$

We have $R_L = 9 R_o \Rightarrow v_o = 0.9 A_{vo} v_i$

$A_{vo} = 2$, $\frac{R_s}{R_i} = 0.1$, $\frac{R_s}{R_f} = 0.1$ so

$$v_i = \frac{v_s}{1 + 0.1 + 0.1(-1)} = v_s$$

(This makes sense, since $i_{in} = 0 \Rightarrow$ no voltage drop across R_s.)

$$\therefore \quad v_o = 2 \cdot v_s (0.9)$$

$$\boxed{\frac{v_o}{v_s} = 1.8}.$$