Name: _____ (please print)

Signature: _____

ECE 3455
Quiz #1
February 11, 2009

Quiz duration: 25 minutes

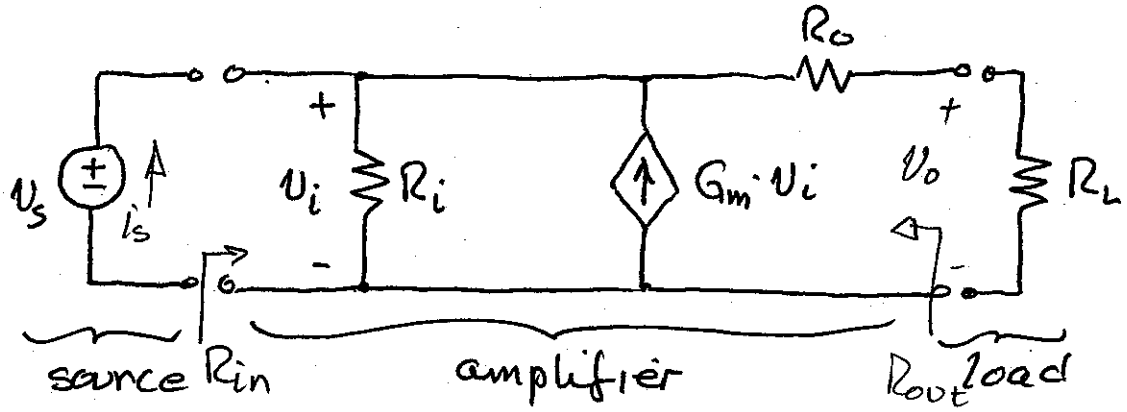
1. You may have one 8 ½ x 11 in. "crib" sheet, written on both sides, during the quiz. You may have any calculator you choose, but no computers. No other notes or materials will be allowed.
2. Show all work necessary to complete the problem on these pages. A solution without the work shown will receive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

SOLUTION

_____/20

The figure below shows a source, amplifier, and load. The source resistance is 0.

i. Find the input resistance as seen by the source, with the load R_L attached.
ii. Find the parameters of a single voltage amplifier that is equivalent to the amplifier shown. Draw the equivalent voltage amplifier.
iii. Assume that by proper design, G_m can be varied, and that it can take on negative as well as positive values. What value of G_m will maximize the input resistance of the voltage amplifier? What is the maximum input resistance?



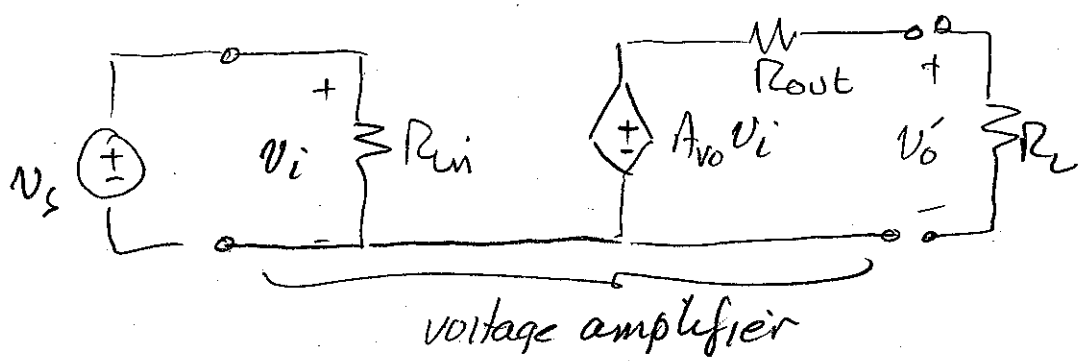
i. we will use v_s as our "test" source:

$$i_s' = \frac{v_i}{R_i} - G_m v_i + \frac{v_i}{R_o + R_L}$$

$$= v_i \left(\frac{1}{R_i} - G_m + \frac{1}{R_o + R_L} \right) \qquad v_i = v_s$$

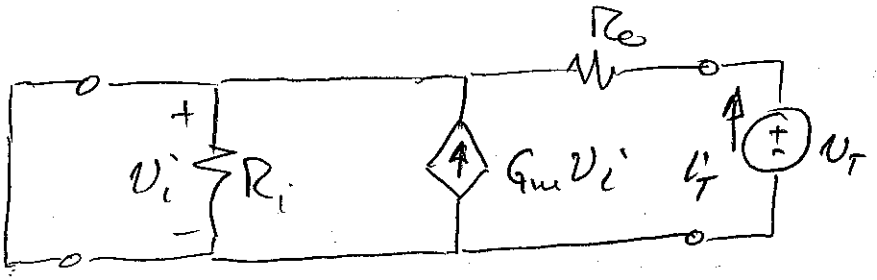
$$\therefore R_{in} = \frac{v_s}{i_s'} = \left(\frac{1}{R_i} - G_m + \frac{1}{R_o + R_L} \right)^{-1}$$

ii. For an equivalent voltage amplifier, we will need R_{in} (which we have), R_{out}, and A_{vo}:



Room for Extra Work

R_{out}: Put a test source at the output and de-activate the source v_s:



But $v_i = 0 \Rightarrow G_m v_i = 0 \Rightarrow \frac{v_T}{i_T} = R_o \equiv R_{out}$

Finally, going back to the original circuit, we see that

$$v_o = v_s \cdot \frac{R_L}{R_o + R_L}$$

Comparing this with our voltage amplifier, we have

$$v_o' = A_{vo} v_i \frac{R_L}{R_o + R_L} \quad \text{and} \quad v_i = v_s$$

so clearly $A_{vo} = 1$.

iii. For $G_m = \left(\frac{1}{R_i} + \frac{1}{R_o + R_L}\right)$ we have $R_{in} = \infty$.