Name: ______________________________ (please print)

Signature: ___________________________

ECE 3355 – Quiz #1
September 10, 2019

Keep this quiz closed and face up until you are told to begin.

1. This quiz is closed book, closed notes. You may use one 8.5” x 11” crib sheet, or its equivalent.
2. Show all work on these pages. Show all work necessary to complete the problem. A solution without the appropriate work shown will receive no credit. A solution which is not given in a reasonable order will lose credit.
3. Show all units in solutions, intermediate results, and figures.
4. If the grader has difficulty following your work because it is messy or disorganized, you will lose credit.
5. Do not use red ink. Do not use red pencil.
6. You will have 30 minutes to work on this quiz.

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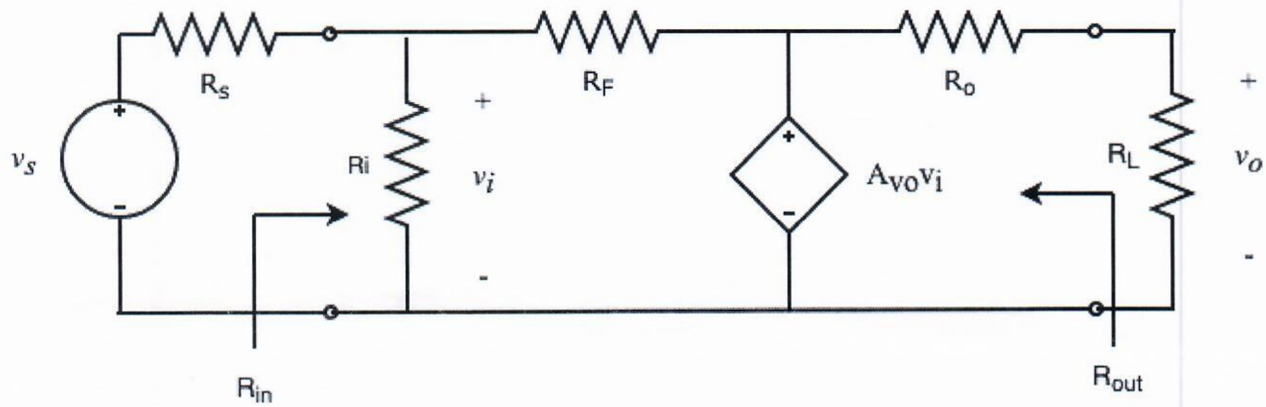
The figure below shows a source (v_s, R_s), an amplifier, and a load (R_L).

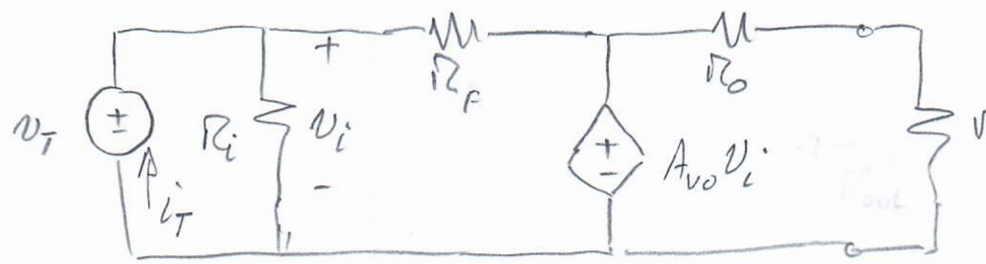
a) Find an expression for the input resistance R_{in} seen by the source. Your expression for R_{in} should be in terms of the other resistances, and the gain parameter A_{vo}.

b) Find an expression for the output resistance R_{out} seen by the load.

c) We can adjust the input resistance R_{in} by varying R_F. Find a value for R_F that provides the largest possible input resistance. What is R_{in} in this case? (Hint: maximizing R_{in} will also minimize the test current used to find R_{in}.)



a) We remove v_s, R_s and use a test source:



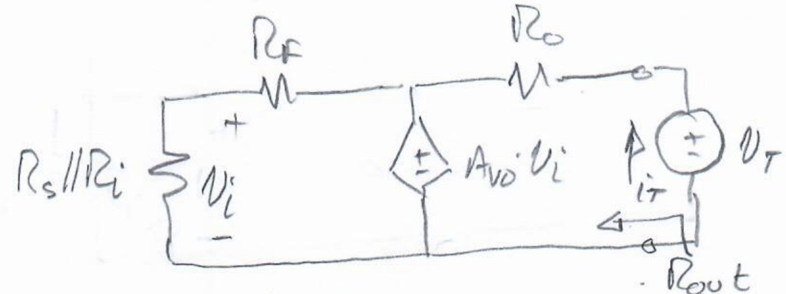
$v_i = v_T$

$$i_T = \frac{v_T}{R_i} + \frac{v_T - A_{vo} v_T}{R_F} = v_T \left(\frac{1}{R_i} + \frac{1}{R_F} - \frac{A_{vo}}{R_F} \right)$$

$$\frac{v_T}{i_T} = R_{in} = \left(\frac{1}{R_i} + \frac{1 - A_{vo}}{R_F} \right)^{-1}$$

Room for Extra Work

b) We put a test source in place of R_L but leave R_S, v_S in place. Then deactivating $v_S \Rightarrow v_S \to 0$. Then we have:



$$\text{But } v_i = A_{vo} v_i \cdot \frac{R_S \| R_i}{R_S \| R_i + R_F} \Rightarrow v_i \left(1 - A_{vo} \frac{R_S \| R_i}{R_S \| R_i + R_F}\right) = 0$$

So either $v_i = 0$, or $A_{vo} \frac{R_S \| R_i}{R_S \| R_i + R_F} = 1$. If the latter is true, then any value of v_i satisfies the circuit equations. So, we take $v_i = 0$.

In that case $R_{out} = R_o$

c) We can make $i_T = 0 \Rightarrow R_{in} = \infty$ if:

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

$$\Rightarrow R_F = R_i (A_{vo} - 1)$$