Name: _____ (please print)

Signature: _____

ECE 3355 – Quiz #1
January 30, 2020

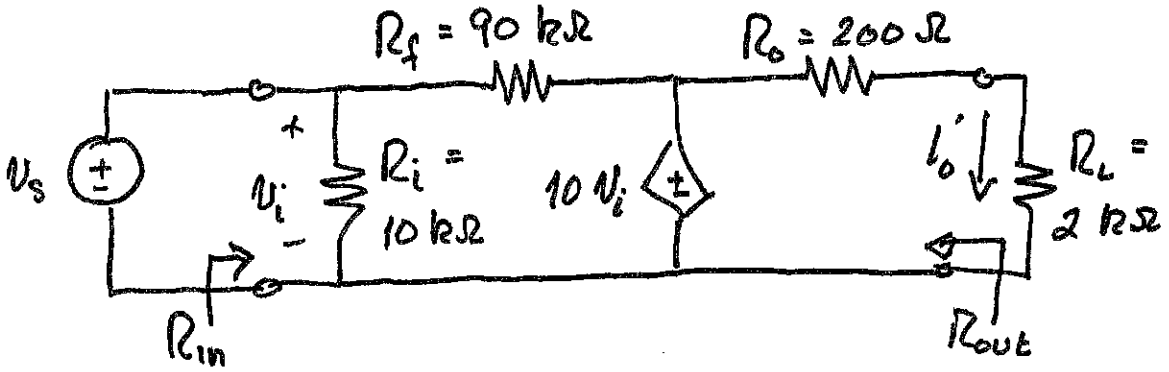
Keep this quiz closed and face up until you are told to begin.

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.

_____/25

Room for Extra Work

The figure below shows a source (v_s), a voltage amplifier, and a load (R_L). The source resistance is 0.



a) Find an equivalent transconductance amplifier that has the same input resistance R_{in} and output resistance R_{out} as the given amplifier, and that provides the same load current i_o to the load R_L.

b) Draw your transconductance amplifier circuit model, showing input resistance, output resistance, and gain parameter clearly.

c) We wish to design the original voltage amplifier to have an input resistance of 100 kΩ by adjusting the value of R_f. Can this be done? If so, what value of R_f should be used? If not, state why this is not possible.

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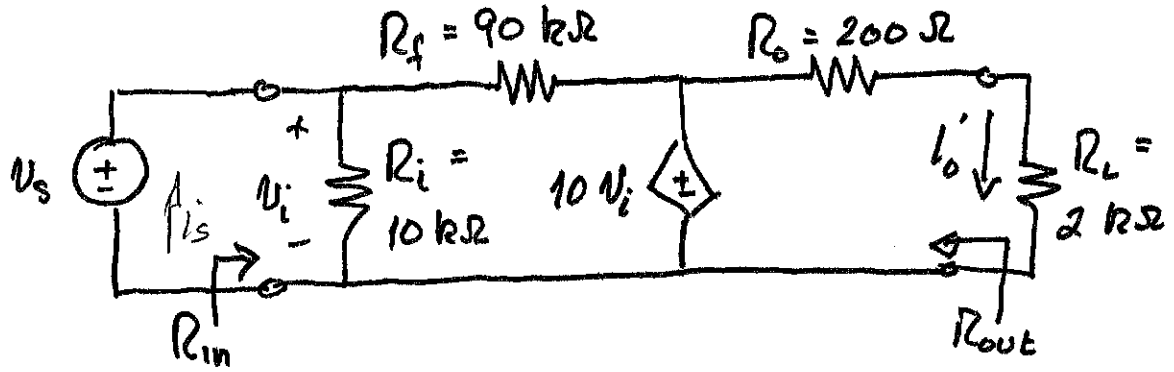

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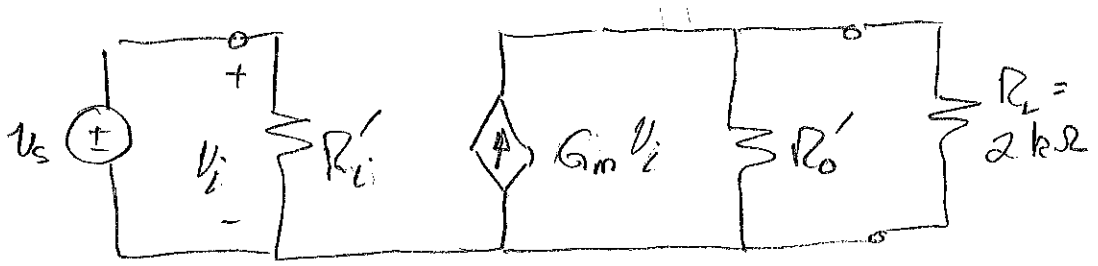
x5 b) Draw your transconductance amplifier circuit model, showing input resistance, output resistance, and gain parameter clearly.

x5 c) We wish to design the original voltage amplifier to have an input resistance of 100 kΩ by adjusting the value of R_f. Can this be done? If so, what value of R_f should be used? If not, state why this is not possible.

a) start with a transconductance amplifier:



Find R_{in} of voltage amplifier:

$$i_s = \frac{v_i}{R_i} + \frac{v_i - 10v_i}{R_f} = v_i\left(\frac{1}{R_i} - \frac{9}{R_f}\right)$$

$$= v_s\left(\frac{1}{R_i} - \frac{9}{R_f}\right)$$

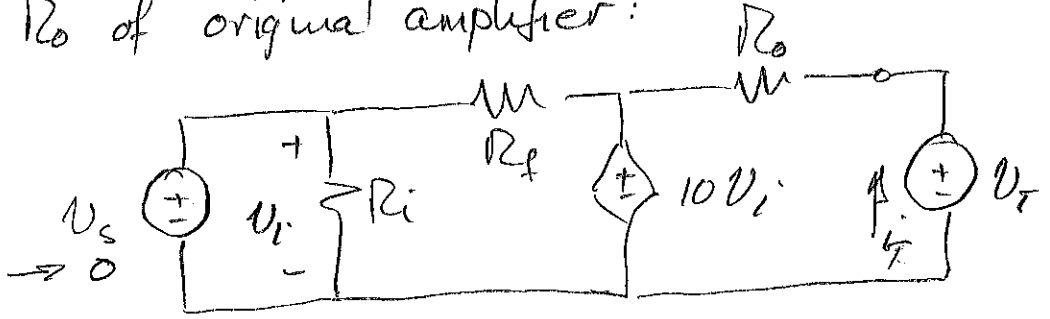
17

Room for Extra Work

+5

$$i_s = v_s\left(\frac{1}{10k} - \frac{9}{90k}\right) = 0 \Rightarrow R_{in} = \infty$$

Find R_o of original amplifier:



$$v_s \to 0 \Rightarrow v_i \to 0 \Rightarrow \frac{v_T}{i_T} = R_{out} = R_o = 200\,\Omega$$

+3

Gain parameter:

original amp: $i_o = \dfrac{10 v_i}{R_o + R_L} = \dfrac{10 v_s}{2200}$

transcond. amp: $i_o = G_m v_s \cdot \dfrac{R_o'}{R_o' + R_L}$

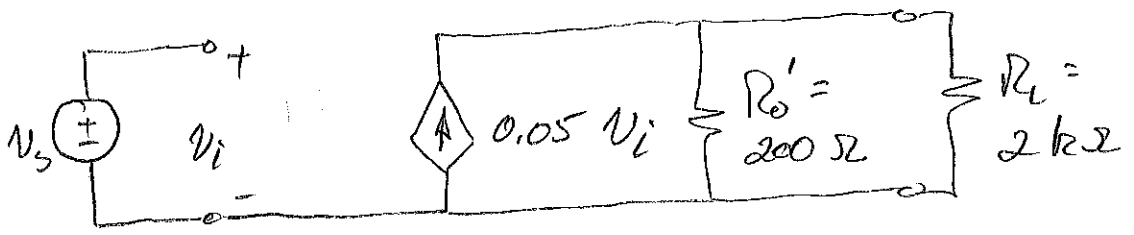
And $R_o' = 200\,\Omega$, $R_L = 2000\,\Omega$, so...

+7

$$\frac{10 v_s}{2200} = \frac{G_m 200}{2200} \Rightarrow G_m = \frac{10}{200} = 0.05\,\frac{A}{V}$$

+5

b)



p. 2

Room for Extra Work

c) $i_s = \frac{v_s}{R_i} + \frac{v_s - 10v_s}{R_f} \Rightarrow R_{in} = \frac{v_s}{i_s} = \left(\frac{1}{R_i} - \frac{9}{R_f}\right)^{-1}$

$\left(\frac{1}{R_i} - \frac{9}{R_f}\right)^{-1} = 10^5 \Rightarrow 10^{-4} - \frac{9}{R_f} = 10^{-5}$ +5

$\Rightarrow \boxed{R_f = \frac{-9}{10^{-5} - 10^{-4}} = 100\ k\Omega}$

So yes, we can do this!