Name: ______________________________ (please print)

Signature: __________________________

ECE 3355
Quiz #1
June 14, 2017

1. You may have an 8 ½ x 11" crib sheet, but no other materials, and no communication devices of any kind.
2. Show all work necessary to complete the problem on these pages. If you go on to another page, indicate clearly where your work can be found. A solution without the work shown will receive no credit.
3. Show all units in expressions and figures.
4. Do not use red ink.
5. You will have 25 minutes to work on this quiz.

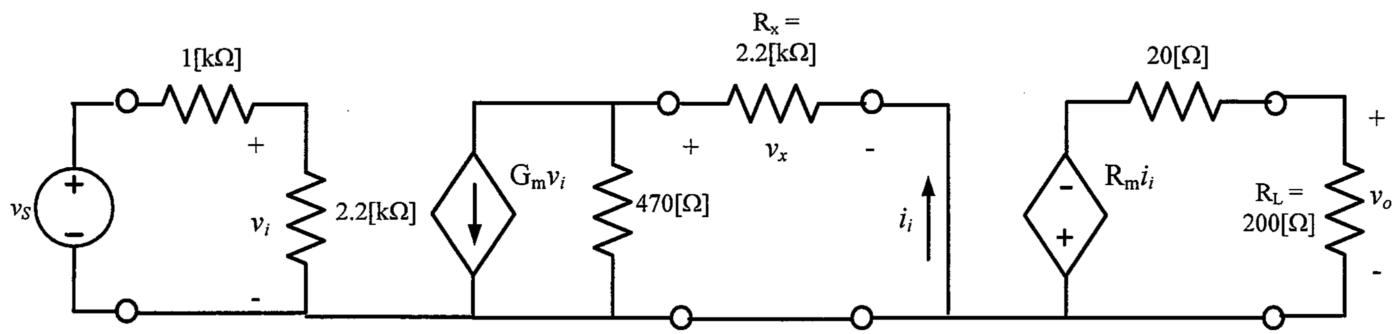
________________/25

Room for extra work

Two amplifiers are cascaded as shown, with a resistor R_x connecting the two. A source v_s and load R_L are also shown. The source resistance is 0. The gain parameters G_m and R_m are not specified, but it is known that when $v_s = 10$ mV, $v_x =$ - 8.653 V and $v_o =$ - 893.86 mV.

a) Find a single equivalent amplifier model that duplicates the behavior of the cascaded amplifiers and resistor R_x. Be sure to include the input and output resistances in your model.

b) Find the gain parameters G_m and R_m.



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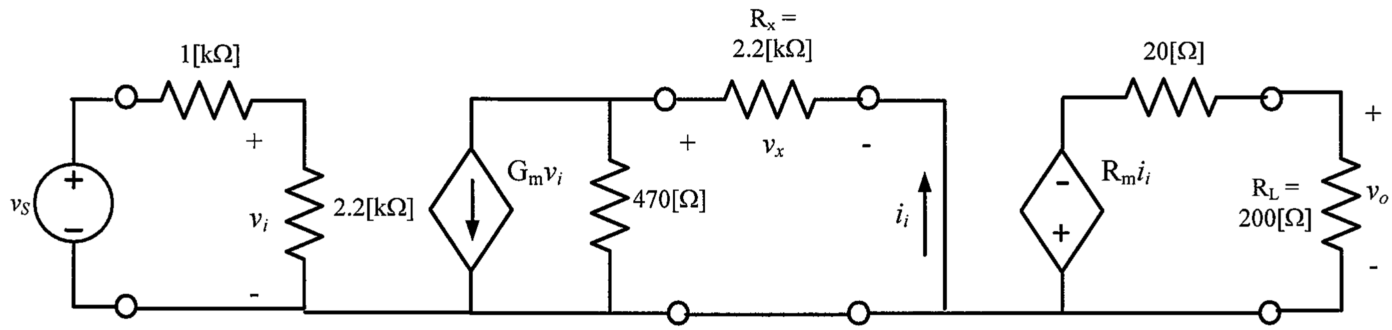
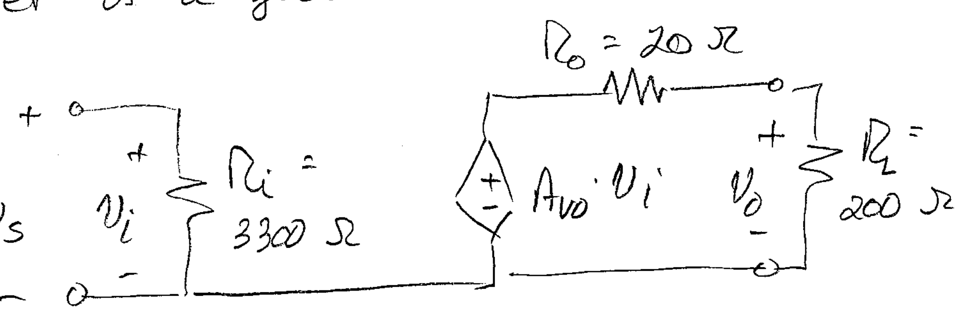


We have a small R_o, so transresistance or voltage amplifier is a good choice.



We have $v_o = A_{vo} v_i \frac{200}{220} = A_{vo} v_s \frac{200}{220} = A_{vo}' v_s (0.90909)$

This is not the same v_i as in the original ckt!

Now we look at the original circuit.

Room for extra work

$v_o = -R_m i_i \frac{200}{220}$ $i_i = G_m v_i \frac{470}{2200+470}$

$v_i = v_s \frac{2200}{2200+1000}$

$\Rightarrow \quad v_o = -R_m G_m v_s \left(\frac{200}{220}\right)\left(\frac{470}{2670}\right)\left(\frac{2200}{3200}\right)$

$v_o = -R_m G_m v_s (0.1100)$

But now $\quad A_{vo} v_s (0.90909) = -R_m G_m v_s (0.1100)$

$\Rightarrow \quad \boxed{A_{vo} = -R_m G_m (0.121)}$

So we need G_m and R_m to specify this.

$v_s = 0.01\ V \Rightarrow v_i = 6.875\ mV \Rightarrow i_i = G_m (0.00121)$

$v_x = -8.653\ V = -G_m (0.00121)(2200)$

$\boxed{\therefore\ G_m = 3.25\ \frac{A}{V}}$

$v_o = -893.86 \times 10^{-3} = -R_m i_i \frac{200}{220}$

$i_i = 3.25(0.00121) = 0.003933$

$\Rightarrow \boxed{R_m = 250\ \frac{V}{A}}$

So $\boxed{A_{vo} = -R_m G_m (0.121) = -98.312\ \frac{V}{V}}$

check: $v_o = A_{vo} \cdot v_s \cdot \frac{200}{220} = -893.7\ mV$ (close!) ✓