Name: ______________________________ (please print)

Signature: ___________________________

ECE 3455
Quiz #2
Summer 2010

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.

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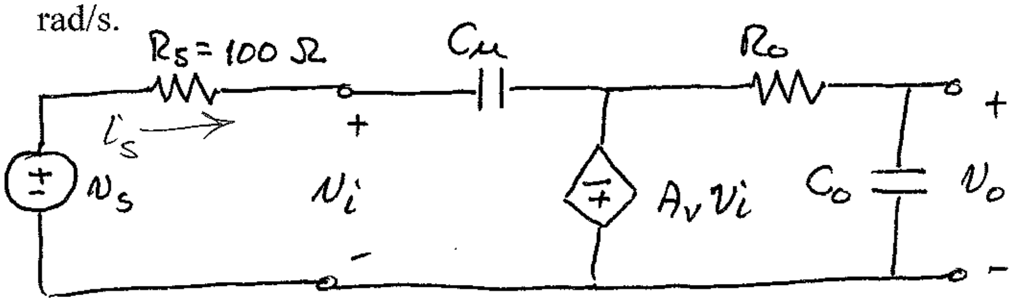
For the circuit below, do the following.

i. Find the transfer function $T(\omega) = \mathbf{V_o}/\mathbf{V_s}$.
ii. If it is required to have a gain of 12 dB at dc, what value does A_v need to take?
iii. Find component values such that there is a breakpoint due to C_o at 30,000 rad/s.



i) We can do this with or without Miller:

without:

$$\bar{I}_s = \frac{\bar{V}_s + A_v \bar{V}_i}{R_s + 1/j\omega C_\mu} \qquad \bar{V}_o = -A_v \bar{V}_i \frac{1/j\omega C_o}{R_o + 1/j\omega C_o}$$

$$= -A_v \bar{V}_i \frac{1}{1 + j\omega C_o R_o}$$

$$\bar{V}_i = \bar{V}_s - R_s \bar{I}_s$$

$$= \bar{V}_s - \frac{\bar{V}_s R_s + A_v \bar{V}_i R_s}{R_s + 1/j\omega C_\mu}$$

$$\Rightarrow \bar{V}_i \left(1 + \frac{A_v R_s}{R_s + 1/j\omega C_\mu}\right) = \bar{V}_s \left(1 - \frac{R_s}{R_s + 1/j\omega C_\mu}\right)$$

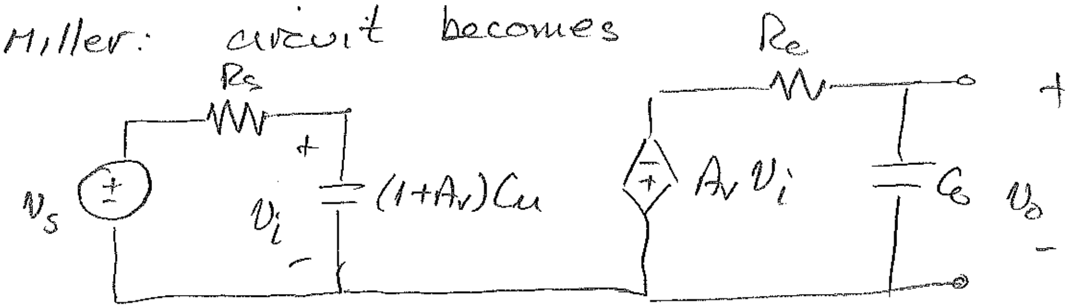
$$\bar{V}_i \left(1 + \frac{A_v j\omega C_\mu R_s}{1 + j\omega C_\mu R_s}\right) = \bar{V}_s \left(1 - \frac{j\omega C_\mu R_s}{1 + j\omega C_\mu R_s}\right)$$

$$\bar{V}_i = \bar{V}_s \frac{1}{1 + (1 + A_v) j\omega C_\mu R_s}$$

$$\Rightarrow \boxed{\frac{\bar{V}_o}{\bar{V}_s} = \frac{-A_v}{1 + j\omega(1 + A_v) C_\mu R_s} \cdot \frac{1}{1 + j\omega C_o R_o}}$$

Room for Extra Work

with Miller: circuit becomes



$K = -A_v \quad Z = 1/j\omega C_\mu \Rightarrow Z_1 = \dfrac{Z}{1-K} = \dfrac{1}{(1+A_v)j\omega C_\mu}$

Now $\bar{V}_o = -A_v \bar{V}_i \dfrac{1}{1+j\omega C_o R_o}$

$\bar{V}_i = \bar{V}_s \dfrac{1/(1+A_v)C_\mu j\omega}{R_s + 1/(1+A_v)C_\mu j\omega} = \bar{V}_s \dfrac{1}{1+j\omega(1+A_v)C_\mu R_s}$

$$T(\omega) = \frac{\bar{V}_o}{\bar{V}_s} = \frac{-A_v}{1+j\omega C_o R_o}\,\frac{1}{1+j\omega(1+A_v)C_\mu R_s}$$

ii) At dc ($\omega \to 0$), $|T(\omega)| = A_v = 12\text{dB} \Rightarrow$ $\underline{A_v = 4\ V/V}$

iii) $\dfrac{1}{C_o R_o} = 30000$ rad/s C_o and R_o can in principal be anything so long as the product produces the correct breakpoint.

Since this is a voltage amp, let's choose a relatively low output resistance:

$R_o = 100\ \Omega \Rightarrow C_o = 0.333\ \mu F$