Name: _____ (please print)

Signature: _____

ECE 3455
Quiz 2
February 20, 2008

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.

_____/20

The transfer function T(ω) for a certain filter is shown below. Take R = 1 kΩ and C = 2.5 μF.

a) Using the paper provided on the next page, draw the straight-line approximation to the **Magnitude** Bode plot for this transfer function.
b) What is the **phase** of the transfer function as ω approaches 0?

$$T(\omega) = 10 \cdot \frac{(j\omega)^2 (1 + j\omega RC)^2}{(1 + j\omega \cdot 5RC)(1 + j\omega \cdot 20RC)^2 (j\omega)^3}$$

a)

Analysis: $\frac{(j\omega)^2}{(j\omega)^3} = \frac{1}{j\omega}$

So...

1 pole at 0 rad/s
2 zero's at $1/RC$ = 400 rad/s
1 pole at $1/5RC$ = 80 rad/s
2 poles at $1/20RC$ = 20 rad/s

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what frequency range should we use?

The first "event" is a pole at zero; the second is another pole at $1/20RC$ = 20 rad/s. So we will begin plotting at 1 rad/s to have enough space to show the pole at 0.

The last "event" is zero at 400 rad/s so we will stop plotting after 1000 rad/s.

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Room for Extra Work

How about the vertical axis? A few keystrokes on a calculator show that:

$$20 \log(|T(1)|) \approx 20 \text{ dB}$$
$$20 \log(|T(1000)|) \approx -110 \text{ dB}$$

so we choose our vertical scale accordingly.

To fix one point we use $20 \log(|T(1)|) = 20$ dB.

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b) Phase? As $\omega \to 0$, the function becomes

$$T(\omega) \xrightarrow[\omega \to 0]{} \frac{(1+0)^2}{(1+0)(1+0)^2 j\omega}$$

So $\angle T(\omega) \to \angle \frac{1}{j\omega} = \underline{\underline{-90^\circ}}$.

o : breakpoint