Name: ______________________________ (please print)

Signature: ___________________________

ECE 3455
Quiz 2
September 23, 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.

_________________/20

The transfer function T(ω) for a certain amplifier is shown below. It is known that for very large values of ω, the magnitude of the transfer function is 78 dB.

We are given that $R_1C_1 = 3.333 \times 10^{-5}$ s; $R_2C_2 = 3.333 \times 10^{-4}$ s; $R_3C_3 = 0.001667$ s. The values of R_4C_4 and K are unknown.

$$T(\omega) = K\frac{(j\omega R_4C_4)^2\left(\frac{1}{R_3C_3} + 3j\omega\right)^2}{(1 + j\omega R_2C_2)(8000 + j\omega)\left(\frac{1}{R_1C_1} + j\omega\right)^2}$$

Using the paper provided on the next page, draw the straight-line approximation to the **magnitude** Bode plot for this transfer function.

Poles and zeroes occur for each of the factors in T(ω), and at frequencies for which the Re & Im parts are equal. So...

z_1 at 0 (2x)

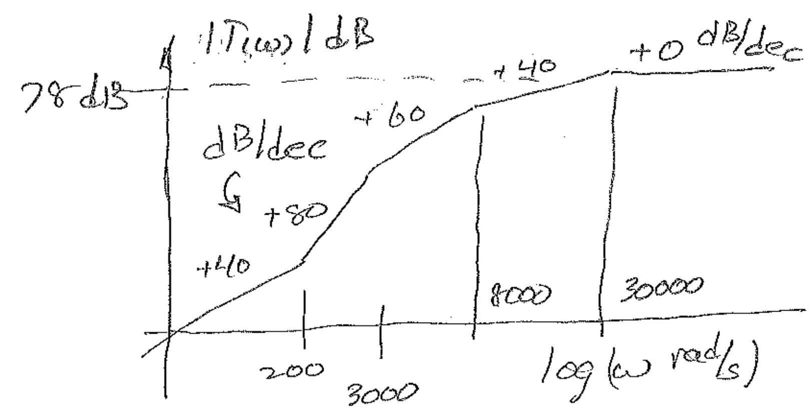
z_2 at $3\omega = \frac{1}{R_3C_3} \Rightarrow \omega = \frac{1}{3R_3C_3} = 200$ rad/s (2x)

P1 at $1/R_2C_2 = 3000$ rad/s

P2 at $\omega = 8000$ rad/s

P3 at $1/R_1C_1 = 30\,000$ rad/s (2x)

Rough sketch:



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Room for Extra Work

we don't necessarily need to find K unless we want to evaluate $|T(\omega)|$ at some particular frequency. we will do this, since it may help to set the vertical scale.

$$|T(\omega)|_{\omega \to \infty} \to 78\ dB \Rightarrow |T(\omega)| = 10^{78/20} = 7943.$$

Now $\omega \to \infty \Rightarrow T(\omega) \to K \frac{(j\omega R_4 C_4)^2\ (3j\omega)^2}{(j\omega R_2 C_2)(j\omega)(j\omega)^2}$

$$= K \cdot \frac{(R_4 C_4)^2 \cdot 3^2}{R_2 C_2} = 7943.$$

So we cannot find K because we don't know $R_4 C_4$, but we don't need it:

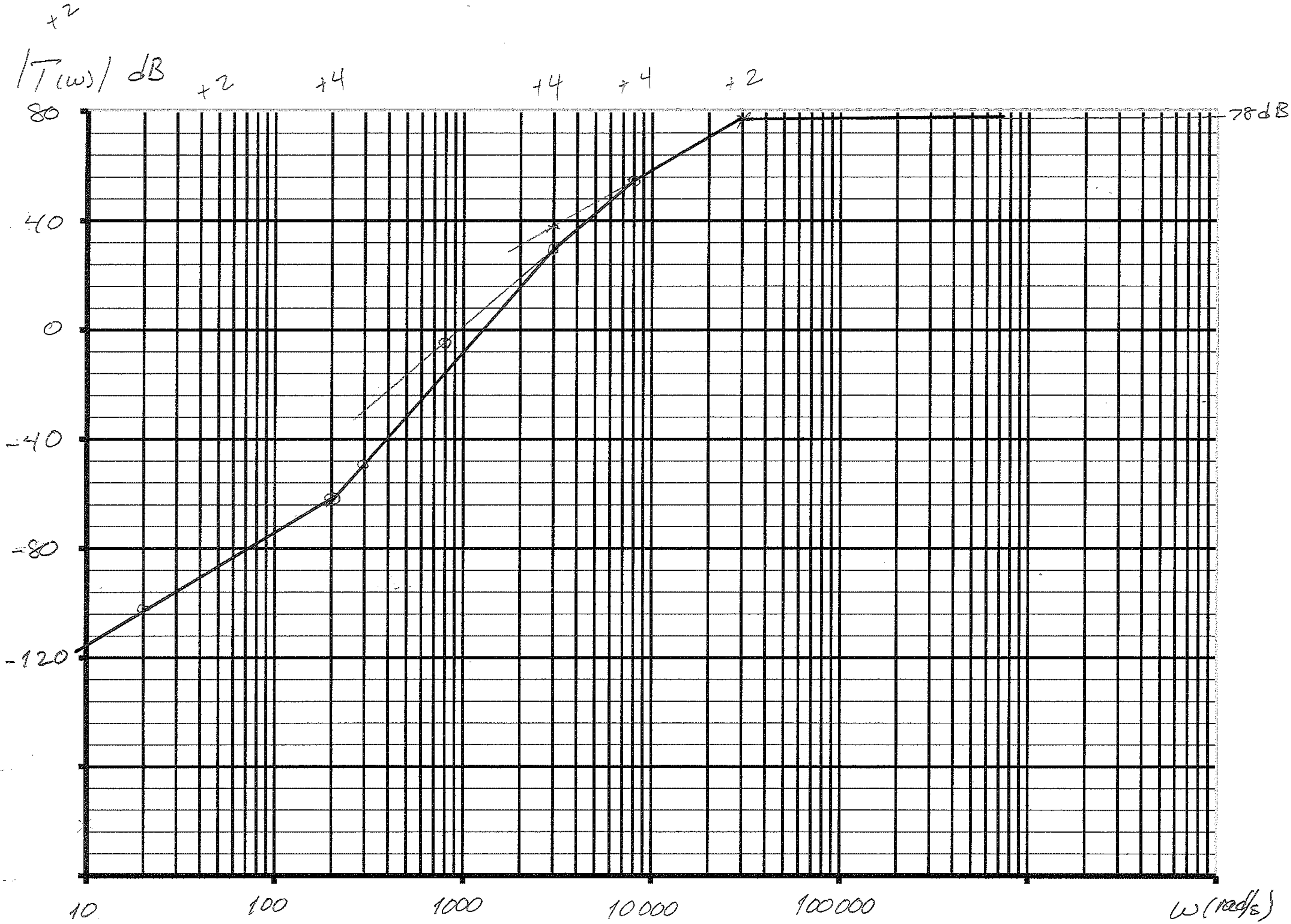
$$7943 = K \cdot (R_4 C_4)^2 \cdot \frac{9}{3.333 \times 10^{-4}} \Rightarrow K \cdot (R_4 C_4)^2 = 0.294$$

Now we can find $|T(\omega)|$ at 10 rad/s (arbitrary choice):

$$|T(10\ \text{rad/s})| = \left| \frac{0.294 \cdot (j10)^2 \cdot \left(\frac{1}{0.001667} + j10\right)^2}{(1 + j \cdot 10 \cdot 3.333 \times 10^{-4})(8000 + j10)\left(\frac{1}{3.33 \times 10^{-5}} + j10\right)^2} \right|$$

$$= 1.46 \times 10^{-6} \to -117\ dB.$$

On the plot, I chose to work backward from 78 dB, knowing slopes and breakpoints along the way. I ended up pretty close to -117 dB.



no vertical scale: -5

+2