Name: ______________________________ (please print)

Signature: ___________________________

ECE 3355
Quiz 2
February 13, 2020

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~~ 25

Room for Extra Work

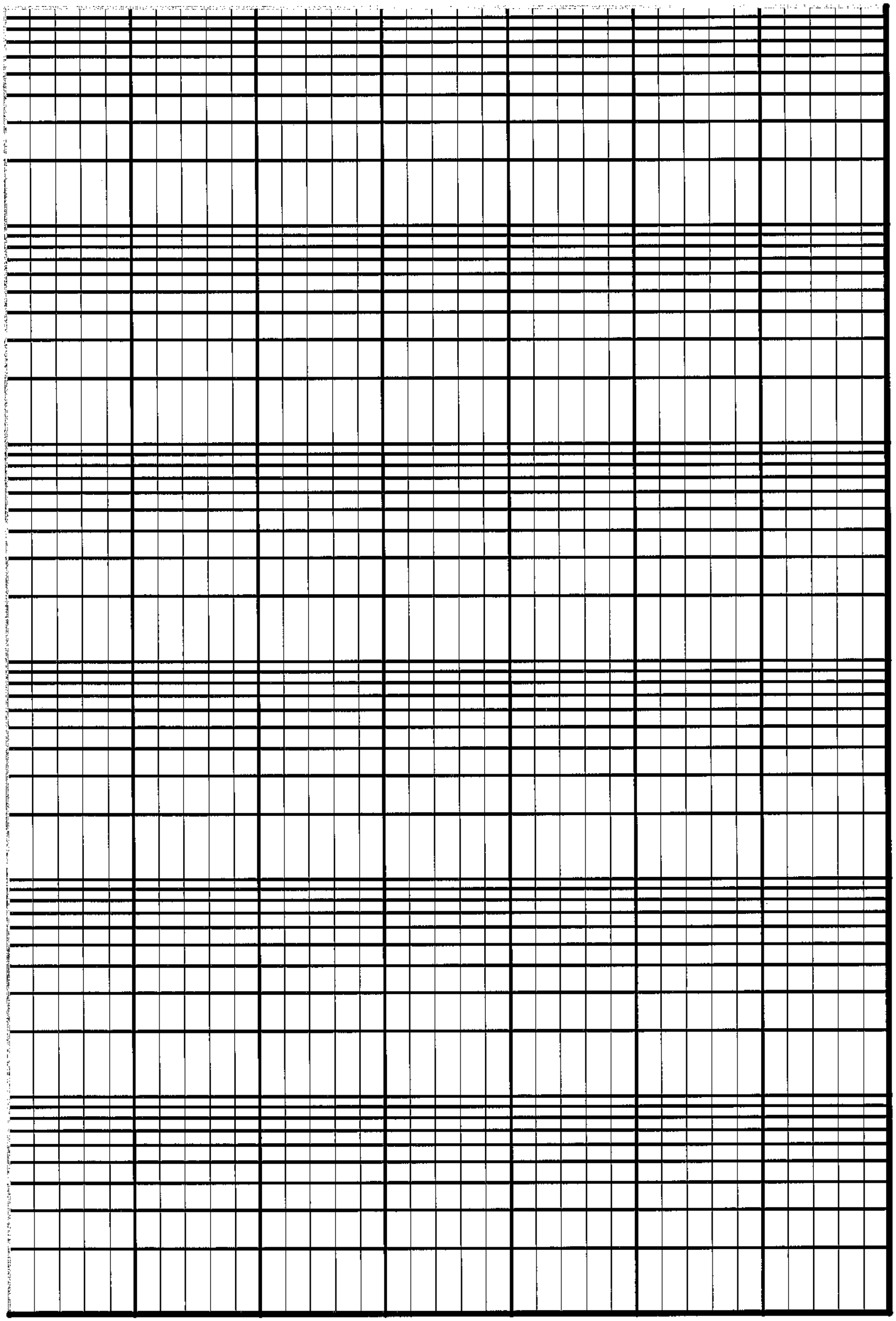
The transfer function T(ω) for a certain amplifier is shown below. It is known that the magnitude of the transfer function at very large values of ω is 0 dB.

We are given that $R_1C_1 = 5 \times 10^{-5}$ s; $R_2C_2 = 3.333 \times 10^{-4}$ s; $R_3C_3 = 0.01667$ s; and $R_4C_4 = 10^{-3}$ s.

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

a) Find the value of K, assuming it is a real number.

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



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a) Find the value of K, assuming it is a real number.

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

a) For $\omega \to \infty$, $T(\omega) \to K \cdot \frac{(j\omega)(j\omega R_4C_4)^2}{(j\omega R_2C_2)^2 \cdot (3j\omega)}$

$$= K \cdot \frac{(R_4C_4)^2}{(R_2C_2)^2 \cdot 3} = 3K$$

+6

Since $|T(\omega \to \infty)| = 0$ dB, $3K = 1 \Rightarrow \boxed{K = 1/3}$

b) Zeros: $0, 0, 1/R_1C_1 = 0, 0, 20000$ rad/s +3

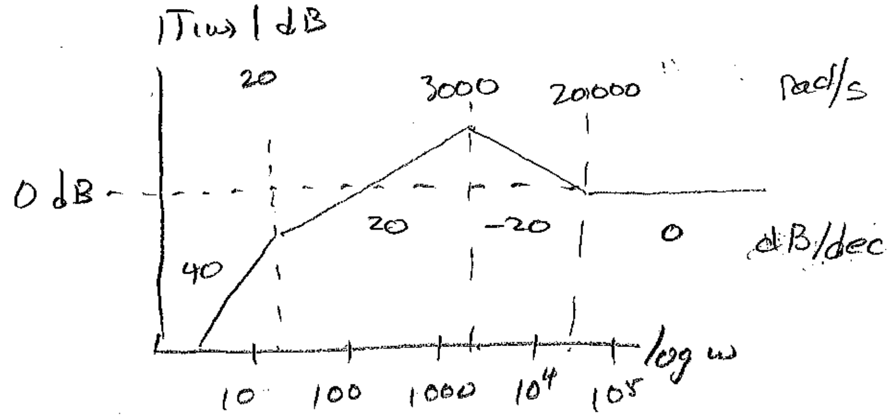
poles: $\frac{1}{3R_3C_3}, \frac{1}{R_2C_2}, \frac{1}{R_2C_2} = 20, 3000, 3000$ rad/s +3

So we have a double zero at 0 ⇒ +40 dB/dec
and a double pole at 3000 rad/s ⇒ −40 dB/dec
at those breakpoints.

plot: +13

Room for Extra Work

Rough sketch:



More careful drawing is on graph paper.

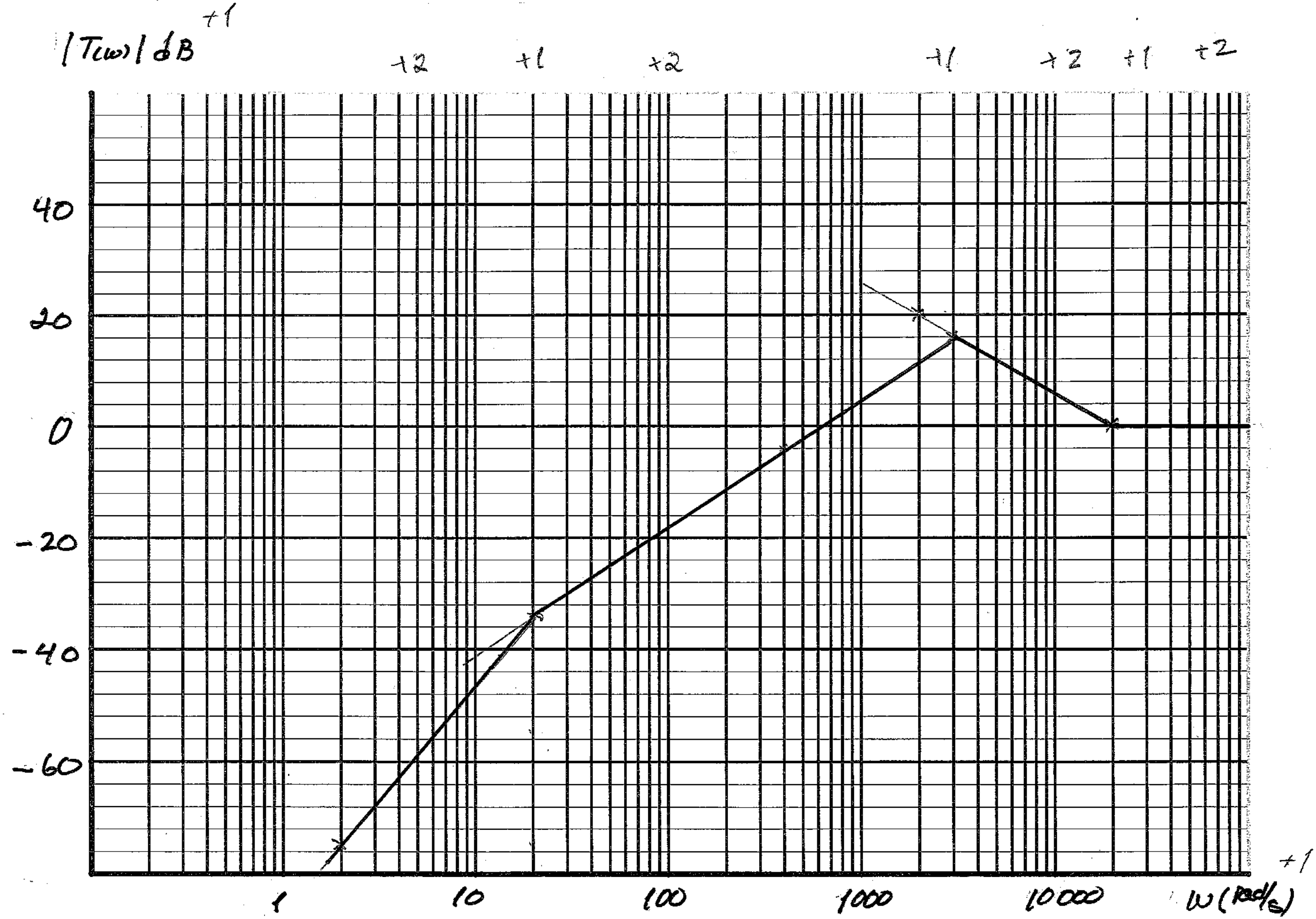
If we re-write $T(\omega)$ by multiplying and dividing by $\frac{R_1C_1}{R_3C_3}$, we get

$$T(\omega) = K \frac{R_3C_3}{R_1C_1} \cdot \frac{(1+j\omega C_1R_1)(j\omega C_4R_4)^2}{(1+j\omega C_2R_2)^2(1+j\omega 3C_3R_3)}$$

If in addition we lump R_3C_3/R_1C_1 into the constant K, we have

$$T(\omega) = K' \frac{(1+j\omega C_1R_1)(j\omega C_4R_4)^2}{(1+j\omega C_2R_2)^2(1+j\omega 3C_3R_3)}$$

In this case, K' works out to <u>111.1</u>.



|T(ω)| dB
+1
+2
+1
+2
+1
+2
+1
+2
+1
40
20
0
-20
-40
-60
1
10
100
1000
10000
ω (rad/s)