ECE2210 Exam 3 given: Fall 09

(The space between problems has been removed.)

1. (20 pts) a) Draw the asymptotic Bode plot (the straight-line approximation) of the transfer function below. Accurately draw it on the graph provided.

$$H(f) := \frac{633\cdot Hz\cdot\left(1+\frac{0.0005}{Hz}\cdot j\cdot f\right)}{(40\cdot Hz + j\cdot f)}$$

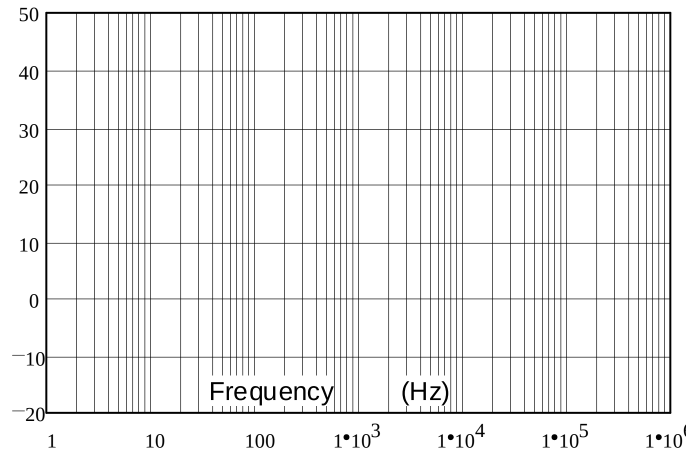
dB

Magnitude plot

$|H(f)|$

Straight-line approximation ____

Actual _ _ _ _



You must show the steps you use to get the Bode plot. That is, show things like the corner frequency(ies) , the approximations of the transfer function in each frequency region, calculations of dB, etc..

b) The asymptotic Bode plot is not exact. Using a dotted line, sketch the actual magnitude of the transfer function $|H(f)|$ on the plot above. Indicate the point(s) where the difference between the two lines is the biggest (draw arrow(s)) and write down the actual magnitude(s) at that (those) point(s).

c) If there are any corners in the Bode plot associated with **<u>zeroes</u>** in the transfer function, list that/those corner frequency(ies) at right (f_z).

d) If there are any corners in the Bode plot associated with **<u>poles</u>** in the transfer function, list that/those corner frequency(ies) at right (f_p).

2. (16 pts) Analysis of a circuit (not pictured) yields the characteristic equation and solutions below.

$$0 = s^2 + 200\cdot s + 650000 \qquad s_1 := (-100 + 800\cdot j)\cdot\frac{1}{sec} \quad \text{and} \quad s_2 := (-100 - 800\cdot j)\cdot\frac{1}{sec}$$

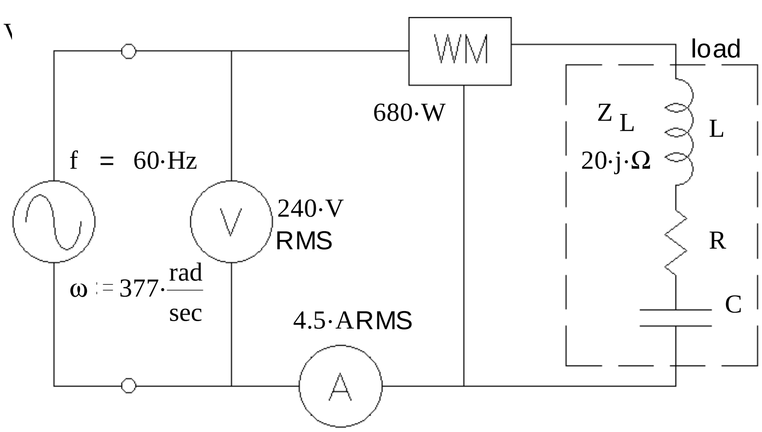
Further analysis yields the following initial and final conditions:

$i_L(0) = 10\cdot mA$	$v_L(0) = -6\cdot V$	$v_C(0) = -6\cdot V$	$i_C(0) = -40\cdot mA$
$i_L(\infty) = 50\cdot mA$	$v_L(\infty) = 0\cdot V$	$v_C(\infty) = 10\cdot V$	$i_C(\infty) = 0\cdot mA$

Some components: $L := 0.2\cdot mH$ $\quad R := 60\cdot\Omega$ $\quad C := 20\cdot\mu F$

Write the full expression for $v_C(t)$, including all the constants that you find. $\quad v_C(t) = ?$ $\quad$ Include **units** in your answer

3. (25 pts) L, R, & C together are the load in the circuit shown. The RMS voltmeter measures 240 V, the RMS ammeter measures 4.5 A, and the wattmeter measures 680 W. Find the following: Be sure to show the correct units for each value.



a) The value of the load resistor. R = ?

b) The apparent power. $|S|$ = ?

c) The magnitude of the reactive power. $|Q|$ = ?

d) The impedance of the capacitor. $\mathbf{Z_C}$ = ?

e) The complex power. $\mathbf{S}$ = ?

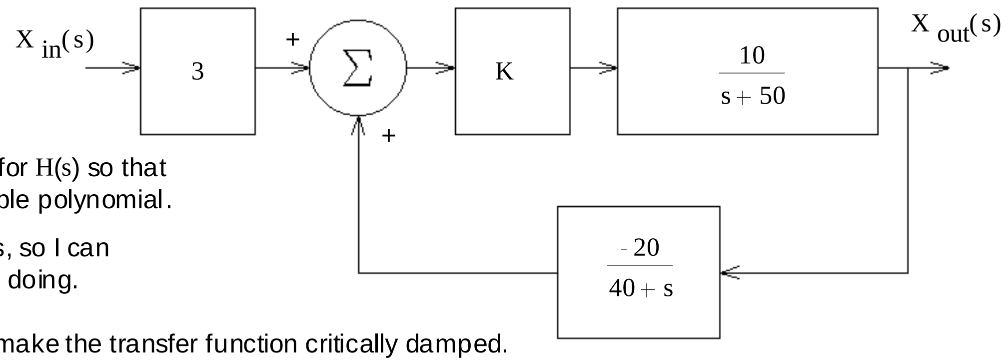
f) The power factor. pf = ?

g) The power factor is: i) leading ii) lagging

h) The two components of the load are in a box which cannot be opened. Add (draw it) another component to the circuit above which can correct the power factor (make pf = 1). Show the correct component in the correct place and <u>find its value on the next page</u>. This component should not affect the real power consumption of the load.

4. (15 pts) a) A feedback system is shown in the figure. What is the transfer function of the whole system, with feedback.

$$H(s) = \frac{X_{out}(s)}{X_{in}(s)} = ?$$



Simplify your expression for H(s) so that the denominator is a simple polynomial.

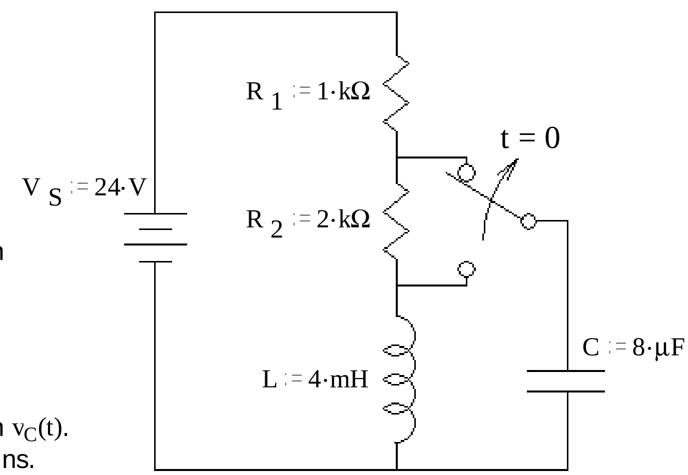
Be clear about your signs, so I can tell you know what you're doing.

b) Find the value of K to make the transfer function critically damped.

c) Does the transfer function have a zero? Answer "no" or find the s value(s) of the zero(s).

5. (24 pts) The switch has been down for a long time and is switched up (as shown) at time $t = 0$.

a) What are the final conditions of i_L and the v_C?
$i_L(\infty) = ?$ $v_C(\infty) = ?$



b) Find the initial condition and initial slope of i_L that you would need to have in order to find all the constants in $i_L(t)$. Don't find $i_L(t)$ or it's constants, just the initial conditions.

c) Find the initial condition and initial slope of v_C that you would need to have in order to find all the constants in $v_C(t)$. Don't find $v_C(t)$ or it's constants, just the initial conditions.

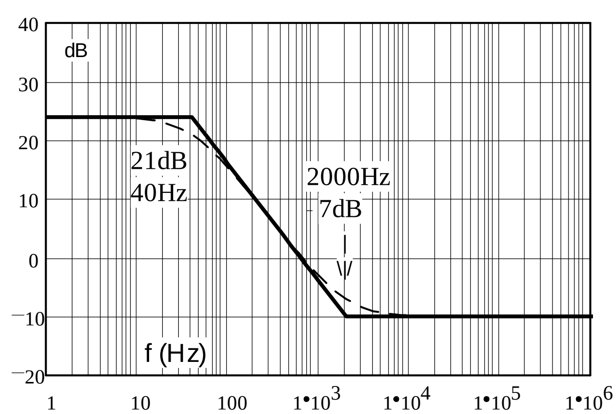
Answers

1. a) & b)

Magnitude plot $|H(f)|$

Straight-line approximation __

Actual _ _ _ _



c) $f_{C2} = 2 \cdot kHz$

d) $f_{C1} = 40 \cdot Hz$

2. $10 \cdot V + e^{-\frac{100}{sec} \cdot t} \cdot \left(-16 \cdot V \cdot \cos\left(\frac{800}{sec} \cdot t\right) - 4.5 \cdot V \cdot \sin\left(\frac{800}{sec} \cdot t\right)\right)$

3. a) $33.6 \cdot \Omega$ b) $1.08 \cdot kVA$ c) $839 \cdot VAR$ d) $-61.4 \cdot j \cdot \Omega$ e) $680 - 639j \cdot VA$ f) 0.63 g) i)

h) Add an second inductor in parallel with load, $182 \cdot mH$

4. a) $3 \cdot \frac{(10 \cdot K) \cdot (s + 40)}{s^2 + 90 \cdot s + 2000 + 200 \cdot K}$ b) 0.125 c) -40

5. a) $16 \cdot V$ $8 \cdot mA$ b) $8 \cdot mA$ $-4000 \cdot \frac{A}{sec}$ c) $0 \cdot V$ $2000 \cdot \frac{V}{sec}$