ECE 2210/00 Exam 3 given: Spring 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.

   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..

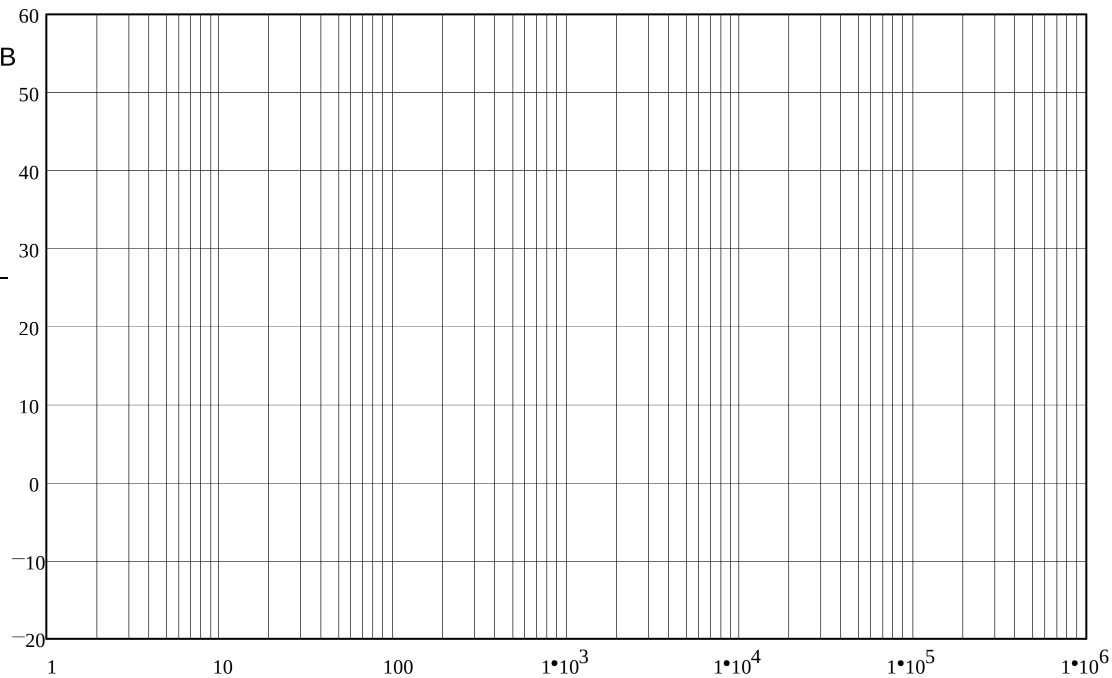
$$H(f) := \frac{10 \cdot j \cdot f \cdot \left(1 + \frac{j \cdot f}{40 \cdot kHz}\right)}{(200 \cdot Hz + j \cdot f)}$$

Magnitude plot dB

$|H(f)|$

Straight-line approximation ____

Actual _ _ _ _



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).

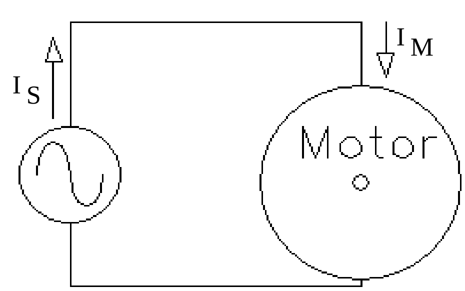
c) If there are any corners in the Bode plot associated with **poles** in the transfer function, list that/those corner frequency(ies) below (f_p).

d) If there are any corners in the Bode plot associated with **zeroes** in the transfer function, list that/those corner frequency(ies) below (f_z).

2. (12 pts) An electric motor is hooked to a 240-V, 60-Hz source.

   The motor draws the following complex power.

$$\mathbf{S} := (900 + 600 \cdot j) \cdot VA$$



a) Add (draw it) a component to the drawing which can correct the power factor (make pf = 1). Show the correct component in the correct place and find its value. This component should not affect the mechanical power output of the motor.

b) Is the source current $|I_S|$ the same as the motor current $|I_M|$ now that the component of part a) is added?

   If not, which is greater and by how much?

   Hint: $|I_M|$ is still the original current, find it from the conditions before you added the component of part a).

3. (22 pts) R_L, & C_L together are the load in the circuit shown. The voltmeter, ammeter, and wattmeter measurements are shown. Find the following:
Include the correct units for each value.

$f := 60 \cdot Hz$

a) The real power. P = ?

b) The value of the load resistor. R_L = ?

c) The apparent power. |**S**| = ?

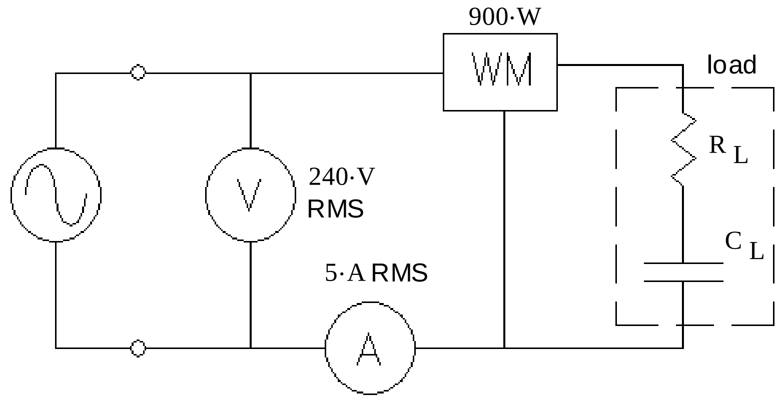
d) The reactive power. Q = ?

e) The value of the capacitor. C_L = ?

f) The complex power. **S** = ?

g) The power factor. pf = ?

h) The power factor is: i) leading ii) lagging (circle one)



4. (22 pts) Analysis of a circuit (not pictured) yields the characteristic equation below.

$$0 = s^2 + 800 \cdot s + 160000$$

$R := 60 \cdot \Omega$ $L := 350 \cdot mH$ $C := 20 \cdot \mu F$ $V_{in} := 12 \cdot V$

Further analysis yields the following initial and final conditions:

$i_L(0) = 30 \cdot mA$ $v_L(0) = -7 \cdot V$ $v_C(0) = 5 \cdot V$ $i_C(0) = 70 \cdot mA$

$i_L(\infty) = 90 \cdot mA$ $v_L(\infty) = 0 \cdot V$ $v_C(\infty) = 12 \cdot V$ $i_C(\infty) = 0 \cdot mA$

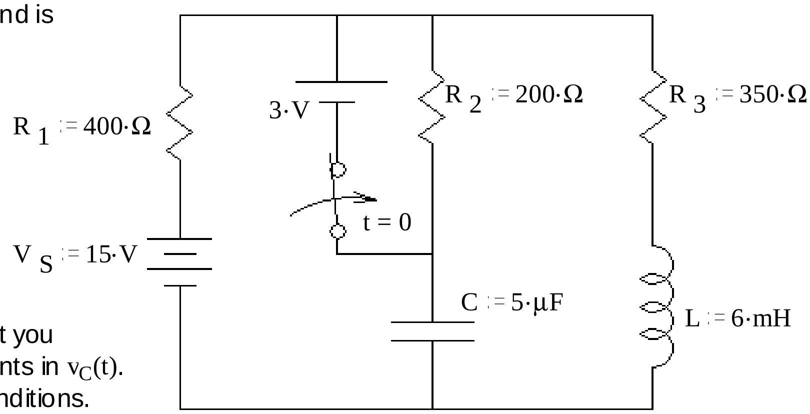
Write the full expression for $i_L(t)$, including all the constants that you find. $i_L(t)$ = ? Include **units** in your answer

5. (24 pts) The switch has been open for a long time and is closed (as shown) at time t = 0.

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

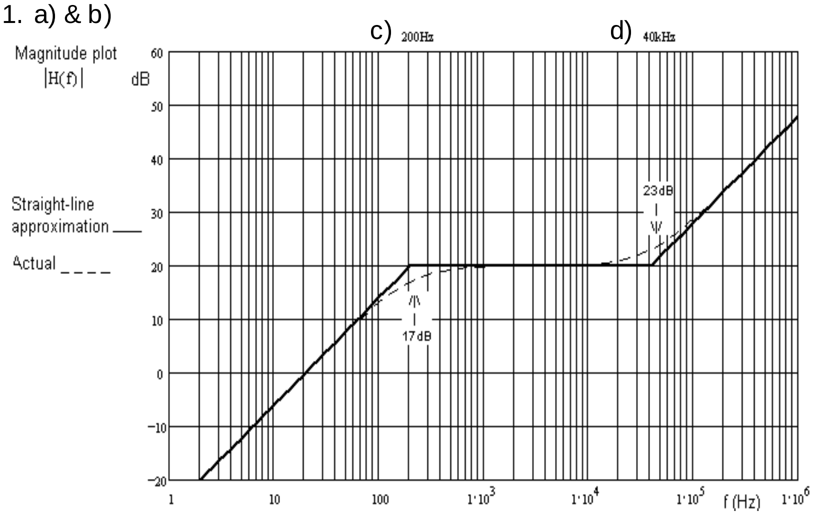
b) Find the initial condition and initial slope of i_L that you would need to have in order to find all the constants in $i_L(t)$. Don't find $i_L(t)$ or it's constants, just the initial conditions.

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)



2. a) $27.6 \cdot \mu F$ b) I_M $0.757 \cdot A$

3. a) $900 \cdot W$ b) $36 \cdot \Omega$ c) $1.2 \cdot kVA$
d) $-794 \cdot VAR$ e) $83.5 \cdot \mu F$
f) $(900 - 794 \cdot j) \cdot VA$ g) 0.75
h) i) leading

4. $i_L(t) := 90 \cdot mA - 60 \cdot mA \cdot e^{-\frac{400}{sec} \cdot t} - 44 \cdot \frac{A}{sec} \cdot t \cdot e^{-\frac{400}{sec} \cdot t}$

5. a) $20 \cdot mA$ $4 \cdot V$ b) $20 \cdot mA$ $500 \cdot \frac{A}{sec}$
c) $7 \cdot V$ $-1500 \cdot \frac{V}{sec}$