ECE2210 Exam 3 Spring 2022

Useful Information

Bode Plots

Look for places in $|H(s)|$ where a real number and a $j\omega$ or jf term are added.
Set real = |imaginary| to find poles and zeroes.
Poles come from denominator of transfer function, zeroes from numerator.
Divide frequencies into regions & find approx $|H(s)|$ in each region by simplifying each (real + imaginary) to just the largest part.

Slopes: -20, 0, or +20 dB/decade
dB is $20\cdot\log_{10}(|H(\omega)|)$
cut corners by $3\cdot dB$

Overdamped $b^2 - 4\cdot k > 0$ s_1 and s_2 are real and negative

$X(t) = X(\infty) + B\cdot e^{s_1\cdot t} + D\cdot e^{s_2\cdot t}$ $X(0) = X(\infty) + B + D$ $\frac{d}{dt}X(0) = B\cdot s_1 + D\cdot s_2$

Critically damped $b^2 - 4\cdot k = 0$ $s_1 = s_2 = -\frac{b}{2} = s$ s_1 and s_2 are real, equal and negative

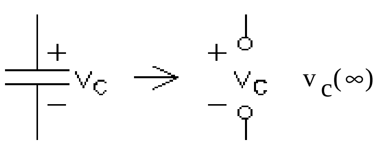
$X(t) = X(\infty) + B\cdot e^{s\cdot t} + D\cdot t\cdot e^{s\cdot t}$ $B = X(0) - X(\infty)$ $D = \frac{d}{dt}X(0) - B\cdot s$

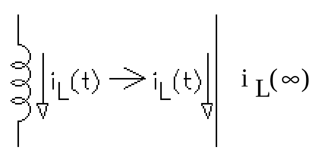
Underdamped $b^2 - 4\cdot k < 0$ $s = \alpha \pm j\omega$ complex s_1 and s_2

$X(t) = X(\infty) + e^{\alpha\cdot t}\cdot(B\cdot\cos(\omega\cdot t) + D\cdot\sin(\omega\cdot t))$ $B = X(0) - X(\infty)$ $D = \dfrac{\frac{d}{dt}X(0) - B\cdot\alpha}{\omega}$

$\frac{d}{dt}i_L(0) = \frac{v_L(0)}{L}$ $\frac{d}{dt}v_C(0) = \frac{i_C(0)}{C}$

Final Conditions, or "after a long time"

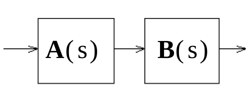




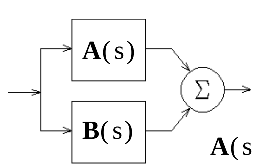
Replace capacitors with opens Replace inductors with wires

Capacitor voltage **cannot** change instantaneously Inductor current **cannot** change instantaneously

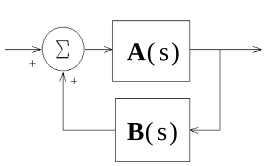
System Block Diagrams



$\mathbf{A}(s)\cdot\mathbf{B}(s)$



$\mathbf{A}(s) + \mathbf{B}(s)$

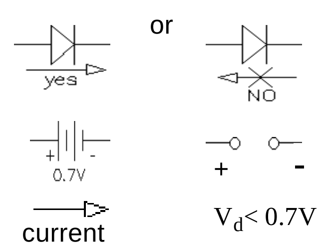


Standard feedback loop transfer function

$$\frac{\mathbf{A}(s)}{1 - \mathbf{A}(s)\cdot\mathbf{B}(s)}$$

Diodes

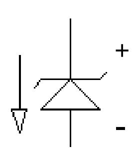
conducting not conducting



Use these models for the diodes and LEDs on this exam.

$V_d < 0.7V$ Check

LEDs: 2V



V_Z = zener voltage

April 1 2022

Closed Book, Closed notes, Calculators OK. Show all work to receive credit
Circle answers, show units, and round off reasonably

1. (22 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 and use the method from the class notes 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..

$$H(f) := \frac{5000\cdot Hz\cdot j\cdot f}{(1\cdot Hz + 0.05\cdot j\cdot f)\cdot\left(1\cdot kHz + \frac{j\cdot f}{30}\right)}$$

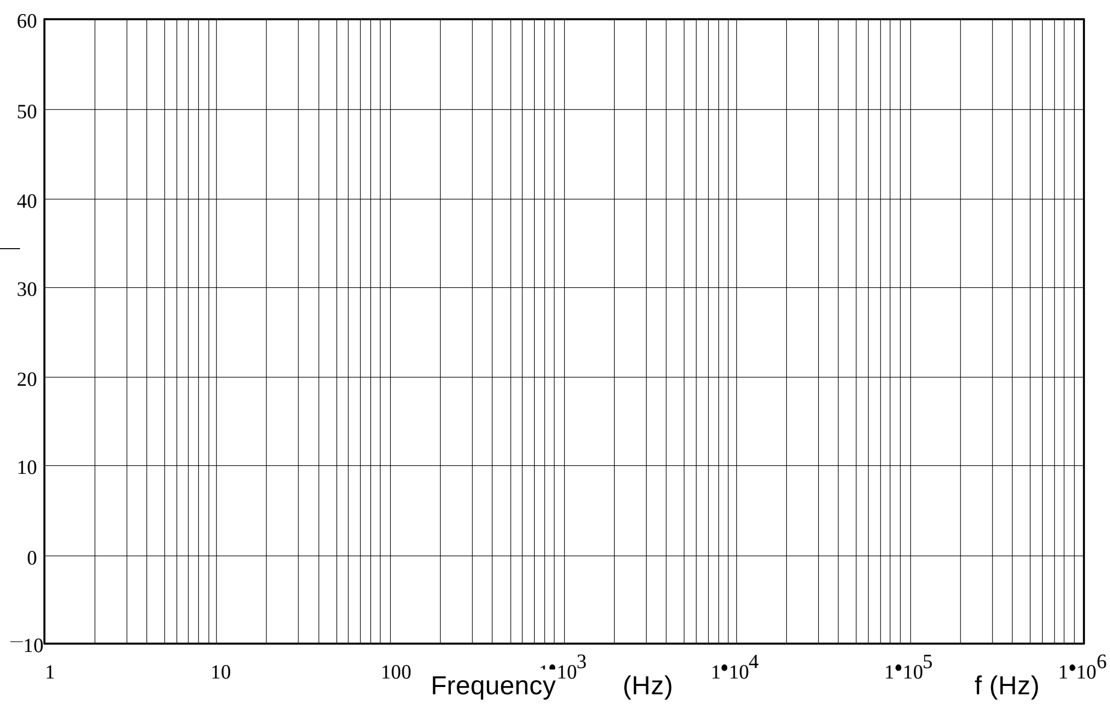
   Indicate which corner frequency(ies) are **poles** and/or **zeroes** .

Magnitude plot

Straight-line approximation _____

Actual _ _ _ _

40dB



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).

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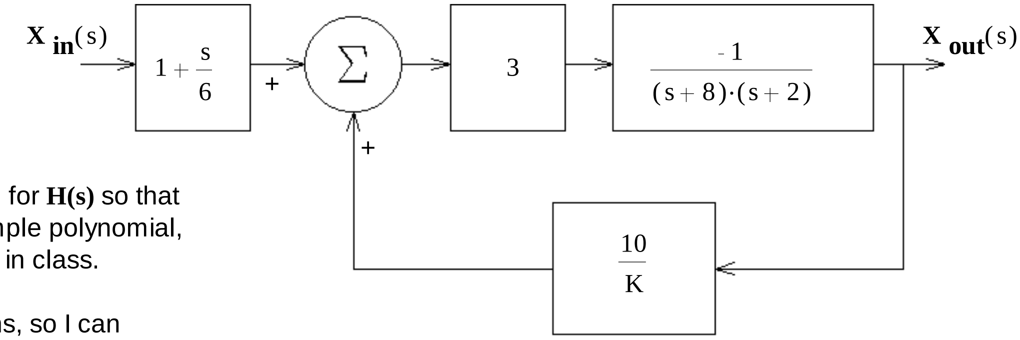
2. (20 pts) a) A feedback system is shown in the figure. What is the transfer function of the whole system, with feedback.

$$\mathbf{H}(s) = \frac{\mathbf{X}_{\mathbf{out}}(s)}{\mathbf{X}_{\mathbf{in}}(s)} = ?$$



SHOW YOUR WORK
Simplify your expression for **H(s)** so that the denominator is a simple polynomial, like I do in solutions and in class.
Factored form is better.
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) If K is **Greater** than this value the system will be: underdamped or overdamped

Circle one

d) Does the transfer function have a zero? Answer no or find the s value of that zero.

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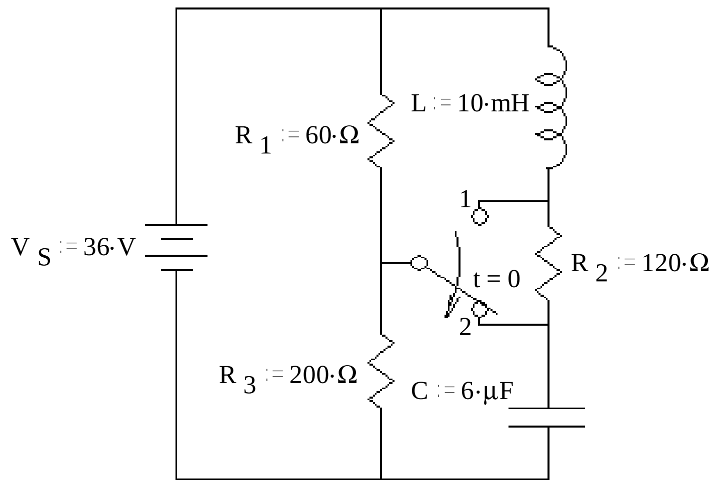

3. (32 pts) The switch has been up in position 1 for a long time and is switched down to postion 2 (as shown) at time $t = 0$.

   SHOW YOUR WORK, no credit for guesses!

   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.

Turn Over, last problem on the back ---->

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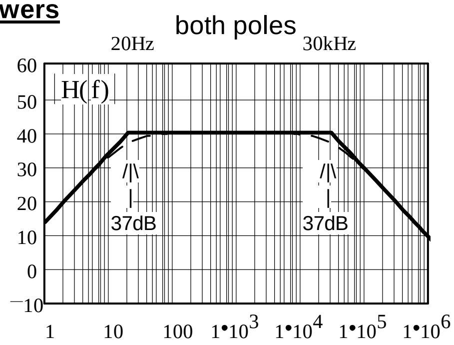
Answers

1.



2. a) $\dfrac{-\frac{3}{6}\cdot(s+6)}{s^2+10\cdot s+16+\frac{30}{K}}$ b) 3.333 c) overdamped d) -6

3. a) $50\cdot mA$ $30\cdot V$ b) $180\cdot mA$ $-2160\cdot\frac{A}{sec}$ c) $36\cdot V$ $0\cdot\frac{V}{sec}$

4. a) $1.3\cdot V$ $15\cdot mA$ $43\cdot mA$ $63\cdot mA$
b) no $1.3\cdot V > 0.7V$ c) yes $15\cdot mA > 0$ d) yes $43\cdot mA > 0$

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4. (22 pts) Assume that diode D_1 does **NOT** conduct.

   Assume that diodes D_2 and D_3 **DO conduct.**

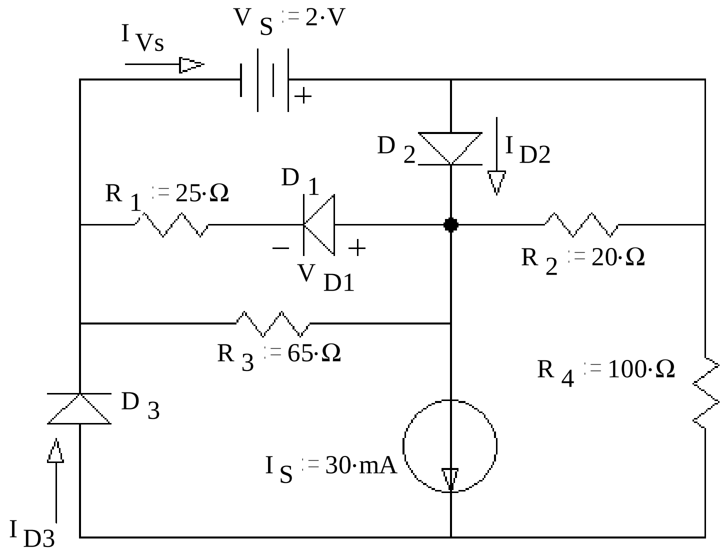
   a) Stick with these assumptions even if your answers come out absurd.
   Find the following:

   V_{D1} = ___________

   I_{D2} = ___________

   I_{D3} = ___________

   I_{Vs} = ___________



b) Based on the numbers above, was the assumption about D_1 correct? Circle one: yes no

   How do you know? (Specifically show a value which is or is not within a correct range.)

c) Based on the numbers above, was the assumption about D_2 correct? Circle one: yes no
   How do you know? (Show a value & range.)

d) Based on the numbers above, was the assumption about D_3 correct? Circle one: yes no
   How do you know? (Show a value & range.)

Prob 4 ______/ 26

Total ________ / 100