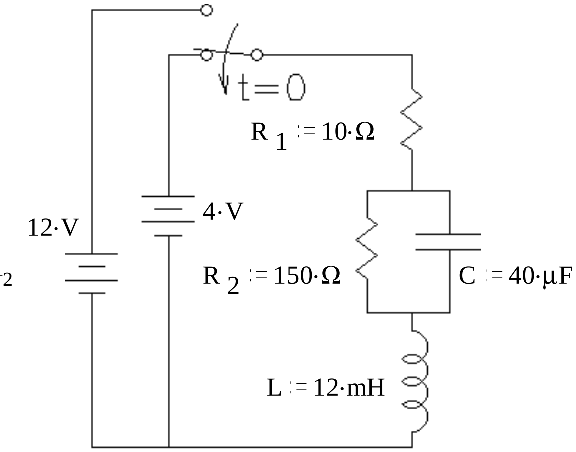
ECE 2210 homework # 18

1. Analysis of the circuit shown yields the characteristic equation below. The switch has been in the top position for a long time and is switched down at time $t = 0$. Find the initial conditions and write the full expression for $i_L(t)$, including all the constants that you find.

$$s^2 + \left(\frac{1}{C \cdot R_2} + \frac{R_1}{L}\right) \cdot s + \left(\frac{R_1}{L \cdot C \cdot R_2} + \frac{1}{L \cdot C}\right) = 0$$

$$\left(\frac{1}{C \cdot R_2} + \frac{R_1}{L}\right) = 1000 \cdot \text{sec}^{-1} \qquad \left(\frac{R_1}{L \cdot C \cdot R_2} + \frac{1}{L \cdot C}\right) = 2.222 \cdot 10^6 \cdot \text{sec}^{-2}$$

$$s^2 + 1000 \cdot \frac{1}{\text{sec}} \cdot s + 2.222 \cdot 10^6 \cdot \frac{1}{\text{sec}^2} = 0$$



2. What value of R_1 would make the above circuit critically damped?

3. Look at the circuit in HW 17, problem 2. Change R_1 and R_2 to 50Ω and consider the voltage across R_1 to be the output voltage. The transfer function would be:

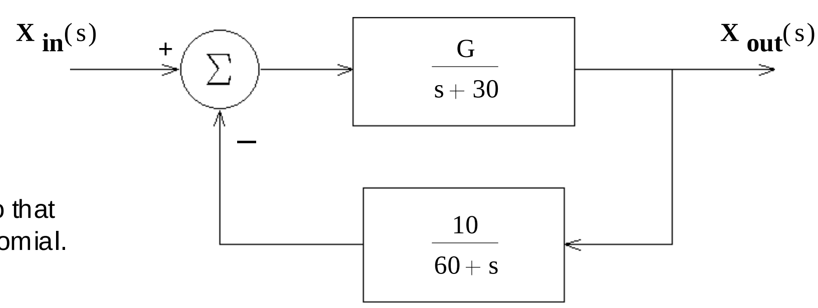
$$\mathbf{H}(s) = \frac{\mathbf{V}_{\mathbf{R1}}(s)}{\mathbf{V}_{\mathbf{in}}(s)} = \frac{s^2 + \frac{R_2}{L} \cdot s + \frac{1}{L \cdot C}}{s^2 + \frac{R_1 \cdot R_2 \cdot C + L}{R_1 \cdot L \cdot C} \cdot s + \frac{R_1 + R_2}{R_1 \cdot L \cdot C}} = \frac{s^2 + 2500 \cdot s + 1.25 \cdot 10^6}{s^2 + 3000 \cdot s + 2.5 \cdot 10^6}$$

a) What are the poles and zeros of this transfer function?

b) Plot these poles and zeros on the complex plane.

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

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



Simplify your expression for $\mathbf{H}(s)$ so that the denominator is a simple polynomial.

b) $G := 5$ Find the poles and zeroes of the system.

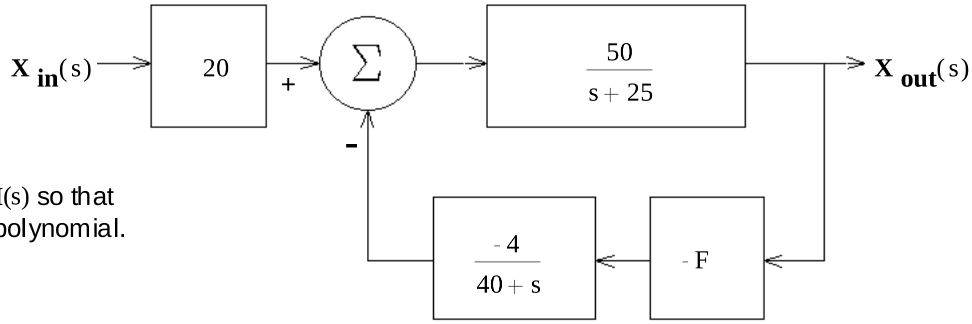
c) What type of damping response does this system have?

d) Find the value of G to make the transfer function critically damped.

e) If G is double the value found in part d) what will the damping response of the system will be?

5. a) A feedback system is shown in the figure. What is the transfer function of the whole system, with feedback.

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



Simplify your expression for $\mathbf{H}(s)$ so that the denominator is a simple polynomial.

b) Find the maximum value of F so that the system does not become underdamped.

c) Find the transfer function with $F := 0.2$

d) With $F = 0.2$, at what value of $\mathbf{s}$ can the system produce an output even with no input? (That is, what value of $\mathbf{s}$ makes $\mathbf{H}(s) = \infty$?)

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

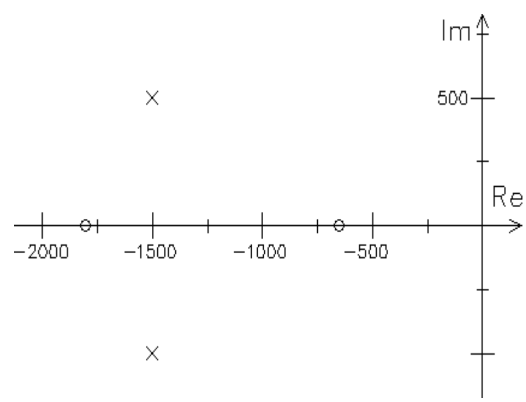
Answers

1 $i_L(0) = 75 \cdot mA \qquad v_C(0) = 11.25 \cdot V$

$$i_L(t) = 25 \cdot mA + e^{\frac{-500}{sec} \cdot t} \cdot \left(50 \cdot mA \cdot \cos\left(\frac{1404}{sec} \cdot t\right) - 457 \cdot mA \cdot \sin\left(\frac{1404}{sec} \cdot t\right)\right)$$

2. $R_1 = 36.64 \cdot \Omega$

3. a) Zeroes: -691 & -1809 Poles: $-1500 \pm 500 \cdot j$ b)



4. a) $\dfrac{G \cdot (s + 60)}{s^2 + 90 \cdot s + 1800 + G \cdot 10}$ b) poles: -31.8 & -58.2 zero: -60

c) overdamped d) 22.5 e) underdamped

5. a) $1000 \cdot \dfrac{s + 40}{s^2 + 65 \cdot s + 1000 + 200 \cdot F}$ b) 0.281 c) $1000 \cdot \dfrac{s + 40}{s^2 + 65 \cdot s + 1040}$ d) -28.5 or -36.5

e) -40

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