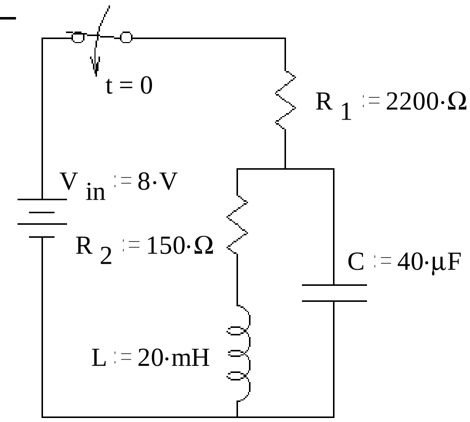
ECE 2210 Homework 2ndTr3 A.Stolp

2nd - Order Transients Name________________________________ d

1. a) Find the characteristic equation of the circuit at right.



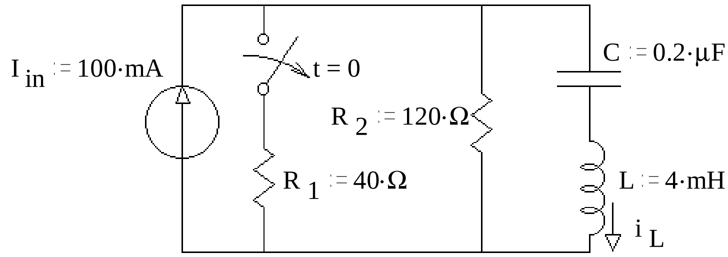
b) Find the solutions to the characteristic equation.

c) Is this circuit over, under, or critically damped?

1. continued   d) Find the final conditions:

e) The switch has been open for a long time and is switched down at time $t = 0$. Find the initial conditions:

f) Write the full expression for $v_C(t)$, including all the constants.



2. The transfer function of the circuit shown is: $\mathbf{H}(s) = \dfrac{\mathbf{I_L}(s)}{\mathbf{I_{in}}(s)} = \dfrac{\dfrac{R_2}{L} \cdot s}{s^2 + \dfrac{R_2}{L} \cdot s + \dfrac{1}{L \cdot C}}$

a) Find the solutions to the characteristic equation.

b) Is this circuit over, under, or critically damped?

c) The switch is opened at time $t = 0$. Find the final and initial conditions of i_L .

d) Write the full expression for $i_L(t)$, including all the constants that you find.

Answers

1.a) $0 = s^2 + \left(\frac{R_2}{L} + \frac{1}{R_1 \cdot C}\right) \cdot s + \left(\frac{1}{L \cdot C} + \frac{R_2}{R_1 \cdot L \cdot C}\right)$ b) $s_1 := -182.2 \cdot \frac{1}{sec}$, $s_2 := -7329 \cdot \frac{1}{sec}$ c) overdamped

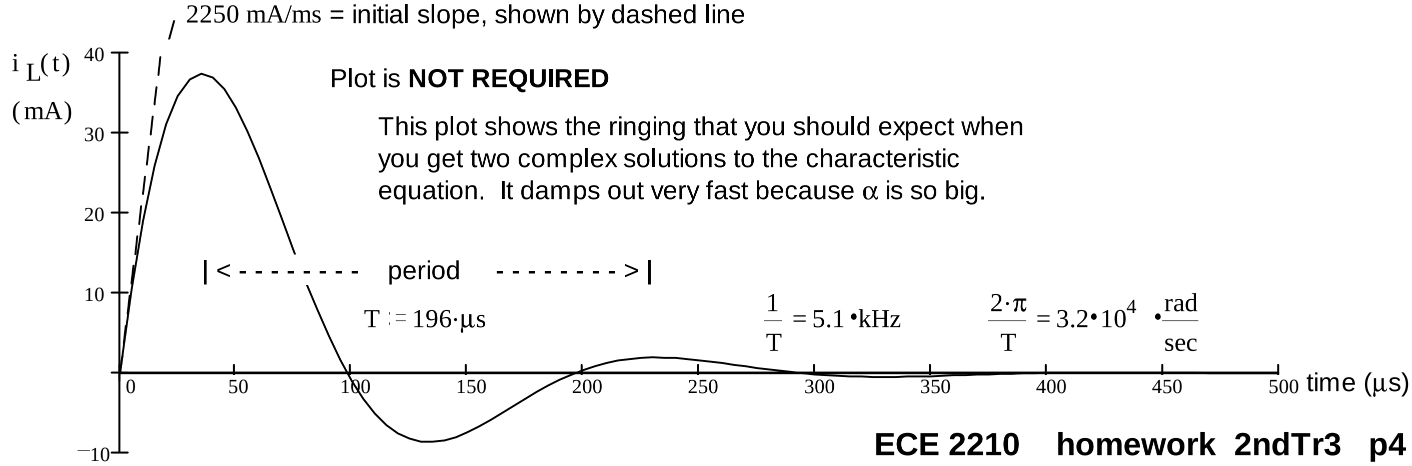
d) $0.511 \cdot V$ $3.404 \cdot mA$ e) $0 \cdot V$ $0 \cdot mA$ $90.91 \cdot \frac{V}{sec}$ $0 \cdot \frac{A}{sec}$

f) $v_C(t) = 0.511 \cdot V - 0.511 \cdot V \cdot e^{-182.2 \cdot t} + 0.000295 \cdot V \cdot e^{-7329 \cdot t}$

2. a) $-15000 \pm 32016j$ 1/sec
b) underdamped

c) $12 \cdot V$ $0 \cdot mA$ $0 \cdot mA$ $2250 \cdot \frac{A}{sec}$ d) $i_L(t) := 0 \cdot mA + e^{\frac{-15000}{sec} \cdot t} \cdot \left(70.3 \cdot \sin\left(\frac{32016}{sec} \cdot t\right)\right) \cdot mA$

2250 mA/ms = initial slope, shown by dashed line



Plot is **NOT REQUIRED**

This plot shows the ringing that you should expect when you get two complex solutions to the characteristic equation. It damps out very fast because α is so big.

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$T := 196 \cdot \mu s$ $\frac{1}{T} = 5.1 \cdot kHz$ $\frac{2 \cdot \pi}{T} = 3.2 \cdot 10^4 \cdot \frac{rad}{sec}$