Lab 9.2.2

Tuesday, November 26, 2024 6:37 PM

$$v_C(t) = \underbrace{1.3e^{-9.2\times10^4 t}\sin(7\times10^5 t)}_{\text{underdamped}}.$$

$s = -\sigma + j\omega$ Response: $A \cdot e^{-\sigma t} \sin(\omega t)$ — from lab manual

w/ $\omega_d \approx 7\cdot10^5$, $\sigma = 9.2\cdot10^4$

$\omega_d = \sqrt{\frac{1}{LC} - \sigma^2}$, $\sigma = \frac{1}{2RC}$

given: $L = 10^{-3}$ H, $C = 2\cdot10^{-9}$ F

$\sigma = 9.2\cdot10^4 = \frac{1}{2R\cdot2\cdot10^{-9}} \Rightarrow R \approx 2717.39\,\Omega$

$R \approx 2.7K$

* taking laplace then inverse laplace w/ $R = 2.7k$ to get V_c as funct of t and V

```
import sympy as sp
import numpy as np
import matplotlib.pyplot as plt


graph = False
# Define symbols
s, v, R, t = sp.symbols('s v R t', positive=True)

# Fixed numeric values for C and L
C = 2e-9  # Capacitance in farads
L = 1e-3  # Inductance in henries

# Uncomment these lines to define numeric values; comment them out to use symbolic coe
#v = 4.55  # Example numeric value for input voltage
R = 2700  # Resistance in ohms

# Define symbolic impedance
Z_L = s * L  # Impedance of the inductor
Z_C = 1 / (s * C)  # Impedance of the capacitor
Z_CL = 1 / (1/Z_L + 1/Z_C)  # Parallel combination of Z_L and Z_C
Z_EQ = Z_CL + R  # Total impedance

# Define transfer function H(s)
V = v / s  # Input voltage in Laplace domain
H_s = V * Z_CL / Z_EQ

# Substitute numeric values for `R` and `v` (already numeric here)
H_s = sp.simplify(H_s)

# Compute the inverse Laplace transform numerically
try:
    h_t = sp.inverse_laplace_transform(H_s, s, t)
```

yields: (V_{c}(t)): 0.264165990659424*v*exp(-92592.5925925926*t)*sin(701018.26780547*t)

$$V_c(t) = 0.264165990659424 \cdot v \cdot e^{-92592.5925925926 \cdot t} \cdot \sin(701018.26780547 \cdot t)$$

$0.264 \cdot v = 1.3 \Rightarrow v \approx 4.92\text{ V}$

Plugging in $V = 4.92$, $R = 2700 \Rightarrow$ 1.29969667404436*exp(-92592.5925925926*t)*sin(701018.26780547*t) $\approx$ $v_C(t) = 1.3e^{-9.2\times10^4 t}\sin(7\times10^5 t).$

$$\boxed{R = 2.7\text{ K}\Omega \quad V = 4.92\text{ V}}$$