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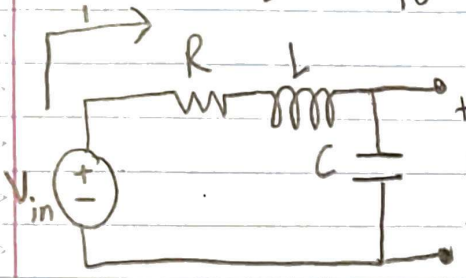
Lab 10.S.1



(a)

$V_{in} = iR + L\dot{i} + V_{out}$

$V_{in} = \dot{i}R + L\ddot{i} + \frac{i}{C}$

$\ddot{i} + \dot{i}R + \frac{1}{C}i = \dot{V}_{in}$

$V_{in} = (C\dot{V}_{out})R + L(C\ddot{V}_{out}) + V_{out}$

$$\boxed{\ddot{V}_{out} + \frac{R}{L}\dot{V}_{out} + \frac{1}{LC}V_{out} = V_{in}}$$

$V = L\dot{i}$ $\quad i = C\dot{V}_{out}$ $\quad \dot{i} = \frac{i}{C}$ $\quad \dot{i} = C\ddot{V}$ $\quad VC = Q$ $\quad i = C\dot{V}_{out}$

(c) $t \approx \frac{1.8}{\omega_0} = 1.8\sqrt{LC}$

$f_d = \frac{\omega_d}{2\pi} = \frac{\sqrt{\frac{1}{LC} - \frac{R^2}{4L^2}}}{2\pi}$

$M_p(\%) = 100e^{-\frac{R}{2}\sqrt{\frac{C}{L}}}$

Now we use:

$C = 100nF$	measured: 99.1nF
$L = 1mH$	L: 1 mH
$R = 1.1\Omega$	R = 1.39Ω

Gen form $\ddot{x}(t) + 2\alpha\dot{x}(t) + \omega_0^2 x(t) = f(t)$

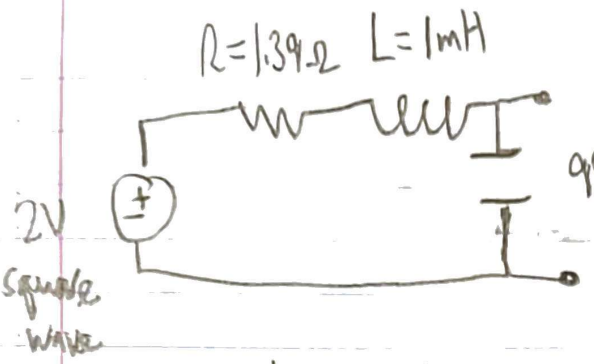
$2\alpha = 2\zeta\omega_0$

damping ratio → $\zeta = \frac{\alpha}{\omega_0} = \frac{\left(\frac{R}{2L}\right)}{\left(\frac{1}{\sqrt{LC}}\right)} = \frac{R\sqrt{LC}}{2L} = \boxed{\frac{R}{2}\sqrt{\frac{C}{L}}}$

$\omega_d = \sqrt{\omega_0^2 - \alpha^2}$ $\quad \boxed{\omega_0 = \frac{1}{\sqrt{LC}}}$

$\boxed{\omega_d = \sqrt{\frac{1}{LC} - \frac{R^2}{4L^2}}}$ $\quad \alpha = \frac{R}{2L}$

DC gain: $1 \leftarrow \frac{1}{LCs^2 + RCs + 1}(0) = \frac{1}{1}$



$t_r = t_{90\%} - t_{10\%}$

↑ rise time

$t_r = 16.8\,\mu s$ ← measured

$t = 1.8\sqrt{LC} = 1.8\sqrt{(1E-3)(99.1E-9)} = 17.9\,\mu s$
theor

$\frac{1.8}{\sqrt{\frac{1}{LC} - \frac{R^2}{4L^2}}} = \frac{1.8}{\sqrt{\frac{1}{(1E-3)(99.1E-9)} - \frac{1.39^2}{4(1E-3)^2}}}$

damp ratio $\zeta = \frac{-\ln\left(\frac{82.7}{100}\right)}{\sqrt{\pi^2 + \ln^2\left(\frac{82.7}{100}\right)}}$

≈ 0.061

$\omega_d = \sqrt{\frac{1}{LC} - \frac{R^2}{4L^2}}$

$= 100450$

$\omega_n = \frac{\omega_d}{\sqrt{1-\zeta^2}} = \frac{100450}{\sqrt{1-0.061^2}}$

≈ 100638 rad/s

Overshoot (M_p)

$M_p = \frac{V_{peak} - V_{final}}{V_{final}} \times 100\%$

$M_p = \frac{18.5 - 10.125}{10.125} \times 100\%$

$\approx 82.7\%$ overshoot

DC Gain $= \frac{V_{final}}{V_{input}} \quad \frac{10.125}{10.125 - (-10)} \approx 0.5$

$T = \frac{2\pi}{\omega} \approx \frac{2\pi}{100450}$

period of oscillation

$\approx 62.5\,\mu s$