Expt: Second Order Circuits

par: $\frac{V}{R} + \frac{1}{L}\int_0^t V(t)\,dt + C\frac{dV}{dt} = i_C$

Series

RLC in Parallel:

Natural Response

$\omega_0 = \frac{1}{\sqrt{LC}}$, $\alpha = \frac{1}{2RC}$

$C\frac{d^2V(t)}{dt^2} + \frac{1}{R}\frac{dV(t)}{dt} + \frac{1}{L}V(t) = 0$

i_C i_R i_L

$S_{1,2} = -\alpha \mp \sqrt{\alpha^2 - \omega_0^2}$

if $\alpha > \omega_0$: overdamped: $V(t) = A_1 e^{s_1 t} + A_2 e^{s_2 t}$

if $\alpha = \omega_0$: Critical damping: $V(t) = A_1 t e^{-\alpha t} + A_2 e^{-\alpha t}$

if $\alpha < \omega_0$: underdamped: $V(t) = e^{-\alpha t}[B_1 \cos\omega_d t + B_2 \sin\omega_d t]$

where $\omega_d = \sqrt{\omega_0^2 - \alpha^2}$

RLC in Series:

$\omega_0 = \frac{1}{\sqrt{LC}}$, $\alpha = \frac{R}{2L}$

$L\frac{d^2i(t)}{dt} + R\frac{di(t)}{dt} + \frac{1}{C}i(t) = 0$

V_L V_R V_C

$S_{1,2} = -\alpha \pm \sqrt{|\omega_0^2 - \alpha^2|}$

Same Cases.

$L\frac{di}{dt} + R\,i(t) + V_C(0) + \frac{1}{C}\int_0^t i(t)$ Step Response

$= 0$

V_f, i_f: source

$V(t) = V_n + V_f$

V_s

$i(t) = i_n + i_f$

i_s

If Natural Response

Parallel $\rightarrow \frac{dV}{dt} = \frac{i_C(0^+)}{C}$

~~over~~

series $\rightarrow \frac{dV}{dt} = \frac{i_L(0^-)}{C}$

If Step Response

Series $\rightarrow \frac{dV}{dt} = \frac{i_L(0)}{C}$

parallel