Circuits Process Guidesheet

Topic

RLC Circuits

Governing Equations and Assumptions

$$v(t) = A_1 e^{s_1 t} + A_2 e^{s_2 t}$$
$$s_{1,2} = -\alpha \pm \sqrt{\alpha^2 - \omega_0^2}$$

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

$$i(t) = A_1 e^{s_1 t} + A_2 e^{s_2 t}$$
$$s_{1,2} = -\alpha \pm \sqrt{\alpha^2 - \omega_0^2}$$

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

Process

1. Determine the Damping
   Compare α^2 & ω_0^2
   - $\omega_0^2 < \alpha^2 \Rightarrow$ Overdamped
   - $\omega_0^2 > \alpha^2 \Rightarrow$ Underdamped
   - $\omega_0^2 = \alpha^2 \Rightarrow$ Critically Damped
2. Apply the correct $v(t)$ or $i(t)$ expression based on the damping
3. Determine the constants

   Parallel:
   $$v(0^+) = V_0$$
   $$\frac{dv(0^+)}{dt} = -\frac{I_0}{C} - \frac{V_0}{RC}$$

   Series:
   $$i(0^+) = I_0$$
   $$\frac{di(0^+)}{dt} = -\frac{I_0 R}{L} - \frac{V_0}{L}$$
4. If needed, solve for other quantities

   Parallel:
   $$i_R(t) = \frac{v(t)}{R}, \quad i_C(t) = C\frac{dv}{dt}, \quad i_L(t) = -i_R(t) - i_C(t)$$

   Series:
   $$v_R(t) = i(t)R, \quad v_L(t) = L\frac{di}{dt}, \quad v_C(t) = -v_R(t) - v_L(t)$$