Chapter 8: RLC Circuits

Natural Response:

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

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

① $\omega_0^2 < \alpha^2$ overdamped

$$v(t) = A_1 e^{s_1 t} + A_2 e^{s_2 t}$$

② $\omega_0^2 > \alpha^2$ underdamped

$$v(t) = B_1 e^{-\alpha t} \cos\omega_d t + B_2 e^{-\alpha t} \sin\omega_d t$$

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

③ $\omega_0^2 = \alpha^2$ critically damped

$$v(t) = D_1 t e^{-\alpha t} + D_2 e^{-\alpha t}$$

Step Response:

$$\begin{cases} i(t) = i_f + \left\{ \text{Function of the same form as natural Response} \right\} \\ v(t) = V_f + \left\{ \text{function of the same form as natural response} \right\} \end{cases}$$

Chap. 7. R-L & R-C Circuit

First-order RL & RC Circuits

General Solution for Natural & Step Response of RL & RC circuits is given by:

$$x(t) = x_f + \left[x(t_0) - x_f\right] e^{-(t-t_0)/\tau}$$

Note: t_0 may be equal to zero or some other stated time.

R-L Circuit: $\tau = \dfrac{L_{eq}}{R_{Thevenin}}$

R-C circuit: $\tau = R_{Thev.} C_{eq}$

$V_C(0^+) = V_C(0^-)$ & $i_L(0^+) = i_L(0^-)$

Energy stored in Capacitor:

$$w_c = \frac{1}{2} C V_c^2$$

Energy stored in Inductors:

$$w_L = \frac{1}{2} L I_L^2$$

$$i_c = C\frac{dV_c}{dt}, \quad V_L = L\frac{di_L}{dt}$$

$$P = i \times v$$

Ohm's Law: $V = IR$ or $I = \dfrac{V}{R}$

Power: $P = I^2 R = I \cdot V = \dfrac{V^2}{R}$

Nodal Analysis: Application of Kirchoff Current Law (KCL)

Mesh Analysis: Application of Kirchoff Voltage Law (KVL)