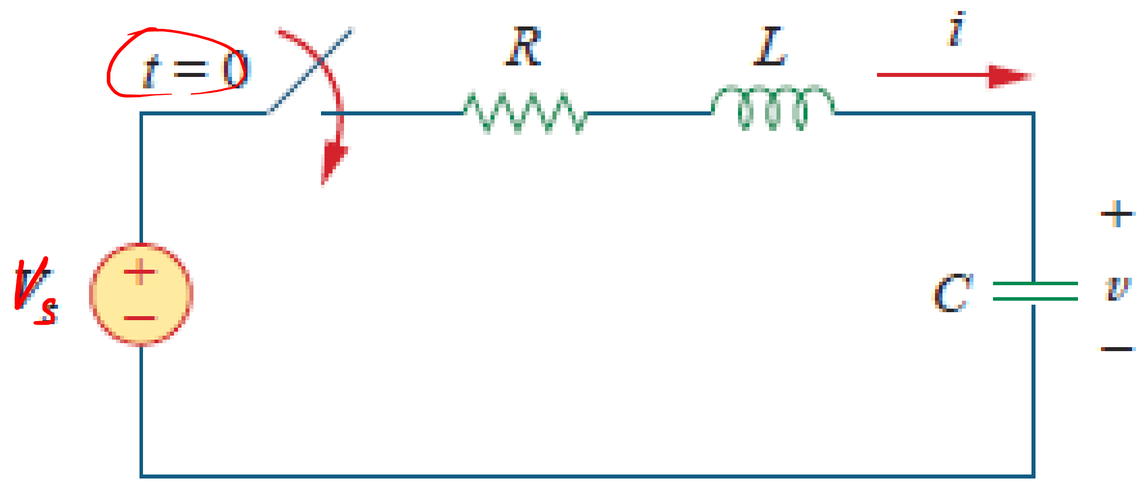
Step Response of a Series *RLC* Circuit

$\underline{\underline{t>0}}$



Applying KVL around the loop for $t > 0$,

$$L\frac{di}{dt} + Ri + v = V_s$$

$$i = C\frac{dv}{dt}$$

Substituting for i in Eq.

V_s

$$\boxed{\frac{d^2v}{dt^2} + \frac{R}{L}\frac{dv}{dt} + \frac{v}{LC} = \frac{V_s}{LC}}$$

$$\boxed{v(t) = \underline{\underline{v_t(t)}} + \underline{\underline{v_{ss}(t)}}}$$

$$v_t(t) = A_1e^{s_1t} + A_2e^{s_2t} \qquad \text{(Overdamped)}$$

$$v_t(t) = (A_1 + A_2t)e^{-\alpha t} \qquad \text{(Critically damped)}$$

$$v_t(t) = (A_1 \cos \omega_d t + A_2 \sin \omega_d t)e^{-\alpha t} \qquad \text{(Underdamped)}$$

The steady-state response is the final value of $v(t)$.

the final value of the capacitor voltage is the same as the source voltage Vs . Hence,

$V_t + V_{ss}$

$$v_{ss}(t) = v(\infty) = V_s$$

Thus, the complete solutions for the overdamped, underdamped, and critically damped cases are:

$$v(t) = V_s + A_1 e^{s_1 t} + A_2 e^{s_2 t} \quad \text{(Overdamped)}$$

$$v(t) = V_s + (A_1 + A_2 t)e^{-\alpha t} \quad \text{(Critically damped)}$$

$$v(t) = V_s + (A_1 \cos \omega_d t + A_2 \sin \omega_d t)e^{-\alpha t} \quad \text{(Underdamped)}$$

The values of the constants A_1 and A_2 are obtained from the initial conditions: $v(0)$ and $dv(0)/dt$. Keep in mind that v and i are, respectively, the voltage across the capacitor and the current through the inductor.

Ex - 8.5

Ex - 8.7

Work out all the carry

Ex - 8.3

Ex - 8.4

DA-2

Wednesday