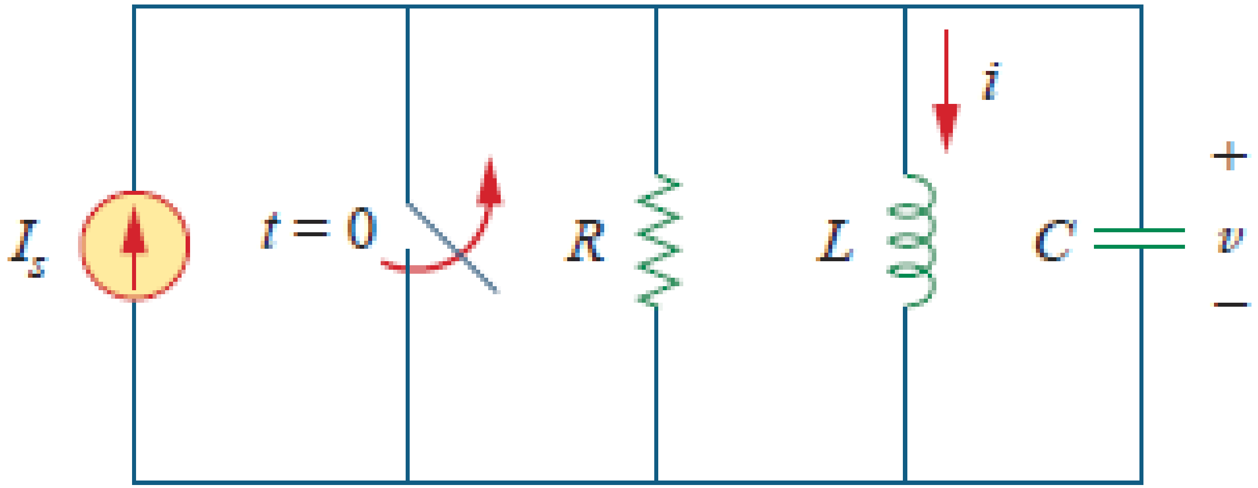
Step Response of a Parallel *RLC* Circuit



Consider the parallel *RLC* circuit shown in Fig. We want to find i due to a sudden application of a dc current. Applying KCL at the top node for $t > 0$,

$$\frac{v}{R} + i + C\frac{dv}{dt} = I_s$$

$$v = L\frac{di}{dt}$$

Substituting for v in Eq.

$$\frac{d^2i}{dt^2} + \frac{1}{RC}\frac{di}{dt} + \frac{i}{LC} = \frac{I_s}{LC}$$

The complete solution to Eq. consists of the transient response $i_t(t)$ and the steady-state response i_{ss}; that is,

$$i(t) = i_t(t) + i_{ss}(t)$$

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$$i(t) = I_s + A_1 e^{s_1 t} + A_2 e^{s_2 t} \qquad \text{(Overdamped)}$$

$$i(t) = I_s + (A_1 + A_2 t)e^{-\alpha t} \qquad \text{(Critically damped)}$$

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

The constants A_1 and A_2 in each case can be determined from the initial conditions for i and di/dt.