ELECTRICALCIRCUITS

RLC Circuits with DC Source

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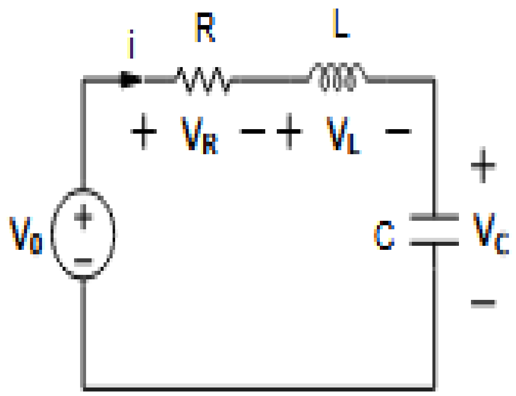
Series RLC circuit:



KVL: $V_R + V_L + V_C = V_0 \Rightarrow i\,R + L\frac{di}{dt} + \frac{1}{C}\int i\,dt = V_0$

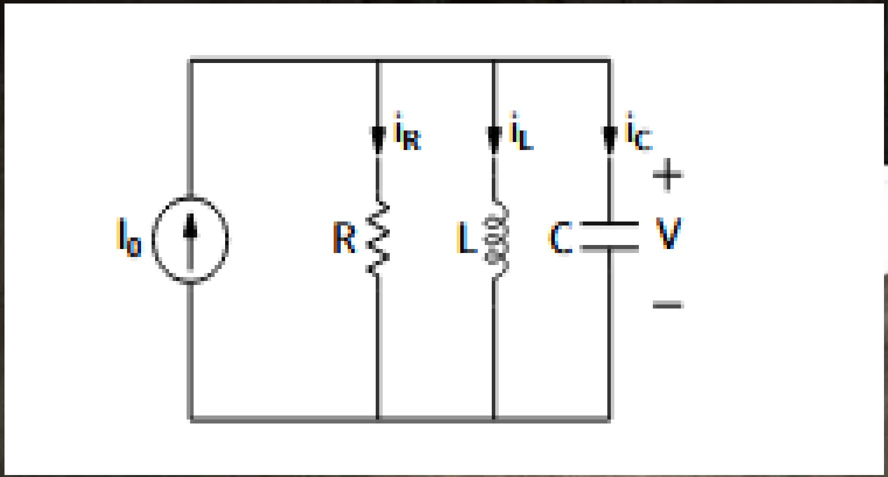
Differentiating w. r. t. t, we get,

$$R\frac{di}{dt} + L\frac{d^2 i}{dt^2} + \frac{1}{C}\,i = 0.$$

i.e., $\frac{d^2 i}{dt^2} + \frac{R}{L}\frac{di}{dt} + \frac{1}{LC}\,i = 0,$

a second-order ODE with constant coefficients.

Parallel RLC circuit:



KCL: $i_R + i_L + i_C = I_0 \Rightarrow \frac{1}{R} V + \frac{1}{L} \int V\,dt + C \frac{dV}{dt} = I_0$

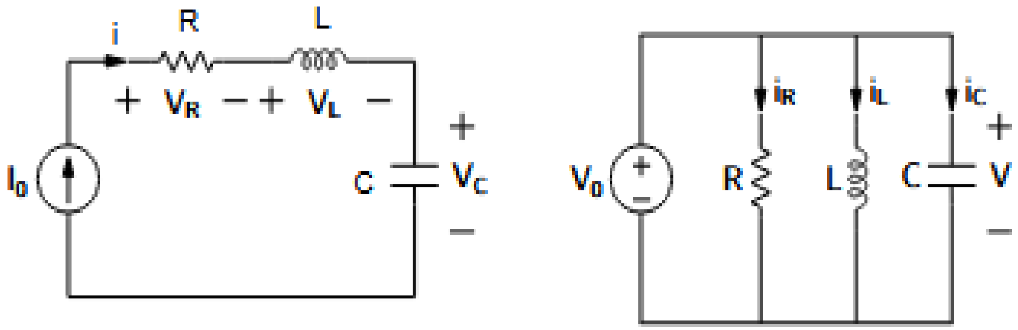
Differentiating w. r. t. t, we get,

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

i.e., $\frac{d^2 V}{dt^2} + \frac{1}{RC}\frac{dV}{dt} + \frac{1}{LC} V = 0,$

a second-order ODE with constant coefficients.

Series/Parallel RLC circuits:



* A series RLC circuit driven by a constant current source is trivial to analyze. Since the current through each element is known, the voltage can be found in a straightforward manner.

$$V_R = i\,R,\ \ V_L = L\,\frac{di}{dt},\ \ V_C = \frac{1}{C}\int i\,dt\,.$$

* A parallel RLC circuit driven by a constant voltage source is trivial to analyze. Since the voltage across each element is known, the current can be found in a straightforward manner.

$$i_R = V/R,\ \ i_C = C\,\frac{dV}{dt},\ \ i_L = \frac{1}{L}\int V\,dt\,.$$