RCL CIRCUITS

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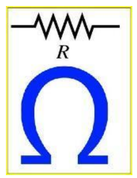
Abstract

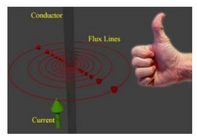
We are interested to analyze the relationships among the passive elements involved in one type of circuitry called RCL circuits and come up with the best mathematical model to describe the varying components. .

Introduction

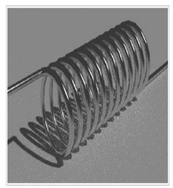
Each letter in the name of the circuit denotes what are the constituents' components of the circuit: R is for resistor, L stands for inductor, C represents capacitance. . RCL circuits can be connected in two ways: series or parallel circuits. Using Mathlab, it would allow us to display the mathematical relations between the input and output variables.



Resistor



Magnetic Field



Inductor

Methods and Results

1. Important principles of circuits

Two basic principles important to note given by Kirchhoff's circuit law before talking about circuits is that:

Kirchhoff's First Law/ Kirchhoff's Current Law (KCL)

Electric charge is conservative which insinuates that the sum of the currents going into (i.e. charge flowing in) a junction (of wires) equals the sum of the currents leaving (i.e. charge flowing out) that junction.

Kirchhoff's Second Law/ Kirchhoff's Voltage Law (KVL)

For a closed wire loop with unchanging current, the sum of voltage is be zero. However, this is only correct if the current is not changing in the circuit. If the current is changing, then the path integral is not zero, but rather $-\frac{d\Phi m}{dt}$. Therefore, the Law describing voltage changes in a closed loop is:

$$\sum(Voltage\ drops) = -\oint \vec{E} \cdot \vec{dl} = \frac{d\Phi}{dt}$$

These 3 forms of the solution are obtained from taking the roots of the characteristic equation, thus we can then generalize the three cases/responses that these solutions can yield:

<u>Overdamped response</u>

Both roots are real and distinct

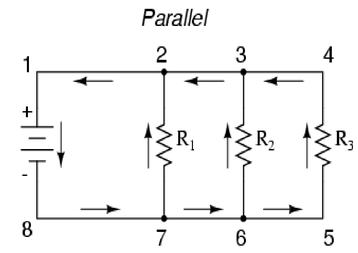
<u>Underdamped response</u>

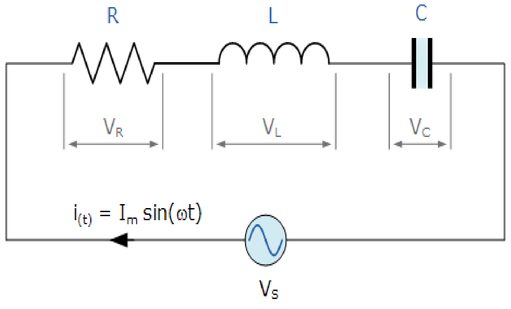
Both roots are complex numbers and conjugates

<u>Critically damped response</u>

Both roots are real and equivalent

As there are two ways to connect RLC circuit: series or parallel, the difference between them underlies the concept of Kirchhoff's Law. Based upon that, we are able to come up with many useful applications of RLC circuits, such as radio receivers, television sets to tune to select a narrow frequency range from ambient radio waves, and many more. Moreover, through Maxwell's Equations, we were able to come up with the differential equation that would best model the function of such circuit.





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