A COMPARATIVE STUDY ON CURRENT FLOW IN R-L CIRCUIT

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Abstract: The intension of this paper is a comparative study about the current flow in R-L Circuit. Here, we have calculated current flow in R-L Circuits using Differential Equations with the Inductance(L), Resistance(R) and Voltage(V) values. A practical experiment is also made using R-L circuit to get the current flow. Here, we compare the theoretical and practical result.

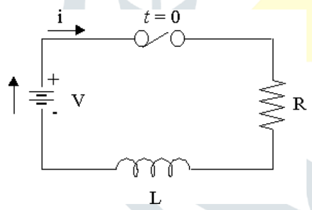
Keywords*:* Inductance, Resistance, R-L circuit, Current, Differential Equations**.**

Introduction:

A differential equation is a mathematical equation that relates some function with its derivatives. In applications, the functions usually represent physical quantities, the derivatives represent their rates of change, and the equation defines a relationship between the two. Because such relations are extremely common, differential equations plays a prominent role in many disciplines including engineering, physics, economics and biology.

R-L circuit:

A resistor-inductor circuit(RL circuit), or RL filter or RL network, is an electric circuit composed of resistors and inductors driven by a voltage or current source. A first-order R-L circuit is composed of one resistor and one inductor and is the simplest type of RL circuit. Frequently RL circuits are used for DC power supplies to RF amplifiers, where the inductor is used to pass DC bias current and block the RF getting back into the power supply. A RL series circuit consists of basically of an inductor of inductance, L connected in series with a resistor of resistance, R.



R-L circuit

The RL circuit shown above has a resistor and an inductor connected in series. A current voltage V is applied when the switch is closed**.**

The voltage across the resistor is given by: $V_R = iR$.

The voltage across inductor is given by: $V_L = L\frac{di}{dt}$.

Kirchhoff's voltage law says that the directed sum of the voltages around a circuit must be zero. This results in the following differential equation:

$$Ri + L\frac{di}{dt} = V.$$

Once the switch is closed, the current in the circuit is not constant. Instead, it will build up from zero to some steady state.

The solution of the differential equation $Ri + L\frac{di}{dt} = V$ is**:**

$$i = \frac{V}{R}\left(1 - e^{-\left(\frac{R}{L}\right)t}\right).$$

Main Work:

1)An RL circuit has an emf of 10V, a resistance of 100Ω, an inductance of 1H, and no initial current. Find the current in the circuit at any time t.

Solution:

Given that, V=10, R=100, L=1. We have to find the current in a circuit,

We know that,

$$i = \frac{V}{R}\left(1 - e^{-\left(\frac{R}{L}\right)t}\right).$$

Substituting the given values in the formula,

$$i = \frac{10}{100}\left(1 - e^{-\left(\frac{100}{1}\right)0.01}\right)$$

$$i = \frac{1}{10}\left(1 - \frac{1}{e^{1}}\right)$$

$$i = \frac{1}{10}(1 - 0.36783)$$

$$i = \frac{1}{10}(0.63212)$$

$i = 0.063212$ approx.We know that, 1amp=1000mA. Hence, $i = 63.2m$

In practical, when applying the given values in a circuit we get, i=72.6mA.

2)An RL circuit has an emf of 10V, a resistance of 100Ω, an inductance of 1H and no initial current. Find the current in the circuit at any time t.

Solution:

Given that, V=10, R=100, L=0.05. We have to find the current in a circuit,

We know that,

$$i = \frac{V}{R}\left(1 - e^{-\left(\frac{R}{L}\right)t}\right).$$

Substituting the given values in the formula,

$$i = \frac{10}{100}\left(1 - e^{-\left(\frac{100}{0.05}\right)0.05}\right)$$

$$i = \frac{1}{10}\left(1 - \frac{1}{e^{100}}\right)$$

$$i = \frac{1}{10}(1 - 0.0.0031829799)$$

$$i = \frac{1}{10}(0.9968170201)$$

$i = 0.09968$ approx.We know that, 1amp=1000mA. Hence, $i = 99.68mA$

In practical, when applying the given values in a circuit we get, i=89.2mA.

Conclusion:

In this paper, we have presented a new approach that the theoretical and practical outputs are approximately same. Few examples are presented in this paper to have a clear view of the comparative study on current flow in R-L circuit. There is a slight difference in the practical and theoretical results. The percentage error between theory and practical output are 12 and 13.

S.No	Theoretical value	Practical value	Deviation	Error Percentage
1	63.2	72.6	9.4	13
2	99.6	89.2	10.4	12

In future, our intension is to do a comparative study about the current flow in R-L-C circuit with the voltage values.

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