University of California Merced
School of Engineering
Department of Electrical Engineering

ENGR 065 Circuit Theory

Lab #9: RL and RC Circuits

Authors

Andre Martin

Luis Mora

Instructor

Ricardo Pinto de Castro

TA

Haoyu Li

Section

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Objectives

- Measure time constant of first order circuits
- Learn how to use the oscilloscope and function generator
- Observe RL and RC circuits in their transient and steady-state (DC conditions).

1. Introduction

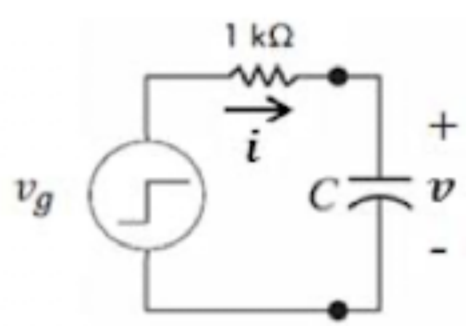
The purpose of this lab is to learn how to use oscilloscope and function generator to measure the time constant in an RL and RC circuit in their transient states. The oscilloscope allows us to see the change on voltage or current over a period of time and visually see it as a graph. The function generator, acts as an adjustable power source where you can give a minimum and maximum voltage as well as a set frequency.

2. Procedure

Preliminary work

To begin this lab, watch the instructional videos on how to use the oscilloscope and the function generator. Complete the entries in the tables of the theoretical/ calculated values of each circuit.

RC Circuit with Function Generator



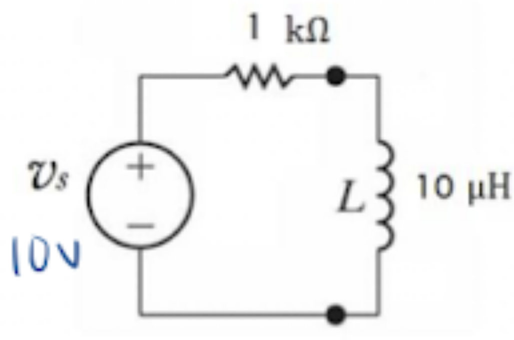
1. Using a 1kΩ resistor and a 1 microFarads capacitor, we will construct the following circuit with the function.

2. Set the function generator to a square wave (0-10V) with a frequency of 100 Hz.

3. Measure the time constant, tune the view of the graph on the oscilloscope to narrow down the value.

4. Next, repeat steps 1-3 with two 1 microFarad capacitors in series and then with the same two capacitors

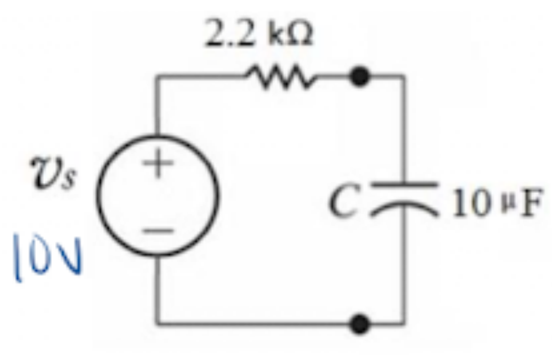
RL Circuit with a Constant Voltage Source



1. Using a 1kΩ resistor and a 10 microHenrys inductor, construct the following circuit using a DC power supply set a 10 volts in order to obtain constant voltage.
2. Measure the current in the circuit with an ammeter.

3. Measure the voltage across the resistor and the inductor with a voltmeter.

RC Circuit with Constant Voltage Source

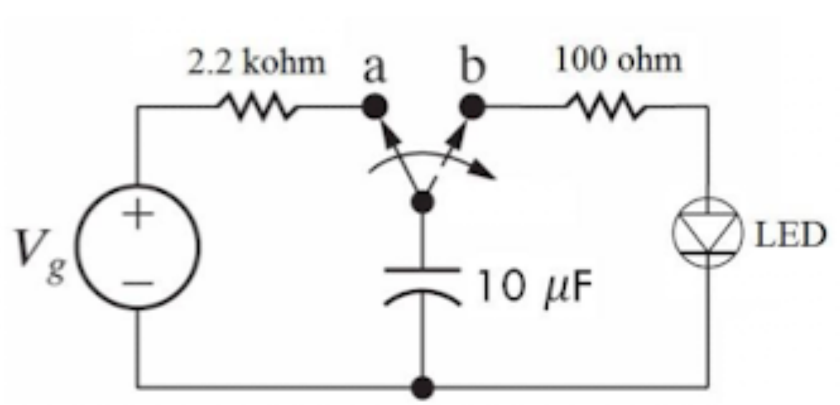


To see how a capacitor acts under DC conditions we will construct a circuit using a constant voltage source

1. Use a resistor of 2.2kΩ and capacitor of 10 microFarads. Set the voltage to 10 volts.

2. Measure the current in the circuit with an ammeter.

3. Measure the voltage across the circuit and the the capacitor with a voltmeter.



RC Circuit with LED

1. Construct the following circuit consisting of a switch, a 2.2kΩ resistor, and LED and a 10 microFarads capacitor.

2. Place the switch in the A position then turn it to the B position and observe the LED.

3. Return the switch to the A position and measure the voltage across the capacitor.

4. In the B position, measure the voltage across the capacitor.

3. Discussion and Analysis

RC Circuit with Function Generator

Capacitance	Resistance	Calculated Time Constant*	Measured Time Constant
$1\mu F$	1 kΩ	0.001	1.040 ms

With a single 1 microFarad capacitor we can see the time constant was 1 milliseconds.

Capacitance	Resistance	Calculated Time Constant*	Measured Time Constant
0.5 μF	1 kΩ	0.0005	480 μs

However, when a second capacitor was places in series we can see the total capacitance decreased by half and as a result the time constant also decreased by half.

Capacitance	Resistance	Calculated Time Constant*	Measured Time Constant
2 μF	1 kΩ	0.002	2.6 ms

Similarly, when the capacitors were rearranged in parallel, the capacitance doubled and the time constant also doubled from the original value of a single capacitor.

RL Circuit with a Constant Voltage Supply

	Calculated Value*	Measured Value
Current	0.1 A	0 A
Voltage across the inductor	0 V	8.04 V
Voltage across the resistor	10 V	5.3 V

When the Inductor was connected with the to a constant voltage supply, it acted as a short circuit and in turn the resistor acted as the only consumer resulting in a voltage drop equivalent to the power supplies voltage.

RC Circuit with a Constant Voltage Supply

	Calculated Value*	Measured Value
Current	0A	0 A
Voltage across the capacitor	10V	0.3 V
Voltage across the resistor	0V	5.39V

When the capacitor was connected to a constant voltage supply it acted as an open circuit resulting in a current value of 0A throughout the circuit. The Voltage across the capacitor was equivalent to the power supplies voltage.

RC Circuit with LED

In the LED circuit, we observed the LED briefly emitted light when the switch changed from the A position to the B position. This must have been due to the capacitor releasing the stored energy which in turn was enough energy to power the LED for a brief moment.

4. Conclusions

The objectives of this lab were performed successfully. Students became familiar with using the Oscilloscope and the Function Generator. Also, the RL and RC circuits were effectively analyzed in both their transient and steady states. The concept of capacitors in series and parallel was applied in the application of the time constant, and it was noticed that increasing the capacitance in an existing circuit increases the time constant.