SRM INSTITUTE OF SCIENCE AND TECHNOLOGY, Kattankulathur – 603 203

Title of Experiment	: **3.Transient analysis of Series RL, RC circuits**
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Register Number	: RA2111050010001
Date of Experiment	: 8th october 2021

Sl. No.	Marks Split up	Maximum marks (50)	Marks obtained
1	Pre Lab questions	5	
2	Preparation of observation	15	
3	Execution of experiment	15	
4	Calculation / Evaluation of Result	10	
5	Post Lab questions	5	
Total		**50**	

Staff Signature

PRE LAB QUESTIONS

1) Define Transient.

A transient event is a short-lived burst of energy in a system caused by a sudden change of state. The source of the transient energy may be an internal event or a nearby event.

2) Time constant for RL Circuit.

Thus for series RL circuit, time constant is The initial rate of rise of current is large up to first time constant. At a later stage, the rate of rise of current reduces.
Theoretically I reach maximum value after infinite time. T = L/R

3) Time constant for RC Circuit.

The RC time constant, also called tau, the time constant (in seconds) of an RC circuit, is equal to the product of the circuit resistance (in ohms) and the circuit capacitance (in farads), τ=RC [seconds] It is the time required to charge the capacitor, through the resistor, from an initial charge voltage of zero to approximately 63.2% of the value of an applied DC voltage, or to discharge the capacitor through the same resistor to approximately 36.8% of its initial charge voltage.

4) How will you design the values of L & C in a transient circuit? --.. . ..- ...

The time constant of an RL circuit is the equivalent inductance divided by the Thévenin resistance as viewed from the terminals of the equivalent inductor.

A pulse is a voltage or current that changes from one level to another and back again. If a waveform's high time equals its low time, it is called a square wave. The length of each cycle of a pulse train is its period (). The pulse width () of an ideal square wave is equal to half the time period.
The relation between pulse width and frequency for the square wave is given by: .
Series RL circuit.
In an RL circuit, voltage across the inductor decreases with time, while in the RC circuit, the voltage across the capacitor increases with time. Thus, current in an RL circuit has the same form as voltage in an RC circuit: they both rise to their final value exponentially according to .
The expression for the current in the inductor is given by: , where is the applied source voltage to the circuit for . The response curve increases and is shown in Figure 3.
The current in an inductor increases in a series RL circuit.
The expression for the current decay across the inductor is given by: , where is the initial current stored in the inductor and is the time constant. The response curve is a decaying exponential.

Experiment No. 3 Date :	Transient analysis of series RL, RC circuits

Aim:

To obtain the transient response and measure the time constant of a series RL and RC circuit for a pulse waveform.

Apparatus Required:

Sl. No.	Apparatus	Range	Quantity
1	Function Generator	800 Hz	1
2	Inductor	1 mH	1
3	Resistor	4 KΩ	1
4	Capacitor	1 nF	1
5	Bread Board & Wires	--	Required
6	CRO		1
7	CRO Probes		2

Theory

In this experiment, we apply a pulse waveform to the RL or RC circuit to analyze the transient response of the circuit. The pulse-width relative to a circuit's time constant determines how it is affected by an RC or RL circuit.

Time Constant (τ): A measure of time required for certain changes in voltages and currents in RC and RL circuits. Generally, when the elapsed time exceeds five time constants (5τ) after switching has occurred, the currents and voltages have reached their final value, which is also called steady-state response.

The time constant of an RC circuit is the product of equivalent capacitance and the Thevenin's resistance as viewed from the terminals of the equivalent capacitor.

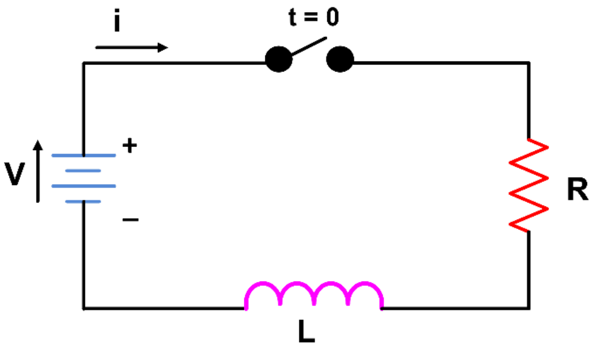
$$\tau = RC$$

A Pulse is a voltage or current that changes from one level to the other and back again. If a waveform's high time equals its low time, as in figure, it is called a square wave. The length of each cycle of a pulse train is termed its period (T). The pulse width (tp) of an ideal square wave is equal to half the time period.

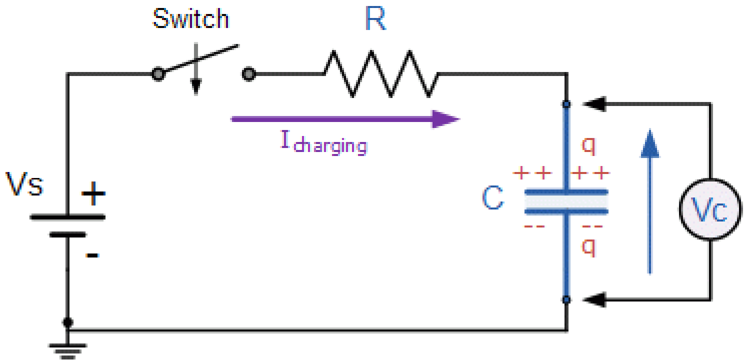
Procedure for RL:

1. Make the connections as per the circuit diagram.
2. Choose square wave mode in signal generator
3. Using CRO, adjust the amplitude to be 2 volts peak to peak.
4. Take care of the precaution and set the input frequency.
5. Observe and plot the output waveform.
6. Calculate the time required by the output to reach 0.632 times the final value (peak).
7. This value gives the practical time constant. Tabulate the theoretical and practical values.

Circuit Diagram



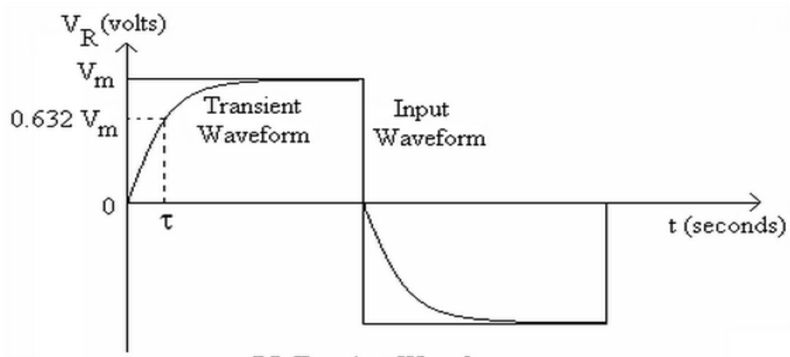
a) RL Circuit



b) RL Circuit

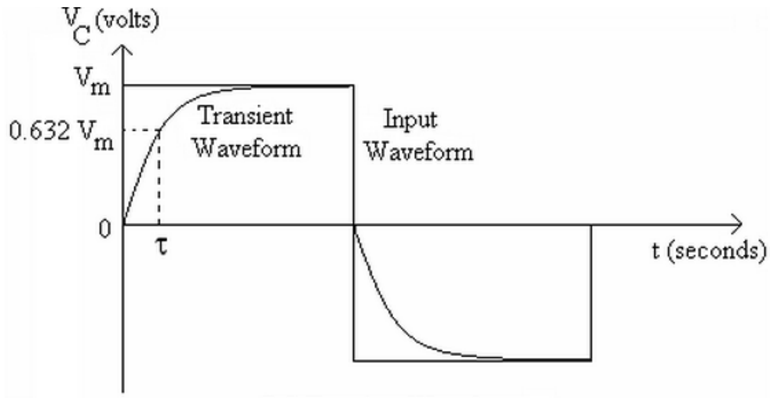
Model Graph:

a) RL Transient :Output voltage across Resistor:



RL Transient Waveform

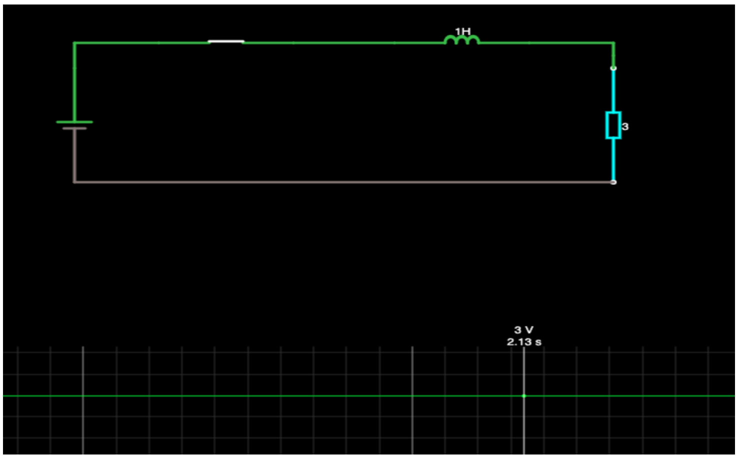
b) RC Transient :Output voltage across Capacitor:



RC Transient Waveform

eCIRCUIT Simulation diagram:

a)RL CIRCUIT

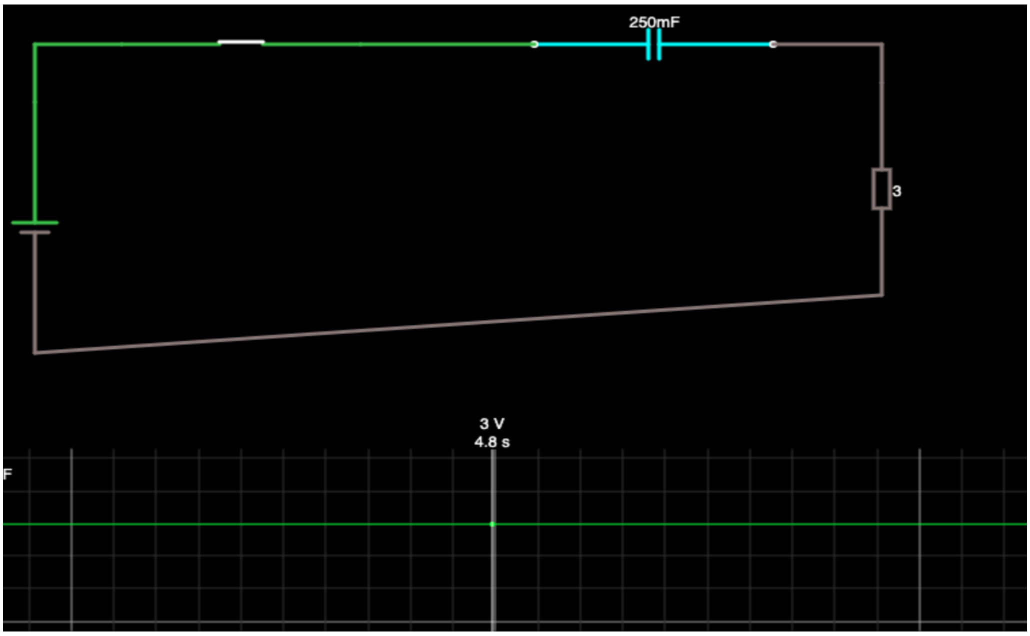


OBSERVATION TABLE:
Supply voltage = 3V

R	**L**	**Energized**	
		Time	$V_R(t)$
3	1	2.13 S	3
3	2	4.26 S	3

Inductance	Resistance	Calculated Time constant L/R	Observed Time constant from waveform
1	3	1/3 = 0.333	1.89V = 0.333 S
2	3	2/3 = 0.666	1.89V = 0.662 S

b)RC CIRCUIT



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BSERVATION TABLE: -

R	C	Charging	
		Time	Vc(t)
3	0.5	9.6 S	3
3	0.25	4.8 S	3

Capacitance	Resistance	Calculated Time constant RC	Observed Time constant from waveform
0.5	3	T = RC = 1.5 S	1.89 V = 1.49 S
0.25	3	T = RC = 0.75 S	1.89 V = 0.742 S

Result:

After the transient analysis we saw that the practical and theoretical values of time constant of RL and RC are approximately

POST LAB QUESTIONS

1) Why is it necessary to discharge the capacitor every time you want to record another transient voltage across the capacitor?

A charged capacitor left by itself will retain the charge for even months or years. So when it is disconnected from supply, the instant voltage it carries across terminals is maintained, which could often be dangerous.So before you handle a disconnected capacitor, it is very essential to discharge it to remove all charge and corresponding voltage. It is usual to discharge it through a resistor first, and then short the terminals directly to bring the voltage to zero.

2) If the capacitor remains charged, what would you expect to see across the capacitor when you re-close the switch to try to record another transient?

When a capacitor is fully charged, no current flows through it, so if somebody tries to record a transient he would see no change in capacitor, be it any value of voltage he won't see any change in the capacitor so transient would be recorded. If one wants to get the transient value one should use a discharged capacitor.

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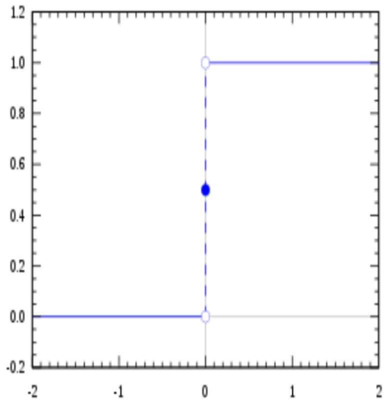
3) what does the derivative of a step function look like?

The differentiation of the unit step is Impulse.
Differentiation s finding the small changes in any function - Let us call it f(x)
The x axis time t. the y axis is value
In the x Axis until time = 0-,, the value is 0 ; At time 0 the value is 1; The difference between time, t = 0- and 0 is 1;
At time 0 , the value is 1; At all time t = 0+ the value is constantly 1 When two values are equal, the difference is 0;
Therefore, for all time t = 0+, when the value is 1, the difference remains 0.
This implies only at t = 0, the differential value is 1, and hence the differentiation of the unit step function is always an impulse



4) What does the integral of a step function look like?

Let f be a step function on the interval I. Then there exists an [a,b]□I such that f is a step function in the usual sense on [a,b] and such that f(x)=0 for all x□I□[a,b]. The Integral of f over I is defined to be ∫If(x)dx=∫baf(x)dx.