EEL101: Basic Electrical Lab

Experiment No: 3 Date:

Batch No.		**Team Number**	
	Team Member 1	**Team Member 2**	**Team Member 3**
Name			
ID No			

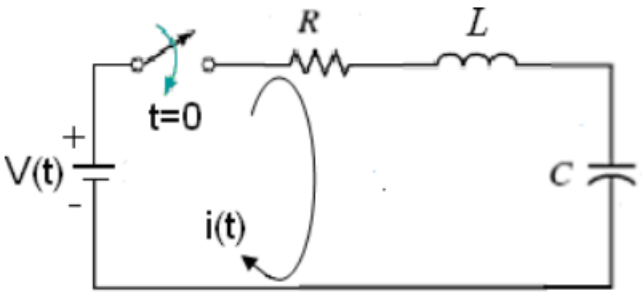
Aim: To study the transient response of a series RL, RC and RLC circuit and understand the time constant concept with square and sinusoidal AC power supply**.**

Apparatus Required:

S.No.	Instrument	Range	Quantity
1.	Digital Storage Oscilloscope (DSO)		
2.	Function Generator/AC supply		
3.	Resistor		
4.	Inductor		
5.	Capacitor		
6.	Bread Board		
7.	Connecting Wires		
8.	CRO Probes		

Theory:

1. **Transient Response**: When a circuit's state is changed, typically by applying or removing a voltage or current source, the circuit response changes over time before reaching a steady state. This change is known as the transient response.
2. **Time Constant (τ):** It is 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.
    a. For an RC circuit, the time constant tau is given by tau = RC, where R is the resistance and C is the capacitance.
    b. For an RL circuit, the time constant tau is given by tau = L/R, where L is the inductance.
    c. For an RLC circuit, the time constant depends on the damping factor and is more complex to calculate.



(Fig. 3)

Circuit Diagrams

Applying KVL, we obtain

$$v(t) = Ri(t) + L\frac{di(t)}{dt} + \frac{1}{C}\int i(t)dt$$

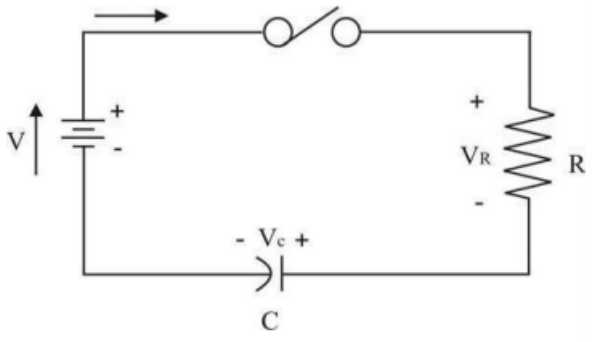
Taking Laplace transform on both sides of the above equation,

$$V(s) = RI(s) + L[sI(s) - i(0\_)] + \frac{I(s)}{sC} + \frac{v_C(0\_)}{s}$$

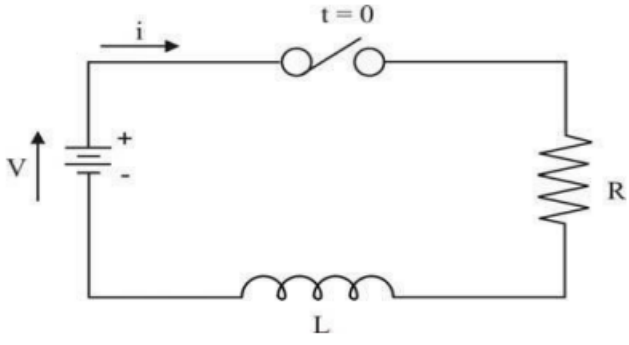
Now as all initial conditions set equal to zero, i.e. $i(0\_) = 0$ and $v_c\ (0\_) = 0$, so the equation becomes,

$$V(s) = I(s)\left[R + sL + \frac{1}{sC}\right]$$

Here, $v(t) = u(t)\ \therefore V(s)=1/S$



(Fig. 1)



(Fig. 2)

Precautions:

1. Ensure all circuit connections are secure before applying power.
2. Do not exceed the voltage and current ratings of the components.
3. Be cautious when handling the power supply to avoid electric shock.

Procedure:

For RC circuit:

Make the connections as shown in Figure 1

1. Make sure that the switch is in off position and no power supply is provided to the circuit from the function generator or AC supply.
2. Circuit Assembly: Connect a resistor and capacitor in series on a breadboard or the test bench for 230V AC application.
3. Power Supply Connection: Attach the function generator or AC supply across the RC series combination.
4. Switch the main switch on so that the function generator or AC supply will get connected to the RC circuit.
5. For breadboard circuit: Apply the square wave of 2Vpp voltage and frequency corresponding to the tau, five times tau and fifteen times tau through the function generator to the circuit, where tau is the time constant of the RC circuit.
   For AC setup: Apply 0-230V, 50 Hz supply to the circuit.
6. Measurement Setup: Connect the oscilloscope (DSO) across the function generator/AC supply and capacitor to measure voltage and the response.
7. Observe the transient response (exponentially rising) on DSO till the steady state is achieved.
8. Now immediately press RUN/STOP Switch of DSO to hold the response shown on the DSO screen.
9. Capture the response in any USB 2.0 type storage device.

For RL circuit:

Make the connections as shown in Figure 2

1. Make sure that the switch is in off position and no power supply is provided to the circuit from the function generator or AC supply.
2. Circuit Assembly: Connect a resistor and inductor in series on a breadboard the test bench for 230V AC application.
3. Power Supply Connection: Attach the function generator or AC supply across the RL series combination.
4. Switch the main switch on so that the DC function generator or AC supply will get connected to the RC circuit.
5. For breadboard circuit: Apply the square wave of 2Vpp voltage and frequency

corresponding to the tau, five times tau and fifteen times tau through the function generator to the circuit, where tau is the time constant of the RL circuit.

For AC setup: Apply 0-230V, 50 Hz supply to the circuit.

6. Connect DSO across the inductor.
7. Observe the transient response (firstly sudden increase in voltage and then exponentially decaying on DSO. Now immediately press RUN/STOP Switch off DSO to hold the response shown on the DSO screen.
8. Capture the response in any USB 2.0 storage device.

<u>For RLC circuit:</u>

Make the connections as shown in Figure 3.

1. Make sure that the switch is in off position and no power supply is provided to the circuit from the function generator or AC supply.
2. Circuit Assembly: Connect a resistor, inductor, and capacitor in series.
3. Power Supply Connection: Attach the function generator or AC supply across the RLC series combination. Switch the toggle switch in upward direction so that DC Supply will connect to the RC circuit.
4. Connect DSO across capacitor.
5. Observe the transient response (exponentially rising) on DSO till the steady state is achieved.
6. Toggle switch in downward direction so that resistor R will short with capacitor, C and inductor L.
7. Now observe the response (exponentially decaying) till it reaches the reference level of DSO. Now immediately press RUN/STOP Switch of DSO to hold the response shown on the DSO.
8. Capture the response in any storage device of USB 2.0 type.