North East University Bangladesh
Department of CSE
Course no: CSE 122
Experiment no: 06
Experiment Name: RC and RL Transients

CAUTIONS:

1. **Don't switch on the supply of the circuit until you have verified the circuit carefully**
2. **Take readings of apparatus carefully**
3. **Take care of any bare circuit elements in energized condition**
4. **Never try to touch bare live wires**

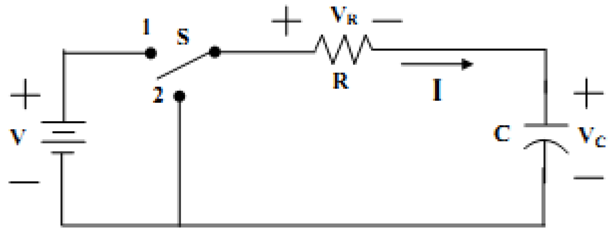
Part A: Study of Transient Behavior of RC Circuit.

Objective

The objective of this experiment is to study Transient Response of RC circuit with step Input. In this experiment we shall apply a square wave input to an RC circuit separately and observe the respective wave-shapes and determine the time constants.

Theory

The transient response is the temporary response that results from a switching operation and disappears with time. The steady state response is that which exists after a long time following any switching operation.
Let us consider an RC circuit shown in figure.



CHARGING PHASE: When the switch is connected to position 1, applying KVL we can write

$$V = Ri + \frac{1}{C}\int idt \text{ ------------ } (1)$$

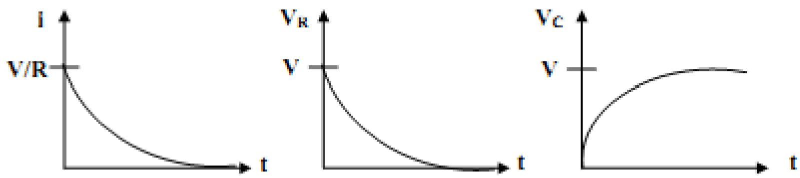
If the capacitor is initially uncharged the solution to the equation 1 is

$$i = \frac{V}{R}e^{-\frac{t}{\tau}} \text{ ---------------- } (2)$$

$$V_R = Ve^{-\frac{t}{\tau}} \text{ --------------- } (3)$$

$$V_C = V - V_R = V(1 - e^{-\frac{t}{\tau}}) \text{ ------ } (4)$$

Therefore the voltage across the resistor and capacitor are given by Where τ = RC and is called the time constant of the circuit. Equation (2), (3) & (4) are plotted below:



It is seen from the curves that the voltage across the capacitor rises from zero to V volts exponentially and the charging current is maximum at the start i.e. when C is uncharged, then it decreases exponentially and finally ceases to zero when the capacitor voltage becomes V.

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DISCHARGING PHASE: When the switch is connected to position 2,applying KVL we can write

$$0 = Ri + \frac{1}{C}\int idt \text{ ------------(5)}$$

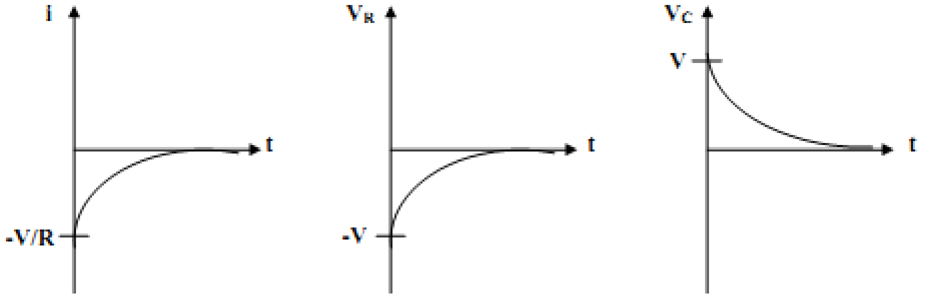
Since the voltage across the capacitor is now V, the solution of equation (5) is therefore the voltage across the resistor and capacitor are given by

$$i = -\frac{V}{R}e^{-\frac{t}{\tau}} \text{ ---------------(6)}$$

$$V_R = -Ve^{-\frac{t}{\tau}} \text{ ---------------(7)}$$

$$V_C = Ve^{-\frac{t}{\tau}} \text{ ---------------(8)}$$

The equations 6,7,8 are plotted below



It is seen from the curves that the voltage across the capacitor falls from V to zero volts exponentially. The charging current is maximum at the start i.e. when the switch is just thrown to position 2, then it decreases exponentially and finally ceases to zero when the capacitor voltage becomes zero.

Apparatus Needed

- Trainer Board (Bread board)
- Oscilloscope and Chords
- Resistance: 1KΩ
- Capacitance: 1µF
- DC Voltmeter
- DC Ammeter
- DC power supply
- Connecting wires

Experimental setup

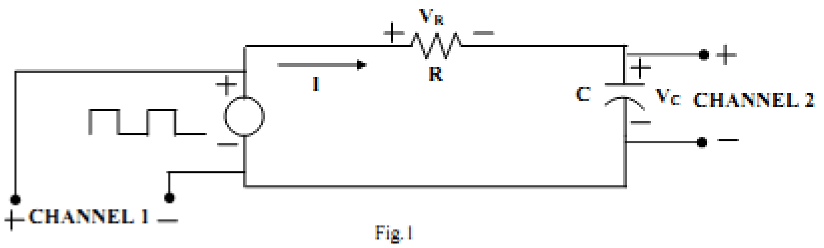


Fig.1

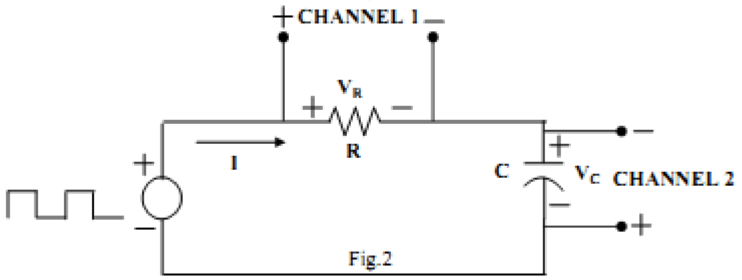


Fig.2

Procedure

1. Setup the circuit as shown in figure 1.
2. Apply 100Hz square wave from signal generator.
3. Observe the wave shapes at Ch.1 and Ch.2 in DUAL mode and draw them. Find the time constant from the wave shape of VC.
4. Disconnect Ch.1 and Ch.2 and reconnect them as shown in figure 2.
5. Observe the wave shapes at Ch.1 and Ch.2 (INV.) in DUAL mode and draw them.

Report

1. Draw all the wave shapes on graph paper.

Part B: Study of Transient Behavior of RL Circuit.

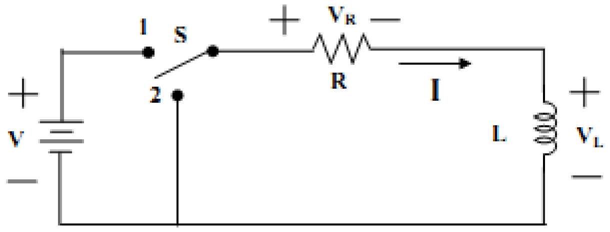
Objective

The objective of this experiment is to study Transient Response of RL circuit with step Input. In this experiment we shall apply a square wave input to an RL circuit separately and observe the respective wave-shapes and determine the time constants.

Theory

The transient response is the temporary response that results from a switching operation and disappears with time. The steady state response is that which exists after a long time following any switching operation.

Let us consider an RC circuit shown in figure.



Storage Phase: When the switch is connected to position 1, applying KVL we can write

$$V = Ri + L\frac{di}{dt} ------------(1)$$

If the inductor is initially relaxed the solution to the equation 1 is

$$i = \frac{V}{R}(1 - e^{-\frac{t}{\tau}}) ----------------(2)$$

$$V_R = V(1 - e^{-\frac{t}{\tau}}) ---------------(3)$$

$$V_L = V - V_R = Ve^{-\frac{t}{\tau}} ------(4)$$

Therefore the voltage across the resistor and capacitor are given by Where τ = L/R and is called the time constant of the circuit. Equation (2), (3) & (4) are plotted below:

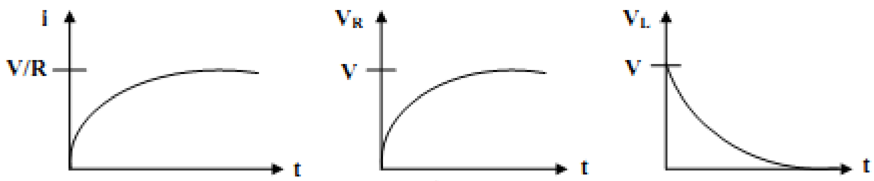


Fig.1

It is seen from the curves that the voltage across the inductor falls from V to zero volts exponentially. The current is zero at the start i.e. when the switch is just thrown to position 1, then it increases exponentially and finally reach to V/R amps when the inductor voltage becomes zero.

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Decaying Phase: When the switch is connected to position 2,applying KVL we can write

$$0 = Ri + L\frac{di}{dt} \text{-------------(5)}$$

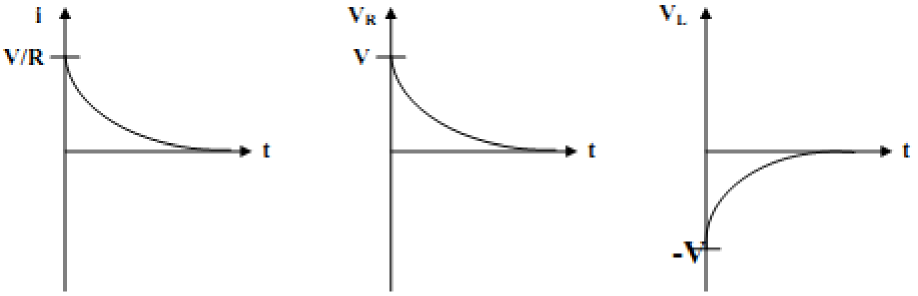
$$i = \frac{V}{R}e^{-\frac{t}{\tau}} \text{---------------(6)}$$

The solution of equation (5) is therefore the voltage across the resistor and inductor are given by

$$V_R = Ve^{-\frac{t}{\tau}} \text{--------------(7)}$$

$$V_L = -Ve^{-\frac{t}{\tau}} \text{--------------(8)}$$

The equations 6,7,8 are plotted below

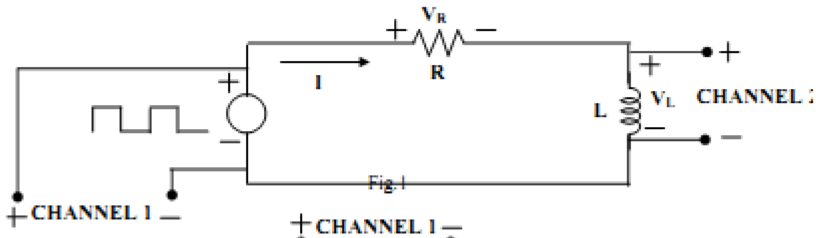


It is seen from the curves that the voltage across the inductor rises from -V to zero volts exponentially. The current is maximum at the start i.e. when the switch is just thrown to position 2, then it decreases exponentially and finally ceases to zero when the inductor voltage becomes zero.

Apparatus Needed

- Trainer Board (Bread board)
- Oscilloscope and Chords
- Resistance: 47 Ω
- Inductance: 680 uH
- DC Voltmeter
- DC Ammeter
- DC power supply
- Connecting wires

Experimental setup



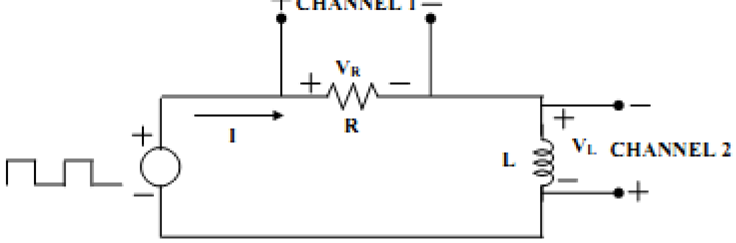


Fig.2

Procedure

6. Setup the circuit as shown in figure 1.
7. Apply suitable square wave from signal generator (10-100 khz) so that the wave shape is similar to theory.
8. Observe the wave shapes at Ch.1 and Ch.2 in DUAL mode and draw them. Find the time constant from the wave shape of VL.
9. Disconnect Ch.1 and Ch.2 and reconnect them as shown in figure 2.
10. Observe the wave shapes at Ch.1 and Ch.2 (INV.) in DUAL mode and draw them.

Report

2. Draw all the wave shapes on graph paper.

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