**Experiment No-7**

To Study and Implement RL Series Circuit.

**OBJECTIVE:**

1. To study and draw the phasor diagram of the current and the voltage.
2. To calculate the impedance values in the circuit (RL).

**APPARATUS:**

1. Resistor
2. Inductor
3. DMM
4. Connecting Wires
5. AC Power Supply

**Introduction:**

A sinusoidal signal is applied to a series resistive-inductive circuit, and the voltages developed across the resistor and inductor is investigated for amplitude and phase relationship to the input.

**Theory:**

Consider a simple RL circuit as shown in fig.7.1 in which [resistor](https://www.electrical4u.com/types-of-resistor/), R and inductor, L are connected in series with a [voltage](https://www.electrical4u.com/voltage-or-electric-potential-difference/) supply of V volts. Let us think the [current](https://www.electrical4u.com/electric-current-and-theory-of-electricity/) flowing in the circuit is I (amp) and current through resistor and [inductor](https://www.electrical4u.com/what-is-inductor-and-inductance-theory-of-inductor/) is IR and IL respectively. Since both [resistance](https://www.electrical4u.com/electrical-resistance-and-laws-of-resistance/) and inductor are connected in series, so the current in both the elements and the circuit remains the same. i.e IR = IL = I. Let VR and Vl be the [voltage drop](https://www.electrical4u.com/voltage-drop-calculation/) across resistor and inductor.

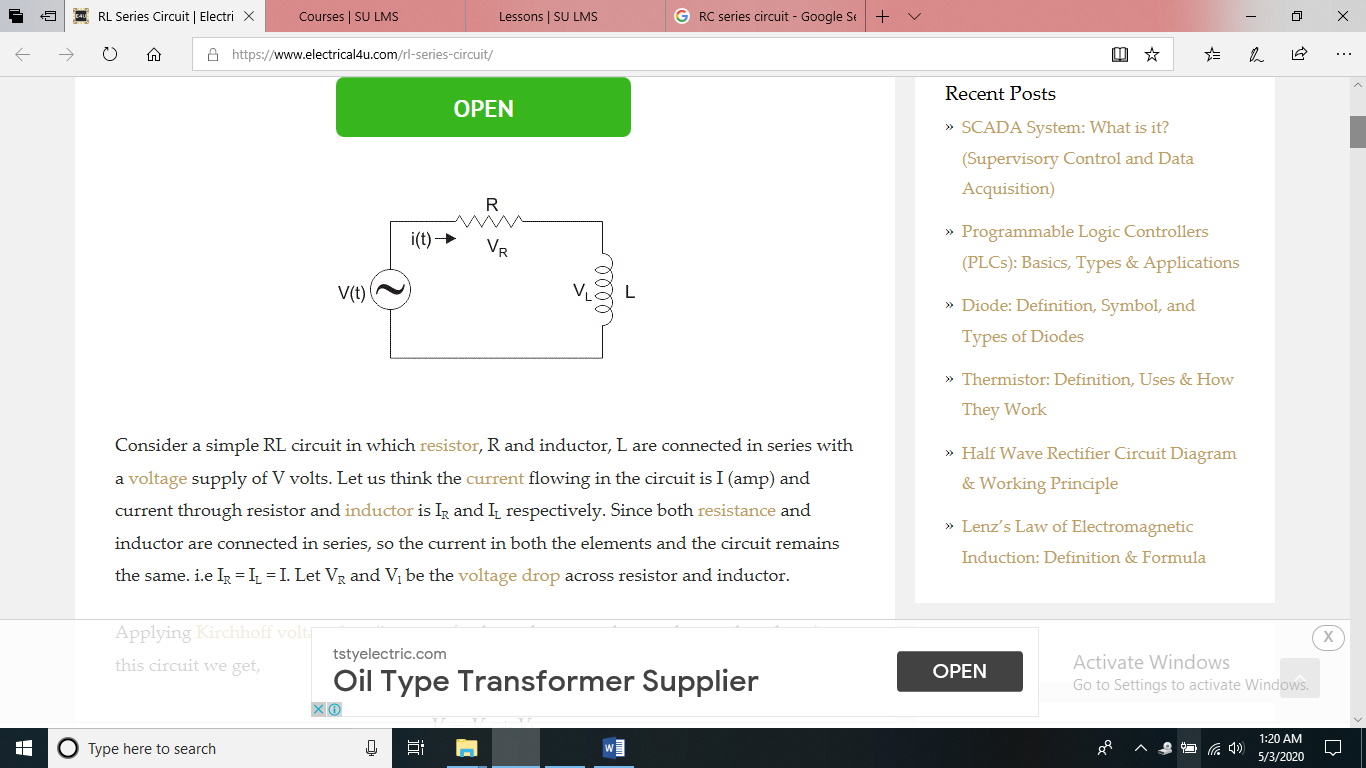


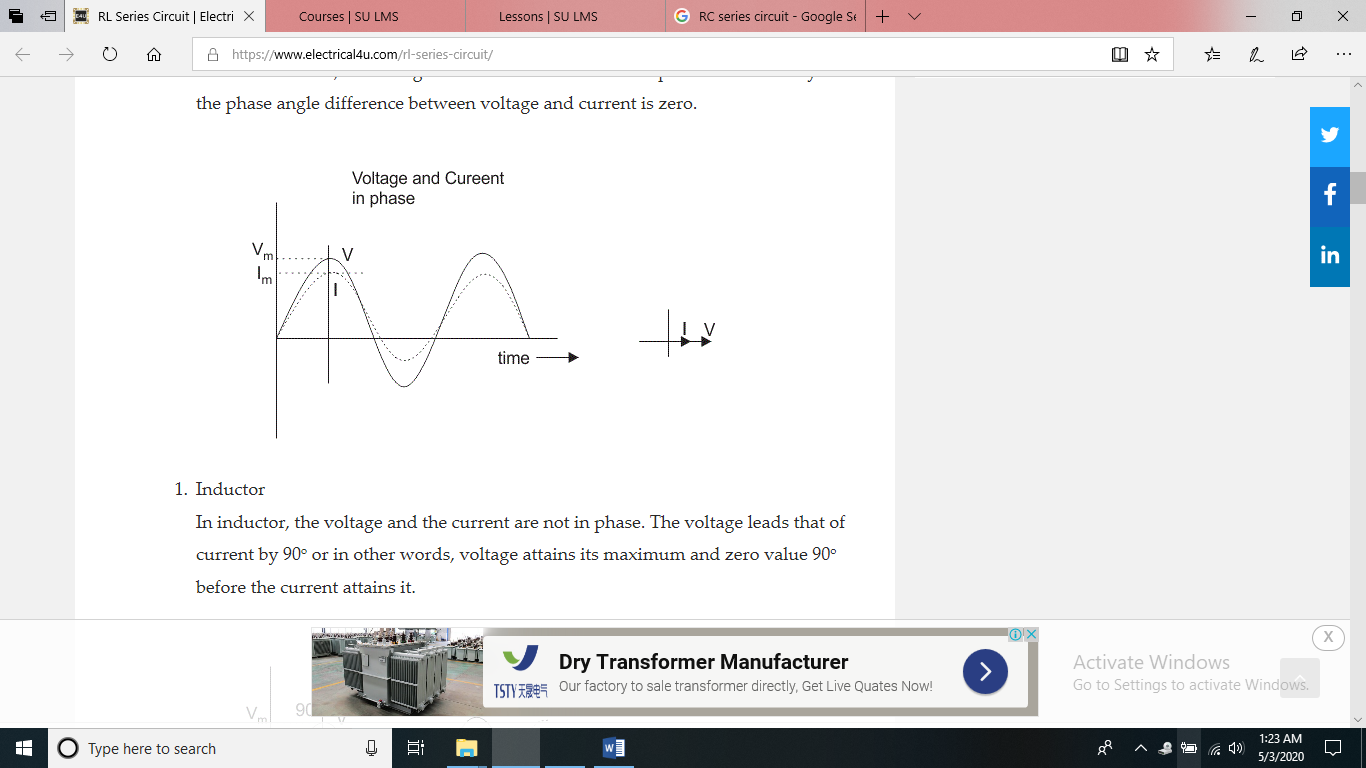
Fig 7.1: RL Series Circuit

Applying [Kirchhoff voltage law](https://www.electrical4u.com/kirchhoff-current-law-and-kirchhoff-voltage-law/) (i.e sum of voltage drop must be equal to apply voltage) to this circuit we get, V=Vr+Vl

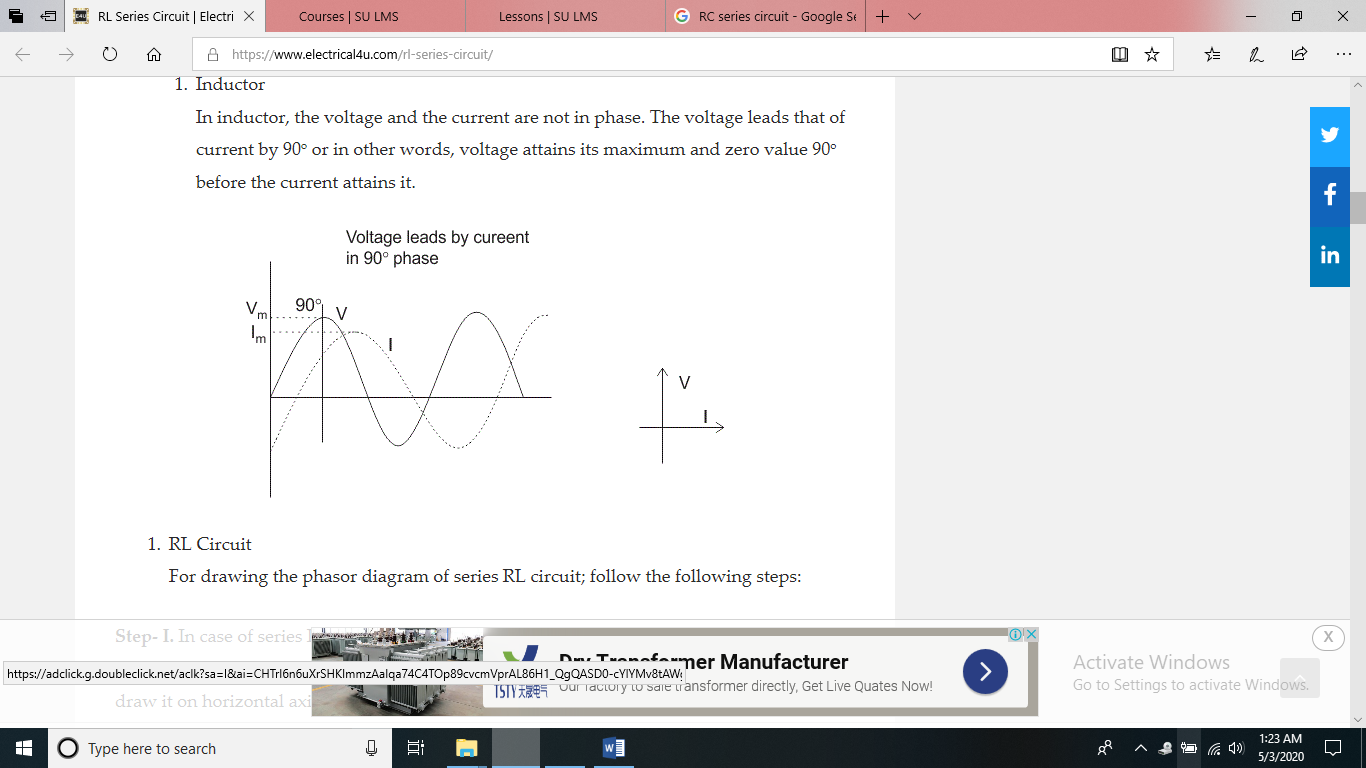
**Phasor Diagram for RL Circuit:**

Before drawing the **phasor diagram of series RL circuit**, one should know the relationship between voltage and current in case of resistor and inductor.

1. In case of resistor, the voltage and the current are in same phase or we can say that the phase angle difference between voltage and current is zero.



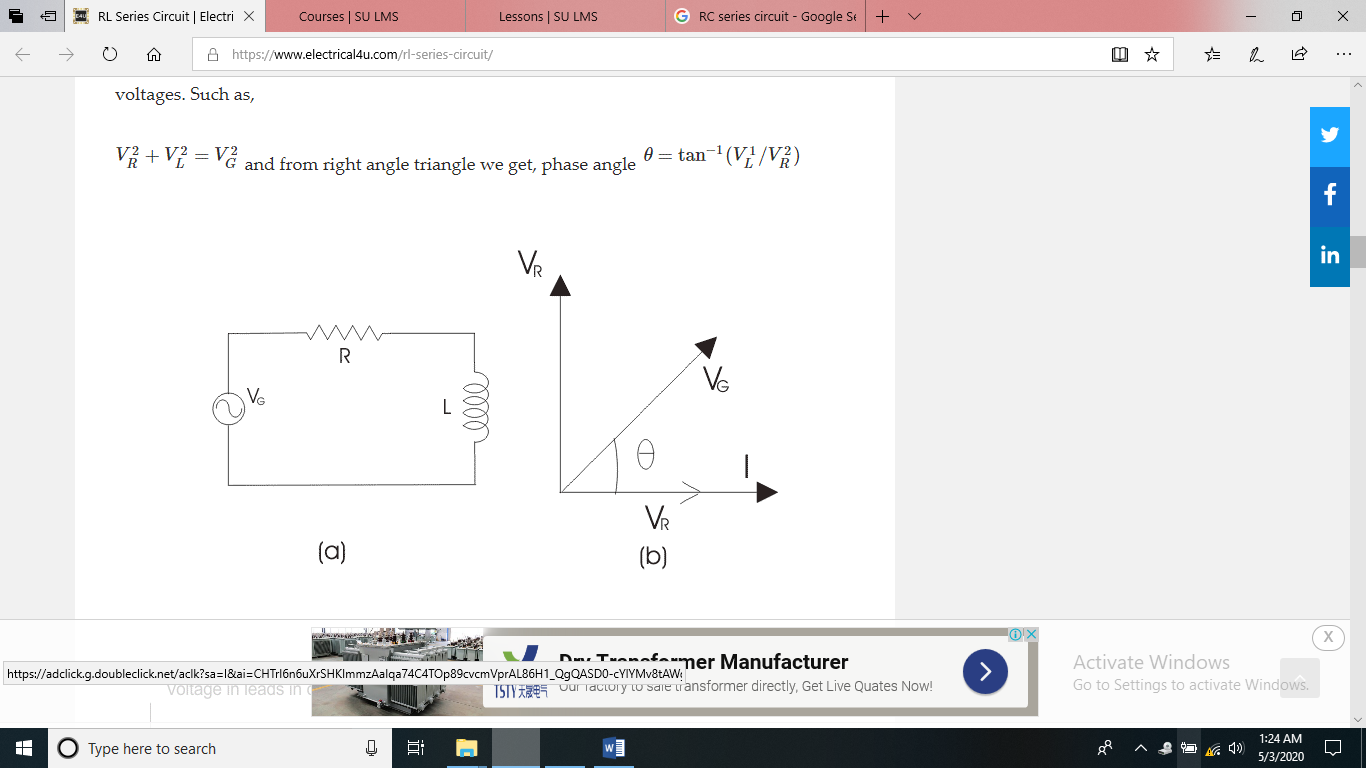
1. In inductor, the voltage and the current are not in phase. The voltage leads that of current by 90o or in other words, voltage attains its maximum and zero value 90o before the current attains it.



1. For drawing the phasor diagram of series RL circuit; follow the following steps:

**Step- I.** In case of series RL circuit, resistor and inductor are connected in series, so current flowing in both the elements are same i.e IR = IL = I. So, take current phasor as reference and draw it on horizontal axis as shown in diagram.  
**Step- II.** In case of resistor, both voltage and current are in same phase. So draw the voltage phasor, VR along same axis or direction as that of current phasor. i.e VR is in phase with I.

**Step- III.** We know that in inductor, voltage leads current by 90o, so draw VL (voltage drop across inductor) perpendicular to current phasor.  
**Step- IV.** Now we have two voltages VR and VL. Draw the resultant vector (VG) of these two voltages. Such as,



**Impedance of Series RL Circuit:**

The impedance of series RL circuit opposes the flow of alternating current. The impedance of series RL Circuit is nothing but the combine effect of resistance (R) and inductive reactance (XL) of the circuit as a whole. The impedance Z in ohms is given by,

Z = (R2 + XL2)0.5 and from right angle triangle, phase angle θ = tan– 1(XL/R).

**Power in RL Circuit:**

In series RL circuit, some energy is dissipated by the resistor and some energy is alternately stored and returned by the inductor-

1. The instantaneous power deliver by [voltage source](https://www.electrical4u.com/voltage-source/) V is P = VI (watts).
2. Power dissipated by the resistor in the form of heat, P = I2R (watts).
3. The rate at which energy is stored in inductor.

**Related Terms:**

**Average power,**             P=VICos Ѳ

**Quadrature power,**    Q=VISin Ѳ

|  |  |
| --- | --- |
| Ѳ=Tan-1(XL/R) |  |

|  |  |  |
| --- | --- | --- |
| =Tan-1 (VL/Vr) |  |  |
|  |  |  |

Vr=VTCos0

Vl=VTSin0

|  |  |  |
| --- | --- | --- |
| pf=Cos θ |  |  |

Power factor,

**Procedure:**

1. Connect the circuit as shown in fig. 7.1.
2. Check the circuit with ohmmeter before the power supply is applied.
3. Set AC ammeter at 1 A and AC voltmeter at 50 V.
4. Apply the power supply to the experimental circuit. Read the values from the instruments and record the results in Table 7-1.
5. Change the power supply according to the listed in Table 7-1, and then record the data in Table 7-1
6. Calculate the values of R, **XL,** ZT, 0, pf, P, S and Q record them in Table 7-1.
7. Draw the phasor diagram of current versus voltage.

**Observation Table 7-1:**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Values of measured | | | | Values of calculated | | | | | | | |
| VT  (V) | I  (A) | VL  (V) | VR  (V) | R  (Ω) | XL  (Ω) | ZT  (Ω) | Ѳ | PF | P  (W) | S  (VA) | Q  (VAR) |
| 4 |  |  |  |  |  |  |  |  |  |  |  |
| 15 |  |  |  |  |  |  |  |  |  |  |  |

**Phasor Diagrams:**

**Power Triangle:**

**Conclusions:**

**Comments:**