

# **ELECTROTECHNICH LAB.**

## **PART 5**

**Yrd. Doç. Dr. Taha İMECİ**

**Arş. Gör. Ezgi YAMAÇ**

**Arş. Gör. Ufuk ŞANVER**

**İSTANBUL COMMERCE UNIVERSITY**

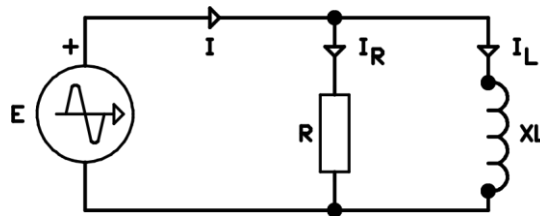
## Contents

<b>PARALLEL CIRCUITS IN AC.....</b>	<b>2</b>
18.1 EXAMINATION OF RL PARALLEL AC CIRCUIT .....	2
18.2 EXAMINATION OF RC PARALLEL AC CIRCUIT .....	5
18.3 EXAMINATION OF RLC PARALLEL AC CIRCUIT.....	7

# PARALLEL CIRCUITS IN AC

## 18.1 EXAMINATION OF RL PARALLEL AC CIRCUIT

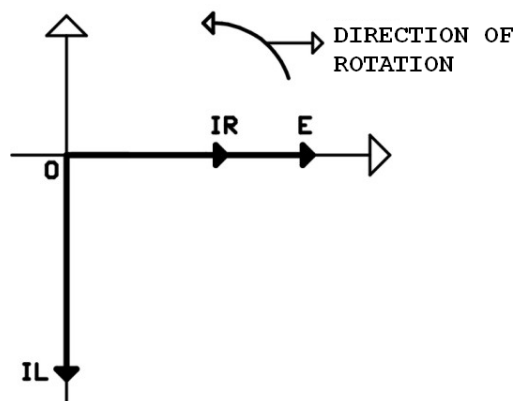
In figure 16.19, the AC circuit formed by the parallel connection of resistor and inductor is shown.



**Figure 16.19**

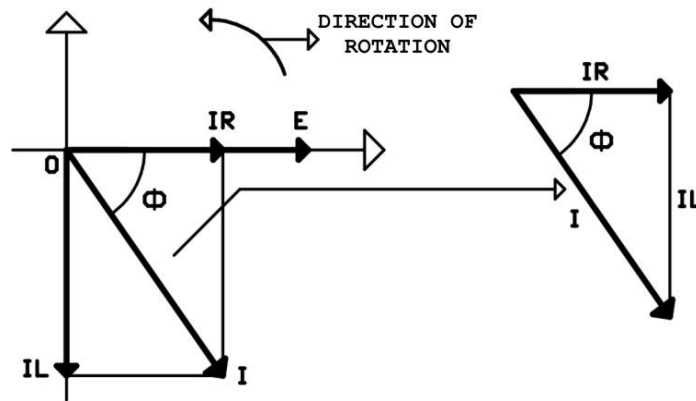
In figure, there is circuit voltage on the terminals of resistor and inductor. Current passes through the resistor depending on resistor's value and it passes through the inductor depending on inductor's inductive reactance. Circuit current is the Vectorial sum of currents passing through resistor and inductor.

The current passing through the resistor is in the same phase with circuit voltage. The current passing through the inductor is  $90^\circ$  behind the circuit voltage. In order to draw the phasor diagram of such a circuit, first the voltage as reference variable should be taken to the positive field of the horizontal axis. Then the other variables will be positioned depending on the reference



**Figure 16.20**

After drawing the phasor diagram, circuit current is calculated by the help of Pythagorean Theorem

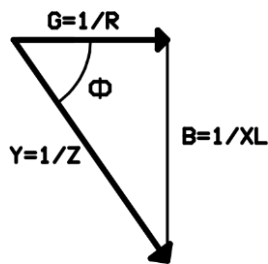


**Figure 16.21**

$$I^2 = IR^2 + IL^2$$

$$I = \sqrt{IR^2 + IL^2}$$

Conductance, admittance, susceptance triangle can be drawn by dividing circuit current equation by the square of circuit voltage.



**Figure 16.22**

This triangle is called "YGB" triangle.

$$\frac{I^2}{E^2} = \frac{IR^2}{E^2} + \frac{IL^2}{E^2}$$

$$Y^2 = G^2 + B^2$$

**In Formula;**

- Y**- Admittance of circuit
- G**- Conductance of resistor
- B**- Susceptance of inductor

In YGB triangle, circuit impedance can be written such as the parallelly connected resistors.

$$\frac{1}{Z^2} = \frac{1}{R^2} + \frac{1}{XL^2}$$

The easy way in calculating circuit impedance is to divide the circuit voltage by circuit current.

$$Z = \frac{E}{I}$$

Power coefficient of the circuit (**cosΦ**) is calculated by law of cosines.

$$\text{Cos}\phi = \frac{IR}{I}$$

Phase angle of the circuit is the one which is the cosine of power coefficient. Phase angle is found by looking at the trigonometric scale.

The active power dissipated by circuit;

$$P = E.I.\text{Cos}\phi$$

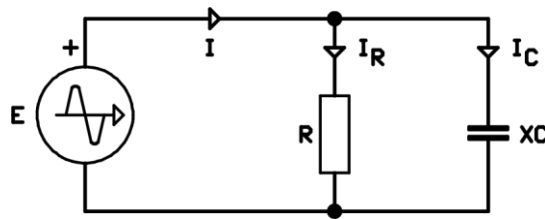
Practically, the known values in AC circuits are circuit voltage, circuit current and the values of the components. The demanded values are respectively reactances of components, leg currents, circuit current, circuit impedance, power factor, circuit phase angle and the power dissipated by the circuit. Solution should be made on this order.

**NOTE: If there is an inductor in serially connected AC circuits, internal resistance of the inductor presents opposition to current just as a real resistance. For this reason, internal resistance of the inductor was added to the real resistance in the experiments of serial AC circuits that include inductor.**

**In parallel connected AC circuits, the leg which the inductor is connected is actually formed by the serial connection of inductor and internal resistance of inductor. In order to prevent the mathematical operations to be too complex, inductor's resistance is omitted in our parallel AC experiments.**

## 18.2 EXAMINATION OF RC PARALLEL AC CIRCUIT

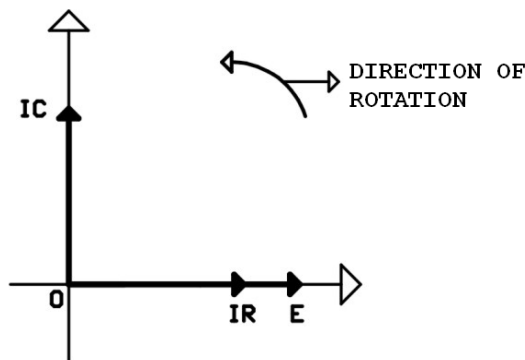
In figure 16.25, the AC circuit formed by the parallel connection of resistor and capacitor is shown.



**Figure 16.25**

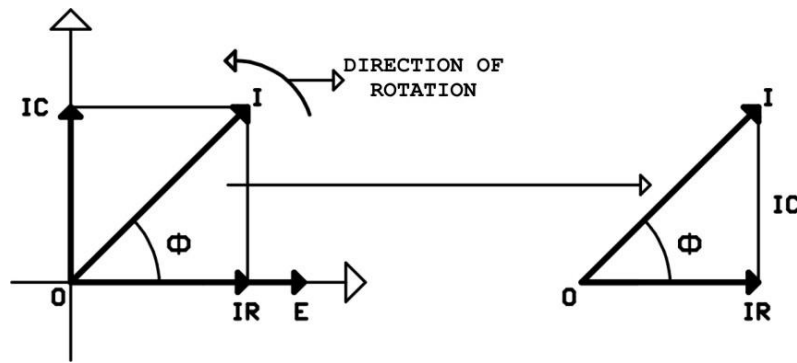
In figure, there is circuit voltage on the terminals of resistor and capacitor. Current passes through the resistor depending on resistor's value and it passes through the capacitor depending on capacitor's capacitive reactance. Circuit current is the Vectorial sum of currents passing through resistor and capacitor.

The current passing through the resistor is in the same phase with circuit voltage. The current passing through the capacitor is  $90^\circ$  ahead of the circuit voltage. In order to draw the phasor diagram of such a circuit, first the voltage as reference variable should be taken to the positive field of the horizontal axis. Then the other variables will be positioned depending on the reference



**Figure 16.26**

Circuit current is calculated by the help of Pythagorean Theorem



**Figure 16.27**

$$I^2 = IR^2 + IC^2$$

$$I = \sqrt{IR^2 + IC^2}$$

The way of calculating circuit impedance is to divide circuit voltage by circuit current.

$$Z = \frac{E}{I}$$

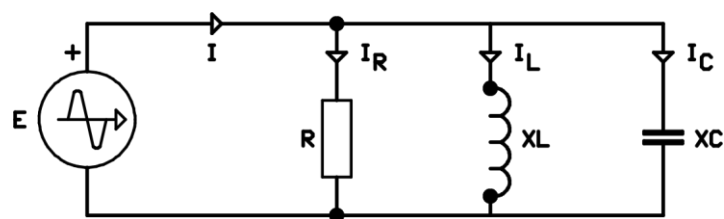
Power coefficient of the circuit (**cosΦ**) is calculated by law of cosines.

$$\text{Cos}\phi = \frac{IR}{I}$$

Phase angle of the circuit is the one which is the cosine of power coefficient. Phase angle is found by looking at the trigonometric scale. The active power dissipated by circuit;

$$P = E.I.\text{Cos}\phi$$

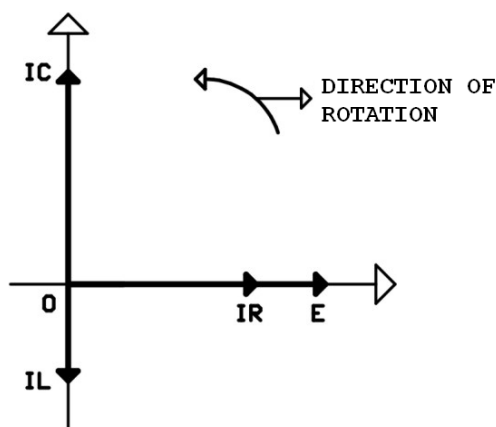
### 18.3 EXAMINATION OF RLC PARALLEL AC CIRCUIT



**Figure 16.30**

In figure 16.25, the AC circuit formed by the parallel connection of resistor, inductor and capacitor is shown. In figure, there is circuit voltage on the terminals of all the components. Current passes through the resistor depending on resistors value, it passes through the capacitor depending on capacitor's capacitive reactance and it passes through the inductor depending on inductor's inductive reactance.

The current passing through the resistor is in the same phase with circuit voltage. The current passing through the capacitor is  $90^\circ$  ahead of the circuit voltage. The current passing through the inductor is  $90^\circ$  behind of the circuit voltage. So there is a phase difference of  $180^\circ$  between current passing through the capacitor (**IC**) and current passing through the inductor (**IL**). In order to draw the phasor diagram of such a parallel circuit, first the voltage as reference variable should be taken to the positive field of the horizontal axis. Then the other variables will be positioned depending on the reference.



**Figure 16.31**

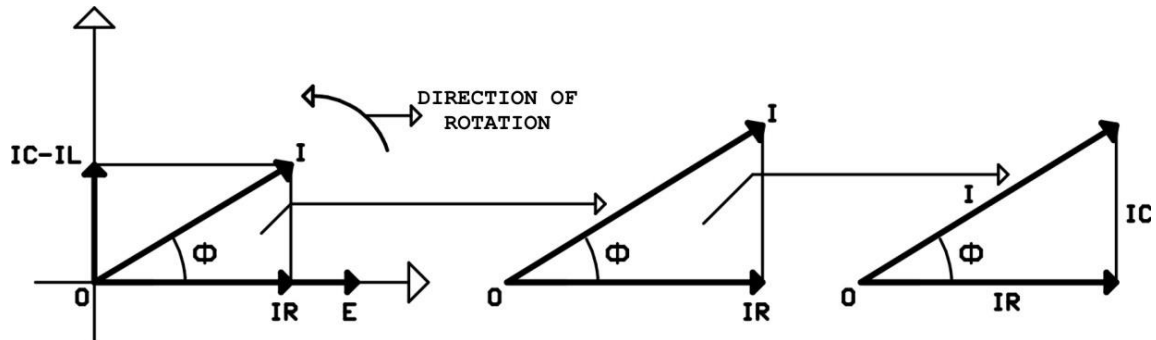
It is clearly seen in figure 16.31 that there is a phase difference of  $180^\circ$  between (**IL**) and (**IC**). The resultant of two forces with a  $180^\circ$  phase difference has a magnitude as much as the difference between these two forces and its direction will be the direction of the greater force. If we explain this process in phasor diagram, the resultant force can be seen in two different situations.



If  $I_C > I_L$ , direction of the resultant force will be in " $I_C$ " direction and its magnitude will be " $I_C - I_L$ ". In that situation the circuit is capacitive.

If  $I_L > I_C$ , direction of the resultant force will be in " $I_L$ " direction and its magnitude will be " $I_L - I_C$ ". In that situation the circuit is inductive.

It is seen in the phasor diagram that " $I_C$ " is greater than " $I_L$ ". Phasor diagram will be as in figure 16.32



**Figure 16.32**

Let's call the  $I_C - I_L$  difference as difference current and symbolize it as " $I_F$ ". After drawing the phasor diagram, circuit current is calculated by the help of Pythagorean Theorem.

$$I^2 = IR^2 + (IC - IL)^2$$

$$I^2 = IR^2 + IF^2$$

$$I = \sqrt{IR^2 + IF^2}$$

Circuit impedance is the division of circuit voltage by circuit current.

$$Z = \frac{E}{I}$$

Power coefficient of the circuit ( $\cos\Phi$ ) is calculated by law of cosines.

$$\cos\phi = \frac{IR}{IF}$$

Phase angle of the circuit is the one which is the cosine of power coefficient. Phase angle is found by looking at the trigonometric scale.

The active power dissipated by circuit;

$$P = E.I.\cos\phi$$