

What is impedance

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Impedance (Z) is similar to **Resistance (R)**. Impedance and Resistance both oppose the current in circuit. Both are almost the same thing, But **resistance related to DC Circuit**. Resistance oppose the steady electric current in DC circuit. **Resistance remains same** (constant) at any different frequency range.

Impedance is related with AC circuit. Impedance **vary** according to changing the frequency, this is not constant at different frequency range. Impedance also includes reactance (Inductive and capacitive property of the circuit).

Reactance- Reactance is the Resistance produced to AC Currents by Inductors and Capacitors only. This is a measure of the type of opposition to AC electricity due to capacitance or inductance.

The **impedance** is denoted by **Z** and unit of it is **Ohm (Ω)**.

If the level of ohm is higher then level impedance is also higher.

Impedance = Resistance + Reactance (Either inductive or Capacitive or both)

In DC circuit, **Impedance** is effective Resistance of the circuit.

$$Z = R$$

In AC circuits, it possesses both magnitude and phase, unlike resistance, which has only magnitude.

In the case of capacitor, When the frequency increased then the resistance (Impedance) of capacitor decreases. In Inductor this is just opposite, When we increase the frequency range then Impedance increase in inductor.

$$\text{Impedance } Z = \frac{V}{I}$$

Impedance is defined as combination of resistance and reactance.

As we cannot assume any circuit with DC Current without Resistance, We cannot assume a circuit with AC current without Impedance.

Resistive Power- Energy burns by resistive power to Heat goes through that system,

In Reactive Power- the energy goes to Antennas, Speaker, transmission line, cable etc represents how much energy to be stored and propagates. Not burn to heat ie Impedance.

⚡ **Resistance** - $R = \frac{V}{I}$ If there is Only **Resistor** is connected with Load in any circuit then $\frac{V}{I}$ is called Resistor.



⚡ **Reactance** $x = \frac{V}{I}$ If any circuit there is Only **inductor** or **capacitor** connected with load. Then the value of v/i is called reactance.

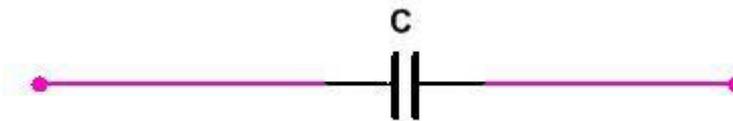
In Reactance There are 2 cases

(1) If **inductor** is connected then in this case **reactance** is called **inductive reactance**,



and its value in scalar form $X_L = \omega L$, and in vector form $X_L = j\omega L$ Where $\omega = 2\pi f$. Here if frequency is increased then the value of ωL is also increased.

(2) If **Capacitor** is connected then the Reactance is called **Capacitive Reactance** and it is denoted by $X_C = \frac{1}{\omega C}$ (scalar form).



In vector form $X_C = \frac{1}{j\omega C}$ Where $\omega = \frac{1}{2\pi f C}$ If frequency (f) is increased then value of X_C is decreased. i.e. ω inversely proportional to $2\pi f$.

⚡ **Impedance** – If Any circuit consist Resistance **-Inductor. Or Resistance - Capacitor, Or Resistance-inductor-Capacitor**. Then the value of v/i is called Impedance.

It is denoted by $Z = \frac{V}{I}$

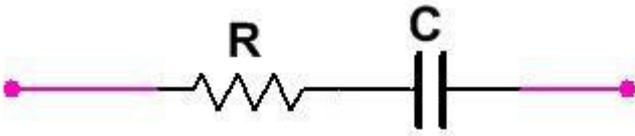
● **If Resistor(R) and Inductor(L) connected –**



The value of Impedance $Z = \sqrt{R^2 + (L\omega)^2}$ (scalar form)

In vector form $Z = R + j\omega L$

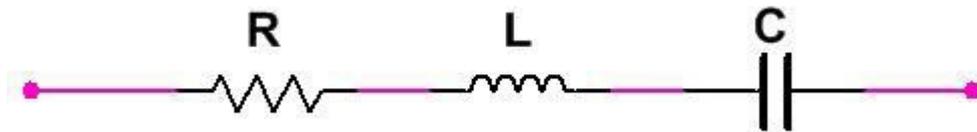
● **If Resistor (R) and Capacitor(C) connected Then**



$$\text{Impedance } Z = \sqrt{R^2 + \left(\frac{1}{C\omega}\right)^2}$$

$$\text{And In vector form impedance } Z = R + \frac{1}{j\omega C}$$

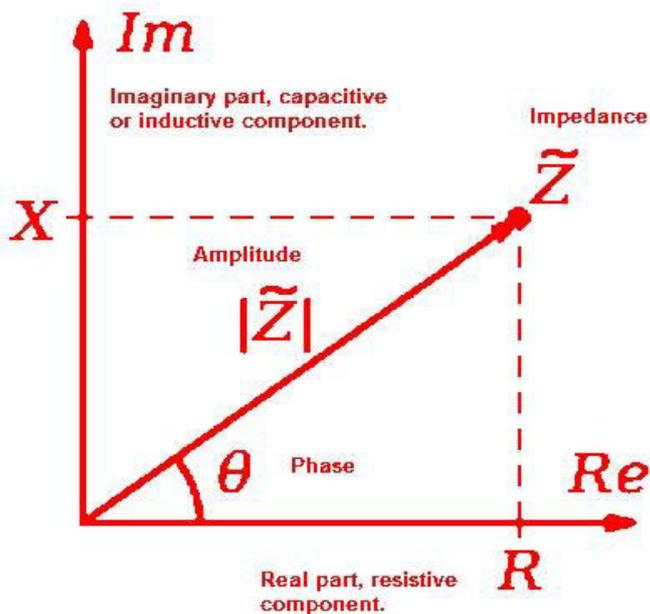
● If Resistor (R) , Inductor (L) capacitor (C) Connected Then



$$\text{Impedance } Z = \sqrt{R^2 + \left(L\omega - \frac{1}{C\omega}\right)^2}$$

$$\text{In vector form } Z = R + j\omega L + \frac{1}{j\omega C}$$

Impedance Phasor Diagram



Unit

- Impedance - Ω
- Reactance - Ω
- Resistance - Ω