

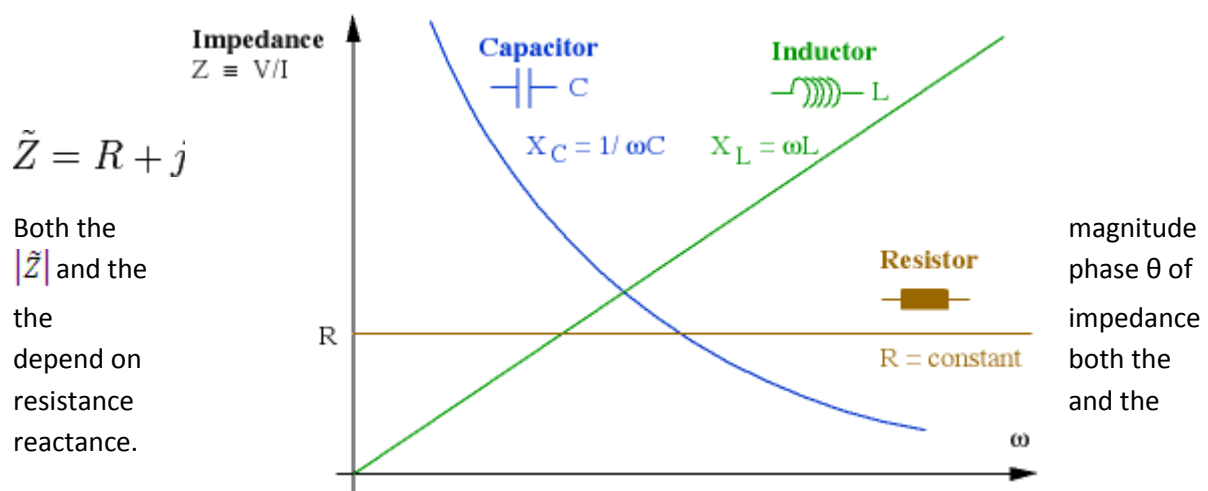
Explanation of Experiment 4,5 Series and Parallel AC Circuits

Impedance of components:

Let's recap what we now know about voltage and current in linear components. The impedance is the general term for the ratio of voltage to current. Resistance is the special case of impedance when $\phi = 0$, reactance the special case when $\phi = \pm 90^\circ$. The table below summarises the impedance of the different components. It is easy to remember that the voltage on the capacitor is behind the current, because the charge doesn't build up until after the current has been flowing for a while.

Resistor	Capacitor	Inductor
R	C	L
Resistance	Capacitive reactance	Inductive reactance
$V_R/I = R$	$V_C/I = X_C = \frac{1}{\omega C}$	$V_L/I = X_L = \omega L$
V and I in phase	V lags I by $\pi/2$	V leads I by $\pi/2$

The same information is given graphically below. It is easy to remember the frequency dependence by thinking of the DC (zero frequency) behaviour: at DC, an inductance is a short circuit (a piece of wire) so its impedance is zero. At DC, a capacitor is an open circuit, as its circuit diagram shows, so its impedance goes to infinity.



$$|\tilde{Z}| = \sqrt{ZZ^*} = \sqrt{R^2 + X^2}$$

$$\angle \mathbf{Z} = \arctan \left(\frac{X}{R} \right)$$

The magnitude is the ratio of the voltage and current amplitudes, while the phase is the voltage-current phase difference.

If, $X > 0$ the reactance is said to be inductive

If, $X = 0$ then the impedance is purely resistive

If, $X < 0$ the reactance is said to be capacitive

The reciprocal of reactance (that is, $1 / X$) is susceptance.

Admittance of components:

The admittance (Y) is the inverse of the impedance (Z). The SI unit of admittance is the Siemens. Oliver Heaviside coined the term in December 1887.[1]

$$Y = Z^{-1} = 1/Z$$

where

Y is the admittance, measured in Siemens

Z is the impedance, measured in ohms

Note that the synonymous unit mho, and the symbol \mathcal{U} (an upside-down Omega Ω), are also in common use.

Admittance is a measure of how easily a circuit or device will allow a current to flow. Resistance is a measure of the opposition of a circuit to the flow of a steady current, while impedance takes into account not only the resistance but also dynamic effects (known as reactance). Likewise, admittance is not only a measure of the ease with which a steady current can flow (conductance, G, the inverse of resistance), but also the dynamic effects of susceptance, B, (the inverse of reactance):

$$Y = G + jB$$

$$\angle Y = \arctan \left(\frac{B}{G} \right) = \arctan \left(\frac{-X}{R} \right)$$

where

G is the conductance, measured in Siemens

B is the susceptance, also measured in Siemens

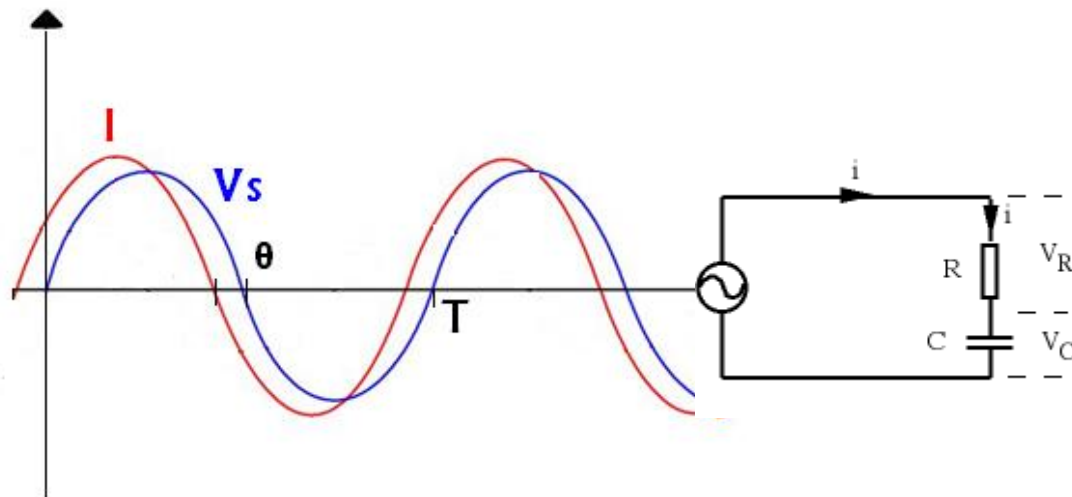
$$B_C = \frac{1}{X_C}, B_L = \frac{1}{X_L}$$

Note that (as shown above) the signs of reactance become reversed in the admittance domain, i.e. capacitive susceptance is positive and inductive susceptance is negative.

$$G = \frac{1}{R} = \frac{I}{V}$$

Phase shift measurements, and Phasor Diagram

Series RC circuit



I leads V_s or V_s lags I

T is the period after which the signal start to repeats it self

$$f = \frac{1}{T}$$

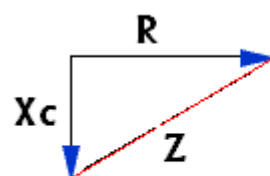
For each Period T(sec) $\rightarrow 360^\circ$, therefore

$$\theta(\text{degrees}) = \frac{\theta(\text{sec}) * 360^\circ}{T(\text{sec})}$$

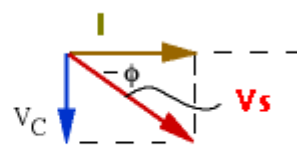
$\theta = 0$ (pure resistive), + (leading), - (lagging).

$\theta = -90$ (capacitive load)

$\theta = +90$ (inductive load)



Impedance triangle

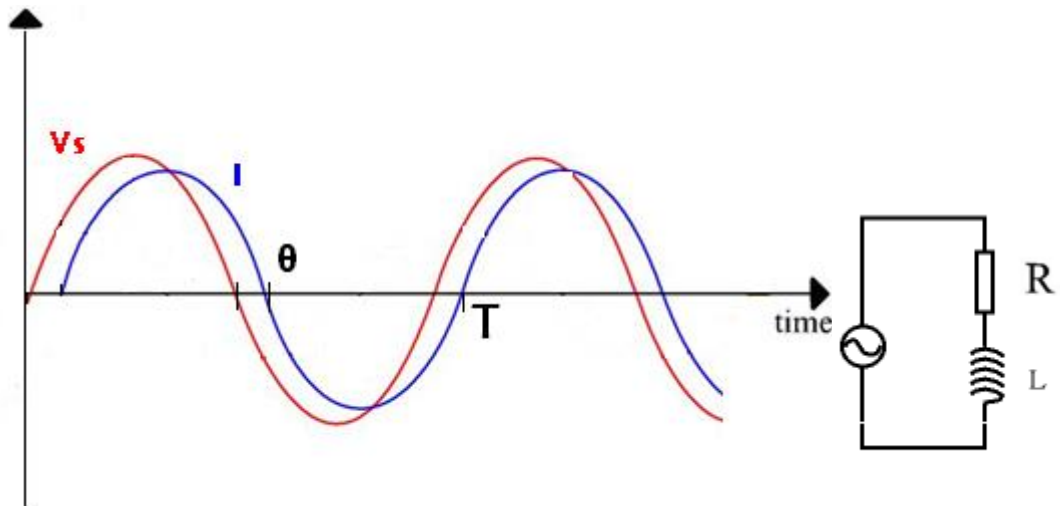


Phasor diagram

For series circuit take the current signal as reference for power triangles.

For parallel circuit take the voltage as reference for power triangles.

Series RL Circuit:



I lags V_s or V_s leads I

