NOTES -Class 29

Concept of Admittance

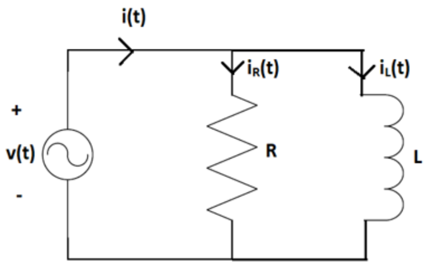
Admittance of an element is equal to the reciprocal of its impedance.

Admittance, $Y = \frac{1}{Z}$

It is measured in Siemens (S) or Mho (℧).

Element	Impedance (Z)	Admittance (Y)	Remarks
Resistor (R)	R	$\frac{1}{R} = G$	G is the conductance
Inductor (L)	jX_L	$\frac{1}{jX_L} = -jB_L$	B_L is the Inductive Susceptance
Capacitor (C)	$-jX_C$	$\frac{1}{-jX_c} = jB_c$	B_C is the Capacitive Susceptance

Parallel RL Circuit



By KCL, $i(t) = i_R(t) + i_L(t)$

In Phasor form, $\dot{I} = \bar{I_R} + \bar{I_L}$

$\bar{I_R} = \bar{V} * G \qquad \bar{I_L} = \bar{V} * (-jB_L)$

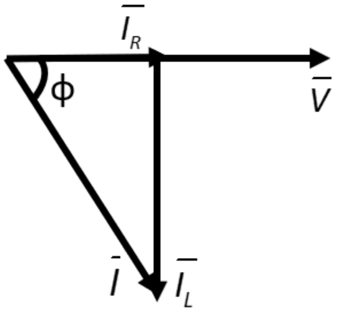
$\bar{I} = \bar{V} * (G - jB_L)$

$$Y_T = \frac{\bar{I}}{\bar{V}} = (G\text{-}jB_L) = \sqrt{G^2 + B_L^2} \angle -\mathrm{Tan}^{-1}\left(\frac{B_L}{G}\right)$$

In a parallel circuit, the total admittance is equal to the sum of individual branch admittances.

Phasor Diagram:

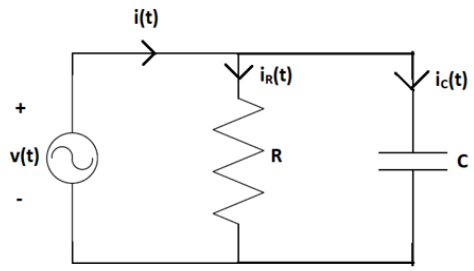
Note: In parallel AC circuits, it is preferable to consider the supply voltage as reference phasor while drawing phasor diagram.



$$\phi = \mathrm{Tan}^{-1}\left(\frac{|\overline{I}_L|}{|\overline{I}_R|}\right) = \mathrm{Tan}^{-1}\left(\frac{I_L}{I_R}\right)$$

$$= \mathrm{Tan}^{-1}\left(\frac{B_L}{G}\right)$$

Parallel RC Circuit



By KCL, $i(t) = i_R(t) + i_C(t)$

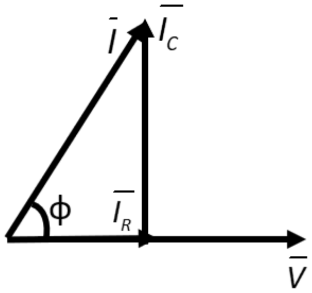
In Phasor form, $\overline{I} = \overline{I}_R + \overline{I}_C$

$$\overline{I}_R = \overline{V} * G \qquad \overline{I}_C = \overline{V} * (jB_C)$$

$$\overline{I} = \overline{V} * (G + jB_C)$$

$$Y_T = \frac{\overline{I}}{\overline{V}} = (G + jB_C) = \sqrt{G^2 + B_C^2}\angle \mathrm{Tan}^{-1}\left(\frac{B_C}{G}\right)$$

Phasor Diagram:



$$\phi = -\mathrm{Tan}^{-1}\left(\frac{|\overline{I_C}|}{|\overline{I_R}|}\right) = -\mathrm{Tan}^{-1}\left(\frac{I_C}{I_R}\right)$$

$$= -\mathrm{Tan}^{-1}\left(\frac{B_C}{G}\right)$$

Note: Phase Angle of a network is equal to impedance angle (or) negative of admittance angle.

Question 10:

The terminal voltage and current for a parallel circuit are 141.4sin 2000t V and 7.07sin (2000t+36^0)A.

Obtain the simplest two element parallel circuit, which would have the above relationship.

Solution:

To find the elements in a network, use the impedance form if it is a series network and use the admittance form if it is a parallel network.

$$v(t) = 141.4\sin(2000t)\text{ V} \quad \Rightarrow \bar{V} = \frac{141.4}{\sqrt{2}}\angle 0°\text{ V}$$

$$i(t) = 7.07\sin(2000t+36°)\text{ A} \quad \Rightarrow \bar{I} = \frac{7.07}{\sqrt{2}}\angle 36°\text{ A}$$

$$\text{Admittance,}Y = \frac{\bar{I}}{\bar{V}} = 0.05\angle 36°\text{S} = (0.04 + j0.029)\text{ S}$$

Comparing with the standard form ($G+jB_C$),

$G = 0.04S$; $B_C = 0.029S$

Hence, it is a parallel RC network

$$R = \frac{1}{G} = 25\Omega \text{ and } C = \frac{B_C}{\omega} = \frac{0.029}{2000} = 14.5\mu F$$

Question 11:

A resistor of 30Ω and a capacitor of unknown value are connected in parallel across a 110V, 50Hz Supply. The combination draws a current of 5A from the supply. Find the value of unknown Capacitance.

Solution:

$$|Y_T| = \frac{|I|}{|V|} = \frac{5}{110} = 0.045 \text{ S} \quad \text{-----} \ (1)$$

For a parallel RC network, $|Y_T| = \sqrt{G^2 + B_C^2}$ ----- (2)

$$G = \frac{1}{R} = 0.033\text{S}$$

Substituting G in (2) and equating (1) & (2),

$B_C = 0.0306\text{S}$

$$C = \frac{B_C}{\omega} = \frac{0.0306}{100\pi} = 97.38\mu\text{F}$$