

ELEMENTS OF ELECTRICAL ENGINEERING

Course Code : UE25EE141A/B



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ELEMENTS OF ELECTRICAL ENGINEERING (UE25EE141A/B)

Analysis of Parallel RL and Parallel RC Circuits

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Admittance

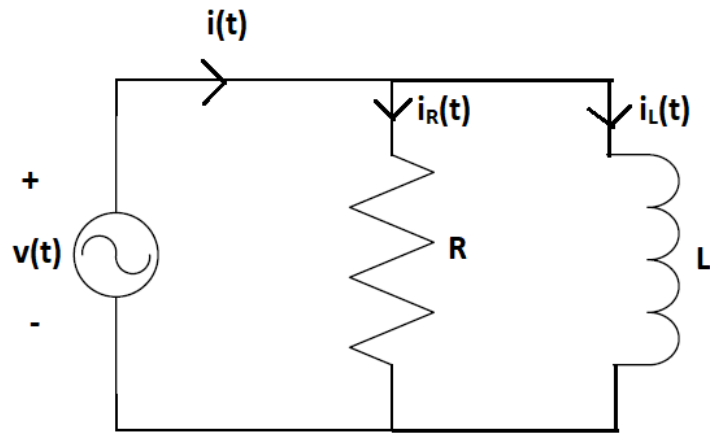
Admittance of an element is equal to the reciprocal of its impedance.

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

It is measured in Siemens (S) or Mho (Ω)

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, $\bar{i} = \bar{i}_R + \bar{i}_L$

$$\bar{i}_R = \bar{V} * G \quad \bar{i}_L = \bar{V} * (-jB_L)$$

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

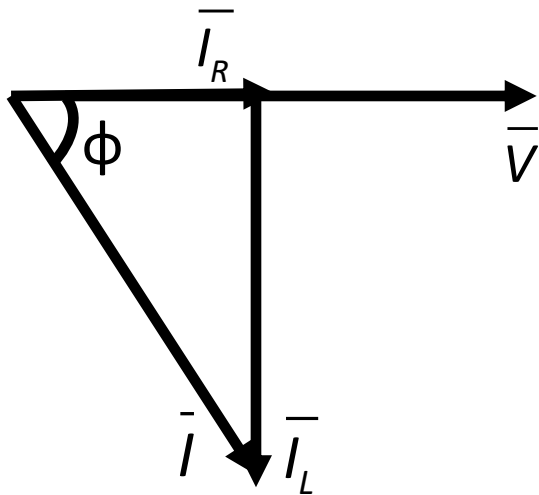
$$Y_T = \frac{\bar{i}}{\bar{V}} = (G - jB_L) = \sqrt{G^2 + B_L^2} \angle -\tan^{-1}\left(\frac{B_L}{G}\right)$$

Parallel RL Circuit

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

Phasor Diagram:

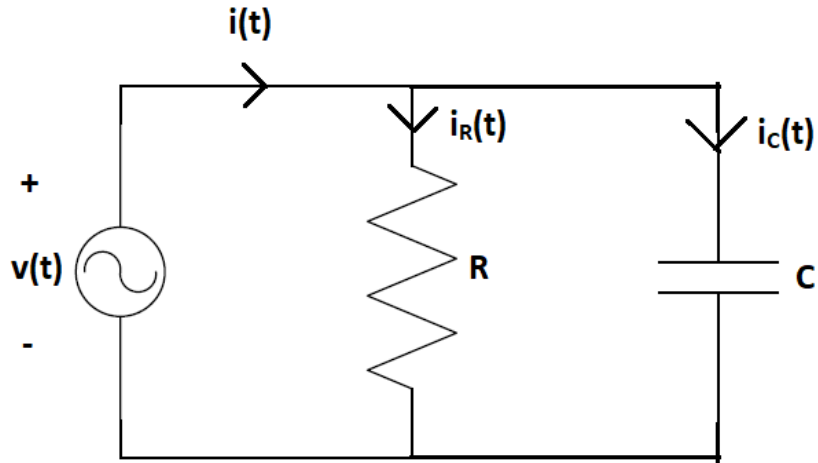
Note: In parallel AC circuits, it is preferable to consider the supply voltage as reference phasor while drawing phasor diagram.



$$\phi = \tan^{-1} \left(\frac{|I_L|}{|I_R|} \right) = \tan^{-1} \left(\frac{I_L}{I_R} \right)$$
$$= \tan^{-1} \left(\frac{B_L}{G} \right)$$

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

Parallel RC Circuit



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

In Phasor form, $\bar{i} = \bar{i}_R + \bar{i}_C$

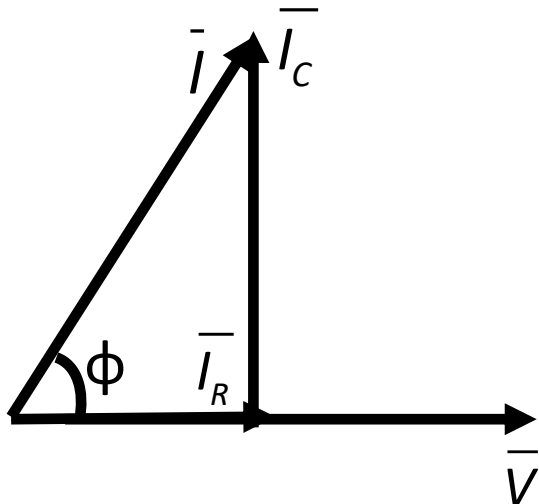
$$\bar{i}_R = \bar{V} * G \quad \bar{i}_C = \bar{V} * (jB_C)$$

$$\bar{i} = \bar{V} * (G + jB_C)$$

Parallel RC Circuit

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

Phasor Diagram:



$$\begin{aligned}\phi &= -\tan^{-1}\left(\frac{|I_C|}{|I_R|}\right) = -\tan^{-1}\left(\frac{I_C}{I_R}\right) \\ &= -\tan^{-1}\left(\frac{B_C}{G}\right)\end{aligned}$$

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

Numerical Example 1

Question:

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

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

Numerical Example 1

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.

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

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

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

Comparing with the standard form $(G+jB_c)$,
 $G = 0.04\text{S}$; $B_c = 0.029\text{S}$

Hence, it is a parallel RC network

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

Text Book:

1. **“Basic Electrical Engineering” S.K Bhattacharya, 1stEdition Pearson India Education Services Pvt. Ltd., 2017**
2. **“Basic Electrical Engineering”, D. C. Kulshreshta, 2ndEdition, McGraw-Hill. 2019**
3. **“Special Electrical Machines” E G Janardanan, PHI Learning Pvt. Ltd., 2014**

Reference Books:

1. **“Engineering Circuit Analysis” William Hayt, Jack Kemmerly, Jamie Phillips and Steven Durbin, 10th Edition McGraw Hill, 2023**
2. **“Electrical and Electronic Technology” E. Hughes (Revised by J. Hiley, K. Brown & I.M Smith), 12th Edition, Pearson Education, 2016.**



THANK YOU

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