



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

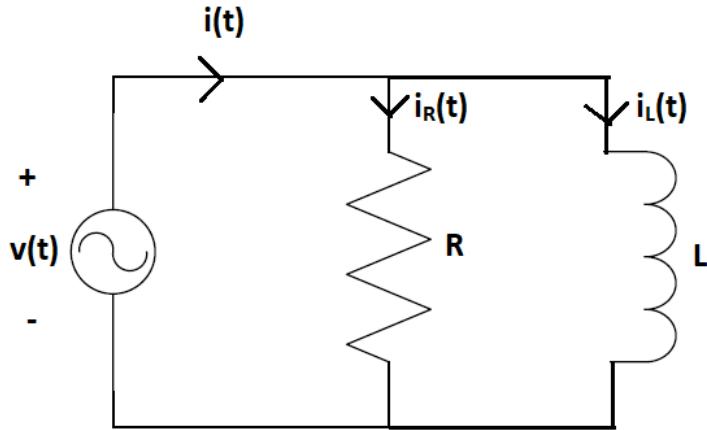
Admittance of an element is equal to the reciprocal of its impedance.

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

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



$$\text{By KCL, } i(t) = i_R(t) + i_L(t)$$

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

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

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

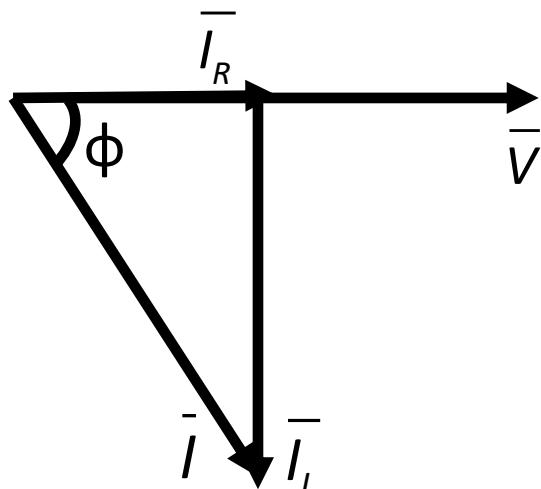
$$Y_T = \frac{\bar{i}}{\bar{V}} = (G - jB_L) = \sqrt{G^2 + B_L^2} \angle -\tan^{-1}\left(\frac{B_L}{G}\right)$$

Parallel RL Circuit

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

Phasor Diagram:

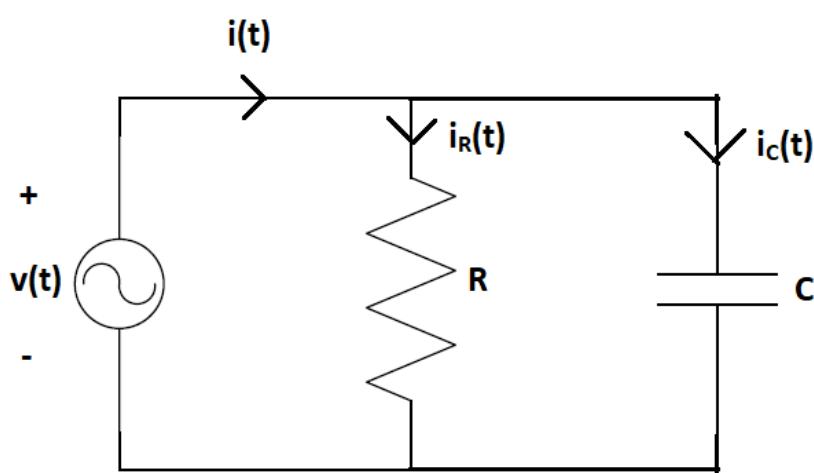
Note: In parallel AC circuits, it is preferable to consider the supply voltage as reference phasor while drawing phasor diagram.



$$\begin{aligned}\phi &= \tan^{-1}\left(\frac{|\bar{I}_L|}{|\bar{I}_R|}\right) = \tan^{-1}\left(\frac{|I_L|}{|I_R|}\right) \\ &= \tan^{-1}\left(\frac{B_L}{G}\right)\end{aligned}$$

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, $\bar{i} = \bar{I}_R + \bar{I}_C$

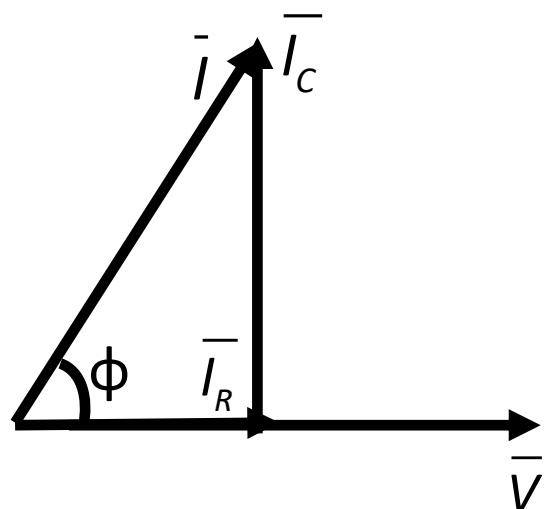
$$\bar{I}_R = \bar{V} * G \quad \bar{I}_C = \bar{V} * (jB_C)$$

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

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:



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

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 $7.07\sin(2000t+36^0)$ 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, 1st Edition Pearson India Education Services Pvt. Ltd., 2017
2. "Basic Electrical Engineering", D. C. Kulshreshtha, 2nd Edition, 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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