



ELEMENTS OF ELECTRICAL ENGINEERING

Course Code : UE25EE141A/B

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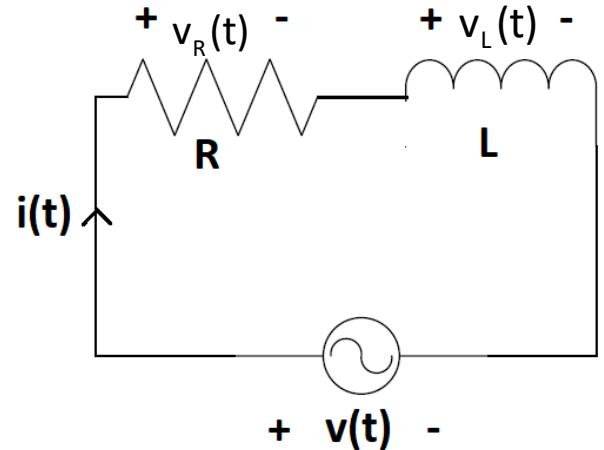
ELEMENTS OF ELECTRICAL ENGINEERING (UE25EE141A/B)

Analysis of series RL circuit with
Impedance and power triangles

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Series RL Circuit



By KVL, $v(t) = v_R(t) + v_L(t)$

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

In general for any element,

(Voltage Phasor) = (Current Phasor)*(Impedance)

$$\bar{V}_R = \bar{i} * R$$

$$\bar{V}_L = \bar{i} * (jX_L)$$

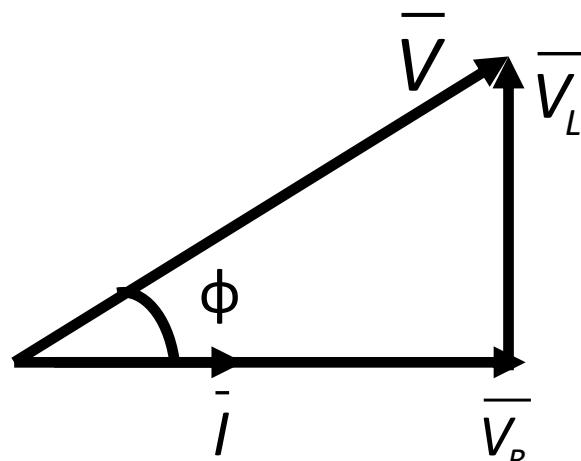
$$\bar{V} = \bar{i} * (R+jX_L)$$

$$Z_T = \frac{\bar{V}}{\bar{I}} = (R+jX_L) = \sqrt{R^2+X_L^2} \angle \tan^{-1}\left(\frac{X_L}{R}\right)$$

It can be observed that the total impedance of a series AC network is equal to the sum of individual element impedances.

Phasor Diagram:

Note: While drawing phasor diagram for a series AC network, considering current phasor as reference is preferable.

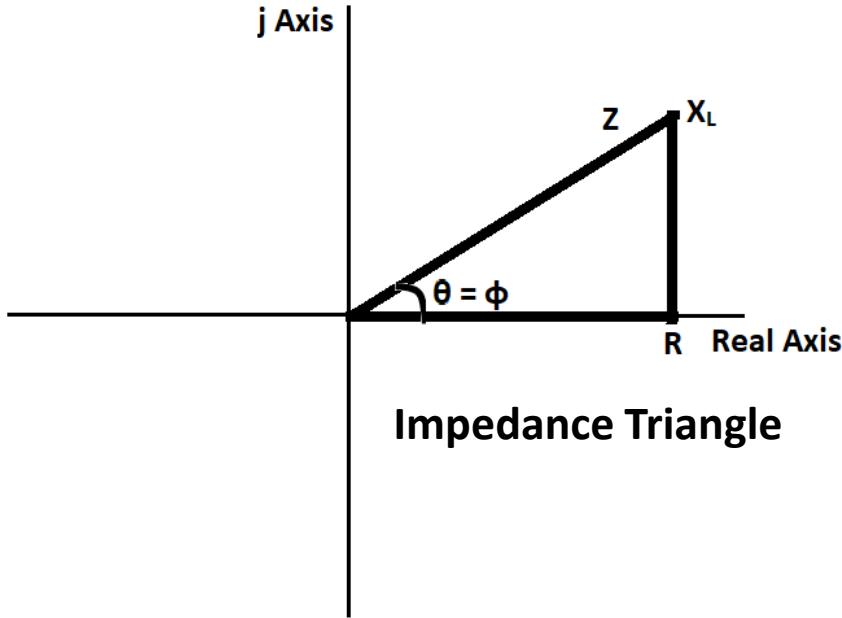


$$\begin{aligned} \phi &= \tan^{-1}\left(\frac{|\bar{V}_L|}{|\bar{V}_R|}\right) = \tan^{-1}\left(\frac{V_L}{V_R}\right) \\ &= \tan^{-1}\left(\frac{X_L}{R}\right) \end{aligned}$$

+ve phase angle means voltage leads current.

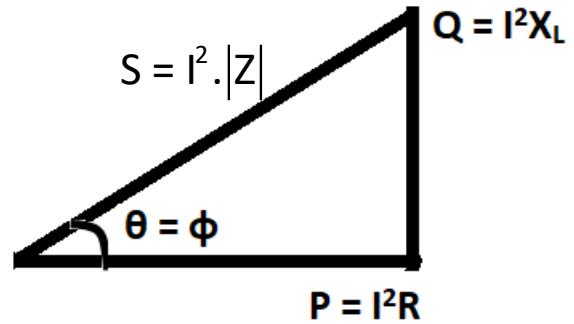
Impedance & Power Triangles – Series RL Circuit

For a series RL circuit, $Z = R + jX_L = \sqrt{R^2 + X_L^2} \angle \tan^{-1}\left(\frac{X_L}{R}\right)$



Impedance Triangle

Impedance Triangle of a series RL circuit lies Quadrant I of complex plane.



Power Triangle

$$P = VI\cos\phi = (I.|Z|).I.\frac{R}{|Z|} = I^2R$$

$$Q = VI\sin\phi = (I.|Z|).I.\frac{X_L}{|Z|} = I^2X_L$$

$$S = VI = (I.|Z|).I = I^2|Z|$$

Question:

Find the instantaneous expression for the current when a voltage represented by $v(t) = 283\sin 100\pi t$ Volts is applied to a coil having $R = 50\Omega$ and $L = 0.159H$.

Also find active, reactive and apparent powers in the network by using power triangle concept.

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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