Series LCR circuit

05.06.09

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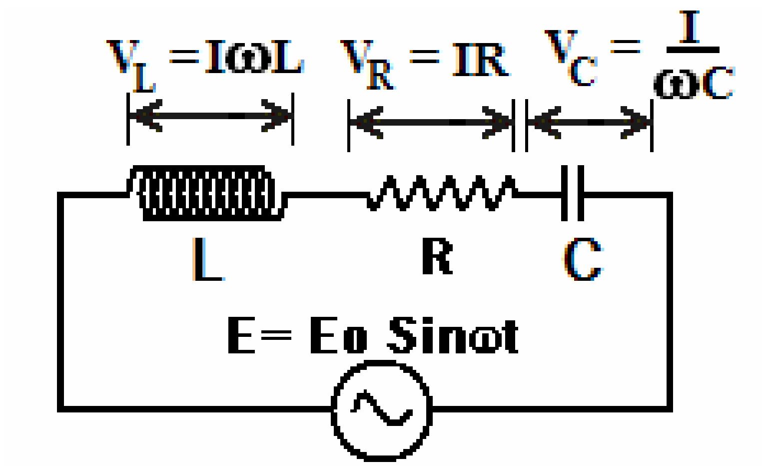
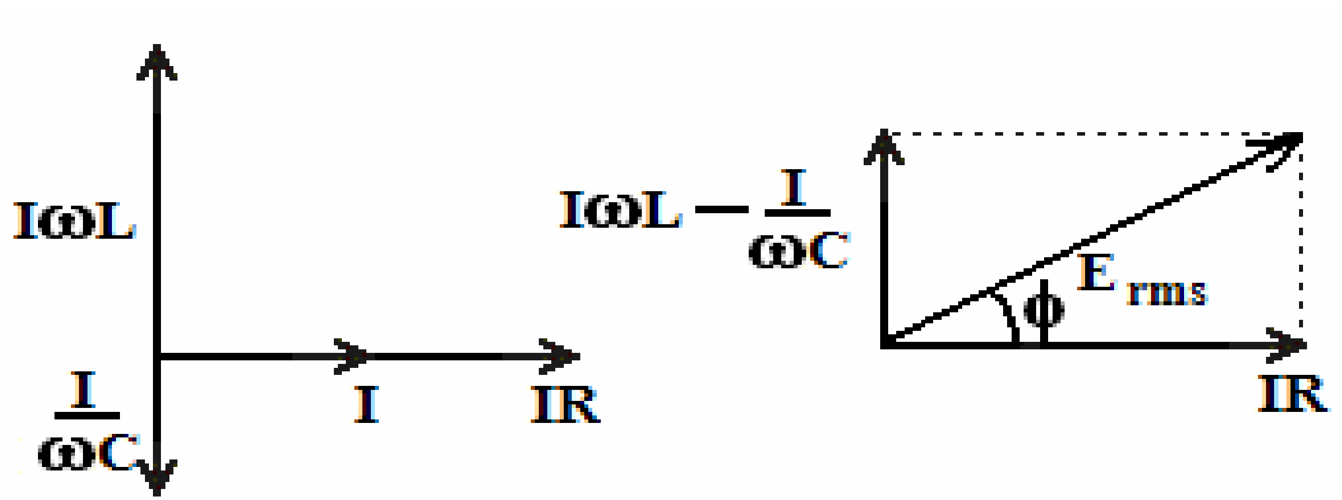
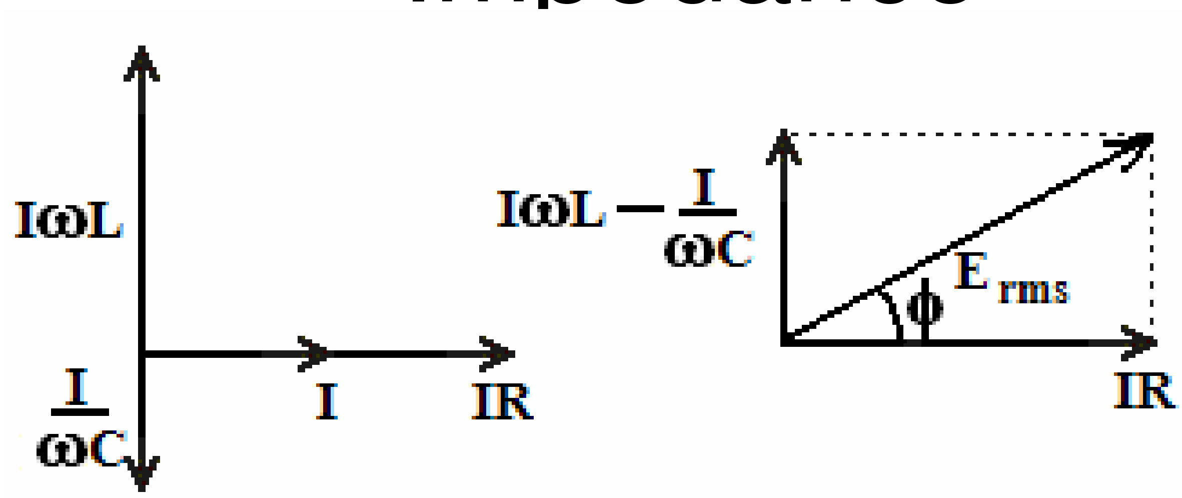
Series L-C-R Circuit





Impedance



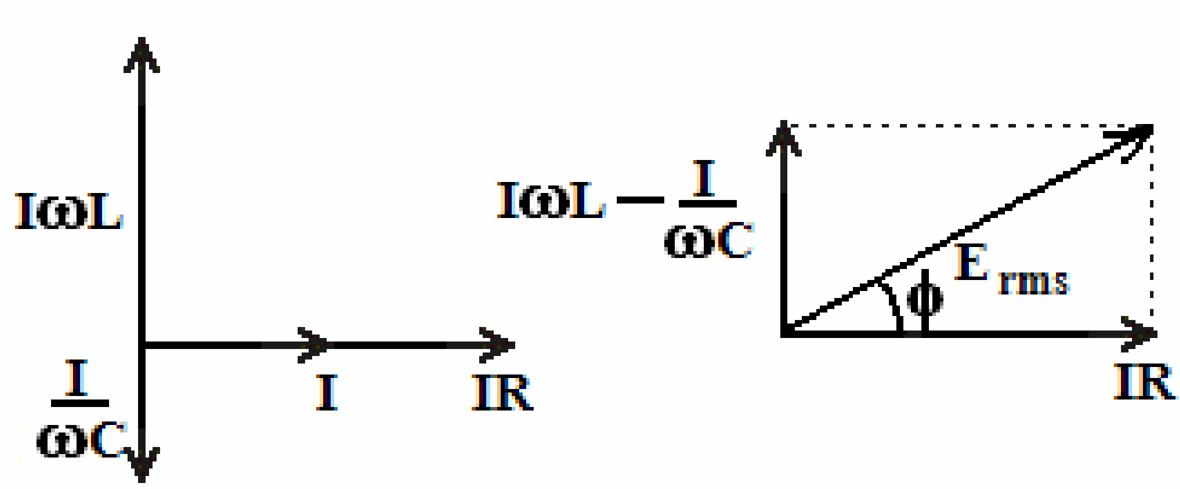
$$E = \sqrt{I^2R^2 + \left(I\omega L - \frac{I}{\omega C}\right)^2} = \sqrt{I^2R^2 + I^2\left(\omega L - \frac{I}{\omega C}\right)^2}$$

$$= I\sqrt{R^2 + \left(\omega L - \frac{I}{\omega C}\right)^2} = I\sqrt{R^2 + (X_L - X_C)^2}$$

$$or\ I = \frac{E}{\sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}} \text{ OR } \frac{E}{\sqrt{R^2 + (X_L - X_C)^2}}$$

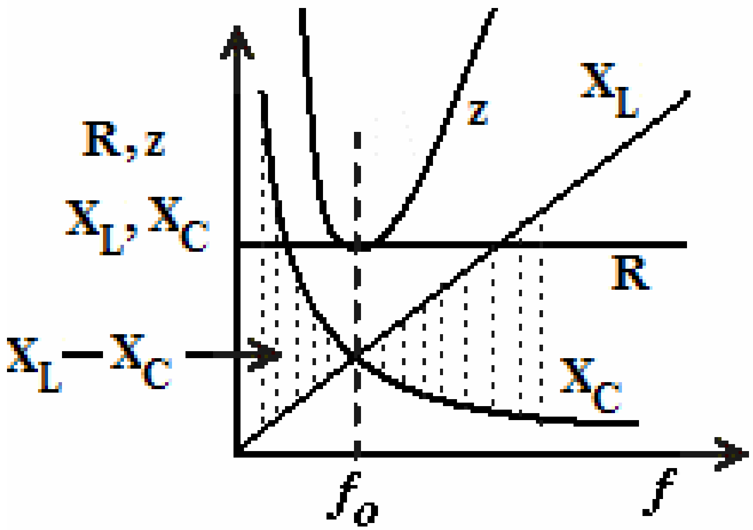
$\sqrt{R^2 + (X_L - X_C)^2}$ is called impedance and denoted by 'z', has unit ohm

Phase difference between current

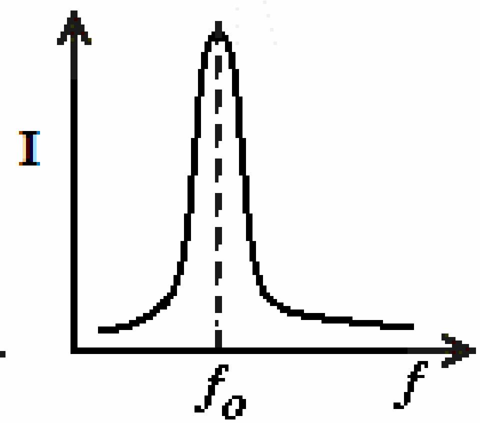


$$tan\,\phi = \frac{I\left(\omega L - \frac{1}{\omega C}\right)}{IR} \quad or \quad \phi = \tan^{-1}\left[\frac{\omega L - \frac{1}{\omega C}}{R}\right] = \tan^{-1}\frac{X_L - X_C}{R}$$

Variation of impedance with frequency

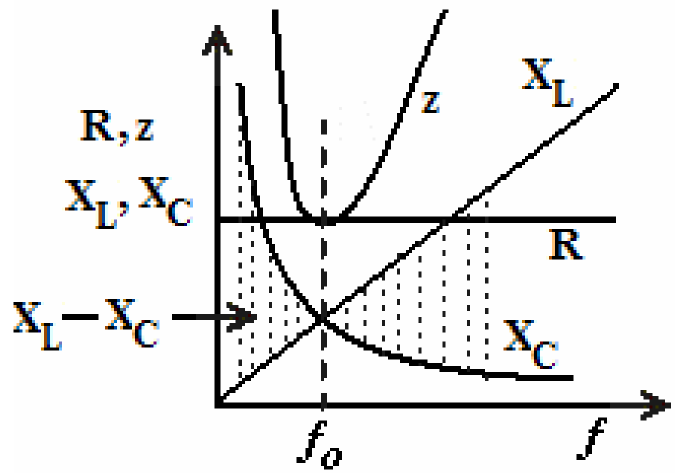


Figure(A)

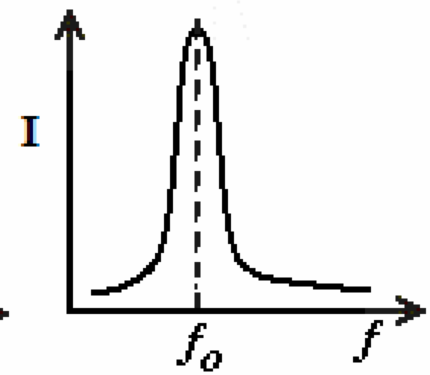


Figure(B)

Resonance



Figure(A)



Figure(B)

$$z=\sqrt{R^2+\left(\omega L-\frac{1}{\omega C}\right)^2}$$ would be minimum when $\omega L=\frac{1}{\omega C}$

or $\omega^2=\frac{1}{LC}$ or $\omega=\frac{1}{\sqrt{LC}}$ or $2\pi\nu=\frac{1}{\sqrt{LC}}$ or $\boxed{\nu=\frac{1}{2\pi\sqrt{LC}}}$

and minimum value of 'z' is = R and current is maximum = $\frac{E}{R}$