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Class 12 Subject Physics(Unit 04) Date 08 07 2020

Note-Wattless Current is not now in syllabus in session (2020 21)

Power in AC Circuit with L, C, R:

$E = E_0 \sin \omega t$

$I = I_0 \sin (\omega t + \Phi)$ (where Φ is the phase angle between emf and current)

Instantaneous Power = $E I$

$= E_0 I_0 \sin \omega t \sin (\omega t + \Phi)$

$= E_0 I_0 [\sin^2 \omega t \cos\Phi + \sin \omega t \cos\omega t \cos\Phi]$

If the instantaneous power is assumed to be constant for an infinitesimally small time dt, then the work done is

$dW = E_0 I_0 [\sin^2 \omega t \cos\Phi + \sin \omega t \cos\omega t \cos\Phi]$

Work done over a complete cycle is

$$W = \int_0^T E_0 I_0 [\sin^2 \omega t \cos\Phi + \sin \omega t \cos\omega t \cos\Phi] dt$$

$W = E_0 I_0 \cos \Phi \times T / 2$

Average Power over a cycle is $P_{av} = W / T$

$P_{av} = (E_0 I_0 / 2) \cos \Phi$

$P_{av} = (E_0/\sqrt{2}) (I_0/\sqrt{2}) \cos \Phi$

$P_{av} = E_v I_v \cos \Phi$

(where $\cos \Phi = R / Z$

$= R / \sqrt{[R^2 + (\omega L - 1/\omega C)^2]}$

is called Power Factor)

$P_{av} = E_v I_v \cos \Phi$

Power in AC Circuit with R:

In R, current and emf are in phase.

$\Phi = 0°$

$P_{av} = E_v I_v \cos \Phi = E_v I_v \cos 0° = E_v I_v$

Power in AC Circuit with L:

In L, current lags behind emf by $\pi/2$.

$\Phi = -\pi/2$

$P_{av} = E_v I_v \cos (-\pi/2) = E_v I_v (0) = 0$

Power in AC Circuit with C:

In C, current leads emf by $\pi/2$.

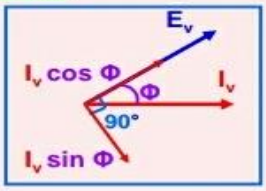
$\Phi = +\pi/2$

$P_{av} = E_v I_v \cos (\pi/2) = E_v I_v (0) = 0$

Note:

Power (Energy) is not dissipated in Inductor and Capacitor and hence they find a lot of practical applications and in devices using alternating current.

Wattless Current or Idle Current:



The component $I_v \cos \Phi$ generates power with E_v.

However, the component $I_v \sin \Phi$ does not contribute to power along E_v and hence power generated is zero. This component of current is called wattless or idle current.

$P = E_v I_v \sin \Phi \cos 90° = 0$