POWER IN AN AC CIRCUIT

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The rate of doing work or the activity of a current, in the case of a steady current, is given by VI. In an alternating current both V and I vary harmonically and differ in phase. If $v = V_0 \sin \omega t$ is the applied emf across the circuit at any instant t and the corresponding current is given by $i = I_0 \sin(\omega t - \phi)$, where ϕ is the phase difference between the emf and the current. If emf and current are in volts and amperes respectively, then the instantaneous power in watts is given by

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$$vi = V_0 I_0 \sin \omega t \sin(\omega t - \phi)$$
$$= V_0 I_0 \left[\sin^2 \omega t \cos\phi - \frac{1}{2} \sin 2\omega t \sin\phi \right].$$

The mean rate of doing work or the average power,

$$P = \frac{1}{T} \int_0^T vi\,dt = \frac{1}{2} V_0 I_0 \cos\phi$$

$$= \frac{V_0}{\sqrt{2}} \cdot \frac{I_0}{\sqrt{2}} \cos\phi$$

= Virtual volts × Virtual amperes × $\cos\phi$ — (1)

where the term $\cos\phi$ is known as power factor. It is said to be leading if current leads voltage, lagging if current lags voltage.