

Power in AC Circuits



Voltage of ac source: $\mathcal{E} = \mathcal{E}_{max} \cos \omega t$

Current through circuit: $I = I_{max} \cos(\omega t - \delta)$

Instantaneous power supplied: $P(t) = \mathcal{E}(t)I(t) = [\mathcal{E}_{max} \cos \omega t][I_{max} \cos(\omega t - \delta)]$

Use $\cos(\omega t - \delta) = \cos \omega t \cos \delta + \sin \omega t \sin \delta$

$$\Rightarrow P(t) = \mathcal{E}_{max} I_{max} [\cos^2 \omega t \cos \delta + \cos \omega t \sin \omega t \sin \delta]$$

Time averages: $[\cos^2 \omega t]_{AV} = \frac{1}{2}$, $[\cos \omega t \sin \omega t]_{AV} = 0$

Average power supplied by source: $P_{AV} = \frac{1}{2} \mathcal{E}_{max} I_{max} \cos \delta = \mathcal{E}_{rms} I_{rms} \cos \delta$

Power factor: $\cos \delta$

