# Instantaneous Power of an AC Circuit

In an a.c. circuit the current and emf vary continuously with time. Therefore power at a given instant of time is calculated and then its mean is taken over a complete cycle. Thus, we define instantaneous power of an a.c. circuit as the product of the instantaneous emf and the instantaneous current flowing through it.

The instantaneous value of emf and current is given by
$e = E0 \sin \omega t$
$i = I0 \sin (\omega t + \theta)$
where θ is the phase difference between the emf and current in an a.c. circuit
The average power consumed over one complete cycle is
$Pav = [E0I0/2] x \cos\theta$
$Pav = Erms\ Irms \cos\theta$
Alternate Method
Instantaneous power $is=vi=Vm \sin wt \times Im \sin (wt-\theta)$
$=1/2 \times Vm\ Im [\cos\theta - \cos(2wt - \theta)]$

The instantaneous power consists of two parts
(i) The constant part (1/2) VmIm cosθ contributing to real power.
(ii) The pulsating component is 1/2 x VmIm cos(2wt-θ)
This has a frequency twice that of the voltage/current.

It is not contributing to actual power since its average value over a complete cycle is zero.

Therefore, average power consumed $(1/2)\ VmIm\cos\theta = Vi\cos\theta$ where V and I represent the r.m.s values.

Now $P=VI \cos\theta=VI \times (R/Z)=(V/Z) xI.\ R=I2R\ (\cos\theta=R/Z)$ or $P=I2R$ watt
Active and Reactive Components of power
Active component of power is in phase with the applied voltage V i.e. V.I cosθ. It is known as 'wattful' component.

Reactive component of power is in quadrature with V i.e. V.I. sinθ. It is known as 'wattless' or 'idle' component.
kVA is called the apparent power.
While dealing electric power in general, we use kilowatt as the unit.
$kW=kVA\cos\theta$; $kVAR = kVA \times \sin\theta$; $kVA= \sqrt{(kw2+kVAR2)}$

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