Instantaneous Power

The instantaneous power for any device is computed from the voltage across it and the current in it. *Instantaneous power* is

$$p(t) = v(t)i(t)$$

Average Power

Periodic voltage and current functions produce a periodic instantaneous power function.

$$P = \frac{1}{T}\int_{t_0}^{t_0+T} p(t)\,dt = \frac{1}{T}\int_{t_0}^{t_0+T} v(t)i(t)\,dt \qquad t_o = 0 \qquad P = \frac{1}{T}\int_{0}^{T} p(t)\,dt$$

Total average power is the sum of the powers at the frequencies in the Fourier series.

$$P = V_0 I_0 + \sum_{n=1}^{\infty}\left(\frac{V_{n,\max} I_{n,\max}}{2}\right)\cos(\theta_n - \phi_n)$$

EFFECTIVE VALUES: RMS

The effective value of a voltage or current is also known as the root-mean-square (rms) value. (Sinusoids)

$$V_{\text{rms}} = V_m/\sqrt{2},\ I_{\text{rms}} = I_m/\sqrt{2},$$

If a voltage is the sum of more than two periodic voltages, all orthogonal, the rms value is

$$V_{\text{rms}} = \sqrt{V_{1,\text{rms}}^2 + V_{2,\text{rms}}^2 + V_{3,\text{rms}}^2 + \cdots}$$

$$I_{\text{rms}} = \sqrt{I_{1,\text{rms}}^2 + I_{2,\text{rms}}^2 + I_{3,\text{rms}}^2 + \cdots}$$

Apparent Power *S*

$$S = V_{\text{rms}} I_{\text{rms}}$$

Power Factor

The *power factor* of a load is defined as the ratio of average power P to apparent power S:

$$\text{pf} = \frac{P}{S} = \frac{P}{V_{\text{rms}} I_{\text{rms}}}$$

Total harmonic distortion (**THD**) quantify the non-sinusoidal property of a waveform. THD is the ratio of the rms value of all the nonfundamental frequency terms to the rms value of the fundamental frequency term.

$$\text{THD} = \sqrt{\frac{I_{\text{rms}}^2 - I_{1,\text{rms}}^2}{I_{1,\text{rms}}^2}}$$