RMS VALUE ,INSTANTANEOUS POWER & REAL POWER

R.M.S VALUE

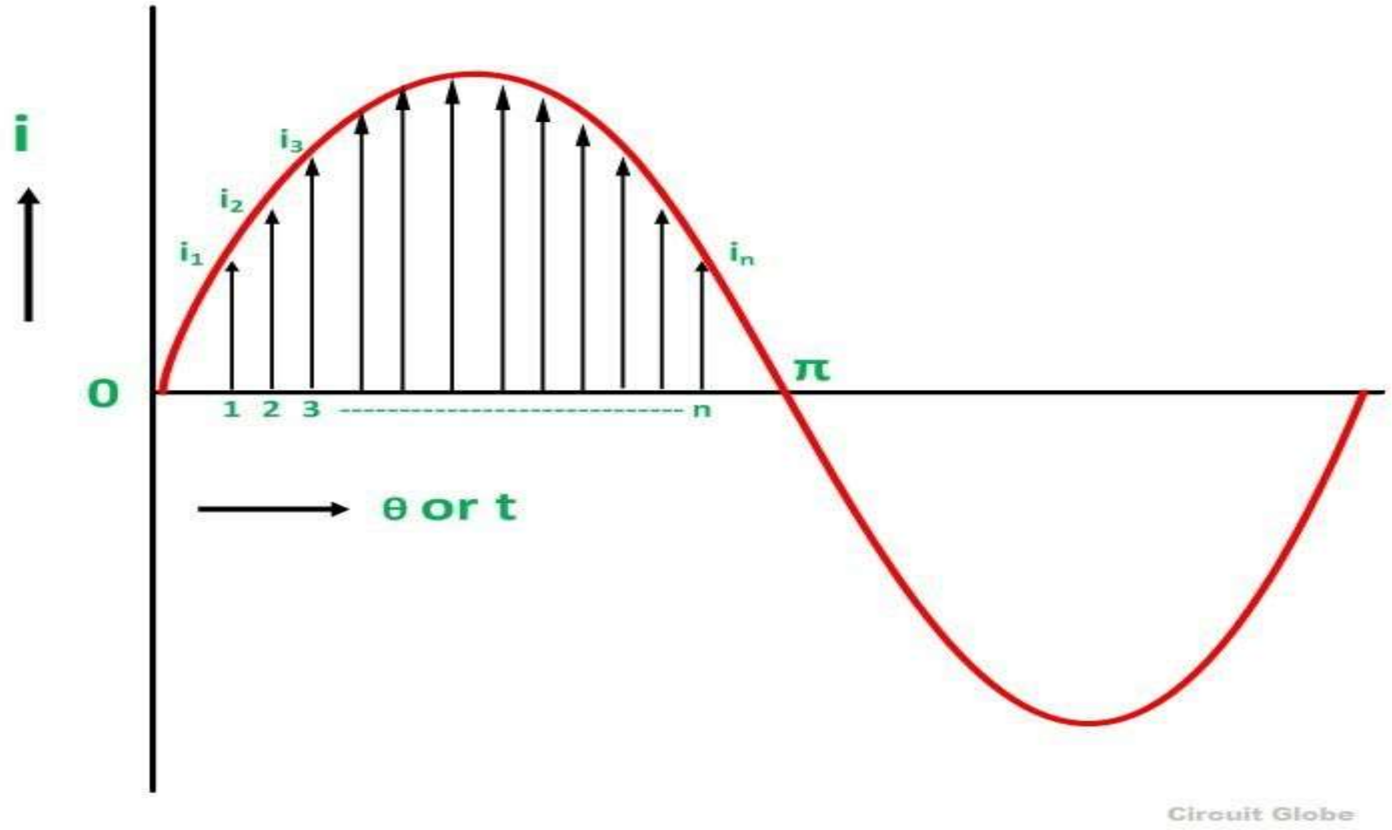
Definition: The **RMS** (**Root Mean Square**) value (also known as **effective** or **virtual** value) of an alternating current.

steady current which, when flows through a resistor of known resistance for a given period of time than as a result the same quantity of heat is produced by the alternating current when flows through the same resistor for the same period of time is called **R.M.S** or **effective value** of the alternating current.

In other words, the **R.M.S value is defined** as the square root of means of squares of instantaneous values.

Let I be the alternating current flowing through a resistor R for time t seconds, which produces the same amount of heat as produced by the direct current (I_{eff}). The base of one alteration is divided into n equal parts so that each interval is of t/n seconds as shown in the figure below.

R.M.S VALUE



R.M.S VALUE

RMS value of alternating current(I) = √mean value of i^2

$$=\sqrt{i_1^2 + i_2^2 + i_3 + \ldots + i_n^2 \;/\; n}$$

Similarly, RMS value of alternating voltage can be expressed as –

For symmetrical waveforms, the RMS value can be calculated by considering halfcycle or full-cycle. But, in case of Unsymmetrical waveforms, full-cycle should be considered.

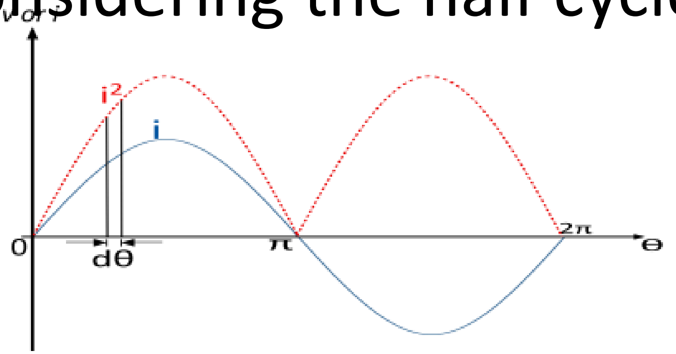
For symmetrical wave,

$$\text{RMS value} = \sqrt{\frac{\text{Area of half cycle squared wave}}{\text{half cycle base length}}}$$

RMS value of Sinusoid

R.M.S VALUE

Since the sinusoidal wave is a symmetrical wave. Hence we can calculate the RMS value of this by considering the half cycle only.



The equation of sinusoidal alternating current is given by

$i = I_m \sin\theta$

Let us consider a strip of width $d\theta$ in the positive half cycle of the squared current wave (shown red coloured dotted). Let the i^2 be the average height of the strip.

Area of strip= $i^2\, d\theta$

R.M.S VALUE

Area of half cycle of squared wave$={}_0^\pi\int i^2 d\theta = {}_0^\pi \int I^2{}_m \sin^2\theta \, d\theta$

Therefore, $=\dfrac{\pi I^2 m}{2}$

$I_{RMS} = \sqrt{\dfrac{\text{Area of half cycle squared wave}}{\text{base length of half cycle}}}$

$= \sqrt{\dfrac{\pi I_m^2/2}{\pi}}$

$= \sqrt{I_m / 2} = 0.707Im$

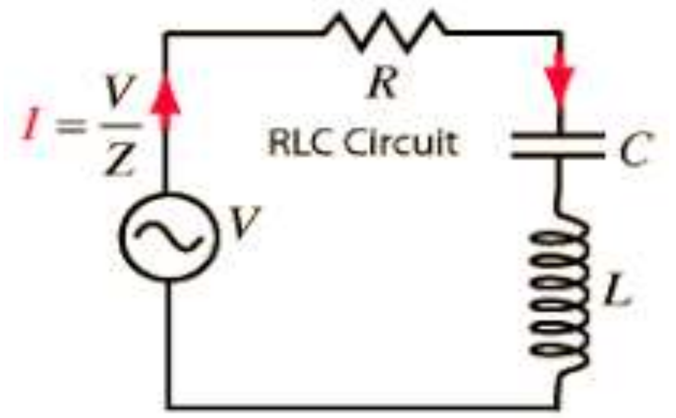
Similarly, the RMS value of sinusoidal alternating voltage is

$VRMS = \sqrt{V_m / 2} = 0.707Vm$

Thus, the RMS value of sinusoidal alternating voltage or current is equal to 0.707 times of the peak value.

Instantaneous Power

In DC circuits, the instantaneous electric power in an AC circuit is given by P=VI where V and I are the instantaneous voltage and current.

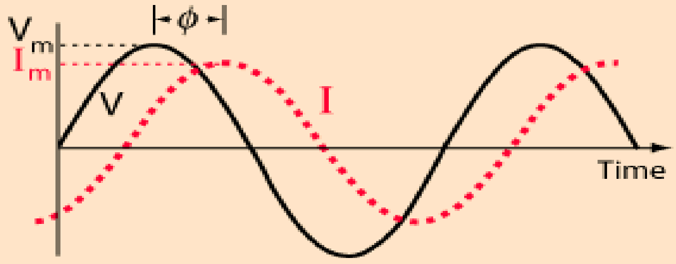


Instantaneous Power

As in DC circuits, the instantaneous electric power in an AC circuit is given by P=VI where V and I are the instantaneous voltage and current. Since ,

$$V = V_m \sin \omega t$$
$$I = I_m \sin(\omega t - \phi)$$

Then the instantaneous power at any time **t** can be expressed as



$$P_{\text{instantaneous}} = V_m I_m \sin \omega t \sin(\omega t - \phi)$$

By using the trig identity

$$\sin(\omega t - \phi) = \sin \omega t \cos \phi - \cos \omega t \sin \phi$$

The instantaneous power is

$$P_{\text{instantaneous}} = V_m I_m \cos\phi \sin^2 \omega t - V_m I_m \sin\phi \sin \omega t \cos \omega t$$

Real Power

The part of total power in an AC circuit which is consumed by the equipment to do useful work is called real power or active power. The total amount of power flowing from source to load in an AC circuit is known as apparent power. Real power is denoted by letter 'P'.

Formula for

Real power is P= VI Sin ϑ

Apparent Power S=V I

Reactive Power Q= V I Cos ϑ

Power Triangle