ALTERNATING CURRENT

The main
reason for preferring use of ac voltage over dc
voltage is that ac voltages
can be easily and efficiently converted from one
voltage to the other by means of transformers

Voltage that varies like a **sine** function with time is called alternating voltage (ac voltage) and the current driven by it in a circuit is called the alternating current (ac current)

AC circuits exhibit characteristics which are exploited in many devices of daily use.

We consider a source which produces sinusoidally varying potential difference across its terminals. Let this potential difference, also called ac voltage,

be given by $\mathbf{v = v_m \sin \omega t}$

where $\mathbf{v_m}$ is the amplitude of the oscillating potential difference and ω is its angular frequency.

To find the value of current through the resistor, we apply Kirchhoff's loop rule

$$\mathbf{v_m \sin \omega t = i R} \quad \text{or} \quad i = \frac{v_m}{R} \sin \omega t$$

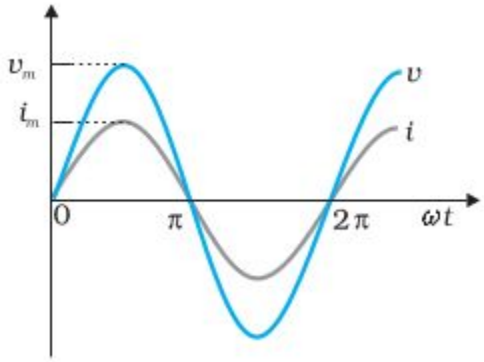
Since R is a constant, we can write this equation as

$$\mathbf{i = i_m \sin \omega t}$$

where the current amplitude $\mathbf{i_m}$ is given by where $i_m = \frac{v_m}{R}$ is the current amplitude

Ohm's law which for resistors works

equally well for both **ac and dc** voltages.



The voltage across a pure resistor and the current through it are plotted as a function of time in the Figure

Both voltage and current reach zero, minimum and maximum values at the same time. Clearly, the voltage and current are **in phase** with each other.

The sum of the instantaneous current values over one complete cycle is zero, and the average current is zero. The fact that the average current is zero. But the **average power** consumed is **not zero**

The instantaneous power dissipated in the resistor is

$$p = i^2 R = i_m^2 R \sin^2 \omega t$$

The average value of p over a cycle is

$$\bar{p} = \langle i^2 R \rangle = \langle i_m^2 R \sin^2 \omega t \rangle$$

$$= i_m^2 R \langle \sin^2 \omega t \rangle$$

we can see that

$$< \sin^2 \omega t > = \frac{1}{2}$$

Thus,

$$\overline{p} = \frac{1}{2} i_m^2 R$$

To express ac power in the same form as dc power, a special value of current is defined and used. It is called, root mean square (rms) or effective current

The rms current I is related to the peak current im by

$$I = \sqrt{\overline{i^2}} = \sqrt{\frac{1}{2} i_m^2} = \frac{i_m}{\sqrt{2}}$$

$$= 0.707\ i_m$$

In terms of I, the average power, denoted by P is

$$P = \overline{p} = \frac{1}{2} i_m^2 R = I^2 R$$

$$V = \frac{v_m}{\sqrt{2}} = 0.707\ v_m$$

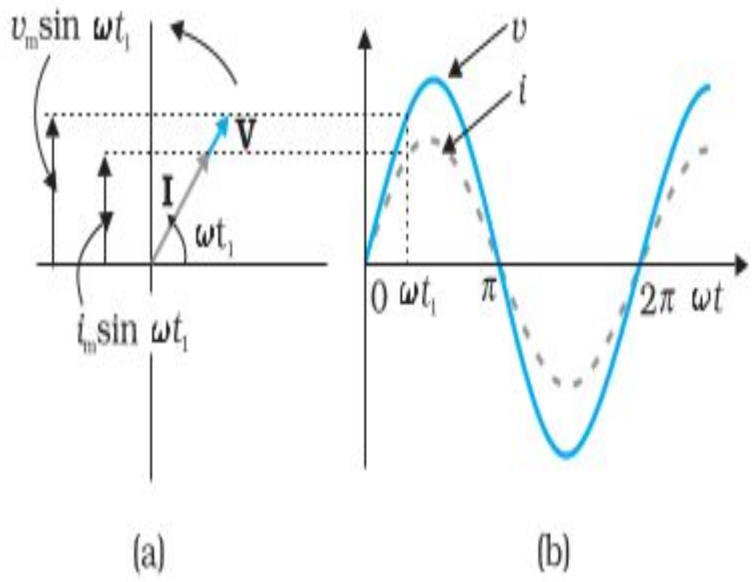
is the rms voltage or effective voltage

In terms of rms values, the equation for power and relation between current and voltage in ac circuits are essentially the same as those for the dc case.

PHASORS

In order to show phase relationship between voltage and current in an ac circuit, we use the notion of phasors.

A phasor is a vector which rotates about the origin with angular speed ω,



The magnitudes of phasors V and I represent the amplitudes or the peak values vm and im of these oscillating quantities.

The **projection** of voltage and current phasors on vertical axis, i.e., $\mathbf{v_m \sin\omega t}$ and $\mathbf{i_m \sin\omega t}$, respectively represent the value of voltage and current at that instant.