Important Values of Alternating Quantities.

(1) Peak value (i0 or V0)

The maximum value of alternating quantity (i or V) is defined as peak value or amplitude.

(2) Mean square value $(\overline{V^2}$ **or** $\overline{i^2})$

The average of square of instantaneous values in one cycle is called mean square value. It is always positive for one complete cycle. e.g. $\overline{V^2} = \frac{1}{T}\int_0^T V^2 dt = \frac{V_0^2}{2}$ or $\overline{i^2} = \frac{i_0^2}{2}$

(3) Root mean square (r.m.s.) value

Root of mean of square of voltage or current in an ac circuit for one complete cycle is called r.m.s. value. It is denoted by Vrms or irms

$$i_{rms} = \sqrt{\frac{i_1^2 + i_2^2 + ...}{n}} = \sqrt{\overline{i^2}} = \sqrt{\frac{\int_0^T i^2 dt}{\int_0^T dt}} = \frac{i_0}{\sqrt{2}}$$

= 0.707 i0 = 70.7% of i0

Similarly $V_{rms} = \frac{V_0}{\sqrt{2}} = 0.707\ V_0 = 70.7\%$ of V0

(i) The r.m.s. value of alternating current is also called virtual value or effective value.

(ii) In general when values of voltage or current for alternating circuits are given, these are r.m.s. value.

(iii) ac ammeter and voltmeter are always measure r.m.s. value. Values printed on ac circuits are r.m.s. values.

(iv) In our houses ac is supplied at 220 V, which is the r.m.s. value of voltage. Its peak value is $\sqrt{2} \times 200 = 311\,V.$

(v) r.m.s. value of ac is equal to that value of dc, which when passed through a resistance for a given time will produce the same amount of heat as produced by the alternating current when passed through the same resistance for same time.

Note: R.M.S. value of a complex current wave (e.g. i = a sinω t + b cosω t) is equal to the square root of the sum of the squares of the R.M.S. values of its individual components i.e.

$$i_{rms} = \sqrt{\left(\frac{a}{\sqrt{2}}\right)^2 + \left(\frac{b}{\sqrt{2}}\right)^2} = \frac{1}{\sqrt{2}}\left(\sqrt{a^2 + b^2}\right)$$

(4) Mean or Average value (iav or Vav)

The average of instantaneous values of current or voltage in one cycle is called its mean value. The average value of alternating quantity for one complete cycle is zero.

The average value of ac over half cycle (t = 0 to T/2)

$$i_{av} = \frac{\int_0^{T/2} i\,dt}{\int_0^{T/2} dt} = \frac{2i_0}{\pi} = 0.637\, i_0 = 63.7\%$$

of i0, Similarly

$$V_{av} = \frac{2V_0}{\pi} = 0.637\, V_0 = 63.7\%$$

of V0.

Specific Examples

Currents	Average value (For complete cycle)	Peak value	r.m.s. value	Angular frequency
i = i0 sinω t	0	i0	$\frac{i_0}{\sqrt{2}}$	ω
i = i0 sinω t cos ω t	0	$\frac{i_0}{2}$	$\frac{i_0}{2\sqrt{2}}$	2ω
i = i0 sinω t + i0 cosω t	0	$\sqrt{2}\, i_0$	i0	ω

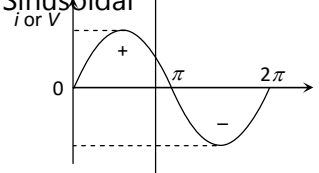
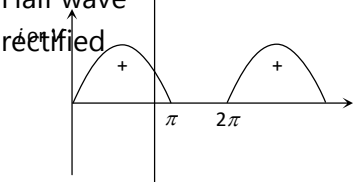
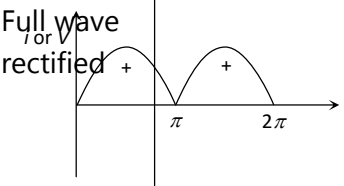
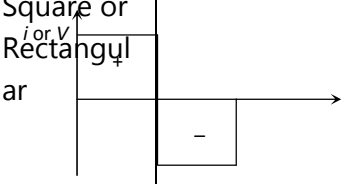
(5) Peak to peak value

It is equal to the sum of the magnitudes of positive and negative peak values

∴ Peak to peak value = V0 + V0 = 2V0 $= 2\sqrt{2}\ V_{rms} = 2.828\ V_{rms}$

(6) Peak factor and form factor

The ratio of R.M.S. value of ac to its average during half cycle is defined as form factor. The ratio of peak value and R.M.S. value is called peak factor

Nature of wave form	Wave form	r.m.s. value	average value	Form factor $R_f = \frac{\text{r.m.s. value}}{\text{Average value}}$	Peak factor $R_p = \frac{\text{Peak value}}{\text{r.m.s. value}}$
Sinusoidal		$\frac{i_0}{\sqrt{2}}$	$\frac{2}{\pi} i_0$	$\frac{\pi}{2\sqrt{2}} = 1.11$	$\sqrt{2} = 1.41$
Half wave rectified		$\frac{i_0}{2}$	$\frac{i_0}{\pi}$	$\frac{\pi}{2} = 1.57$	2
Full wave rectified		$\frac{i_0}{\sqrt{2}}$	$\frac{2i_0}{\pi}$	$\frac{\pi}{2\sqrt{2}}$	$\sqrt{2}$
Square or Rectangular		i_0	i_0	1	1