RMS value of Alternating Current and current

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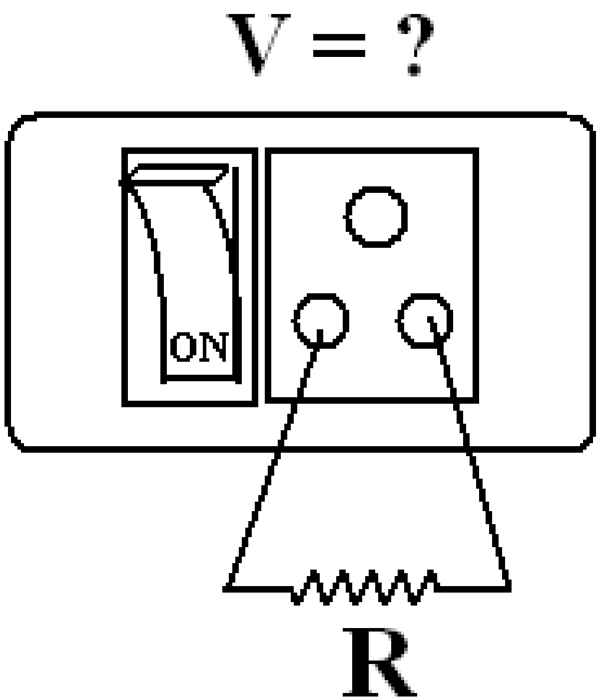
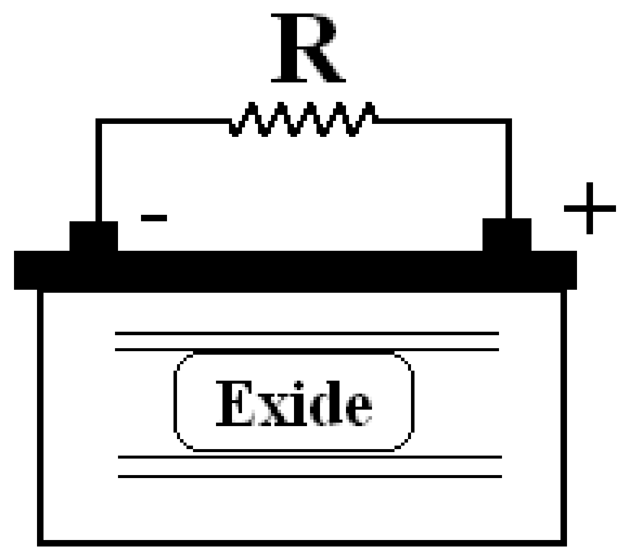
RMS value of Alternating current

It is a comparison between heat produced by Alternating Current and Direct Current





RMS value of Alternating Voltage

Root mean square or R.M.S. value of Alternating voltage is defined as that value of steady Potential Difference, which would generate the same amount of heat in a given resistance is given time, as is done by A.C. voltage , when maintained across the same resistance for the same time.

The R.M.S. value is also called ***effective value*** or ***virtual value of alternating voltage***. It is represented by V_{rms}, V_{eff} or V_v

RMS value of Alternating current

Root mean square or R.M.S. value of Alternating current is defined as that value of steady current, which would generate the same amount of heat in a given resistance is given time, as is done by A.C. current , when maintained across the same resistance for the same time.

The R.M.S. value is also called ***effective value*** or ***virtual value of alternating Current***. It is represented by I_{rms}, I_{eff} or I_v.

Expression for RMS value of Alternating current

Let $I = I_o \text{Sin}\ \omega t$

Let this current on flowing through R for a small time 'dt' produces a heat $dH = I^2 Rdt$.

Hence in one complete cycle $(\text{zero} \rightarrow T)$ the heat produced by A.C. is

$$H = \int_0^T dH = \int_0^T I^2 Rdt = \int_0^T I_0^2 R\ \text{Sin}^2 \omega t.\ dt$$

$$= I^2 R \int_0^T \left[\frac{1 - \text{Cos}\ 2\omega t}{2}\right] dt \qquad [\text{ As } 2\text{Sin}^2\theta = 1 - \text{Cos}\ \theta]$$

Expression for RMS value of Alternating current

$$\text{which is} = \frac{I_0^2 R}{2}\left[\int_0^T (1-\cos 2\omega t).dt\right] = \frac{I_0^2 R}{2}\left[t - \frac{\sin 2\omega t}{2\omega}\right]_0^T$$

$$= \frac{I_0 R^2}{2}\left[\left(T - \frac{\sin\left(\frac{2.2\pi}{T}.T\right)}{2\omega}\right) - \left(0 - \frac{\sin 0}{2\omega}\right)\right] = \frac{I_0^2 R}{2}[T].....(1)$$

$$[\ \sin 4\pi = \sin 0 = 0]$$

If I_v is the virtual value of A.C., then heat produced by this steady current in time T is $H = I_v^2 R.T$ ....(2)

From (2) and (3) we get

$$I_v^2 R.T = \frac{I_0^2 R}{2}.T \text{ or } I_v^2 = \frac{I_0^2}{2} \text{ or } \boxed{I_v = \frac{I_0}{\sqrt{2}}} \text{ or } I_v = 0.707\, I_0$$

Expression for RMS value of Alternating Voltage

On the similar lines one can calculate the RMS value of Alternating Voltage

Small heat produced by Alternating Voltage in small time dt is $= \frac{(E_0 \sin\omega t)^2}{R} dt$

on integrating it over 0 to T and equating with heat produced by DC in the same time i.e. $E_v{}^2 T/R$ we get

$$E_v = \frac{E_o}{\sqrt{2}}$$