Complete PHYSICS

IIT-JEE · NEET · CBSE eBOOKS

CLASS 11&12th

CLASS 12th

Alternating Current

01. Alternating Current and E.M.F.

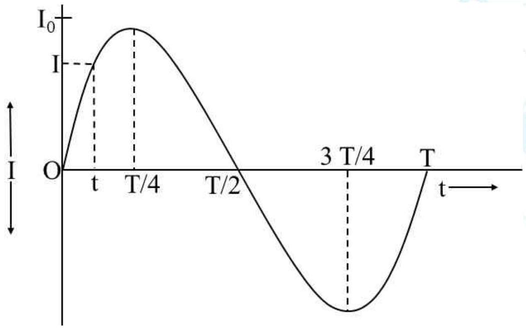
The electric current, whose magnitude changes with time and direction reverses periodically, is alternating current. The instantaneous value (value at any time t) of the alternating current is given by

$$I = I_0 \sin \omega t \quad \text{...(i)}$$

or

$$I = I_0 \cos \omega t, \quad \text{...(ii)}$$

Since alternating current varies continuously with time, its effect is measured by defining either the ***mean value*** (or ***average value***) of a.c. or by defining ***root mean square value*** (or ***virtual value***) of a.c.



02. Mean or Average Value of A.C

It is that steady current, which when passed through a circuit for half the time period of the alternating current, sends the same amount of charge as is done by the alternating current in the same time through the same circuit.

It is denoted by I_m or I_a.

03. Root Mean Square (RMS) or Virtual Value of A.C.

It is that steady current, which when passed through a resistance for a given time will produce the same amount of heat as the alternating current does in the same resistance and in the same time.

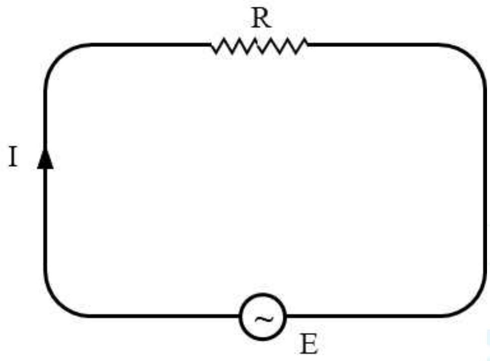
It is denoted by I_{rms} or I_v.

The r.m.s. or virtual value of a.c. is same even for a complete cycle of a.c. This fact is made use of to construct ***hot wire instruments*** for measuring current and voltages.

04. A.C. Through a Resistor

Instantaneous value of alternating e.m.f.

$$E = E_0 \sin \omega t$$



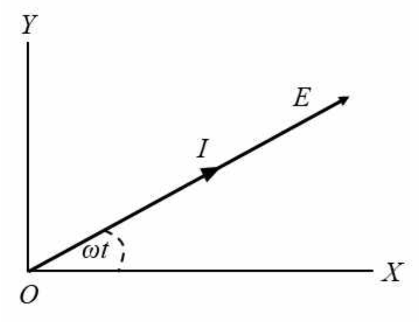
If I is the current in the circuit

$$E = IR$$

the peak value of alternating current in the circuit.

$$I = I_0 \sin \omega t$$

alternating current is ***in phase*** with the e.m.f., when a.c. flows through a resistance.



05. A.C. Through An Inductor

instantaneous value of alternating e.m.f.

$$E = E_0 \sin \omega t \qquad \text{...(i)}$$

instantaneous induced e.m.f. produced across $L = -L\dfrac{dI}{dt}$

Since there is no circuit element across which potential drop may occur,

$$E + \left(-L\frac{dI}{dt}\right) = 0$$

or $\quad dI = \dfrac{E}{L}dt$

or $\quad I = \dfrac{E_0}{L}\left(\dfrac{-\cos\omega t}{\omega}\right) = -\dfrac{E_0}{\omega L}\cos\omega t = \dfrac{E_0}{\omega L} sin\left(\omega t - \dfrac{\pi}{2}\right)$