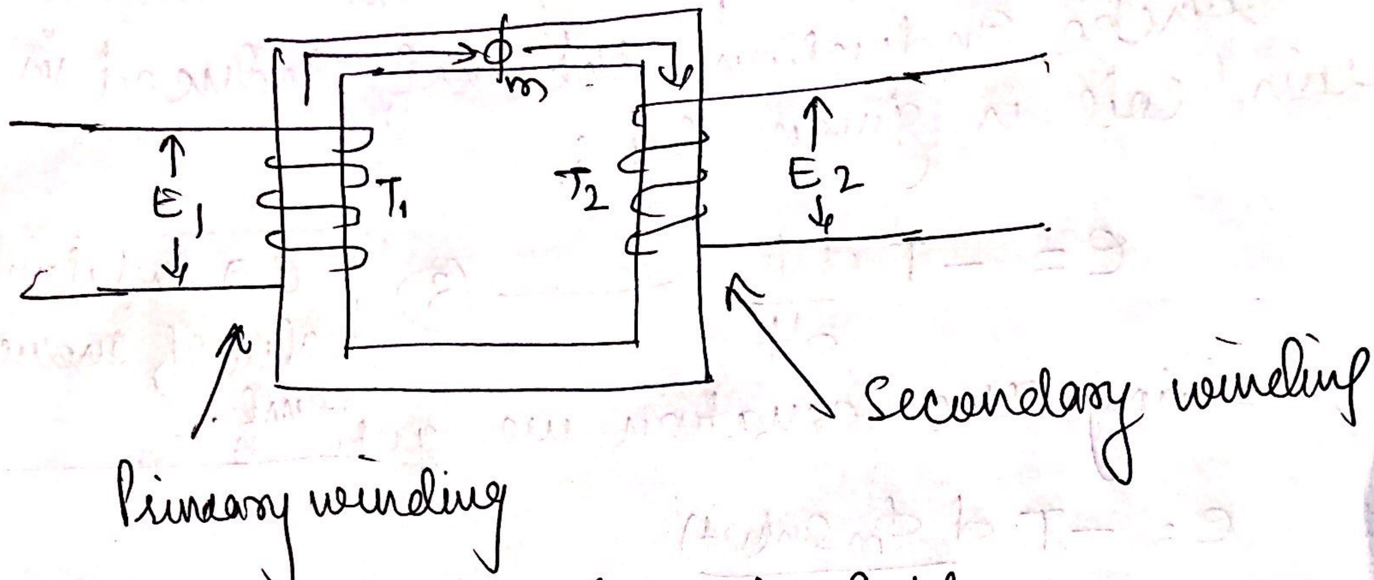
EMF equation of the transformer



ϕ_m = peak value of mutual flux

T_1 & T_2 = Number of turns of the primary & Secondary windings respectively.

E_1 and E_2 ⇒ RMS values of emfs induced in primary and secondary respectively.

The Input to the Transformer is AC (i.e bidirectional and is given by

$$v_1 = V_m \sin(\omega t) \quad \text{——— (1)}$$

This sinusoidal voltage establish a sinusoidal flux in the primary winding of the transformer. The flux generated is given by:

$$\phi = \phi_m \sin(\omega t) \quad \text{——— (2)}$$

where ϕ ⇒ Instantaneous value of flux.

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Let this flux links with a coil of turns "T". Then as per Faraday's Law of Electro-magnetic Induction, the emf induced in this coil is given by :

$$e = -T \frac{d\phi}{dt} \quad \text{———} \quad (3)$$

e ⇒ Instantaneous value of induced emf.

deriving the equation we get:

$$e = -T \frac{d\,\phi_m \sin(\omega t)}{dt}$$

$$e = -T \phi_m \frac{d(\sin \omega t)}{dt}$$

$$\boxed{e = -T \phi_m \omega \cos \omega t} \quad \text{———} \quad (4)$$

eqn (4) can also be written as :→

$$\boxed{e = +T \phi_m \omega \sin\left(\omega t - \frac{\pi}{2}\right)} \quad \text{———} \quad (5)$$

eqn (5) indicates the instantaneous value of induced emf in the ~~coil~~ coil.

Now; the same phenomenon occurs in the primary and secondary windings of the transformer.

simplifying eqn (5) we get.

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$$e = E_m \sin\left(\omega t - \frac{\pi}{2}\right) \quad \text{—— (6)}$$

where: $\boxed{E_m = T \phi_m \omega}$ ⇐ E_m is the peak value of induced emf

Now; the RMS value of induced emf is given by:

$$E = \frac{E_m}{\sqrt{2}}$$

$$\text{or, } E = \frac{T \phi_m \omega}{\sqrt{2}}$$

$$\text{or, } E = \frac{T \phi_m \times 2\pi f}{\sqrt{2}}$$

$$(\because \omega = 2\pi f)$$

$$\text{or, } \boxed{E = 4.44\, \phi_m f T} \quad \text{—— (7)}$$

eq^n (7) is the emf equation of the coil.

Now, the same principle is applicable to transformer also.

Hence; the emf equations of the transformer are given as:

$$E_1 = 4.44\, \phi_m f T_1 \quad \text{—— (8)}$$

$$E_2 = 4.44\, \phi_m f T_2 \quad \text{—— (9)}$$

From eq^n (8) & (9) we observe that:

$E_1 \propto T_1$ and

$E_2 \propto T_2$

That means, the magnitude of the emf of the Transformer is directly proportional to the number of turns of the winding.

From eq^n (8) and (9) we have also observed that, the emf of transformer depends upon: ϕ_m, f and T

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however, in both eq^n. (i.e 8 & 9) we have noticed that the flux (ϕ_m) and frequency (f) remains same.

This means that; the flux and frequency are the common parameters of the two ~~wind~~ windings of the transformer.

The instantaneous values of the emf equation of the transformer are given as;

for primary winding:

$$e_1 = E_{m_1} \sin\left(\omega t - \frac{\pi}{2}\right) \quad \text{—— (10)}$$

for secondary winding;

$$e_2 = E_{m_2} \sin\left(\omega t - \frac{\pi}{2}\right) \quad \text{—— (11)}$$

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