TRANSFORMER

PRESENTED BY

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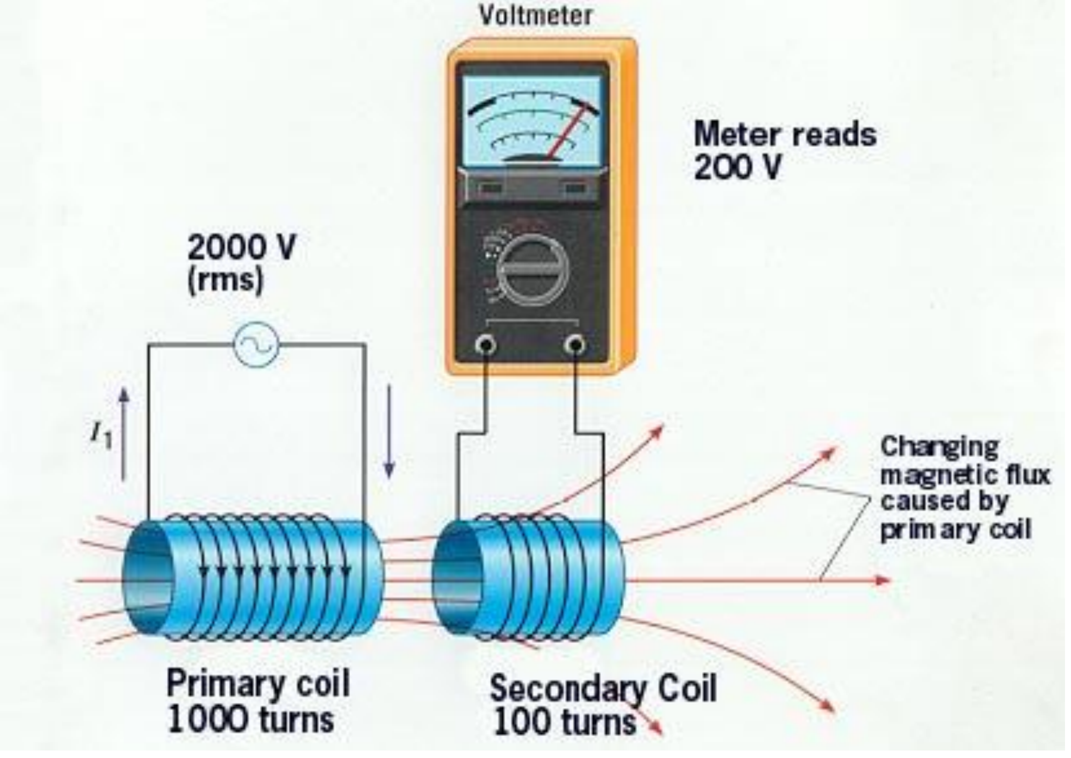
Transformer

An A.C. device used to change high voltage low current A.C. into low voltage high current A.C. and vice-versa without changing the frequency

In brief,

1. Transfers electric power from one circuit to another
2. It does so without a change of frequency
3. It accomplishes this by electromagnetic induction
4. Where the two electric circuits are in mutual inductive influence of each other.

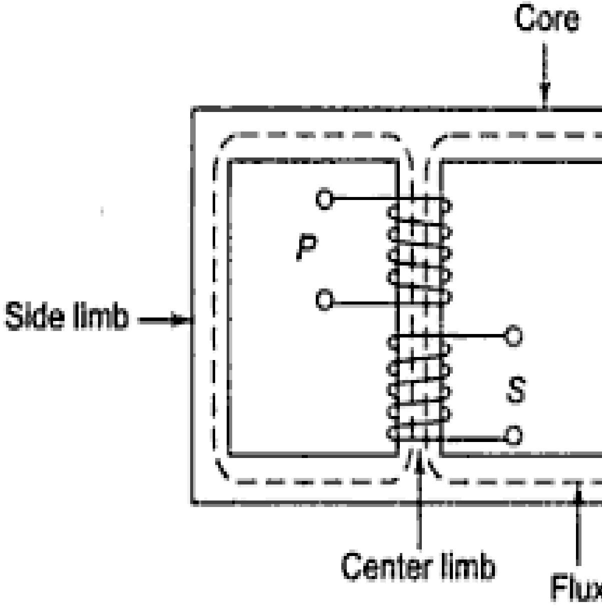
Principle of operation



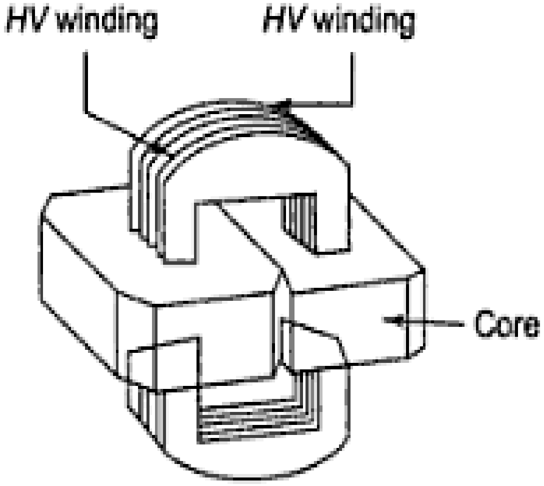
It is based on principle of MUTUAL INDUCTION.

According to which an e.m.f. is induced in a coil when current in the neighbouring coil changes.

Constructional detail : Shell type



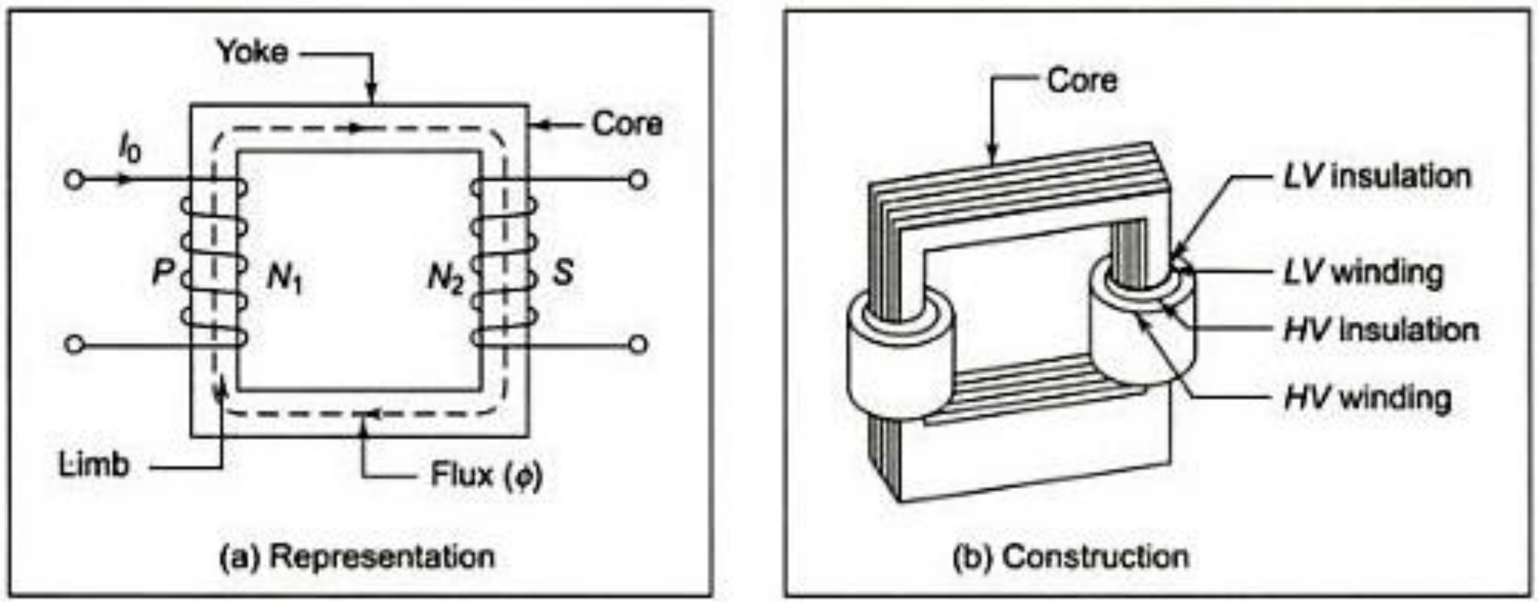
(a) Representation



(b) Construction

- Windings are wrapped around the center leg of a laminated core.

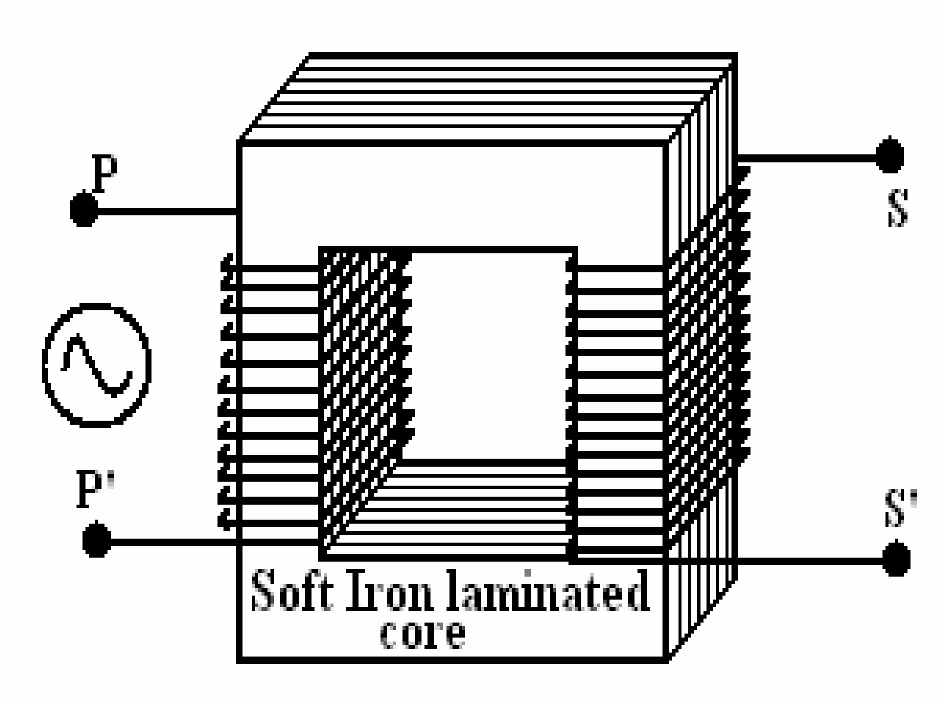
Core type



- Windings are wrapped around two sides of a laminated square core.

Working of a transformer

1. When current in the primary coil changes being alternating in nature, a changing magnetic field is produced
2. This changing magnetic field gets associated with the secondary through the soft iron core
3. Hence magnetic flux linked with the secondary coil changes.
4. Which induces e.m.f. in the secondary.



Single Phase Transformer

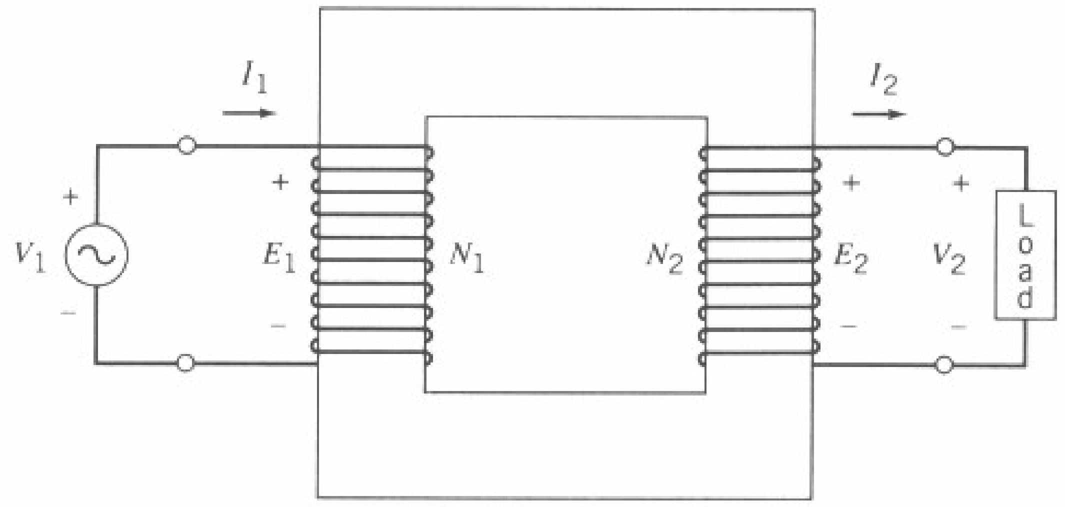
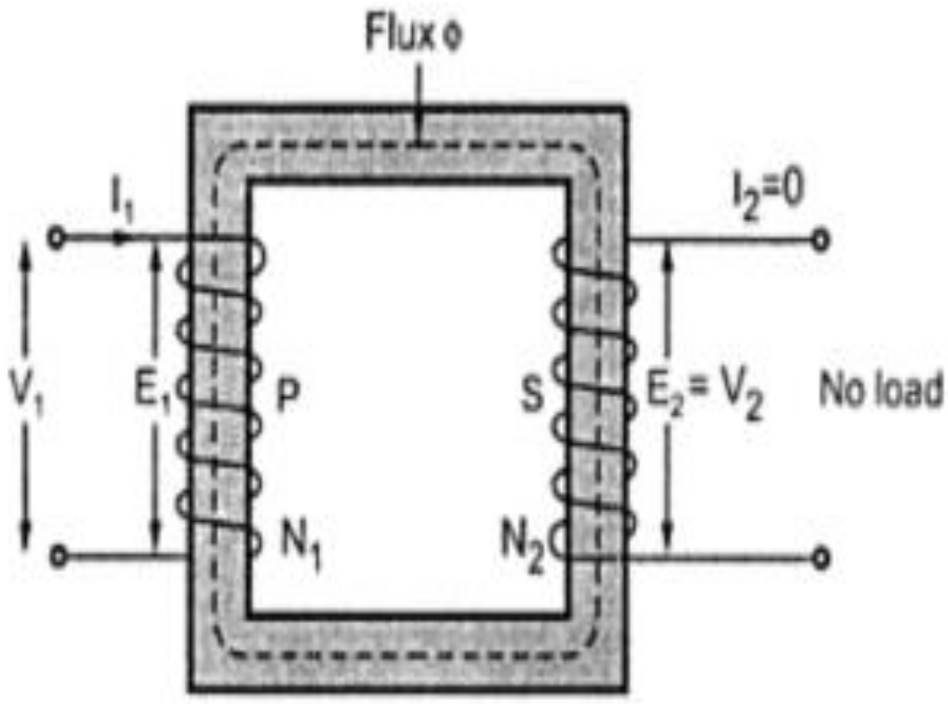
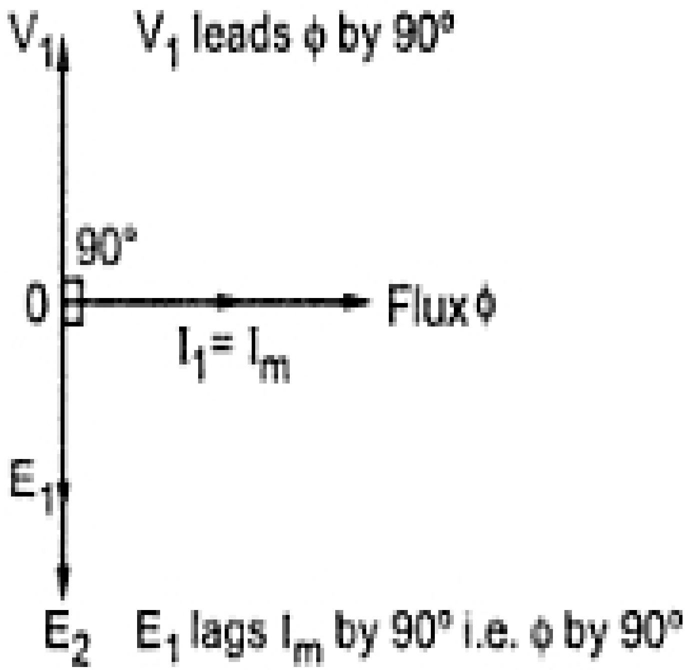


FIGURE 4.8 A transformer circuit.

- A single phase transformer
  - Two or more winding, coupled by a common magnetic core

Ideal transformer





V_1 – supply voltage ; I_1- noload input current ;

V_{2-} output voltgae; I_2- output current

I_m- magnetising current;

E_1-self induced emf ; E_2- mutually induced emf

Losses in a transformer

Core or Iron loss:

Hysteresis loss $W_h = \eta B^{1.6}_{max} f V$ watt;

eddy current loss $W_e = \eta B^2_{max} f^2 t^2$ watt

Copper loss:

Total Cu loss $= I_1^2 R_1 + I_2^2 R_2 = I_1^2 R_{01} + I_2^2 R_{02}$.

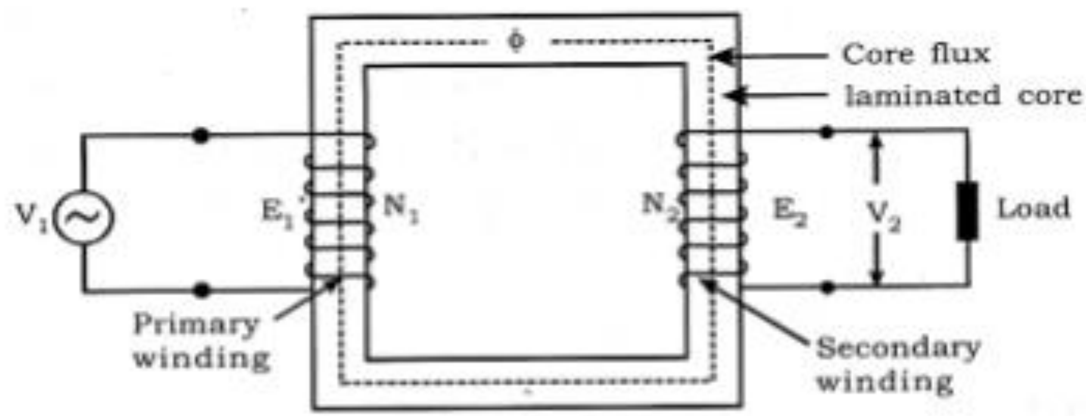
All day efficiency

$$\text{ordinary commercial efficiency} = \frac{\text{out put in watts}}{\text{input in watts}}$$

$$\eta_{all\ \text{day}} = \frac{\text{output in kWh}}{\text{Input in kWh}}(\,for\ \text{24 hours})$$

- All day efficiency is always less than the commercial efficiency

1.3 EMF Equation of Transformer



Let an alternating voltage V_1 with frequency F be applied to primary winding of the transformer as shown in figure above. Let the number of turns in the primary be N_1. The alternating voltage will set up a flux given by

$$\Phi = \Phi_m \sin \omega t$$

Where; Φ_m is the maximum value of flux.

$\omega = 2\pi F$

By Faradays Law, induced EMF, $e_1 = -N_1 \frac{d\phi}{dt}$

$$e_1 = -N_1 \frac{d}{dt} (\Phi m \text{ Sin } \omega t)$$

i.e $$e_1 = -N_1 \omega \Phi_m \cos \omega t$$

$$= -N_1 2\pi F \Phi_m \cos \omega t$$

$$e_1 = N_1 2\pi F \Phi_m \sin (\omega t - 90)$$

in the above equation e_1 attains maximum value when $\sin (\omega t - 90) = 1$.Therefore the maximum value E_1 is given by

$$E_1 = N_1 2\pi F \Phi_m$$

i.e $$\boldsymbol{E_1 = 4.44\, N_1 F\, \Phi_m}$$

Similarly $$\boldsymbol{E_2 = 4.44\, N_2 F\, \Phi_m}$$

1.4 Transformation Ratio

$$\text{Transformation ratio, } K = \frac{N_2}{N_1} = \frac{V_2}{V_1} = \frac{E_2}{E_1} = \frac{I_1}{I_2}$$