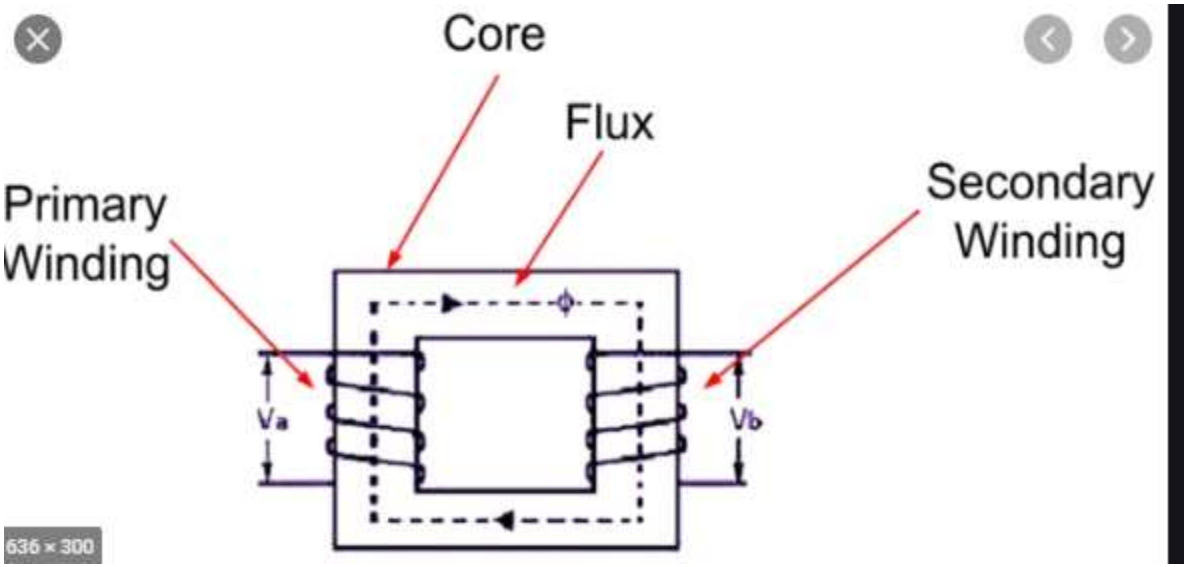
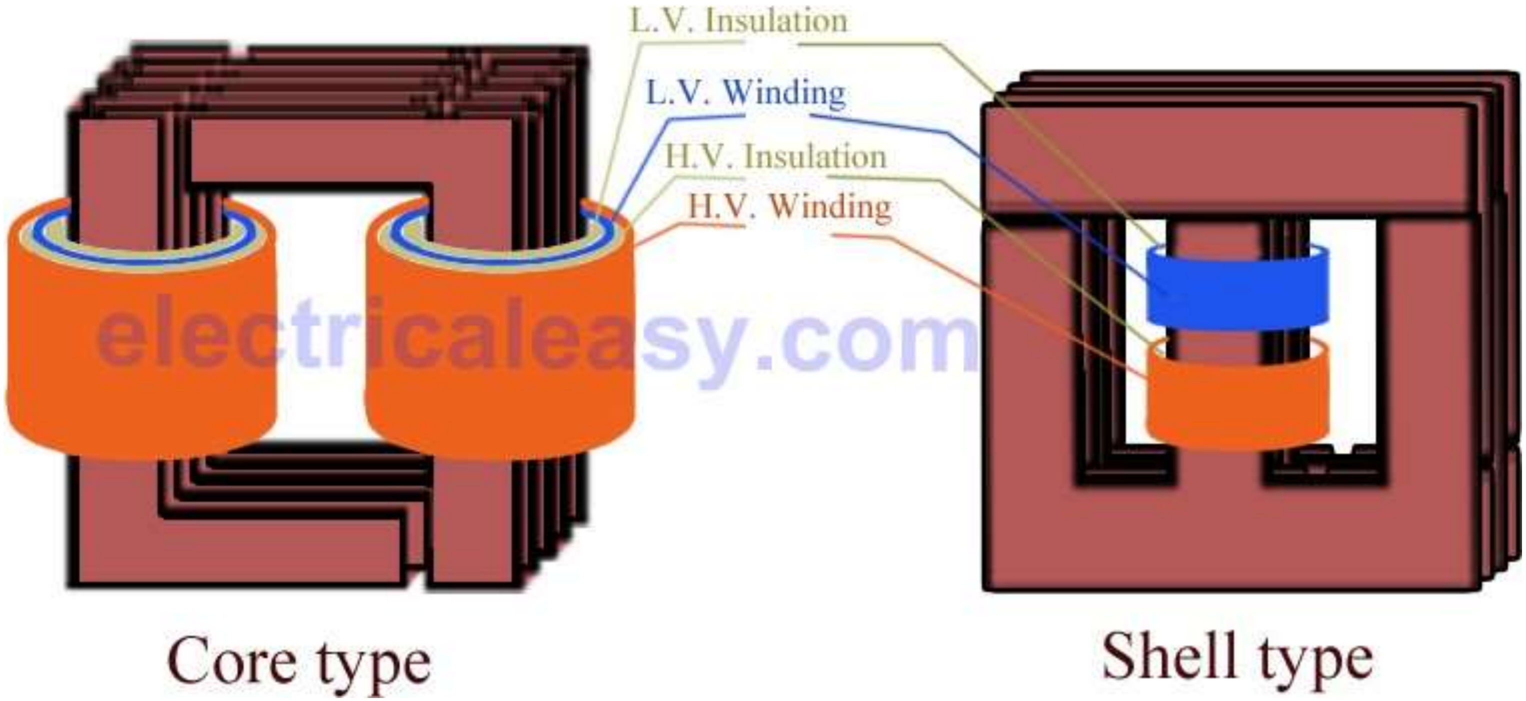
(A)On the basis of construction, transformers can be classified into two types as;

- Core type transformer and
- Shell type transformer

Core type transformer

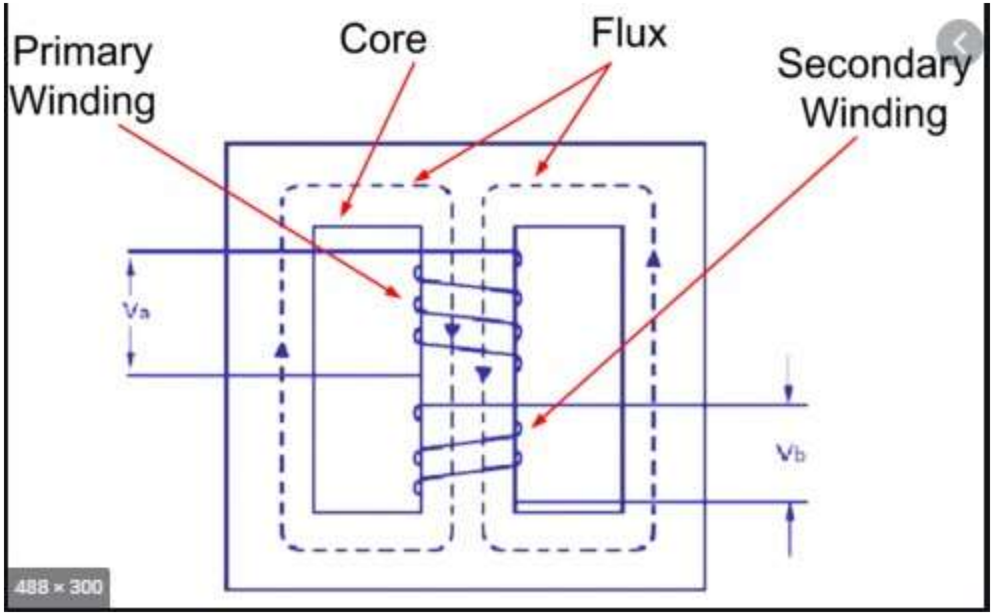


- Core is rectangular having 2 limbs
- core is made up of large number of thin laminations
- windings are uniformly distributed over core
- coils are cylindrical in type wound in helical layer with different layers insulated from each other by paper or mica
- coils are placed on both limbs



L.V. Insulation
L.V. Winding
H.V. Insulation
H.V. Winding
electricaleasy.com
Core type
Shell type

- Shell type



Both windings are placed on central limb Core encircles windings

Core is laminated

For very high voltage transformations shell type is preferred

Winding is surrounded by core so natural cooling does not exits

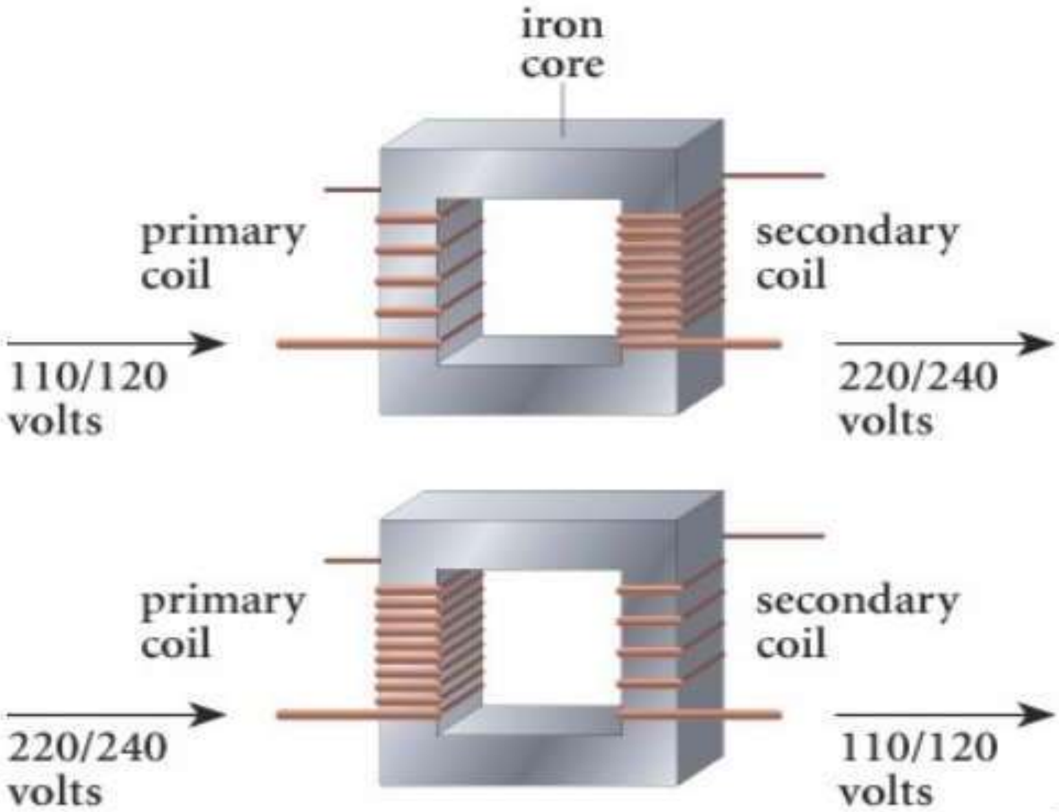
Comparison of core and shell

Sr. No.	Core Type	Shell Type
1.	The winding encircles the core.	The core encircles most part of the windings.
2.	The cylindrical type of coils are used.	Generally, multilayer disc type or sandwich coils are used.
3.	As windings are distributed, the natural cooling is more effective.	As windings are surrounded by the core, the natural cooling does not exist.
4.	The coils can be easily removed from maintenance point of view.	For removing any winding for the maintenance, large number of laminations are required to be removed. This is difficult.
5.	The construction is preferred for low voltage transformers.	The construction is used for very high voltage transformers.
6.	It has a single magnetic circuit.	It has a double magnetic circuit.
7.	In a single phase type, the core has two limbs.	In a single phase type, the core has three limbs.

(B) On the basis of their purpose

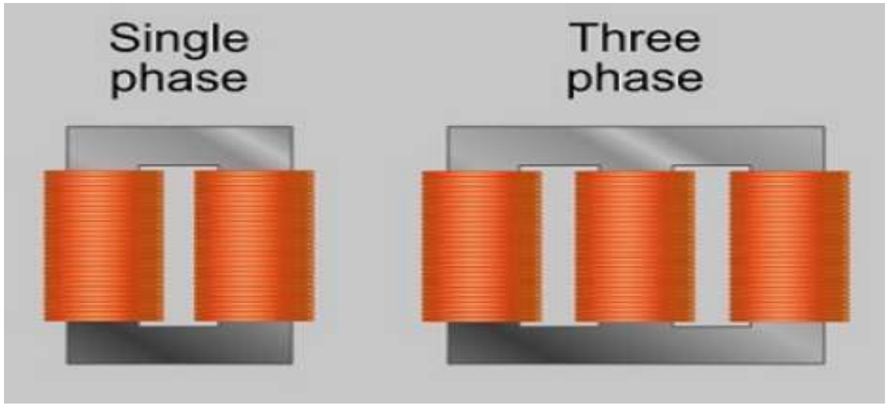
Step up transformer: Voltage increases (with subsequent decrease in current) at secondary.

Step down transformer: Voltage decreases (with subsequent increase in current) at secondary.



(C) On the basis of type of supply

- Single phase transformer
- Three phase transformer



(D) On the basis of their use

Power transformer: Used in **transmission network** high rating

Distribution transformer: Used in **distribution network** comparatively lower rating than that of power transformers.

Instrument transformer: Used in relay and protection purpose in different instruments in industries.

- Current transformer (CT)
- Potential transformer (PT)

(E) On the basis of cooling employed

- Oil-filled water cooled type
- Oil-filled self cooled type
- Air blast type (air cooled)

E.M.F equation

32.6. E.M.F. Equation of a Transformer

Let N_1 = No. of turns in primary

N_2 = No. of turns in secondary

Φ_m = Maximum flux in core in webers

$= B_m \times A$

f = Frequency of a.c. input in Hz

As shown in Fig. 32.14, flux increases from its zero value to maximum value Φ_m in one quarter of the cycle *i.e.* in $1/4f$ second.

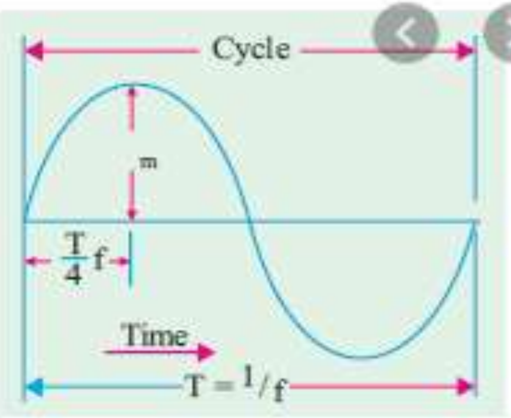


Fig. 32.14

$\therefore$ Average rate of change of flux $= \dfrac{\Phi_m}{1/4f}$

$= 4f\Phi_m$ Wb/s or volt

Now, rate of change of flux per turn means induced e.m.f. in volts.

$\therefore$ Average e.m.f./turn $= 4f\Phi_m$ volt

If flux Φ varies *sinusoidally*, then r.m.s. value of induced e.m.f. is obtained by multiplying the average value with form factor.

$$\text{Form factor} = \frac{\text{r.m.s. value}}{\text{average value}} = 1.11$$

$\therefore$ r.m.s. value of e.m.f./turn $= 1.11 \times 4f\Phi_m = 4.44f\Phi_m$ volt

Now, r.m.s. value of the induced e.m.f. in the whole of primary winding

= (induced e.m.f/turn) × No. of primary turns

$$E_1 = 4.44fN_1\Phi_m = 4.44fN_1B_mA \quad \text{...(i)}$$