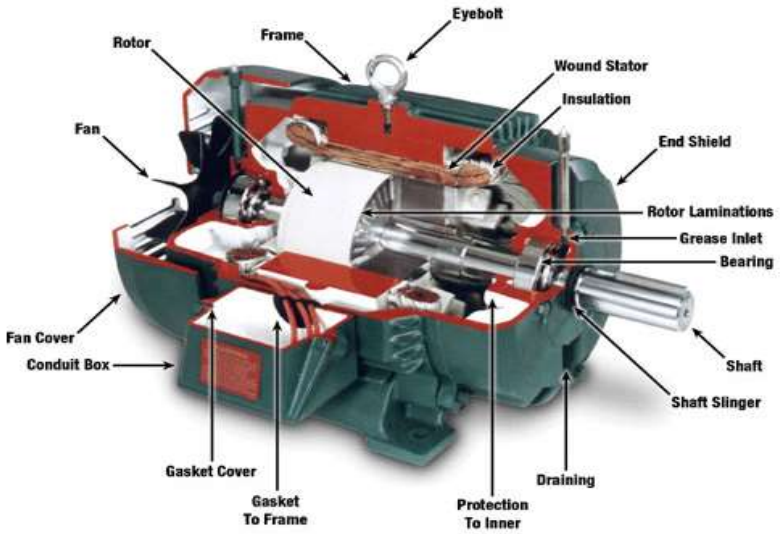
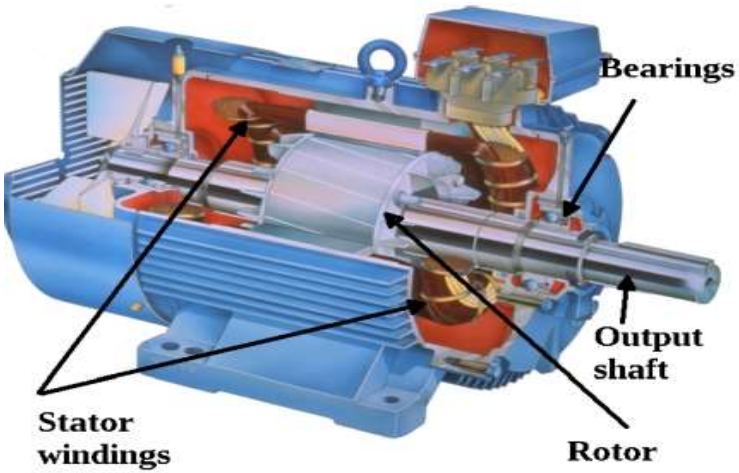
UNIT-III: Fundamentals of Electrical Machines

TRANSFOREMR

DC MACHINE



INDUCTION MOTOR



Need of transformer

- In most cases, appliances are manufactured to work under some specific voltages. Transformers are used to adjust the voltages to a proper level.
- The transformers are the basic components for the transmission of the electricity.
- Transformer is used to increase the voltage at the power generating station(Step up) and used to decrease the voltage(Step down) for house hold purpose.

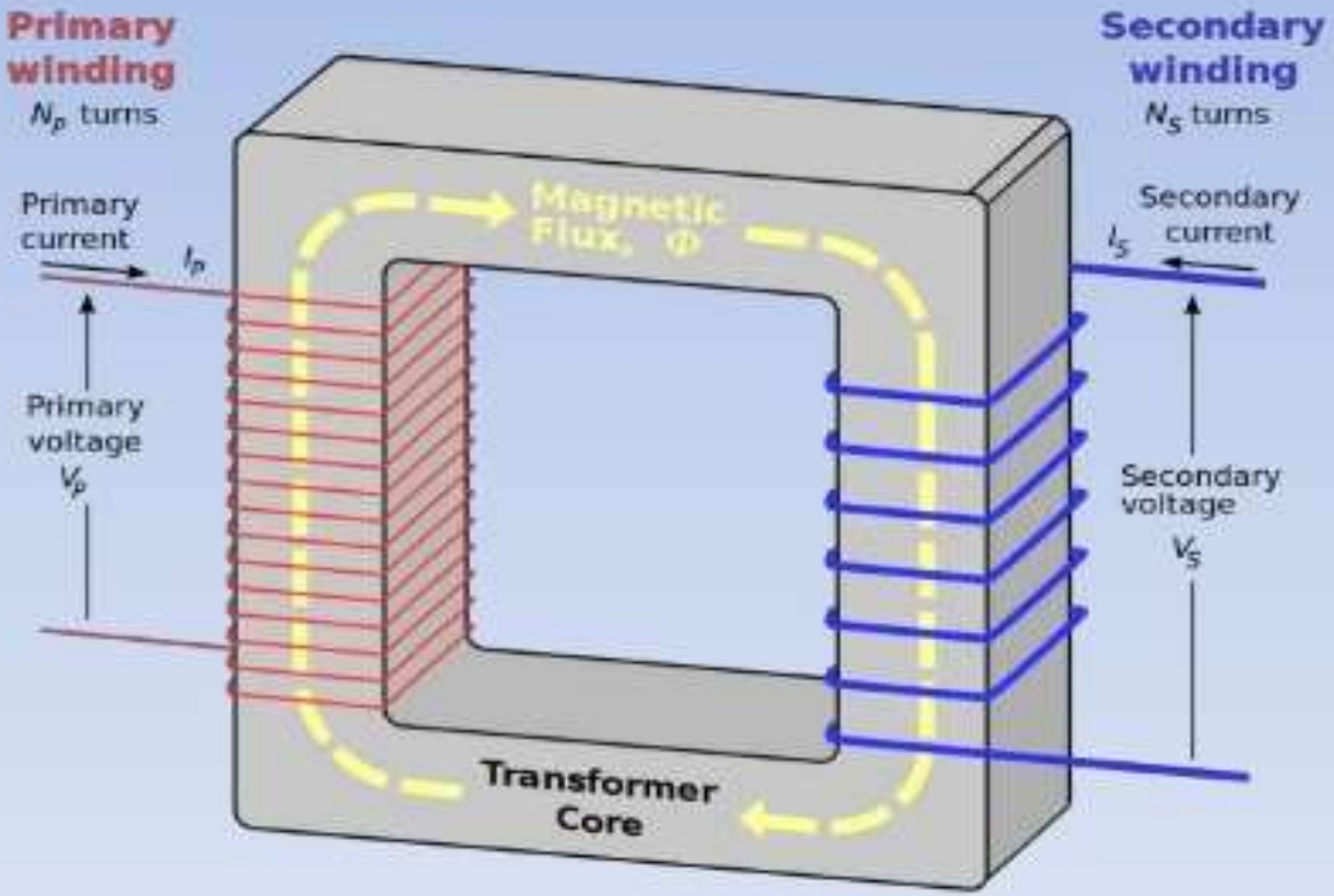
- By increasing the voltages the loss of the electricity in the transmission purpose is minimized.

Definition of Transformer

TRANSFORMER: transformer is a static device which transforms electrical energy from one circuit to another without any direct electrical connection and with the help of mutual induction between two windings. It transforms power from one circuit to another without changing its frequency but may be in different voltage level.

In Brief, A **transformer** is a static electrical device that transfers electrical energy between two or more circuits through electromagnetic induction.

Transformer Construction



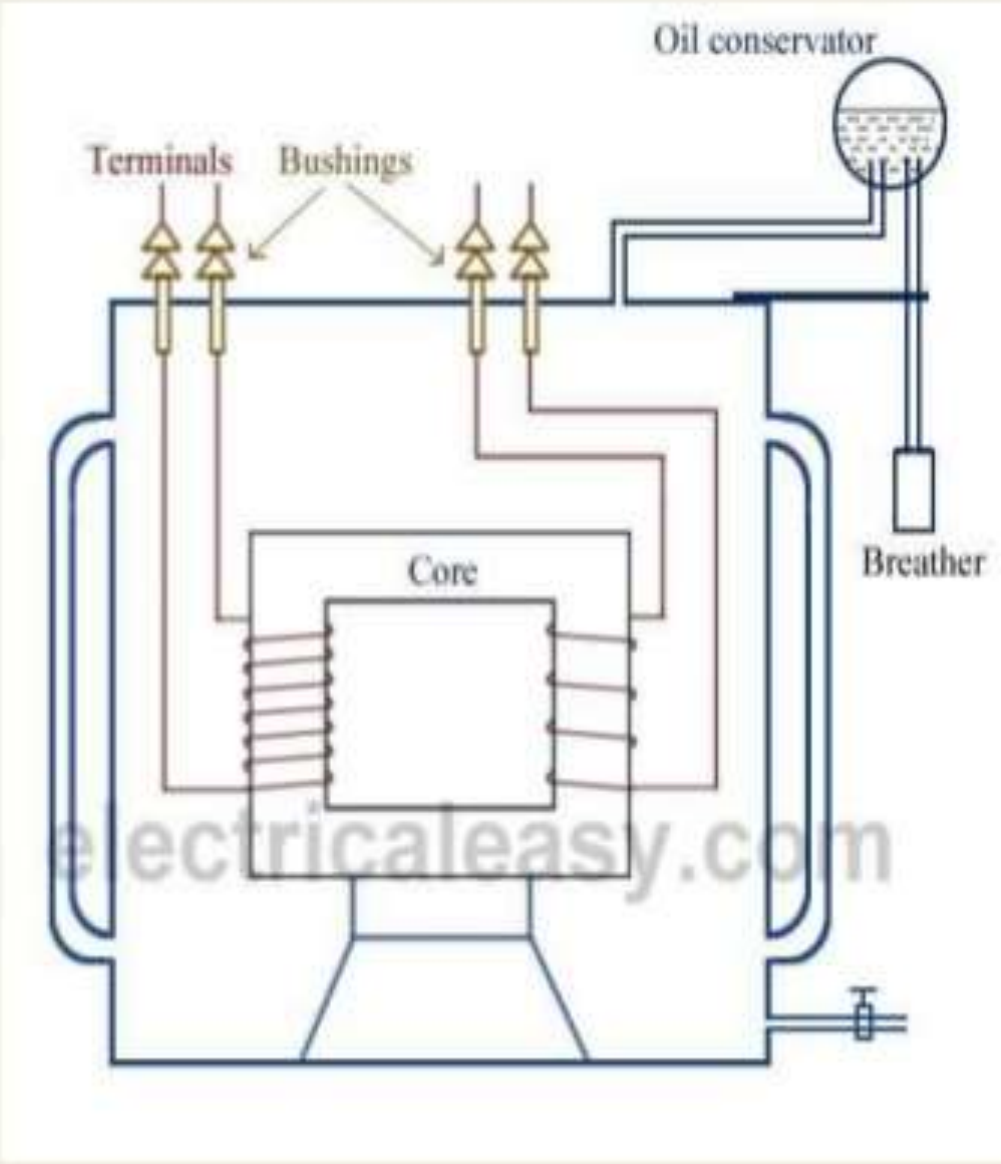
Construction of Transformer

•Basically a transformer consists of two inductive windings and a laminated steel core. The coils are insulated from each other as well as from the steel core.

•core is constructed by assembling laminated sheets of steel, with minimum air-gap between them (to achieve continuous magnetic path).

•The silicon steel used is to provide high permeability and low hysteresis loss.

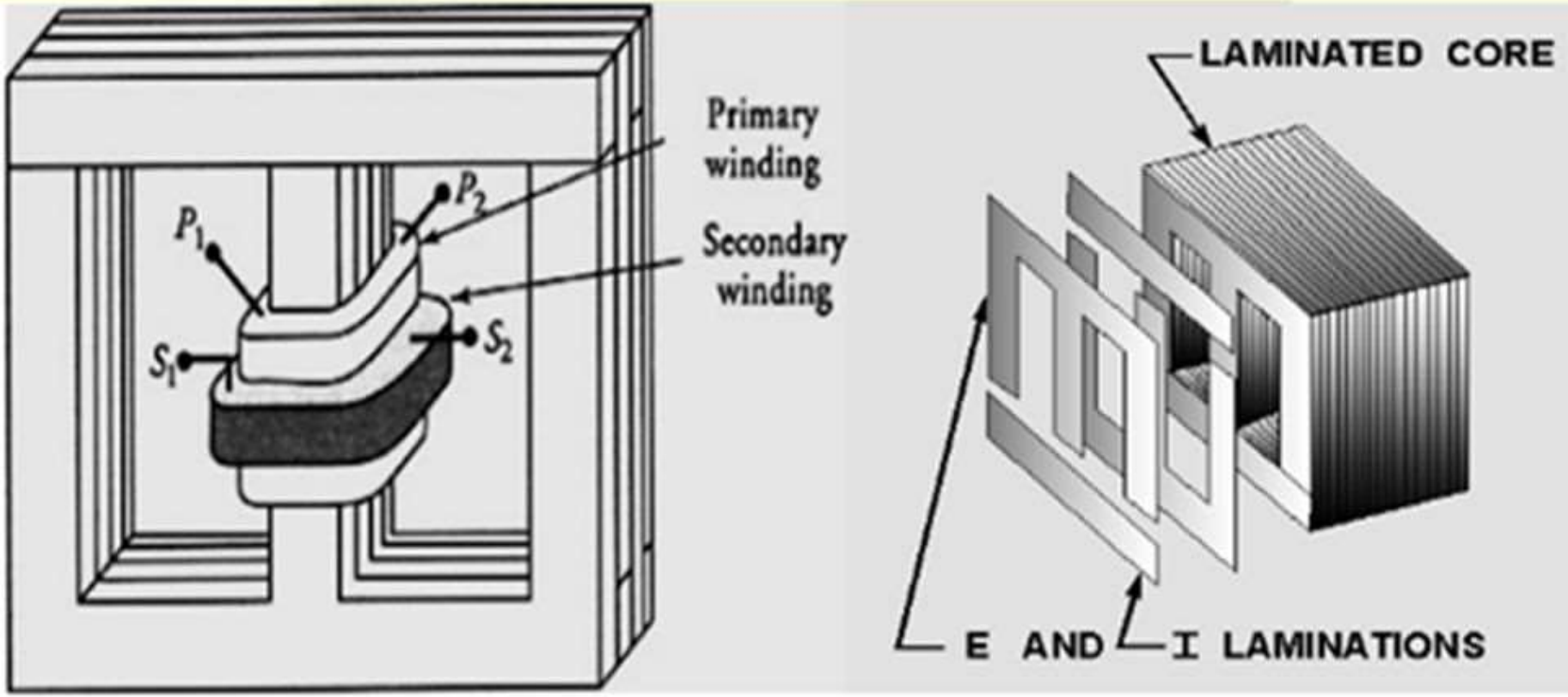
•Laminated sheets of steel are used to reduce eddy current loss.



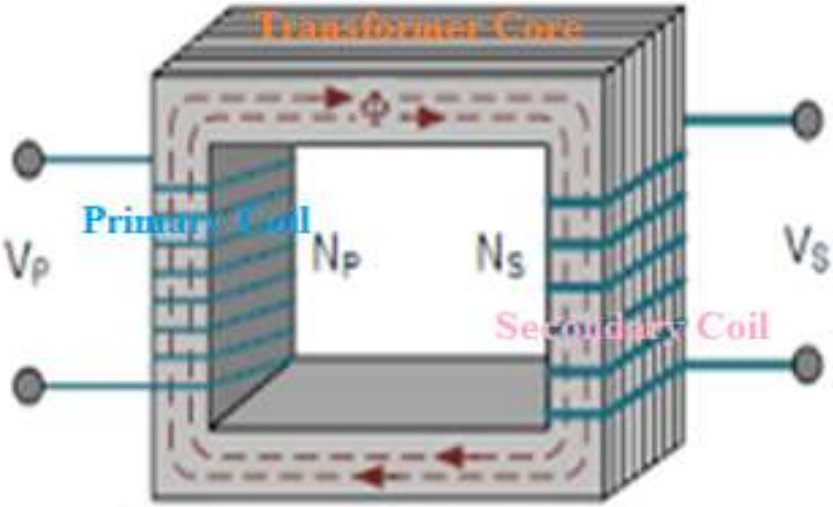
Transformer Construction

Core is made up of laminations to reduce the eddy current losses.

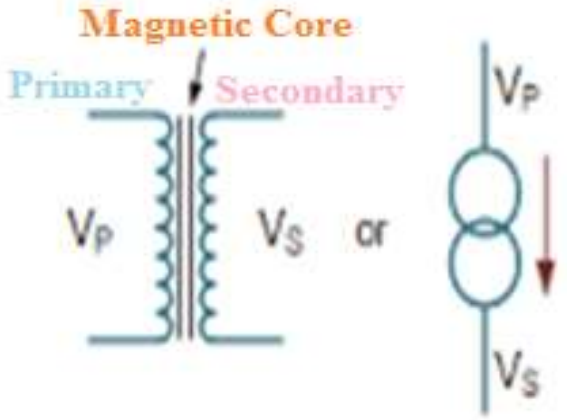
The thickness of laminations is usually 0.4mm.



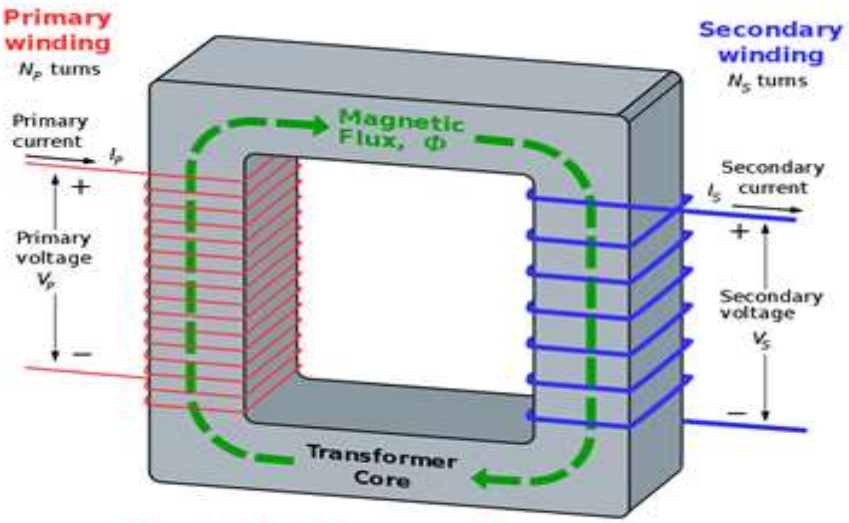
TRANSFORMER SYMBOLS



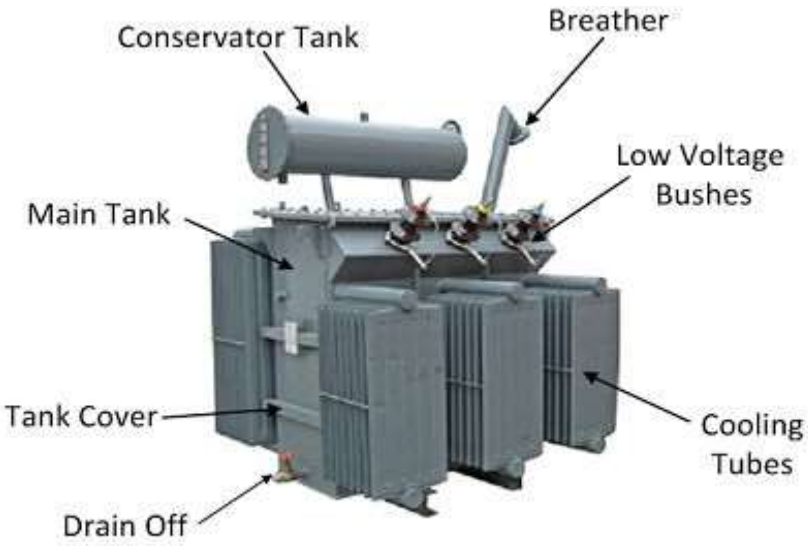
Transformer Construction



Transformer Symbol



Inside Transformer



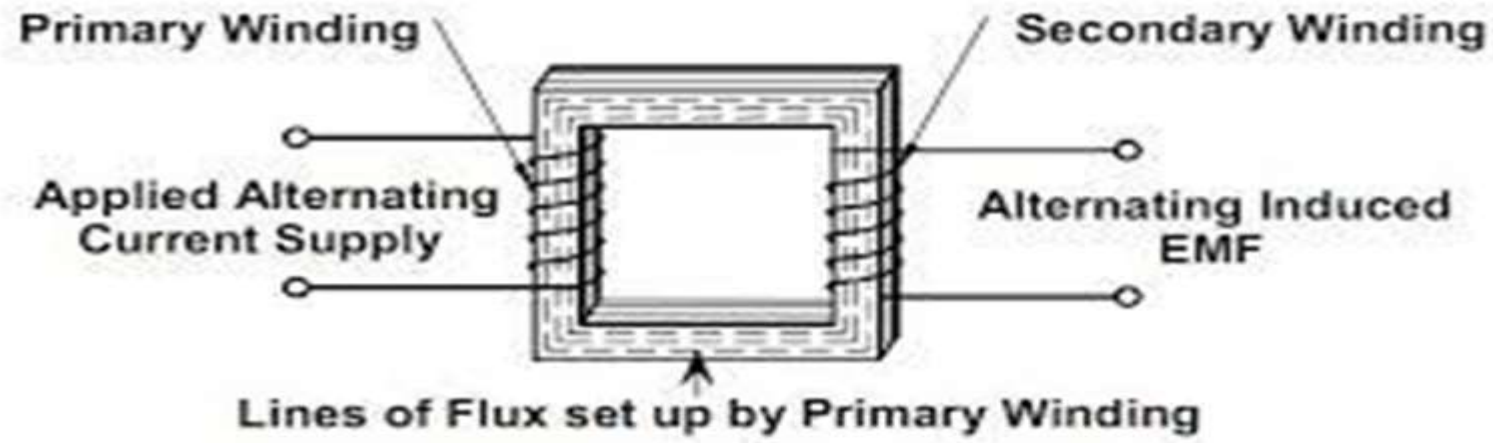
Outside Transformer

Principle of Transformer

- The transformer works on the principle of mutual induction

"The principle of mutual induction states that when the two coils are inductively coupled and if the current in coil change uniformly then the e.m.f. induced in the other coils. This e.m.f can drive a current when a closed path is provide to it."

- When the alternating current flows in the primary coils, a changing magnetic flux is generated around the primary coil.
- The changing magnetic flux is transferred to the secondary coil through the iron core
- The changing magnetic flux is cut by the secondary coil, hence induces an e.m.f in the secondary coil



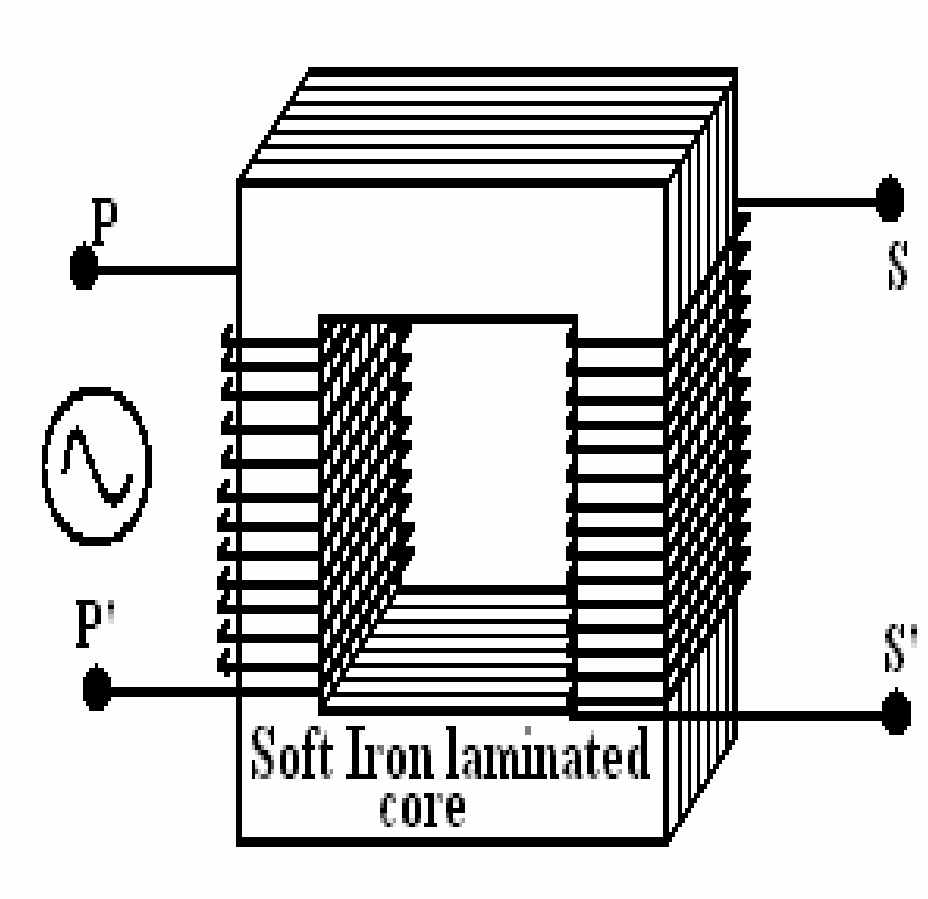
Quick Quiz (Poll 1)

- What is the principle of Transformer?

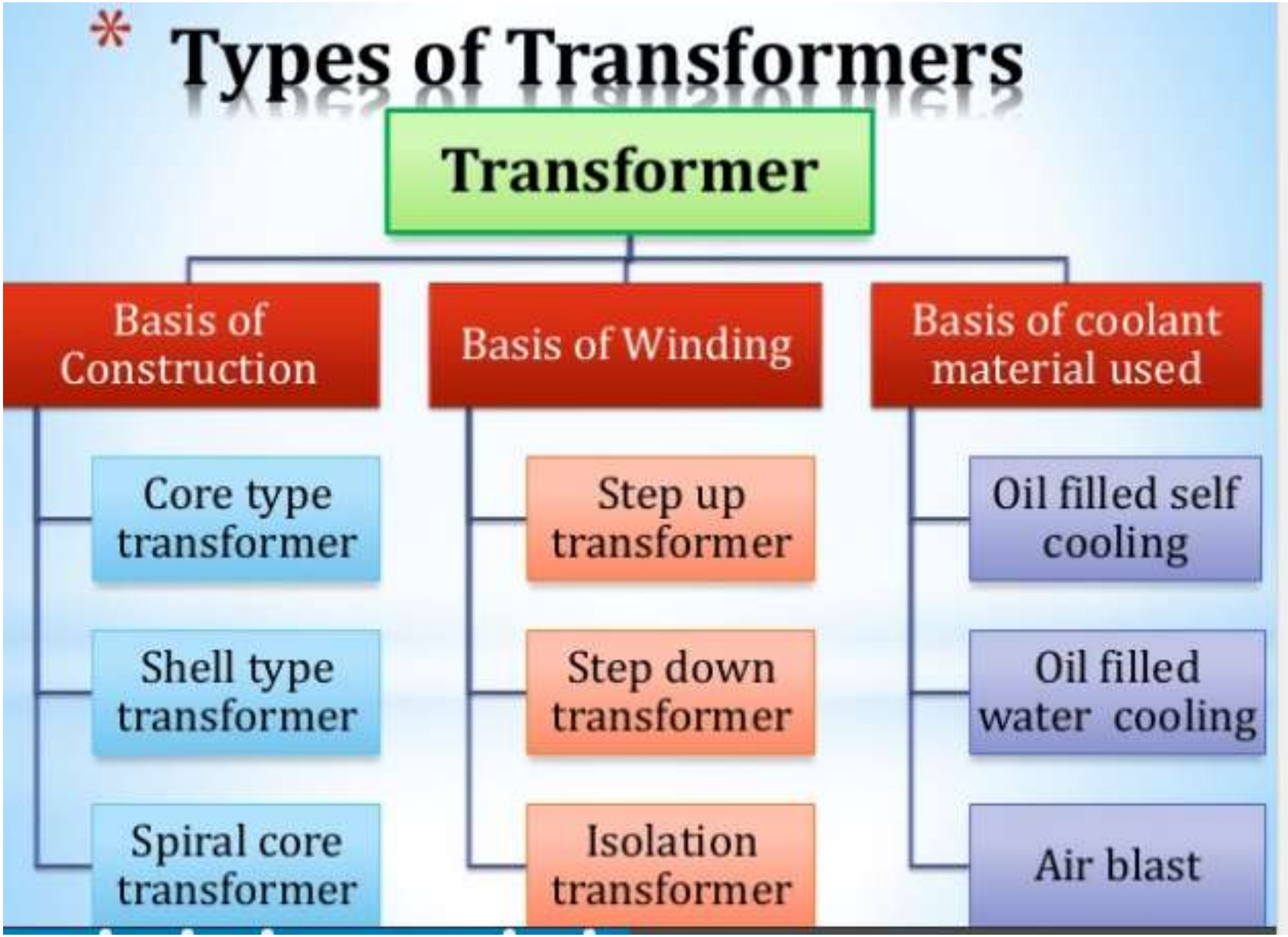
A. Fleming's Left hand rule
B. Electromagnetic Induction
C. Fleming's Right hand rule
D. All of the above

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.



Transformer Cores

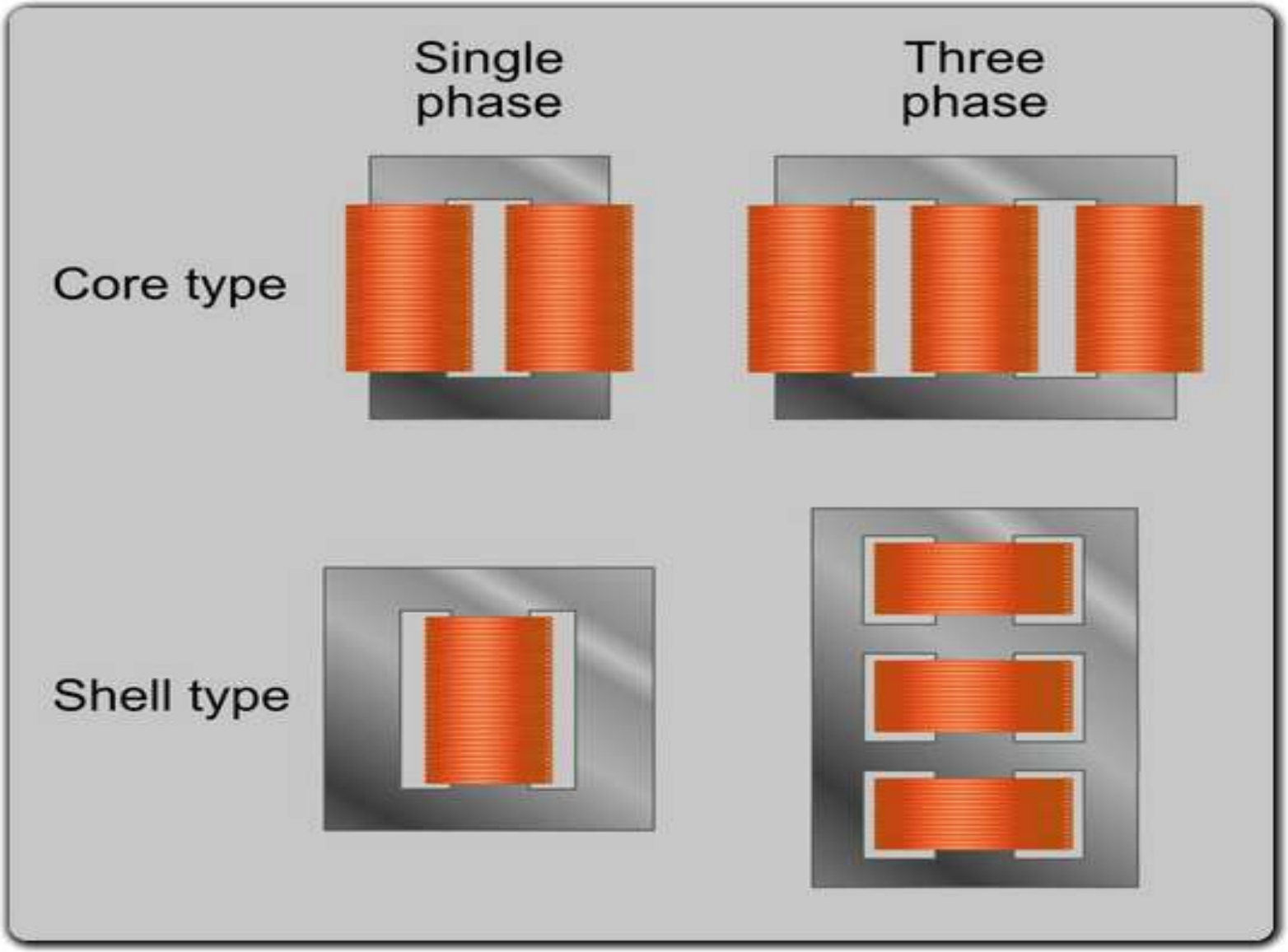

Types of Transformers
Transformer
Basis of Construction
Basis of Winding
Basis of coolant material used
Core type transformer
Shell type transformer
Spiral core transformer
Step up transformer
Step down transformer
Isolation transformer
Oil filled self cooling
Oil filled water cooling
Air blast

* Basis of construction

Core type transformer: Its core has two limbs .The windings are wounded on two limbs of the core material.

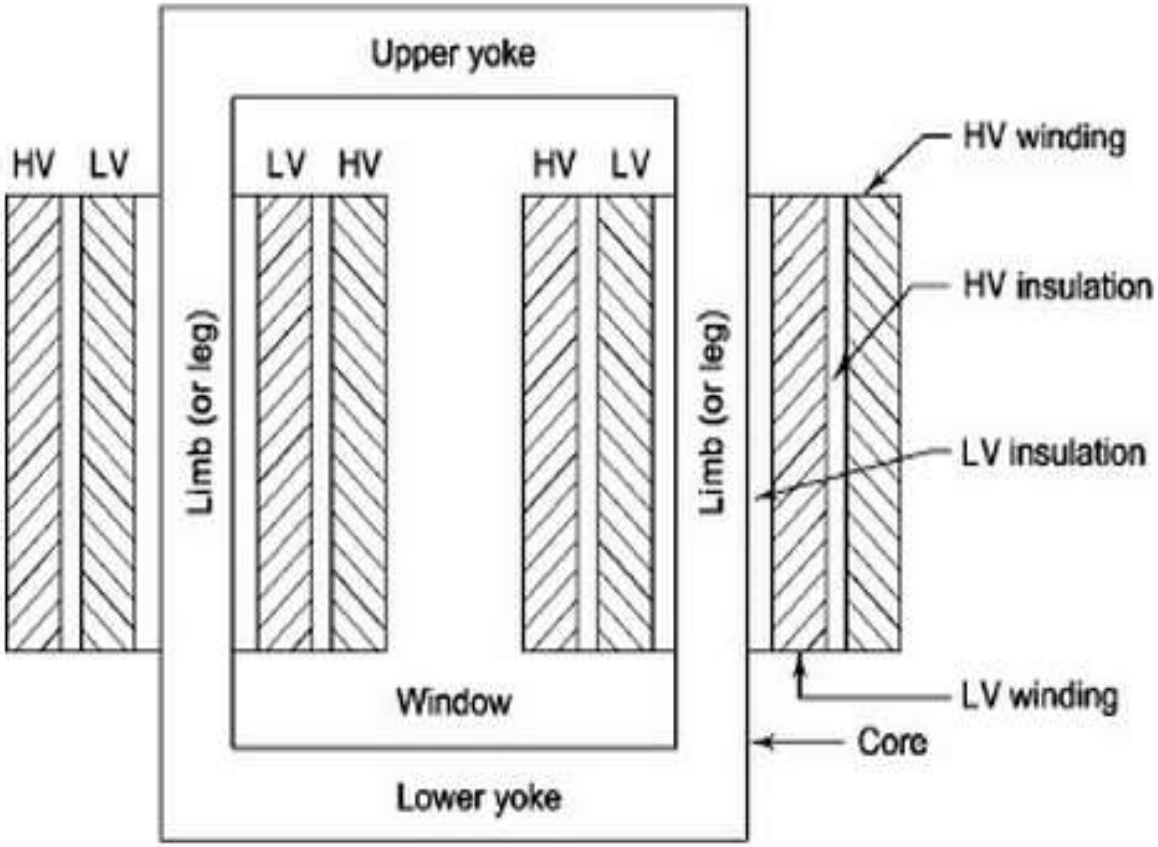
Shell type transformer: Its core has three limbs and two windows. Both the windings are wounded on the central limb.(one over the other)

Spiral core transformer: The core constructed is similar to wheels of spokes. The windings are wounded these spokes like structure.


Single phase
Three phase
Core type
Shell type

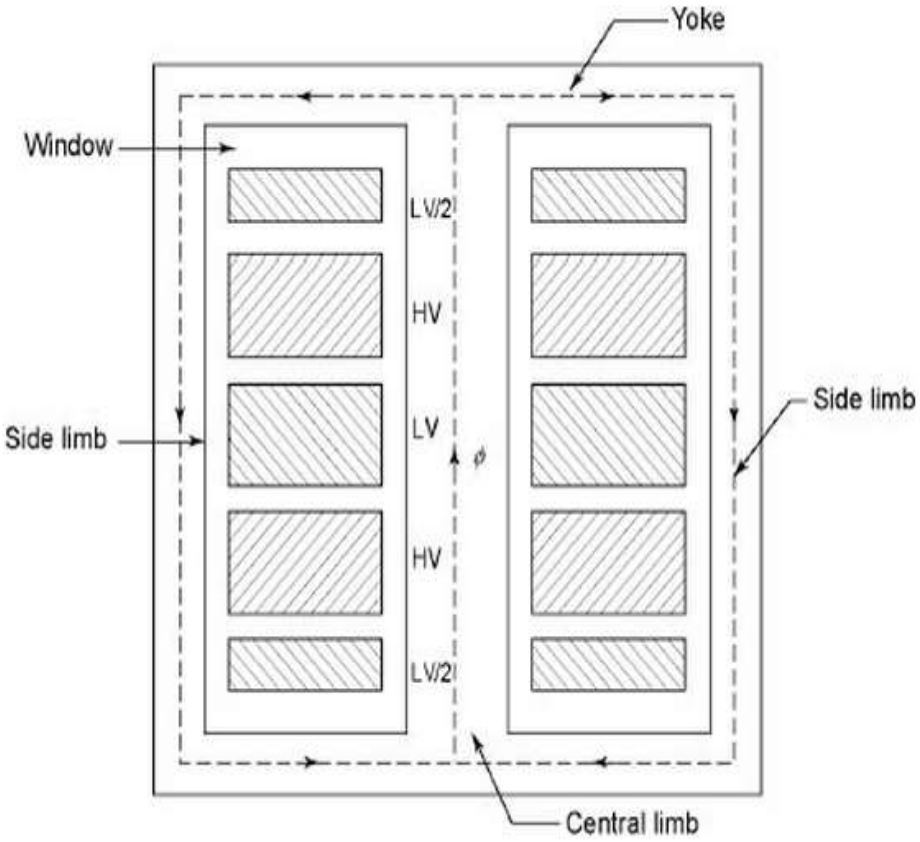
Concentric Windings

This type of winding is used in Core type Transformer. All the turns of LV and HV are concentrated about the same axis.



Sandwich Windings

This type of winding Is used in shell type Transformer. Each HV layer is sandwiched by two LV layers.



Basis of Windings

* Step up Transformer: The no of windings on Primary side is less than the no. of windings on the secondary side.

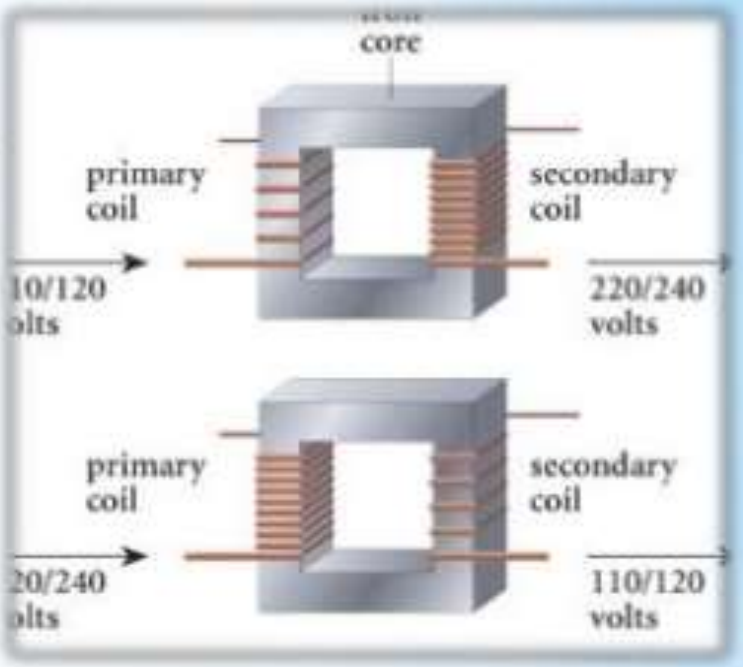
$$Np < Ns$$

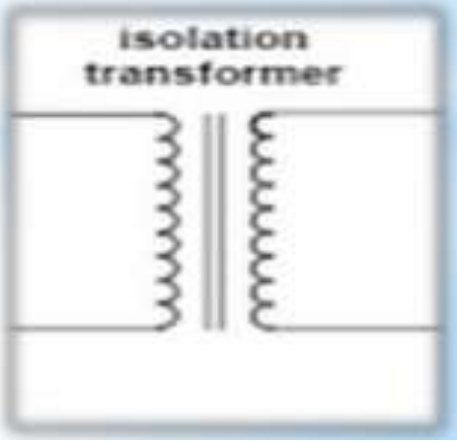
* Step down Transformer: The no. of winding on Primary side are more than the no. of windings on the secondary side.

$$Np > Ns$$

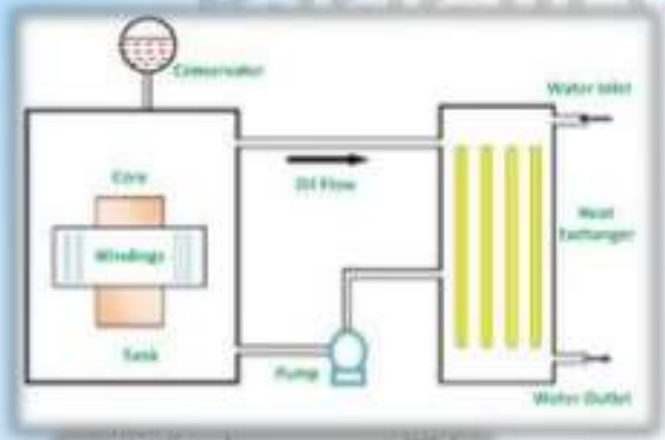
* Isolation Transformer: The no. of winding on Primary side are equal to the no. of windings on the secondary side.

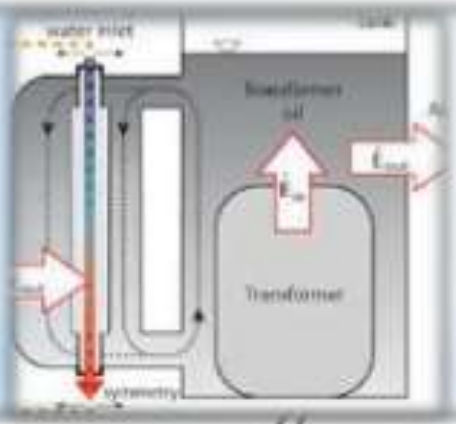
$$Np = Ns$$

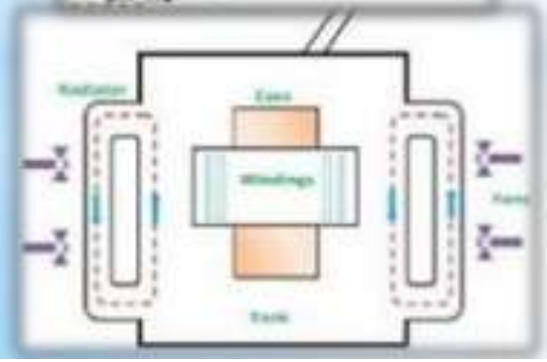




Basis of coolant







* ***Oil filled self cooling:*** Oil filled self cooled type uses small and medium-sized distribution transformers. The assembled windings and core of such transformers are mounted in a welded, oil-tight steel tanks provided with a steel cover.. The oil helps in transferring the heat from the core and the windings to the case from where it is radiated out to the surroundings.
* ***Oil filled water cooled:*** This type is used for much more economic construction of large transformers. The cooling coil is mounted near the surface of the oil, through which cold water keeps circulating. This water carries the heat from the device.
* **Air Blast:** This type is used for transformers that use voltages below 25,000 volts. The transformer is used at houses.

Quick Quiz (Poll 2)

- A transformer transform

A. Current

B. Voltage & current

C. Frequency

D. Voltage

Quick Quiz (Poll 3)

- Transformer cores are laminated in order to

a. simplify its construction

b. minimise eddy current losses

c. reduce cost

d. reduce hysterisis loss