Assignment no:-2

1. Write constructional features of a transformer.

2. Explain the working principle of transformer.

3. Draw and explain the working of Buchholtg relay.

4. Draw different configurations of three phase transformers e.g. star-delta, delta star, delta-delta, star-star.

Assignment no:-3

1. Write constructional features of a three phase transformer.

2. Explain the working principle of three phase transformer.

3. explain different methods for cooling of transformers.

4. Draw and explain phasor diagrams of transformer on load condition.

SEMINAR TOPIC FOR 4TH SEM ELECTRICAL MACHINES-1

S.NO:	ROLL NO:	SEMINAR TOPIC
1	2018/81 to 111	DC MACHINES
2	2018/112 to 132	SPEED CONTROL OF DC MOTORS
3	2018/133 to 146	LOSSES IN DC MACHINES
4	2019/177 to 153	SINGLE PHASE TRANSFORMER
5	2019/154 to 157	THREE PHASE TRANSFORMER
6	2019/158 to 160	TYPES OF 3-PHASE TRANSFORMERS

1. working of single phase transformer

https://youtu.be/ai3eriqcSYc

2.Why transformers are rated in KVA

https://youtu.be/IRx0j7pNMHI

3. conservator tank

https://youtu.be/erWuSacsNDQ

4.bucchulz relay

https://youtu.be/AOyimChW9cI

5. tap changer

https://youtu.be/nYbnvIMppmo

6.Basics of three phase transformer

https://youtu.be/pVlPThJWy68

Transformer

Transformer.

Main article: Transformer

A transformer is a static device that converts alternating current from one voltage level to another level (higher or lower), or to the same level, without changing the frequency. A transformer transfers electrical energy from one circuit to another through inductively coupled conductors—the transformer's coils. A varying electric current in the first or primary winding creates a varying magnetic flux in the transformer's core and thus a varying magnetic field through the secondary winding. This varying magnetic field induces a varying electromotive force (emf) or "voltage" in the secondary winding. This effect is called mutual induction.

There are three types of transformers

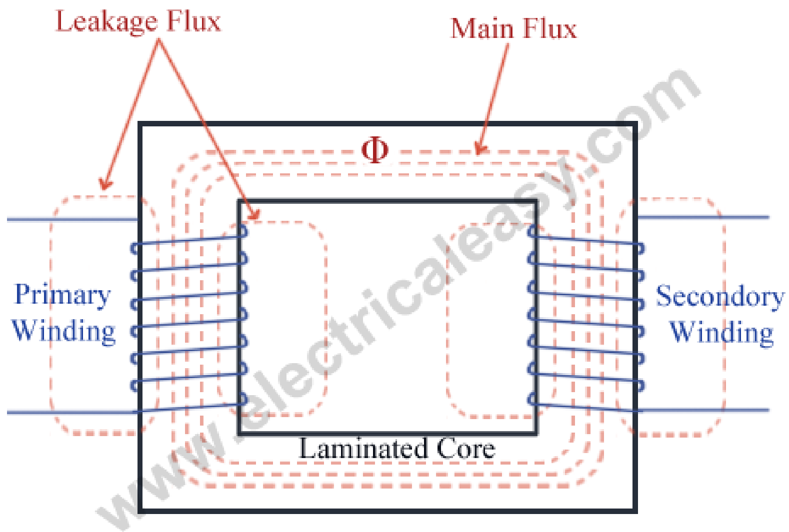
1. Step-up transformer
2. Step-down transformer
3. Isolation transformer

There are four types of transformers based on structure

1. core type
2. shell type
3. power type
4. instrument type

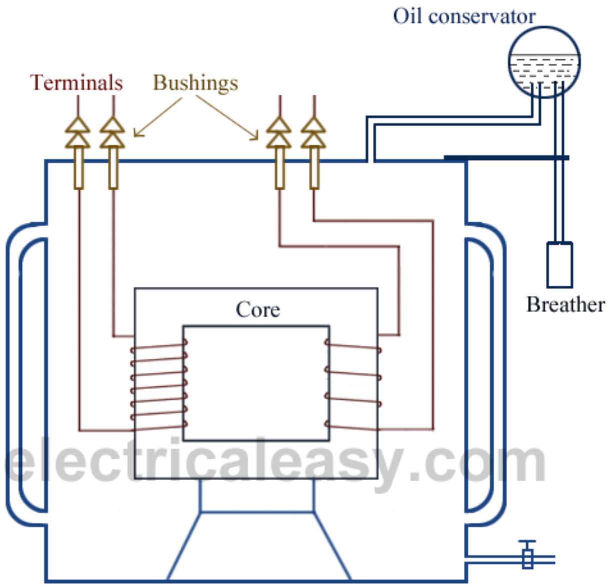
Electrical transformer is a static electrical machine which transforms electrical power from one circuit to another circuit, without changing the frequency. Transformer can increase or decrease the voltage with corresponding decrease or increase in current.

Working principle of transformer

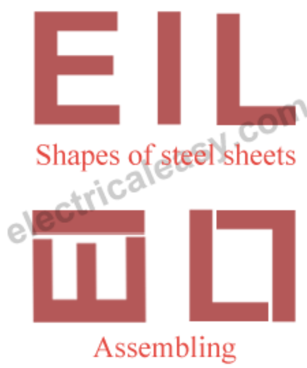


The basic principle behind working of a transformer is the phenomenon of mutual induction between two windings linked by common magnetic flux. The figure at right shows the simplest form of a transformer. Basically a transformer consists of two inductive coils; primary winding and secondary winding. The coils are electrically separated but magnetically linked to each other. When, primary winding is connected to a source of alternating voltage, alternating magnetic flux is produced around the winding. The core provides magnetic path for the flux, to get linked with the secondary winding. Most of the flux gets linked with the secondary winding which is called as 'useful flux' or main 'flux', and the flux which does not get linked with secondary winding is called as 'leakage flux'. As the flux produced is alternating (the direction of it is continuously changing), EMF gets induced in the secondary winding according to Faraday's law of electromagnetic induction. This emf is called 'mutually induced emf', and the frequency of mutually induced emf is same as that of supplied emf. If the secondary winding is closed circuit, then mutually induced current flows through it, and hence the electrical energy is transferred from one circuit (primary) to another circuit (secondary).

Basic 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. A transformer may also consist of a container for winding and core assembly (called as tank), suitable bushings to take our the terminals, oil conservator to provide oil in the transformer tank for cooling purposes etc. The figure at left illustrates the basic construction of a transformer.

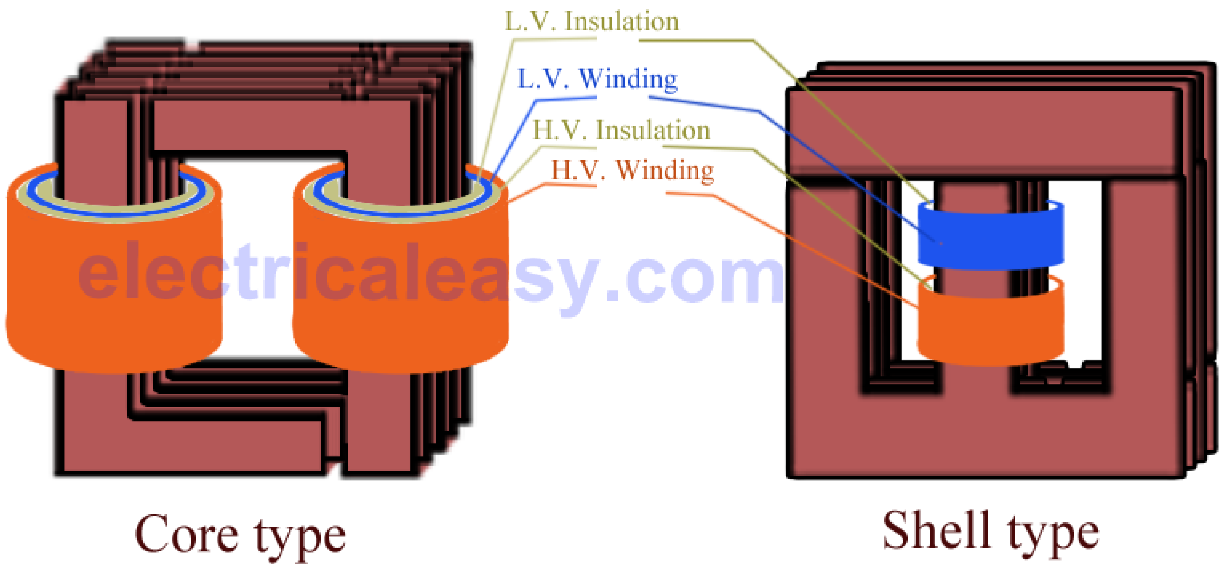


In all types of transformers, core is constructed by assembling (stacking) laminated sheets of steel, with minimum air-gap between them (to achieve continuous magnetic path). The steel used is having high silicon content and sometimes heat treated, to provide high permeability and low hysteresis loss. Laminated sheets of steel are used to reduce eddy current loss. The sheets are cut in the shape as E,I and L. To avoid high reluctance at joints, laminations are stacked by alternating the sides of joint. That is, if joints of first sheet assembly are at front face, the joints of following assemble are kept at back face.

Types of transformers

Transformers can be classified on different basis, like types of construction, types of cooling etc.

(A) On the basis of construction, transformers can be classified into two types as; (i) Core type transformer and (ii) Shell type transformer, which are described below.



(i) Core type transformer

In core type transformer, windings are cylindrical former wound, mounted on the core limbs as shown in the figure above. The cylindrical coils have different layers and each layer is insulated from each other. Materials like paper, cloth or mica can be used for insulation. Low voltage windings are placed nearer to the core, as they are easier to insulate.

(ii) Shell type transformer

The coils are former wound and mounted in layers stacked with insulation between them. A shell type transformer may have simple rectangular form (as shown in above fig), or it may have a distributed form.

(B) On the basis of their purpose

1. Step up transformer: Voltage increases (with subsequent decrease in current) at secondary.
2. Step down transformer: Voltage decreases (with subsequent increase in current) at secondary.

(C) On the basis of type of supply

1. Single phase transformer
2. Three phase transformer

(D) On the basis of their use

1. Power transformer: Used in transmission network, high rating
2. Distribution transformer: Used in distribution network, comparatively lower rating than that of power transformers.
3. 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

1. Oil-filled self cooled type
2. Oil-filled water cooled type
3. Air blast type (air cooled)

EMF equation of the Transformer

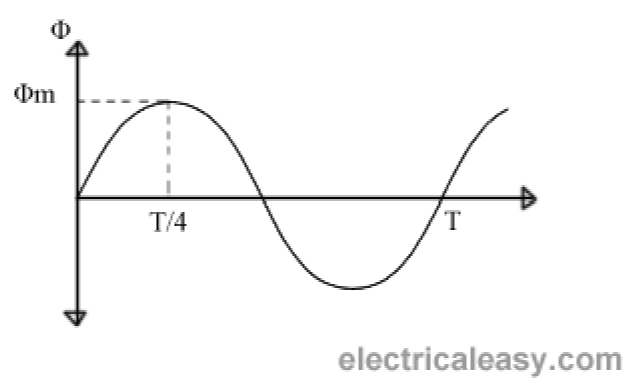
Let,

N_1 = Number of turns in primary winding

N_2 = Number of turns in secondary winding

Φ_m = Maximum flux in the core (in Wb) = (B_m x A)

f = frequency of the AC supply (in Hz)



As, shown in the fig., the flux rises sinusoidally to its maximum value Φ_m from 0. It reaches to the maximum value in one quarter of the cycle i.e in T/4 sec (where, T is time period of the sin wave of the supply = 1/f).

Therefore,

average rate of change of flux = $\Phi_m / (T/4) = \Phi_m / (1/4f)$

Therefore,
average rate of change of flux = $4f\ \Phi_m$ .... (Wb/s).
Now,
Induced emf per turn = rate of change of flux per turn

Therefore, average emf per turn = $4f\ \Phi_m$ ....(Volts).

Now, we know, Form factor = RMS value / average value
Therefore, RMS value of emf per turn = Form factor X average emf per turn.

As, the flux Φ varies sinusoidally, form factor of a sine wave is 1.11

Therefore, RMS value of emf per turn = $1.11 \times 4f\ \Phi_m = 4.44f\ \Phi_m$.

RMS value of induced emf in whole primary winding (E_1) = RMS value of emf per turn X Number of turns in primary winding

$E_1 = 4.44f\ N_1\ \Phi_m$ .... eq 1

Similarly, RMS induced emf in secondary winding (E_2) can be given as

$E_2 = 4.44f\ N_2\ \Phi_m$. .... eq 2

from the above equations 1 and 2,

$$\frac{E_1}{N_1} = \frac{E_2}{N_2} = 4.44f\ \Phi m$$

This is called the emf equation of transformer, which shows, emf / number of turns is same for both primary and secondary winding.

For an ideal transformer on no load, $E_1 = V_1$ and $E_2 = V_2$.
where, V_1 = supply voltage of primary winding
V_2 = terminal voltage of secondary winding

Voltage Transformation Ratio (K)

As derived above,

$$\frac{E_1}{N_1} = \frac{E_2}{N_2} = K$$

Where, K = constant

This constant K is known as voltage transformation ratio.

- If $N_2 > N_1$, i.e. $K > 1$, then the transformer is called step-up transformer.
- If $N_2 < N_1$, i.e. $K < 1$, then the transformer is called step-down transformer

Three-Phase Transformer Construction

A three phase transformer is used to transfer a large amount of power. The three phase transformer is required to step-up and step-down the voltages at various stages of a power system network. The three phase transformer is constructed in two ways.

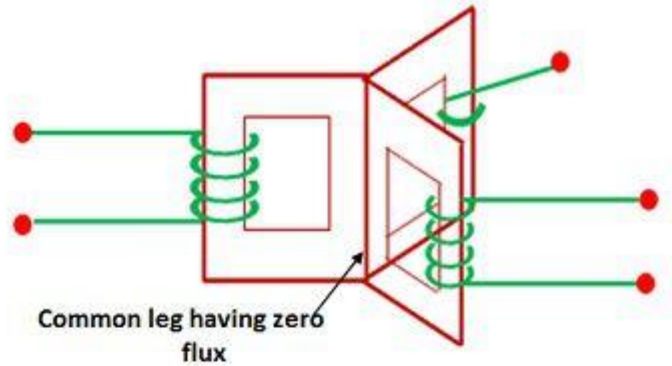
Three separate single phase transformer is suitably connected for three phase operation.

A single three-phase transformer in which the cores and windings for all the three phases are merged into a single structure.

The three single-phase transformer can be used as a three-phase transformer when their primary and secondary winding are connected to each other. The three phase transformer supply has many advantages as compared to three single phase units like it requires very less space and also very lighter smaller and cheaper in size. The three phase transformer is mainly classified into two types, i.e., the core type transformer and the shell type transformer.

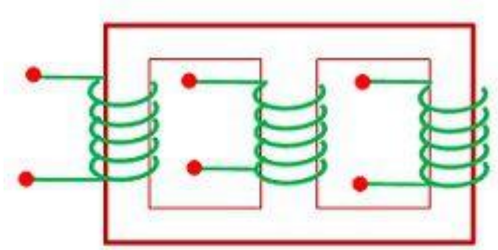
Core Type Three Phase Transformer

Consider a three single phase core type transformer positioned at 120° to each other as shown in the figure below. If the balanced three-phase sinusoidal voltages are applied to the windings, the fluxes ϕ_a, ϕ_b and ϕ_c will also be sinusoidal and balanced. If the three legs carrying these fluxes are combined, the total flux in the merged leg becomes zero. This leg can, therefore, be removed because it carries the no flux. This structure is not convenient for the core.



Three Single Phase Core in Contact With Another

Circuit Globe The core of the three phase transformer is usually made up of three limbs in the same plane. This can be built using stack lamination. The each leg of this core carries the low voltage and high voltage winding. The low voltage windings are insulated from the core than the high voltage windings.

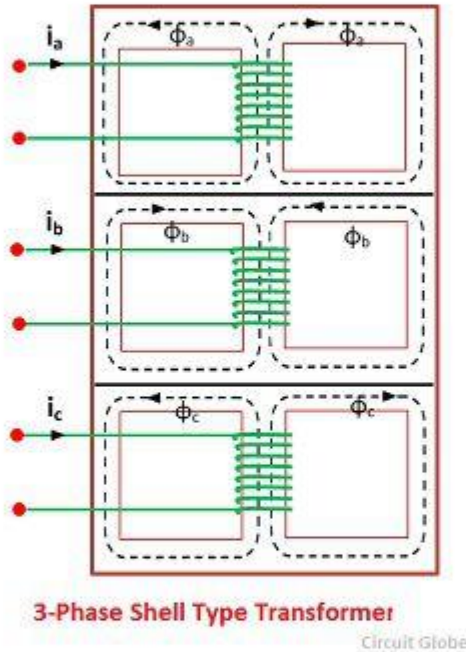


Core Structure Using Stacked Lamination

Circuit Globe The low windings are placed next to the core with suitable insulation between the core and the low voltage windings. The high voltage windings are placed over the low voltage windings with suitable insulation between them. The magnetic paths of the leg a and c are greater than that of leg b, the construction is not symmetrical, and there is a resultant imbalance in the magnetising current.

Shell type Three Phase Transformer

The shell type 3-phase transformer can be constructed by stacking three single phase shell transformer as shown in the figure below. The winding direction of the central unit b is made opposite to that of units a and c. If the system is balanced with phase sequence a-b-c, the flux will also be balanced



3-Phase Shell Type Transformer

The magnitude of this combined flux is equal to the magnitude of each of its components. The cross section area of the combined yoke is same as that of the outer leg and top and bottom section of the yoke. The imbalance in the magnetic path has very little effect on the performance of the three shell-type transformers. The windings of the shell type three phase transformer are either connected in delta or star as desired.