Ministry of Higher Education
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تكنولوجيا الكهرباء

Electrical Technology

Lecture 2

Lecture Name: TRANSFORMER

By

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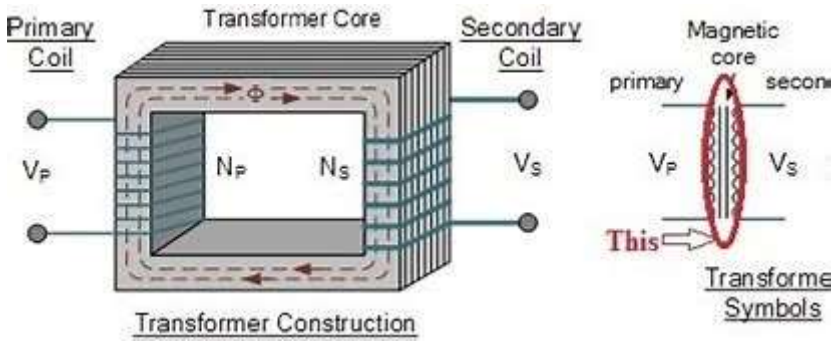
STRUCTURE OF TRANSFORMER •

The transformer two inductive coils, these are electrical separated but linked through a common magnetic current circuit. • These two coils have a high mutual induction. • One of the two coils is connected of alternating voltage. this coil in which electrical energy is fed with the help of source called primary winding (P) shown in fig.



• The other winding is connected to a load the electrical energy is transformed to this winding drawn out to the load. This winding is called secondary winding(S) shown in fig

The primary and secondary coil wound on a ferromagnetic metal core:

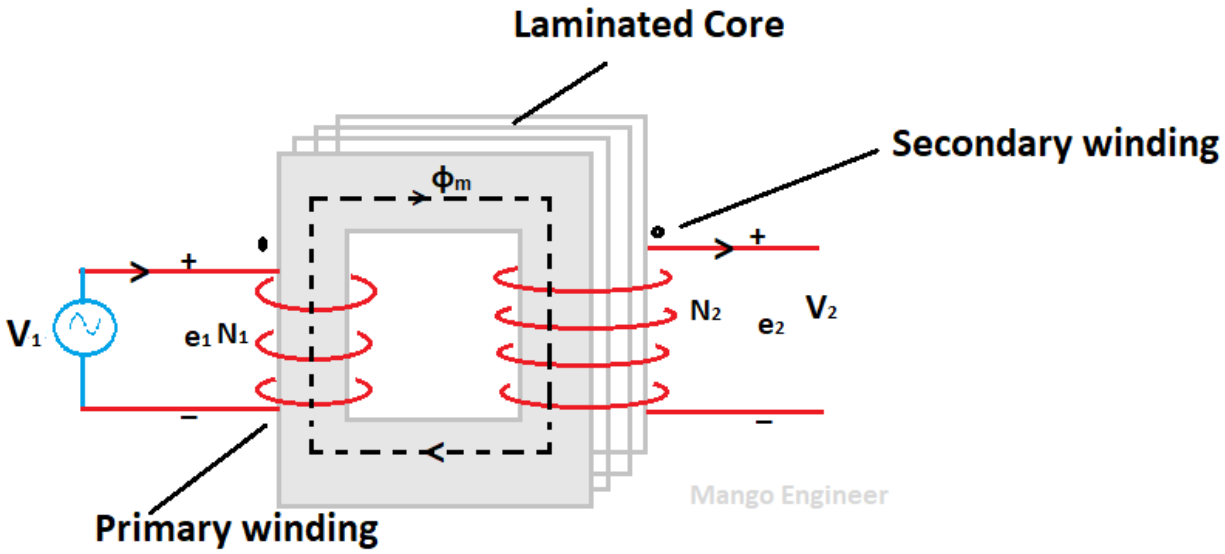
• The function of the core is to transfer the changing magnetic flux from the primary coil to the secondary coil •

The primary has N1 no of turns and the secondary has N2 no of turns the of turns plays major important role in the function of transformer.

NOTE: • It works on the principle of mutual induction.

Principle of Operation A transformer in its simplest form will consist of a rectangular laminated magnetic structure on which two coils of different number of turns are wound as shown in Figure

The winding to which AC voltage is impressed is called the primary of the transformer and the winding across which the load is connected is called the secondary of the transformer



Relation of the primary and the secondary voltage is given with the following formula

$$\frac{V1}{V2} = \frac{N1}{N2}$$

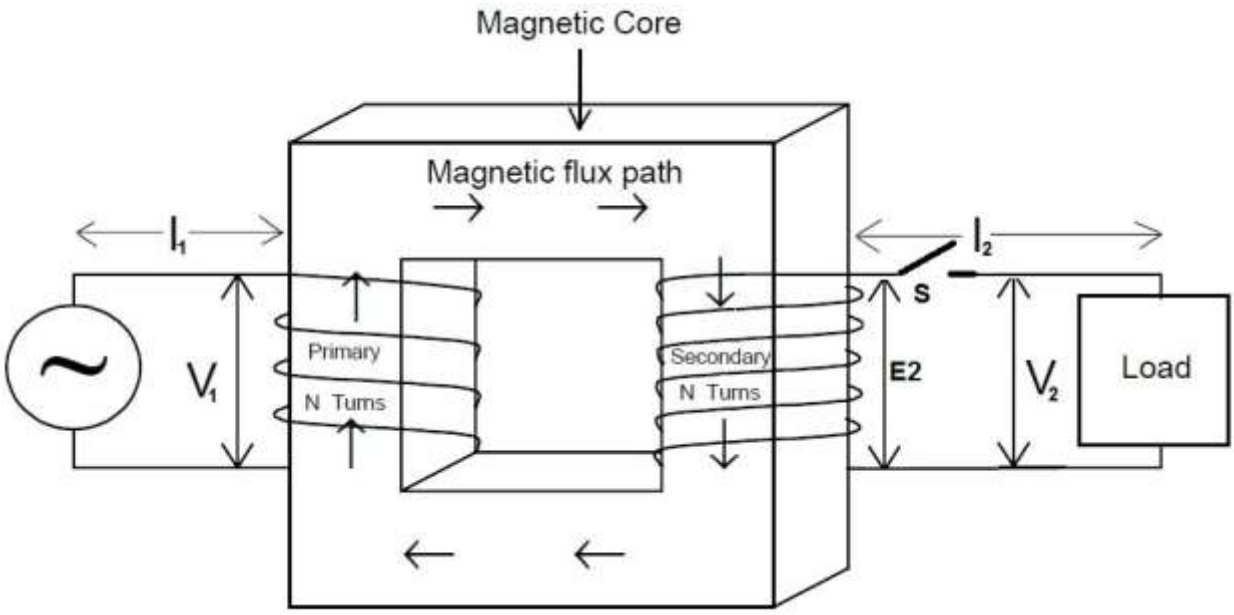
Relation between the primary and the secondary current is described by the following formula:

$$\frac{I1}{I2} = \frac{N2}{N1}$$

Transformer power can be calculated by one of the following formula: $\boldsymbol{p} = \boldsymbol{V}2 \ . \ \boldsymbol{I}2 = \boldsymbol{V}1. \ \boldsymbol{I}1$

Their ratio is called efficiency: $\eta = \frac{\mathrm{P2}}{\mathrm{P1}}$

Exp 1: Transformer has the following parameters: $\boldsymbol{V1 = 220}$, $\boldsymbol{N1 = 735}$, $\boldsymbol{N2 = 80}$, $RL = 30\Omega$ Find $\boldsymbol{V}2$, $\boldsymbol{I}2$, $\boldsymbol{I}1$ $\boldsymbol{P2}$ and the $\boldsymbol{P}1$ when the $\boldsymbol{\eta}$ $equal\ to$ 85%?



Sol:

$$\frac{V1}{V2} = \frac{N1}{N2}$$

V2* N1 = V1* N2

V2= V1 $\frac{N2}{N1}$

V2=220 * $\frac{80}{735}$

V2=24v

I2= $\frac{V2}{RL}$

I2=24/30= 0.8A

$I1/\ I2 = N2/\ N1\ ,\ I1 = I2 * N2/\ N1 = 0.8 * 80\ /735 = 87mA$

$P2 = V2\ .\ I2 = 24 * 0.\ 8 = 19.\ 2W$

$\eta = P2\ P1\ ,$

$P1 = P2/\ \eta = 19.\ 2/\ 0.85 = 22.5w$

Exp 2. A transformer has 600 primary turns connected to a 1.5 kV supply. Determine the number of secondary turns for a 240 V output voltage, assuming no losses.

For a transformer,

$$\frac{V1}{V2} = \frac{N1}{N2}$$

N2 *V1=N1*V2

$$\mathbf{N2= N1}\ \frac{V2}{V1}$$

$$\mathbf{N2= 600*}\frac{240}{1500}$$

N2= 96 turn

Exp 3. An ideal transformer with a turns ratio of $2:9$ is fed from a 220 V supply. Determine its output voltage.

$$\frac{V1}{V2} = \frac{N1}{N2}$$

$$\frac{220}{V2} = \frac{2}{9}$$

$$\mathbf{V2=}\frac{220*9}{2}$$

V2=990V

Exp 4. A transformer has 800 primary turns and 2000 secondary turns. If the primary voltage is 160 V, determine the secondary voltage assuming an ideal transformer.

$$\frac{V1}{V2} = \frac{N1}{N2}$$

$$\frac{160}{V2} = \frac{800}{2000}$$

$$V2 = \frac{160 * 2000}{800}$$

V2 =400v

Exp 5. An ideal transformer with a turns ratio 3:8 has an output voltage of 640 V. Determine its input voltage.

$$\frac{V1}{V2} = \frac{N1}{N2}$$

$$\frac{V1}{640} = \frac{3}{8}$$

$$V1 = \frac{640 * 3}{8}$$

V1=240v

COMPONENT OF TRANSFORMER

These are two basic of transformer construction

1. Magnetic core

2. Windings or coils

1.MAGNETIC CORE

1. The core of transformer either square or rectangular type in size

2. It is further divided into two parts vertical and horizontal

3. The vertical portion on which coils are wounds called limb while horizontal portion is called yoke.

4. Core is made of laminated core type constructions, eddy current losses get minimize.

5. Generally high-grade silicon steel laminations (0.3 to 0.5mm) are used.

2.WINDING

1. Conducting material is used in the winding of the transformer.

2. The coils are used are wound on the limbs are insulated from each other.

3. The two different windings are wounds on two different limbs

4. The leakage flux increases which affects the performance and efficiency of transformer.

5. To reduce the leakage flux, it is necessary that the windings should be very close to each other to have high mutual induction

TRANSFORMER Classification

A. In terms of number of windings

1. Conventional transformer: two windings

2. Autotransformer: one winding

3. Others: more than two windings

B. In terms of number of phases

1. Single-phase transformer

2. Three-phase transformer

C. Depending on the voltage level at which the winding is operated

1. Step-up transformer: primary winding is a low voltage (LV) winding

2. Step-down transformer: primary winding is a high voltage (HV) Winding.

D. Core type construction transformer

1. CORE TYPE CONSTRUCTION

2. SHELL TYPE CONSTRUCTION

CORE TYPE CONSTRUCTION

- **In this one magnetic circuit and cylindrical coils are used.**
- **Normally L and T shaped laminations are used.**

• Commonly primary winding would on one limb while secondary on the other but performance will be reducing.

• To get high performance it is necessary that other the two winding should be very close to each other.

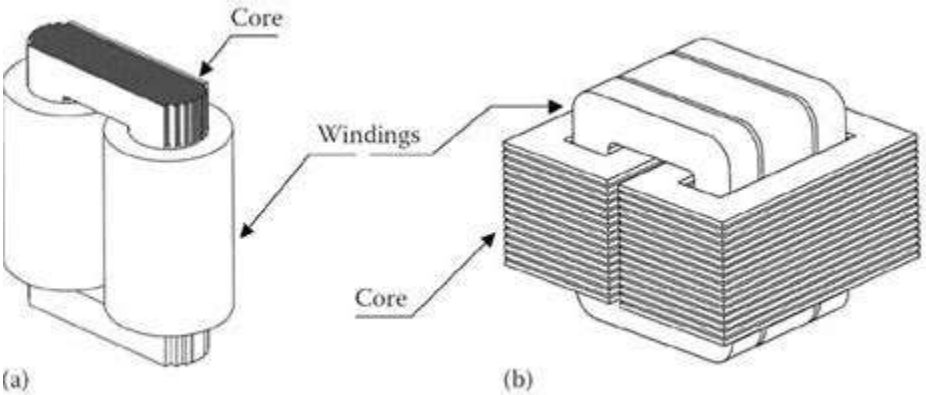
SHELL TYPE CONSTRUCTION In this type two magnetic circuit are used:
• The winding is wound on central limbs.

• For the shell type each high voltage winding lies between two voltage portion sandwiching the high voltage winding.

• Sub division of windings reduces the leakage flux.

• Greater the number of sub division lesser the reactance.

• This type of construction is used for high voltage.



CORE TYPE **SHELL TYPE**