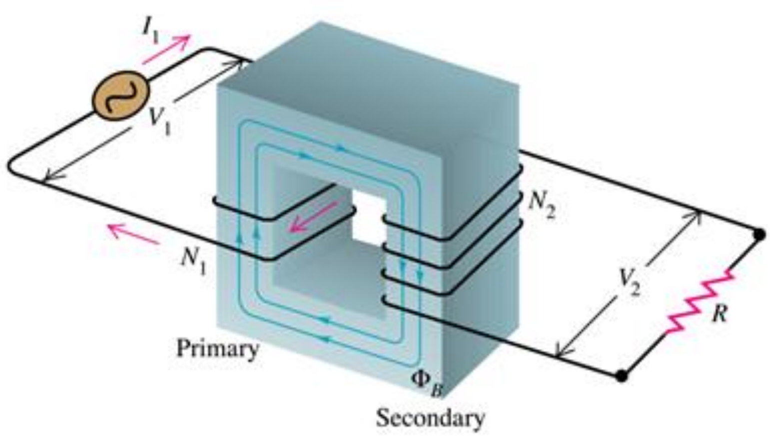
Project Report

Project Name: Transformer



Submitted To:

Submitted By:

Aim

To design step down Transformer

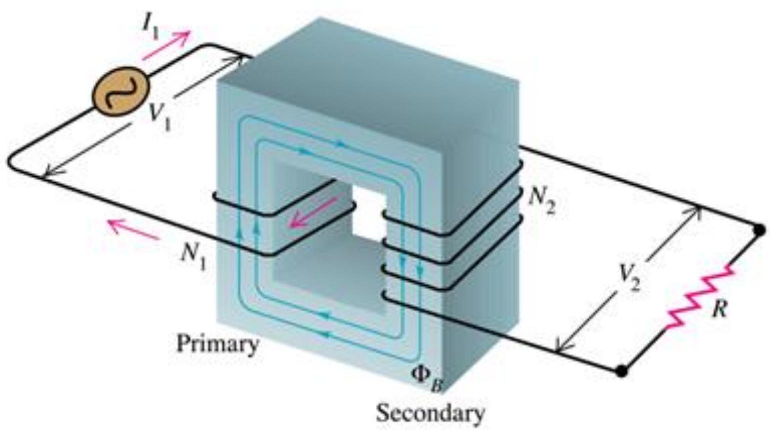
Components

Transformer with copper windings in primary and secondary section, wire, bulb (3 volt)

Principle

A transformer is based on the principle of mutual induction i.e. whenever amount of magnetic flux linked with coil changes, emf is induced in neighboring coil.

Theory and Construction



A transformer consists of rectangular soft iron core made of laminated sheets, well insulated from one another.

Two coils P_1P_2 and S_1S_2 are wound on same core but well insulated from one another. Both the coils are insulated from the core.

The source of alternating emf is connected to P_1P_2, the primary coil and load resistance R is connected to S_1S_2, the secondary coil through an open switch S.

Theory and working :

[If ϕ_p and ϕ_s = amount of flux linked with primary and secondary

$$n_s \frac{d\phi_s}{dt} = n_p \frac{d\phi_p}{dt}$$

$$n_s E_s = n_p E_p$$

$$\frac{E_s}{E_p} = \frac{n_s}{n_p}$$

If $n_s > n_p$

$E_s > E_p$

$\rightarrow$ **the transformer is step up transformer**

If $n_p > n_s$

$\therefore$ $E_p > E_s$

$\rightarrow$ **the transformer is step down transformer**

And $\frac{n_s}{n_p} = k$ represents transformation ratio.

The rate at which generator transfers energy to primary = $I_p E_p$

The rate at which generator transfers energy to secondary = $I_s E_s$

According to conservation of energy (for 100% efficient transformer)

Input Power = Output Power

$I_p E_p = I_s E_s$

$$I_S = I_P \frac{E_P}{E_S}$$

$$\frac{E_p}{E_s} = \frac{n_p}{n_s} = \frac{I_s}{I_p}$$

If transformer is not 100% efficient

$$\eta = \frac{Output\ \ Power}{Input\ \ Power} = \frac{E_S I_S}{E_P I_P}$$

Efficiency of Transformer

It is defined as ratio of output power in input power

$$\eta = \frac{Output\ \ Power}{Input\ \ Power} = \frac{E_S I_S}{E_P I_P}$$

Losses of Transformer

1. <u>Copper loss</u> : It is the energy loss in the form of heat in copper coils of a transformer. Copper loss is I^2R loss, in primary side it is $I_1^2 R_1^2$ and in secondary side it is $I_2^2 R_2^2$ loss, where I_1 & I_2 are primary & secondary current of transformer and R_1 & R_2 are resistances of primary & secondary winding. As the both primary & secondary currents depend upon load of transformer, **copper loss in transformer** vary with load.

2. <u>Iron loss</u> : It is the energy loss in the form of heat in the iron core of transformer. This is due to formation of eddy currents in iron core.

3. <u>Leakage of magnetic flux</u> : Rate of change of magnetic flux linked with each turn of S_1S_2 is less than rate of change of magnetic flux linked with each turn of P_1P_2.

4. <u>Hysteresis loss:</u> This is the loss of energy due to repeated magnetization and demagnetization of the iron core. The magnetic core of transformer is made of 'Cold Rolled Grain Oriented Silicon Steel'. Steel is very good ferromagnetic material. This kind of materials is very sensitive to be magnetized. That means, whenever magnetic flux would pass through, it will behave like magnet. Ferromagnetic substances have numbers of domains in their structure. Domains are very small regions in the material structure, where all the dipoles are paralleled to same direction. In other words, the domains are like small permanent magnets situated randomly in the structure of substance. These domains are arranged inside the material structure in such a random manner, that net resultant magnetic field of the said material is zero. Whenever external magnetic field is applied to that substance, these randomly directed domains get arranged themselves in parallel to the axis of applied external magnetic field. After removing this external magnetic field, maximum numbers of domains again come to random positions, but some of them still remain in their changed position. Because of these unchanged domains, the substance becomes slightly magnetized permanently. This magnetism is called " Spontaneous Magnetism". To neutralize this magnetism, some opposite external magnetic field is required to be applied. The external magnetic field applied in the transformer core is alternating. For every cycle due to this domain reversal, there will be extra work done. For this reason, there will be a consumption of electrical energy which is known as Hysteresis loss of transformer.

5. <u>Magnetostriction or Humming loss</u> : i.e humming noise of a transformer due to vibration of core. Magnetic flux in a ferromagnetic material, such as the core, causes it to physically expand and contract slightly with each cycle of the magnetic field, an effect known as magnetostriction. This produces the buzzing sound commonly associated with transformers, and can cause losses due to frictional heating.

Uses of Application

1.Voltage regulators for TV. Refrigerator, etc.

2. In transmission of a.c. over long distances

Need for laminated core

When a.c. input is applied across primary coil, the induced emf is produced in secondary coil due to change in magnetic flux across it. The magnetic flux also changes through soft icon core and it produces induced emf in the iron core also. The induced emf developed in iron core produces current in iron core in the form of closed loop known as **eddy currents.** As a results large amount of heat is produced and it may damage the insulation of copper windings. To avoid this laminated core is used in transformer.

Cooling of Transformer

Small dry-type and liquid-immersed transformers are often self-cooled by natural convection and radiation heat dissipation. As power ratings increase, transformers are often cooled by forced-air cooling, forced-oil cooling, water-cooling, or combinations of these. Large transformers are filled with transformer oil that both cools and insulates the windings. Transformer oil is a highly refined mineral oil that cools the windings and insulation by circulating within the transformer tank.