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by

Transformer Design

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***Abstract*— This work is mainly about the designing, working, and outcomes of a transformer with output values of 50%, 80%, 90%, and 100%. The transformer with input voltages starting from zero to maximum supported voltages and offers us the output voltages of 46. 66% of the input voltages while the bobbin size is calculated using design parameters of a transformer using given equations.**

***Keywords*—** *bobbin, taps, shell type laminations.*

I. Introduction

Today, power transmission over a long distance is a best application of a passive electrical device commonly known as Transformer mainly used for increasing or decreasing output voltages as per user demand by keeping the power constant. A simple transformer basically consists of two coils Primary and Secondary moreover the input and output voltages are directly linked with the number of turns of wire/coil. In transformer the power in input and output will be remain same. An electrostatic device that is used to transfer electrical energy from one circuit to the other by the phenomenon of mutual induction of two electric circuits without change in frequency. A various contemporary in anybody coil of the transformer produces a changing in magnetic flux with inside the transformer's core which induces a changing electromotive force throughout some other coils wound across the identical core. Electrical electricity may be transferred among separate coils without a metallic (conductive) connection among the 2 circuits. Faraday's law of electromagnetic induction, observed in 1831, describes the precipitated voltage impact in any coil because of a converting magnetic flux encircled through the coil. Here (Figure 1) depicts the structure of an ideal transformer which consist of a Core, primary, and secondary winding/coils. Transformer is basic element of power transmission system, power distribution system, electrical appliances, battery chargers, UPS, power supplies, stabilizers, and electronics toys. Design of large transformer for example 1KV to MVA's is quite complicated and time consuming, in which core design, cooling system design and other protection system is included. In this lab activity will we use a simple design to demonstrate and understand the construction of small transformer used in daily life.

The relation between Primary and secondary voltages, number of turns and current can be shown with the (Eq 1).

$$\frac{Np}{Ns} = \frac{Vp}{Vs} = \frac{Is}{Ip} = a \quad - - - (Eq\ 1)$$

Where (a) is the turns ratio of the transformer. There are many types of transformers and we have discussed some of them below as.

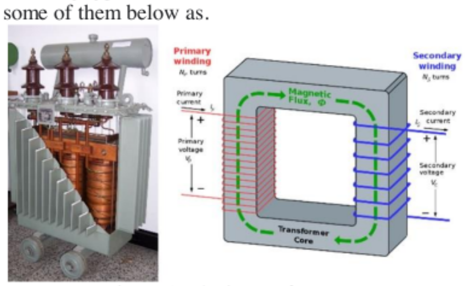

Figure 1. Ideal Transformer

1) Step up and Step down transformer

Step up transformer transforms low voltage, immoderate cutting-edge proper right into an immoderate voltage. The variety of turns in secondary winding may be more then variety of turns in primary winding. Step down transformer the variety of turns in primary winding is more than variety of turns in secondary winding.

2) Single phase transformer

Single phase transformer will get hold of single-phase AC power and outputs single phase AC and it's far used as a step-down transformer to decrease the residence voltages to a suitable value without extrude in frequency. AC supply is given as primary and secondary winding.

3) Three Phase Transformer

Three phase transformers use to change voltages of electrical with the three phases transformer. It is used for electric power generation, transmission, and distribution. Three phase transformer connection with WYE and Delta.

4) Power Transformer

It is basically a static machine use a transforming power from one circuit to another without changing a frequency. It bases on principle of mutual induction

II. Design Methodologgy and Calculations

A. *Bobbin Size Selection*

If you know the power in watts, then take its square root and divide it by 5.6 (constant) you will get the bobbin size. For Example:

$$W = VA \times PF$$

Rating 140VA

PF =0.8 (usually used)

$$W = 140*0.8 = 112 \text{ Watts}$$

$$\sqrt{112} / 5.6 = 1.8898 \text{ inch}$$

Here an important thing to remember is don't use a bobbin of size smaller than the computed value and it is a good practice to use higher closer possible size of bobbin with respect to the computed value. For the above-mentioned case a bobbin of size 2 x 2 inches is to be selected as shown in (Figure 2).

Figure 2. Selected Bobbin of size 2x2 inches

B. *Bobbin area calculation*

After finding out the desired bobbin size we can easily calculate the area of the selected bobbin as mentioned here (2x2.54) x (2x2.54) cm^2. Note that here 2.54 is multiplied with the calculated size to convert inches to cm.

C. *Turns Per Volt*

To calculate the no of turns of primary and secondary winding. Divide a constant 42 with bobbin area to get "turns per volt".

D. *Primary and Secondar wire gauge calculations*

To calculate current on each side of winding, divide VA rating by the corresponding voltage. Using AWG table, find the gauge of the wire needed for corresponding side. Primary Winding Current = 140VA/220V = 0.636363A The wire gauge for primary wire is selected from AWG table according to the calculations carried out above that comes 23 AWG. Secondary Winding Current = 140VA/100V = 1.4A The wire gauge is selected from AWG table according to the calculations carried out above that comes 20 AWG.

III. RESULTS

We were supposed to have an output voltage of 46% of the input voltages let us say the machine will give 101.2V at 220 input voltages and here we have designed our transformer in such a way that it can provide us the output voltages of 50%, 80%, 90, and 100% of the total output voltages (101). (Figure 3), (Figure 4), (Figure 5), and (Figure 6) depicts the output voltages respectively.

Figure 3. DMM reading of 50% of the output voltages

Figure 4. DMM reading of 80% of the output voltages

Figure 5. DMM reading of 90% of the output voltages

Figure 6. DMM reading of 100% of the output voltages

Now, we would like to talk about how we got these different voltages from a single transformer at the same time. The output voltages and current depends on the number of turns in coils at the primary and secondary winding. By substituting given values/ratings of number of coils on the primary side, the primary voltages and the secondary voltages we can easily find out the desired number of turns that has to be on the secondary coil to get the desired secondary voltages and in during the winding of secondary coil you have to count till the desired number of turns and then take some wire out of the coil but remember you don't have to cut the wire. after that turn the wire or you can say make a loop of wire and start winding again till the next desired number of turns. This way of winding (Figure 7) makes a center taped winding transformer from which you can get any number of desired voltages and this technique works for both step up and step-down transformer. Here H1 and H2 represents the terminals of primary winding whereas X1, X2, and X3 depicts the terminals of secondary winding from where we can get output voltages. Furthermore, if you use X1 and X3 you will get 100% of the output voltages but if you use X1 and X2 or X2 and X3 you will get 50% of the output voltages. This type of winding can be quite handy when you want multiple values of voltages from a single machine and want to keep the power constant. (Figure 8) depicts the group members of this project, this transformer is designed by Rafay Aamir and Muhammad Aetisam.

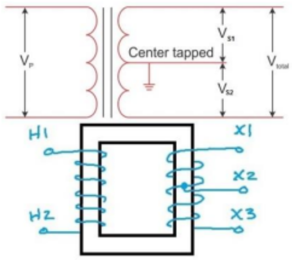

Figure 7. Center taped winding of a transformer.

Figure 8. Researchers of this project

IV. CONCLUSION

Our work deals mainly with the construction, operation, and properties of a transformer that can provide the voltages of 50%, 80%, 90% and 100% of the output voltages. The paper is about the designing process of a transformer that will provide a stranger a complete knowledge of how to design an efficient transformer.

V. REFERENCES

[1] Mack, James E.; Shoemaker, Thomas (2006). "Chapter 15 Distribution Transformer" (PDF). *The Lineman's and Cableman's Handbook (11th ed.). New York: McGraw-Hill. pp. 15-1 to 15-22.* ISBN 0-07-146789-0. *Archived from* the original (PDF)*on 2013-02-10.* Retrieved 2013-01-12.

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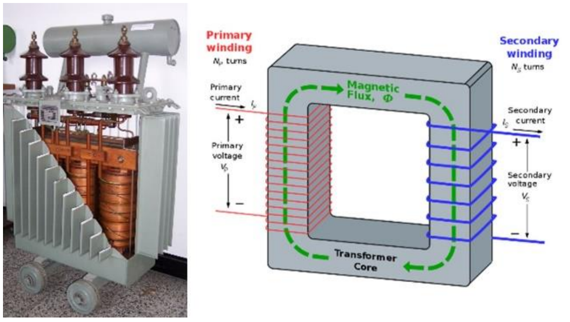

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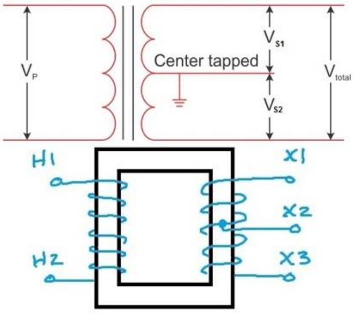

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