EAST WEST UNIVERSITY

Department of EEE

Section: 01
Course Name: Electrical Machines
Course Code: EEE301

Project

Course Instructor: Dr. Khalid Imtiaz Saad,
Assistant Professor, Department of EEE

Submitted By

- ★Arpon Podder (2020-1-80-005)
- ★Rohit Bhowmick(2020-1-80-006)
- ★Joy Majumdar(2020-1-80-009)
- ★Moin Khan Orpon(2020-2-80-026)

Calculation

Give data,
Primary voltage, V_1=220 V

Secondary Voltage, V_2 =75 V

Apparent Power, S = 10 VA

Frequency, f =50 Hz

Magnetic Flux density = 1.2 Wbm^{-2}

Density of copper = 8960 kgm^{-3}

Current density = 2.3 Amm^{-2}

<u>For primary side calculation</u>

- **Core Calculation**

Central limb length, $l = 5.8cm = 0.0580\, m$
Central limb width, $w = 4\, cm = 0.0400\, m$
Area of the core, $A = (l \times w)$

$$= 2.320000 \times 10^{-3} m^2$$

Turns per volts, $T = \frac{1}{4.44fBA}$

$$= \frac{1}{4.44\times50\times1.2\times6.31825\times10^{-3}}$$

$$= 1.6180\, V^{-1}$$

- **Primary winding calculation:**

Primary current ,$I_1 = \frac{S}{V_1}$

$$= \frac{10}{220} A$$

$$= 0.0455\, A$$

Total number of turns,$N_1 = T \times V_1$

$$= 1.6180 \times 220$$

$$= 355.95$$

- **Size of conductor (Primary):**

Area = $\frac{Current}{Current\ Density}$

$$= \frac{0.0455}{2.3}$$

$$= 0.0198\, mm^2$$

$$= 3.0632 \times 10^{-5}\, inch^2$$

- **Weight of winding (Primary):**

For rectangular bobbin,

Perimeter of the Bobbin $= 2 \times (w + l)$

$= 2 \times (0.0400 + 0.0580)\, m$

$= 0.1960\, m$

Total length of all turns of primary

$= (Length\ of\ one\ turn \times total\ number\ of\ turns\ of\ primary)$

$= (0.1960 \times 355.95)$

$= 69.7680\, m$

Volume of copper wire $= (Area\ of\ conductor \times length)$

$= (1.9763 \times 10^{-8} \times 69.7680)$

$= 1.3788 \times 10^{-6}\, m^{3}$

Weight of primary conductor $= (Density \times volume)$

$= (1.3788 \times 10^{-6} \times 8960)\, kg$

$= 1.234 \times 10^{-2}\, kg$

Table 1: Calculation for primary side

Parameter	Formula	Value
Power rating	Given	10 VA
Voltage	Given	220 V
Current	$I_1 = \frac{S}{V_1}$	0.0455A
Conductor size	$Current\ density = \frac{Current}{Area}$	$0.0198\ mm^2$
Wire gage	Check from table	34
Number of turns	$N_1 = Turns\ Per\ volt \times Primary\ side\ voltage$	355.95
Total wire length	$Total\ length\ of\ all\ turns\ primary = Length\ Of\ one\ turn \times Total\ number\ of\ turns\ of\ primary$	$69.7680\ m$
Volume of conductor	$Volume = Area \times Length$	$1.3788 \times 10^{-6}\ m^3$
Weight of conductor	$Weight = Density \times Volume$	$1.234 \times 10^{-2}\ kg$

For secondary side Calculation

- **Secondary winding calculation:**

Secondary current ,$I_2 = \frac{S}{V_2}$

$= \frac{10}{75}\ A$

$= 0.133\ A$

Total number of turns,$N_2 = T \times V_2$

$= (1.6180 \times 75)$

$= 121.34$

- **Size of conductor:**

Area $= \frac{Current}{Current\ Density}$

$= \frac{0.133}{2.3}\ mm^2$

$= 0.0580\ mm^2$

$= 8.9855 \times 10^{-5}\ inch^2$

- **Weight of winding(Secondary):**

For rectangular bobbin,

Perimeter of the Bobbin /Length of one turn $= 2 \times (w + l)$

$= 2 \times (0.0400 + 0.0580)$

$= 0.1960\ m$

Total length of all turns of Secondary

$= (Length\ of\ one\ turn \times total\ number\ of\ turns\ of\ secondary)$

$= (0.1960 \times 121.34)\ m$

$= 23.7846\ m$

Volume of copper wire $= area\ of\ conductor \times length$

$= (23.7846 \times 5.7971 \times 10^{-8})\ m^3$

$= 1.3788 \times 10^{-6}\ m^3$

Weight of secondary conductor $= density \times Volume$

$= (1.3788 \times 10^{-6} \times 8960)\ kg$

$= 1.234 \times 10^{-2}\ kg$

Table 2: Calculation for secondary side

Parameter	Formula	Value
Power rating	Given	10VA
Voltage	Given	75 V
Current	$I_2 = \frac{S}{V_2}$	$0.133\ A$
Conductor size	$Current\ density = \frac{Current}{Area}$	$0.0580\ mm^2$
Wire gage	Check from table	29
Number of turns	$N_2 = Turns\ Per\ volt \times Secondary\ side\ voltage$	121.341
Total wire length	$Total\ length\ of\ all\ turns\ secondary = Length\ Of\ one\ turn \times Total\ number\ of\ turns\ in\ secondary$	$23.7846m$
Volume of conductor	$Volume = Area \times Length$	1.3788×10^{-6}
Weight of conductor	$Weight = Density \times Volume$	$1.234 \times 10^{-2}\ kg$

Activity Log

		Course Code: EEE301	
		Course Name: Electrical Machines	
		Group No: 06	
		Group Members:	
		01. Arpon Podder(2020-1-80-005)	
		02. Rohit Bhowmick(2020-1-80-006)	
		03.Joy Majumdar(2020-1-80-009)	
		04.Moin Khan Orpon(2020-2-80-026)	
Date	**Activity**	**Description**	**Participants**
12/11/22	Market analysis	Rohit and Arpon went to **Narayanganj market** and Joy went to **Patuatuli**	Arpon,Rohit,Joy
15/11/22	Bought Bobbin	We went to Patuyatuli and bought the bobbin	Arpon, Rohit, Joy
18/11/22	Calculation	We did calculation and we connect with us via google meet	Arpon, Rohit, Moin
26/11/22	Buying transformer materials	We went to Patuyatuli and bought the transformer materials	Arpon, Rohit, Moin, Joy
08/12/22	Construct the Transformer	We constructed the transformer at Joy's house.	Arpon, Rohit, Moin, Joy
13/12/22	Group discussion	We discussed between us via google meet	Arpon, Rohit, Moin, Joy

Verifications

Objective

The objectives of this experiment are:

- To study the performance of a single-phase transformer.
- To measure the voltage regulation for resistive, inductive and capacitive loads.

Theory:

The idea behind how a transformer operates is that energy can be transferred by magnetic induction from one set of coils to another set using a changing magnetic flux. One of the most significant and widely utilized equipment in the electrical sector is the transformer. The transformer's primary winding (coil) is the coil that receives power from an AC source, and the secondary winding is the coil that transmits that power to the load (coil). Transformers can be built in two different ways. Shell type and Core type. Coils (HT and LT) are wrapped around the various transformer legs in the core type. The large space between the coils in a core type transformer makes it ideal for applications requiring high voltage. The coils of a shell-type transformer, on the other hand, are on the same core leg. Low voltage applications are acceptable for this specific transformer type. This type of transformer leaks flux less frequently. The transformer secondary voltage will vary somewhat with the load and its power factor. This variation is expressed through a quantity named Voltage Regulation. The expression of voltage regulation is as follows:

$$\text{Voltage Regulation} = \frac{V_{no\ load} - V_{full\ load}}{V_{full\ load}} \times 100\%$$

Equipment List:

1. Multi-tap laboratory transformer
2. AC Ammeter
3. AC Voltmeter
4. Resistive load
5. Inductive load
6. Capacitive load
7. Connection Leads
8. Power Supply.

Procedure:

1. Using our transformer, Power Supply, Resistive Load, AC Ammeter and AC Voltmeter, resistive, inductive and capacitive load connecting the circuit shown in Figure 1.

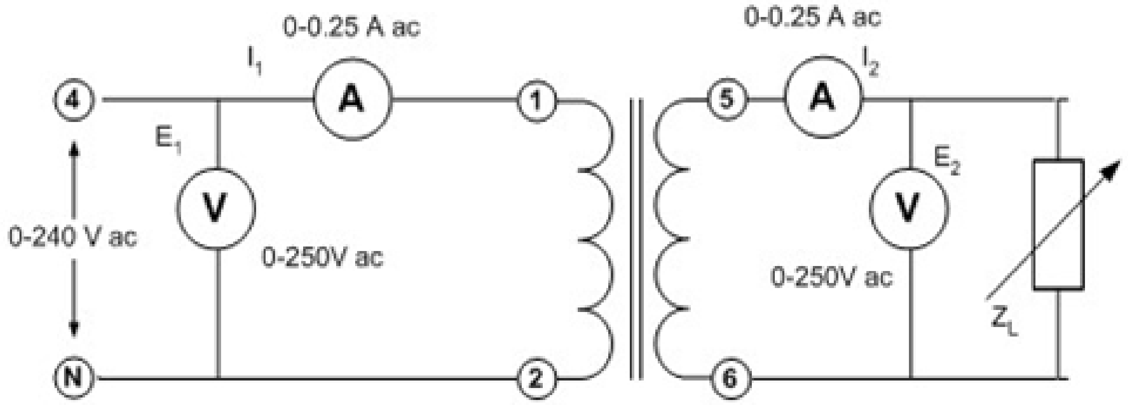

Figure 1: Connection diagram to measure voltage regulation

2. (a) Firstly, place all of the Resistive Load switches in their open position for ∞ Ω load, zero load current.

   (b) Turn on the power supply and adjust for exactly 220 V ac as indicated by voltmeter E_1. Then, we can measure I_1, I_2 *and* E_2.

(c) For the same input voltage $E_1 = 220\ V\ ac$ and Z_L=685.71 Ω we have to measure I_1, I_2 and E_2.

(d) We have to repeat the same process for Z_L= 800Ω , 960Ω and 1200 Ω.

3. Repeat procedure 2 using the Inductive Load in place of the Resistance Load.
4. Repeat procedure 2 using the Capacitive Load in place of the Resistance Load.

Lab Work

Data Sheet for Project:

Student Name	Arpon Podder Rohit Bhowmick Joy Majumdar Moin Khan Orpon
Student ID	2020-1-80-005 2020-1-80-006 2020-1-80-009 2020-2-80-026
Course Code	EEE301
Section	01
Group Number	06
Date	19/12/2022
Instructor's signature	19/12/22

$i_\phi = 0.375\,A + i_{load}$

1. **Data for resistive load:**

Table 1: Recorded values for resistive loads

Load, $Z_L(\Omega)$	Input Voltage, E_1 (V)	Input Current, I_1 (A)	Output Voltage, E_2 (V)	Output Current, I_2 (A)	Turns Ratio (V1/V2)	Voltage Regulation
∞	220	0.35	70	0.01	3.1428	
685.71	220	0.37	70	0.13	3.1428	
800	220	0.35	68	0.11	3.235	
960	220	0.36	68	0.09	3.235	
1200	220	0.35	68	0.075	3.235	

2.Data for inductive load

Table 2: Recorded values for inductive loads

Load, $Z_t(\Omega)$	Input Voltage, E_1 (V)	Input Current, I_1 (A)	Output Voltage, E_2 (V)	Output Current, I_2 (A)	Turns Ratio (V1/V2)	Voltage Regulation
∞	220	0.33	70	0.01	3.1428	
685.71	220	0.4	68	0.13	3.235	
800	220	0.38	69	0.11	3.188	
960	220	0.37	69	0.09	3.188	
1200	220	0.37	69	0.06	3.188	

3.Data for Capacitive load

Table 3: Recorded values for capacitive loads

Load, $Z_t(\Omega)$	Input Voltage, E_1 (V1)	Input Current, I_1 (A)	Output Voltage, E_2 (V2)	Output Current, I_2 (A)	Turns Ratio (V1/V2)	Voltage Regulation
∞	220	0.35	70	0.01	3.1428	
685.71	220	0.3	70	0.13	3.1428	
800	220	0.32	70	0.11	3.1428	
960	220	0.3	69	0.09	3.188	
1200	220	0.3	70	0.065	3.1428	

Data Sheet for Project:

Student Name	Arpon Podder Rohit Bhowmick Joy Majumdar Moin Khan Orpon
Student ID	2020-1-80-005 2020-1-80-006 2020-1-80-009 2020-2-80-026
Section	01
Group Number	06
Date	22/12/2022
Instructor’s signature	

1. Data for resistive load:

Table 1: Recorded values for resistive loads

Load, Z_L (Ω)	Input Voltage, E_1 (V)	Input Current, I_1 (A)	Output Voltage, E_2 (V)	Output Current, I_2 (A)	Turns Ratio (V1/V2)
∞	220	0.35	70	0.01	3.1428
685.71	220	0.37	70	0.13	3.1428
800	220	0.35	68	0.11	3.235
960	220	0.36	68	0.09	3.235
1200	220	0.35	68	0.075	3.235

2. Data for inductive load

Table 2: Recorded values for inductive loads

Load, Z_L (Ω)	Input Voltage, E_1 (V)	Input Current, I_1 (A)	Output Voltage, E_2 (V)	Output Current, I_2 (A)	Turns Ratio (V1/V2)
∞	220	0.33	70	0.01	3.1428
685.71	220	0.4	68	0.13	3.235
800	220	0.38	69	0.11	3.188
960	220	0.37	69	0.09	3.188
1200	220	0.37	69	0.06	3.188

3.Data for Capacitive load

Table 3: Recorded values for capacitive loads

Load, Z_L (Ω)	Input Voltage, E_1 (V)	Input Current, I_1 (A)	Output Voltage, E_2 (V)	Output Current, I_2 (A)	Turns Ratio (V1/V2)
∞	220	0.35	70	0.01	3.1428
685.71	220	0.3	70	0.13	3.1428
800	220	0.32	70	0.11	3.1428
960	220	0.3	69	0.09	3.188
1200	220	0.3	70	0.065	3.1428

Discussion

First of all, creating a transformer taught us something new. Basically, after performing the theoretical calculations for the transformer, we encountered some issues with the practical appliance. Initially, we bought a big bobbin for the 1st calculation. At first using this big bobbing the turns of the primary and secondary come much less and the cost of the core becomes higher. So, we bought a new bobbin which is smaller than the previous one. We construct the transformer with the new one. But the value of the output voltage doesn't come as expected. Our instructor gives us the output voltage 75V but in the lab we get the output voltage 70V. Our transformer's exciting current is 0.375A which is very high as we don't expect. On the other hand, we construct the step-down transformer which $i_2 > i_1$ but in the lab we get the opposite one.

Our transformer has a lot of current loss. In a transformer, four main possible types of losses are resistive loss, eddy currents loss, hysteresis loss, and flux loss. Also our transformer may have some noise. The Magnetostriction Effect is mainly responsible for transformer noise. When ferromagnetic materials come into touch with a magnetic field, this is where the dimensions of those materials change. An electrical transformer's iron core becomes magnetized as a result of the alternating current passing through its coils. There is a humming sound as a result of the core's expansion and contraction. There are also generate some heat in our transformer which is responsible for losses.