Electric Machines Laboratory (EE2P003)

EXPERIMENT-1

SCOTT CONNECTION OF SINGLE-PHASE TRANSFORMERS

Shorya Sharma
19EE01017

AIM OF THE EXPERIMENT:

Perform Scott connection on two single phase transformers.

APPARATUS REQUIRED:

Instruments/Equipment:

Sl. No	Instruments/Equipments	Type	Specification	Quantity
1	Ammeter	MI	0 – 5 A	5 Nos
2	Voltmeter	MI	0 – 600 V	1 No
3	Voltmeter	MI	0 - 300 V	2 Nos
4	Load Box	Resistive	4 kW, 250 V	2 Nos
5	3-Φ variac	Iron core	10 A, 415 V	1 No
6	Connecting Wires	Cu	1.5 sq. mm	As required

Machines Required:

Sl.No	Machine	Specification	Quantity
1.	1- Φ Transformer having 50% & 86.6% tapping.	3 kVA, 220/110 V	2 Nos

THEORY:

Three phases to two-phase conversion or vice-versa is essential under the following circumstances.

(i) To supply power to two phase electric furnaces.

(ii) To supply power to two phase apparatus from a 3-□ source.

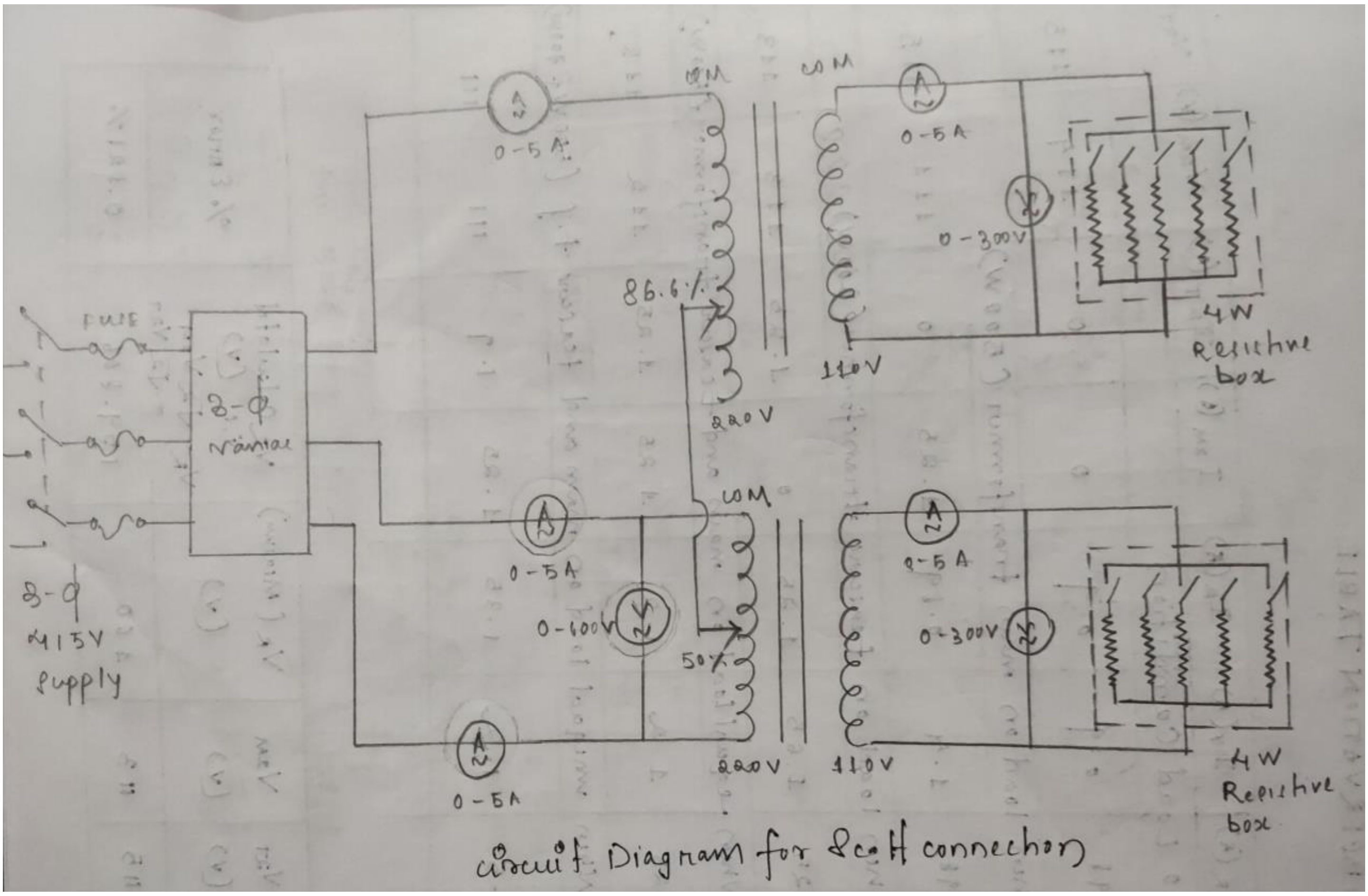
(iii) To interlink three phase system and two phase systems.

(iv) To supply power to three phase apparatus from a two-phase source.

The common type of connection which can achieve the above conversion is normally called Scott-connection. Two single-phase transformers of identical rating with suitable tapping provided on both, are required for the Scott connection. The two transformers used for this conversion must have the following tapings on their primary windings. Transformer A – 50 percent tapping and is called the main transformer.

Transformer B- 86.6 percent tapping and is called the teasure transformer.

CIRCUIT DIAGRAM:



PRECAUTIONS:

1.Connection should be right and tight.

2.Check the circuit connection thoroughly before switching on the supply.

3.Instruments should be connected in proper polarity and range.

4.Do not touch any non-insulated part of any instrument or equipment.

5.Be ensured the zero setting of instrument is on right position. Avoid parallax error.

6.Before switching on the supply set the 3-Φ variac at its minimum position and all load switches in off position.

PROCEDURE:

1.Connect the circuit as per the circuit diagram.
2.Adjust the 3-□ Variac for minimum voltage in output circuit.
3.Close the TPST switch and apply rated voltage across the primaries of the transformers.
4.Note down the no-load readings with $I_{2T} = I_{2M} = 0$.
5.Apply load on the teasure transformer and note down the readings.
6.Repeat step-6 for various load condition.
7.Similarly apply load and take reading for various load condition on the main transformers.
8.Apply load on both secondaries adjust equal loading for both secondaries, Record the readings of all the meters.
9.Repeat step-9 for various equal loading condition on the two secondaries.
10.Repeat step-9 for various unequal loading conditions on the two secondaries.
11.Switch off the load from both the secondaries and switch off the main supply.
12.With load circuit removed, connect the two secondary windings in series and observe the resultant voltage V_R

$$=\sqrt{2}\, V_{2T} = =\sqrt{2}\, V_{2M}$$

OBSERVATION:

Table-1

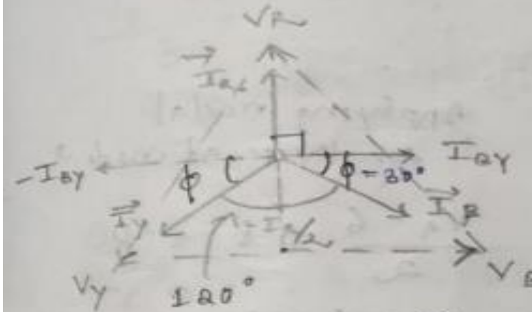
Sl.No	I_R	I_Y	I_B	I_{2M}	I_{2T}	V_{2M}	V_{2T}
No load condition							
	0.98	**0.9**	**0.9**	**0**	**0**	**114**	**115**
When load on main transformer (**500W**)							
	0.98	**1.4**	**0.89**	**1.25**	**0**	**111**	**115**
When load on teasure transformer (**500W**)							
	1.25	**0.65**	**1.25**	**0**	**1.25**	**113**	**113**
When equal load on main & teasure transformer (**500W and 500W**)							
	1.25	**1.2**	**1.2**	**1.25**	**1.25**	**112**	**113**
When unequal load on main & treasure transformer (**500W and 700W**)							
	1.5	**1.2**	**1.35**	**1.25**	**1.9**	**111**	**111**

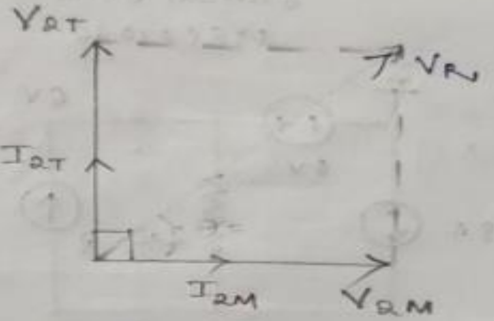
Table-2

V_{2T}	V_{2M}	V_R (Measured)	V_R calculated i.e. $V_R = \sqrt{2}\ V_{2T} = = \sqrt{2}\ V_{2M}$	% Error
115	**113**	**160**	$V_R = \sqrt{2}\ V_{2T} = 162.63$ $V_R = \sqrt{2}\ V_{2M} = 159.80$	**(0.1251% + |-1.617%|)/2 = 0.871%**

Calculations:

Balanced Loads





$$\vec{I}_R = \frac{N_2}{N}\vec{I}_{2T}$$

$$= \frac{2N_2}{\sqrt{3}N_1}\vec{I}_{2T}$$

$|\vec{I}_R| =$ ~~0.569 A~~ 0.75 A

N_1 = no. of turns on primary side of main t.f

N_2 = no. of turns on secondary side of main and teaser t.f

N = No. of turns on primary side of teaser t.f.

So $\vec{I}_R$ and $\vec{I}_{2T}$ are in same phase

Now

$$\vec{I}_{BY} = \frac{N_2}{N_1}\vec{I}_{2M}$$

So $\vec{I}_{BY}$ and $\vec{I}_{2M}$ are in phase

$|\vec{I}_{BY}| = 0.65$ A

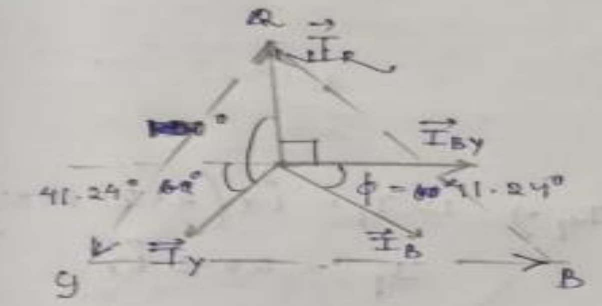
The I_R current gets divided equally at the 50% tapped point on main t-f

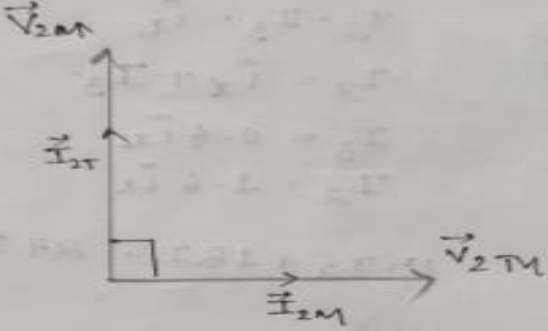
$\vec{I}_B = \vec{I}_{BY} - \vec{I}_R/2 \rightarrow 0.75\ A = |\vec{I}_B|$

$\vec{I}_Y = -\vec{I}_{BY} - \vec{I}_R/2 \rightarrow 0.75\ A = |\vec{I}_Y|$

$$\phi = \tan^{-1}\left(\frac{|\vec{I}_R/2|}{|\vec{I}_{BY}|}\right) = 30.00034° \approx 30°$$

unbalanced Load.





N_2 = No. of turns in secondary side of main and teaser t-f

N_1 = No. of turns in primary side of main t-f

N = No. of turns on primary side of teaser t-f

$$\vec{I}_R = \frac{N_2}{N}\vec{I}_{2T}$$

$$= \frac{2N_2}{\sqrt{3}N_1}\vec{I}_{2T}$$

So $\vec{I}_R$ and $\vec{I}_{2T}$ are in phase. $|\vec{I}_R| = 1.14\ A$

Now

$$\vec{I}_{BY} = \frac{N_2}{N_1}\vec{I}_{2M}$$

So $\vec{I}_{BY}$ and $\vec{I}_{2M}$ are in phase.

$$\vec{I}_{BY} = \frac{115}{220} \times \vec{I}_{2M}$$

$$|\vec{I}_{BY}| = 0.65\ A$$

The I_R current gets divided equally at the 50% tapped point on main t-f

$\vec{I}_B = \vec{I}_{BY} - \vec{I}_R/2 \Rightarrow |\vec{I}_B| = \cancel{1.318\ A}\ 0.864\ A$

$\vec{I}_Y = -\vec{I}_R/2 - \vec{I}_{BY} \Rightarrow |\vec{I}_Y| = \cancel{1.318\ A}\ 0.864\ A$

$$\phi = \tan^{-1}\left(\frac{-\vec{I}_R/2}{\vec{I}_{BY}}\right) = \cancel{60°}\ 41.24°$$

$V_R = 160\ V$ (measured)

$V_{2M} = 113\ V$

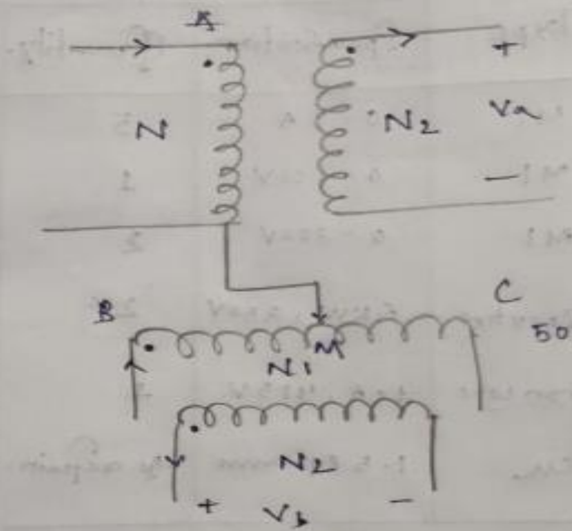
V_R (calculated) $= \sqrt{2}\, V_{2M} = 159.806$

$$\%\ \text{Error} = \frac{160 - 159.806}{160} \times 100$$

$$= 0.12125\%$$

DISCUSSION

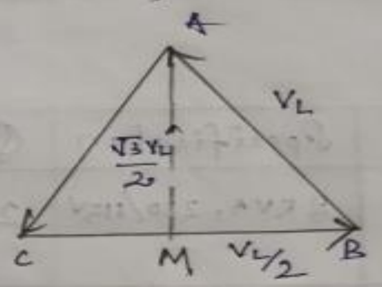
(i) Why is it essential that 86.6% tapping must be there in teaser transformer?

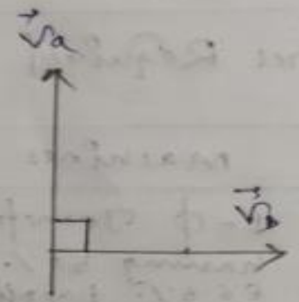


condition for to make a 2φ balance system

(i) voltage phasor must be 90° to each other

(ii) $|\bar{V}_a| = |\bar{V}_b|$





Now $V_{AB} = V_L$ $\qquad V_{AM} = \frac{\sqrt{3}V_L}{2}$

$$V_a = \frac{N_2}{N} V_{AM} = \frac{N_2}{N}\frac{\sqrt{3}}{2}V_L$$

$$V_b = \frac{N_2}{N_1} V_{BC} = \frac{N_2}{N_1} V_L$$

for $|V_a| = |V_b| \Rightarrow \frac{\cancel{N_2}}{N}\frac{\sqrt{3}}{2} = \frac{\cancel{N_2}}{N_1} \Rightarrow N = \frac{\sqrt{3}}{2}N_1$

$$\boxed{N = 0.166 N_1}$$

(ii) What tapping should be available on the main transformer and why?

50% tapping should be available on the main transformer

This is because when you see the circuit diagram connection of 3 ϕ to 2 ϕ conversion, in order to get equilibrium 2 ϕ output the connection should be such that the ratio should maintain 86.6 : 50.

(iii) What is the advantages and disadvantages of Scott connection over Open Delta connection?

Advantages of the Scott T connections are

- If desired a 3 phase, two phase or single phase load my be supplied simultaneously
- The neutral point can be available for grounding or loading purpose.

CONCLUSIONS:

Thus, we successfully obtained the desired two-phase supply from the given 3 phase supply from the given Scott Connection of Single-Phase Transformer.