EEE 270

(Electrical Drives and Instrumentation Sessional)

EXPT. NO. | 05

NAME OF THE EXPERIMENT:

STUDY OF A SINGLE PHASE TRANSFORMER AND DETERMINATION OF TURN RATIO

Group No.	**05**
Writer's ID	**1705027**
NAME	**SAEM HASAN**
Section	A-1
Department	CSE
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Objective

The experiment emphasizes on single phase transformers and the goal is to study these transformers and determine their turn ratio.

Introduction:

A tranformer is a static device comprising coils coupled through a magnetic medium connecting two ports at different or same voltage levels in an electric system allowing the interchange of electrical energy between the ports in either direction via the magnetic field. The most important tasks performed by transformers are:

① Changing voltage and current levels in electric power systems.
② Matching source and load impedances for maximum power transfer ~~mer~~ in electronic and communication system.
③ Electrical isolation (isolating one circuit from another)

A transformer in its simplest form, consists essentially ~~for~~ of two insulated windings interlinked by a common or ~~mutal~~ mutual magnetic field established in a core of magnetic material. When one of the windings, termed the primary, is connected to an alternating voltage source, an alternative flux is produced in the core with amplitude depending on the primary voltage and number of primary turns. This mutual flux links the other windings, called the secondary. A voltage is induced in this secondary and its magnitude will depend on the number of secondary turns. If the secondary voltage is greater than the primary value, the transformer is called a step-up transformer; If it is less, it is known as a step down transformer; If primary and secondary voltages are equal, the transformer is said to have a one to one ratio. One to one tranformers are used to electrically isolate two parts of a circuit. Any transformer may be used as step up or step down depending on the way it is connected. The turn ratio of a transformer is defined as.

$$a = \frac{N_1}{N_2} = \frac{E_1}{E_2} = \frac{I_1}{I_2}$$

In this experiment, we shall determine the turn ratio of a power transformer.

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Apparatus:

1. two AC voltmeters (0-300V, 0-150V)
2. Two AC ammeters (0-10A, 0-30A)
3. One single phase transformer
4. One rheostat (current rating ≥ 5A)
5. Auto transformer (variac)
6. Wires and chords.

Experimental setup

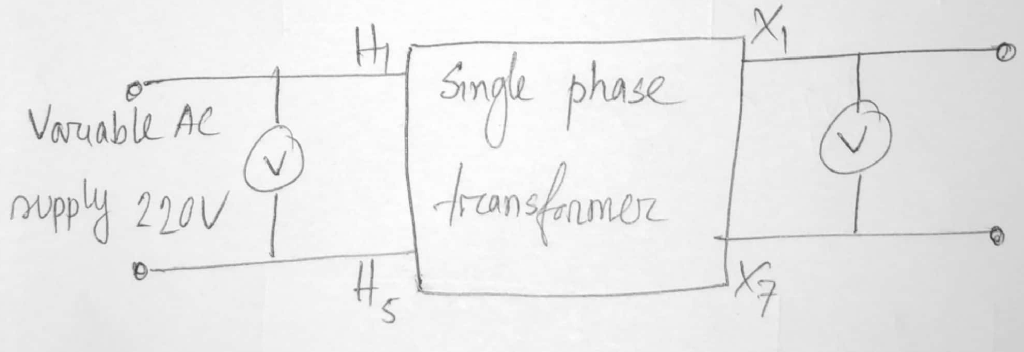

figure (a)

Figure (b)

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Report :

① and ②

Ans:

Voltage Ratio:

$V_p (V)$	$V_s (V)$	$a = \frac{V_p}{V_s}$
120	61	1.9673
145.7	74.2	1.9638
161.1	82	1.9646
182.4	93.2	1.9573
202.9	102.9	1.9719

Avg, $a = 1.965$

Current Ratio:

$I_p (A)$	$I_s (A)$	$a = \frac{I_s}{I_p}$
0.35	0.6	1.7142
0.37	0.65	1.7567
0.40	0.70	1.75
0.44	0.75	1.7045
0.48	0.8	1.667

Avg, $a = 1.718$

(2) In both process, the values were pretty close. But if we compare values between two processes, then we see turns ratio by voltage had higher values than turn ratio by current. The reason behind it is that, the seconds current gives rise to its own flux which affects the primary flux and hence the primary current.

(3) Which method of determining turn ratio is more accurate and why?

<u>Ans:</u> Turn ratio determined by voltage is more accurate. Because here, we are able to measure directly voltage applied in the primary coil and induced voltage in the secondary coil, whose ratio is the considered turn ratio.

But in case of the current ratio method, the secondary current I_s gives rise to its own flux which in turn weakens the primary flux. As a consequence, the ~~[illegible]~~ currents with real values cannot be computed correctly. This causes the failure to correctly find out the turn ratio in this process. Thus the voltage ratio method is more accurate.

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④ Ans

Ideal transformer: An ideal transformer is an imaginary transformer with no loss in it which means an ideal transformer won't have any core loss, copper loss and any other losses. Efficiency of this transformer is considered to be 100%.

Turn Ratio: Turn ratio is the ratio of the turns in primary and secondary windings. If primary windings have N_p turns and secondary windings have N_s turns then turn ratio, $a = \frac{N_p}{N_s}$

Nominal Ratio: Nominal Ratio is the ratio of rated primary winding phasor and rated secondary winding phasor and ~~rated secondary~~ In potential transformers, it is the ratio of voltages whereas in current transformer, it is the ratio of currents.

$$\text{Nominal Ratio} = \frac{\text{Rated Primary winding phasor}}{\text{Rated secondary winding phasor}}$$

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Transformation Ratio: Transformation Ratio is the ratio of the voltage applied at the primary coil(V_1) and induced voltage of the secondary coil(V_2).

$$\text{Transformation Ratio} = \frac{V_2}{V_1}$$

Step-up transformer:

A transformer that increases the voltage from primary to secondary winding is called step-up transformer. It has more turns in secondary winding than in primary.

Step-down transformer:

A transformer that decreases the voltage from primary to secondary winding is called step down transformer. It has more turns in primary winding than in secondary.

(5) Ans:

Copper loss of a tranformer depends on current and iron loss depends on voltage. Hence total transformer loss depends on volt-ampire (VA) and not on phase angle between voltage and current, that is, it is independent

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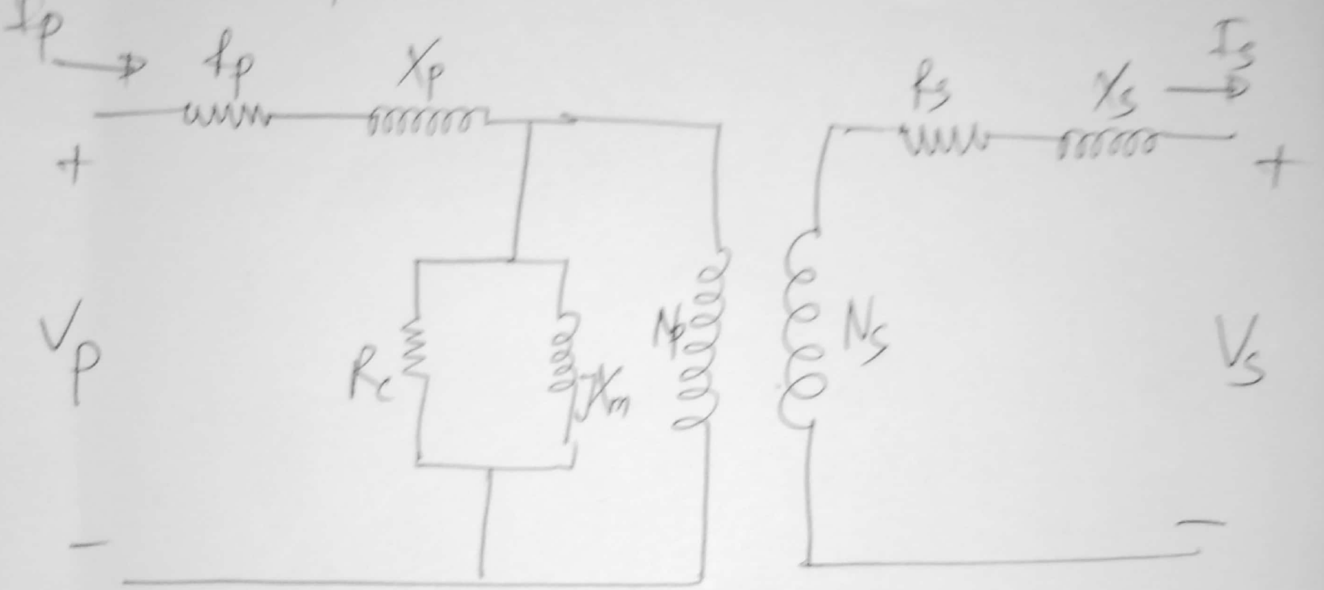
of load power factor. That is why rating of transformer is in KVA and not in KW.

⑥ Ans:

Exact equivalent circuit:



R_p = resistance of primary winding X_p = Reactance of primary winding

R_s = resistance of secondary winding X_s = Reactance of secondary winding

R_c = resistance that models core loss current

X_M = reactance that models magnetization current

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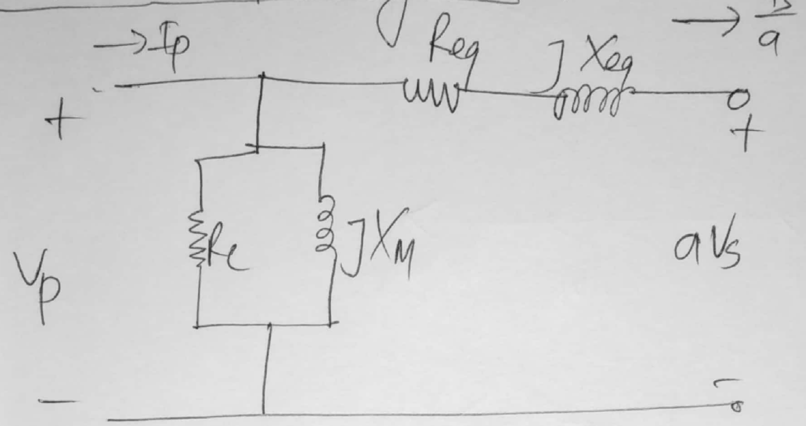
Approximate Equivalent Circuit

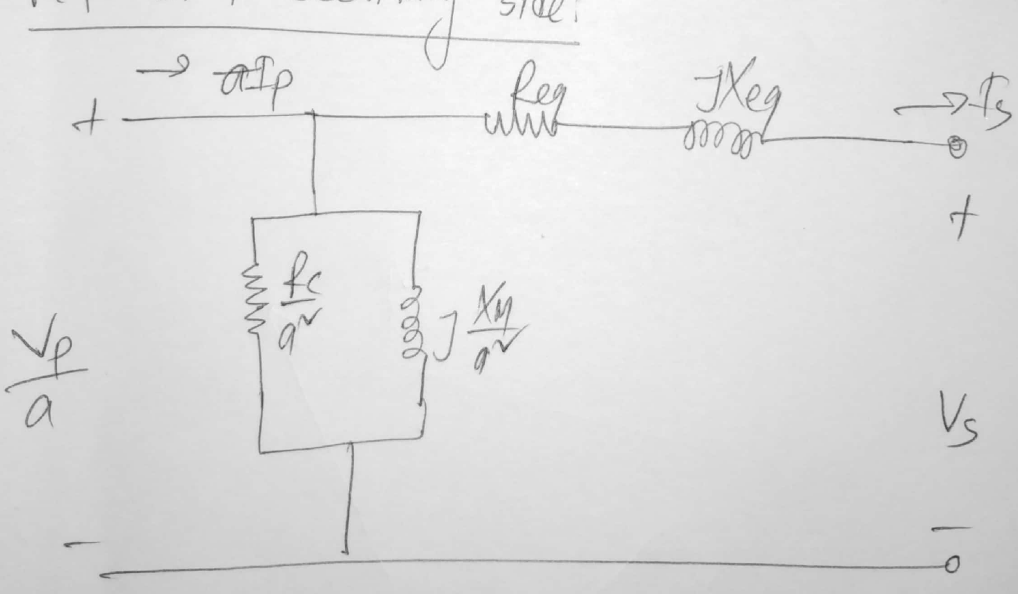
Referred to primary side:



a= turn ratior $\quad R_{eq} = R_p + a^2 R_s$

$X_{eq} = X_p + a^2 X_s$

Referred to secondary side:



$$R_{eq} = \frac{R_p}{a^2} + R_s$$

$$X_{eq} = \frac{X_p}{a^2} + X_s$$

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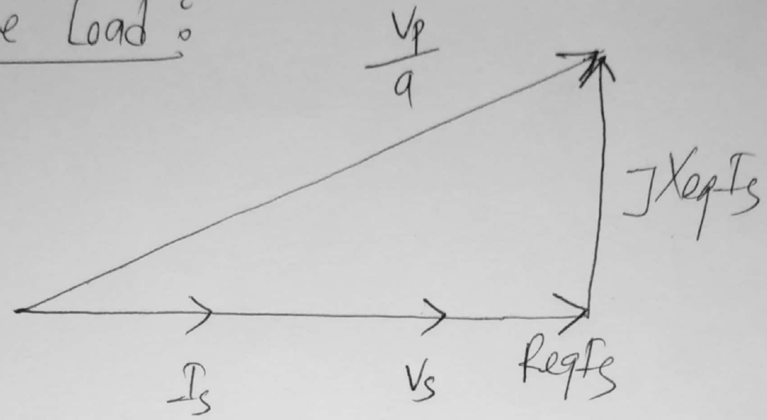
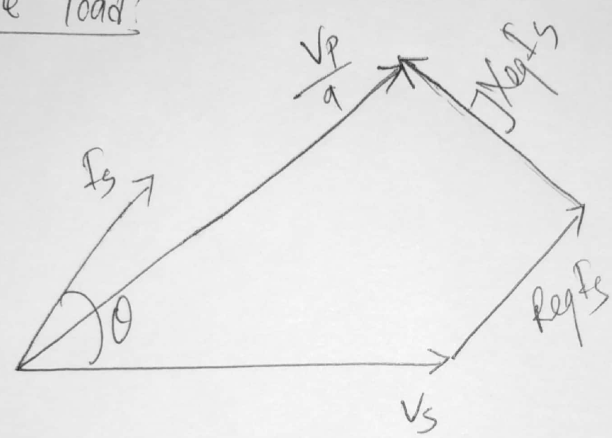
7 Ans

Resistive Load :



Capacitive load:



Inductive load :