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EE160: Experiment 6

Objectives :- (i) To study open circuit (oc) test in transformer.

(ii) To study short circuit (sc) test in transformer.

(iii) To determine the transformer equivalent circuit from open circuit and short circuit test.

Theory :-

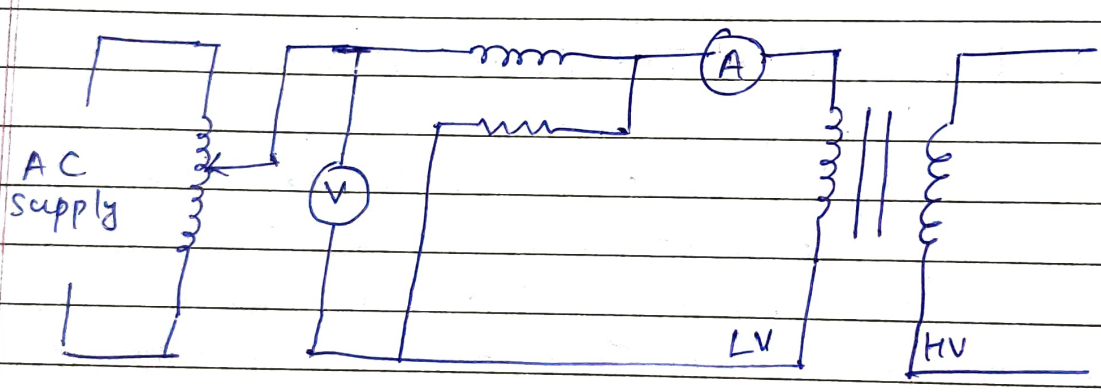
(a) Open Circuit Test in transformer

The purpose of oc test is to determine the no load current and losses of transformer because of which their no load paramcter is determined. This test is performed on the primary winding of transformer. The wattmeter, ammeter and the voltage are connected in their primary winding. The nominal rated voltage is supplied to their primary winding with the help of AC source.

The secondary winding is kept open and the voltmeter is connected to their terminal. The voltmeter measures the secondary induced voltage. As the secondary of

the transformer is open, the no-load current flow through the primary winding. The value of no load current is very small as compared to the full-rated current. The copper loss occurs only on the primary winding of the transformer because secondary winding is open. The reading of wattmeter represents the core and iron losses. The core loss is same for all types of loads.

The equivalent circuit is as follows:



Mathematical Calculation

W_o - Wattmeter Reading
V_i - Voltmeter Reading
I_o - Ammeter Reading

Then, iron loss of transformer $P_i = W_o$

$$W_o = (V_i)(I_o)\cos\phi \quad \text{---(1)}$$

The no-load power factor is

$$\cos\phi = \frac{W_o}{(V_1 I_o)}$$

working component I_w is

$$I_w = \frac{W_o}{V_1} \quad \text{—(II)}$$

Substituting value of W_o from (I) in (II),

$$\boxed{I_w = I_o \cos\phi}$$

Magnetising component is

$$I_m^2 = I_o^2 - I_w^2$$

$$I_m = \sqrt{I_o^2 - I_w^2}$$

$$\boxed{I_m = I_o \sin\phi}$$

Load Parameters:

Equivalent exciting resistance: $R_o = \frac{V_1}{I_w}$

Equivalent exciting reactance: $X_o = \frac{V_1}{I_m}$

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(b) Short Circuit Test in Transformer

This test is performed for determining the below mentioned parameter of transformer

(i) It determines the copper loss on the full load. The copper loss is used for finding the efficiency of transformer.

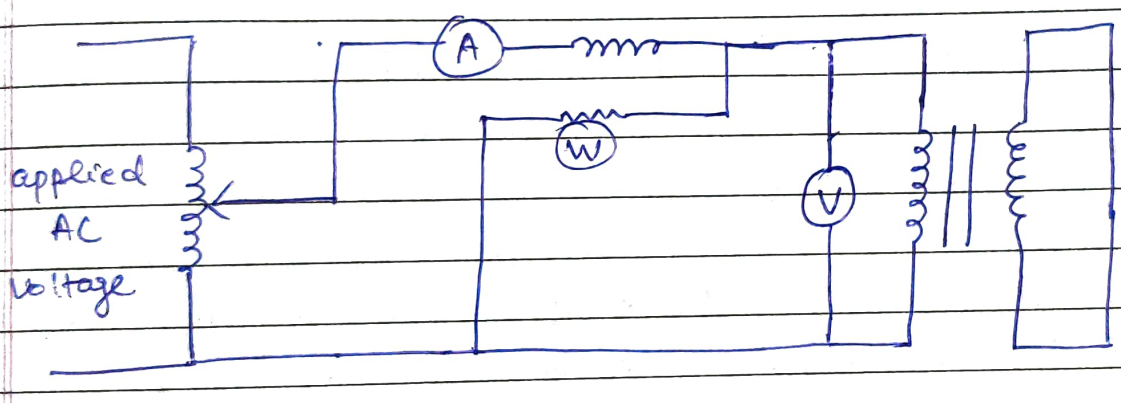
(ii) The equivalent resistance, impedance and leakage reactance are known by SC test.

This test is performed on the secondary or the high voltage winding of the transformer. Their primary winding is short circuited by the help of thick strip or ammeter which is connected to their terminal. The low voltage source is connected across the secondary winding because of which full load current flow from both the secondary and primary winding of the transformer. The full load current is measured by the ammeter connected across their secondary winding.

The low voltage source is applied across the secondary winding which is approximately 5-10% of the normal rated voltage. The flux is set up in the core of the transformer. The magnitude of flux is

small as compared to the normal flux. It is loss in SC test because of low value of flux. The reading of wattmeter only determines the copper loss occuring on their windings. The voltmeter measures the voltage applied to their high voltage winding. The secondary current is induced in the transformer because of applied voltage.

The equivalent circuit is as follows:



Mathematical Calculations:

W_c - Wattmeter Reading
V_{sc} - Voltmeter Reading
I_{sc} - Ammeter Reading

The full load copper loss of transformer is given by:

$$P_c = \left(\frac{I_{fl}}{I_{sc}}\right)^2 W_c$$

$$I_{sc}^2 R_s = W_c$$

Equivalent resistance referred to secondary side

$$R_s = \frac{W_c}{I_{sc}^2}$$

Equivalent Impedance referred to secondary side,

$$Z_s = \frac{V_{sc}}{I_{sc}}$$

Equivalent Reactance referred to secondary side is,

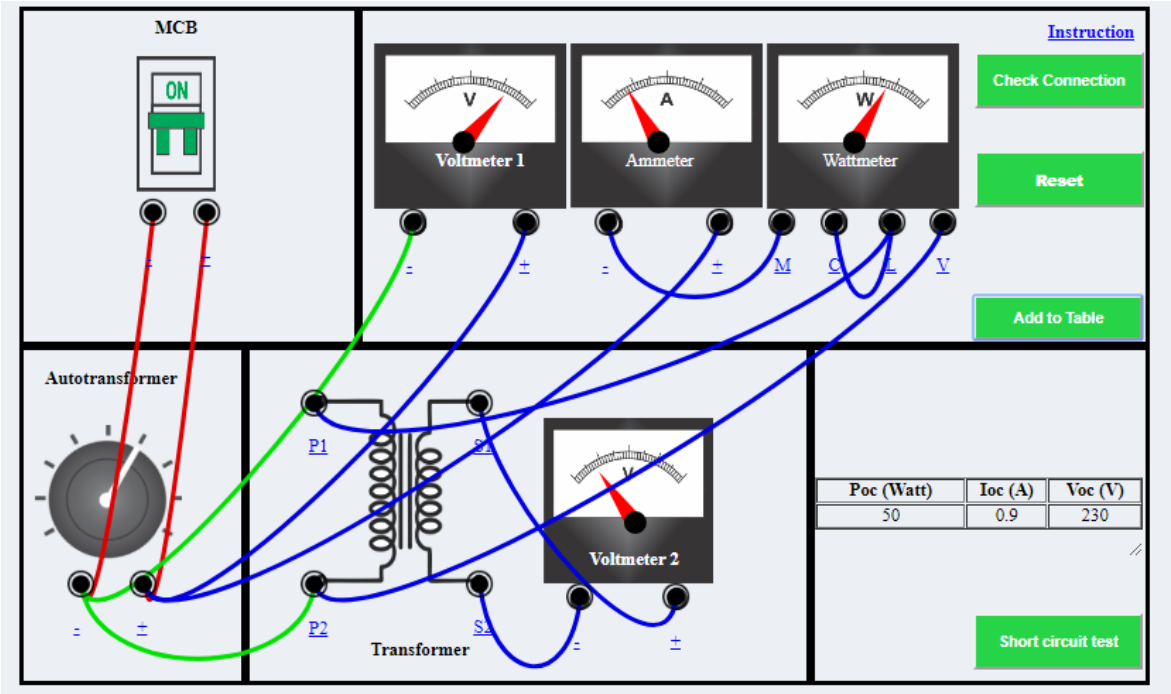
$$X_s = \sqrt{Z_s^2 - R_s^2}$$

Procedure: (i) Make proper connection by clicking the node. If wire is misplaced, click node number to detach the nodes wire.
(ii) Check connection
(iii) Click on autotransformer to get the change in all meters.
(iv) Then click add to table to get reading of open circuit transformer.
(v) OS test is done. Click start button for SC test.
(vi) Make proper connections
(vii) Check connection
(viii) Add to table to get reading over SC transformer.
(ix) SC test is done.
(x) We obtain the result in diagram form.

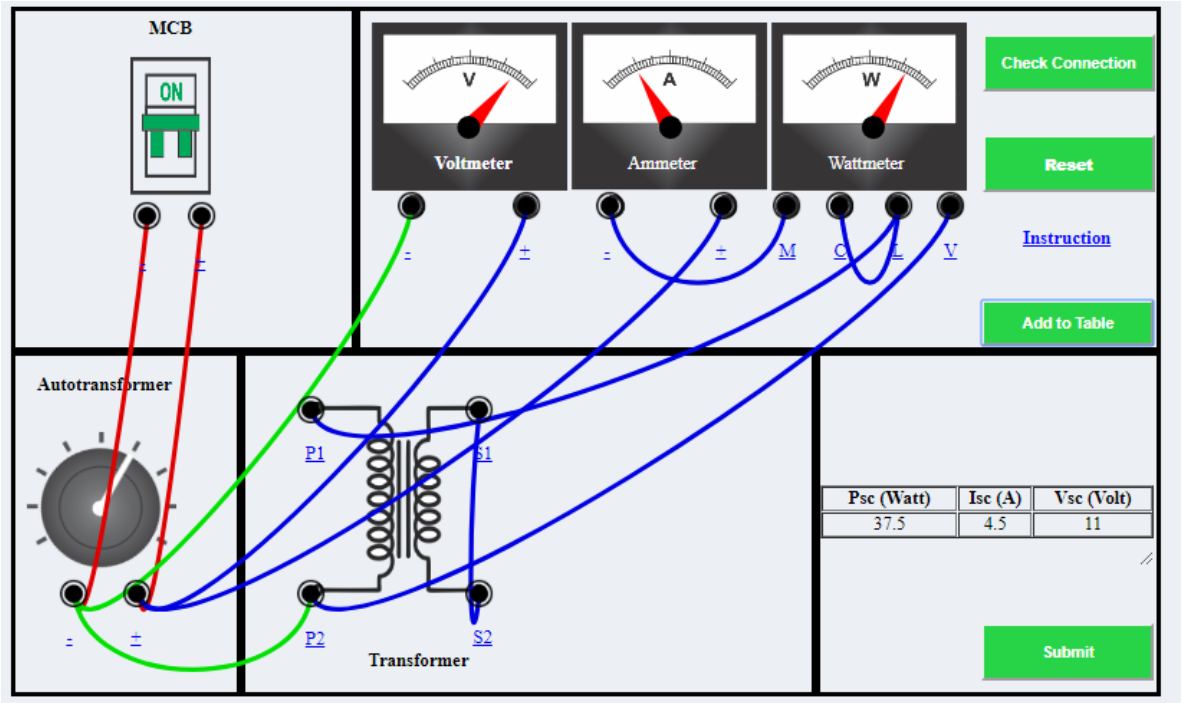
Simulation Results

Determination of Transformer equivalent circuit from Open Circuit and Short Circuit Test.

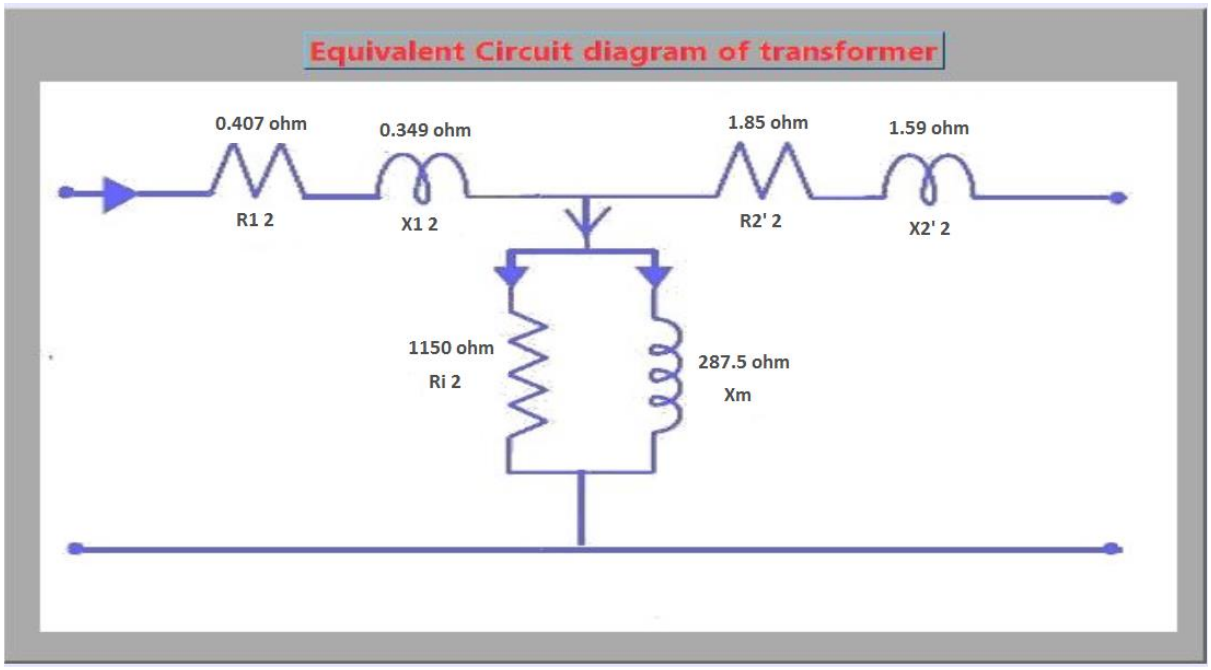
1. Open Circuit Test



2. Short Circuit Test



Determination of Transformer equivalent circuit from Open Circuit and Short Circuit Test.



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Conclusion:-

(i) The open circuit (OC) and short circuit (SC) tests are performed for determining the parameter of transformer like their efficiency, voltage regulation, circuit constant etc.

(ii) These tests are performed without the actual loading and because of this reason, very less power is required for the test.

(iii) These tests give a very accurate result as compared to the full load test.

Quiz Performance

Determination of Transformer equivalent circuit from Open Circuit and Short Circuit Test

○ b: power distribution
○ c: arc welding
○ d: none of the mentioned

If the per unit leakage impedance for the primary of a transformer is 'x' on the given rated base value. If the voltage and volt-amperes are halved, then the changed per unit impedance will be
○ a: 0.5x
◉ b: 2x
○ c: 4x
○ d: x

The voltage regulation for transformer is given by
○ a: (E2-V2)/E2
○ b: (E2-V2)/V2
○ c: (V2-E2)/E2
◉ d: (V2-E2)/V2

A 2000/1000/500 three winding transformer is to be used as auto transformer with supply of 3000 V. Two loads of 1050 kVA at 3500V, and other one at 180 kVA at 1000V. The total kVA supplied will be
○ a: 1150 kVA
○ b: 1440 kVA
○ c: 1680 kVA
◉ d: 1230 kVA

Two single phase transformers A and B are operating in parallel having same impedance. But the x/r ratio of them are not equal. Then total kVA output of the output will be
○ a: equal to sum of kVA of A and B
○ b: more than sum of kVA of A and B
◉ c: less than sum of kVA of A and B
○ d: any of the mentioned

Submit Quiz

5 out of 5

Determination of Transformer equivalent circuit from Open Circuit and Short Circuit Test.

While conducting testing on the single phase transformer, one of the student tries to measure the resistance by putting an ammeter across one terminal of primary and other to secondary, the reading obtained will be

- (●) a: infinite
- ( ) b: zero
- ( ) c: finite
- ( ) d: negative finite

While estimating voltage regulation of a transformer, keeping

- ( ) a: secondary voltage constant
- (●) b: primary voltage constant
- ( ) c: voltage changes constant at primary
- ( ) d: all of the mentioned

The efficiency of a 20 KVA, 2000/200 V, single phase transformer at unity pf is 98%. The the total losses at this condition is

- (●) a: 408W
- ( ) b: 4.08kW
- ( ) c: 204W
- ( ) d: 2.04kW

The efficiency of a 20 KVA, 2000/200 V, single phase transformer at unity pf is 98%. The given total losses at full load is 200 W. The pu resistance is

- ( ) a: 0.1
- (●) b: 0.01
- ( ) c: 1.0
- ( ) d: 0.0196

Transformer operating in parallel will share a common load in the best possible manner if

- ( ) a: leakage impedances are proportional to their kVA rating
- ( ) b: leakage impedances are equal
- (●) c: pu leakage impedances are equal
- ( ) d: any of the mentioned

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