**Experiment No.**: - 8 **Date:**

**Aim:** - Determination of single-phase transformer equivalent circuit parameters using open – circuit and short circuit test.

**Brief Theory:** - The open circuit and short circuit test on single phase transformer is to determine the efficiency and regulation of a transformer on any load condition and at any power factor. Open circuit & short circuit test are also called as **OC & SC test** on transformer. This method is also used to find the equivalent circuit parameters of transformer. This method of finding the parameters of a transformer is called as an indirect loading method.

1. **Open circuit test:**

   The shunt branch equivalent circuit parameters ($R_o$, $X_o$) can be determined by performing this test. Since, the core loss and the magnetizing current depend on applied voltage, this test is performed by applying the rated voltage to LV winding and keeping the HV winding open. The circuit diagram to conduct this test is shown in fig.(a). The ammeter(A), Voltmeter(V) and Wattmeter(W) are connected in LV side of transformer as shown in Fig.(a). Since, the secondary terminals are open (no load is connected across the secondary), current drawn from the source is called as no load current. Through open circuit test find core loss of transformer.

2. **Short circuit test:**

   The series equivalent circuit parameters ($R_1$, $X_1$, $R_2^{'}$, $X_2^{'}$) can be determined by performing this test. In this test, the secondary winding is short circuited with the help of thick wire. As high voltage side is low current side, it is convenient to connect high voltage side to supply and shorting the low voltage secondary side. Suppose the input voltage is reduced to a small fraction of rated value and secondary terminals are short-circuited. A current will circulate in the secondary winding. Since a small fraction of rated voltage is applied to the primary winding, the flux in the core and hence the core loss is very small. Now, the current flowing through the winding of transformer is rated current Hence, total loss will be copper loss at full load. The ammeter(A), Voltmeter(V) and Wattmeter(W) are connected in HV side of transformer as shown in Fig.(b).

**Experimentation Circuit Diagram:**

## a) Circuit diagram of open circuit test:

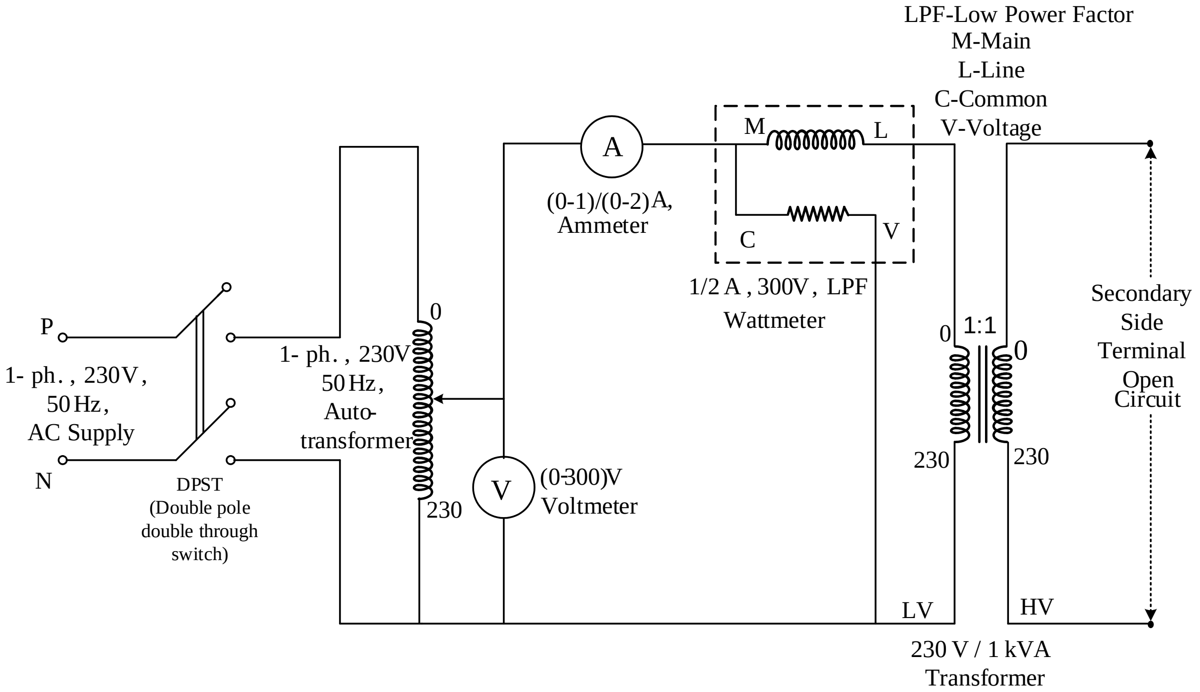


Fig.(a)

## b) Circuit diagram of short circuit test:

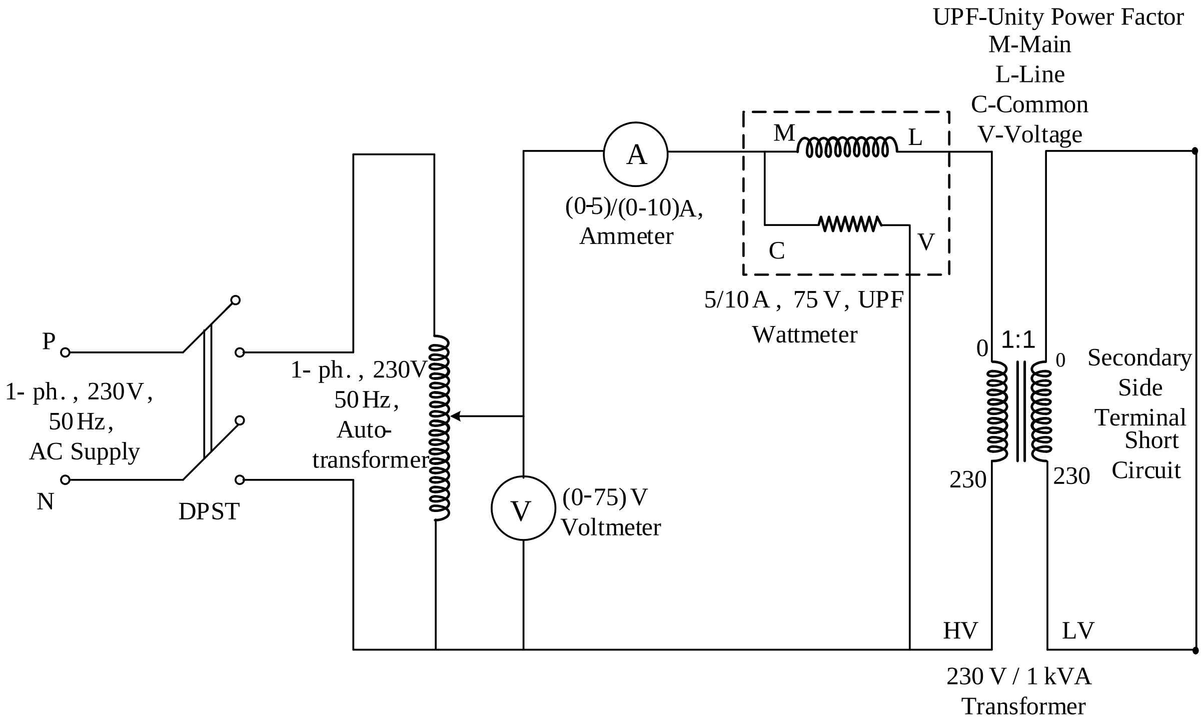


Fig.(b)

**List of apparatus:**

| Sr. No. | Name | Type | Range | Quantity |
|---|---|---|---|---|
| 1 | Voltmeter | Moving Iron (MI) type | 0-300 V (OC) | 01 |
| | | | 0-75 V (SC) | 01 |
| 2 | Ammeter | Moving Iron (MI) type | (0-1)/(0-2) A (OC) | 01 |
| | | | (0-5)/(0-10) A (SC) | 01 |
| 3 | Wattmeter | (Dynamometer) type wattmeter | 1/2A,300V, LPF(OC) | 01 |
| | | | 5/10A,75V, UPF(SC) | 01 |
| 4 | Auto - transformer | Single phase variac (AC) | 0-230 V | 01 |
| 5 | Single Phase Transformer | (Core Type) AC | 1kVA / 230 V (turns ratio 1:1) | 01 |
| 6 | Connecting Wires | - | - | - |

**Procedure:**

**a) Procedure of open circuit test:**

i. Connect the circuit as shown in circuit diagram

ii. Apply voltage equal to the rated voltage

iii. Note the reading of wattmeter, ammeter and voltmeter.

iv. Reduce the output voltage of the variac to zero and switch-off the supply.

**b) Procedure of short circuit test:**

i. Connect the circuit as shown in circuit diagram.

ii. Increase the voltage gradually such that rated current of the transformer is passing through the primary.

iii. Note the reading of wattmeter, ammeter and voltmeter.

iv. Reduce the output of the variac to zero and switch – off the supply.

**Observation table:**

**a) Open circuit test:**

| | | |
|---|---|---|
| $V_{OC}$ = | $I_{OC}$ = | $W_{OC}$ =<br>Multiplying Factor = |

**b) Short circuit test:**

| | | |
|---|---|---|
| $V_{SC}$ = | $I_{sc}$ = | $W_{sc}$ =<br>Multiplying Factor = |

**Calculations:**

**1. Calculations of OC test to find equivalent circuit parameters:**

$$W_{OC} = V_{OC} I_{OC} \cos\emptyset_0$$

$$\cos\emptyset_O = \frac{W_{OC}}{V_{OC} * I_{OC}} =$$

$$I_w = I_{OC} \cos\emptyset_0 \qquad R_w = V_{OC}/I_w$$

$$I_m = I_{OC} \sin\emptyset_0 \qquad X_m = V_{OC}/I_m$$

**2. Calculations of SC test to find equivalent circuit parameters:**

$$W_{sc} = I_{sc}^2 * R_{sc}$$

$$R_{sc} = \frac{W_{sc}}{I_{sc}^2} \qquad Z_{sc} = \frac{V_{sc}}{I_{sc}}$$

$$X_{sc} = \sqrt{Z_{sc}^2 - R_{sc}^2}$$

$$R_1 = R_2' = \frac{R_{sc}}{2} \qquad X_1 = X_2' = \frac{X_{sc}}{2}$$

**3. Draw the equivalent circuit Diagram of transformer:**

4. **Calculate efficiency of the transformer**:

$$\eta = \frac{\text{output power}}{\text{input power}}$$

$$\eta = \frac{\text{output power}}{\text{output power+ iron losses+copper losses}}$$

$$\eta = \frac{x.S.\cos\Phi}{x.S.\cos\Phi + W_0 + W_{sc}.\,x^2}$$

'S' is the rated VA (1000 VA)

'x' is fraction of full load the transformer (loading factor)

***Φ*** is the load power factor angle

The output power of the transformer is x.S. cos ***Φ***

Wsc = is the copper loss

The corresponding loss while supplying the fraction of load is $x^2$.Wsc.

5. **Find out the efficiency** with rated voltage at 25%, 50%, 75%, 100% of full load current at unity power factor, 0.8 lag power factor and 0.8 lead power factor.

a) **Calculate efficiency at PF or Cosø = 1**

**i)** $x_1$ = 25%

$\eta_1$ =

**ii)** $x_2$= 50%

$\eta_2$ =

**iii)** $x_3$= 75%

$\eta_3$ =

**iv)** $x_4$= 100%

$\eta_4$ =

**b) Calculate efficiency at PF or Cosø = 0.8**

i) $\mathbf{x_1}$ = 25%

$\eta_1$ =

ii) $\mathbf{x_2}$= 50%

$\eta_2$ =

iii) $\mathbf{x_3}$= 75%

$\eta_3$ =

iv) $\mathbf{x_4}$= 100%

$\eta_4$ =

**6. Calculate Voltage regulation of transformer:**

$$\textbf{\% Regulation} = \frac{I_{SC}.R_{SC}.\cos\Phi \pm I_{SC}.X_{SC}.\sin\Phi}{V_{rated}\,(230\text{ V})} * 100$$

a) cosø = 1, sinø =0

VR =

b) cosø = 0.8 (lead), - ve sign

VR =

c) cosø = 0.8 (lag), + ve sign

VR =

**7. GRAPH:** Draw the efficiency v/s output curve.

**8. CONCLUSION:**