Lab-02

TITLE: DRAW EQUIVALENT CIRCUIT OF TRANSFORMER BY SHORT CIRCUIT AND OPEN CIRCUIT TEST

OBJECTIVE:

i) To find open circuit and short circuit parameter of transformer.
ii) To draw equivalent circuit of given transformer.

APPARATUS:

i) 1-ϕ transformer
ii) Ammeter
iii) Wattmeter
iv) Voltmeter
v) Connecting wires

THEORY:

A transformer is a static electric device that transfers electrical energy between circuits through electromagnetic induction. To analyze and understand transformer behaviour, its equivalent circuit is derived, representing the electrical characteristics in terms of resistances, reactances and other parameters. The short circuit (SC) and opencircuit(OC) tests are practical methods used to determine these parameters.

1) Open Circuit Test:

i) Conducted by applying rated voltage to the primary winding while keeping the secondary winding open.
ii) It determines the core (magnetizing) losses, which are mainly due to hysteresis and eddy currents in core.
iii) From this test, parameters like magnetizing reactance (X_0) and core loss resistance (R_0) are derived.

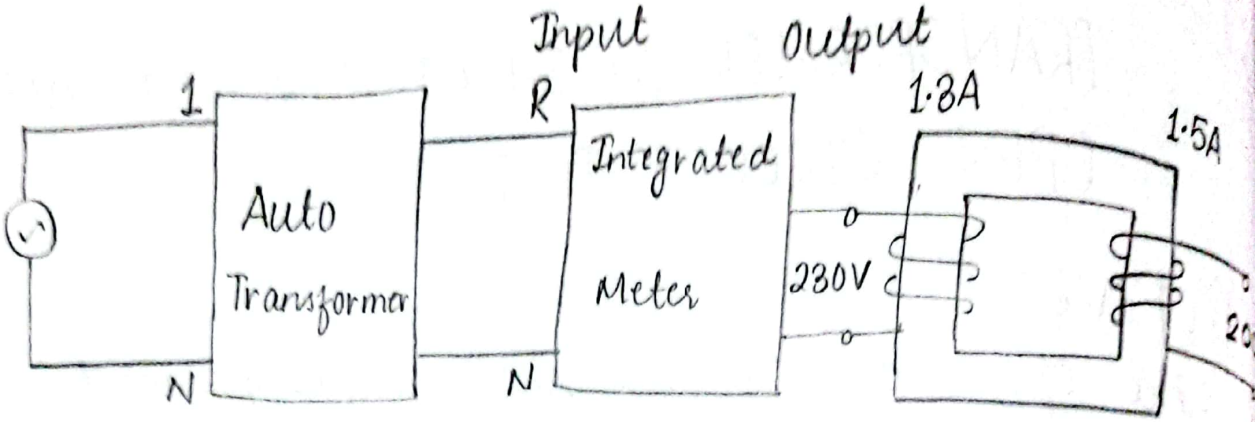

Fig (i): Open Circuit Test diagram

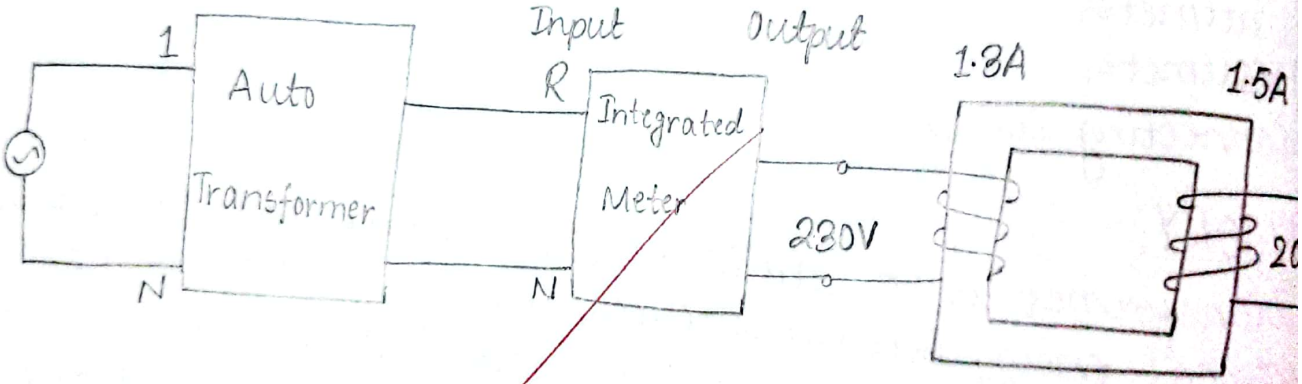

Fig (ii): Short Circuit Test diagram

2) Short Circuit Test:

i) Performed by short-circuiting the secondary winding and applying a reduced voltage to the primary winding to produce full-load current.

ii) This test determines the copper losses in winding and helps calculate the equivalent impedence (Z_{eq}) and its components equivalent resistance (R_{eq}) and reactance (X_{eq}).

By using these parameters, we can make an equivalent circuit of transformer.

OBSERVATION TABLE:

i) Open Circuit Test:

SN	I_o (A)	V_o (V)	P_o (W)
1	0.11	230	8
2	0.137	200	9
3	0.241	115	9

ii) Short Circuit Test:

SN	I_{sc} (A)	V_{sc} (V)	P_{sc} (W)
1	1.3	13.7	17
2	1.3	10.9	14
3	1.3	5.1	6

CALCULATION:

i) For Open circuit test:

$$\cos\phi_o = \frac{P_o}{V_o I_o}$$

$$\therefore \cos\phi_{o1} = \frac{8}{230 \times 0.11} = 0.316$$

$$\cos\phi_{o2} = \frac{9}{200 \times 0.137} = 0.328$$

$$\cos\phi_{o3} = \frac{9}{115 \times 0.241} = 0.324$$

$I_w = I_0 \cos\phi$

$\therefore I_{w_1} = 0.11 \times 0.316 = 0.035A$

$I_{w_2} = 0.137 \times 0.328 = 0.045A$

$I_{w_3} = 0.241 \times 0.324 = 0.078A$

$I_\mu = I_0 \sin\phi$

$I_{\mu_1} = 0.11 \times 0.949 = 0.104A$

$I_{\mu_2} = 0.137 \times 0.945 = 0.129A$

$I_{\mu_3} = 0.241 \times 0.946 = 0.228A$

$R_0 = \frac{V_1}{I_w}$

$R_{01} = \frac{230}{0.035} = 6.57 \times 10^3 \Omega$

$R_{02} = \frac{200}{0.045} = 4.44 \times 10^3 \Omega$

$R_{03} = \frac{115}{0.078} = 1.47 \times 10^3 \Omega$

$X_0 = \frac{V_1}{I_\mu}$

$X_{01} = \frac{230}{0.104} = 2.212 \times 10^3 \Omega$

$X_{02} = \frac{200}{0.129} = 1.55 \times 10^3 \Omega$

$X_{03} = \frac{115}{0.228} = 504.39 \Omega$

Mean $R_0 = \frac{(6.57 + 4.44 + 1.47) \times 10^3}{3} = 4160 \Omega$

Mean $X_0 = \frac{2.212 \times 10^3 + 1.55 \times 10^3 + 504.39}{3} = 1422.13 \Omega$

ii) For short circuit test:

$R_{eq} = \frac{P_{sc}}{I_{sc}^2}$

$R_{eq_1} = \frac{17}{(1.3)^2} = 10.06 \Omega$

$R_{eq_2} = \frac{14}{(1.3)^2} = 8.28 \Omega$

$R_{eq_3} = \frac{6}{(1.3)^2} = 3.55 \Omega$

$Z_{eq} = \frac{V_{sc}}{I_{sc}}$

$Z_{eq_1} = \frac{13.7}{1.3} = 10.54 \Omega$

$Z_{eq_2} = \frac{10.9}{1.3} = 8.38 \Omega$

$Z_{eq_3} = \frac{5.1}{1.3} = 3.92$

Mean $R_{eq} = \frac{10.06 + 8.28 + 3.55}{3} = 7.3 \Omega$

Mean $Z_{eq} = \frac{10.54 + 8.38 + 3.92}{3} = 7.61 \Omega$

$X_{eq} = \sqrt{Z_{eq}^2 - R_{eq}^2} = \sqrt{(7.61)^2 - (7.3)^2} = 2.15 \Omega$

RESULT:

The equivalent circuit will look like:

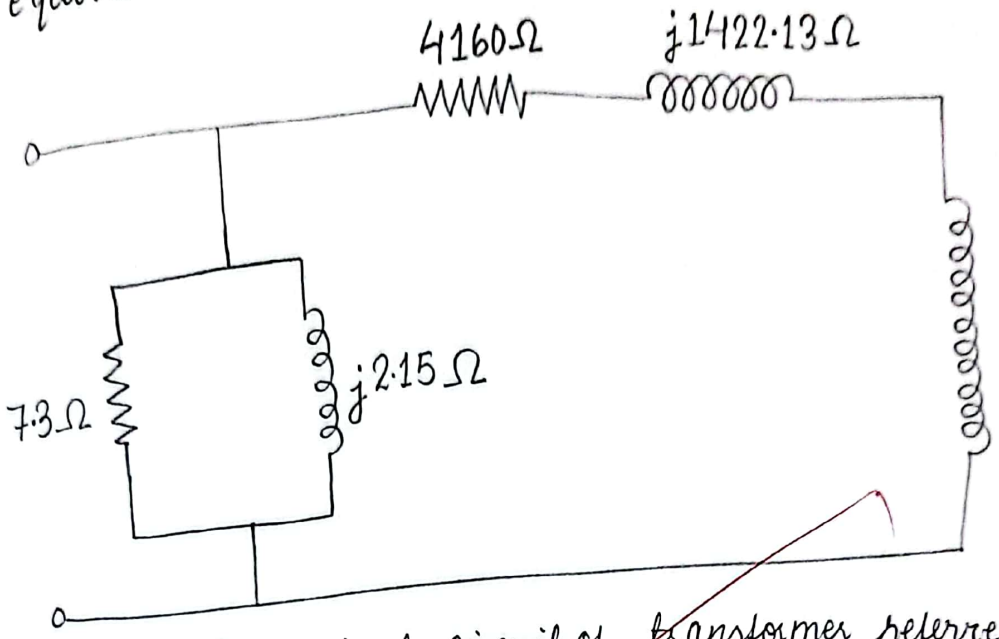

Fig: Equivalent circuit of transformer referred to primary side.

SAGARMATHA ENGINEERING COLLEGE

(TU Affiliated)

Sanepa, Lalitpur

LAB NO:

LAB REPORT ON:

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Name:…….

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Roll No:……..

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