KING FAHD UNIVERSITY OF PETROLEUM & MINERALS

Electric Engineering Department

EE 306   Electric Energy Engineering - Experiment#3

EQUIVALENT CIRCUIT OF TRANSFORMER

Objectives:

1. To determine the equivalent circuit of a single phase transformer

2. To verify the voltage current relationship

Apparatus:

1 Single-phase transformer
1 Variable AC power supply
1 AC voltmeter
2 AC ammeters
1 Wattmeter
1 Variable load resistance

Theory

The approximate equivalent circuit of a transformer is given in Fig. 1.
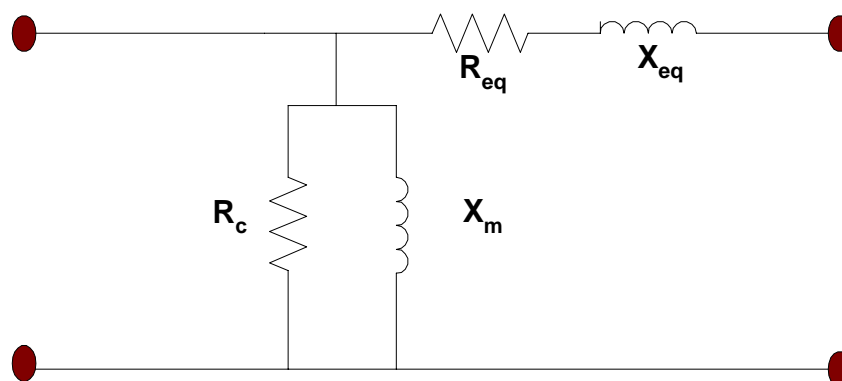

Fig 1. Equivalent Ciruict of transformer

Where, $R_c = 1/g$ and $x_m = 1/b$. These quantities are obtained from the open circuit power, voltage and current measurements. These are

$$Y = g - jb = I_o / V_o \qquad (1)$$

$$g = P_o / V_o^2 \qquad (2)$$

and,

$$b = \sqrt{|Y|^2 - g^2} \qquad (3)$$

The equivalent resistances and reactances (R_{eq}, X_{eq}) are obtained from the current, voltage and power measurements in the primary winding when the secondary is shorted. These are written as

$$R_{eq} = P_{sc} / I_{sc}^2 \qquad (4)$$

$$|Z_{eq}| = V_{sc} / I_{sc} \qquad (5)$$

$$X_{eq} = \sqrt{|Z_{eq}|^2 - R_{eq}^2} \qquad (6)$$

Procedure

1. Note the current, voltage and volt-ampere ratings of both windings of the transformer. Note the turns ratio
2. Connect the circuit as shown in Fig2. with the high voltage side open circuited
3. Adjust the supply voltage until the voltage on the primary side is the rated value.
4. Record the current, voltage and power in this condition. Take another reading at 110 % of the rated value.
5. Next, connect the transformer for the short circuit test as given in Fig 3. The variable supply will be on the high voltage side.
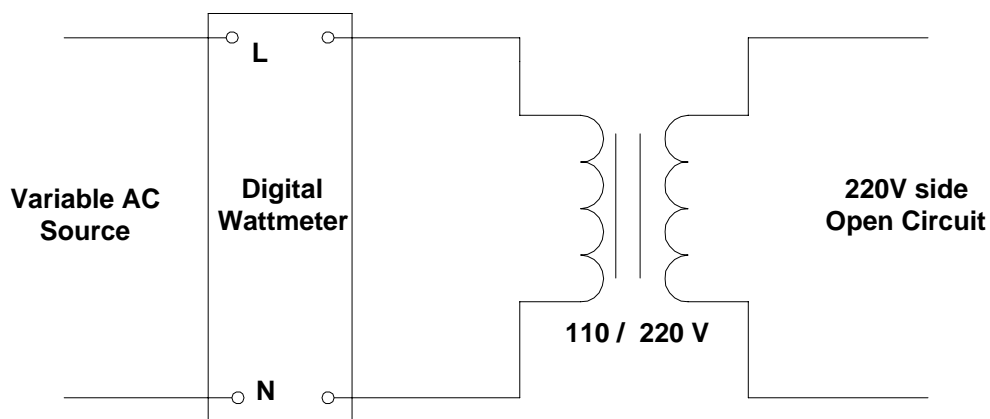
Fig. 2 : The Open Circuit Test connection

6. Gradually increase the supply voltage from zero until the rated current flows in the shorted secondary winding
7. Record the current, voltage and power. Repeat step 6 for 110 % of rated current and record the values.
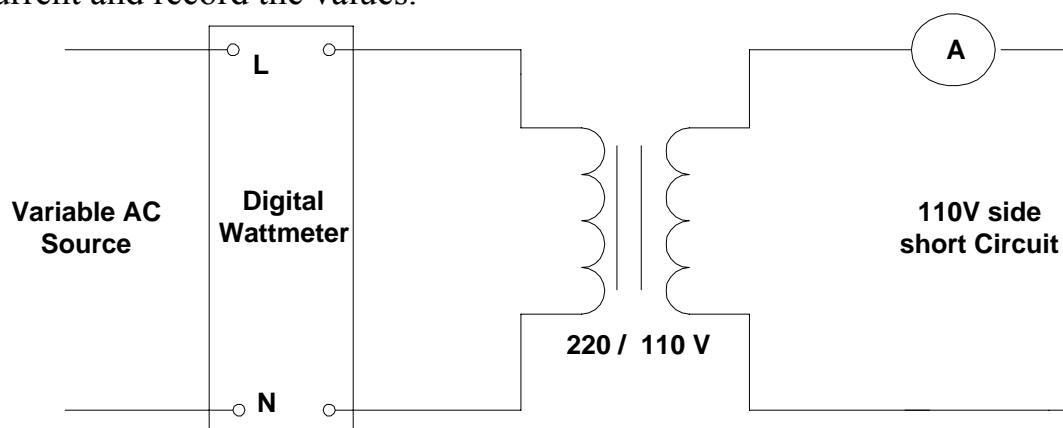

Fig. 3 : The Short Circuit Test connection

8. Connect the circuit as shown in Fig. 4 for a load test

9. Adjust the supply voltage and the resistive load such that rated current flows through the load at rated voltage

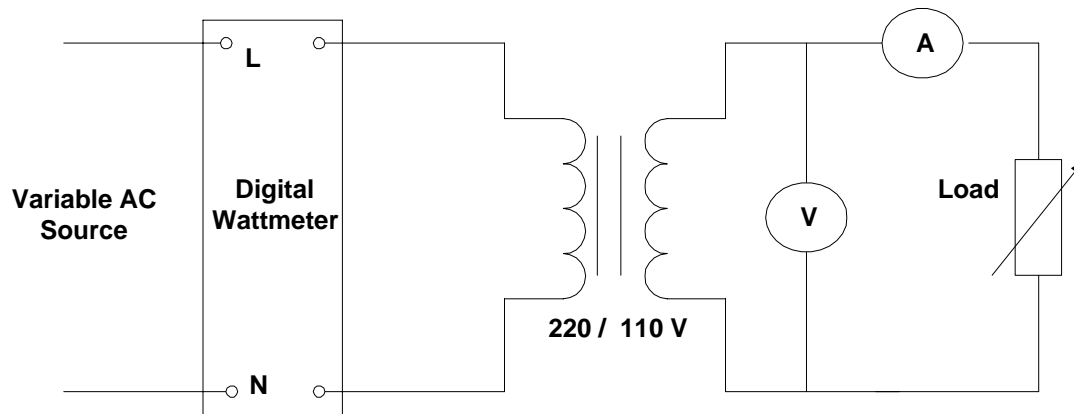Measure the voltages and currents on both sides of the transformer

Fig. 4 : The Load Test connection

Report

1. Calculate R_c, X_m, R_{eq} and X_{eq} from the open circuit and short circuit tests.
2. Draw the approximate equivalent circuit diagrams and label the parameter values. Note that some of the values have to be transferred to the other side of the winding by multiplying with approximate constant.
3. For the unity power factor loading condition of Fig 4, calculate the primary current and voltage using the equivalent circuit you obtained. Start with the measured values of current and voltage on the load side.
4. Compare the calculated quantities with measured ones and compute the percent error
5. State the possible sources of errors, if any.