

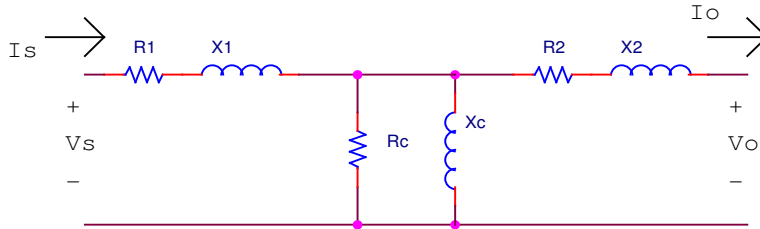
Transformer Equivalent Circuit -- Lab Review Sheet

Objectives:

In this lab you will develop the equivalent circuit of a single phase transformer. This will be accomplished through a short circuit and open circuit test.

Transformer Model:

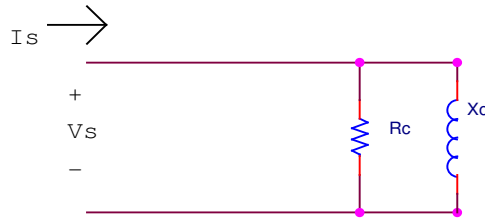
The equivalent model of a real transformer is as follows:



Open Circuit Test:

The open circuit test gives R_c and X_c . This test is performed by applying rated voltage to the low voltage side and leaving the high voltage side open. Either side may be used but the voltage is applied to the low voltage side for safety reasons.

With the output side left open in the previous figure and assuming that the shunt impedances (R_c and X_c) are much larger than the series impedances (R_1 and X_1) the equivalent circuit model reduces to the following diagram.



The values of R_c and X_c can be calculated using the following formulas from the voltage, current and power measured in this test.

$$S_{oc} = V_{oc} I_{oc}$$

$$Q_{oc} = \sqrt{(S_{oc})^2 - (P_{oc})^2}$$

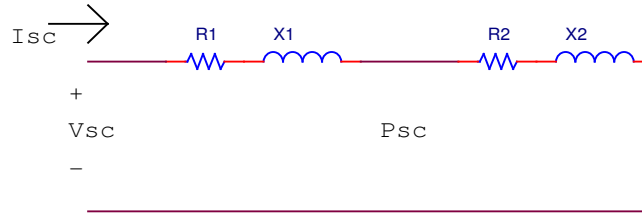
$$R_c = \frac{V_{oc}^2}{P_{oc}}$$

$$X_c = \frac{V_{oc}^2}{Q_{oc}}$$

Short Circuit Test:

The short circuit test gives R_1 , X_1 , R_2 and X_2 . This test is performed by applying rated current to the high voltage side and shorting the low voltage side. The high voltage side corresponds to the low current side, applying the test current to the low current side is done for safety reasons.

With the output side shorted in the first figure and assuming that the shunt impedances (R_c and X_c) are much larger than the series impedances (R_1 , X_1 , R_2 and X_2) the equivalent circuit model reduces to the following diagram.



The following formulas the equivalent impedances as follows.

$$S_{SC} = V_{SC} I_{SC}$$

$$Q_{SC} = \sqrt{(S_{SC})^2 - (P_{SC})^2}$$

$$R_{EQ} = \frac{P_{SC}}{I_{SC}^2}$$

$$X_{EQ} = \frac{Q_{SC}}{I_{SC}^2}$$

Since we are using 1:1 transformers we can assume that $X1 = X2$ and $R1 = R2$, this gives the following formulas for the impedance values.

$$R_1 = R_2 = \frac{R_{EQ}}{2}$$

$$X_1 = X_2 = \frac{X_{EQ}}{2}$$

Power Rating:

The power rating of a transformer is the product of the rated voltage and current on one of the sides. Since we ran these tests on the same side (because they are 1:1) we can use the open circuit voltage and the short circuit current. These are used because the open circuit test performed at rated voltage while the short circuit test is performed at rated current.

$$Power\ Rating = V_{RATE} I_{RATE} = V_{OC} I_{SC}$$