ELEC 302 Lab 3
Non-Ideal Transformer Properties

REFERENCE: Appropriate chapters of ELEC 316 text.

OBJECTIVE: The objective of this experiment is the experimental observation of the basic principals of transformer operation. The transformer efficiency and the transformer voltage regulation will be determined.

EQUIPMENT:

Power Supply Module (0-120Vac)	EMS 8821
Resistance Module	EMS 8311
Inductance Module	EMS 8321
Capacitance Module	EMS 8331
Transformer Module	EMS 8341
Data Acquisition Interface (DAI)	EMS 9062
DAI 24V Power Supply	EMS 30004

Notes: This entire experiment is conducted at 60 Hz. All of the currents and voltages in this experiment are RMS

INTRODUCTION:

In this experiment, you will investigate the non-ideal properties of a transformer. The losses that occur in a real transformer can be accounted for by using an equivalent transformer circuit such as the one depicted in Figure 1. The values of the equivalent circuit components R_{eq}, X_{eq}, R_c, and X_m can be determined experimentally from the open circuit and short circuit test.

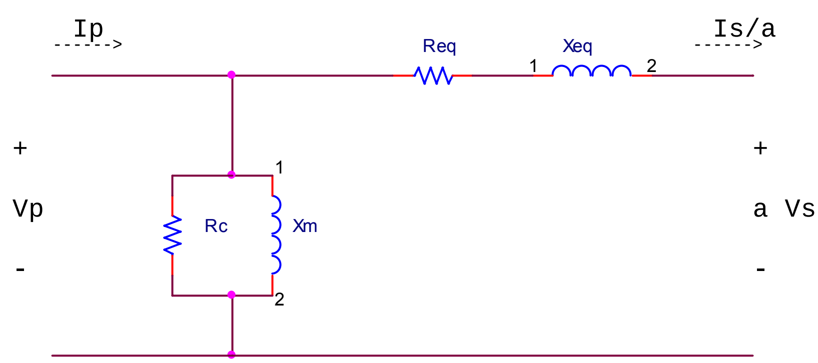

Figure 1: Approximate equivalent circuit of a transformer referred to the primary side.

PRIOR PREPARATION:

Complete the following at a time determined by the laboratory instructor.

1.Given the following transformer open circuit and short circuit test data determine the resulting transformer equivalent circuit components.

Open Circuit Test	Short Circuit Test
Voc = 120 V	Vsc = 10 V
Ioc = 0.02 A	Isc = 0.4 A
Poc = 2.0 W	Psc = 3.0 W

2.Using the equivalent circuit determine from part 1, determine the transformer voltage regulation and efficiency for a 300 Ω load and 120V primary supply. Use a turns ratio of 1:1.

PROCEDURE:

WARNING!
High voltages are present in this laboratory experiment!
Do not make or modify any banana jack connections with the power on!
Prior to energizing any circuit, ensure that the supply voltage has been adjusted to zero, slowly increase the supply voltage to the desired value while continuously monitoring the circuit currents. Note the transformer winding maximum current ratings. DO NOT EXCEED THESE RATINGS

PART ONE: Transformer Performance

1. Verify the all components required in the equipment section are present at the EMS workstation.

2. Using the fluke multi-meter, measure and record the DC resistance of each transformer winding in Table 1. Note: This step may be omitted if you retained the values from lab 2.

3. Make sure the main power switch of the Power Supply is OFF and the voltage control knob is fully CCW. Set the voltmeter selector switch to position 4-N.

4. Construct the circuit of Figure 2. use the first impedance listed in Table 2 (open circuit). The symbols I1, I2, E1 and E2 refer to the DAI metering connections.

5. Ensure the DAI 24V supply is connected to the main Power Supply (turn it on), and that the DAI USB connector is attached to the computer.

6. Start the computer and the LVDAM EMS application. On the *File* menu open file C:\Program Files\Lab Volt\Samples\E302_3.dai. The Metering window should display meters for E1, I1, P1, E2, I2, and P2.

7. Select focus to the metering window by clicking on it. Select *Options -> Acquisition Settings*, set the *Sample Window* dialog box to *extended*. Then click OK, and close the box. Select *View* -> check *continuous refresh.*

8. Turn on the main voltage power supply and adjust the supply voltage to 120V. Monitor both the installed EMS voltmeter, and the metering window for proper indications. If proper indications are not immediately established, turn the voltage control knob CCW and turn off the power supply. Obtain instructor assistance.

9. Record in Table 2, the primary voltage E1, primary current I1, input power P1, secondary voltage E2, the secondary current I2, and the output power P2.

10. Turn the voltage control knob CCW, and turn off the main power supply.

11. Repeat steps 8 through 10 for the remaining load impedances in Table 2.

    Note: Before making any circuit changes that require installing or removing leads verify the power supply voltage is turned to zero and the power supply is OFF

PART TWO: Open Circuit Test

12. Construct the circuit of Figure 3. Apply rated voltage (120V) to the primary windings. Record the values of primary voltage, primary current, input power P1. Turn the voltage control knob CCW, and turn off the main power supply.

E1 = __________ I1 = ____________ P1 = ____________

PART THREE: Short Circuit Test

13. Construct the circuit of Figure 4. Note that I2 shorts the secondary windings 5-6. Turn on the power and slowly adjust the voltage control to obtain a secondary current of 0.4 A. DO NOT EXCEED THE SECONDARY WINDING CURRENT RATING. Record the values of primary voltage, primary current, input power P1 and secondary current through windings 5-6. Turn the voltage control knob CCW, and turn off the main power supply.

E1 = __________ I1 = ____________ P1 = __________ I2 = ____________

REPORT:

Your report should be completed in the format requested by the instructor. Specifically, it must contain the following items.

1. Completed Tables 1 and 2. A discussion of any questions posed in the lab procedure.
2. Use the data collected in part one of the lab to determine the transformer voltage regulation (VR) and transformer efficiency (η) for each of the loads.
3. Use the data collected in parts two and three of the lab to determine the circuit element values for the components of the transformer equivalent circuit shown in figure 1. Place these values in a table.
4. Using the equivalent circuit compute and tabulate the core losses, and copper losses of the transformer for each of the loads used in part one.
5. Using the equivalent circuit compute and tabulate the transformer regulation, and the transformer efficiency for each of the loads of part one.
6. Compare the results of 2 with that of 5, and discuss the accuracy of the equivalent circuit.

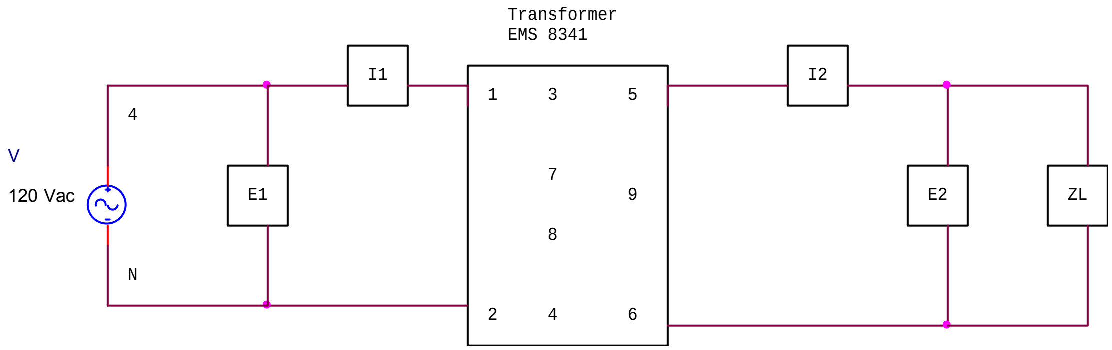

Figure 2 Single Phase Transformer Circuit for part one.

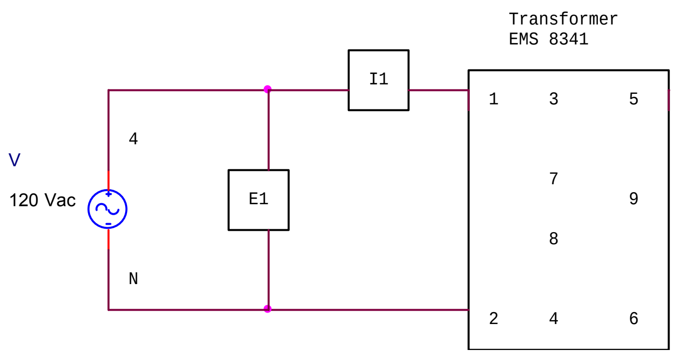

Figure 3 Single Phase Transformer Circuit for part two (open circuit test).

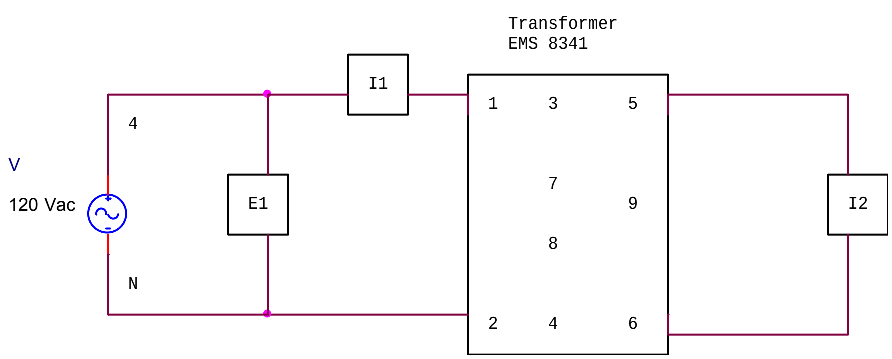

Figure 4 Single Phase Transformer Circuit for part three (short circuit test).

Winding #	Resistance Ω
1-2	
5-6	

Table 1. Winding Resistances

Load Z_L Ω	Primary Voltage E1 V	Primary Current I1 A	Input Power P1 W	Load Voltage E2 V	Load Current I2 A	Output Power P2 W
∞						
300						
300+j300						
300-j300						

Table 2. Primary and secondary voltages and currents