ELECTRICAL AND COMPUTER ENGINEERING THE CITADEL

ELEC 302 Lab 2
Transformer Fundamentals

REFERENCE: Appropriate chapters of ELEC 316 text.

OBJECTIVE: The objective of this experiment is the experimental observation of the basic principals of transformer operation.

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 basic properties of a transformer. The transformer that you are studying should to a high degree, exhibit the properties of an ideal transformer.

PRIOR PREPARATION:

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

1. Review transformer fundamental found in your ELEC 316 text.

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: Voltage Ratios

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.
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 1. 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_2.dai. The Metering window should display meters for E1, E2, E3, I1, and I2.
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 and the secondary voltage E2. Does the secondary voltage compare well with the rated value written on the transformer front panel?
10. Turn the voltage control knob CCW, and turn off the main power supply.
    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
11. Rewire the circuit of Figure 1 to allow measurement of the remaining secondary voltages ($E_{3\text{-}4}$, $E_{5\text{-}6}$, $E_{7\text{-}8}$, ect.). Repeat steps 8 through 10 to complete Table 2.

PART TWO: Current Ratio

12. Construct the circuit of Figure 2. 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 and secondary current through windings 5-6. Turn the voltage control knob CCW, and turn off the main power supply.

    E1 = _________ I1 = ___________ I2 = ___________

13. Does the current ratio (I2/I1) correspond to the expected turns ratio ($N_{1\text{-}2}/N_{5\text{-}6}$)?

PART THREE: Saturation

14. Construct the circuit of Figure 3, which will be used to display the effect of core saturation. Since the exciting current is small the voltage E1 across the resistor will be used to show its variation.

15. Note that the supply voltage connection should now be from terminal 4 to 5. Set the voltmeter selector switch to position 4-5.

16. Select the *Data Table* application. Click on *options -> record settings* and select E1, E2, and E3. They should now appear as columns in the data table.

17. Increase the supply voltage in approximately 10V steps from 0-180V. At each step click the *Record Data* button to enter the measurements in the data table. When all data has been taken, turn the voltage control knob CCW, and turn off the main power supply.

Note that the above step requires applying a voltage that exceeds transformer rated voltage. This will not cause any damage to the transformer if applied for short periods of time. DO NOT LINGER AT VOLTAGES ABOVE 120V.

18. Display the *Graph* application screen (use the menu bar on the data table), select E3 (representing the exciting current) as the x-axis, and E1 (applied voltage) as the y- axis. Click the *Line Graph* button to display the curve of primary voltage vs. exciting current.

19. Does the curve illustrate that the transformer core has become saturated?

20. Record the measured data into table 3 for the lab report.

REPORT:

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

1. Completed Tables 1, 2, 3. Discussion of any questions posed in the lab procedure.

2. Compare the nameplate values of secondary voltages to the experimental values in table 2. Compute and tabulate the percent difference.
   Note: Percent Difference = [Experimental –Theoretical] x 100 / Theoretical.

3. Make a plot of the saturation curve found in part three. Discuss the shape of this curve.

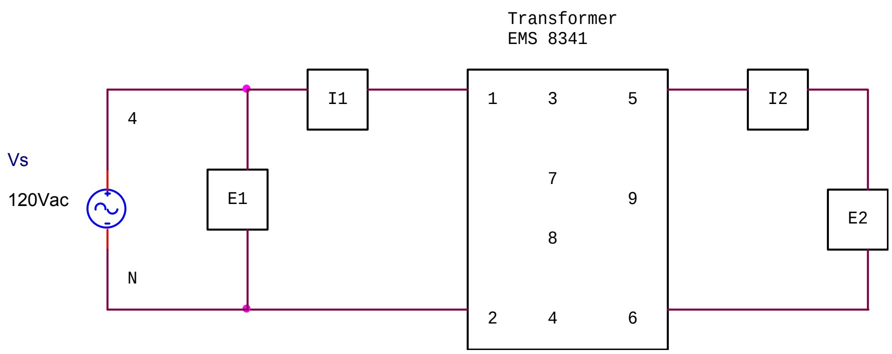

Figure 1 Single Phase Transformer Circuit for part one.

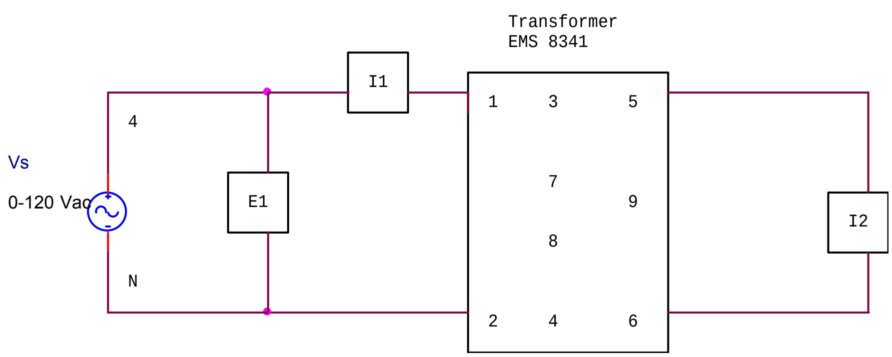

Figure 2 Single Phase Transformer Circuit for part two.

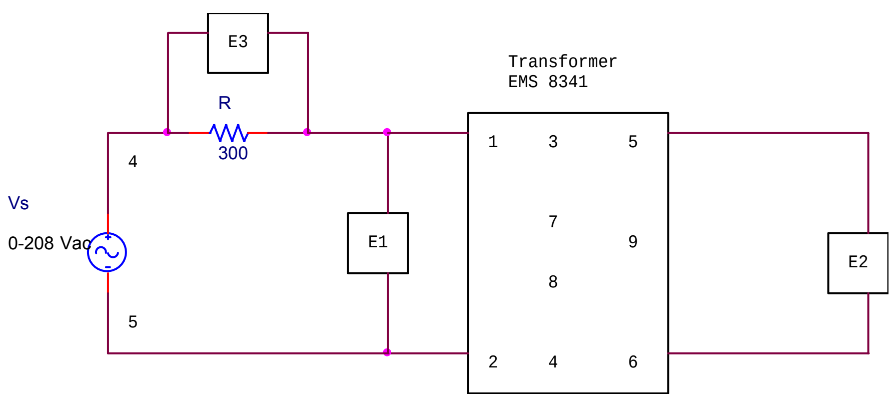

Figure 3 Single Phase Transformer Circuit for part three.

Winding #	Resistance Ω
1-2	
3-4	
5-6	
7-8	
3-7	
8-4	
5-9	
9-6	

Table 1. Winding Resistances

Winding #	Primary Voltage E1 Volts (1-2)	Secondary Voltage E2 Volts	Turns ratio Np:Ns
3-4			
5-6			
7-8			
3-7			
8-4			
5-9			
9-6			

Table 2. Primary and Secondary Voltages

Primary Voltage E1 Volts (1-2)	Secondary Voltage E2 Volts	Exciting Voltage E3 Volts

Table 3. Data for circuit of Fig. 3