Before making any electrical connections, draw an appropriate test circuit including instruments. Have your instructor check this proposed circuit before connections are made, and have your instructor check the wiring before applying power to the circuit.

This laboratory experiment utilizes the EMS 8341 Transformer Module

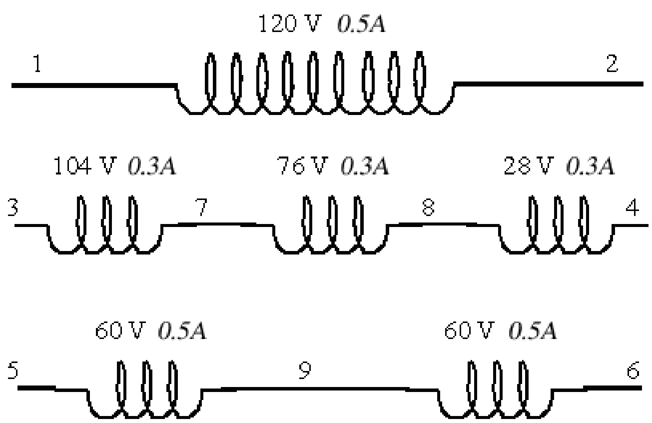

Figure 1 - EMS 8341 Transformer Connections and Voltage Ratings.

Note – Information showing the number of turns for each winding of a transformer is typically not provided by the manufacturer. Instead, the manufacturer provides the transformer's **ratings**, from which the turns-ratio information can be derived. The turns-ratio between two specific windings of within a transformer is directly proportional to the ratio of the rated voltages of those windings. Thus, the effective turns-ratio between two windings can be determined by:

$$turns\ ratio = a = \frac{N_P}{N_S} = \frac{V_{P(rated)}}{V_{S(rated)}}$$

where $V_{P(rated)}$ and $V_{S(rated)}$ are the rated primary and secondary winding voltages respectively.

Both the voltage and current ratings of the individual windings within the EMS 8341 transformer are shown in Figure 1.

For the tapped windings, the voltage rating of an entire winding is the sum of the voltage ratings of the winding's individual tapped sections. For example:

$$V_{5-6(Rated)} = V_{5-9(Rated)} + V_{9-6(Rated)} = 60V + 60V = 120V$$

Note that the current ratings of the tapped windings are equal to the current ratings of the individual tapped sections. For example:

$$I_{5-6(Rated)} = VI_{5-9(Rated)} = I_{9-6(Rated)} = 0.5A$$

1. Turns Ratio Investigation

Measure **secondary voltages** as a function of primary voltage with the secondary windings open circuited. Designate winding 1–2 as the primary winding for this investigation, and windings 3–4, 5–6 and 5–9 as the secondary windings. Record the results in Table 2.1

Report Guide – Turns Ratio Investigation (to be completed at-home)

Plot the **"open-circuit" voltages** (V_{3-4}, V_{5-6} & V_{5-9}) **as a function of V_{1-2}** on a single graph.

Calculate the turns-ratios between winding-pairs 1-2/3-4, 1-2/5-6 and 1-2/5-9 based on your measured values at **each** source setting. Present your results in a well-organized table similar in structure to Table 2.1.

Briefly **discuss** the results of the turns-ratio investigation. Do the calculated ratios correspond to the expected values based on the ratings of the transformer?

2. Polarity Investigation

Determine the polarity relationships between the three windings of the transformer module by performing the following experimental steps:

I. Determine the polarity of winding 5–6 relative to winding 1–2

a. Connect the source to winding 1–2 and set V_{1-2} to 10V.

b. Measure V_{5-6}, the voltage across winding 5-6. V_{5-6} = ______V

c. Connect a wire from terminal 2 to terminal 6 of the transformer.

d. Measure V_{1-5}, the voltage between terminals 1 and 5. V_{1-5} = ______V

e. Remove the connection from terminal 2 to terminal 6

II. Determine the polarity of winding 3–4 relative to winding 1–2

a. Connect the source to winding 1–2 and set V_{1-2} to 10V.

b. Measure V_{3-4}, the voltage across winding 3-4. V_{3-4} = ______V

c. Connect a wire from terminal 2 to terminal 4 of the transformer.

d. Measure V_{1-3}, the voltage between terminals 1 and 3. V_{1-3} = ______V

e. Turn the power OFF and remove all connections to the transformer.

III. Determine the polarity of winding 3–4 relative to winding 5–6

a. Connect the source to winding 5–6 and set V_{5-6} to 10V

b. Measure V_{3-4}, the voltage across winding 3-4. V_{3-4} = ______V

c. Connect a wire from terminal 4 to terminal 5 of the transformer.

d. Measure V_{3-6}, the voltage between terminals 3 and 6. V_{3-6} = ______V

e. Turn the power OFF and remove all connections to the transformer

Report Guide – Polarity Investigation (to be completed at-home)

Accurately **draw the circuit** utilized to determine the polarity of winding 5–6 relative to winding 1–2, with the windings oriented as they are displayed on the transformer module.

Briefly **explain** the methodology used to determine the polarity relationship between windings 1–2 and 5–6.

Report Guide – Polarity Investigation (cont.)

Apply the methodology to all three sets of polarity measurements to completely characterize the transformer windings' polarity relationships.

Provide a **final drawing** of the overall transformer setup that shows **all three windings** oriented as they are displayed on the faceplate of the transformer module. Use the "dot" convention in your drawing to show the polarity relationship between all three windings, with the first "dot" placed at on the terminal #1 side of winding 1–2.

3. Step-Down Operation

Configure winding 1-2 as the primary winding connected to a variable-voltage AC source, and configure winding 5-9 as the secondary winding supplying a **120Ω (600Ω||300Ω||300Ω)** load.

Vary the primary (source) voltage from ***30V to 120V*** in ***30 volt increments.***

Measure the **secondary voltage** (winding 5-9) and both the **primary and secondary currents** (windings 1-2 and 5-9 respectively) at each of the source voltage values and record the results in Table 2.3.

Report Guide – Step-Down Operation (to be completed at-home)

Determine the **ratio of the voltages** V_{1-2}/V_{5-9} and the **ratio of the currents** I_{1-2}/I_{5-9} at each of the source settings. Create a table showing your results.

Briefly **discuss** the results of the step-down operation. Do they correspond to the expected values based on the ratings of the transformer?

4. Step-Up Operation

Configure winding 5-9 as the primary winding connected to a variable-voltage AC source, and configure winding 1-2 as the secondary winding connected to a **600Ω** load.

Vary the primary (source) voltage from ***15V to 60V*** in ***15 volt increments.***

Measure the **secondary voltage** (winding 1-2) and both the **primary and secondary currents** (windings 5-9 and 1-2 respectively) at each of the source voltage values and record the results in Table 2.4.

Report Guide – Step-Up Operation (to be completed at-home)

Determine the **ratio of the voltages** V_{5-9}/V_{1-2} and the **ratio of the currents** I_{5-9}/I_{1-2} at each of the source settings. Create a table showing your results.

Briefly **discuss** the results of the step-down operation. Do they correspond to the expected values based on the ratings of the transformer?

5. Voltage Regulation Investigation – Resistive Load

Designate winding 1–2 as the primary winding and winding 5–6 as the secondary winding for this and the next two measurement steps.

For a purely resistive load, measure **secondary voltage** and **secondary current** for currents ranging from zero to rated load current (in 100mA steps) while maintaining rated primary voltage. Record the results in Table 2.5.

6. Voltage Regulation Investigation – Capacitive Load

For a purely capacitive load, measure **secondary voltage** and **secondary current** for currents ranging from zero to rated load current (in 100mA steps) while maintaining rated primary voltage. Record the results in Table 2.6.

7. Voltage Regulation Investigation – Inductive Load

For a purely inductive load, measure **secondary voltage** and **secondary current** for currents ranging from zero to rated load current (in 100mA steps) while maintaining rated primary voltage. Record the results in Table 2.7.

Report Guide – Voltage Regulation Investigations – Steps 5-7 (to be completed at-home)

On a single graph, plot **secondary voltage as a function of secondary current** for all three load cases (resistive, capacitive, and inductive). Be sure to completely label your graph.

Discuss your plotted results with respect to voltage regulation for a practical transformer. (I.e. – explain why the transformer performed as recorded during this investigation.)

8. Excitation Current Investigation

Measure **primary current** as a function of applied primary voltage with the secondary winding open circuited. Designate winding 1–2 as the primary winding for this investigation. Record the results in Table 2.8

Report Guide – Excitation Current Investigation (to be completed at-home)

Plot the **applied primary voltage as a function of the measured primary current**. Be sure to completely label your graph including title, axes labels, trace labels and units.

Discuss your plotted results with respect to the magnetic characteristics of the transformer. (I.e. – explain why the transformer performed as seen in the investigation.)

For this experiment, you are required to submit an **electronically-generated lab-report** that contains **no hand-written information**.

All lab-reports must be completed **individually** with no collaboration between students.

All lab-reports must be **submitted electronically** in the form of a **SINGLE** **Microsoft Word or Adobe Acrobat** document, sent as an **EMAIL-ATTACHMENT** to the instructor's email address:

jeffwagner@kennesaw.edu

Lab reports that are submitted in the form of **multiple documents** **will not be accepted**.

The "**Subject**" of the email submission must be "**ECET 3500**".

The attached **file** that contains the lab-report information **must be named** in the following format:

3500-LabXX-Lastname**.docx** **(or .doc or .pdf)** **←(No spaces in file name)**

where "XX" is the two-digit lab number (i.e. – 02) and "Lastname" is your last name.

Improperly named lab-report files **will not be accepted**.

In terms of overall **formatting** **for all "memo-style" lab reports**:

Your report must be **well-written** in a neat and logical manner, with an attention to detail clearly shown throughout the entire report.

All of the **information** relating to the experimental measurements and the subsequent analysis must be presented **sequentially in the order that the experimental steps were performed**.

A **brief description** must be provided **at the beginning of each experimental step** that describes both the purpose of the step and the experimental procedure relating to that step.

All **measured data** must be **neatly tabulated** and shown within the appropriate section relating to the portion of the experiment during which the data was recorded.

A **title** and **brief description** must be provided for each **table or figure** shown in the report.

A **sample calculation** must be provided for each unique calculation **that shows both the formula and the numerical values** utilized to achieve the final result.

If a **discussion** of the results is required for any specific experimental step, the discussion should be clear, concise, and directly related to the investigation at-hand. **Do not simply state** that "the results correspond to the expected values" **without** clearly characterizing the expectations.

Your instructor may provide additional requirements as to the format of your reports.

1. Turns Ratio Investigation

V_{1-2} (volts)	V_{3-4} (volts)	V_{5-6} (volts)	V_{5-9} (volts)
30			
60			
90			
120			
150			
180			
210			

Table 2.1 – Open Circuit Voltages

2. Polarity Investigation

I. Determine the polarity of winding 5–6 relative to winding 1–2

V_{5-6} = ______V V_{1-5} = ______V

II. Determine the polarity of winding 3–4 relative to winding 1–2

V_{3-4} = ______V V_{1-3} = ______V

III. Determine the polarity of winding 3–4 relative to winding 5–6

V_{3-4} = ______V V_{3-6} = ______V

3. Step-Down Operation

V_{1-2} (volts)	V_{5-9} (volts)	I_{1-2} (amps)	I_{5-9} (amps)
30			
60			
90			
120			

Table 2.3 – Step-Down Transformer Voltages and Currents

4. Step-Up Operation

V_{5-9} (volts)	V_{1-2} (volts)	I_{5-9} (amps)	I_{1-2} (amps)
15			
30			
45			
60			

Table 2.4 – Step-Up Transformer Voltages and Currents

5. Voltage Regulation Investigation – Resistive Load

V_P (V)	V_{S-R} (V)	I_{S-R} (mA)
120		
120		
120		
120		
120		

Table 2.5 – Voltage Regulation – Resistive Load

6. Voltage Regulation Investigation – Capacitive Load

V_P (V)	V_{S-C} (V)	I_{S-C} (mA)
120		
120		
120		
120		
120		

Table 2.6 – Voltage Regulation – Capacitive Load

7. Voltage Regulation Investigation – Inductive Load

V_P (V)	V_{S-L} (V)	I_{S-L} (mA)
120		
120		
120		
120		
120		

Table 2.7 – Voltage Regulation – Inductive Load

8. Excitation Current Investigation

V_P (V)	I_P (mA)	V_P (V)	I_P (mA)
20		120	
40		140	
60		160	
80		180	
100		200	

Table 2.8 – Excitation Current