EELE 250 Circuits, Devices, and Motors

Lab #8: Transformers

Scope:

- Use a *power analyzer* to measure AC voltage, current, and power.
- Understand transformer principles, connections, polarity, and power efficiency.
- Make measurements using single-phase and three-phase electrical hookups.

Home preparation:

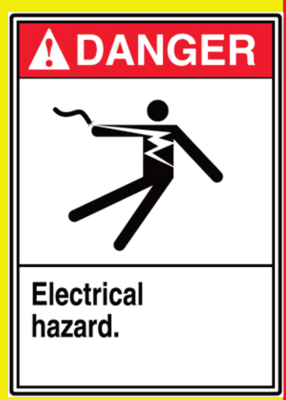
- Review Hambley chapter 15.
- Read through the experiment and plan out each step.
- Attach/paste the experimental steps into your notebook.

Laboratory experiment:

An electrical transformer is a passive electromagnetic element that is used to convert AC voltages from one level to another. As a passive element, the output power is equal to or less than the input power, so a transformer that steps-up the voltage will necessarily step-down the current, and vice versa. The *efficiency* of the transformer is the ratio of the output power to the input power.

IMPORTANT NOTE: Unlike previous lab experiments in this course, the transformer measurements being made in this experiment involve voltages and currents THAT COULD BE LETHAL. You must follow the safety guidelines at all times.

- Never touch "live" terminals. Make sure that the power is off before changing ANY connections.
- Any changes to the circuitry must first be examined and approved by your instructor or lab teaching assistant. Never "guess" about the proper configuration.
- It is especially important to remain focused on what you are doing so that there are no distractions that could cause you or your classmates to be injured or equipment to be damaged.
- No idle conversations or horseplay will be tolerated in the power lab.



Single-Phase Transformer

1. The lab assistant will have a single-phase transformer circuit connected on the lab bench. The circuit will have a transformer with a 117V primary and a 25V secondary. The primary side will have the line power source and a *power analyzer* (combined voltmeter and ammeter). The secondary will have another power analyzer and a connection to a variable resistive load.

   WITH THE POWER OFF, carefully examine the circuit and draw a complete schematic diagram of the devices and the cables, including the power analyzer connections.

2. Examine the labeling on the transformer. What are the current designations on the primary (117V) and the secondary (25V) sides?

   Primary (high voltage side) rating for current: $I_{primary}$ = ____________________________

   Secondary (low voltage side) rating for current: $I_{secondary}$ = _________________________

3. Verify the correctness and integrity of the connections and make sure everyone is clear of the terminals, then ask your lab TA to turn on the power (120V AC on the primary side).
4. Make the measurements required to complete Table 1, using the load resistor switches to select the specified resistance values. Observe the voltages and currents using the power analyzers, and MAKE SURE in each case that you are not exceeding the rated primary and secondary currents.

Table 1: Single-Phase Transformer Measurements and Calculations

	Primary			***Secondary***			
R_{LOAD} [Ω]	**V_{in} [V]**	**I_{in} [A]**	**P_{in} [W]**	**V_{out} [V]**	**I_{out} [A]**	**P_{out} [W]**	**Efficiency (P_{out}/P_{in}) [%]**
∞ (open)							
100							
50							
100 || 50							
25							
50 || 25							
25 || 25							

5. Using your measurements and calculations, prepare a graph of *efficiency* vs. *load current*.

Three-Phase Transformer

6. The lab assistant will have three-phase power source connected to three single-phase 117/25 V transformer circuits on the lab bench. The primary sides will be connected in Y ("wye") configuration while the secondary sides and resistive loads will be connected in Δ ("delta") configuration. One of the phases of the primary and secondary will have a power analyzer.

   WITH THE POWER OFF, carefully examine the circuit and draw a complete schematic diagram of the devices and the connections.

7. Verify the correctness and integrity of the connections and make sure everyone is clear of the terminals, then ask your lab TA to turn on the power (3-phase 120V AC on the primary side).
8. Make the measurements required to complete Table 2, using the three sets of load resistor switches to select the specified resistance values for all three phases. Observe the voltages and currents using the power analyzers, and MAKE SURE in each case that you are not exceeding the rated primary and secondary currents.

Table 2: Three-Phase Transformer Measurements						
	Y-connected Source			*Δ-connected Load*		
R_{LOAD} [Ω]	V_φ [V]	V_L [V]	$I_L = I_\varphi$ [A]	$V_\varphi = V_L$ [V]	I_φ [A]	I_L [A]
∞ (open)						
100						
50						
100		50						
25						
50		25						
25		25						

Post-Lab Questions

1. It is possible to interconnect the primary and secondary windings of the 117/25 V transformer in such a way to create a 117/92 V transformer.* Think about how this can be done, and then sketch the transformer connections required.

2. It is also possible to interconnect the primary and secondary windings of the 117/25 V transformer to create a 117/142 V transformer.* Sketch the transformer connections required.

3. Explain how these *autotransformer* connections could be used to determine the polarity ("dot convention") for the transformer.

4. What is the maximum volt-ampere load you can apply on the three-phase transformer? Explain.

** Note that these connections eliminate the electrical isolation between primary and secondary, creating what is known as an "autotransformer."*