# EELE 354 Lab Assignment 4: Voltage Drop in Cables

## Lab Overview:

For convenience, in analyzing electric circuits, current conductors linking power sources and loads are often assumed to have no impedance (resistance and reactance). However, this approximation can lead to erroneous results for a variety of realistic conditions including if the current through a conductor is large for the size of the conductor, or if the conductor length is very long (e.g. power transmission lines). In this lab, students will investigate the voltage drop and subsequent power lost in conductors as the non-idealities present in conductors such as transmission lines and extension cords can lead to inadequate power being applied to a load.

## Objectives:

The objectives of this laboratory assignment are:

- Measure the voltage drop in a cord carrying electricity to a load under a variety of loading conditions.
- Use circuit laws to determine the approximate impedance of the extension cord and the power lost in the cord.

## Pre-lab Assignment:

**Read through the entire lab assignment.** On page 2, draw the schematic diagram for a single-phase 120 V source supplying power to a resistive load through a cable (extension cord). Place a power analyzer between the power source and the extension cord and one between the end of the cord and the load. This is done so that voltage, current, and power measurements from near the power source and near the load can be compared.

Draw schematic here:

## Lab Experiment:

1. There is a 100-foot extension cord available at your bench. Measure the DC resistance of both the black wire and the white wire of the cord using the multimeter. Additionally, sum the two resistances together to estimate the full closed loop resistance in a circuit using the extension cord.

$R_{black}$ = __________ Ω, $R_{white}$ = __________ Ω, $R_{total}$ = __________ Ω

2. Assemble the circuit corresponding to the schematic drawn in the pre-lab. Think of the resistors as light bulbs of varying power ratings connected in parallel. **Prior to energizing your circuit, have your lab instructor check your circuit.**

3. Once your circuit is approved, turn on the single-phase 120 V power supply. Connect the 100 Ω resistor. Measure the voltage, current and power delivered by the power source. Measure the voltage, current and power delivered to the load. Record the values in the table below. Then, calculate the voltage dropped in the cord, the resistance of the cord, and the power dissipated in the cord. Repeat this process for all the resistance loads indicated in the table. **Note: You will have to combine resistors in parallel to achieve some of the values.**

| $R_{load}$ (Ω) | $I_{source}$ (A) | $V_{source}$ (V) | $P_{source}$ (W) | $I_{load}$ (A) | $V_{load}$ (V) | $P_{load}$ (W) | $V_{drop}$ (V) | $P_{cord}$ (W) | $R_{cord}$ (Ω) |
|---|---|---|---|---|---|---|---|---|---|
| 100 | | | | | | | | | |
| 50 | | | | | | | | | |
| 33.3 | | | | | | | | | |
| 25 | | | | | | | | | |
| 14.3 | | | | | | | | | |

4. De-energize and disassemble your circuit. Return any lab equipment and measurement devices to their appropriate place and ensure your lab bench is clean and organized.

## Lab Questions:

1. Draw a graph of the load voltage, $V_{load}$ as a function of load current, $I_{load}$. This graph can be drawn based on the data points of the table above. Explain why the voltage across the load varies with the load current.

2. Do the estimates of the cord resistance, $R_{cord}$, recorded in the table above correspond well to the cord resistance measurement made in part 1? If not, speculate as to why.

3. As discussed in class, impedances in AC circuits has an in phase component (resistance) and an out of phase component (reactance). In this lab, we approximated the total impedance in the cord as,

$$Z_{cord} \approx R_{cord},$$

thus ignoring the reactance component, $X_{cord}$. This is reasonable for this lab, however for long distance, high-voltage transmission lines this approximation would give erroneous results. Explain why.

Name and initial of lab partners:

Lab Partner 1: ________________________________

Lab Partner 2: ________________________________

Lab Partner 3: ________________________________