LAB 23. REAL CIRCUIT COMPONENTS

Problem

Do real circuit components behave as their simple models?

Equipment

DC Power supply, breadboard, switch, light bulbs, batteries, connector wires, resistors, LED, multimeter

Background

In models, voltage sources are shown as providing a specific potential change independent of the components connected to them. Resistors likewise are assumed to be characterized by a single resistance regardless of their environmental or internal conditions. Is this behavior realistic? How can we check? If these components do not realistically behave this way, how can we realistically model their behavior?

Activity

You will explore the voltage-current behavior of an actual circuit and develop a model to realistically predict its behavior. Each investigative group will explore one type of component. Plan your investigations and present your plan to your instructor before beginning. Give regular updates as your investigation proceeds.

Battery

Is a battery adequately represented as an ideal voltage source? If not, how does it deviate from ideality? Here are some measurements you might take to investigate; you may be able to think of other measurements as well.

1. Measure the voltage across the battery with no load (except the voltmeter).
2. Measure the voltage across the battery with loads of different resistance.

Repeat measurements a few times to check if the battery's properties change with time. Avoid measuring the current output unless you are certain that there is enough resistance in series with the ammeter to avoid exceeding the ammeter's limits. Don't blow a fuse!

Light bulb

Is a light bulb adequately represented as an ohmic resistor? If not, how can we model its voltage-current behavior?

1. Build a circuit containing the light bulb, the DC power supply, a switch, and the voltmeter.

2. At different power supply voltages and polarities, measure the voltage across the light bulb and the current through the circuit. Also visually observe and note the luminosity of the light bulb.

Start with a low power supply voltage: do not increase the voltage across the light bulb enough to burn it out. Also please do not exceed the range of the ammeter. If you do, you will blow a fuse and the ammeter won't work.

Resistor

We assume that resistors behave according to Ohm's law. Is this realistic?

Investigate a resistor in the same fashion as the light bulb described above. Of course, here there is no point in trying to observe or record its luminosity. You might be able to take the resistor to higher voltages than the light bulb.

Light emitting diode

We haven't discussed LEDs at all in class. How do they behave?

What happens if you use the ohmmeter setting of the multimeter to measure the resistance of an LED? Does it matter which lead of the ohmmeter connects to each lead of the LED?

Put an LED in a circuit in series with the power supply, a switch, and an ammeter. Observe the luminosity of the LED and the current through the LED at different voltages, positive and negative. Do different LEDs have different properties

Data Processing

What to do here depends largely on what you measured and what the data show. Here you are seeking to describe how your component behaves under the conditions you probed.

Battery

If the voltage output of the battery is constant, how will your data show that?

Can you find a way to mathematically model the battery that gets reasonably close to its actual performance? Consider mathematically combining an ideal voltage source with other components, such as resistors and capacitors. (Those are about all we know about so far.)

Light bulb

Is the resistance of a light bulb constant? If not, what does s resistance depend on? How much does its resistance vary? How can you visually express its behavior?

Resistor

Is the resistor's resistance constant? How can you visually express its behavior?

Light emitting diode

How does the LED behave in response to applied voltage? Can you formulate a set of simple rules for it?

Lab Report

Report your observations and findings in a *brief* written report with sentences and paragraphs.

Abstract

Identify the component you studied, the circuits you constructed, the measurements you took, and what information you obtained from the measurements.

Purpose

What concepts or principles is this activity intended to help you learn?

Theory

How does your component behave ideally? (You are in luck if you studied the light emitting diode, because you are not responsible to know anything about how they ought to behave.) Is there any theoretical reason to expect them to behave differently? If so, what might that be?

Experimental

Give make and model of any manufactured equipment you used. Report the circuit you used for each measurement, what you varied, and what you measured.

Observations and data

Your primary data should be in your lab notebook. In your report, summarize the data clearly using appropriate tables, statistics or figures.

Analysis and discussion

Did the component behave ideally or not under the conditions of the experiment? (If your component was an LED, simply explain how it behaves.) Justify your assessment. If not, propose rules that more faithfully predict their behavior. Show how your proposed rules more closely match the observations.

Conclusion

How does the real component behave? Did you find a reasonably faithful model of its real behavior?