ELEC 240
Lab 1 - Basic Electrical Measurements

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1 Objective

This lab focuses on the fundamental tools and skills for electrical engineering laboratory work. This includes making current, voltage, and resistance measurements with a digital multimeter, creating graphs in MATLAB, and producing and measuring sinusoids with an oscilloscope and function generator.

2 Materials

- Digital Multimeter (DMM)
- MATLAB
- Banana Plug Cords
- Battery Pack
- 2 AA batteries
- Lightbulb Socket Board
- 10 equal resistant (of any resistance)
- VirtualBench Software with Function Generator, Oscilloscope, and DC power supply
- BNC to Banana Plug Adapter
- Breadboard

3 Test Description

1. **Measuring Voltage with the DMM** We measured the voltage of the battery alone and then the voltage of the lightbulb when connected in series with the battey.

2. **Measuring Current With DMM** We measured current of the circuit with the lightbulb by putting the DMM in series with the lightbulb.

3. **Measuring Resistance with the DMM** We measured the resistance of various individual resistors (ie 330, 430, and 220 Ohms) and then measured the consistency of 10 460 Ohm resistors.

4. **Measuring the I-V Characteristics of a Light Bulb** We connected the lightbulb to the DC power supply from the VirtualBench so we could vary the input voltage. We then took voltage and current measurements as we increased the voltage and noted the discrepancies between the Power Supply output readings and our own measurements of voltage and current.

5. **Viewing Signals with the Oscilloscope** We created a 1kHz sine wave with the function generator then observed this sine wave with the oscilloscope. We observed the effects of changing the Time/Div and other positioning controls.

6. **Making Quantitative Measurements with the Oscilloscope** We used the oscilloscope to measure the DC power supply, a sine wave, and a square wave. We took measurements of frequency and amplitude of the sine and square wave.

7. **Testing Breadboard** Used a DMM to ensure that the breadboard had functional connections between important ports

3.1   Pre-Lab Calculations and Schematics

Current vs Voltage through a Lightbulb

Current vs Voltage through a Resistor
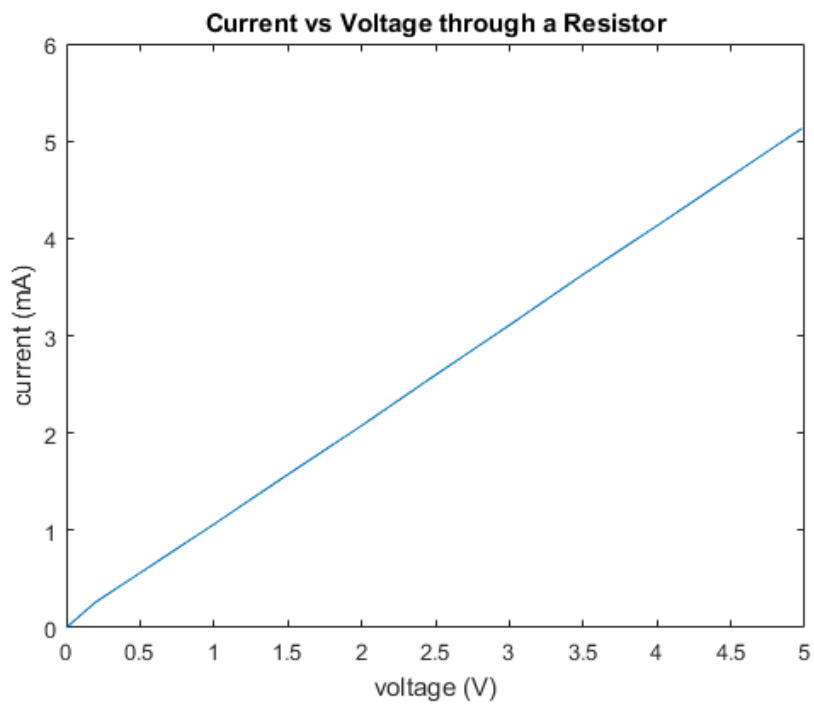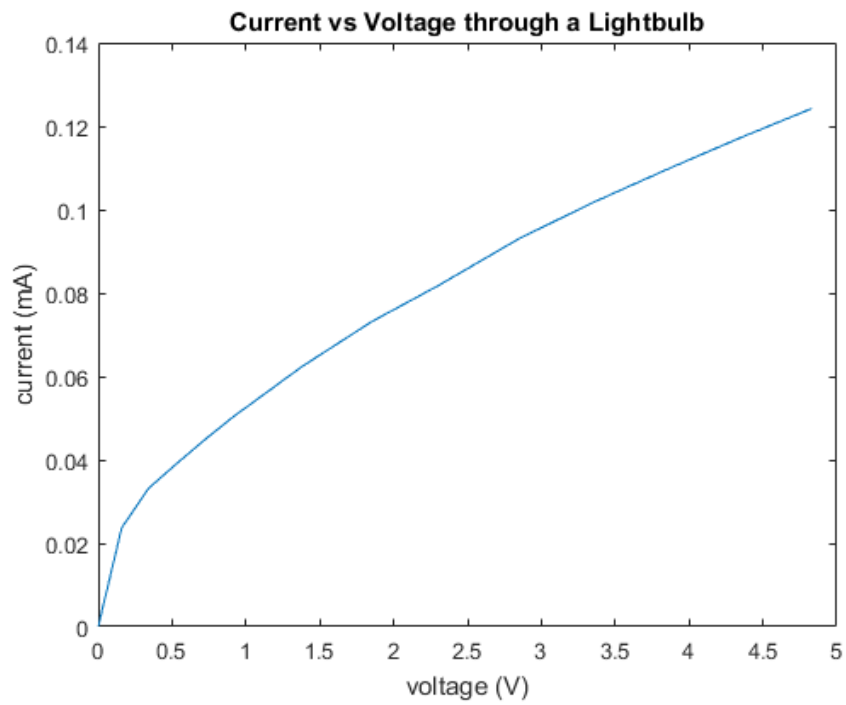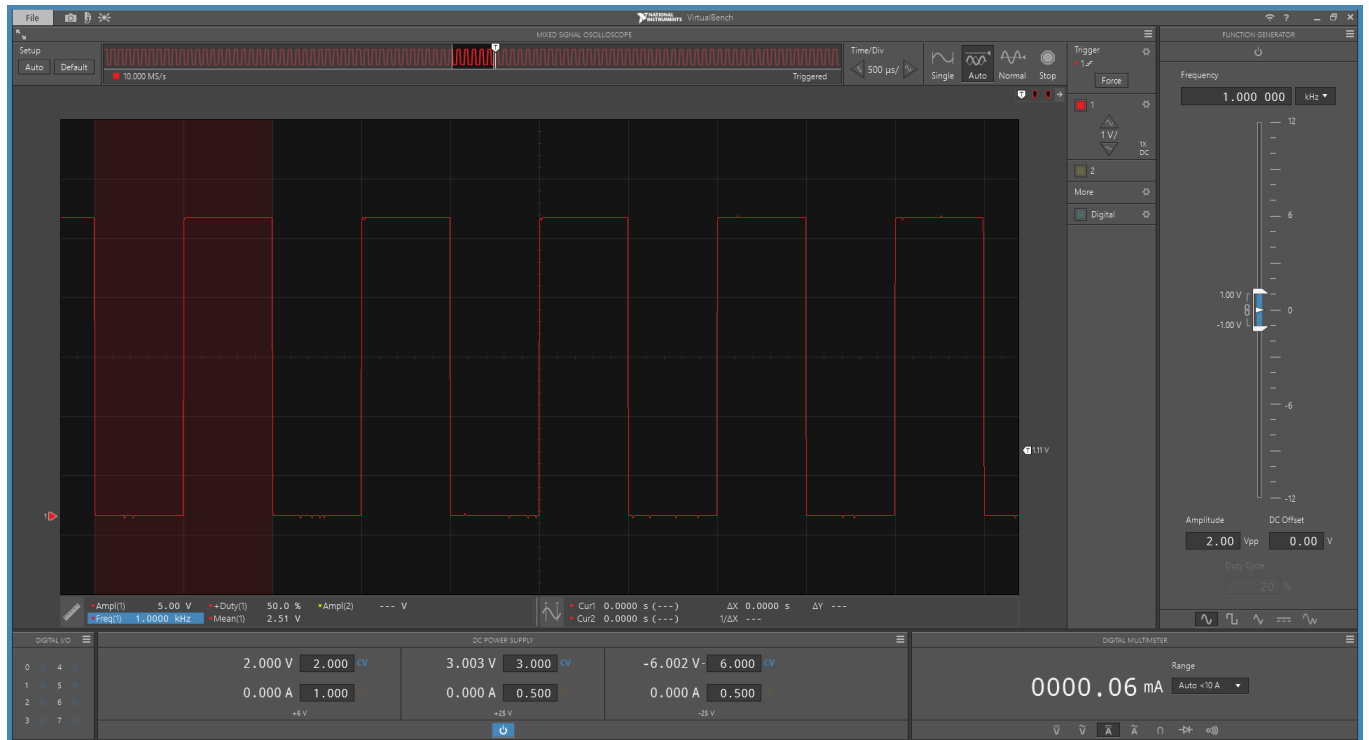
4 Results and Discussion

4.1 Experiment 1.1: The DMM

4.1.1 Part A: Measuring Voltage with the DMM

Note: We were unable to aquire multiple Double A batteries for the initial tests

- Measuring the voltage of a D battery: 1.62V

- Voltage of battery attached to Lightbulb: 1.53V, The voltage has dropped, as some energy is being used to power the bulb

4.1.2 Part B: Measuring Current with the DMM

- Current across the battery in the Lightbulb - Battery circuit: 59.5 mA

- Current across the NC circuit: 59.1 mA

4.1.3 Part C: Measuring Resistance with the DMM

- 330 Ohms Resistor - Measured 325.7 Ohms 430 Ohms Resistor - Measured 424 Ohms 2200 Ohms Resistor - Measured 2153 Ohms

- All resistors had a tolerance of 5%, which is in accordance with the measured values

- Holding the probes between your fingers opens a parallel path for the current to flow, which will lead to an inaccurate measure of the resistance of the circuit

- The resistance of two resistors in series is 2R + 2d, where d is the tolerance of a single resistor

- The resistance of two resistors in parallel is .5R + .5d, where d is the tolerance of a single resistor

- Measuring 10 resistors with a resistance of 4.6 kOhms and a tolerance of 5% In kOhms: 4.61, 4.61, 4.59, 4.61, 4.63, 4.61, 4.63, 4.60, 4.61, 4.62. All of these resistances fall within the tolerance

- Resistance of the body through dry fingers: 1.325 MOhms with a resolution of .1 MOhms

- Resistance of the body throuh wet fingers: 168 kOhms with a resolution of 10 kOhms

- This change in resistance can be attributed to the fact that adding water to fingers increases the surface area of the contact of the leads to the skin, which leads to a decrease in resistance. Following Ohms law, with dry skin, a voltage of 6.625 kV would produce 5 mA of current

- The resistance of the lightbulb is 4.8 Ohms. This is not the answer that we would expect from Ohm's law because a lightbulb is a non-Ohmic circuit element.

- The DMM reads .01 fewer volts that the Virtualbench power supply, hinting a voltage drop somewhere in the small circuit.

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- For a 1kOhm resistor, Ohms Law holds for all V

4.2 Experiment 1.2 The Oscilloscope and Function Generator

4.2.1 Viewing Signals with te Oscilloscope

- The numbers are slightly off from the function generator because of two factors, the first being that the generator is not perfectly able to create the given sine waves, and the second being that the oscilloscope uses various measurements and approximations to create its given outputs which cannot be perfectly accurate.

- The duty cycle changes the ratio of time spent on the positive pulse vs the negative pulse

- The DC offset shifts the curve along the Y axis

- The "DC" voltage used is actually just a recitified AC signal, and an oscilloscope can be used to find the effectiveness of the rectifier.

- The comparison of the found frequency to the given frequency yields no surprises, with them being very similar.With a division of 100 microseconds per div, there is a period of 10 divisions, which is 1 millisecond. The given period (being the inverse of the given frequency) is .999 milliseconds It is within .001 ms.

Note (To be deleted): The heart of your report is the presentation of your results and a discussion of those results. In your discussion, you should not only analyze your results, but also discuss the implications of those results.

5 References

1. https://www.ece.rice.edu/ dpr2/elec240/lab1/

6 Conclusion

7 Errors

Your text here

Note (To be deleted): Briefly list sources of error and discuss how to eliminate or deal with them