Notes on Experiment #7

Prepare for this experiment!

During this experiment you will be building the most elaborate circuit of the term. (See Figure 1. below for circuit diagram and values.) You will also be measuring voltages and currents using all of the techniques we've learned this term. If you come to lab prepared you will finish early. If you do not prepare for this experiment you will not finish on time.

Measure the Resistors First!

The resistors must be accurate in this experiment. Discard any with an error greater than 5%. Ask your lab instructor for a replacement.

Procedure

We will do this experiment twice. The first time through we will use two pure DC sources. The second time through we will use one pure DC source and the function generator set to have pure DC.

For each case above we will measure and record all voltages using:

- The DMM and
- The Oscilloscope.

We will also directly measure and record the current in each element using the DMM. (That means each resistor and each source.)

Set up appropriate data tables for the expected data.

You will then compare this data to the calculated values from your circuit analysis and do error analysis.

Circuit Analysis

Use mesh analysis to determine the mesh currents. Then calculate each element current (including resistors and sources.) Now use Ohm's law to calculate each resistor voltage. You will be doing this twice!

First time: Use the dual DC supply for the two pure DC sources.
- $R_S = 0$ Ohms,
- $V_{S1} = 10$ Volts DC, and
- $V_{S2} = 6$ Volts DC.

**Second time:** Use the function generator for $V_{S1}$ and one side of the dual DC supply for $V_{S2}$. YOU MUST SET THE SOURCES BEFORE YOU CONNECT THEM TO THE CIRCUIT. WHY?

- $R_S = 50$ Ohms (NOT K OHMS),
- $V_{S1} = 10\cos(2000(\pi)t)$ Volts (AC), and
- $V_{S2} = 6$ Volts DC.

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Figure 1.

Have fun.
ECE 210 Experiment #7

Kirchoff's current and voltage laws

Purpose: To verify Kirchoff's laws experimentally

Equipment: Agilent 54621A Oscilloscope, Agilent 33120A 15MHz Function/Arbitrary Waveform Generator, Agilent 34401A Digital Multimeter (DMM), Agilent E3631A Triple Output DC Power Supply, Universal Breadbox

I. Introduction

If a branch of a circuit contains a resistor, the best way to measure the current in that branch is to measure the voltage across the resistor and divide by R. However this gives a value which is only as accurate as the value of R. Consequently, start this investigation by accurately measuring the values of all resistors which will be used.

Of course if a branch of a circuit contains no resistors, the current in that branch must be measured directly with a milliammeter (or else deduced by Kirchoff’s current law from other known currents.)

II. Verifying KCL, KVL, and power balance for a linear circuit (DC)

Set up the circuit in Figure 1. Use the +25 volt output for \( V_{S1} \) (set to 10 volts) and the 6 volt output for \( V_{S2} \) (set to 6 volts.) Set the current limits to 100mA. Use the DMM for measurements.
Make the appropriate measurements to verify KVL around loops 1, 2, and 3, and the perimeter of the circuit. (You will find that you must understand the sign convention for voltages, and you must understand what the DMM tells you about the sign of a measured voltage, in order to do this.) Record the measurements and comment on the accuracy with which KVL is verified for these four loops.

Make the appropriate measurements to verify KCL at nodes A, B, C, and D. (As before, you must understand signs! The DMM counts current as positive if it enters the mA terminal and leaves the COMMON terminal.) Record and comment as for the KVL experiment.

Calculate the power absorbed by all elements in the circuit, including the sources. Add these up and comment on the degree to which your measurements confirm the fact that the total power absorbed in the circuit is zero.

III. **Verifying KCL, KVL, and power balance for a linear circuit (AC)**

Repeat part II, but replace $V_{S1}$ with the function generator, set for $10\cos(2000\pi t)$. Make the voltage measurements with the DMM and with the oscilloscope. Make the current measurements with the DMM. Skip the power calculations.