Notes on Experiment #9

Thevenin's Theorem

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.

The element values are:

- Part 1:
  \[ R_1 = 10\,\text{K}; \, R_2 = 6.8\,\text{K}; \, R_3 = 10\,\text{K}; \, R_4 = 3.3\,\text{K}, \text{ and } R_5 = 2.7\,\text{K} \]

- \( V_1 = 10 \) Volts and \( V_2 = 6 \) Volts.

Procedure

Use a DC source for \( V_1 \) and \( V_2 \).

Procedure

1. Build the circuit but do not connect a load resistor.
2. Measure \( V_{OC} \).
3. Measure \( I_{SC} \).
4. Compare these values to the values from your circuit analysis. There should be almost no error. If there is error then:
   a. you did not build the circuit correctly or
   b. you did not measure correctly.
5. If the data is OK then use the above data values of \( V_{OC} \) and \( I_{SC} \) to calculate \( R_{TH} \).
6. Now measure \( R_{TH} \)! Just set the voltage sources to zero and use an Ohm meter to measure the resistance at the output terminals. PLEASE NOTE: Normally you can not and should not measure \( R_{TH} \) in the above manner. Usually we cannot turn off the internal sources in a circuit. Try measuring \( R_{TH} \) while the sources are connected. You should get a very large error.
7. Does the calculated \( R_{TH} \) equal the measured \( R_{TH} \)? It should!
8. DO NOT GO ON. Show your data to your lab instructor. If all the data is OK then you may go on.
9. Connect the following load resistors \( R_L \) (one at a time) and measure and record:
   a. \( V_L \) and
   b. \( I_L \)
RL = \{100 \text{ Ohms}, 470 \text{ Ohms}, 1 \text{K}, 4.7 \text{K}, 10 \text{K}, 20 \text{K}\}

**IMPORTANT:** Do not use the power resistor decade box for RL. Use the extra resistors supplied in your kit.

10. DO NOT GO ON. Show your data to your lab instructor. If all the data is OK then you may go on. DO NOT DISMANTLE THE CIRCUIT.
11. Now build the Thevenin Equivalent Circuit (TEC) of the elaborate circuit you just worked on.
   a. Set the voltage source \( V_{OC} \) equal to the open circuit voltage \( V_{OC} \) YOU measured and
   b. Use the power resistor decade box as \( R_{TH} \). Do not trust the dials. Measure the resistance on the decade box so that you know that it is set correctly.
   c. Now repeat steps 2 to 10 above. Be sure to use exactly the same load resistors.
12. Compare the data from the original circuit and the TEC. Do error analysis.
13. Plot the suggested graph using the values of RL from above.
14. You're done. Dismantle the circuits, put the parts away, and turn in your report.

**Circuit Analysis**

Calculate the values for \( V_{OC} \), \( I_{SC} \), and \( R_{TH} \) using any method you like. Use the values given at the top of this page. You do not need to calculate the load resistor voltages and currents. That's all.

Have fun.
**ECE 210 Experiment #9**

**Thevenin’s Theorem**

Purpose: To demonstrate this important theorem.

Equipment: Agilent 34401A Digital Multimeter (DMM), Agilent E3631A Triple Output DC Power Supply, Universal Breadbox

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Set up the circuit in Figure 1, which is supposed to represent a moderately complex linear circuit.

![Figure 1](image)

**Figure 1.**

Measure the open circuit voltage $V_{OC}$ ($V_{AB}$ of this circuit) with the DMM. Then measure the short circuit current $I_{SC}$ by attaching the DMM, used as a DC current meter, directly to the output terminals A and B. Calculate $R_{TH} = V_{OC} / I_{SC}$.

Set up a graph with voltage on the horizontal axis and current on the vertical axis, and plot the current-voltage combinations you have obtained from the open circuit voltage measurement (one point on the graph) and the short circuit current measurement (another point.) Attach a variety of values of load resistance $R_L$ (ranging from 10 ohms to 100K.)
See Figure 2.) to the output terminals; for each value of $R_L$, first determine the load voltage and load current which result and then plot the combination as a point on the graph. Comment on the nature of the graph.

![Figure 2.](image)

Now construct the Thevenin equivalent of this circuit, using a DC source set equal to the measured $V_{OC}$ measured above, and a resistance equal to $R_{TH}$ calculated above. See Figure 3.

Attach the same set of $R_L$ values you used earlier, and record the load voltages and currents which result. See Figure 4. If this simplified circuit is in fact equivalent to the original more complex circuit, these values should be the same as before. Are they? Comment.

![Figure 3.](image)

![Figure 4.](image)