UNIVERSITY OF CALIFORNIA, BERKELEY
EE40: Introduction to Microelectronic Circuits

Equivalent Circuits Guide

Important Notes

- Please make sure the current limit set higher than the current required by the circuit but lower than 2 amps. This is to ensure that you provide your circuit with enough power without damaging the equipment.
- Always use measuring devices (DMM) to take your measurements. Do not depend on the power supply to report accurate voltage and current values.
- In this lab, you will use 1.2k., 2.2k., 220., and 1k. resistors. For this lab, you can use resistor values are at within 10% of your theoretical value. If you require the use of other valued resistors, then your theoretical calculations are incorrect.
- These circuits are complicated. Good breadboard practice will be key in completing this lab.

Equivalent Resistor Networks

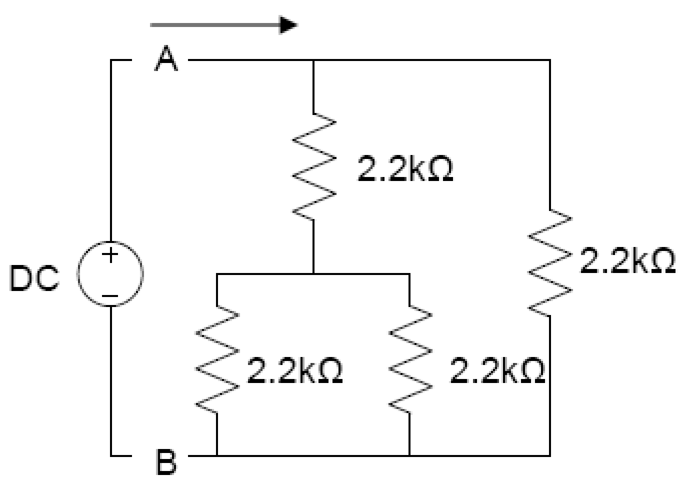

Figure 1

1. Build the circuit shown in Figure 1. To demonstrate the importance of a neat and orderly breadboard layout, use only the resistors and no extra wires (except those connecting o the power supply) to build this circuit. Assuming a maximum of 10 volts, what is the maximum amount of current supplied by the power supply?
2. From your prelab, you calculated the theoretical resistance across **A** and **B**. Disconnect the circuit from the power supply and use the DMM to measure the actual resistance across terminals **A** and **B**.

3. Reconnect the power supply, and record **V_{AB}** and **I** for 5 different supply voltages between 0 and 10 volts. Plot the IV curve of this circuit.
    a. When recording the value of **V_{AB}** and **I**, it is important that you use the digital multimeter (DMM) to take your measurements. The readings from the power supply are inaccurate.
    b. Please set the current limit of the power supply to a value higher than that calculated in Step 1, but lower than 2 amps.

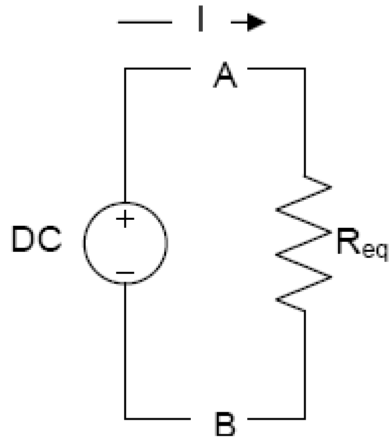

Figure 2

4. Build the circuit shown in Figure 2. Use the value of R_{eq} calculated in the prelab exercises and measured in step 2.
5. Using the power supply, record **V_{AB}** and **I** for 5 different supply voltages between 0 and 10 volts. Plot the IV curve of this circuit.

Thévenin's and Norton's Equivalence

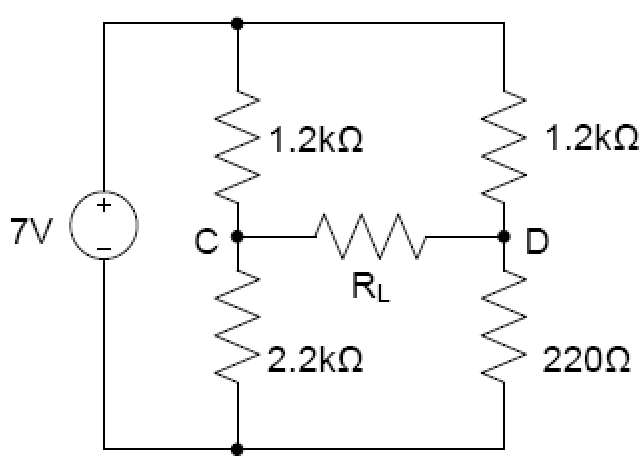

Figure 3

6. Build the circuit shown in Figure 3 *leaving out the resistor labeled R_L* for now.

Again, use only the resistors and no extra wires to build this circuit. Measure the voltage across terminals **C** and **D**. This is your open circuit voltage (**V_{TH}**) and should be the same as you calculated in your prelab.

7. Now measure the current flowing through terminals **C** and **D**. Remember, when measuring current using the DMM, there is 0-resistance across the probes. Then you are essentially measuring the short-circuit current (**I_{SC}**) and should be the same as you calculated in your prelab.
8. Disconnect the power supply, and short terminals **A** and **B**. You *killed* the voltage source. Measure the resistance across terminals **C** and **D**. This is your Thévenin resistance (**R_{TH}**) and should be the same as what you calculated in prelab.
9. Now, "unshort" terminals **A** and **B** and reconnect the power supply (thus restoring the circuit in figure 3). For 3 different values of R_L=220., 1.2k., and 2.2k., install the resistor and measure the voltage across and the current through R_L.

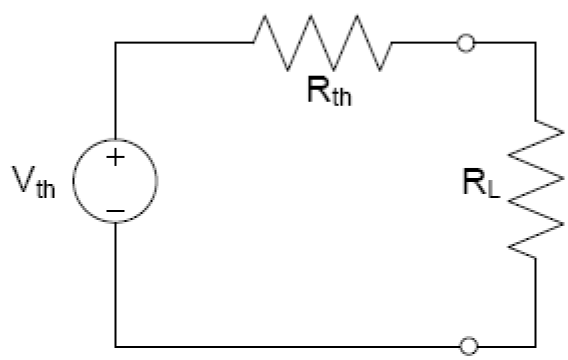

Figure 4

10. Build the circuit shown in Figure 4 with the appropriate values of **V_{TH}** and **R_{TH}** you calculated in your prelab and measured in steps 6 and 8.
11. For the three values of R_L, measure the voltage across and current through R_L.

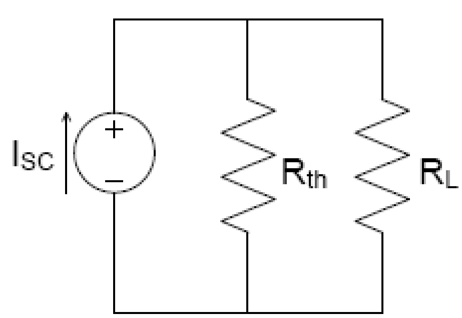

Figure 5

12. Build the circuit shown in Figure 5 with the appropriate values of I_{SC} and R_{TH}

that you calculated in your prelab and measured in steps 7 and 8.
(Hint : to make a viable current source, connect a large (>>**R_{TH}**) resistor in series with the power supply and adjust the voltage of the power supply until the current through the resistor is **I_{SC}**.)

13. For the three values of R_L, measure the voltage across and current through R_L.

Pure Resistive Networks and Frequency

14. Attach the oscilloscope channel across points C and D (on figure 3). This is the system output. Disconnect the power supply, and instead attach points A and B to the function generator. This will apply an AC, rather than DC input to the system. Attach a second oscilloscope channel across points A and B.
15. Output a 1 kilohertz sinusoidal wave with function generator.
16. Observe both input and output waveforms together on the oscilloscope screen. Vary the frequency of the sine wave.

Circuit Simplification and Symmetry

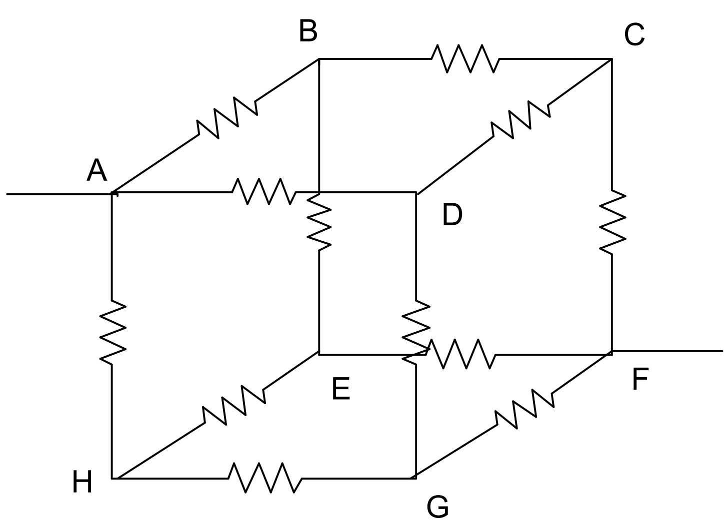

Figure 6

17. Build the circuit in figure 6 on the breadboard. Make all resistor values 1k. As mentioned in the prelab, this circuit should be constructed in a neat and orderly fashion using only the resistors and no extra wires. (Hint: node A and F are the voltage source and

ground respectively. Remember the breadboard configuration need not resemble the circuit's spatial configuration. Only the connections between nodes matters)

18. Measure $\mathbf{R_{eq}}$ between points A and F. Compare this to the value you calculated in the prelab.
19. Reconnect the power supply to points A and F. Adjust the voltage such that the total current supplied is 10 mA. Measure the current through the resistor between point A and D.
20. Restore the system to its original configuration. Now measure the current through the other two resistors originating at point D.