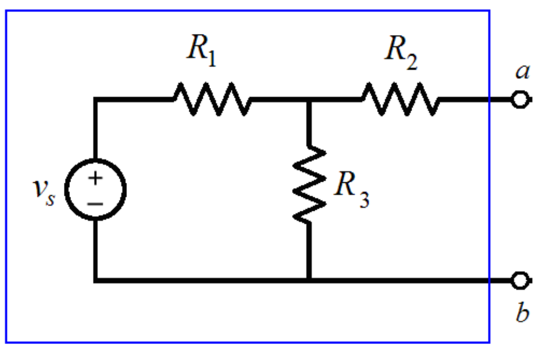
Experiment 6
Lab Activity

Pre-Lab Activity

Read the Pre-reading materials, the laboratory activity and the post-lab before coming to the Laboratory. Solve the following problems and submit your solution to your instructor.

Problems

1. Consider the circuit in the following figure with v_s = 12V, R_1 = 1kΩ, R_2 = 470Ω and R_3 = 4.7kΩ. Employ Multisim to find the Thevenin equivalent circuit.



2. The Thevenin resistance, R_t, can be obtained (manually) by *shorting* the voltage source and then finding the equivalent resistor resulting at the terminal pair *a-b*. Use this method to find R_t.
3. Find the open-circuit voltage, v_{oc}, at the *a-b* terminals by (manually) analyzing the above circuit. Hint: Since the voltage across R_2 is zero (because of the zero current), the circuit is essentially a voltage divider where v_s is divided between R_1 and R_3. Here, v_{oc} is equal to the voltage across R_3.
4. Draw and completely label the Thevenin and the Norton equivalent circuits.
5. Employ the Thevenin circuit obtained for Problem 1 and Equation (1) to find the power delivered to a load resistor R_L = 1kΩ

(connected between nodes *a* and *b*). Repeat for R_L = 470Ω, and R_L = 4.7kΩ.

6. What should the value of R_L be so that the circuit in Problem 1 delivers maximum power to the load resistor? Determine the value of this maximum power.
7. Show that the power, as expressed in Equation (1), is maximized when $R_L = R_t$.
8. Derive Equation (2).

Laboratory Activity

Required components:

One 470Ω resistor (±5%, ½ W)

One 1kΩ resistor (±5%, ½ W)

One 1.3kΩ resistor (±5%, ½ W)

One 4.7kΩ resistor (±5%, ½ W)

One 5kΩ potentiometer (±10%, ½ W)

Note:

- All circuits in this experiment (and in all future experiments) should be constructed on the protoboard.
- When making current measurements, set the ammeter to display the reading in mA. Record your measurement with two significant digits to the right of the decimal point (employ rounding).
- When making voltage measurements, set the voltmeter to display the reading in Volts. Record your measurement with two significant digits to the right of the decimal point (employ rounding).
- When measuring resistance, set the Ohmmeter to *auto-range* and record the displayed reading accurate to two significant digits to the right of the decimal point.

1. Obtain the above resistors from your lab instructor and measure and record their actual resistance.
2. Construct the circuit in Figure 4 with v_s = 12V, R_1 = 1kΩ, R_2 = 470Ω and R_3 = 4.7kΩ. Do not connect the load resistor. Verify the value of v_s using the voltmeter.
3. Measure and record the voltage drop at node *a* relative to node *b* (i.e., measure v_{oc} as shown in Figure 3*a*).
4. Measure and record the short-circuit current (i.e., measure i_{sc} as shown in Figure 3*b*).
5. Compute R_t as v_{oc}/i_{sc}.
6. Now, attach a 1.3kΩ resistor between nodes *a* and *b*. Measure the voltage across and the current through the resistor.
7. Adjust the 5kΩ potentiometer to the value you obtained in Step 5, and use it to replace the 1.3kΩ load resistor. Measure and record the voltage across and the current through the potentiometer.
8. Build the Thevenin equivalent circuit (refer to Figure 12*b*) for the circuit in Step 2. Use the DC power supply to generate the Thevenin voltage you obtained in Step 3. Readjust the 10kΩ potentiometer to the R_t value you obtained in Step 5. Use the potentiometer as your Thevenin resistor.
9. Attach a 1.3kΩ resistor as a load resistor to the Thevenin circuit that you constructed in Step 8. Measure and record the voltage across and the current through this load resistor.
10. Repeat Step 9 for R_L = 470Ω and R_L = 4.7kΩ.
11. **Sort all components and give them back to your instructor.**

Post-Lab Activity

Write a technical report that discusses your observations and includes analysis and justifications of all steps in this activity. Tabulate and/or plot experimental data whenever possible. More specifically, your report should address the following points:

Note:

- Use the actual (measured) resistor values in all theoretical calculations and in Multisim simulations.
- When you are asked to “compare” measured values to theoretical values, always compute the error in percent.

  - Repeat Steps 2 through 10 of the laboratory activity employing Multisim.
  - Compare your experimental results to those obtained employing Multisim.
  - Compare the results of Steps 6 and 9 and discuss their significance in the context of Thevenin’s Theorem.
  - Compute the power dissipated in each of the load resistors (use $p = v.i$) in Step 10. Compare this power value to the theoretical value obtained from Equation (1); use the measured v_t, R_t and R_L values.
  - For Step 7, calculate the power dissipated in the load resistor (use $p = v.i$). Compare this power to the theoretical maximum power value obtained using Equation (2).