Objectives:
The purpose of this laboratory is to demonstrate the concepts of source superposition, equivalent circuits, and maximum power transfer.

Equipment:
1 - Analog Probe Kit (You should Check out)
1 – Breadboard (You should Check out)
1 - DC Power Supply
1 - Digital Multimeter
1 - Oscilloscope
1 - Resistive Decade Box

Components:
1 - 1 kΩ Resistor
1 - 2.4 kΩ Resistor
1 - 3 kΩ Resistor
1 - 6.2 kΩ Resistor
1 - 3.6 kΩ Resistor

Procedure:
1. Using your breadboard, construct the circuit shown below.

![Circuit Schematic]

While constructing this circuit, notice that the two voltage sources both share a common node at the bottom. This will allow you to connect two “hot” output terminals of the voltage source to the 3 kΩ and 6 kΩ resistors, respectively, and connect the common (black) to the bottom node.

2. Measure the open-circuit voltage, $V_{oc}$, across the terminals a and b with $V_1$ and $V_2$ set to the values shown in Figure 1. Using DC analysis, predict the open-circuit voltage.
Q1: How does this value compare to what you would obtain from circuit theory?

3. **Re-measure** Voc by using the superposition concept. To do this, first measure the open circuit voltage when V1 is set to 4 V and V2 is set to 0 V. Next, measure the open-circuit voltage when V1 is set to 0 V and V2 is set to 9 V. **Check** to see if the sum of these voltages equals the open-circuit voltage measured previously. Perform DC analysis, using the concept of source superposition.

Q2: How does this value compare to what you would obtain from circuit theory?

4. Measure the short-circuit current Isc across the terminals a and b with V1 and V2 set to the default values (ie. V1 = 4V and V2 = 9v)

Q3: How does this value compare to what you would obtain from circuit theory?

5. **Re-measure** Isc by using the superposition concept. To do this, first measure the short-circuit current when V1 is set to 4 V and V2 is set to 0 V. Next, measure the short-circuit current when V1 is set to 0 V and V1 is set to 9 V. **Check** to see if the sum of these currents equals the short-circuit current measured previously.

Q4: How does this value compare to what you would obtain from circuit theory?

6. Using the values of Voc and Isc measured above, **calculate** the Thevenin and Norton equivalent circuits of this circuit as “seen” at the terminal pair a b. Using the Thevenin equivalent circuit, *calculate* the voltage that would be obtained across a 3.6 kΩ resistor connected across the terminals a b. **Compare** this with the actual voltage you measure when you place this resistance across the terminals.

Q5: How do they compare?

7. **Remove** the 3.6kΩ resistor present across terminals a and b. **Measure** the maximum power that this network can supply to a resistive load. To accomplish this, first attach the decade resistance box across the terminal pair a b and set the voltage sources V1 and V2 to their original values (4 V and 9 V, respectively).

Measure the power delivered to the load (decade box) as you vary the box resistance from 600Ω to 4kΩ in 200Ω steps. For each setting of the decade box, **measure** the voltage across the terminals a b directly using the multimeter. Repeat the same procedure for each setting of decade box by measuring the voltage across the 1 kΩ resistor with the multi-meter which is nothing but the current through 1 kΩ resistor.
measured indirectly (in ma). **Plot** the power delivered to the load vs. the resistance $R_{\text{max}}$ of the load (decade box). **Tabulate** the values obtained.

**Q6:** What load value $R_{\text{max}}$ receives the most power? What is that maximum power $P_{\text{max}}$?

8. Using the Thevenin equivalent circuit parameters obtained earlier for this network, find the maximum power this network can deliver to a resistive load, and the value of that power. **Compare** these values to $R_{\text{max}}$ and $P_{\text{max}}$ measured above.

**Q7:** How does the measured $R_{\text{max}}$ and $P_{\text{max}}$ compare with the theoretical $R_{\text{max}}$ and $P_{\text{max}}$ obtained from circuit theory?