Superposition and Thevenin's Theorem

ECE 2100 Circuit Analysis Laboratory
updated 6 September 2016

Equipment and Supplies

variable DC voltage source, 0-30V
fixed DC voltage source, 5V
digital multimeter
function generator
breadboard
LTspice
resistors (1/4W) 1kΩ 5.6kΩ 24kΩ (3) random values
variable resistor

Pre-Laboratory Assignment

1. Consider the circuit of Figure 1. Using a hand analysis, find node voltage 2 (with respect to ground of course) for three cases:

    a. V1=5V and V2=0V;

    b. V1=0V and V2=10V;

    c. V1=5V and V2=10V.

    Verify the superposition theorem using your results from parts a, b, and c.

2. Repeat pre-laboratory step 1 using your SPICE engine. Compare simulation results to your hand analysis results.

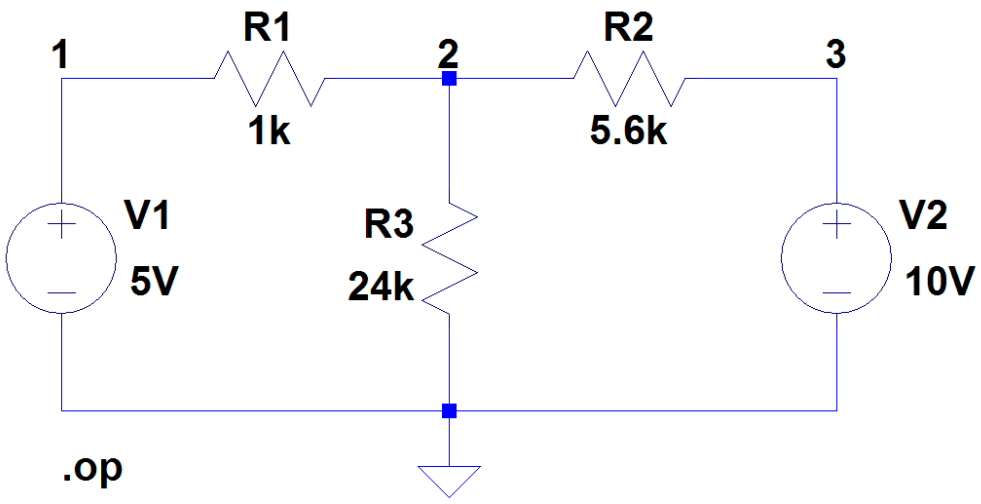

Figure 1. Circuit with Two Sources

3. Consider the circuit of Figure 2. Note that R_L is essentially an open circuit. Find the Thevenin equivalent circuit "looking into" nodes A and B; that is, find the Thevenin equivalent of the circuit "seen" by R_L using hand analysis.

4. Find the Thevenin equivalent circuit using your SPICE engine as follows:

    a. Find V_{TH} by using a .op simulation command; and

    b. Find R_{TH} by using a .tf simulation command as shown. R_{TH} is the value listed as the circuit "output impedance."

    Compare your results of the results of pre-laboratory step 3. **BRING AN ELECTRONIC COPY OF YOUR SPICE FILE TO LAB.**

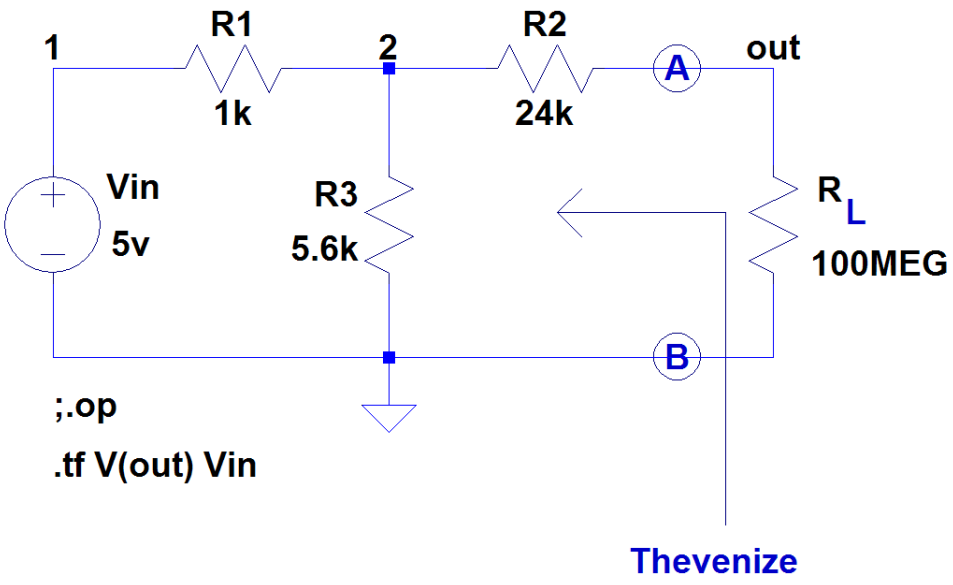

Figure 2. Resistive Circuit

Procedures

Part One

1. Construct the circuit of Figure 1. Acquire experimental data for each of the three cases of pre-laboratory step 1. Compare the experimental, simulated, and hand analysis results using a table:

case	experimental V_2	simulated V_2	analysis V_2	% error (experimental vs. simulated)	% error (experimental vs. analysis)
a					
b					
c					

2. Describe how the work of laboratory procedure step 1 provides an experimental example of the superposition theorem.

Part Two

3. Construct the circuit of Figure 2 and measure V_{AB} (node A is assumed positive with respect to node B) for three different values of R_L. Then find V_{AB} for each of the three R_L values using a hand analysis and SPICE. Tabulate your results in a manner similar to that used in laboratory procedure step 1.

4. Now construct the Thevenin equivalent of the circuit of Figure 2 using a variable resistor to realize R_{TH}. Find V_{AB} for each of the three values of R_L of laboratory procedure part 3 and compare results to the results of laboratory procedure step 3.

5. Explain how the results of laboratory procedure part 4 provide an experimental example of Thevenin's theorem.

Part Three

6. Experimentally determine the Thevenin output resistance of the lab station function generator.

Analysis

1. For a **fixed** R_{TH} maximum power is transferred from V_{TH} when $R_L=R_{TH}$. Using your SPICE engine, demonstrate that the converse is not true for the circuit of Figure 2, i.e. maximum power is not delivered to a fixed R_L by setting $R_{TH}=R_L$.

Credits and Copyright

Adapted from material developed by current and former ECE faculty, including Professor Joseph Kelemen. Thanks to Juan Ramirez for improvement to this lab.