EE301 (Spring 2009)
Laboratory Project 7 - Thevenin and Norton Circuits

Background

The goal of this lab is to demonstrate the validity of Thevenin's and Norton's theorems. These theorems are useful in analyzing complicated linear circuits by reducing them to a single independent source and resistor with respect to a pair of terminals where loads can be changed in and out.

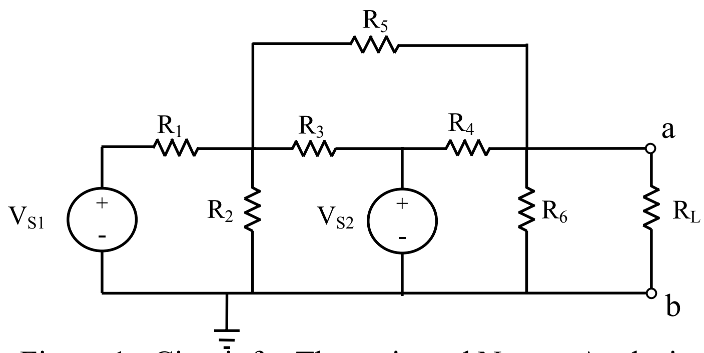

Figure 1: Circuit for Thevenin and Norton Analysis

Given:
R_1=470Ω
R_2=680Ω
R_3=1500Ω
R_4=1000Ω
R_5=1000Ω
R_6=680Ω

V_{S1}= 20 V
V_{S2}= 15 V

Preliminary

Let's suppose we are interested in determining the power dissipated by a load resistor R_L connected between terminals *a* and *b* in the circuit shown above.

1) Assuming R_L = 1000 Ω, use circuit analysis (e.g., nodal or mesh analysis) to find the voltage across and current through the load resistor. Then, calculate the power dissipated by the load resistor.

V_{RL}	
i_{RL}	
P_{RL}	

2) Next, remove the load resistor and calculate the equivalent resistance seen at terminals *a-b*. (Hint: set voltage sources to zero by replacing with a short). This equivalent resistance is the Thevenin R_T and Norton R_N equivalent resistances.
3) Then, with the voltage sources active, calculate the open circuit voltage V_{oc} seen at terminals *a-b*. This voltage is the Thevenin equivalent voltage V_T.
4) With the voltage sources active, calculate the short circuit current flowing from terminal *a* to terminal *b*. This current is the Norton equivalent current I_N. .

R_T	
V_T	
I_N	

5) Draw the Thevenin and Norton equivalent circuits.

6) If the load resistance is R_L = 1000 Ω in the Thevenin and Norton equivalent circuits, and find the voltage across and current through the load resistor. Also, calculate the power dissipated by the load resistor. Compare with the results in part 1).

V_{RL}	
i_{RL}	
P_{RL}	

7) Using either the Thevenin and Norton equivalent circuits, calculate the voltage across, current through, and power dissipated by the load resistor as it is varied R_L = 150, 330, 470, 680, 1k, 1.5k, and 2.2 kΩ.

Table For Thevenin Circuit Calculations

R_L	i_L	V_L	P_L
150 Ω			
330 Ω			
470 Ω			
680 Ω			
1000 Ω			
1500 Ω			
2200 Ω			

Table For Norton Circuit Calculations

R_L	i_L	V_L	P_L
150 Ω			
330 Ω			
470 Ω			
680 Ω			
1000 Ω			
1500 Ω			
2200 Ω			

Experimental

1) Build the circuit shown in the figure **without** the load resistor.
   a) Measure and record the equivalent resistance.
   b) Measure and record the open circuit voltage.
   c) Measure and record the short circuit current.

R_T	
V_T	
I_N	

2) Measure and connect a 1000 Ω load resistance. Measure the voltage across and current through the load resistor. Then, calculate the power dissipated by the load resistor.

R_L	
V_{RL}	
i_{RL}	
P_{RL}	

3) Build the Thevenin equivalent circuit and repeat 2) for R_L = 150, 330, 470, 680, 1k, 1.5k, and 2.2 kΩ. Record results in table.

$\mathbf{R_L}$	$\mathbf{i_L}$	$\mathbf{V_L}$	$\mathbf{P_L}$
150 Ω			
330 Ω			
470 Ω			
680 Ω			
1000 Ω			
1500 Ω			
2200 Ω			

4) Build the Norton equivalent circuit and repeat 2) for R_L = 150, 330, 470, 680, 1k, 1.5k, and 2.2 kΩ. Record results in table.

$\mathbf{R_L}$	$\mathbf{i_L}$	$\mathbf{V_L}$	$\mathbf{P_L}$
150 Ω			
330 Ω			
470 Ω			
680 Ω			
1000 Ω			
1500 Ω			
2200 Ω			

Post-Lab

1) Plot power versus resistance for the measured results. Keeping in mind maximum power transfer, discuss your results. At what load resistance was the power transfer maximum?

2) Did the Thevenin and Norton Equivalent circuits produce the same voltages across and currents through the load resistor?