Thevenin's Theorem Lab Procedure

Instructional Objectives

1. To work through the procedural steps involved in Thevenin's theorem.
2. To verify the values obtained by measuring them using the digital multimeter.
3. To construct a Thevenin equivalent circuit.

Procedure

0. Parts: 1-3.3KΩ, 1-6.2KΩ and 1-8.2KΩ.

We will run through 12 steps to use Thevenin's theorem to find the current through R3 shown in Fig. 5.

1. Building the circuit and doing measurements:

a. Measure R1, R2 and R3 using Digital Multi Meter (DMM)

R1 = ___3.262___KΩ, R2 = _____8.115___KΩ, R3= __6.109____KΩ

b. Connect the power supply to deliver 5V DC to the breadboard.

c. Build the circuit as shown in Figure 5.

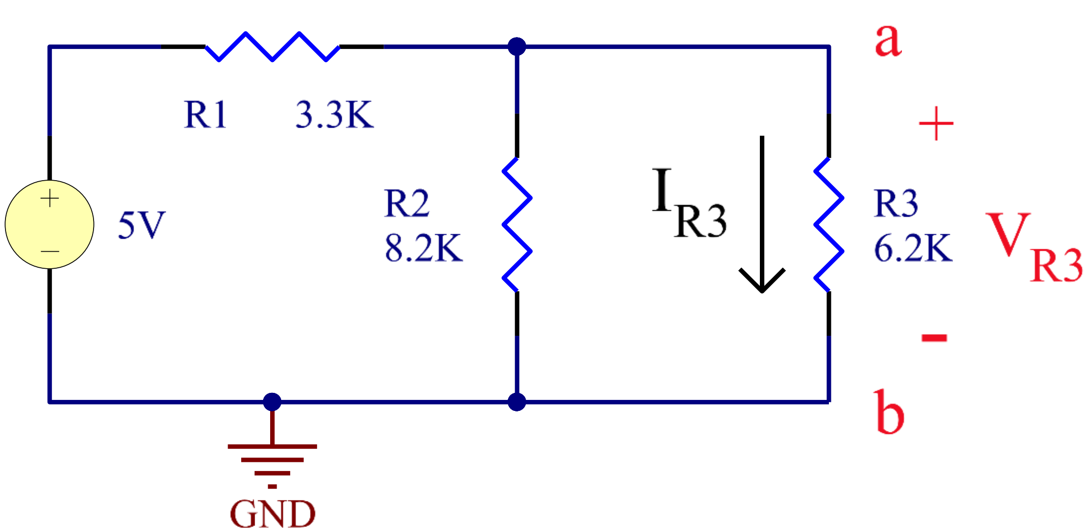

Figure 5

d. Measure the voltage across R3 (V_{R3}) using the DMM. Record the voltage and use the measured value of R3 to **Calculate** I_{R3}:

V_{R3} = ______2.5845_____V $I_{R3} = V_{R3} / R3$ = ______0.00042306_____A

2. Analyzing the circuit.

a. Referring to Fig. 6, which is Fig. 5 with R3 removed, calculate V_{TH} for Fig.6, **showing all work.**

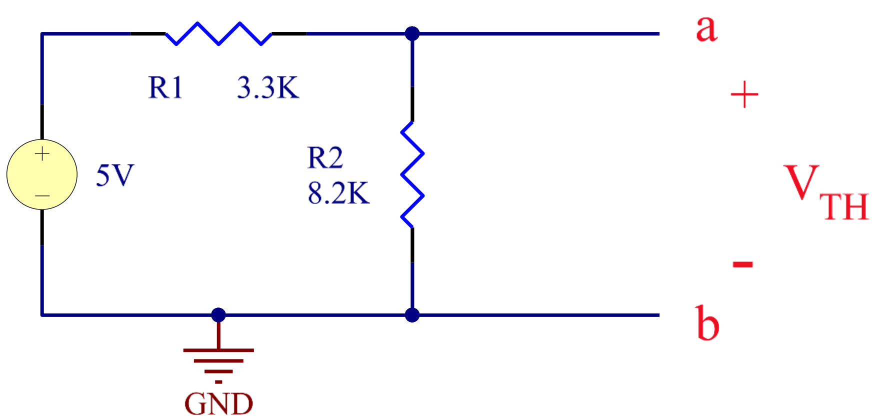

Figure 6

Vth = R2 / (R1+R2) * Vs = 8.2 KΩ / (3.3 KΩ + 8.2 KΩ) * 5V = 3.565V

b. V_{TH} = ________3.565V______(calculated)

c. Verify the real Thevenin equivalent voltage by measurement. Construct the circuit shown in Fig.6. Measure and record V_{TH}.

V_{TH} = __________3.2601V________(measured)

3. Measuring R_{TH} by removing the source and replacing it with a short circuit.

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a. Construct the circuit in Fig. 7, which is the circuit in Fig. 5 with R3 removed and the 5V source replaced by a short circuit (R_{SOURCE} assumed 0).

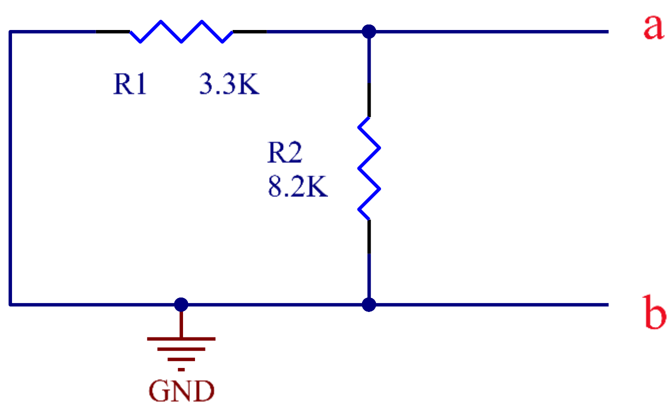

Figure 7

b. Calculate R_{TH} in Fig. 7, **showing all work.**

Rth = R1 || R2 = 1/(1/3.5 KΩ + 1/8.2 KΩ) = 2.353 KΩ

R_{TH} = __________2.353 KΩ _______(calculated)

c. Verify your R_{TH} calculation by measurement. Connect the circuit in Fig. 7.Measure and record the equivalent resistance (R_{TH}) measured between terminals A and B.

R_{TH} = __________2.125 KΩ ________(measured)

4. Drawing the Thevenin equivalent circuit.

a. Draw the Thevenin equivalent circuit and use your calculated values for V_{TH} and R_{TH}. **Label this Fig. 8.** You can use LTSpice or any other program to draw the circuit. Even a photo of a hand drawn picture.

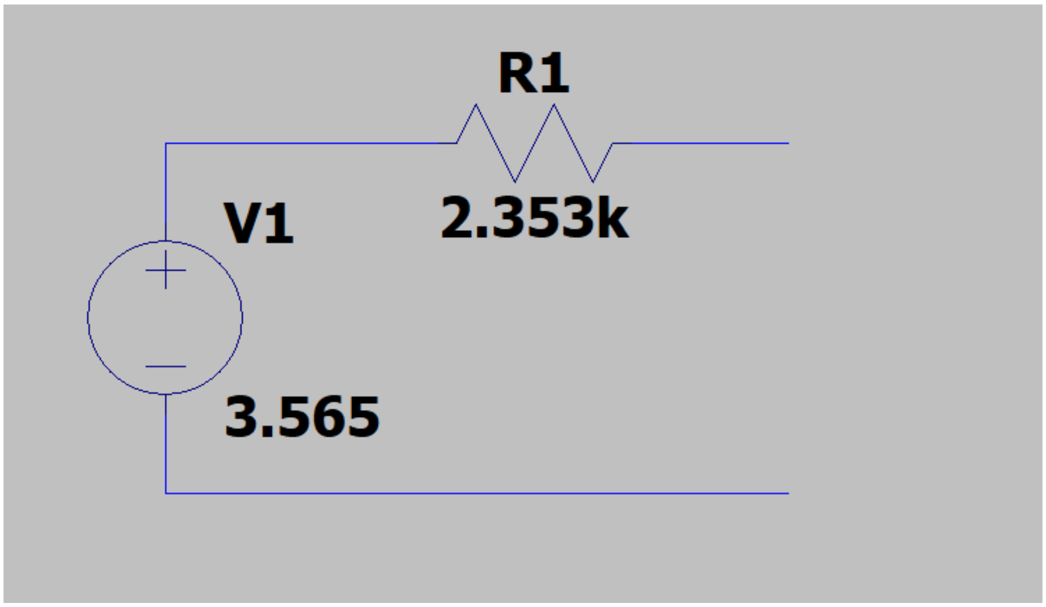

Figure 8

b. With the Thevenin equivalent circuit loaded with R_3, calculate I_{R3} using the Thevenin equivalent circuit from Fig. 8.

$$I_{R3} = \frac{V_{TH}}{R_{TH} + R3} = 3.565V / (2.353\ K\Omega + 6.2\ K\Omega) = 0.4168mA \quad (6)$$

c. Compare the current calculated in procedure 1.d and the current calculated in procedure 4.b.Find the reasons for any discrepancy.

The calculated current from 1d is 0.4168mA, which is close to the measured value 0.42306mA. The discrepancy could be due to factors like: non-ideal devices and components, different experiment environment (temperature, humidity).

5. Building Thevenin equivalent circuit

a. Build the circuit of Fig. 8. Obtain resistance for R_{TH} as close as possible to its calculated value. Hint 2 resistors in parallel is 'real close'.

b. Measure the value of R_{TH} and V_{TH} using the DMM.

R_{TH} = ______2.125K______Ω V_{TH} = ______3.2601______V

******* Load the Thevenin equivalent circuit with R3. *******

c. Measure the voltage across R_{TH} , (V_{RTH} not V_{TH}).

V_{RTH} = ______0.841_______ V

d. Measure the voltage across the load resistor R_3 (V_3)

V_{R3} = _______2.5831______ V

e. Calculate the current through R_{TH} and R3 using measured values of V_{TH}, R_{TH} and R3 (The resistors are in series so the same current flows through each of them).

$I = I_{R3} = V_{RTH} / R_{TH} = V_{TH}/(R_{TH}+R_3)$ ______0.3959______mA

f. Compare these measured results with the results of steps 4. Find the reasons for any discrepancies.

The discrepancy could be due to factors like: non-ideal devices and components, different experiment environment (temperature, humidity).

g. Compare the current calculated in procedure 1.d and the current calculated in procedure 5.e. Find the reasons for any discrepancy
   The calculated current from 0.3959mA, which is relatively close to the measured value 0.42306mA. The discrepancy could be due to factors like: non-ideal devices and components, different experiment environment (temperature, humidity).

6. Complex Thevenin equivalent circuit

In this step, you are required to apply the Thevenin theorem to a more complicated circuit.

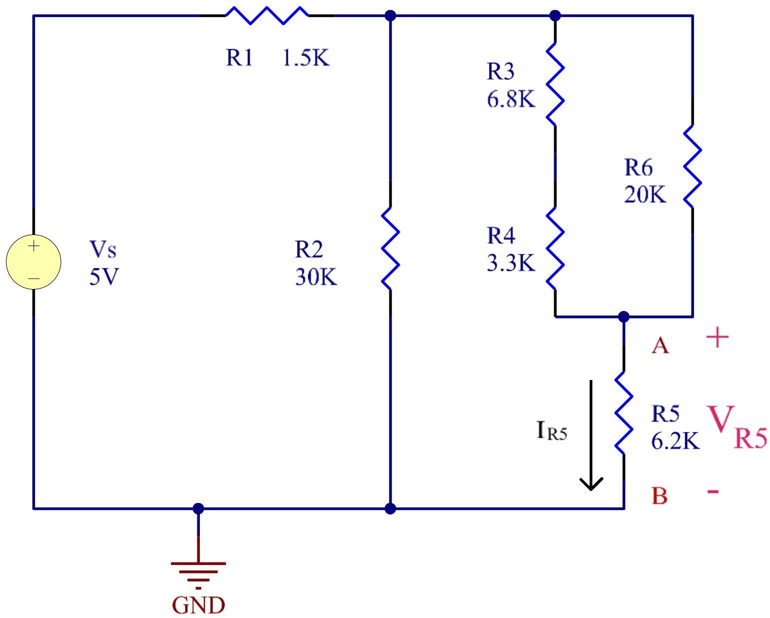

Figure 9

Using procedure explained in the theory section, calculate the value of V_{TH} and R_{TH} for the circuit shown in Figure 9. Use R5 as the load resistance (i.e. R5 is removed for calculating the value of R_{TH} and V_{TH}). You can use the LTSpice simulator to check your Thevenin equivalents for this circuit if you want to.

a. V_{TH} = __4.762____V

b. R_{TH} = ___8.140___KΩ

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7. Calculate the value of I_{R5} using Thevenin Equivalent Circuit

IR5 = Vth / (Rth + Rs) = 4.76V / (8.14 KΩ + 6.2 KΩ) = 0.332mA

a. I_{R5} = ___0.332___mA

8. Implement the Thevenin Equivalent Circuit on the proto board and measure the voltage across R5 as shown in Figure 10. Pick the closest 5% resistor for R_{TH}.

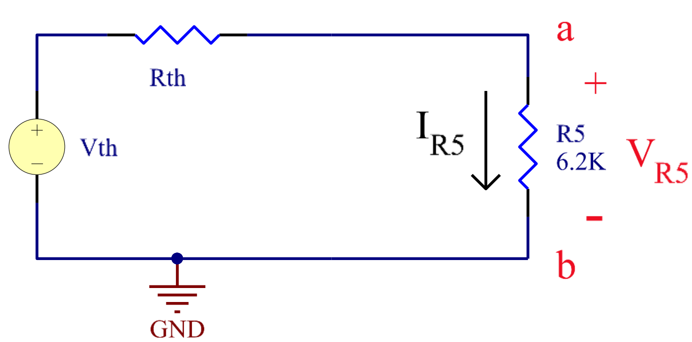

Figure 10. Thevenin equivalent of Circuit in Fig.8.

a. V_{R5} (Measured) =___2.1475___V, $I_{R5} = V_{R5} / R_5$ = ___0.3515___mA

b. Does the value of I_{R5} match the calculated value in Part 7a?
Yes

Post Lab Questions

1. What is meant by the word "equivalent" in Thevenin Equivalent circuits?

   The word “equivalent” means the I-V characteristic of the circuit at two terminals is identical to the original circuit at two terminals.

2. What is the practical value of Thevenin Equivalent circuits? Give several practical applications in which Thevenin Equivalent circuits are used.

   The practical value of Thevenin equivalent circuit is to simplify a complicated circuit into an identical circuit with less circuit components, which could be helpful for us when analyzing a linear circuit.