**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**

1. 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**:
   1. Measure R1, R2 and R3 using Digital Multi Meter (DMM)

R1 = \_\_\_\_*3.263*\_\_\_\_KΩ, R2 = \_\_\_\_*8.143*\_\_\_\_\_KΩ, R3= \_\_\_*6.117*\_\_\_\_\_\_KΩ

* 1. Connect the power supply to deliver 5V DC to the breadboard.
  2. Build the circuit as shown in Figure 5.



Figure 5

* 1. Measure the voltage across R3 (VR3) using the DMM. Record the voltage and use the measured value of R3 to **Calculate** IR3:

VR3 = \_\_\_\_\_\_*2.582*\_\_\_\_\_\_\_\_\_\_\_\_\_V IR3 = VR3 / R3 = \_\_\_\_\_\_*4.22e-4*\_\_\_\_\_\_\_\_\_\_\_\_A

1. **Analyzing the circuit**.
   1. Referring to Fig. 6, which is Fig. 5 with R3 removed, calculate VTH for Fig.6, **showing all work.**

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Figure 6

***Vth = VS \* R2 / (R1+R2) = 5 \* 8.2 / (3.3 + 8.2) = 3.565V***

* 1. VTH = \_\_\_\_\_\_\_\_\_*3.565V*\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_(calculated)
  2. Verify the real Thevenin equivalent voltage by measurement. Construct the circuit shown in Fig.6. Measure and record VTH.

VTH = \_\_\_\_\_\_\_\_\_\_\_*3.565V*\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_(measured)

1. **Measuring RTH by removing the source and replacing it with a short circuit.** 
   1. 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 (RSOURCE assumed 0).

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### Figure 7

* 1. Calculate RTH in Fig. 7, **showing all work.**

***Rth = R1 || R2 = (1/3.5 + 1/8.2) ^-1 = 2.353kOhm***

RTH = \_\_\_\_\_\_\_\_*2.353kOhm*\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_(calculated)

* 1. Verify your RTH calculation by measurement. Connect the circuit in Fig. 7.Measure and record the equivalent resistance (RTH) measured between terminals A and B.

RTH = \_\_\_\_\_\_\_\_\_\_\_\_*2.331kOhm*\_\_\_\_\_\_\_\_\_\_\_\_\_(measured)

1. **Drawing the Thevenin equivalent circuit.**
   1. Draw the Thevenin equivalent circuit and use your calculated values for VTH and RTH. **Label this Fig. 8.** You can use LTSpice or any other program to draw the circuit. Even a photo of a hand drawn picture.

图示

描述已自动生成

Figure 8

* 1. With the Thevenin equivalent circuit loaded with R3, calculate IR3 using the Thevenin equivalent circuit from Fig. 8.

* = 3.565V / (2.353kOhm + 6.117kOhm) = 4.21e-4A*

* 1. 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 4.22e-4A, close to the current calculated from 4.21e-4A. The discrepancy could be caused by: non-ideal devices and components; different environment (temperature, humidity) when measuring data.*

1. **Building Thevenin equivalent circuit**
   1. Build the circuit of Fig. 8. Obtain resistance for RTH as close as possible to its calculated value. Hint 2 resistors in parallel is ‘real close’.
   2. Measure the value of RTH and VTH using the DMM.

RTH = \_\_\_\_\_\_\_\_\_*2.353k*\_\_\_\_\_\_\_\_\_\_\_Ω VTH = \_\_\_\_\_\_\_*3.562*\_\_\_\_\_\_\_\_\_\_\_\_\_\_V

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

* 1. Measure the voltage across RTH , (VRTH not VTH).

VRTH = \_\_\_\_\_\_\_*0.983*\_\_\_\_\_\_\_\_\_\_\_\_ V

* 1. Measure the voltage across the load resistor R3 (V3)

VR3 = \_\_\_\_\_\_\_\_*2.578*\_\_\_\_\_\_\_\_\_\_\_ V

* 1. Calculate the current through RTH and R3 using measured values of VTH, RTH and R3 (The resistors are in series so the same current flows through each of them).

I= IR3 = VRTH / RTH=VTH/(RTH+R3) \_\_\_\_\_\_\_\_*0.421*\_\_\_\_\_\_\_\_\_\_\_\_\_mA

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

*The discrepancy could be caused by: non-ideal devices and components; different environment (temperature, humidity) when measuring data.*

* 1. Compare the current calculated in procedure 1.d and the current calculated in procedure 5.e. Find the reasons for any discrepancy

*The calculated value is the same as the measured result, which is equal to 0.421mA. The discrepancy could be caused by: non-ideal devices and components; different environment (temperature, humidity) when measuring data.*

1. **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 VTH and RTH for the circuit shown in Figure 9. Use R5 as the load resistance (i.e. R5 is removed for calculating the value of RTH and VTH). You can use the LTSpice simulator to check your Thevenin equivalents for this circuit if you want to.

* 1. VTH = \_\_\_\_4.762\_\_\_\_\_V
  2. RTH = \_\_\_\_8.140\_\_\_\_\_KΩ

1. Calculate the value of IR5 using Thevenin Equivalent Circuit

*IRS = Vth / (Rth + Rs) = 4.76V / (8.14kOhm + 6.2kOhm) = 0.332mA*

* 1. IR5 = \_\_\_\_\_*0.332*\_\_\_\_\_mA

1. 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 RTH.



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

* 1. VR5 (Measured) =\_\_\_*2.062*\_\_\_\_\_\_\_V, IR5 = VR5 / R5 = \_\_\_\_\_*0.332*\_\_\_\_\_mA
  2. Does the value of IR5 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.*

1. 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 simply a complicated circuit into an identical circuit that can use less circuit components; it can also help us to analyze a linear power system.*