Electronics – Physics 242

Experiment 1 – Resistive Networks: Voltage Divider and Thevenin Equivalent Circuit

Introduction

The voltage divider is one of the simplest and most useful circuit components. We will explore the effect of varying the load resistance connected to the voltage divider consisting of fixed resistors. Next we will replace the voltage divider by its Thevenin equivalent and test Thevenin's theorem experimentally.

Procedure and Questions

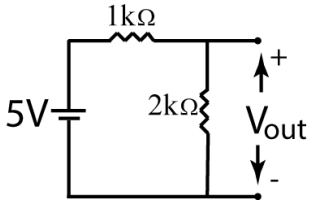

Figure 1.

1. Use the DMM (digital multimeter) configured as an ohmmeter to measure the resistance of a nominally 1 kΩ and 2 kΩ resistor. Then build the voltage divider circuit shown above. Measure the input and output voltages with the DMM. The input voltage is across the 5V source; the output voltage is across the 2 kΩ resistor. Do your results agree with the voltage divider formula? Explain.

2. Measure the resistances of the following resistors with the DMM: 100 kΩ, 10 kΩ, 5.1 kΩ, 2 kΩ, and 1 kΩ. Then, one at a time, connect each resistor as a "load resistor" across the output of your voltage divider (that is, in parallel with the 2 kΩ resistor shown in Fig. 1), and measure the output voltage. Present your data as a table.

3. Make a plot of $\frac{V_i}{V_o}$ vs. $\frac{1}{R_L}$. Describe how your plot is or is not consistent with the voltage divider formula. To do this, first note that the voltage divider formula can be rearranged in the form $\frac{V_i}{V_o} = \frac{1}{R_L} + \frac{3}{2}$, for the case where the resistors are exactly 1 kΩ and 2 kΩ. You should derive a similar equation using your measured resistance values (show all the steps). Then compare the shape, slope, and *y*-intercept of your plot with the theoretical relation you have derived.

4. Explain briefly: Why does the output voltage sag when the load resistance is small?

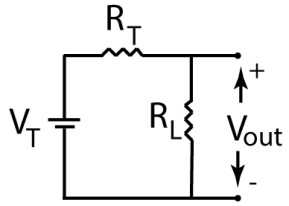

Figure 2.

5. Solve for the Thevenin equivalent of the original voltage divider circuit (with no load resistor, shown in Figure 1). Then set up the Thevenin equivalent circuit on your breadboard (Figure 2 above, with no load resistor). Use one of the variable voltage outputs (0 – 15 V adjustable) to match the Thevenin voltage V_T. Use a potentiometer (variable resistor) to match the Thevenin series resistance R_T. Then successively connect each of the load resistors used previously to the output of your Thevenin equivalent circuit (as shown in Figure 2), and measure the load voltage. How well do the values agree with the ones obtained earlier (in Procedure 2)? Do your results support Thevenin's theorem? Explain briefly.