PHYSICS 220 Physical Electronics

Lab 2: Voltage Divider

Object: To experimentally verify the voltage divider relation.

Apparatus: Tektronix TDS2004B Four Channel Digital Storage Oscilloscope, HP 200CD Oscillator, Fluke 73 Digital Multimeter, Circuit Chassis with 10 kΩ Potentiometer, Resistor, Coaxial Cables with BNC Connectors and BNC 'T'.

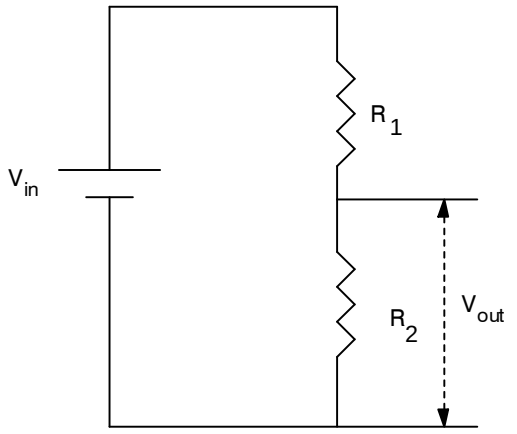

Fig. 1: Voltage divider circuit

Introduction: The voltage divider relation was derived in class for the D.C. circuit shown in Fig 1:

$$\frac{V_{out}}{V_{in}} = \frac{R_2}{R_1 + R_2} \qquad (1)$$

In this laboratory exercise we will use an A.C. input voltage from the HP 200CD Oscillator. As long as the frequency is not too high (where stray capacitance would begin to affect the circuit's behavior) Eq. 1 can be used to predict the ratio of the output to input *amplitudes*.

Exercise:

1. **Theory:** Reproduce the derivation of the voltage divider relation in your laboratory notebook. This relation constitutes the theoretical prediction for this lab.
2. **Variable Resistor and Digital Multimeter**: Identify the 10 kΩ potentiometer (or "pot") in your circuit chassis. Use the Fluke 73 Digital Multimeter (DMM) in resistance measuring mode to investigate the properties of this device. Connect the DMM leads to the end terminals of the pot and observe the resistance. This value should *not* depend on the position of the knob. Next connect the DMM leads such that one is connected to the center terminal (the sliding contact) and the other to one of the end terminals. Now observe that you can vary the resistance

between these two points depending on the position of the knob. This is how you are going to change R_2 in the voltage divider circuit.

3. **Circuit Layout:** Discuss with your lab partner(s) how you plan to construct the circuit shown in Fig. 2, part of which will include soldered connections inside the circuit chassis and part of which will be coaxial cables from/to the oscillator, oscilloscope and circuit chassis. Notice that you can solder to the center conductor on the back side of the BNC connectors mounted on the circuit chassis in to bring signals into or out of the chassis. The oscilloscope should be connected such that you can monitor the input (on channel 1) and output (on channel 2) voltages simultaneously.

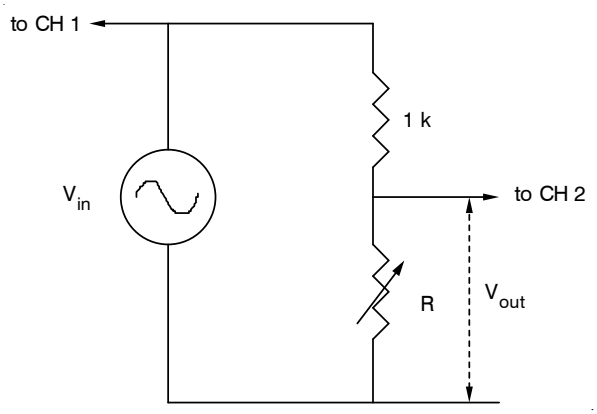

Fig. 2: Voltage divider circuit with A.C. input voltage and variable resistor.

4. **Construct the Circuit**: Using appropriate precautions (*e.g* eye protection) solder the 1 kΩ resistor and the necessary pieces of wire into the circuit chassis to construct the circuit. Connect the oscillator and oscilloscope to complete the circuit. Have your instructor check your circuit before proceeding.
5. **Test the Circuit**: Set the oscillator to produce a 1 kHz sine wave with 1.0 V amplitude. This is V_{in}. Observe qualitatively how the output voltage varies as you change the value of the R_2. Also note how the input voltage changes as you change the load resistance connected to the oscillator. This is because the oscillator has internal (or output resistance). More on this later in the course.
6. **Collect Data:** For a range of settings on the potentiometer measure (1) the input voltage, (2) the output voltage, and (3) the value of R_2. In order to get an accurate measurement of the resistance with the DMM, disconnect the coaxial cable from the output of the circuit when you connect the DMM leads to the pot terminals.
7. **Graph and Analyze the Data:** Graph the results of your measurements on a log-log graph (V_{out}/V_{in} vs R_2) in your notebook. Do you understand the behavior at large and small values of the resistance? Do the results match the predicted behavior for a voltage divider circuit?
8. **Possible Extension:** Can you make a voltage divider using only the potentiometer (without the fixed resistor)?