2.4 Laboratory Procedure / Summary Sheet

Group: ____ Names: ____________________________ ________________________________

____________________________ ________________________________

(1) Select five separate resistors whose nominal values are listed below. Record the band colors for each resistor in the table below. Then connect each resistor to the multimeter using alligator clips and record the measured value for each resistor.

Resistor	Band Colors	Measured Value (Ω)
R_1: 1kΩ		
R_2: 1kΩ		
R_3: 2kΩ		
R_4: 1MΩ		
R_5: 1MΩ		

Make sure you keep track of each of the five resistors (e.g., by laying them out in order on the table with labels, or in the breadboard).

(2) Now construct the voltage divider circuit shown using resistors R_1 and R_2 listed above and set V_i to 10 Vdc using the DC power supply. **When using a power supply or function generator, always adjust the supply voltages before making connections to the circuit. Also be very careful to check that the power and ground leads are not touching when power is applied. This creates a short that can blow a fuse or damage the device.**

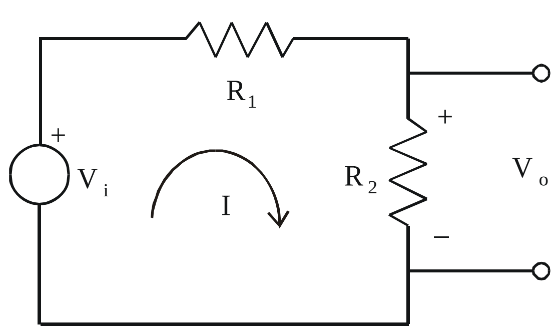

Figure 2.12 Voltage Divider Circuit

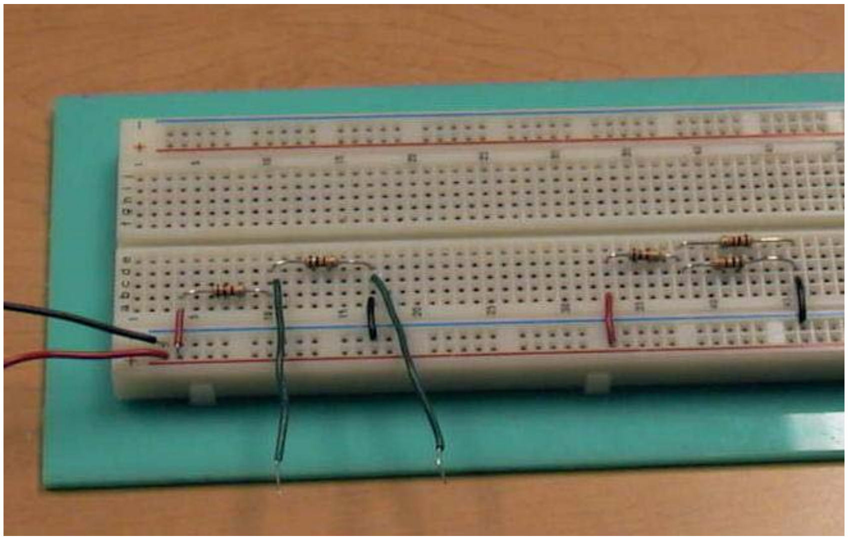

Figure 2.13 Breadboard layout for voltage divider (left) and current divider (right)

After reading all of the information below, complete the table at the top of the next page by measuring or calculating the appropriate values. In your calculations, use the actual (measured) values for R_1 and R_2.

For information on how to use the oscilloscope, see the "instrumentation for powering and making measurements in circuits" video on the Lab Book website (mechatronics.colostate.edu/lab_book.html) and refer to the "How to Find a Signal on an HP54602A Oscilloscope" procedure in Section 3.4.9 of Lab 3.

Note – Make sure you always have a common ground attached to your power supply, circuit, and o-scope when taking voltage measurements with the o-scope.

Remember from Lab 1, to measure current with the multimeter, you must put the meter in series with the element of interest. So to measure the current through the resistors R_1 and R_2, you must pull out the connected ends of R_1 and R_2 and attach the meter probes between the exposed ends.

Note – Be very careful when using the ammeter feature of the multimeter. If you don't place the meter in series with an element, and you put the leads across an element instead, you can burn out the meter's fuse and/or damage the device.

For circuit trouble-shooting advice, please refer to Section 2.3.

Data for the circuit and instructions on the previous two pages:

	Input Voltage V_i (V)	**Output Voltage V_o (V)**	**Current (mA)**
Calculated	10 V		
Multimeter			
Oscilloscope			*

* compute the current using the voltage value measured

(3) Repeat part 2 using the same resistors R_1 and R_2 but using the function generator to drive the circuit at 1KHz with a 3V amplitude (6V peak-to-peak) sine wave. See the video demonstrations on the Lab Book website to see how everything is connected. If an error message appears on the function generator display during power up, just press any button and wait briefly for the message to clear.

NOTE - If using the Philips PM5193 function generator, be sure to connect to the lower "OUTPUT" jack (not the upper "TTL OUT" jack).

Complete the table below by measuring or calculating the appropriate values. In your calculations, use the actual (measured) values for R_1 and R_2. Use rms values for all table entries. **Be aware that the Lab multimeters cannot detect or measure small I_{rms} currents accurately.**

	Input Voltage (V_{rms})	**Output Voltage (V_{rms})**	**Current (I_{rms} in mA)**
Calculated	$\frac{3V}{\sqrt{2}}$		
Multimeter			*
Oscilloscope			*

* compute the current using the voltage value measured

(4) Repeat part 2 (V_i = 10 Vdc) using R_4 and R_5 in place of R_1 and R_2. In this case, the impedances of the instruments are close in value to the load resistances and therefore affect the measured values. Sketch the equivalent circuit for the instruments (voltage supply, and voltmeter or oscilloscope) and the attached circuit. Use this schematic to explain differences between actual (measured) and theoretical values.

Complete the table below by measuring or calculating the appropriate values. In your calculations, use the actual (measured) values for R_4 and R_5.

	Input Voltage (V)	**Output Voltage (V)**	**Current (mA)**
Calculated			
Multimeter			
Oscilloscope			*

*** compute the current using the voltage value measured**

(5) Construct the current divider circuit shown below using resistors R_1, R_2, and R_3 listed in part 1. Set the source V to 6 Vdc.

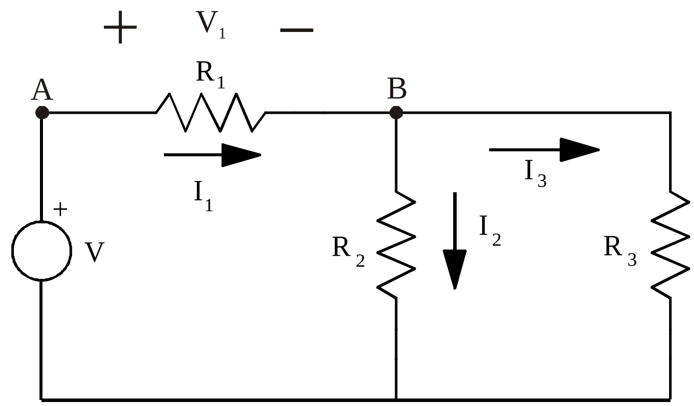

Figure 2.14 Current Divider Circuit

Complete the table below by measuring or calculating the appropriate values. In your calculations, use the actual (measured) values for R_1, R_2, and R_3.

	I_1 (mA)	**I_2 (mA)**	**I_3 (mA)**
Calculated			
Multimeter			
Oscilloscope	*	*	*

* **Compute the current using the voltage values measured. See Section 3.2.4 in the next Lab for more information on how to measure the voltage across R_1. Alternatively, measure the voltages at nodes A and B (relative to ground) and manually subtract the values.**

(6) Repeat part 5 with a 3 V amplitude 500 Hz sine wave ($V = 3\sin(1000\pi t)$).

Complete the table below by measuring or calculating the appropriate values. In your calculations, use the actual (measured) values for R_1, R_2, and R_3. Use rms values for all table entries.

	I_{1rms} (mA)	I_{2rms} (mA)	I_{3rms} (mA)
Calculated			
Multimeter	*	*	*
Oscilloscope	*	*	*

*** compute the current using the voltage value measured**

Normally, the input impedance of a meter or the output impedance of a source can be neglected and very little error will result. However, in some applications where the impedances of the instruments are of a similar magnitude to those of the circuit, serious errors will occur.

LAB 2 QUESTIONS

Group: ____ Names: ___________________________ ________________________________

___________________________ ________________________________

(1) Describe how you read resistor values and tolerances.

(2) Derive formulas, using the voltage divider and current divider rules, for the following voltage and current in Figure 2.14, using V, R_1, R_2, and R_3 only.

V_1 = ___________________________ I_3 = ____________________________

(3) From the data collected in Part 4, calculate the input impedance of the oscilloscope and the voltmeter.

Z_{in} (scope) = ___________________________

Z_{in} (DMM) = ___________________________

Hint: Use Equations 2.22 and 2.23. Also, if using the attenuator probe, be sure to account for the probe's impedance (see Section 3.3 in Lab 3).

(4) The AC wall outlet provides 110 V_{rms} at 60Hz. Sketch and label one period of this waveform.

(5) Using a function generator and three 1 kΩ resistors design a circuit that will supply both a 6V p-p output and a 2V p-p output. Show your work below.