

Physics 517/617 Experiment 1
Instrumentation and Resistor Circuits

1) Study the operation of the oscilloscope, multimeter, power supplies, and wave generator. For the oscilloscope you should try to understand the function of all the knobs or buttons on the front panel. Some buttons may have several functions and some of the functions will not be relevant for this class. Try to follow the examples in p. 38-42 of the instruction manual.

2) Verify Ohm's law by measuring and then plotting voltage vs. current for a resistor. Fit your graph(s) to extract the measured resistance. Use a resistor of your choice. Repeat the measurement with a resistor of a much higher value (e.g. 10-100X) than your previous choice. Use a DC power supply for the circuit.

3) Measure the DC resistance of your multimeter (on voltage scale) using a resistor divider, which consists of two resistors in series with one of them being the multimeter resistor. How does your measurement of the multimeter's resistance compare to the specs of the meter?

Note: You do not need to measure the current in this experiment.

4) The RMS (Root Mean Square) value of a voltage (or current) is defined as

$$V_{RMS} = \sqrt{\frac{1}{T} \int_0^T V^2 dt}$$

Show that $V_{RMS} = V_0 / \sqrt{2}$ for a sine wave voltage, $V = V_0 \sin \omega t$.

Note: The multimeter only measures the RMS value of a voltage or current.

5) This exercise is intended to make you familiar with some of the very useful functions of the oscilloscope. Send a 1 kHz sine wave with an amplitude of 1 V and DC offset of 1 V into the scope. Use **DC coupling** between the scope and the function generator (See p. 109 & 110 of the instruction manual for definitions of DC and AC couplings. Push the CH1 or CH2 MENU button and change the coupling on the menu.)

a) Calculate the expected RMS voltage.

b) Use the "MEASURE" button to measure the following quantities: mean, RMS voltage, peak-to-peak voltage, period, and frequency. Do the measured quantities agree with the expectations?

c) Use the "CURSOR" button to position the two cursors to measure the peak-to-peak voltage and period. Do the measured quantities agree with the expectations?

d) Measure the RMS voltage with an **AC coupling** between the scope and the function generator. Does the measured RMS voltage agree with the expectation?

6) Repeat part 2) using a 10 Hz (or as low frequency as practical) sine wave. Repeat measurements using a much higher (e.g. 1 kHz) frequency sine wave. Any frequency dependence for R?

Note: Use a multimeter for the current measurement and an oscilloscope for the voltage measurement. All of our multimeters measure current and voltage over a limited frequency range. Check the spec sheet for your meter's usable frequency range.

7) Design and build a circuit with the following specs:

- a) four or more different resistors
- b) resistors in series and parallel
- c) circuit draws between 10 and 50 milliamps when connected to 5 V DC.

Calculate and measure the voltage drop and current through each element in the circuit.

8) Use the oscilloscope to check the frequency calibration of your function generator. Start at about 10 Hz and go up to the highest frequency available. Present your results in a log-log plot.

Advanced Experiments for Physics 617

1) Measure the input impedance of your oscilloscope. Determine the effective values of R and C and compare with the scope's specs. Use a resistor divider to measure R and a capacitor divider to measure C.

2) Build a Wheatstone bridge. Measure the resistance of 3 resistors with your bridge. What limits the accuracy of your Wheatstone bridge?