Introductory Lab

PHYS296

Name________________________ **Lab section**____________________

Lab partner's name(s)____

Objective

This lab is designed for you to learn how to use the ***750 interfac*e** and ***Data Studio***. The ***750 interface*** is the interface between the computer and the experimental setup. In PHYS 296, you use the analog output jack(s) to supply DC and/or AC voltage for various experiments and use the analog input channels to measure voltage, current, charge, magnetic field, and temperature through corresponding sensors. ***Data Studi*o** is the program for conducting experiments and analyzing data. For instance, you use it to set and send signal to the ***750 interface***, collect data from the ***750 interface***, and record and analyze data. In order to perform well in PHYS 296, you must be familiar with the basic procedures of using the ***750 interface*** and ***Data Studio***. Today's lab is an introduction to those procedures.

750 Interface

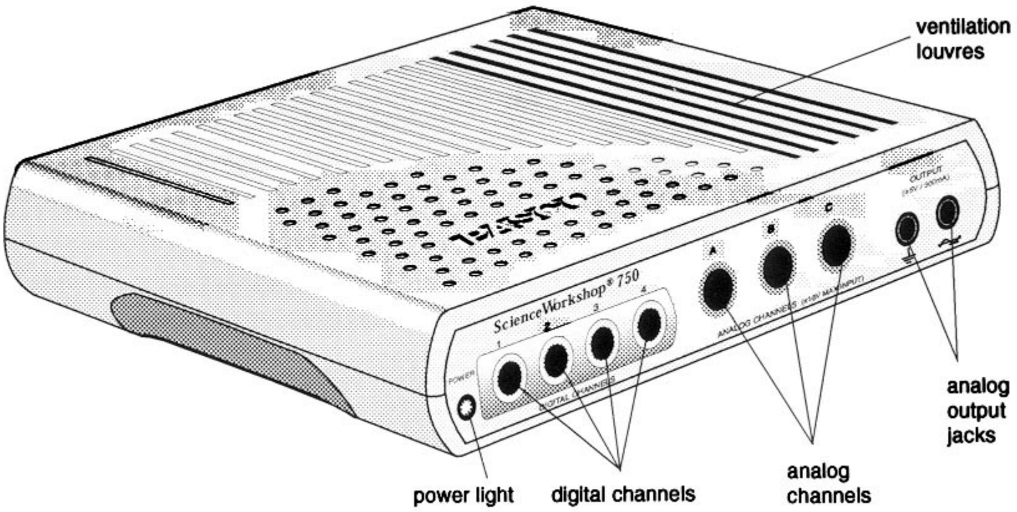

Figure 1 The picture of ***750 Interface***.

The ***750 interface*** is shown in Figure 1. It is connected to the computer through a USB connection and you should never disconnect it. The ***750 interface*** has three analog input channels, one analog output channel, and four digital input channels which are not used in PHYS 296.

(1) The analog input channels are used to measure voltage, current, charge, magnetic field, and temperature through corresponding sensors. **The maximum input voltage for the voltage sensor is *10* V! The maximum input current for the current sensor is *1.5* A!**

(2) The analog output channel is used to provide AC and DC voltage in many experiments. The DC voltage can be set in the range from +*5* to -*5* V. Eight AC waveforms are available with frequency from *1* mHz to *50* kHz and amplitude from *0* to *5* V.

(3) The digital input channels are not used in PHYS 296.

EXPERIMENT I
MEASURE VOLTAGE & CURRENT

In experiment I, you learn how to use the voltage sensor and the current sensor.

Procedures

Set up the Circuit

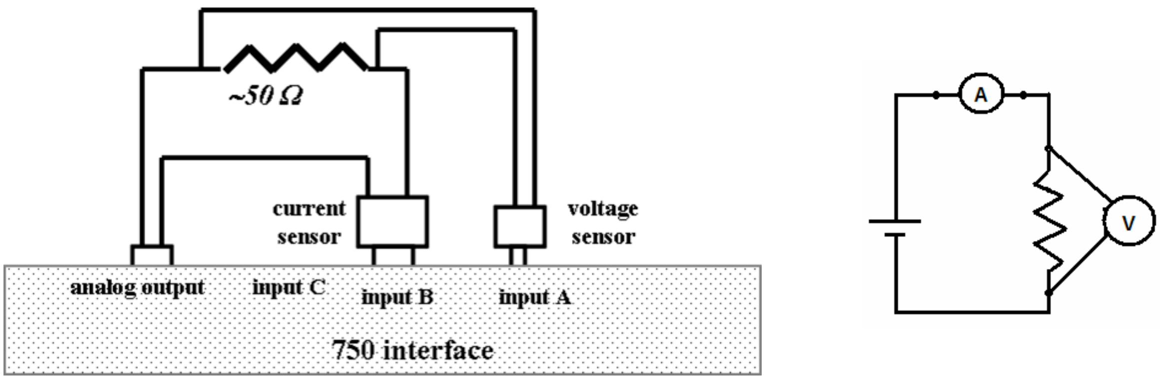

Figure 2 The schematic drawing of the circuit for Experiment I. The block diagram for the circuit is shown on the right.

1. Fig. 2 schematically displays the circuit you need to set up. Connect the current sensor and the voltage sensor to any analog inputs of the ***750 interface***. For example, as shown in Fig. 2, connect the voltage sensor to input A and connect the current sensor to input B. (Note: you can connect the voltage sensor and the current sensor to any analog inputs. But the following discussion corresponds to the setup shown in Fig. 2.)

2. As shown in Fig. 2, first connect the current sensor and the resistor (with resistance ~*50* Ω) in series and connect them to the analog output channel. Note that you should connect the ground of the output to the negative jack of the current sensor. Next, connect the voltage sensor in parallel with the resistor by using its two cables to the two jacks of the resistor, making sure that the positive end is connected to the positive end. In this experiment, the analog output channel supplies the voltage signal to the resistor. You use the voltage sensor to measure the voltage across the resistor and use the current sensor to measure the current flowing through the resistor. **Note: the voltage sensor is connected in parallel with the resistor and the current sensor in series with it!**

Set up Data Studio

3. Double click on the icon of ***DataStudio*** on the desktop to open the software and Click on "Create Experiment". As shown in Fig. 3, the DataStudio window displays the image of the ***750 interface***, a Data window, a Displays window, an Experiment Setup window, and two Menu bars on top.

4. Next, use DataStudio to establish connections to conform with the connections you just set up on the ***750 interface***. First, click on input Channel A to open “Add Sensor” window. Scroll down the menu bar and click on “the voltage sensor”. Click on “OK” to select. A “Voltage Sensor” icon is now displayed below input Channel A. Click on this icon to open “Voltage Sensor” Window which is displayed below “Experiment Setup” window. In “Voltage Sensor” Window, you can set Gain and Sample Rate. The sample rate is the rate of collecting data. Gain for the voltage sensor must be correctly set according to Table 1.

TABLE 1

Input Voltage Range	Sensitivity Setting
-10 V to *+10* V	Gain 1X
-1 V to *+1* V	Gain 10X
*-0.1*V to *+0.1* V	Gain 100X

5. Similar to step 4, use DataStudio to establish input Channel B for current sensor. First, click on input Channel B to open “Add Sensor” window. Click on “the current sensor”. Click on “OK” to select. A “Current Sensor” icon is now displayed below input Channel B. Click on this icon to open “Current Sensor” Window which is displayed below “Experiment Setup” window. In “Current Sensor” Window, you can set Gain and Sample Rate. Gain for the current sensor must be correctly set also according to Table 1, using the fact that the input voltage for the current sensor is its current multiplied by 1 ohm.

6. Next, use DataStudio to establish Output Channel. After clicking on the Output Channel icon, “Signal Generator” window is displayed on the right side. In “Signal Generator” Window, you can the output signal and set the amplitude and the frequency. In this window, nine different signals, including DC, Sine, and Square waves, can be selected. Now, set the output signal to “DC”. Next, select the desired voltage for the DC output, for example *2.00* V. Note: you should change the Gain level accordingly for the voltage sensor. To turn on the output, you can click on either the “on” button or the “auto” button. Once you click on the “on” button, the output is turned on. When you click on the “auto” button, the voltage output is turned on only when you start to record data. So you should choose the “auto” mode. The DC voltage can be set in the range from *+5* to *-5* V. Eight AC waveforms are available with frequency from *1* mHz to *50* kHz and the amplitude from *0* to *5* V. In “Signal Generator” window, the “Measurements and Sample Rate” menu allows you to set the sample rate for collecting data.

7. With ***DataStudio***, you can display data using different methods including digits, analog meter, graph, and scope. In “Displays” window, you can select the desired method. In Experiment I, use both the graph display and the digits display.

8. Double click on “Digits” icon to open the digital-meter display window. A window pops up to allow you to select what signal you want to display. Double click on “Graph” to open the graph display window. Again, a window pops up to allow you to select what signal you want to display. For the graph display, the default setting of the x-axis is to display time. Here, keep the default setting. Set the y-axis to display voltage from input Channel A. You can also drag the icon of the Ch A in “Data” window into the graph display window. This graph window is now set to display the voltage from input Channel A as a function of time. Similarly, add a second graph window to display the current from input Channel B as a function of time.

9. To start collecting data, clicking on the “start” button in DataStudio window. The digital meters will show the numerical values of the voltage and the current. The graph windows will display the voltage and the current versus time. Click on the “stop” button when you collect enough data.

10. Use the "Smart Tool" " (the 6th function in the top menu bar of Graph), which has a "Delta Tool" function to determine the X and Y coordinate differences between any two data points in a trace, such as to determine the time separation between two data points. Alternatively, you can determine the time separation manually. Ask the TA how to change the axis setting in order for you to see the data points more clearly.

Question

1. Both graphs display a horizontal line. Why are they the same shape graphs for both quantities, and why are the shapes horizontal lines? (Hint: think about Ohm's Law.)

11. Note that the time separation between two consecutive data points in the graph depends on the "sample rate" (Note: always use "Hz" as the unit) you set for the sensor. Note: one can set the sample rate using the "Signal Generator" window, or "Voltage Sensor" window, or "Current Sensor" window. Repeat the voltage and current measurements following procedures 9-10 using different sample rates. Record the sample rate and the corresponding time separation in Table 2.

TABLE 2

Sample Rate	Record the time separation between two consecutive data points (s)	
	Use the voltage data of Channel A	Use the current data of Channel B
1 Hz		
5 Hz		
10 Hz		
50 Hz		
100 Hz		

Question

2. Does the time separation between two consecutive data points in the graph increase as the sample rate increases? Explain your observation.

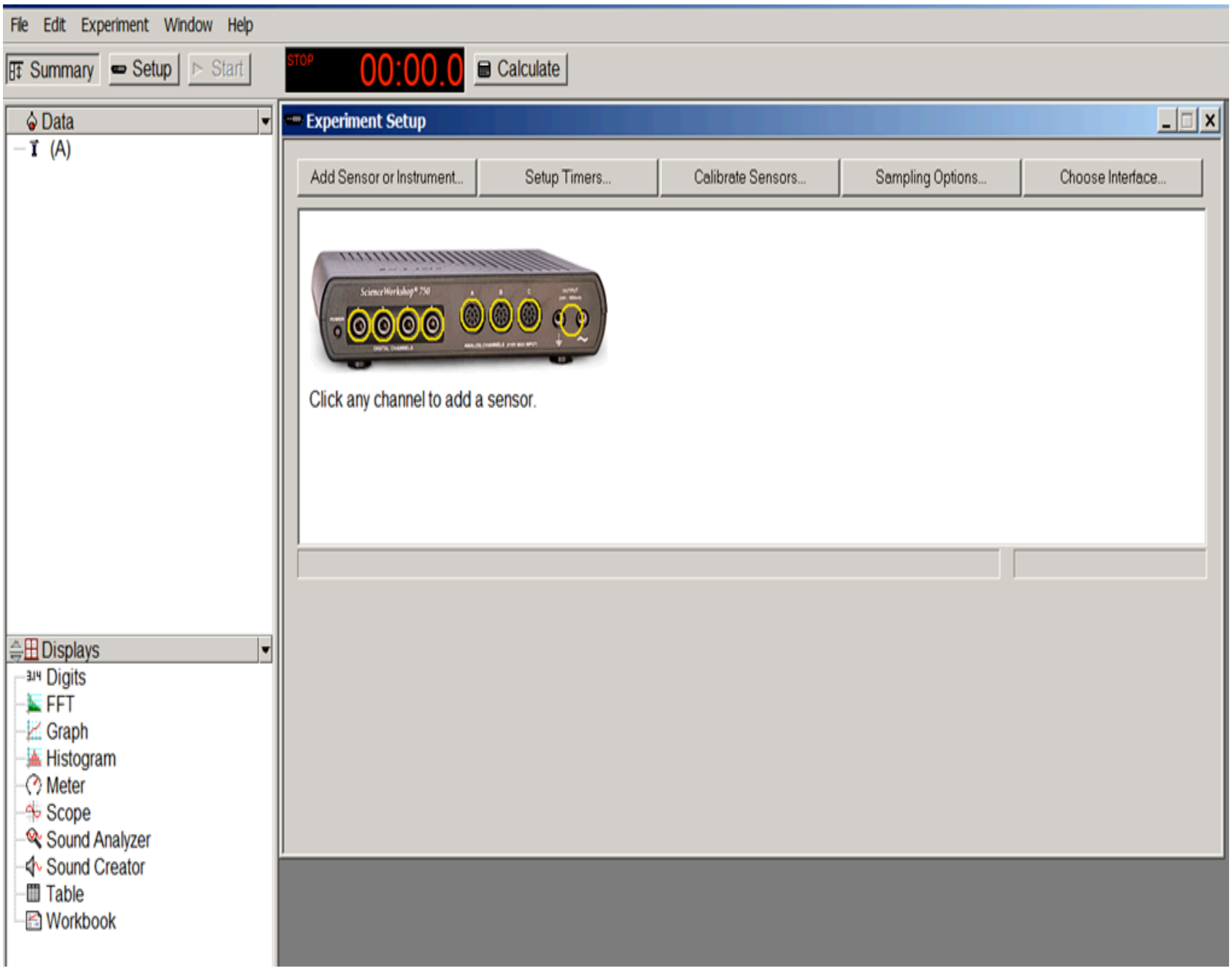

Figure 3 A typical view of the DataStudio Window.

EXPERIMENT II
DISPLAY AC SIGNALS ON OSCILLOSCOPE

Free standing *oscilloscopes* are standard equipment. The oscilloscope can display real-time voltage variation, for example voltage-versus-time for multiple voltage sources or voltage-versus-voltage between different voltage sources. You can rescale the vertical and horizontal axes independently on the oscilloscope during measurement. The oscilloscope can display the voltage variation as traces which are continuously refreshed on the screen as long as the voltage is being measured. The oscilloscope can be set up such that it starts to record a trace when the specific condition (called "trigger condition") is met. "Scope" display in ***DataStudio*** simulates the oscilloscope and can simultaneously display up to three voltage or current channels.

Use the same circuit shown in Fig. 2 for Experiment II. You will learn to use Scope to display the AC voltage across a resistor and the AC current flowing through a resistor.

Procedure

1. Open the signal generator window and select "Sine" wave signal. Select the proper amplitude and frequency for the signal, for example, respectively at *2.00* V and *100* Hz.

2. In the voltage sensor window, set to "Gain 1X". In the current sensor window, set to "Gain 100X". Note: even though Channel B of the ***750 Interface*** is now connected to the current sensor, but the current sensor input a voltage signal equaling the current multiplied by 1 ohm.

3. Double click on the icon of Scope in Displays window. The right side of the Scope window shows the signals to be displayed. You can add a signal to scope display by clicking on the corresponding sensor in Data window and dragging it to the right side of Scope window. A new box appears with information about the added signal.

4. Adjust the value of V/div (volts per vertical division) to fit the traces of the data on the Scope display. Adjust the value of ms/div (milliseconds per horizontal division) to see several cycles of the signal oscillation.

Note: when using Scope, the Scope display controls the sample rate by using the sweep speed (ms/div). Changing the sample rate in other windows, such as "Voltage Sensor" window, does not change the sweep speed in Scope.

5. Ask the TA how to set the trigger. Use the "Scope Setting" menu which contains the "Tool" menu to set the trigger condition. The trigger condition must be set appropriately according to the input signal. Then turn on the trigger button.

6. Click on the "Start" button to collect data. When you see the leftmost point of the trace changes, it means you do not set the trigger correctly. Click on the "Stop" button when you are satisfied with the trigger setting. Now click on the "1" Trace button such that only a single trace will be collected. Now, click on the "Start" button to collect data.

7. Use the "Smart Tool" (the 1st function in the top menu bar of Scope) to determine the X and Y coordinate differences between any two data points in the same trace, to determine the amplitude and the frequency of the signal. It operates the same way as in Graph, but note that each displayed signal corresponds to its own "Smart Tool" identified by the associated color.

8. Now set the Scope to measure the voltage of input channel A. Repeat for different AC outputs as shown in Table 3. Record the data in Table 3 for the voltage of input channel A. Print out the graph for data 1. For these two measurements, you set the trigger condition as: "the voltage level = 0" & "rising", and you must set the value of "ms/div" correctly such that about 5 periods of the "Sine" wave are displayed.

9. Set the Scope to measure the current of input channel B. For this measurement, turn off trigger. Repeat for different AC outputs as shown in Table 4. Record the data in Table 4 for the

current of input channel B. In this experiment, in order to read clearly the current on scope, you need to adjust the corresponding vertical scale to approximately 0.05A/div.

Table 3

AC Output			Displayed Signal on the Scope Corresponding to Channel A	
	Frequency	Amplitude	Period (s)	Amplitude (V)
1	10 Hz	2.5 V		
2	200 Hz	1.0 V		
3	75 Hz	1.5 V		
4	50 Hz	0.5 V		

Table 4

AC Output			Displayed Signal on the Scope Corresponding to Channel B	
	Frequency	Amplitude	Period (s)	Amplitude (A)
1	10 Hz	2.5 V		
2	200 Hz	1.0 V		
3	75 Hz	1.5 V		
4	50 Hz	0.5 V		

Question

1. Discuss the data in Table 3 and Table 4. Explain the similarities and the differences between the two data sets.