Lab 6: Instrument Familiarization

Experiment for Physics 226 Lab at CSUF.

What You Need To Know:

Introduction

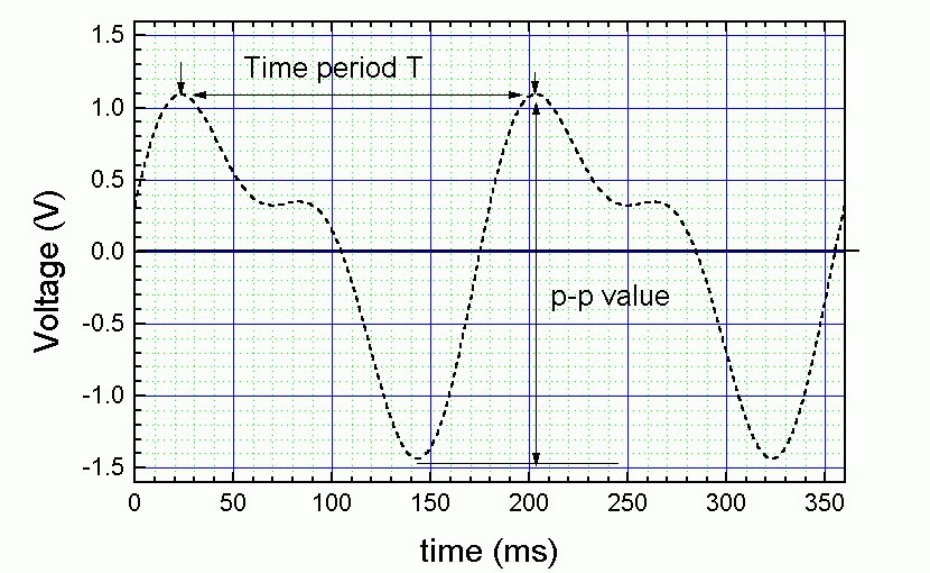
Voltages and currents in an electronic circuit as in a CD player, mobile phone or TV set vary in time. Throughout today's lab you will investigate these types of time varying signals and how to measure them.

The vibrations of the string of a guitar for example produces sound, pressure waves in the air. This changing pressure induces vibrations and produces time dependent voltage in a microphone. This signal is intensified in an amplifier, and a loudspeaker converts it to sound at the end, much louder than the original sound.

Periodic Signal

The sound of a vibrating string produces a periodic voltage in the microphone. If the time period of the signal is T then, $V(t+T) = V(t)$, see *Figure 1*. The waveform repeats every period T.

Figure 1 – Periodic Signal



The periodic signal is characterized by its time period T or frequency $f = 1/T$ and by its peak-to peak value (p-p value). Instead of frequency, the angular frequency $\omega = 2\pi f$ is also often used.

The household supply voltage is another example of a periodic waveform. It varies with time according to a simple harmonic function as shown below:

$$V = V_0 sin(\omega t + \alpha)$$

V_0 is the amplitude of the voltage (in the US 120V), $\omega = 2\pi f = 120\pi$ for a 60Hz waveform and α is a phase constant.

In today's lab we are going to focus on generating, viewing, and measuring periodic signals.

What You Need to Do

Part 1: The Function Generator

One of the most important pieces of equipment in the lab, is the function generator. These are widely used for testing equipment. They are designed to produce several different periodic signals: a sine wave, square wave, and triangle or sawtooth waves. See *Figure 2* below.

Showing the different periodic signals our Function Generator and create. We will focus our labs on Sine and Square waves.

Figure 2 - Showing the different periodic signals our Function Generator can create. We will focus our labs on Sine and Square waves.

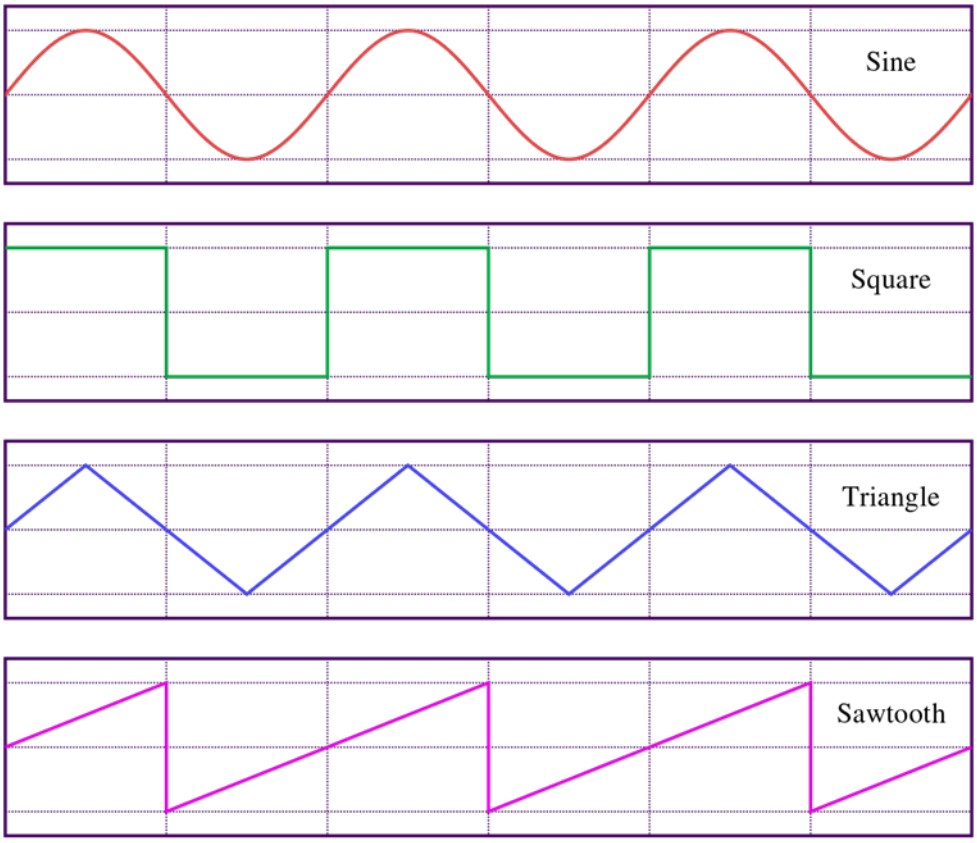
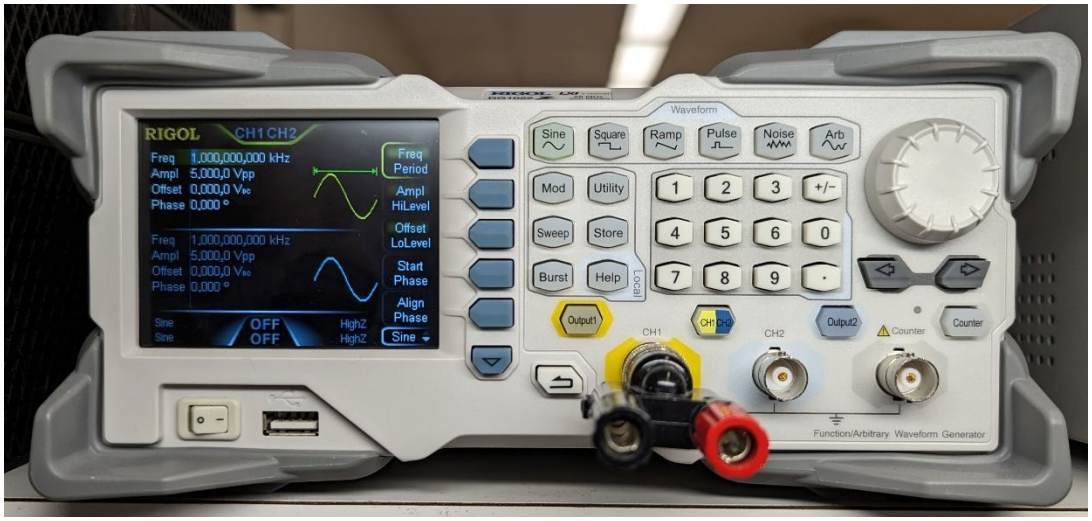


Figure 3 - Our Rigol Function Generator will be used to generate signals to test our electrical circuits we make in future labs. Different waveforms behave uniquely in different circuits, so it is important we know how to create a variety of signals



A) Go ahead and turn on your function generator now, you can locate the power switch to the bottom left, under the display.

B) Locate the Adjustment Knob and adjust it. Notice the highlighted number on the display changing.

Note the number is displayed with commas separating the smaller decimal places. So 1.000000000 kHz is displayed as 1.000,000,000 kHz.

C) The arrows under the adjustment knob can be used to change which digit in the displayed number you're adjusting.

D) The buttons next to the display can be used to adjust different parts of the signal.

E) You can also directly type in the number you want, when you do, you'll see options pop up on the right side of the display, just click the one you need.

So if I wanted 20Hz I'd press 2 0 then the third blue key next to the screen, try it you'll see.

Question 1:

Practice changing the CH1 values to 3.6 Hz with an amplitude of 2.456 Vpp. What are the values for channel 1 EXACTLY as displayed on your device's display?

F) You can also swap channels with the CH1|CH2 button in the bottom center, to adjust the channels.

G) Locate the wavetype buttons and note all the signals in *Figure 2* are available plus a couple. (Ramp handles both sawtooth and triangle.)

Question 2:

practice switching them by making a square wave on channel 1 with 20 kHz frequency and 1 Vpp and a Ramp on Ch2 with 1kHz frequency and 4.5 Vpp. What are the values for channel 2 EXACTLY as displayed on your device's display?

H) Finally note the two output buttons on either side, one for each channel. You'll press those once your circuit/device is ready for a signal.

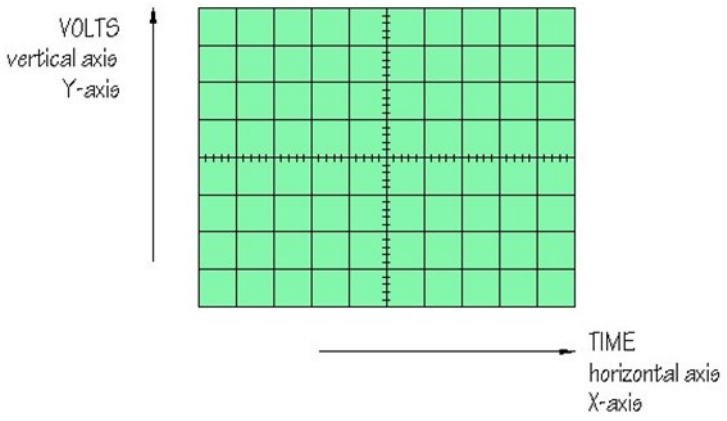
Part 2: The Oscilloscope

We now need to view our signal. In past labs you have used Digital Multi-Meters to measure voltages of DC signals. Unfortunately these devices do not allow us to accurately measure signals which vary in time. For such signals, we require a different measuring device.

An oscilloscope is easily the most useful instrument available for testing circuits because it allows you to **see** the signals at different points in the circuit as a function of time. The best way of investigating an electronic system is to monitor signals at the input and output of each system block, checking that each block is operating as expected and is correctly linked to the next. What follows is a brief outline of the main functions of the oscilloscope (O-Scope).

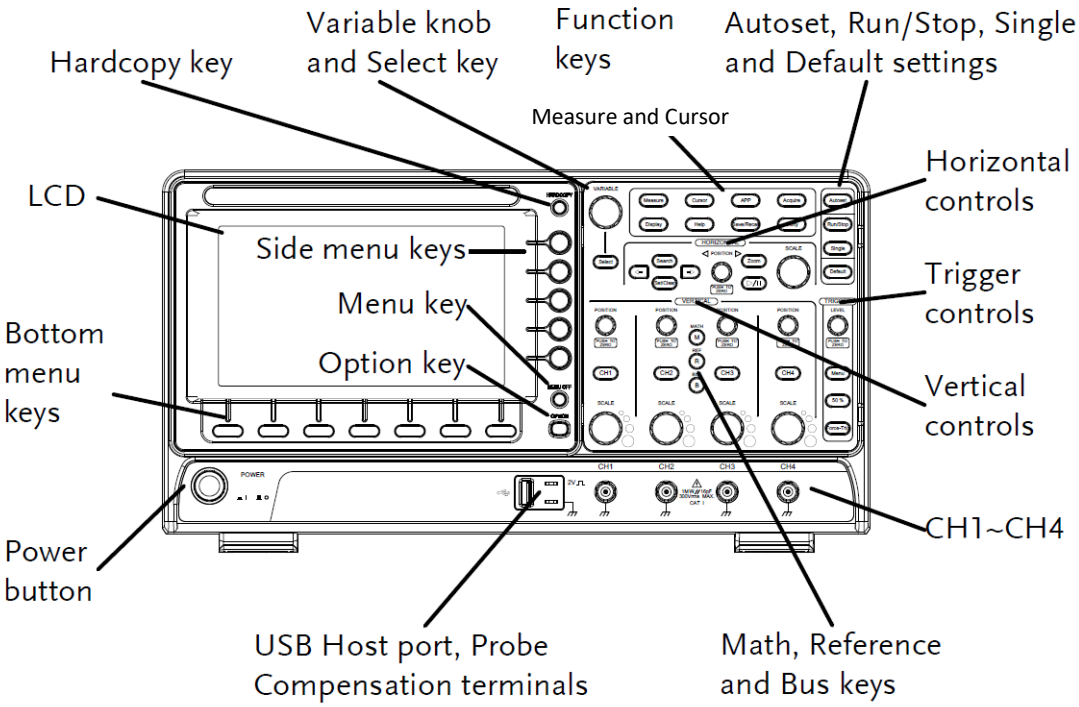
The function of an oscilloscope is extremely simple: it draws a **V** - **t** graph, a graph of voltage against time, voltage on the vertical or Y-axis, and time on the horizontal or X-axis.

Figure 4 - The axis of an O-Scope Screen in V-t mode



The Oscilloscope Basic Design

Figure 5 - Our GW Instek Oscilloscope with common functions labeled. You will be expected to know how to use all labeled functions by the end of lab.



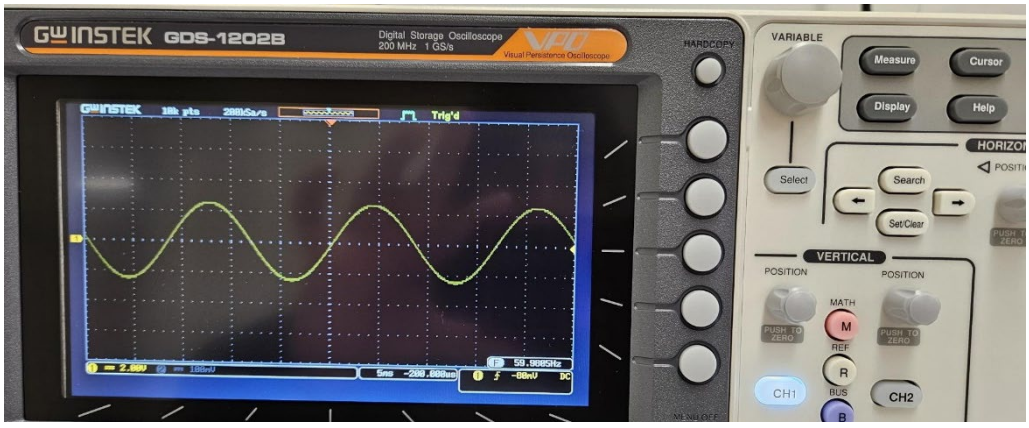
A) Begin by powering on your oscilloscope. Now connect a pair of red and black banana plugs from the red and black ports on the function generator to the red and black ports on Channel 1 of the oscilloscope.

B) Next, set your function generator to output a 60Hz Sine Wave on CH1.

C) Press the Auto Set Button.

D) Verify that your waveform looks like *Figure 6*

Figure 6 - The GW Instek Oscilloscope displaying a 60Hz Sine Wave.



E) Turn the knob in Vertical section under Ch 1 titled Scale (Volts/Div). This changes the scaling of the Y-Axis.

F) Turn the knob above CH1 titled Position. Note that this allows you to shift your Y Offset.

G) In the horizontal menu. Turn knob titled Scale (Time/Div). This changes the scaling of the X-Axis.

H) Press the Yellow button labelled CH1. This opens a menu for Channel 1.

I) Press CH1 again. Notice this turns off the channel. Press it again to turn it on.

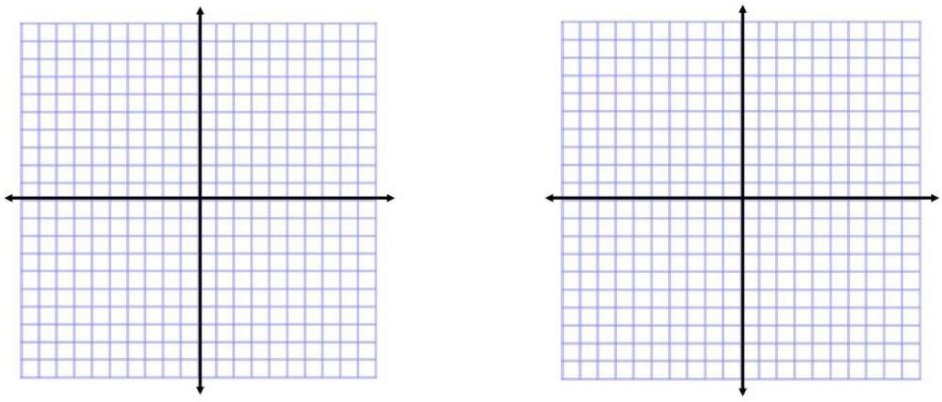
J) Turn off CH2.

K) Go into the CH1 Menu

L) There are three "coupling" modes for Oscilloscopes, DC, AC and Ground. DC coupling enables the scope to look at all signals, alternating or direct. AC coupling only allows you to look Alternating signals.

Question 3:

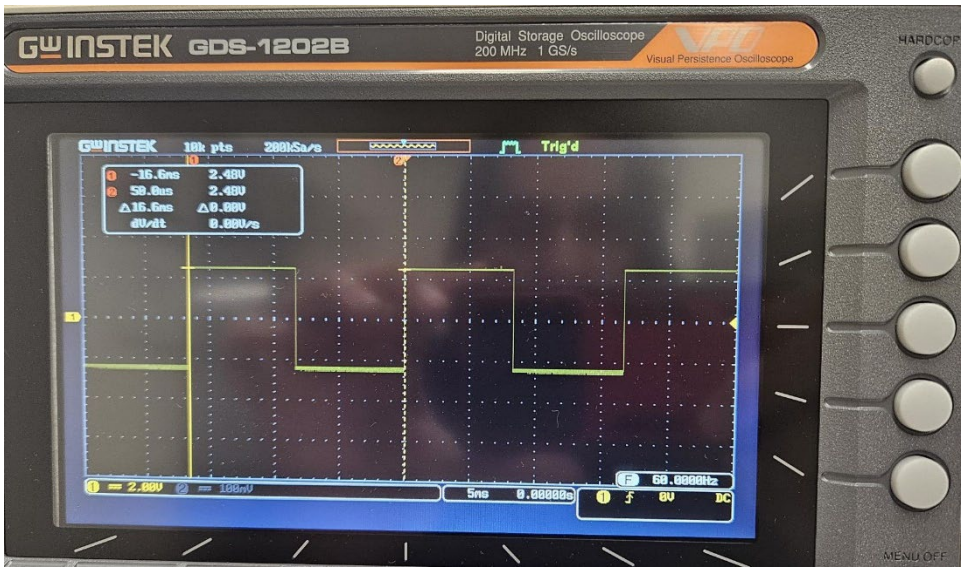
Press the square wave button on the function generator. Now toggle channel one between AC coupling and DC coupling. Draw and describe each of the situations. Is the actual waveform changing?



M) Press the **Cursor** button on the oscilloscope. This will bring up a pair of vertical or horizontal bars used to measure your function in the horizontal or vertical access. The H cursor button or select button will allow you to toggle which line you want to move. If line is solid the variable knob will move the line position. if any line is dashed then that line will not be affected when moving variable knob.

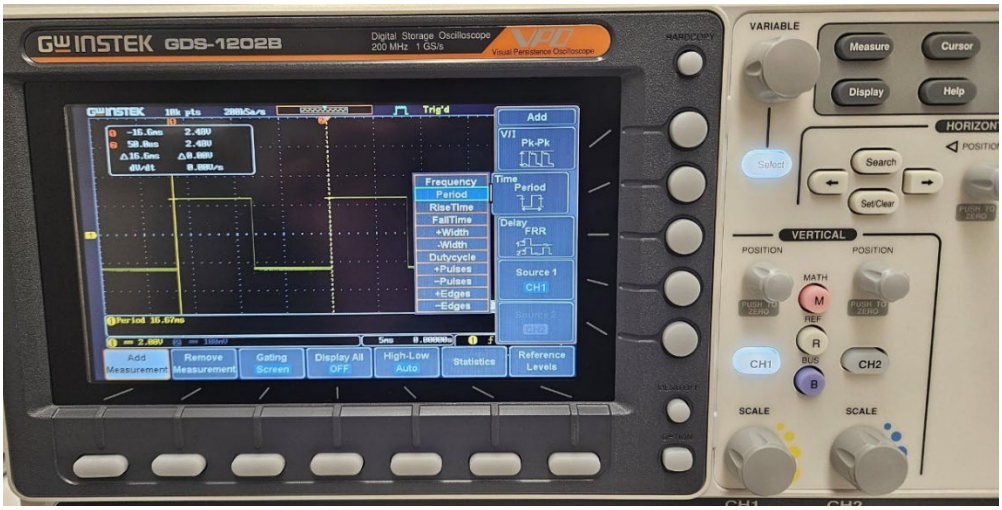
N) Make sure that your bars are set vertically. We are going to measure the period of our function; that is the time it takes to make one full oscillation. Using the **variable knob** place one bar at the start of your waveform, and one at the end of its oscillation (*Figure 7*).

Figure 7 - GW Instek Oscilloscope setting vertical lines for period measurement.



O) After lining up the vertical Lines correctly. Hit the measure button. Then hit add measurement button. then hit period button, now using variable knob to set cursor on period parameter then hit select button. It should now add that measurement to the screen.

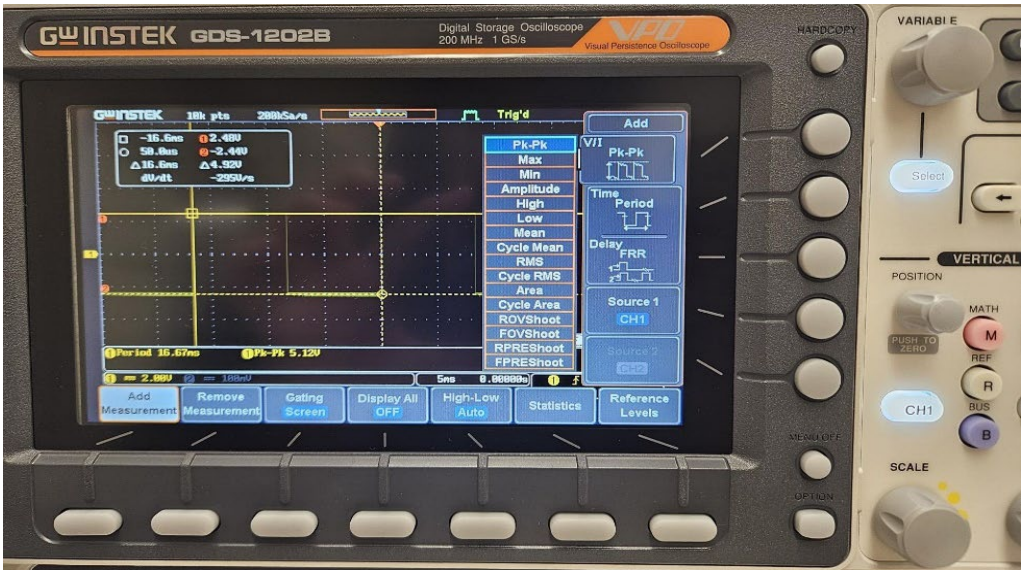
Figure 8 - GDS 1202B Adding Measurement - Period



P) Now let's switch to horizontal bars by pressing **cursor button**. Using the same method as before, but now we measure the voltage from peak to peak (V_{PP}) of your waveform. Jot your value down below. See *Figure 9*

Q) On the function generator try turning the Output Level and the Frequency knobs. Mentally note what happens.

Figure 9 - GDS 1202B Adding Measurement Pk- Pk



Question 4:

Using the Measure menu measure the V_{PP} and the Period and jot them down. How do they compare to your values from cursors?

Question 5:

Use the **Volts/Div** adjust knob until the waveform peaks are no longer visible. How does $\mathbf{V_{PP}}$ measure now?

R) To the far right of the oscilloscope start turning the knob under the trigger menu. Notice that as you start turning it, your signal starts moving horizontally. The trigger tells the oscilloscope when to sample a signal. If the frequency of your sampling and the frequency of your signal differ, your signal will appear jumpy. The trigger menu is how to fix a jumpy signal.

You now officially know enough about the oscilloscope and function generator to be successful in future labs. Please try repeating the exercises for a few different waveforms. It will be important that you are not just familiar with these steps, but comfortable and speedy in taking data with an oscilloscope.

Turn in all requested measurements / graphs / observations to your instructor as your lab report.