PHYSICS 1040L LAB
LAB 6: USE OF THE OSCILLOSCOPE

Object: To become familiar with the operation of the oscilloscope and be able to use an oscilloscope for:
1. Measuring the frequency of an oscillator,
2. Measuring the AC voltage of an unknown source,
3. Observing Lissajous Figures.

Apparatus: An oscilloscope, two audio frequency oscillators, 2 probes.

Theory:
An oscilloscope is a cathode ray tube that fires a beam of electrons at a phosphorescent screen. The beam may be moved vertically or horizontally by external signals. One mode of operation is to connect an external signal to the vertical input, causing the beam to move vertically while the beam is swept in the horizontal direction at some predetermined rate. One sees, then, a trace on the screen that is a plot of the variation of the external signal a function of time. Another mode of operation is to connect inputs to both the horizontal and vertical axes which will provide a plot of one with respect to the other. Take, for example, two signals whose amplitudes, x and y, are varying periodically and connect them to the horizontal and vertical inputs, respectively. These two signals may be represented by:

$$y = y_0 \sin(\omega t) \quad \textbf{(1)}$$

$$x = x_0 \cos(\omega t) \quad \textbf{(2)}$$

where ω is the frequency, t is the time, and y_0 and x_0 are the maximum amplitudes, respectively. These two signals are 90 out of phase since, at t = 0, y = 0 and $x = x_0$. If $x_0 = y_0$ the figure on the screen will be a circle. If x_0 is not equal to y_0, the figure will be an ellipse. You can convince yourself that the above statements are true by squaring each of the above equations and adding them together, obtaining:

$$x^2 + y^2 = R^2 \text{ (for } x_0 = y_0 = R\text{)},$$

and $$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$$ (for $x_0 = a$ and $y_0 = b$)

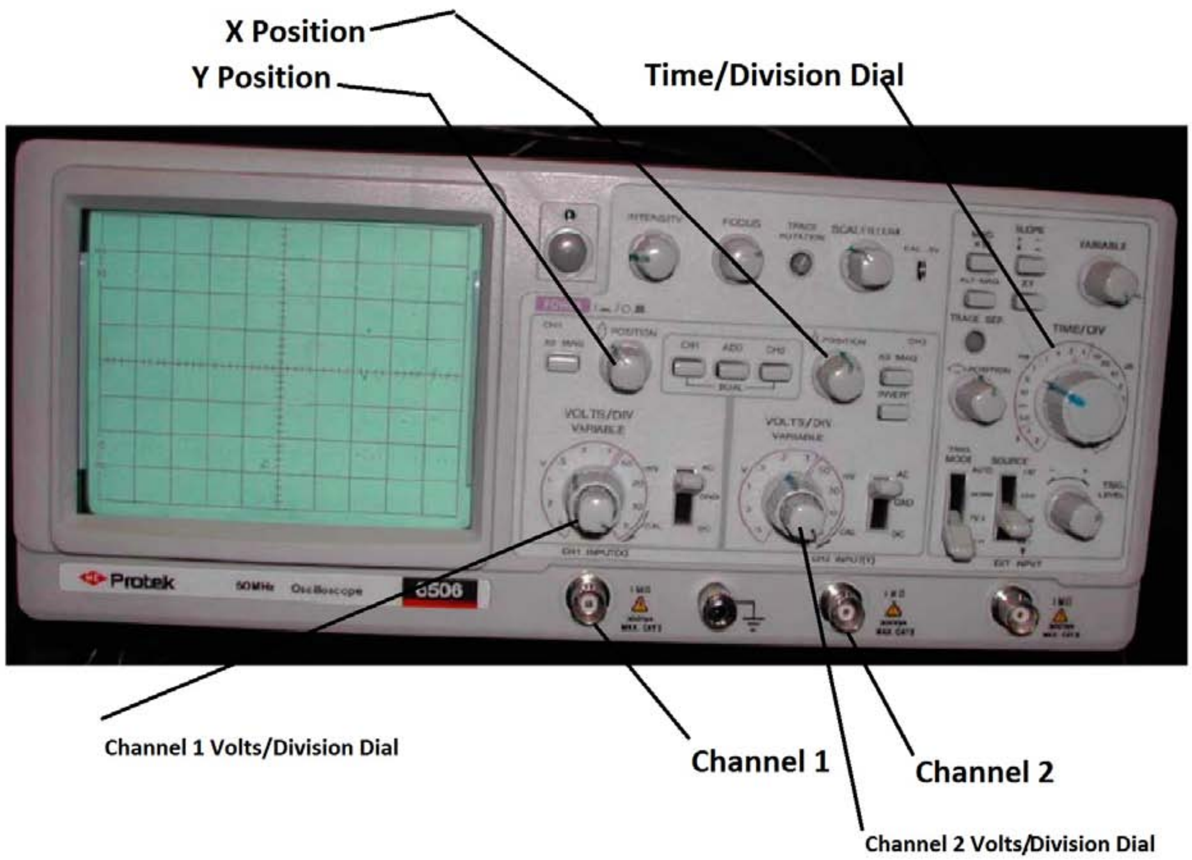

Figure 1: Oscilloscope

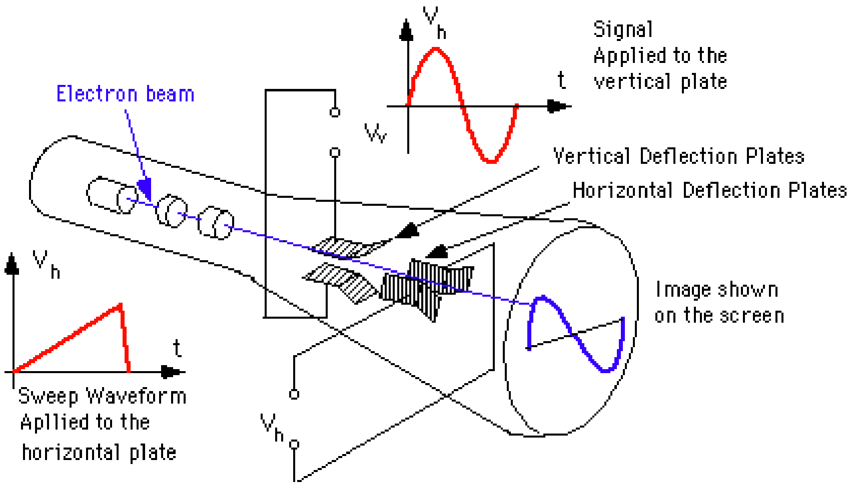

Figure 2: ***Subsystems of an oscilloscope showing the display tube and the deflection system***

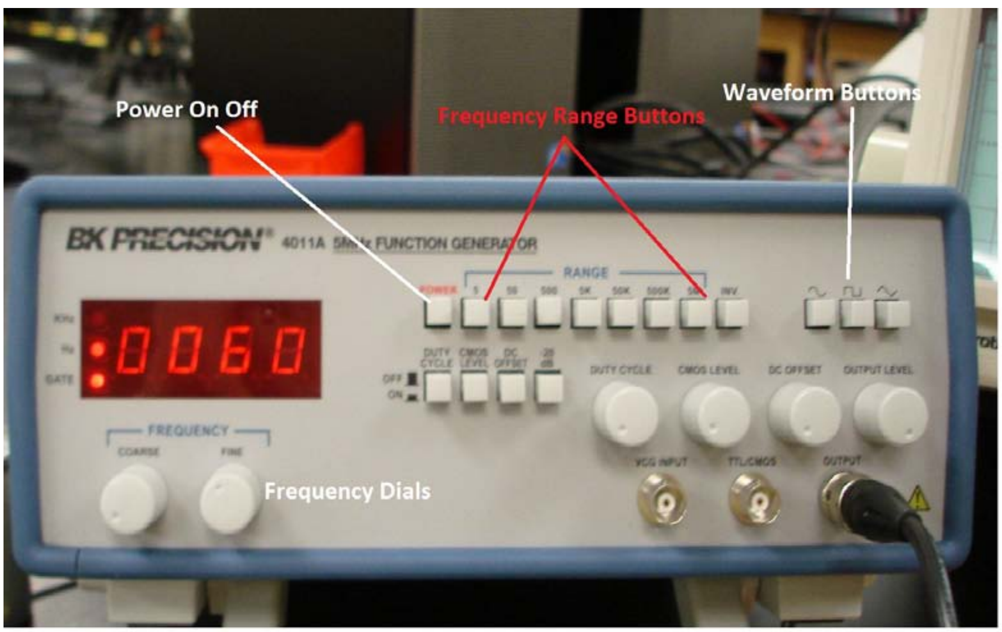

Figure 3; Function Generator

Procedure and Data Analysis

In using the oscilloscope, there are "Care - in use" rules to be considered.

1. When in operation, the oscilloscope should be set on its tilt handle so that the maximum convection cooling is possible.

2. Switching the oscilloscope ON and OFF at short intervals of time should be avoided because it stresses the cathode of the CRT and may cause it to burn out.

3. To reduce risk of damage to the CRT's fluorescent screen, the intensity setting should be set at minimum usable level. Before turning on the Oscilloscope make sure the intensity dial is turned all the way counter clockwise to its minimum intensity setting. Particular care is required when a single spot is displayed.

4. Gradually increase the beam intensity until a horizontal line is displayed.

TO BECOME FAMILIAR WITH THE OSCILLOSCOPE. (See the picture of the oscilloscope, Fig. 1)

1. Make sure the intensity dial is turned all the way counter clockwise

2. Turn the power switch on. The green light will be seen.

3. All red pointers on the knobs must point to the right.

4. Push the x - y button.

5. Gradually increase the beam intensity

6. A bright spot should appear on the screen.

7. Adjust the focus and intensity so that the beam makes a small, clearly visible (but not too bright) spot. Too bright a spot can burn off the phosphor on the back side of the CRT screen.

8. Use the x - pos to control the spot in horizontal direction. Use the y - pos to control the spot in vertical direction. Set the spot to the center of the screen.

TO MEASURE THE FREQUENCY OF AN OSCILLATOR.

9. Connect an oscillator to channel 1 of the oscilloscope.

10. Set the frequency of the oscillator at 500 Hz using the course and fine frequency dials.. This is only an approximate value.

11. Set the x - y button to out (off) position.

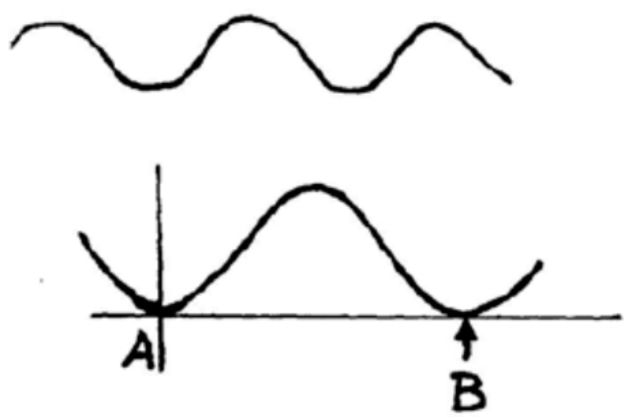

Figure 4: Period is measured from A to B

12. Adjust the Time/ Div until a sine curve is seen on the screen.

13. Use the x - pos and y - pos to set the curve so that it just touches the horizontal line at the bottom and the vertical line on the side as shown in the diagram.

14. Read the number of divisions for one cycle (the number of division between A and B on the diagram).

15. Calculation: Period T= (Time/ Div)*(number of divisions)
Frequency f = 1/ T

TO MEASURE THE RMS-VOLTAGE OF AN UNKNOWN SOURCE.

16. Adjust the Volt/Div so the amplitude of the curve is big enough to be read correctly.

17. Use the x - pos and y - pos to set the curve so that it just touches the horizontal line at the top and the vertical line on the side as shown in the diagram.

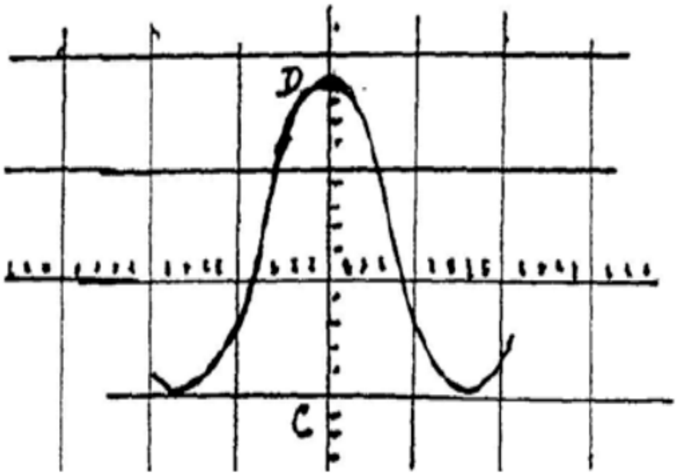

Figure 5: Measuring Peak to Peak Voltage V_{pp}

18. Read the number of divisions for the peak-to-peak value (example: from C to D at the picture) of the voltage. The amplitude of the curve must be one half of peak-to-peak value.

***Example*: CD= 2.8 div; the amplitude = 0.5*(2.8 div)=1.4 div.**

Calculations

Vmax = (Volt/Div)*(number of divisions of the amplitude);

$$rms\ VOLTAGE: V_{rms} = \frac{V_{\max}}{\sqrt{2}}$$

TO OBSERVE LISSAJOUS FIGURES

18. Connect the second oscillator to channel 2.

17. Set **x - y button** to the ON position.

18. Make sure the Volts/Divisions dials set to the same value for both X and Y

19. Set the ratio of frequencies of the two oscillators to the ratios 1:1; 1:2; 2: 1, 1:3, 3:1, 2:3, 3:2 and so on.
20. Observe the figure on the screen for each ratio. Make a sketch of each ratio.

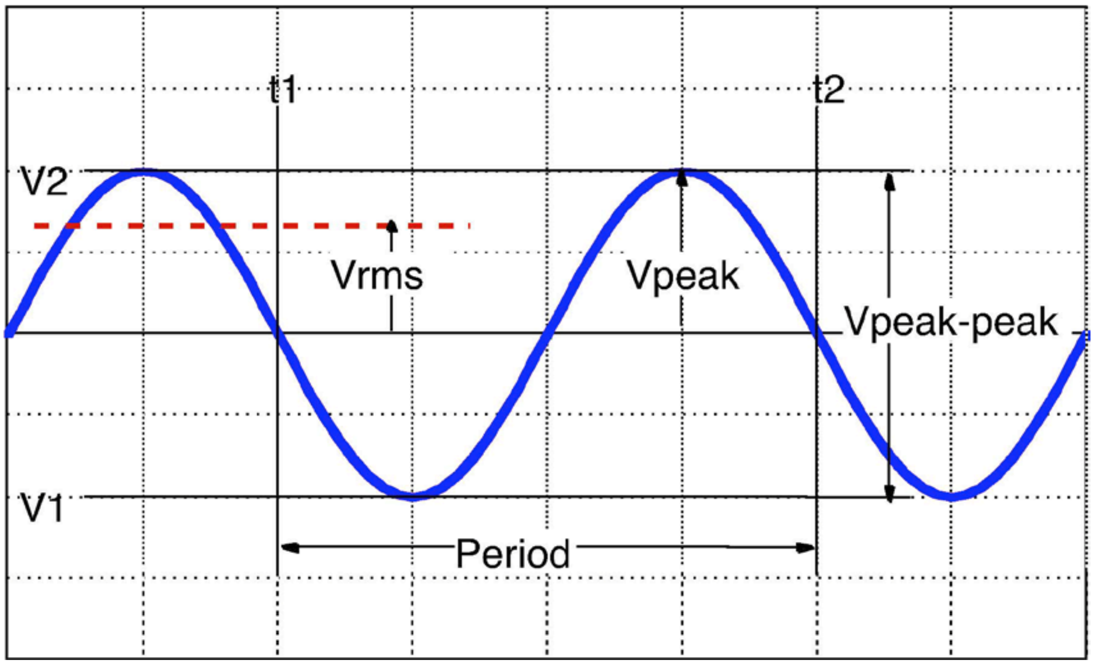

Figure 6: Characterization of sinusoidally varying time signal.

Figure 7: Oscilloscope Voltage Probe. Yours might look a bit different and has a BNC connector instead. They cost around $50 each, use them with caution