Laboratory: Oscilloscope

Objective:

1. To learn how to use the oscilloscope.
2. To study the use of oscilloscope for measuring the basic circuits.

<u>Student preparation:</u>

- Before going to the lab, students must wear a workshop suit. **<u>A student with improper dress will not be allowed in the laboratory room.</u>**
- **Each group must have one breadboard used to build circuits**.
- Knowledge in basic circuit analysis in particular , voltage divider , RC circuit.
- Scientific calculator should bring in.

Since this is the first laboratory, students must carefully re-check all connection before connecting the supply voltage.

Introduction:

The oscilloscope is a very widely used laboratory instrument whose most usual application is to give a visual display of time-varying voltages. An oscilloscope displays the instantaneous amplitude of an ac voltage waveform versus time on the screen of a cathode ray tube(CRT). Inside the CRT are an electron gun assembly, vertical and horizontal deflection plates, and a phosphorescent screen.The electron gun emit a high velocity, low inertia beam of electron that strikes the phosphor coating on the inside face of the CRT,causing it to emit light. The intensity of the light given off at the screen of the CRT is determined by the voltages in the electron gun assembly. The intensity (called brightness) can be varied by a control located on the oscilloscope panel.The motion of the beam over the CRT screen is controlled by deflection voltages generated in the oscilloscope circuits outside the CRT and the deflection plates inside the CRT to which the deflection voltages are applied.

Figure 1 is an elementary block diagram of an oscilloscope. The CRT provides the screen on which waveforms of electrical signals are viewed. These signal waveforms are applied to the vertical input on the oscilloscope and are processed by vertical amplifiers in the circuitry of the oscilloscope external to the CRT. Because the oscilloscope must handle a wide range of signal-voltage amplitudes, a vertical attenuator – a variable voltage divider – sets up the proper signal level for viewing. The signal voltage applied to the vertical deflection plates causes the electron beam of the CRT to be deflected vertically. The resulting up-and-down movement of the beam in the screen, called the *trace*, is significant in that *the extent of vertical deflection is directly proportional to the amplitude of the signal voltage applied to the vertical*, *or* V, *input*.

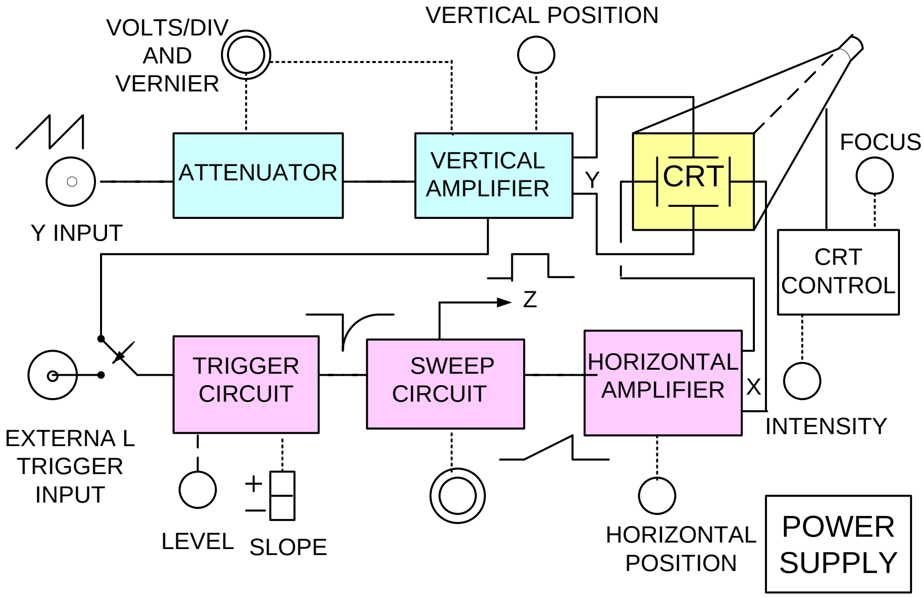


Figure 1. Simplified block diagram of an oscilloscope

To make it possible for the oscilloscope to graph a time-varying voltage, a linear time-base deflection voltage is applied to the horizontal deflection plates. This voltage is also developed, in that oscilloscope circuits external to the CRT, by a time-base or sweep generator. It is this sweep generator that is either triggered or non-triggered.

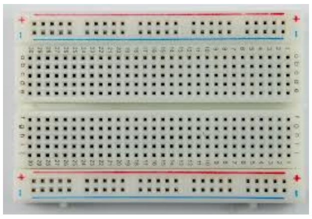
Triggered oscilloscopes with *two* traces are in common use. The two traces are developed on the screen of the scope by means of electrical switching. Dual-trace oscilloscopes make it possible to observe simultaneously two time-related waveforms at different points in an electronic circuit.

Apparatus:

1. Oscilloscope

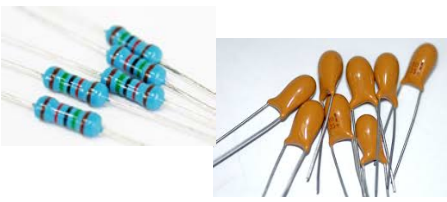
2. Probes

3. Breadboard (Bring by student)



4. Function generator

5. Resistors and Capacitors



6. Jumper wires

Procedures:

Experiment 1(Oscilloscope Set Up)

This experiment is the most important one. Students need to find the trace and display it on the screen by the proper setting. Do the following.

1.1 Find the power button and turn it on.

1.2 Connect one probe to CH1 input using push and rotate as displayed in Figure 2.

Figure 2.

1.3 Clamp the probe tip to the CAL output (bottom left corner of the scope) as shown in Figure 3. Note. CAL=Calibration.

Figure 3.

1.4 Read the texts under CAL and record to the following.

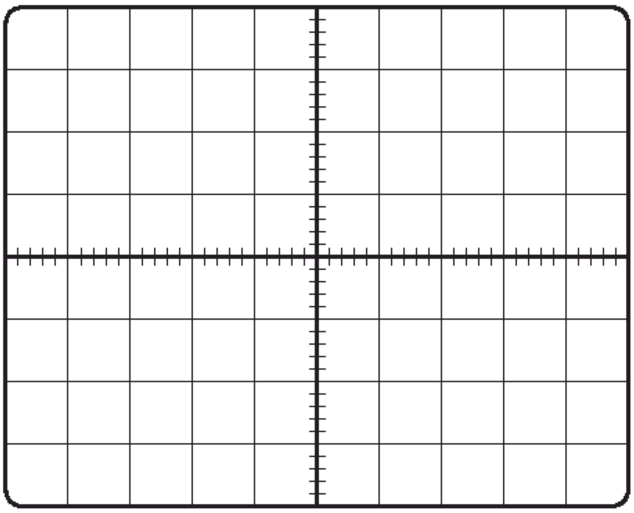
CAL Voltage = ___________ Vp-p CAL frequency = ___________ KHz

1.5 Notice the display. If there is no trace shown on the screen, adjust the oscilloscope i.e. vertical control, horizontal control and triggering control until the trace is shown. This trace is the CAL output generated by the oscilloscpe. See Appendix 1 for the operation of the oscilloscope.

1.6 After the signal is displayed. Press the vertical input coupling of CH1 to **DC** as shown in Figure 4. Note. Check and ensure that the GND of CH1 is not pressed.

Figure 4.

1.7 Adjust the vertical and horizontal display until the waveform is fitted in the display. Record the waveform to the graph provided.



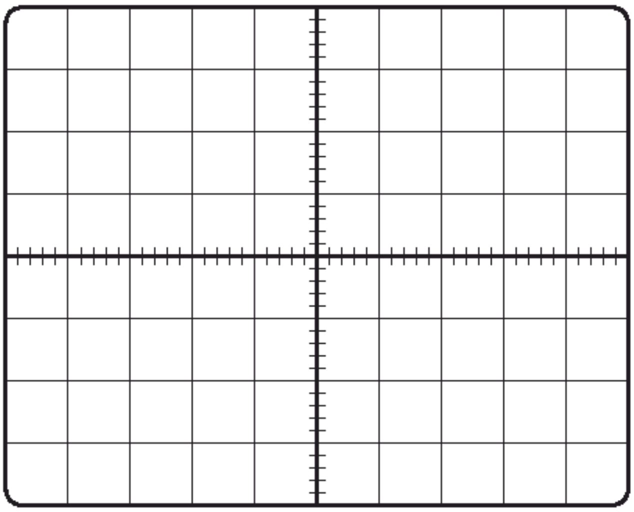
DC Coupling

Y=________ VOLTS/DIV

X=________TIME/DIV

CAL SIGNAL OUTPUT(DC coupling)

1.8 Unpress the vertical input coupling of CH1 to **AC** as shown in Figure 4. Note. Check and ensure that the GND of CH1 is not pressed. Record the waveform to the graph provided.



AC Coupling

Y=________ VOLTS/DIV

X=________TIME/DIV

CAL SIGNAL OUTPUT(AC coupling)

Questions:

1. What are differences between DC and AC vertical input coupling?

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   ____

   ____

2. Describe the signal properties of CAL output.

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<u>**Experiment 2 (Voltage Divider Circuit)**</u>

2.1 Connect the voltage divider circuit as given in Figure 5. on the breadboard. Leave the jumper wires for connecting input and output signals.

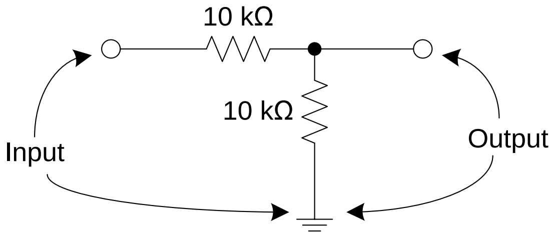


Figure 5. A simple voltage divider circuit.

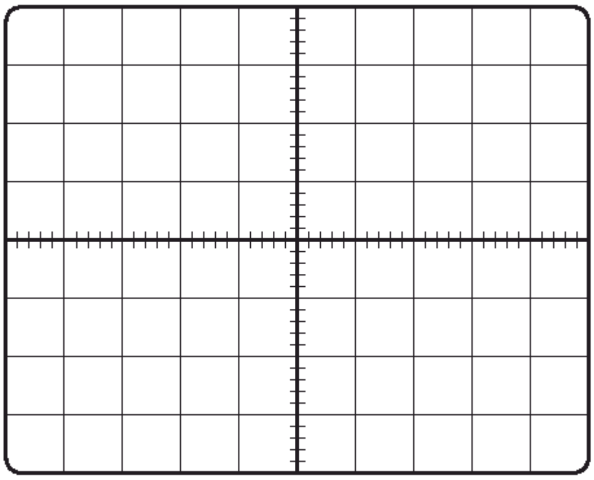
2.2 Turn on the function generator. Connect the output of generator to CH1 input.

2.3 Set the function generator to generate sinusoidal waveform with V= 10 Vp-p , 1 kHz. Confirm the signal with the scope display.

2.4 Connect the output of generator to the input of the circuit via jumper wires.

2.5 Connect the probe of CH1 to measure the input and CH2 to measure the output all using the jumper wires.

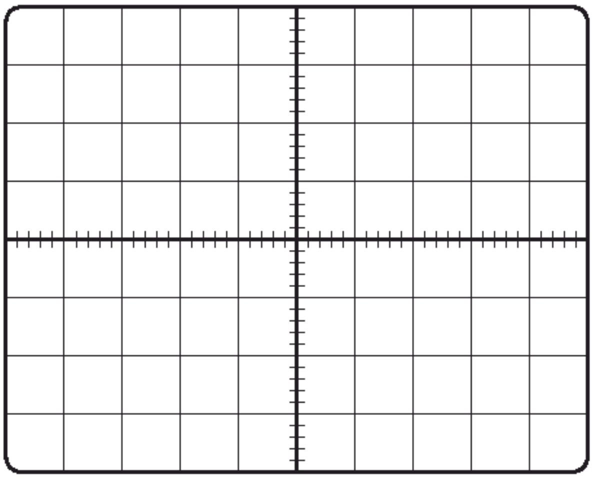
2.6 Adjust the oscilloscope and record the input and output signals to the graph.



Y=________ VOLTS/DIV

X=________TIME/DIV

Input Signal(CH1)



Y=________ VOLTS/DIV

X=________TIME/DIV

Output Signal(CH2)

<u>Experiment 3 (RC Circuit)</u>

3.1 Build the RC circuit as given in Figure 6. on the breadboard. Leave the jumper wires for connecting input and output signals.

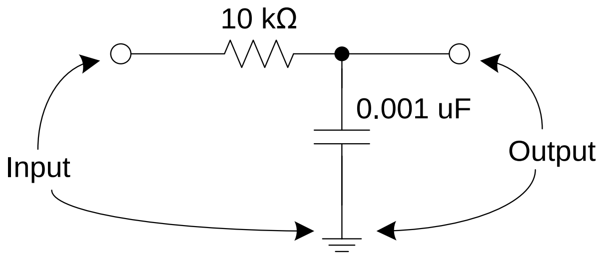


Figure 6. A simple RC circuit.

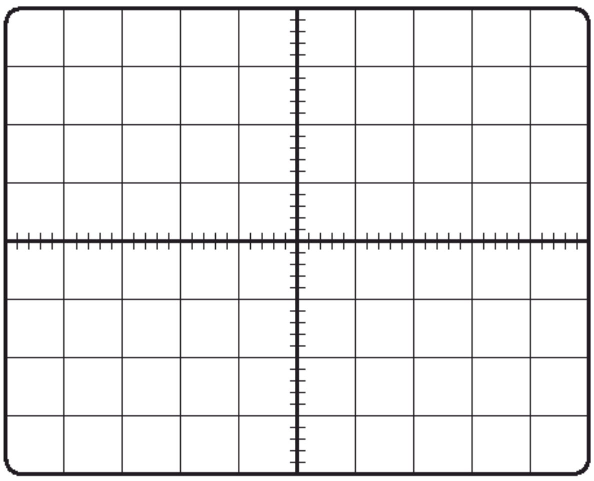
3.2 Turn on the function generator. Connect the output of generator to CH1 input.

3.3 Set the function generator to generate square wave with V= 8 Vp-p , 5 kHz. Confirm the signal with the scope display.

3.4 Connect the output of generator to the input of the circuit via jumper wires.

3.5 Connect the probe of CH1 to measure the input and CH2 to measure the output all using the jumper wires.

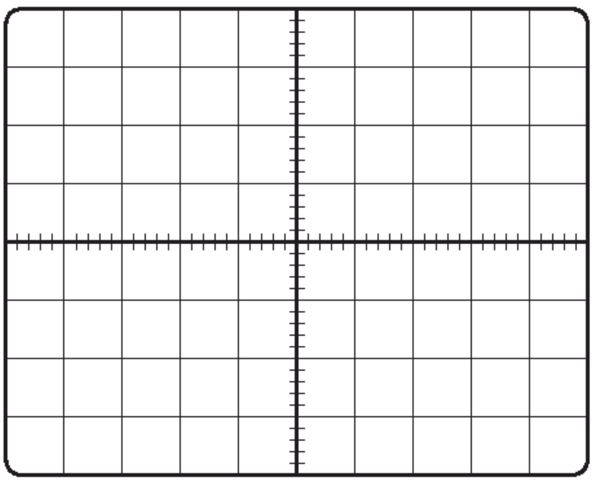
3.6 Adjust the oscilloscope using VOLTS/DIV and TIME/DIV to expand the signal and measure the time decay. Record the input and output signals to the graph.



Y=________ VOLTS/DIV

X=________TIME/DIV

Input Signal(CH1)



Y=________ VOLTS/DIV

X=________TIME/DIV

Output Signal (CH2)

3.7 Calculate RC time constant from the waveform(CH2), and compare it to the value you expected from the theory calculation.

RC from the experimental = ____________________ second

RC from the calculation = _____________________second

3.8 Set the MODE (in vertical control) of the oscilloscope to DUAL(see Figure 7.) to display both CH1 and CH2 at the same time. Adjust the scope using both vertical POSITION knobs(close to MODE) to make the waveforms overlap. Record the input and output signals to the graph.

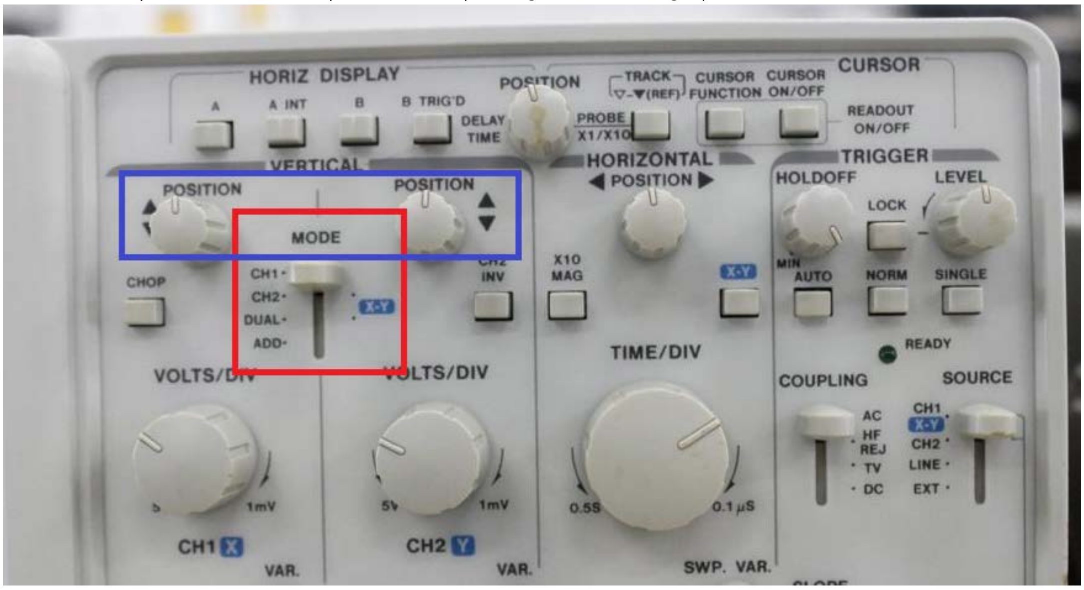
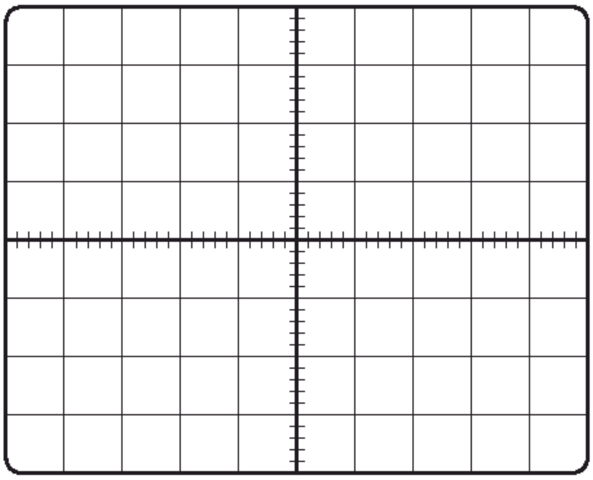


Figure 7.



CH1 AND CH2

CH1
Y=_______ VOLTS/DIV
CH2
Y=_______ VOLTS/DIV
X=_______TIME/DIV

Questions:

1. From results obtained in 3.7, is the RC from experiment close to the RC calculated using the theoretical equation? If not, why?

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Report:

The report should include:

1. All results obtained from the experiment.
2. Discussion and Conclusion on the results.
3. Answers on all questions.

The report is due by next week after the laboratory.

Revised by WL on 07/09/2013

Appendix1:

Display section

1. The *Power*(On, Off) control is the switch controls AC power to the instrument.
2. The *Intensity* control is used to set the brightness of the trace.
3. The *Focus*control is used to narrow the beam into the sharpest trace. There may be an auxiliary astigmatism control for focusing.
4. The etched faceplate in the CRT face that appears as vertical and horizontal graph lines is called the *graticule*. Linear calibration markers (height and width) are frequently etched on the graticule.

Vertical deflection section

5. The *Verticalinput coupling*(AC, DC and GND) connects or disconnects the incoming signal.
6. The *Vertical input mode*(CH1, CH2, DUAL(CHOP/ALT are auto set by TIME/DIV. switch), ADD) selects the waveforms of the specified channel to be displayed.
7. The *Verticalposition*control is used to position the trace on the CRT screen.
8. The *VOLT/DIV*controlis calibrated to measure the amplitude of signal waveforms along the vertical axis. The *Variable(Vernier)* control is a concentric control in the center of the VOLTS/DIV. control to provide a more sensitive control of the vertical height of the waveform on the screen. The variable control also has a calibrated position (CAL) either at the extreme counter-clockwise or clockwise position.

Horizontal deflection section

9. The *TIME/DIV*control is calibrated to measure time along the horizontal axis. The center*Variable (Vernier)*control provides a more sensitive adjustment of the sweep rate on a continuous basis. In its extreme clockwise position, usually marked CAL, the sweep rate is calibrated.
10. The *Horizontal position*controlis used to position the trace on the CRT screen.

Triggering section

11. The *Triggering* controls determine the manner in which a trigger pulse is initiated to start the sweep generator. The typical dual trace scope has anumber of controls associated with the selection of the *triggeringmode*(Auto, normal, single)
12. *Triggeringsource*(CH1, CH2,external or line)select signal source for triggering.
13. *Triggering coupling*(DC, AC, noise reject, HF reject, LF reject) select method by which it is couple,
14. *Triggering level* select the Levelat which the sweep is triggered (- ⟵ 0 ⟶ +) and *triggering slope*select the slope (+ (rising) or – (falling)) at which triggering takes place
15. The *X-Y* switch. When this switch is engaged, one channel of the dual-trace scope becomes the horizontal, or X input, while the other channel becomes the vertical, or Y, input. In this condition the trigger source is disabled.