EXPERIMENT 2
OSCILLOSCOPES AND SIGNAL GENERATORS

In many applications, observing certain voltage waveforms plays a crucial role in understanding the operation of the circuit. For that purpose, several measurement instruments are utilized, such as a voltmeter, ammeter, or oscilloscope. An oscilloscope is a voltage-sensing electronic instrument used to visualize specific voltage waveforms. Oscilloscopes are exploited to display the variation of the voltage waveform. An oscilloscope is illustrated in Figure 1. Read the *notes on the oscilloscope* for more information about the oscilloscopes.

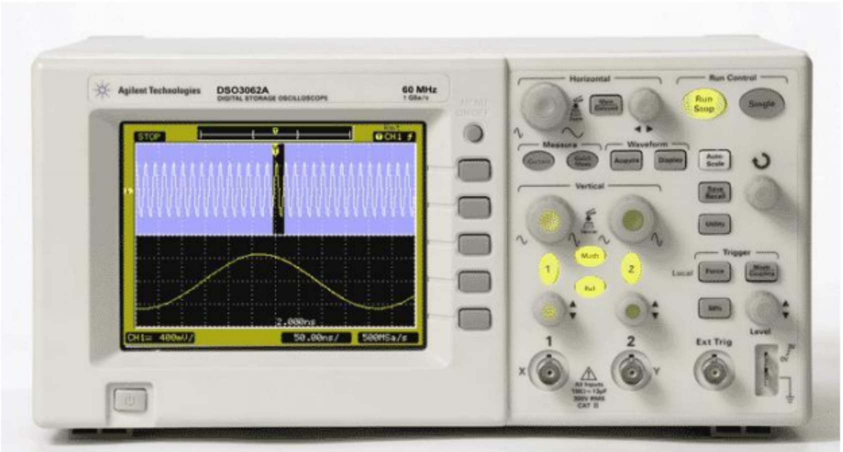


Figure 1. Oscilloscope

2.1 Objective:

In this experiment, you will learn how to operate a digital signal oscilloscope (DSO) and frequency signal generators. Mainly, it is emphasized on:

i. How to determine the amplitude and frequency of a signal using DSO,
ii. X-Y mode operation in this oscilloscope.
iii. RMS measurement of various waveforms

2.2 Equipment List:

- DSO
- Function/Arbitrary Waveform Generator
- CADET
- Multimeter
- Carbon Resistors (five 1kΩ, 3.3 kΩ, 10 kΩ),

2.3 Theoretical Background – The Average and Root-Mean-Square (RMS) values:

Two quantities are of considerable interest in describing waveforms: the average and root-mean-square (RMS) values.

The average value of a time-varying voltage v is defined as

$$V_{av} = \frac{1}{T}\int_0^T V(t)dt$$

where T is the wave period. Symmetry is essential for the efficient evaluation of this equation. Sometimes, we only need to integrate over one-half or one-fourth of the period to find the average value.

For a sinusoidal wave, the average value over a cycle is zero. The area under the positive half cycle of the wave is equal to the area under the negative half cycle.

The RMS value of a voltage waveform is defined as

$$V_{rms} = \sqrt{\frac{1}{T}\int_0^T V^2(t)dt}$$

This is also called the effective value. A waveform with a given effective value will heat a resistor as much as a constant voltage of the same value would. If v is a square wave or a linear function of t (triangular wave), the integration is quite straightforward.

2.4 Preliminary Work:

Read the notes on the oscilloscopes given in the *notes on the oscilloscope* (especially the section on *Measurement Techniques* and *Controls)*. Learn the operation principles of the oscilloscopes and be familiar with the utilities of the buttons on oscilloscopes.

1. Find the voltage between nodes Y and G in Figure 2, where $R_1 = R_2 = R_3 = R_4 = R_5 = 1k\Omega$ and $V_1 = 4.5\sin(4000\pi t)$ Volts and $V_2 = 10$ Volts

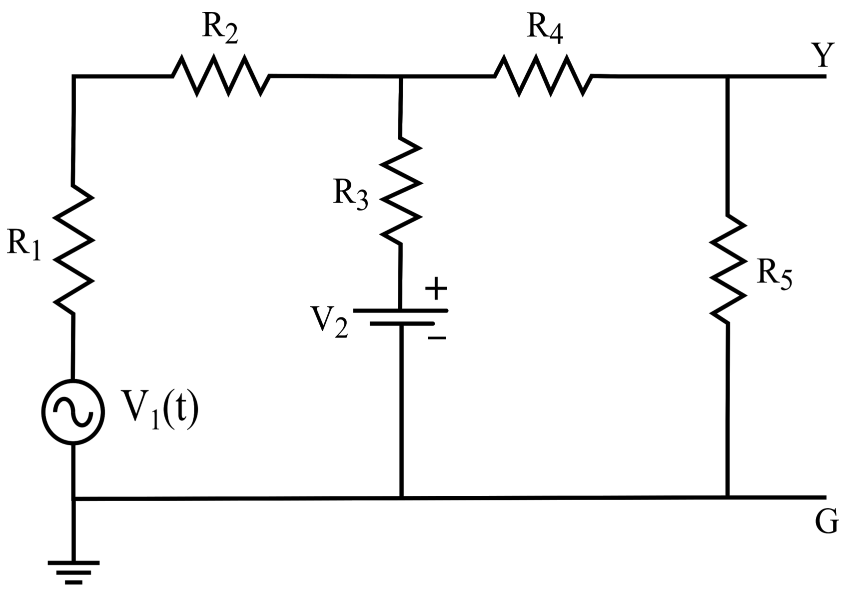


Figure 2

2. Calculate the period of the signals in Table 1, and fill the period column.

Table 1

$V_1(t) = V_{peak}\sin(2\pi ft)$ volts		
V_{peak}	f(Hz)	T=1/f (msec)
3	250	
6	1250	
6	5000	

3. $V_1(t)$=2 sin(4000πt) volts ie. $V_1(t)$ is a sinusoidal signal with a frequency of 2 kHz and a peak amplitude of 2V. According to the following DSO settings of CH1, sketch the waveform, $V_1(t)$. (Be neat, pay attention to positions of maxima and minima of the waveform)

DSO Settings:
CH: CH1, **MODE:** YT, **COUPLING:** AC**, VOLTS/DIV:** 1V**, TIME/DIV:** 0.1ms

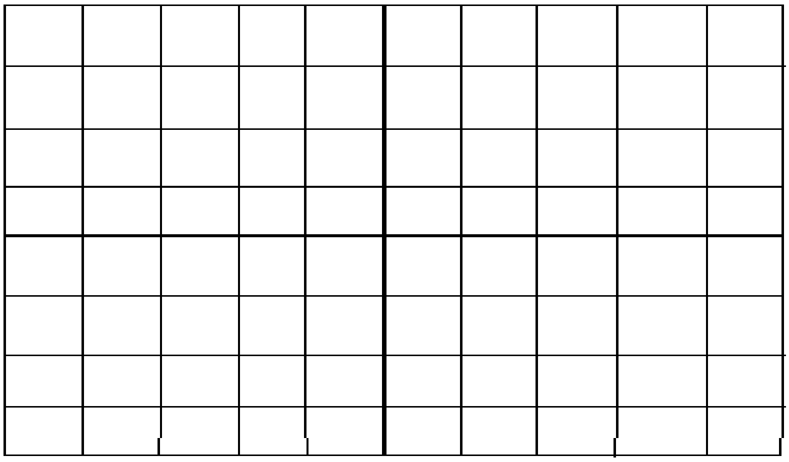


Figure 3

2.5 Experimental Work:

Important: Show a sample of the measurement in each work to the conducting research assistant for **RA signature.**

1.

i. Turn the oscilloscope on.

ii. Connect the signal lead of the probe corresponding to Channel 1 (CH1)

iii. Set the circuit given in Figure 5.

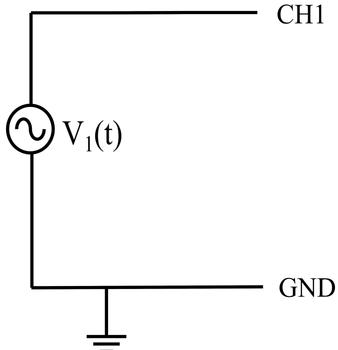


Figure 5

iv. Using the controls on the function generator, set $V_1(t)$= 2sin(4000πt), and observe the signal on the oscilloscope screen (Use the function generator, which is on the left side of your CADETs).

v. Plot the signal on your report sheet and write the period and amplitude of this signal by using the oscilloscope. Don't forget to write your DSO settings.

2. Measure the RMS values of

a. $V_1(t) = 3\sin(4000\pi t)$
b. The triangular waveform of $4V_{pp}$ and 2 kHz

using the circuit in Figure 5 on both oscilloscope and multimeter and sketch them on the same graph on your report sheet.

3. Set up the circuit in Figure 2. Plot the voltage waveform between node Y and node G. Compare the result with your calculation. **Be sure that the DSO is at DC mode** where R_1= R_2= R_3= R_4= R_5=1kΩ, $V_1(t)$= 4.5sin(4000πt), V_2=10 V

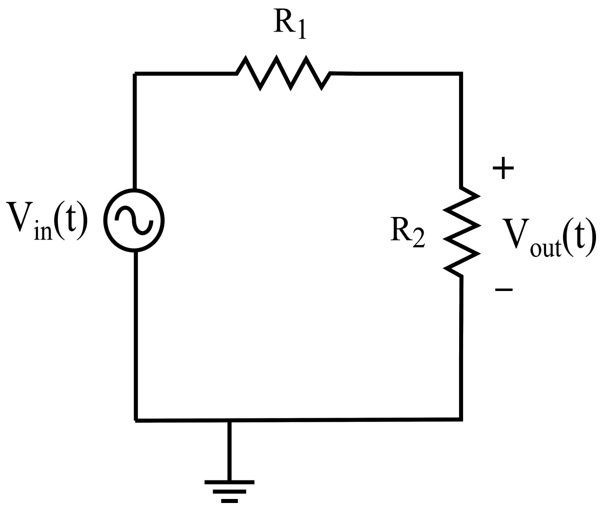


Figure 6

4. Set up the circuit in Figure 6 where R_1= R_2=1kΩ, $V_{in}(t)$= 2sin(2000πt)

a. Observe and plot the $V_{in}(t)$ and $V_{out}(t)$ simultaneously(DUAL MODE).
b. Set the DSO to X-Y operation. Observe and plot the figure on the screen.
c. Replace the R_2 with 3.3kΩ and 10kΩ resistors, respectively. Repeat step **b**.

EXPERIMENT 1 PART 2
REPORT SHEET

Name & Surname :

Date :

Experimental Work:

1.

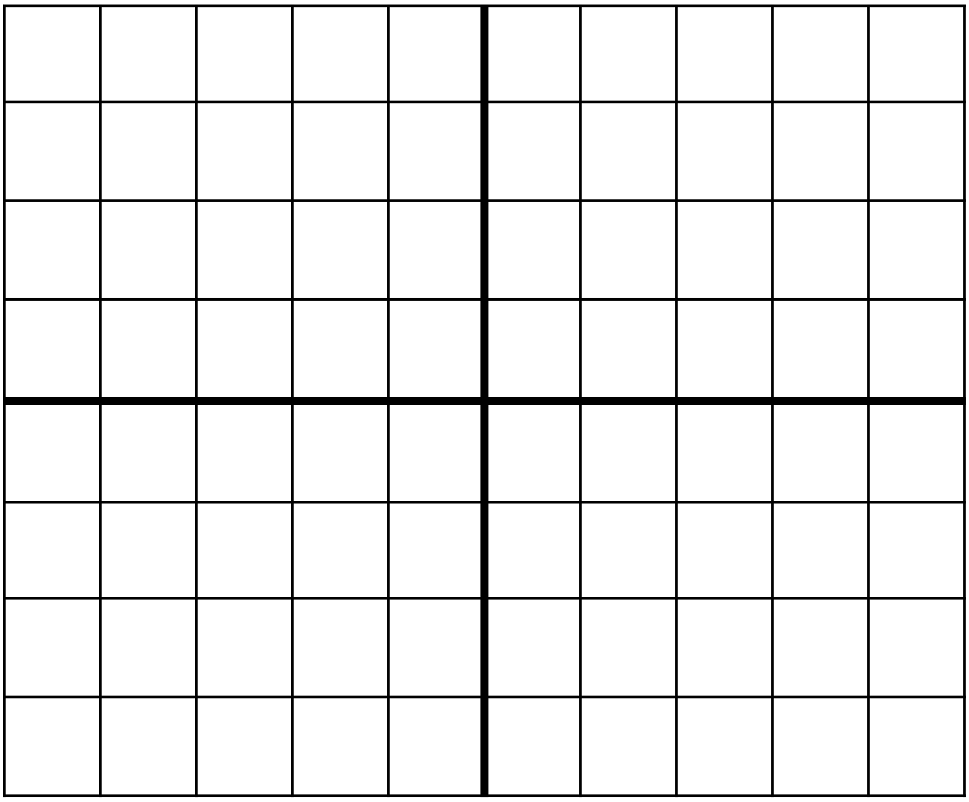
DSO Settings

CH:	**MODE:**	**COUPLING:**
VOLTS/DIV:	**TIME/DIV:**	**PERIOD:**

RA Signature:

Comment:

2.



DSO Settings

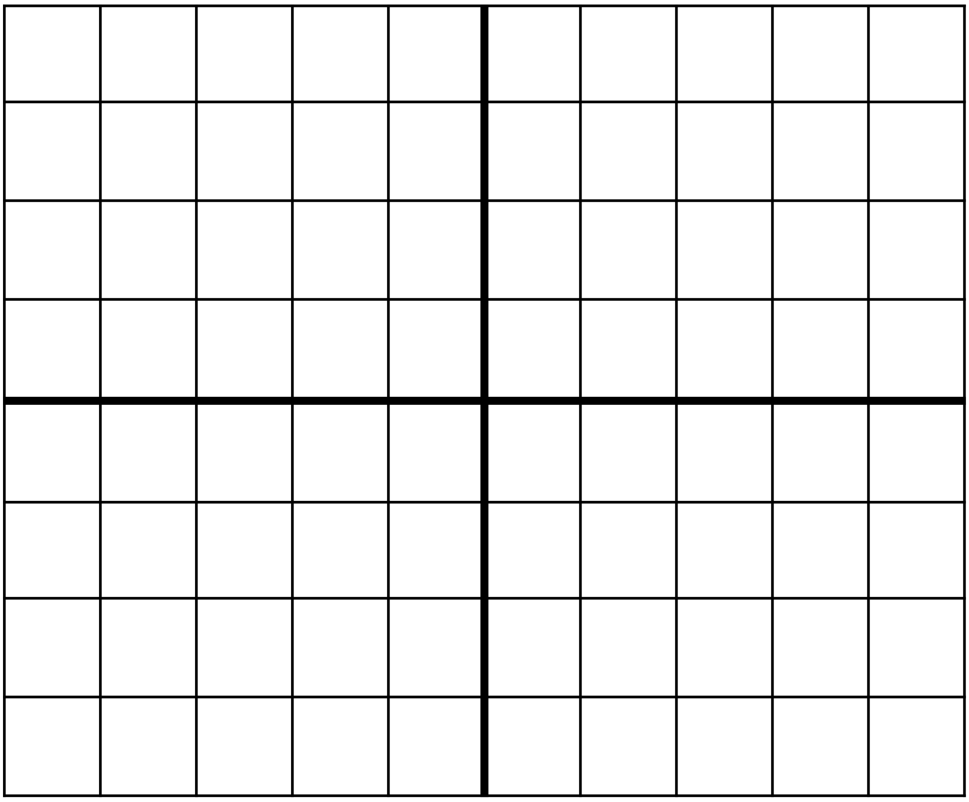
CH: **MODE:** **COUPLING:**
VOLTS/DIV: **TIME/DIV:** **PERIOD:**

i. RMS:......... (DSO)
RMS:......... (Multimeter)

ii. RMS:......... (DSO)
RMS:......... (Multimeter)

RA Signature:

3. V_{YG} = ………………… + ……………..sin(4000t) V (DC and AC components)



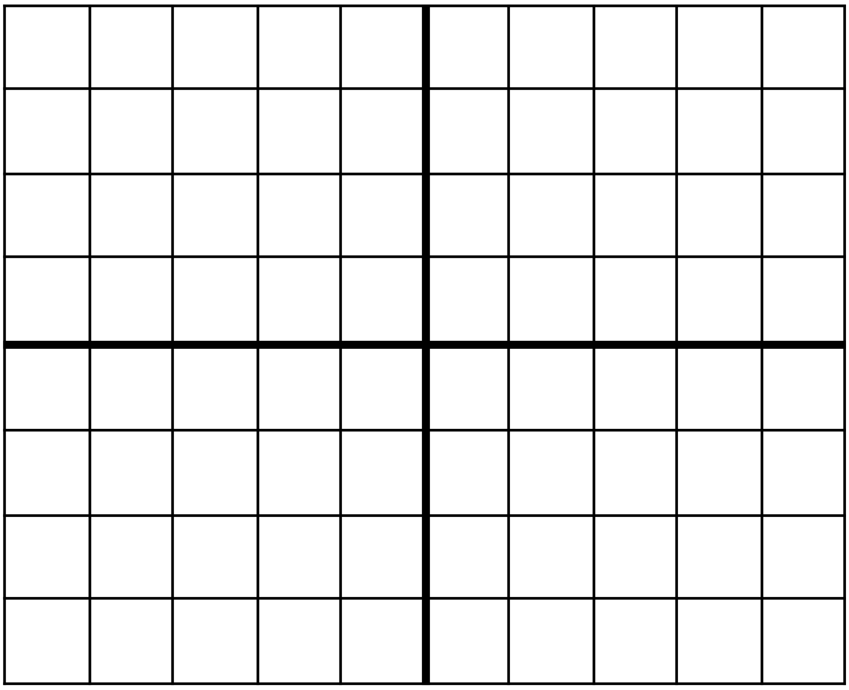
DSO Settings

CH: **MODE:** **COUPLING:**

VOLTS/DIV: **TIME/DIV:** **PERIOD:**

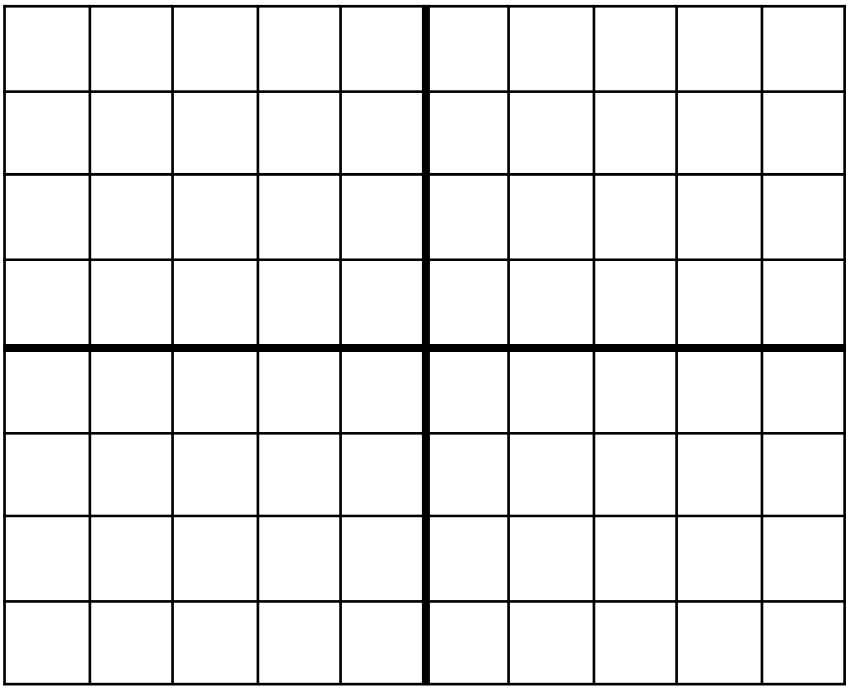
RA Signature:

4.



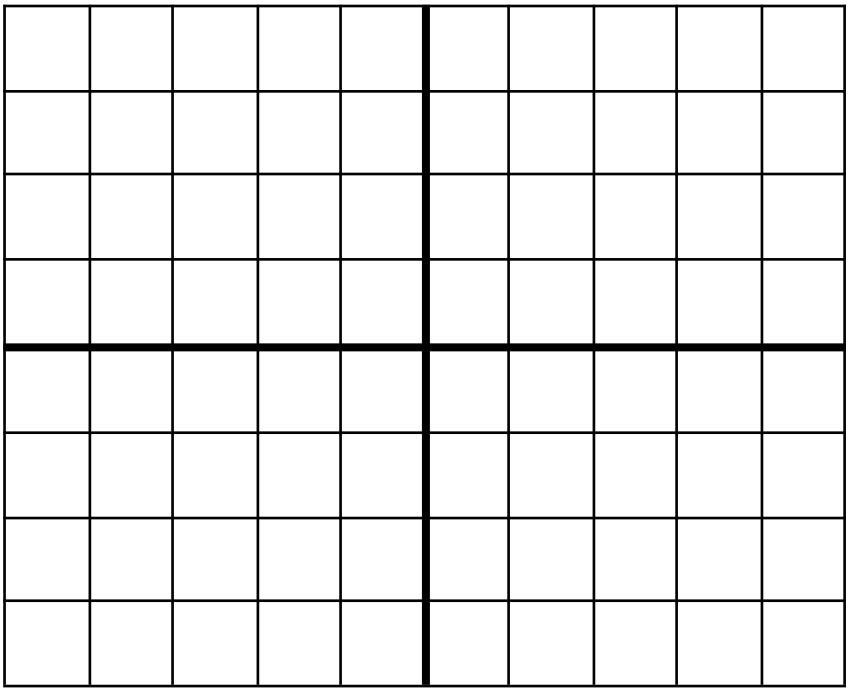
DSO Settings (a)

CH: **MODE:** **COUPLING:**
VOLTS/DIV: **TIME/DIV:** **PERIOD:**



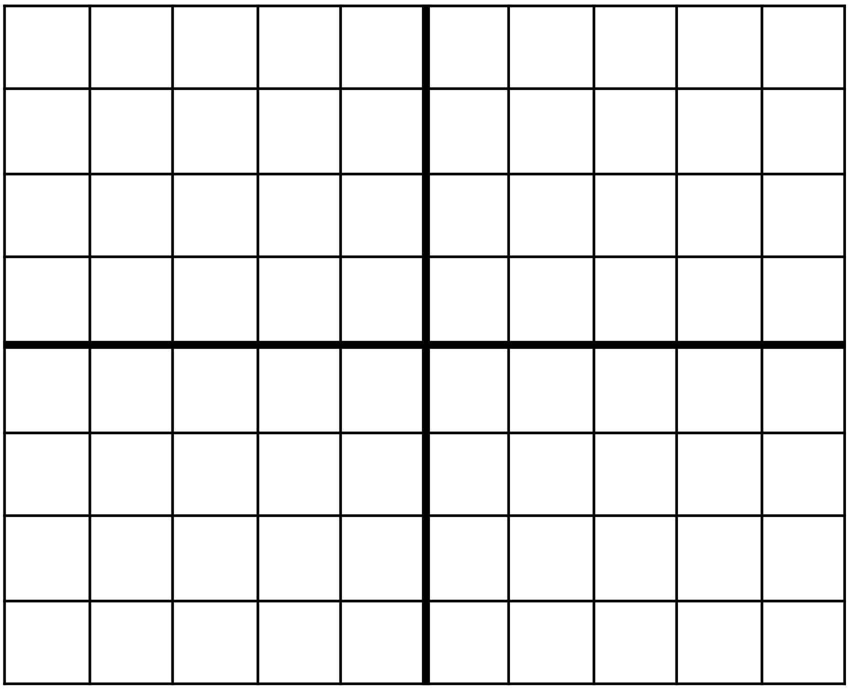
DSO Settings (b)

CH: **MODE:** **COUPLING:**
VOLTS/DIV: **TIME/DIV:** **PERIOD:**



DSO Settings (c for 3.3 kΩ)

CH:	**MODE:**	**COUPLING:**
VOLTS/DIV:	**TIME/DIV:**	**PERIOD:**



DSO Settings (c for 10 kΩ)

CH:	**MODE:**	**COUPLING:**
VOLTS/DIV:	**TIME/DIV:**	**PERIOD:**

RA Signature: