Introduction

Lab Goals

1. Generate test signals such as sinusoidal, triangular, and square waveforms with adjustable amplitude and frequency.
2. Understand how to level-shifted[up or down] with the addition of a dc-offset component
3. Measure dc and/or ac voltage & current, resistance, and frequency
4. Display voltage wave forms on CRT

Procedure

1. Connect the dc-circuit shown in the figure below. Set the oscilloscope controls as follows: Signal Coupling (**CHx Menu**→Coupling) dc, Y-Position (VERTICAL **POSITION** knobs) **screen centre,** and Vertical Sensitivity (**VOLTS/DIV** knobs) **1V/div** for both channels "1" and "2"

   Connect channels "1" and "2" to the display voltage waveforms nodes (1) and (2) respectively

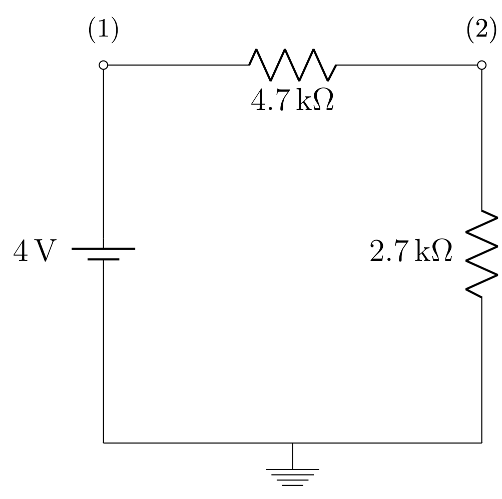

Fig. 1: Connect the nodes to the oscilloscope

2. Use the oscilloscope to measure the voltages nodes (1) and (2)

$$\mathbf{v}_{(1)} = 4.0\text{V} \qquad \mathbf{v}_{(2)} = 1.45\text{V}$$

3. Use the DMM to measure the voltages nodes (1) and (2)

$$\mathbf{v}_{(1)} = 4.052\text{V} \qquad \mathbf{v}_{(2)} = 1.493\text{V}$$

4. With the oscilloscope as in step # 1, set the following additional controls as: Horizontal Sensitivity (**SEC/DIV** knob) **0.2 msec/div**, Trigger Source (**TRIG MENU** → Source) **CH1**, and the Trigger Slope (**TRIG MENU** → Slope) **Rising**

   Replace the dc-source in the circuit of Fig. 1 with the **function generator**. Set the controls of the function generator to provide a **sinusoidal** voltage of **2V (peak)** with a frequency of about **1kHz** node(1).
   Use the DMM to measure the **voltage and frequency**[using the dual display of the DMM] of the signal node(1). Adjust the frequency of the function generator to exactly **1kHz**

   DMM reading: Frequency = 1061Hz   **V(1)** = 1.3453V

5. Set the **"waveform-select"** control of the function generator to **square wave**, and use the DMM to measure the voltage and frequency node(1)

   DMM reading: Frequency = 1058Hz   **V(1)** = 1.9511V

6. Set the waveform-select control of the function generator to **triangular wave**, and use the DMM to measure the voltage & frequency node(1)

   DMM reading: Frequency = 1054Hz   **V(1)** = 1.1299V

7. Use the **"dc-offset"** control of the function generator to provide a **triangular** wave of **4V (peak-to-peak)** with an average **average value of 2V** at a frequency of **1kHz** node(1). Note that the amplitude of the waveform is now fluctuating in the voltage range: **0.0V to 4V** 1kHz. Use the DMM to measure each of the following voltage entries node (1):
   a) The dc-component $\mathbf{v}_{(1)}$ [**dc-value**] = 1.6277V,
   b) The ac-component $\mathbf{v}_{(1)}$ [**dc-value**] = 1.1312V,
   c) The dc+ac-component $\mathbf{v}_{(1)}$ [**ac+dc-value**] = 1.9822V

8. Set the controls of the function generator [with the help of your oscilloscope] to provide a sinusoidal signal to provide a sinusoidal signal of **20mV (peak)** with an average value of **2V** at a frequency of **1kHz** node (1)
   Use the DMM to measure the dc and ac components of the voltage node(1) and record your values in table 1.

9. Set the "frequency" control of function generator to each of he values listed in table 1, and repeat the step above.

10. Use the oscilloscope to measure the phase angle θ of $\mathbf{i(t)}$ relative to $\mathbf{v}_{(1)}\ \mathbf{(t)}$. This measurement can be performed in **one-out-of-two** ways depending on the mode of operation of the oscilloscope [**(Y-Time)** or **(X-Y) mode**]

Y-Time-display mode = 63.4degrees
X-Y-display mode = 63.24degrees

Results

Table 1: DMM Measurements

Frequency (kHz)	DC Component (V)	AC Component (mV)
1.0	50.13	6.83
10.0	51.33	9.78
100.0	51.05	8.23
1000.0	51.29	10.60

Conclusion

1. Compare your measurements from steps #2 and 3. Which set of measurements would you consider more accurate, and why?

   The DMM is a tool built for making precise measurements of signals, enabling readings of up to eight digits of resolution for the voltage, while the oscilloscope focuses more on the wave behavior. Therefore, our voltage calculations for step 3 are expected to be more accurate.

2. The DMM ac-reading is called the **"root-means-square (RMS)"** value of the signal (voltage or current) waveform. For the standard waveforms, such as sinusoid, square, and triangular, the RMS-value is related to the peak-value of the signal as follows
   Use the table above to check weather your measurements from steps #4, 5, and 6 are accurate enough.

   Sinusoid:The recorded value is slightly different due to minor human error and precision errors.

Table 2: RMS-Peak relation for different waveforms

Type of waveform	[RMS-value]/[peak-value]
sinusoid	$[2]^{-0.5}$
Square	1
Triangular	$[3]^{-0.5}$

Square:The peak value recorded for the square wave is 1.1194 which is also marginally larger than the RMS value.

Triangular: Recorded values of the triangular wave was also slightly different than the expected value which was 0.577

3. Under what conditions would you set the oscilloscope coupling-control to **ac**?

   The oscilloscope would be set to AC if a small AC signal is found on very high DC circuits. This would be done to block the DC signal from overpowering the AC signal. By doing this, we are able to view small discrepancies in the wave

4. Discuss the results of your measurements listed in table 1.

   By observing table 4.1, it can be concluded that as the frequency is increasing, the voltage of AC and DC are decreasing. So it can be concluded that the frequency is inversely proportional to the current

5. In comparing the two methods of phase measurement, which one do you think is more accurate, and why?

   When observing step 11, two formats can be found. It can be said that the xy format is more useful and accurate as it is used for graphing IV curves. Also, it allows us to see channel 1 and channel 2 in more detail with better resolution.