EEE102-02 Lab 1 Report:
Introduction to Digital Oscilloscopes

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Purpose:

In this lab, we learn how to use a digital oscilloscope and a signal generator. We also learn how to build a basic circuit on a breadboard and analyze that with aforementioned lab equipment.

Methodology:

When performing this experiment, I used DXOX2002A digital oscilloscope with function generator. In task one, compensation should adjust the capacitance of the probe to balance it to the oscilloscope that is used. In task four, sample acquisition mode samples the signal and presents that data directly. Average mode takes multiple samples of the waveform and averages the same points to reduce noise but cannot be used when waveform is changing. Peak detect mode acquires minimum and maximum values of a signal between the sample points to detect narrow peaks accurately. In task five, AC coupling adds a series capacitor to block the DC part. In task six, increasing the frequency should decrease the capacitive reactance, resulting in less phase and voltage difference.

Results:

Task 1:

I checked that the attenuation factor of the probe is set to 10x on both the oscilloscope and the switch on the probe. I plugged in my probe to channel 1 input of the oscilloscope and connected the tip and ground clip of the probe to probe comp. and ground terminals on the oscilloscope. I pressed the “Auto Scale” button to better see the compensation waveform. The waveform before compensation can be seen in Figure 1.1. Then, using the tool that had come with the probe, I turned the compensation screw until the top and bottom edges of the waveform became straight.

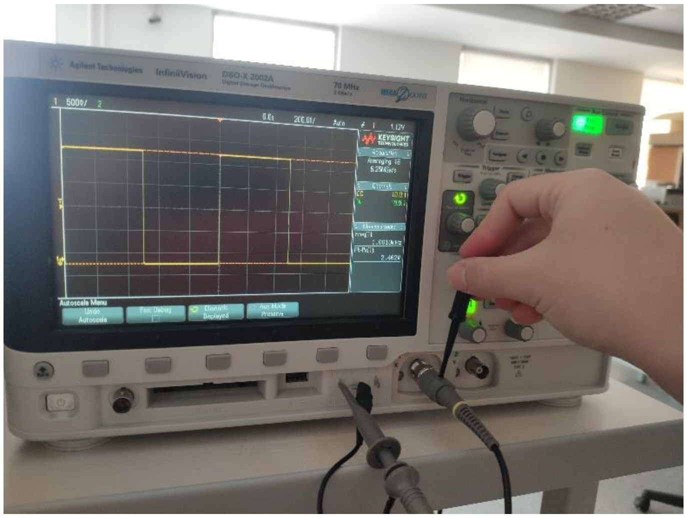

Figure 1.2 Compensating the probe.

Task 2:

The oscilloscope I used has a built-in signal generator. So, I plugged in a BNC cable to the signal generator output of the oscilloscope. I turned on the signal generator by pressing the “Wave Gen” button and set the waveform, frequency, and amplitude to required values by pressing the corresponding interface button and turning the adjustment knob. Finally, I adjusted seconds per division, volts per division and vertical position using corresponding knobs to see the waveform centered and fitted to the screen.

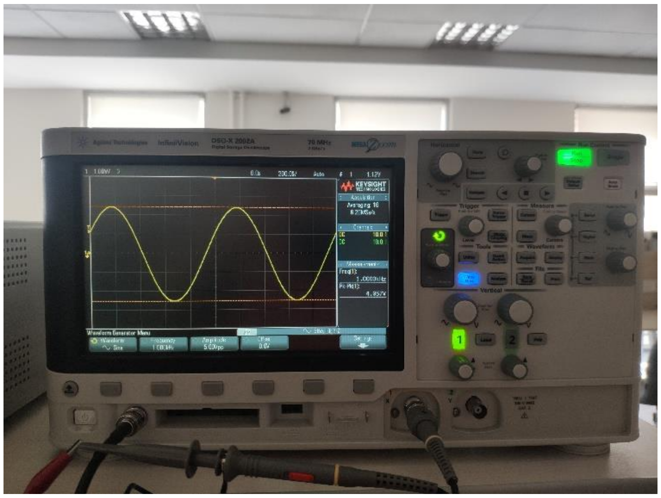

Figure 2.1 5Vpp 1kHz sinusodial signal.

I pressed on the “Trigger” button to open the trigger menu. I saw that slope is set to positive. This means that the trigger point is on the rising edge of the waveform. I changed slope to negative. Now, the trigger point is on the falling edge and the falling edge is displayed at the center of the screen.

Figure 2.2 Rising edge trigger.

Figure 2.3 Falling edge trigger.

Task 3:

I adjusted the signal generator settings again as required. At first the wave was not visible, probably because 1 Vpp is too low for the attenuation circuit on the probe. I had to switch the attenuation switch of the probe to 1x and set it as 1x on the oscilloscope as well. I also had to lower the trigger level for triggering to occur because it was higher than the peak of the waveform.

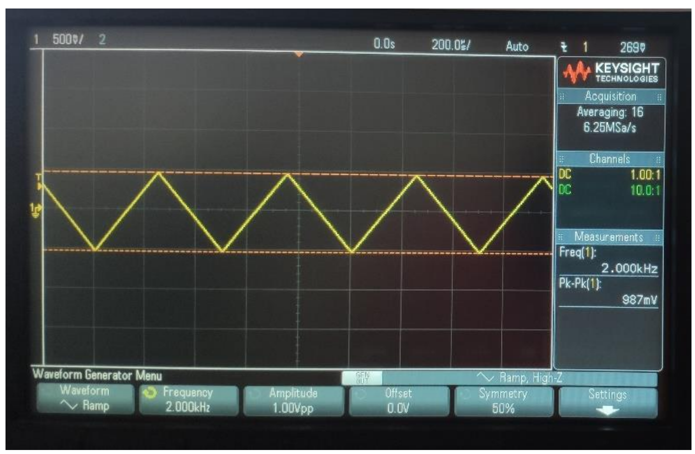

Figure 3.1 1Vpp 2kHz triangular signal.

Triggering is used for fixing the waveform on the screen to study the shape of the waveform. Trigger level determines at which voltage level triggering occurs. As I turn the trigger level knob, I see that the waveform moves left or right to where it intersects the trigger level at the center of the screen. Oscilloscope screen at different trigger levels can be seen in figures 3.2-3.5.

Task 4:

Analog to digital converters create digital data that represents the analog signal feeded to its input. Digital to analog converters take digital data that represents an analog signal and reconstruct that analog signal. Digital oscilloscopes use an analog to digital converter to sample the waveform and convert the voltage level to digital information.

I adjusted the signal generator settings again as required and achieved the following waveform with acquisition set to averaging:

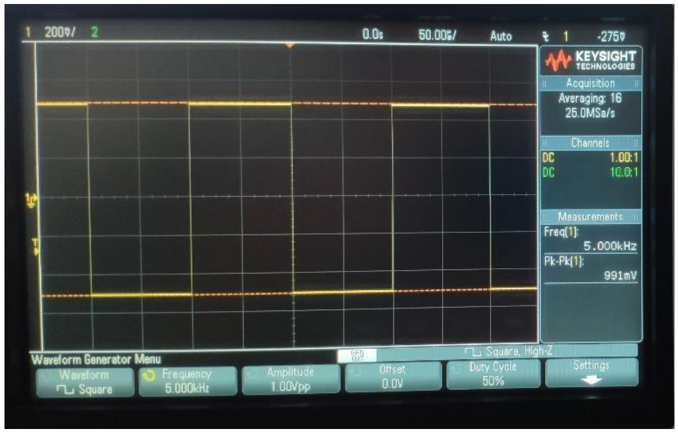

Figure 4.1 1Vpp 5kHz square signal, Acquisition: Averaging.

As expected, averaging reduces noise by averaging multiple samples at the same sample point.

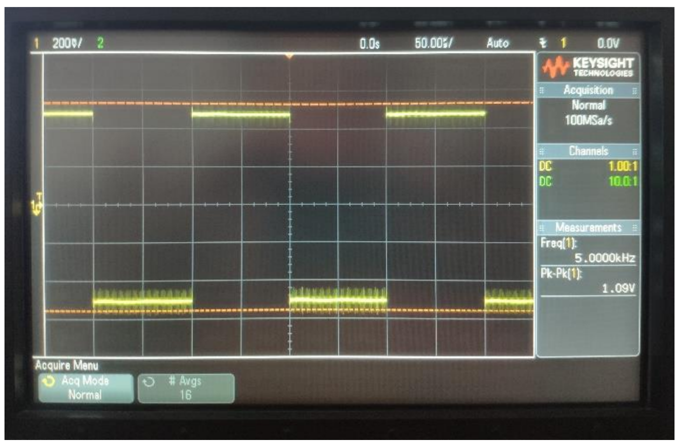

Figure 4.2 1Vpp 5kHz square signal, Acquisition: Sample.

When I set the acquisition mode to sample, the noise became visible as yellow marks around the waveform.

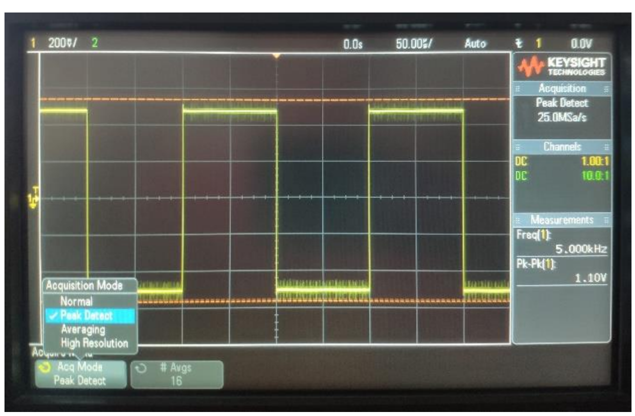

Figure 4.3 1Vpp 5kHz square signal, Acquisition: Peak Detect.

When I set the acquisition mode to peak detect, the only change I saw was that the rising and falling edges of the waveform became more visible compared to sample mode.

Task 5:

I adjusted the signal generator settings again as required and achieved the following waveform with a DC offset:

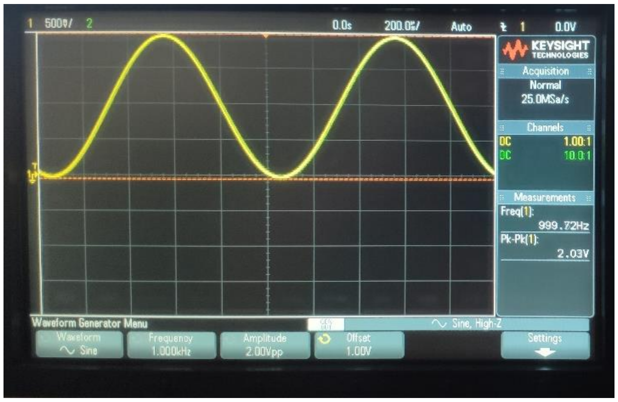

Figure 5.1 2Vpp 1kHz sinusodial signal with a 1V DC offset.

The signal oscillates between 0V and 2V because of the 1V DC offset. Then, from the oscilloscope's channel 1 menu I set coupling to AC:

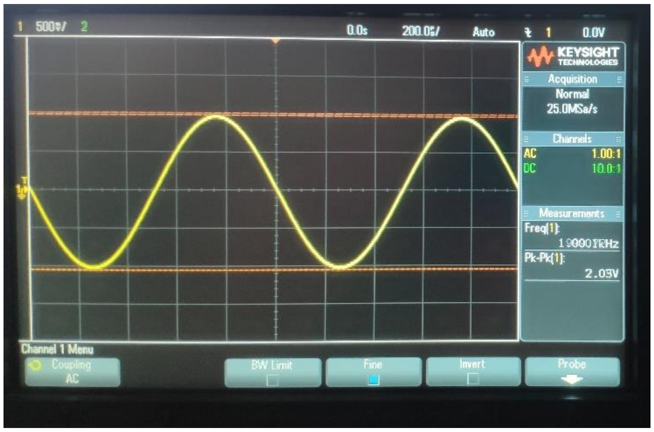

Figure 5.2 Coupling set to AC.

Now, the signal is displayed between -1V and 1V as if there were no DC offset. This is expected as AC coupling only acquires AC component of a signal.

Task 6:

A breadboard is used when building a prototype circuit and experimenting with the circuit easily. You can plug jumper cables and components into the holes on it. There are common terminals that are connected together along both long sides of the breadboard. And on the middle, there are groups of 5 holes that are connected together.

I built the required circuit for this task on a breadboard.

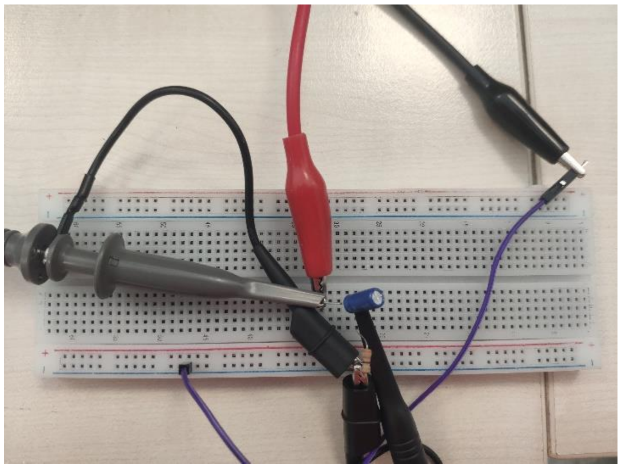

Figure 6.1 Circuit on a breadboard.

After adjusting the signal generator, I inspected both signals on the oscilloscope at 1KHz and 100KHZ. Then, I used measurement options built-in on the oscilloscope to measure the peak-to-peak voltages and calculated the difference.

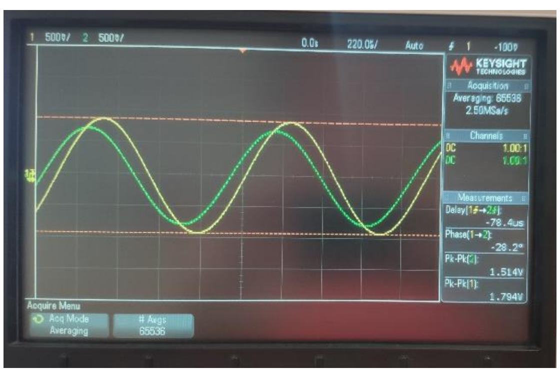

Figure 6.2 Waveform at 1 kHz

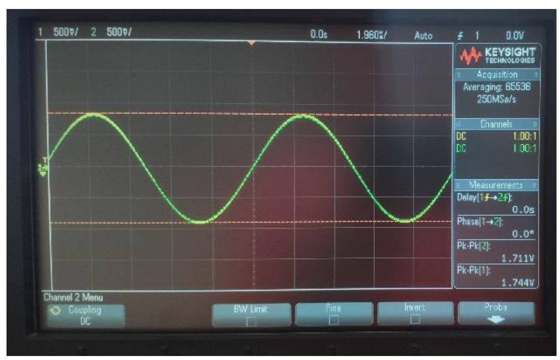

Figure 6.3 Waveform at 100 kHz

Frequency	Vpp of X	Vpp of Y	Difference
1 kHz	1.794 V	1.514 V	280 mV
100 kHz	1.744 V	1.711 V	33 mV

Table 6.1 Voltage differences

Finally, I used time cursors to find out the delay between the signals and calculated the phase difference.

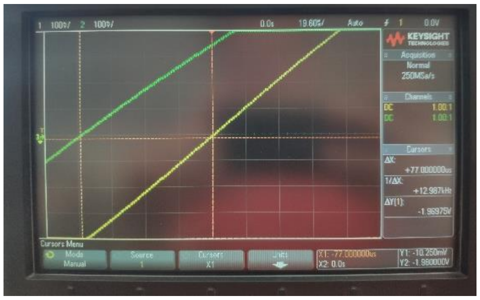

Figure 6.4 Delay at 1 kHz

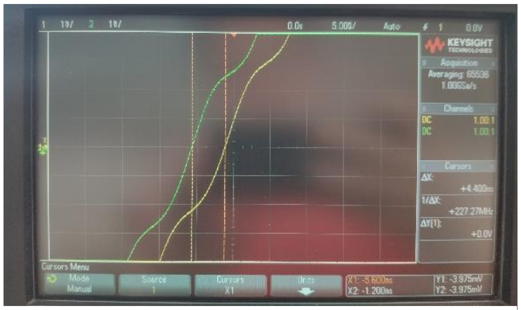

Figure 6.5 Delay at 100 kHz

Frequency (f)	Δt	Phase Difference = 2πfΔt
1 kHz	77 µs	0,484 rad
100 kHz	4.4 ns	0,00276 rad

Table 6.2 Time and phase differences

The results show that as frequency increases, voltage difference and delay decreases. Thus, supporting that as frequency increases capacitive reactance decreases.

Conclusion:

In this lab we got familiar with the basic functions of an oscilloscope and a signal generator. We also learned how to build a circuit on a breadboard and do measurements on that circuit. My experiment results were consistent with expected results. I also learned that when working with low voltages oscilloscope probe may needed to be switched to 1x, disabling the attenuation circuit.

Appendices:

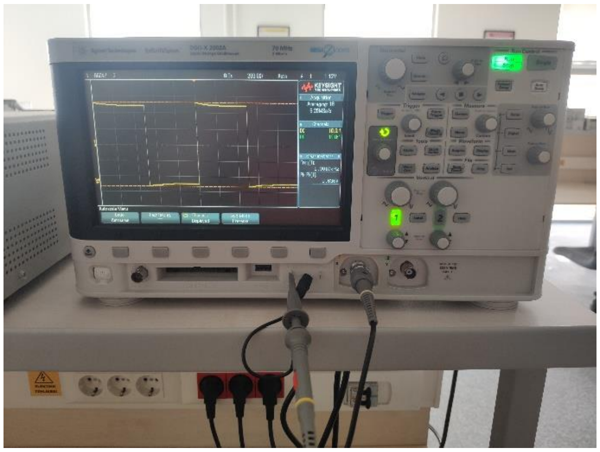

Figure 1.1 Signal before compensation

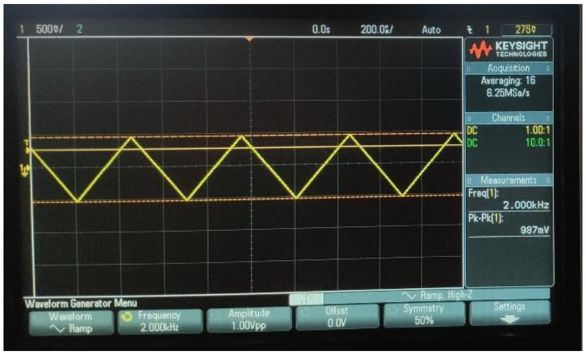

Figure 3.2 Trigger level: 275mV.

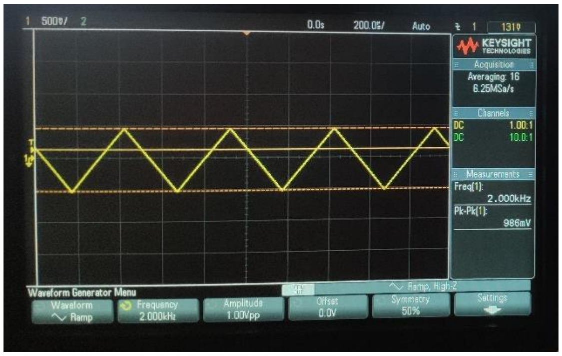

Figure 3.3 Trigger level: 131mV.

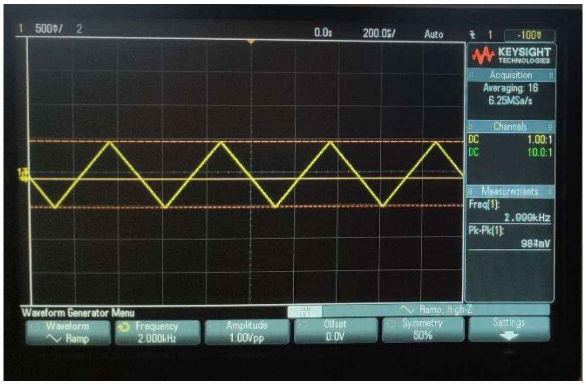

Figure 3.4 Trigger level: -100mV.

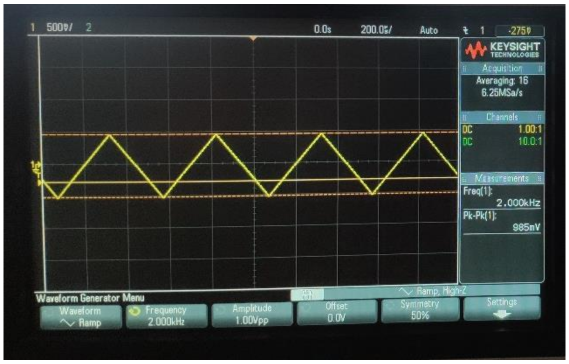

Figure 3.5 Trigger level: -275mV.