Report to Lab 1:
Introduction to Digital Oscilloscopes

Arda Özkut
22101727
Section 2
Physics Department, Bilkent University

(Dated: September 26, 2022)

I. PURPOSE OF THE EXPERIMENT

The purpose of this lab was to familiarise ourselves with the concepts and terms used when using Digital Oscilloscopes, learning how to use breadboards and building simple circuits using breadboards and jumper cables.

II. METHODOLOGY AND RESULTS

Task 1

Probe compensation is essential to take accurate measurements. One needs compensate the probe to balance the electrical properties of the probe relative to the oscilloscope. First I connected the ground and the probe to the compensation signal generator. I used the compensation tool until I got perfectly flat peaks.

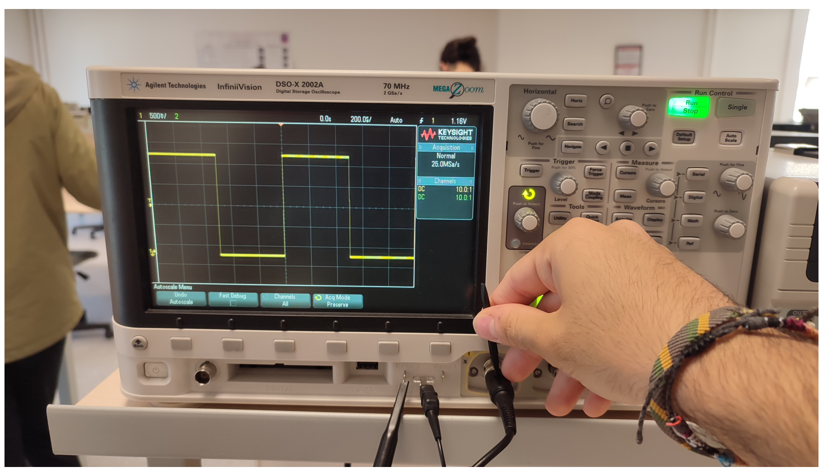

FIG. 1. Probe Compensation

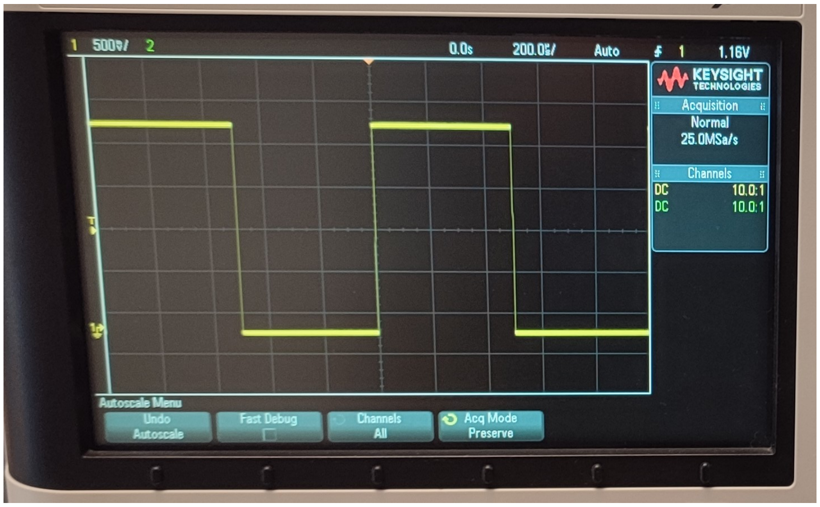

FIG. 2. Compensated Test Signal

Task 2

I used the signal generator function of the oscilloscope and generated a 5 V_{pp}, 1 kHz sinusoidal signal. I first observed it with rising edge triggering and then falling edge triggering.

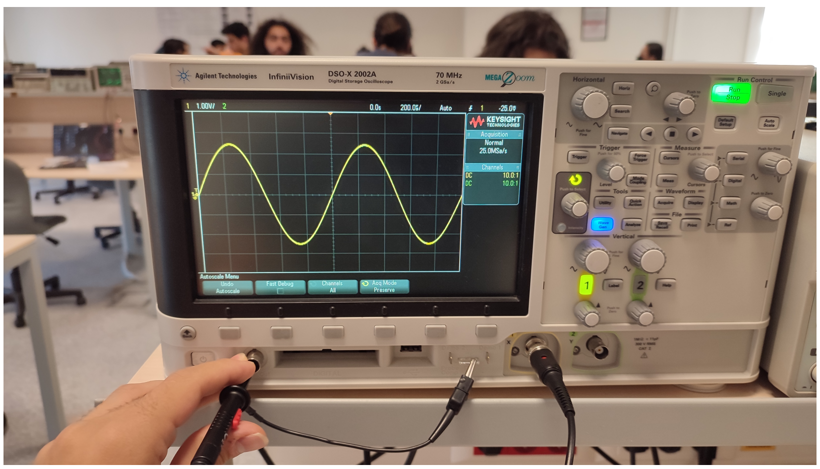

FIG. 3. Rising Edge Triggering, 5 V_{pp}, 1 kHz

With triggering mode changed we can observe that the sweeping value stayed the same. Falling trigger mode triggers the sweep at a location where the graph has negative slope whereas rising trigger triggers the sweep at a location where the graph has positive slope. This difference causes the waveforms to appear symmetrical.

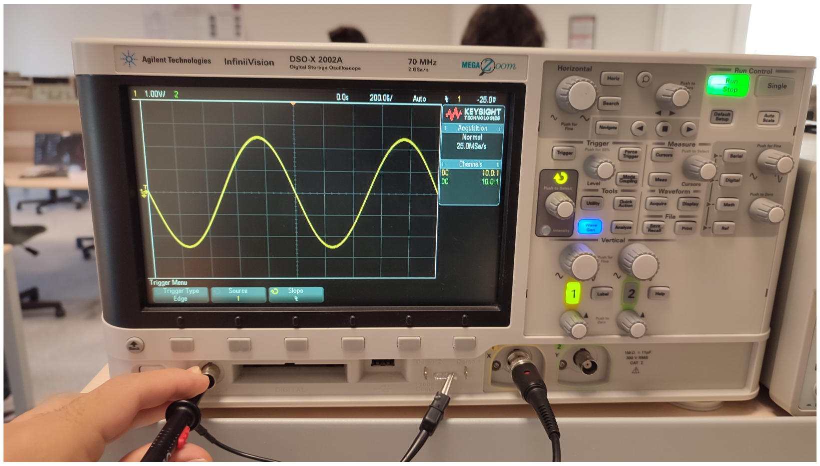

FIG. 4. Falling Edge Triggering, 5 V_{pp}, 1 kHz

Task 3

I applied a triangular wave with 2 kHz frequency and 1 V_{pp} value. When turning the trigger knob I observed that the trigger value changes. Trigger changes the value at which the sweep starts so we see the waveform shift horizontally. When the trigger value surpasses a certain value the curve begins to distort.

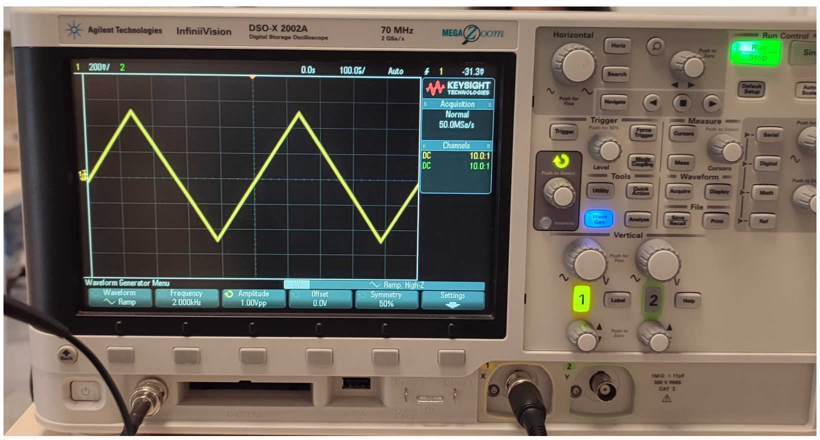

FIG. 5. Triangular Wave, 2 kHz, 1 V_{pp}

Trigger is the way oscilloscopes synchronises and sorts voltage and time data of the waveform to be displayed. The trigger determines where the oscilloscope will record the data that is taken or where the "horizontal sweeping" will begin.

Task 4

DAC, digital to analog converters are systems that take in digital signal and converts it to analog signal DAC are used in speakers and inside graphics cards to control brightness levels. ADC, analog to digital converters convert analog input to digital signal for digital systems to process, view and store. Digital oscilloscopes with function generators use ADCs to convert the signal from the probe into bits of information and DACs to generate desired waves.

I applied a square wave with 5kHz frequency and 1 V_{pp} value. I observed that different acquisition modes did not change the signal shape however averaging and high resolution modes resulted in lower noise in the peak and troughs.

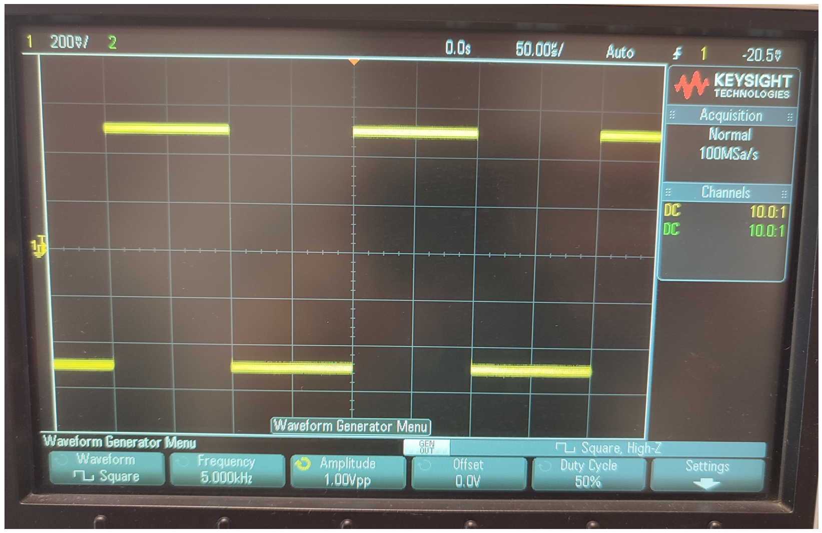

FIG. 6. Normal Acquisition, Square Wave, 5 kHz, 1 V_{pp}

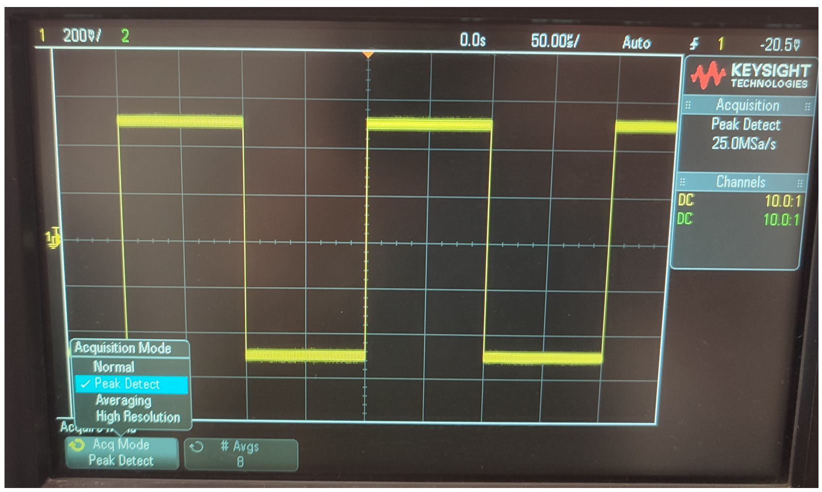

FIG. 7. Peak Detect Acquisition, Square Wave, 5 kHz, 1 V_{pp}

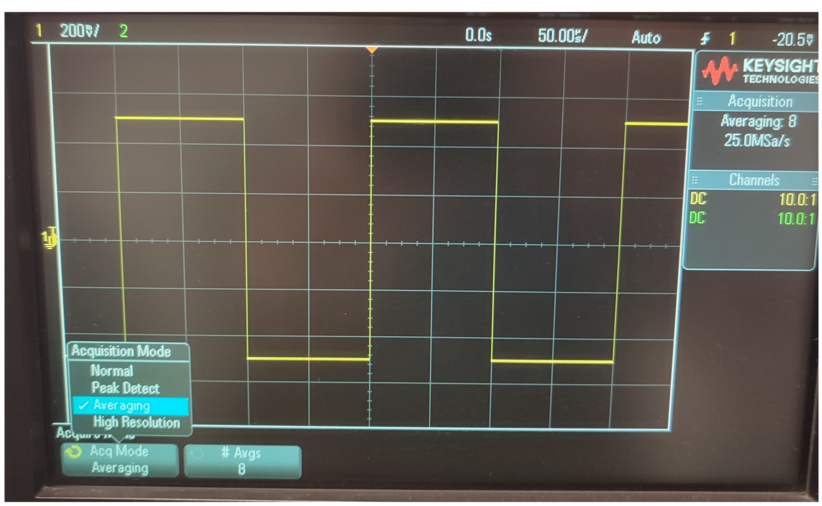

FIG. 8. Averaging Acquisition, Square Wave, 5 kHz, 1 V_{pp}

Task 5

I applied a sinusoidal wave with 1kHz frequency and 2 V_{pp} value. Then I set the DC offset to 1 Volts. I observed that AC coupling cancels out the effects of the DC offset and brings the signal to $y = 0$.

FIG. 9. DC coupling

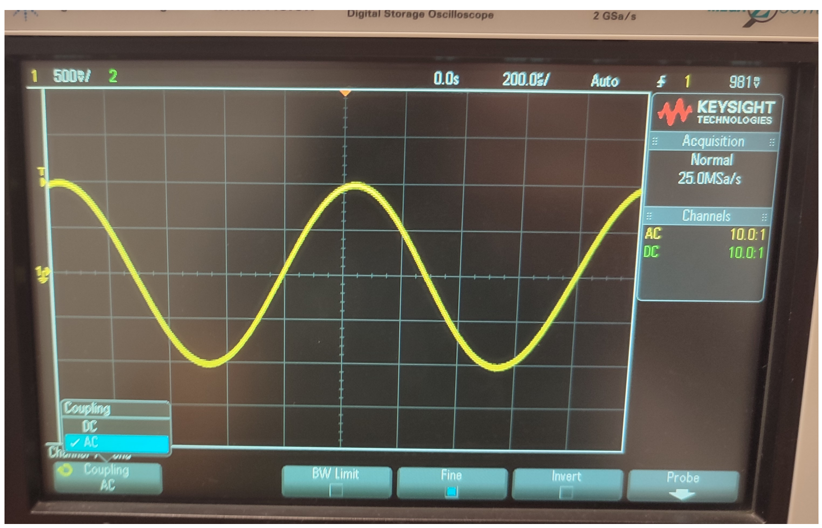

FIG. 10. AC coupling

Task 6

On a breadboard the rows marked with + and - are connected internally, the holes inside a column of the breadboard are also internally connected. When voltage is applied to a set of internally connected holes all the connections will have the same voltage value. We can use jumper cables to design basic and solder-less circuits.

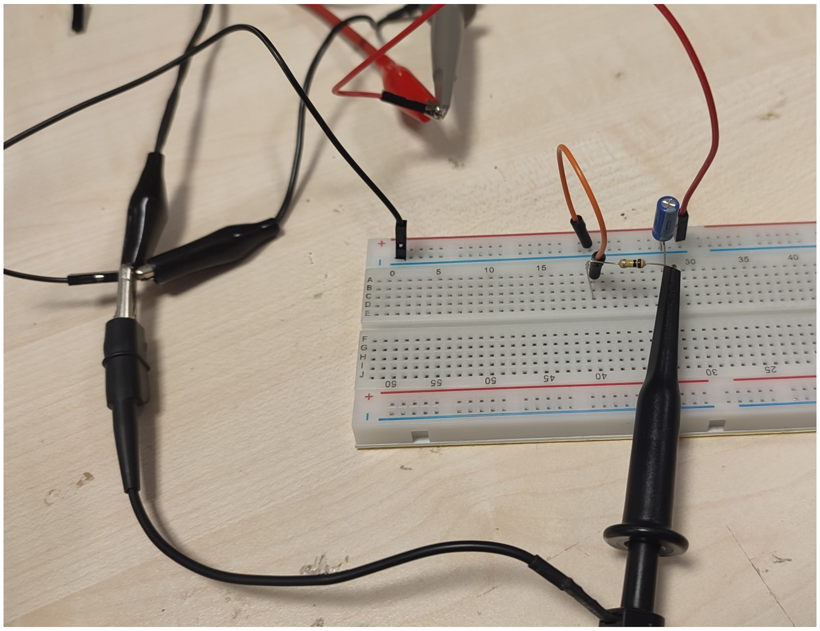

FIG. 11. The circuit constructed on the breadboard

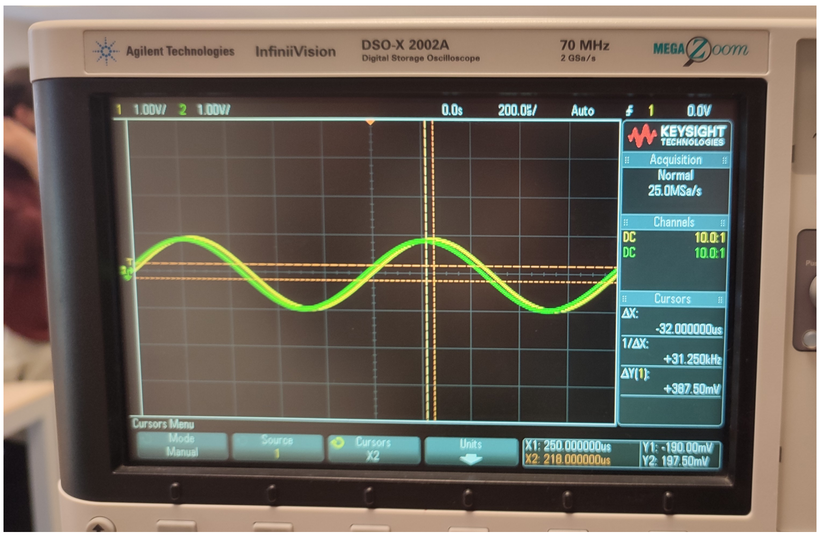

FIG. 12. $\Delta\Phi = 0.201rad$ at 1 kHz

I applied 1kHz frequency, 2 V_{pp} value sine wave then increased the frequency to 100kHz. With the help of the cursors I measured the ΔX of the peaks for the signal 32 μs at 1kHz and 60 ns at 100 kHz. At 1 kHz I observed the phase difference ($\Delta\Phi$) to be at 0.201 radians whereas at 100 kHz $\Delta\Phi = 0.038$ radians. The reason between the phase differences at different frequencies (FIG. 12 and 13) be explained by the impedance value of the circuit. From eq. (1) we can observe that the relation between frequency and impedance is inversely proportional.

$$Z_C = \frac{1}{2\pi fc} \tag{1}$$

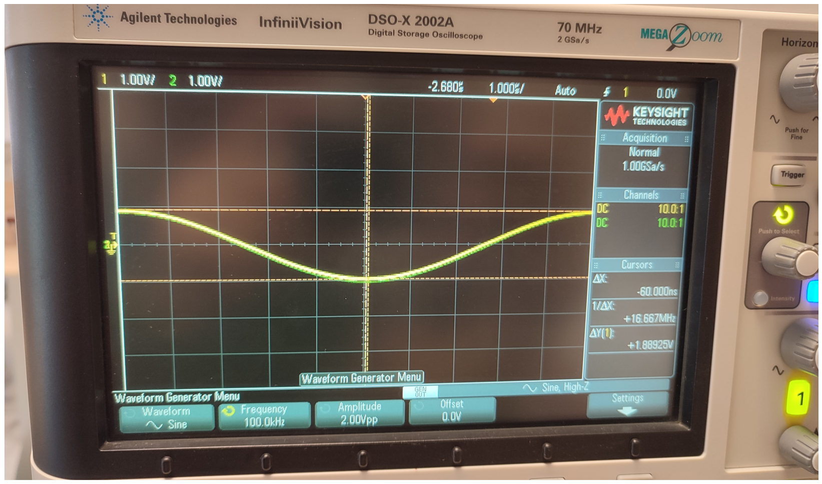

FIG. 13. $\Delta\Phi = 0.038rad$ at 100 kHz

III. CONCLUSION

In Lab 1 I became familiar with oscilloscopes and breadboards. I have learned the basics of a digital oscilloscope and completed the lab session with success.