IC MEASUREMENT – ASSIGNMENT 2

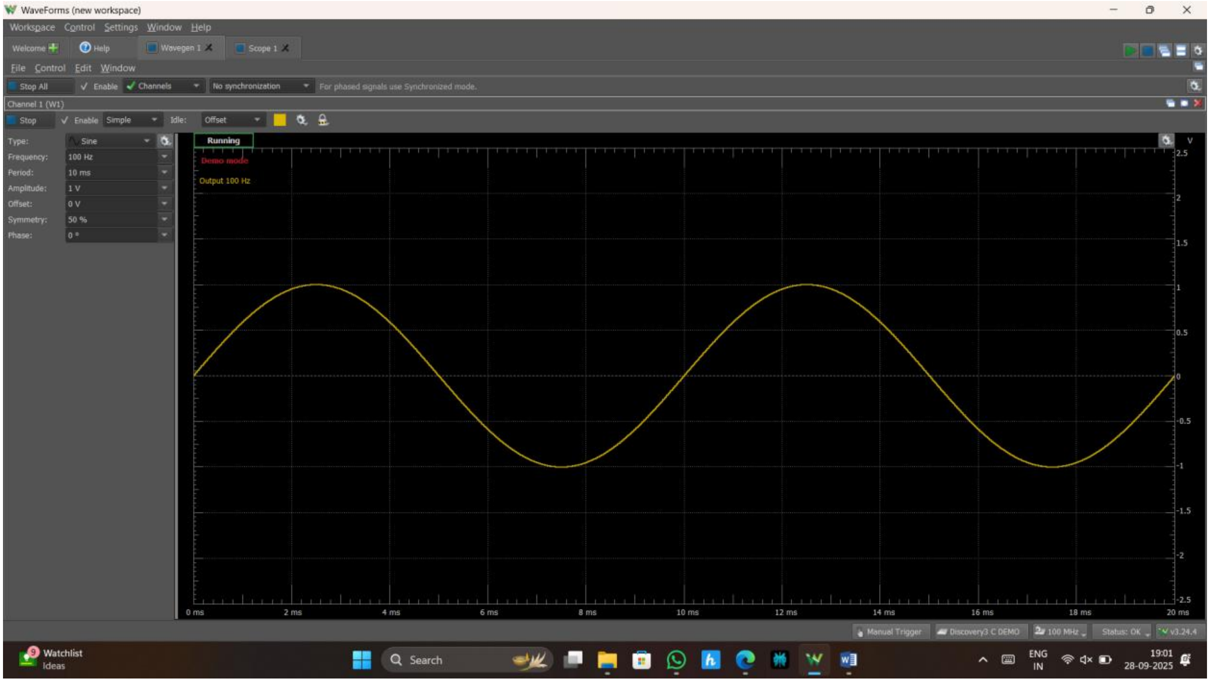
LOW-PASS FILTER CHARACTERIZATION USING AD3

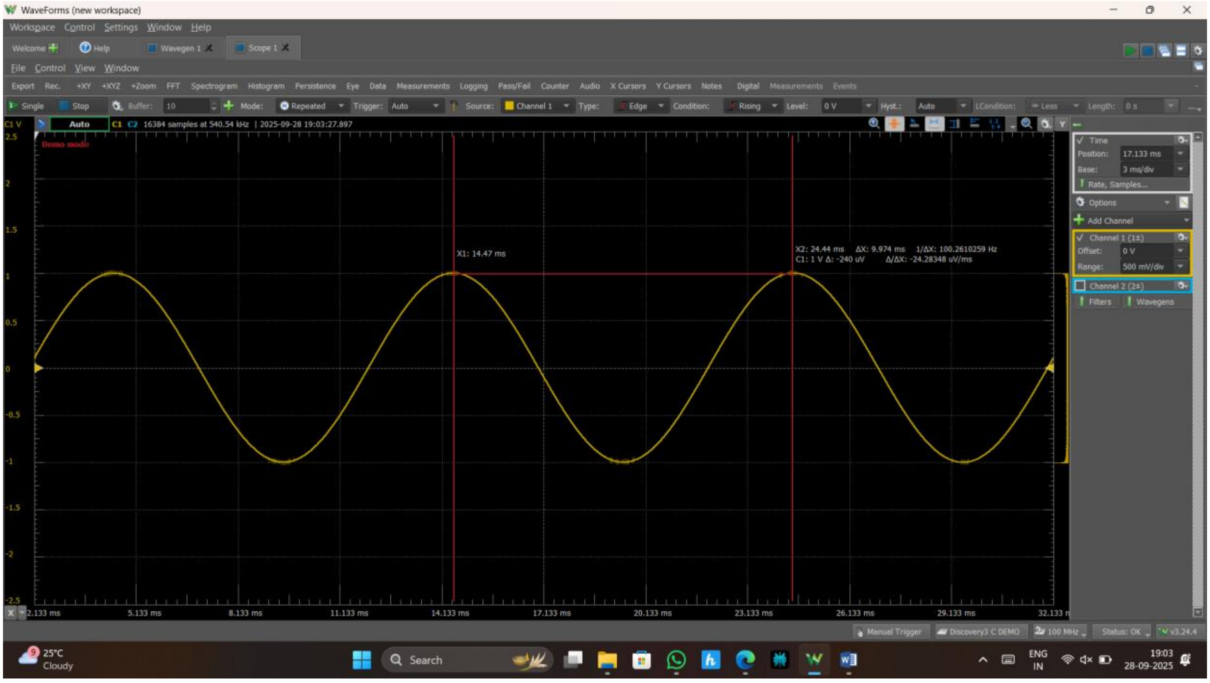
1. Frequency Response Analysis (WaveForms GUI)

(i) Use the Wavegen tool in WaveForms to generate sine waves at multiple frequencies. Suggested test frequencies: 100 Hz, 500 Hz, 1 kHz, 2 kHz, 5 kHz, and 10 kHz.

➔ (a) 100 Hz

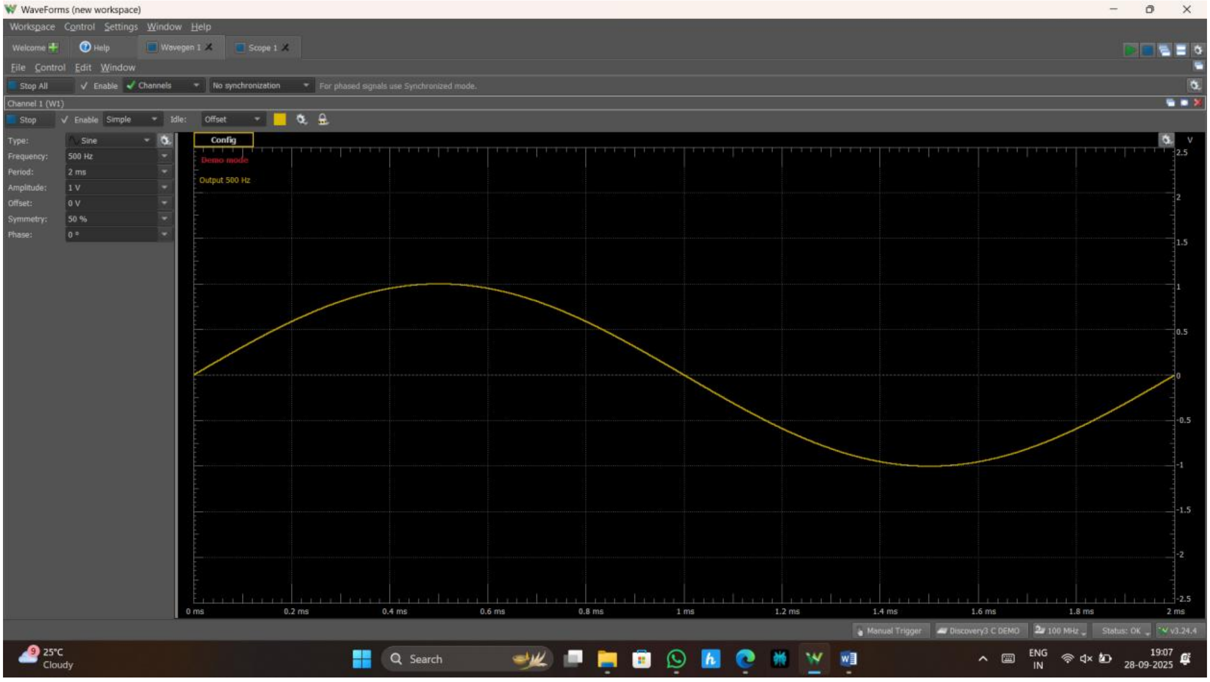
Wavegen and then measuring the frequency in Scope:



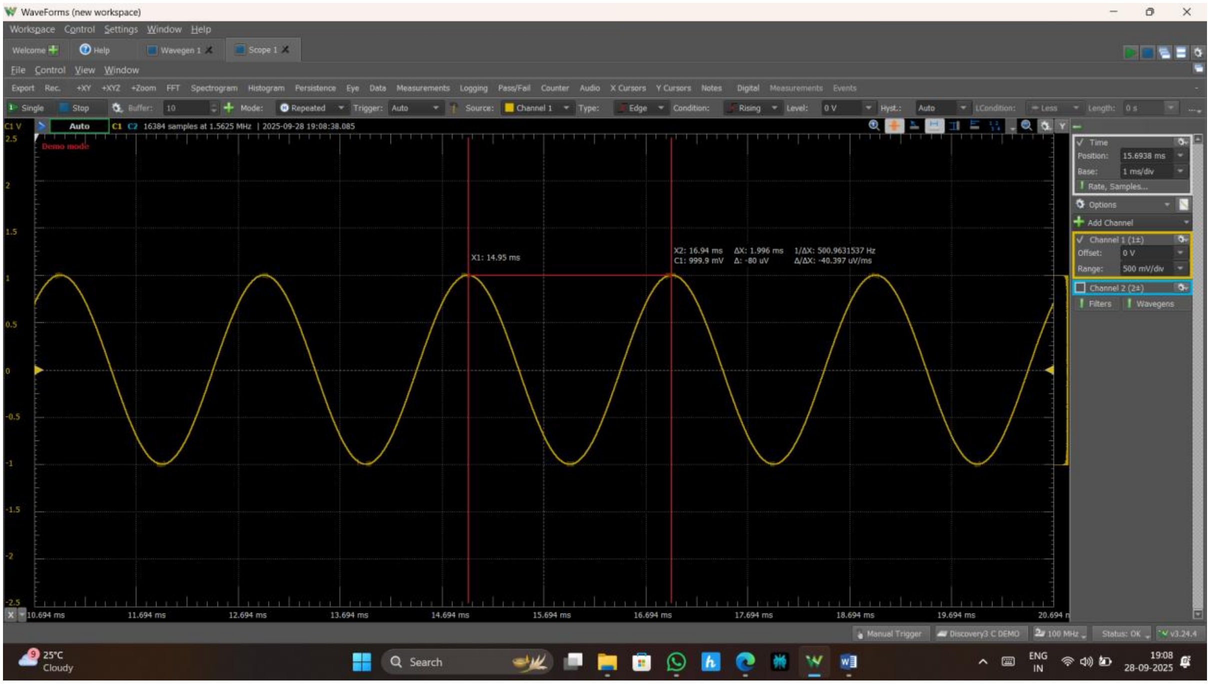


(b) 500 Hz

Wavegen and then measuring the frequency using Scope:

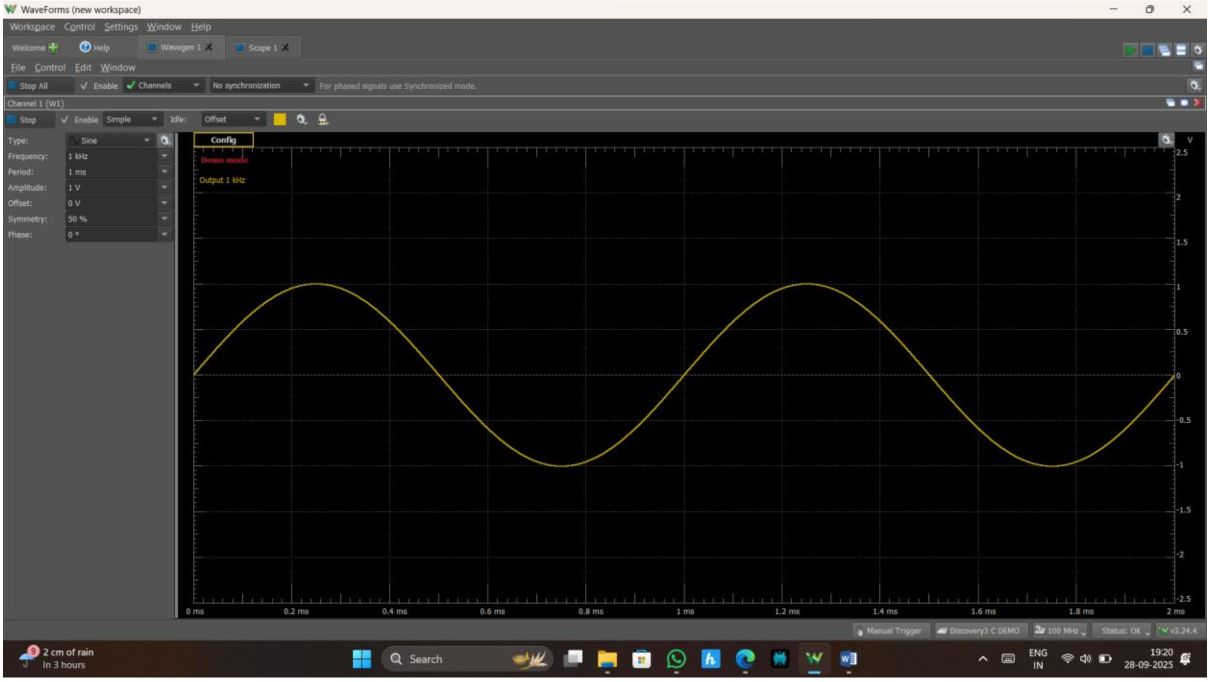


We get the frequency as 500 Hz

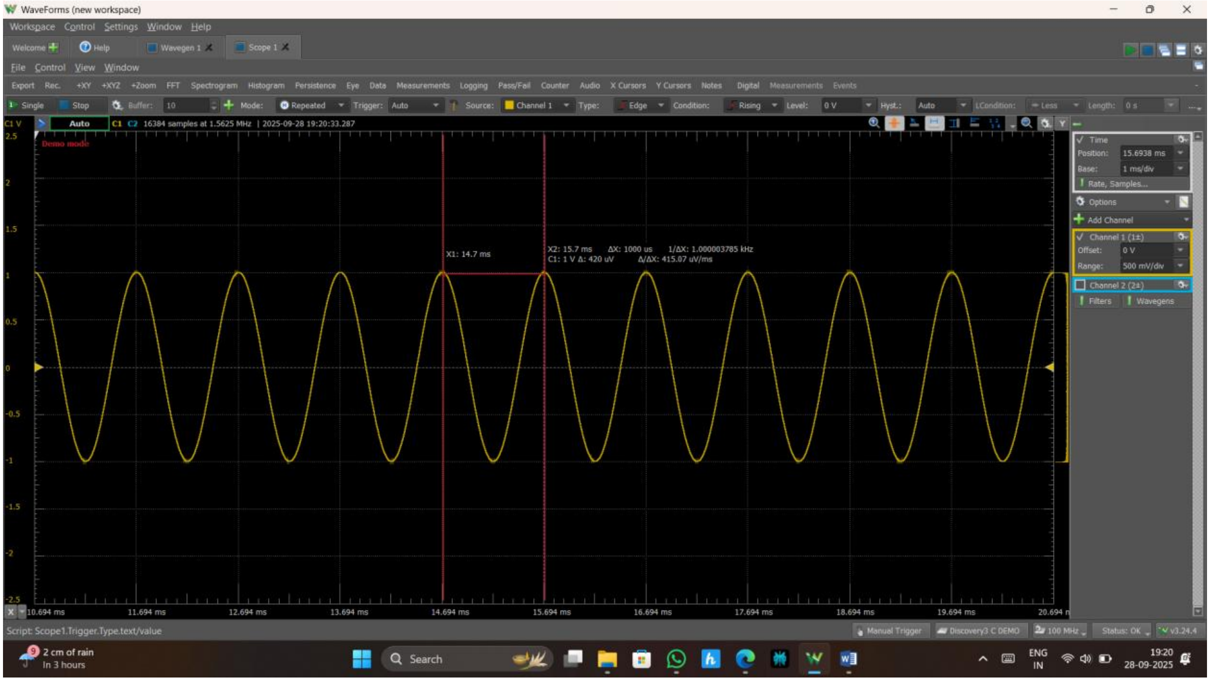


(c) 1 kHz

Wavegen and then measuring the frequency using Scope:

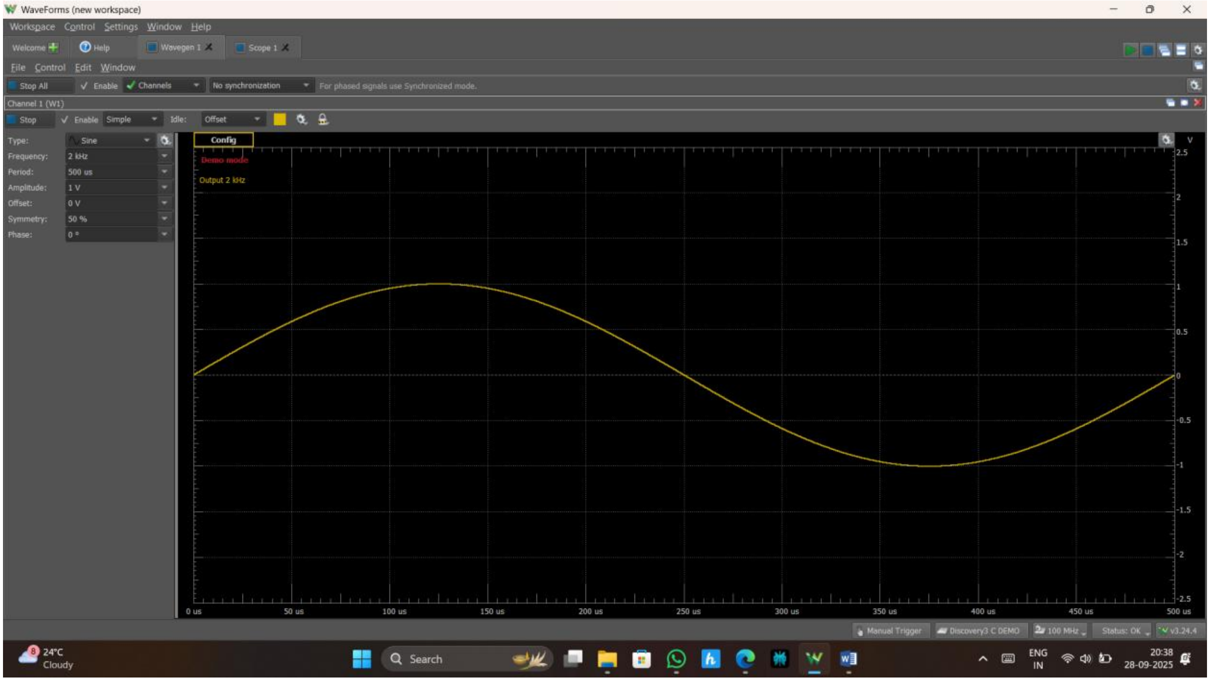


We get the frequency as 1 kHz

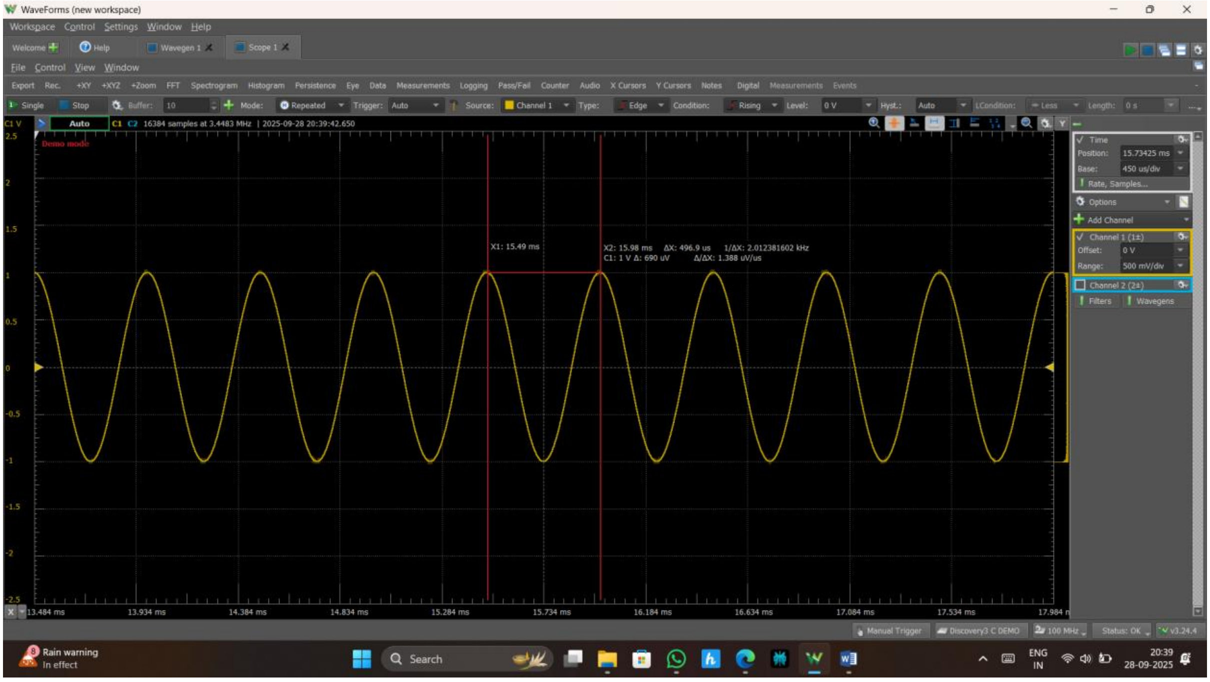


(d) 2 kHz

Wavegen and then measuring the frequency using Scope:

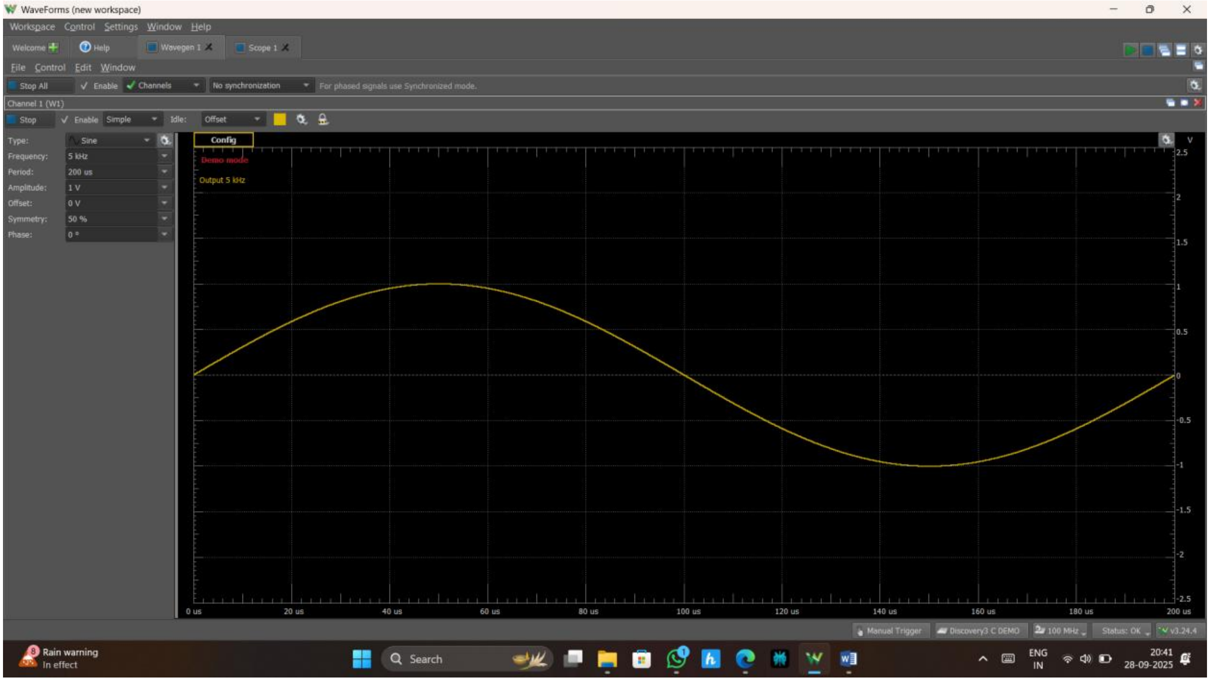


We get the frequency as 2 kHz

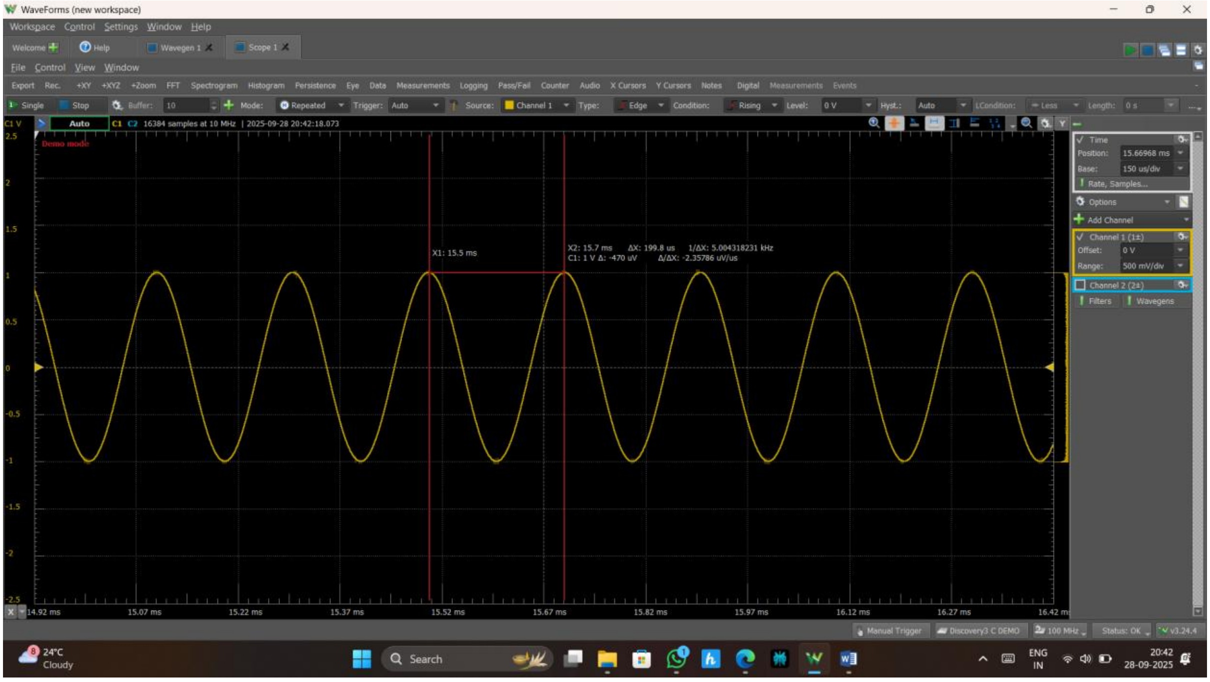


(e) 5 kHz

Wavegen and then measuring the frequency using Scope:

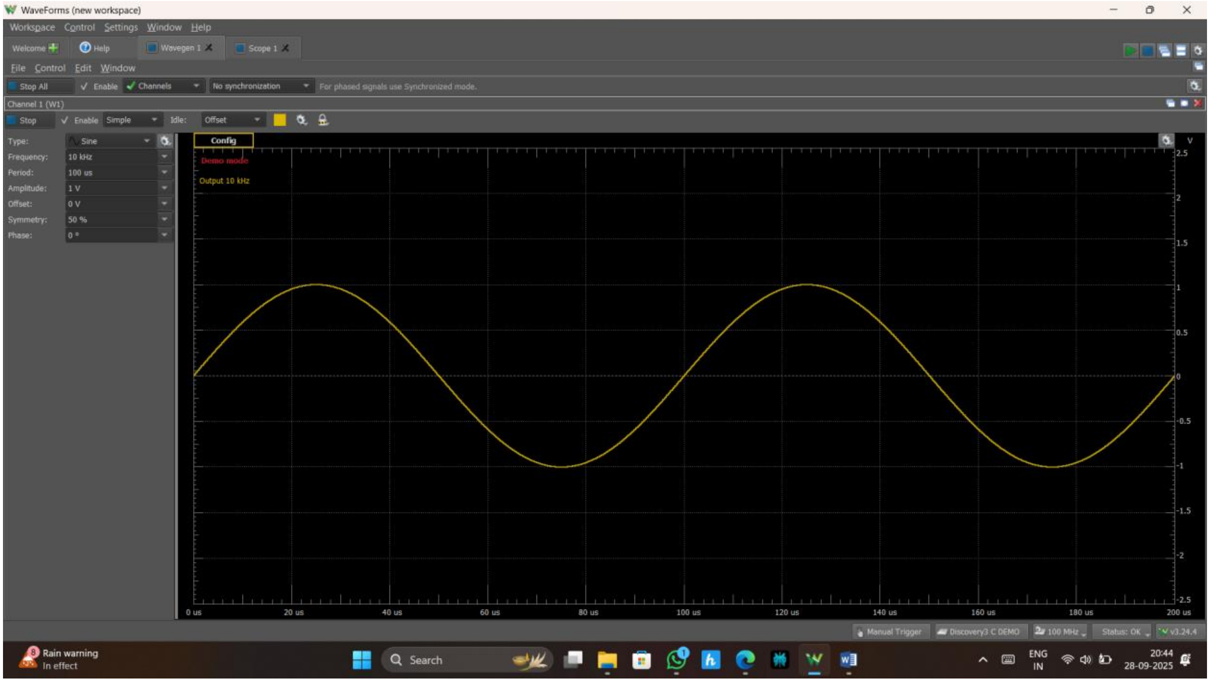


We get the frequency as 5 kHz

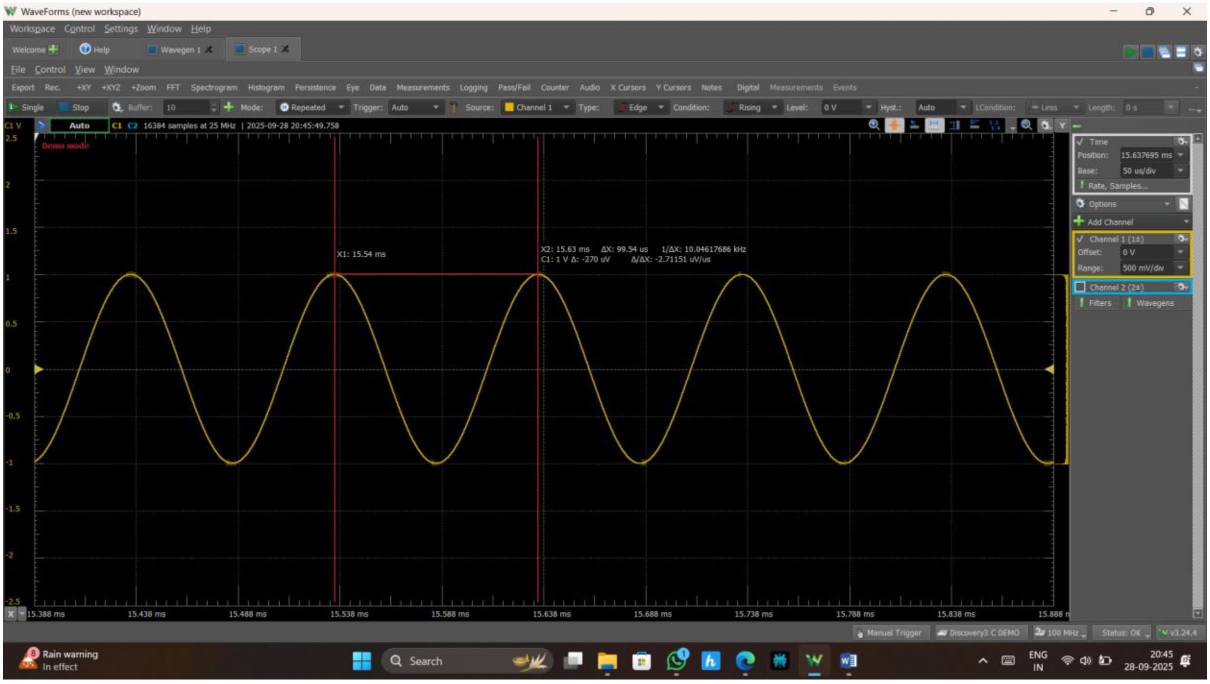


(f) 10 kHz

Wavegen and then measuring the frequency using Scope:



We get the frequency as 10 kHz



2. Using the Scope tool, measure the output voltage of the fixed RC low-pass filter for each frequency.

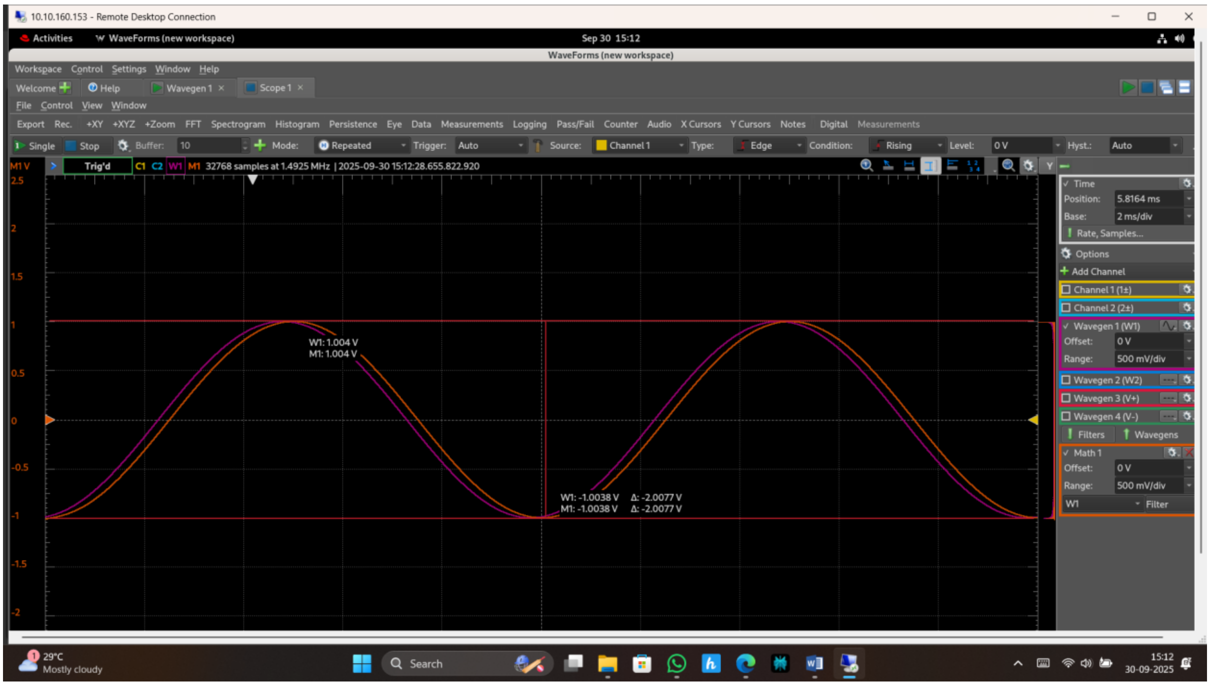
➔ Assumption:

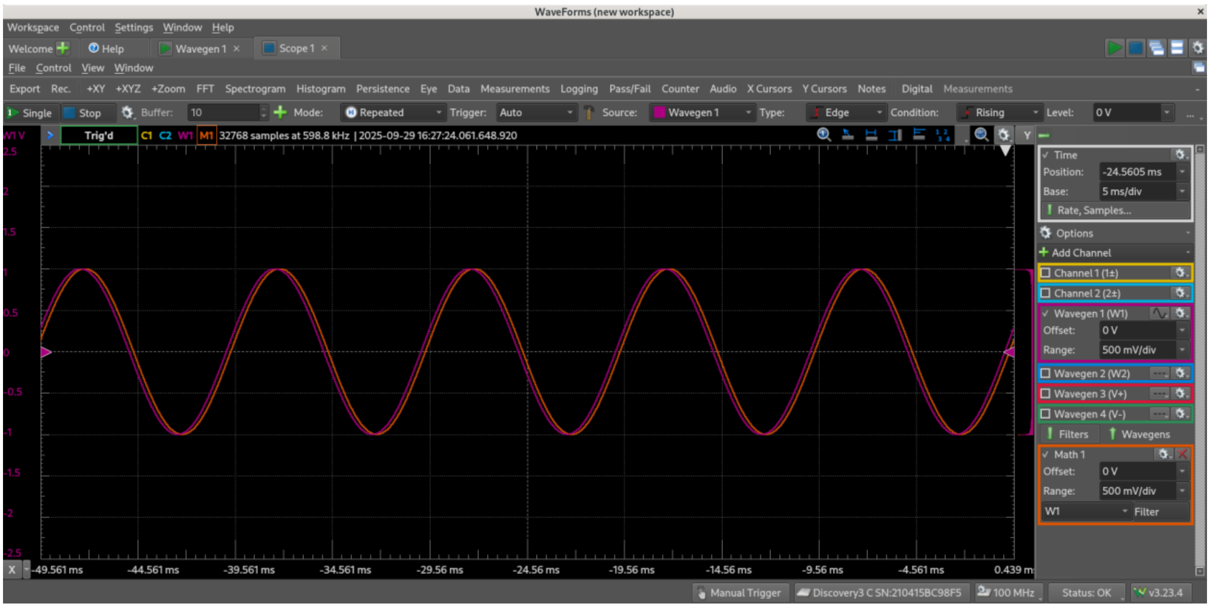
Amplitude = 1 V, i.e., V_{pp} = 2 x Amplitude = 2 V_{pp}

Let the cut-off frequency of the LPF be 1 kHz.

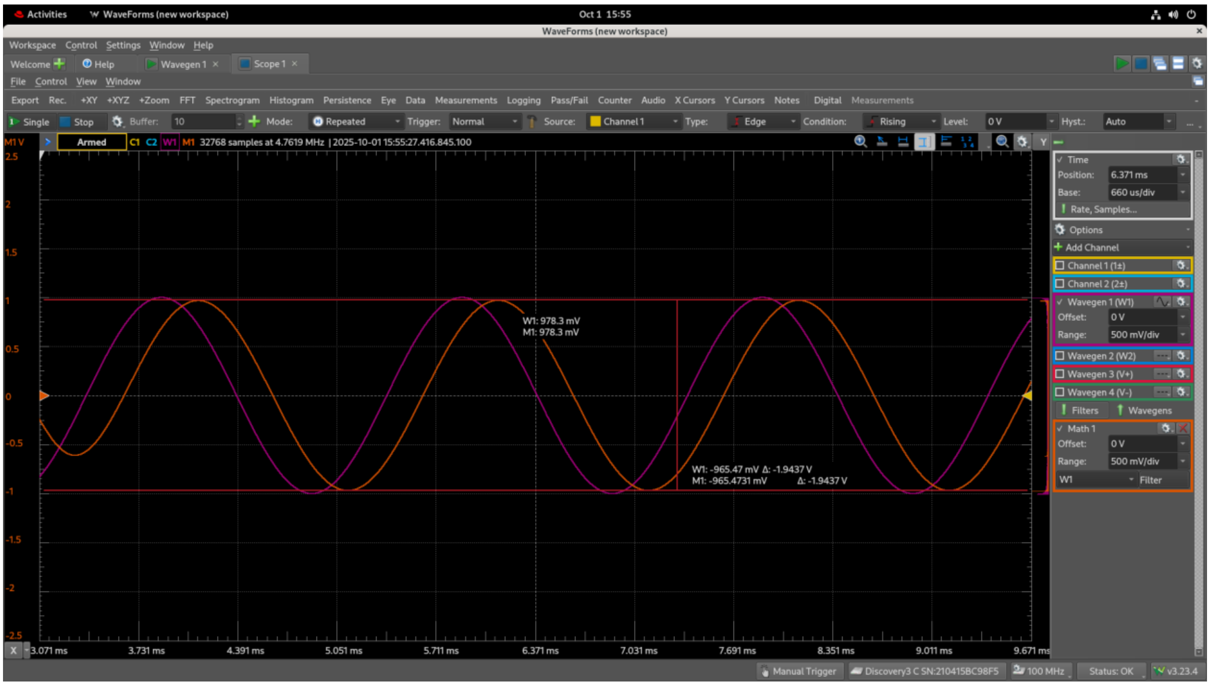
Now, the frequency of the sine source be:

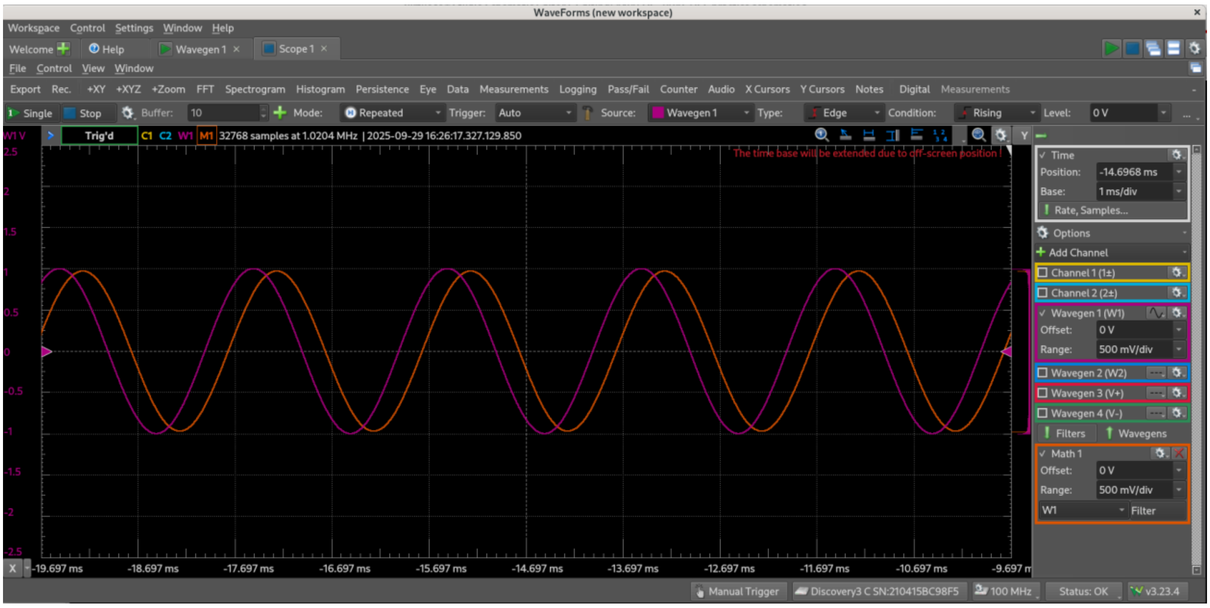
(a) 100 Hz



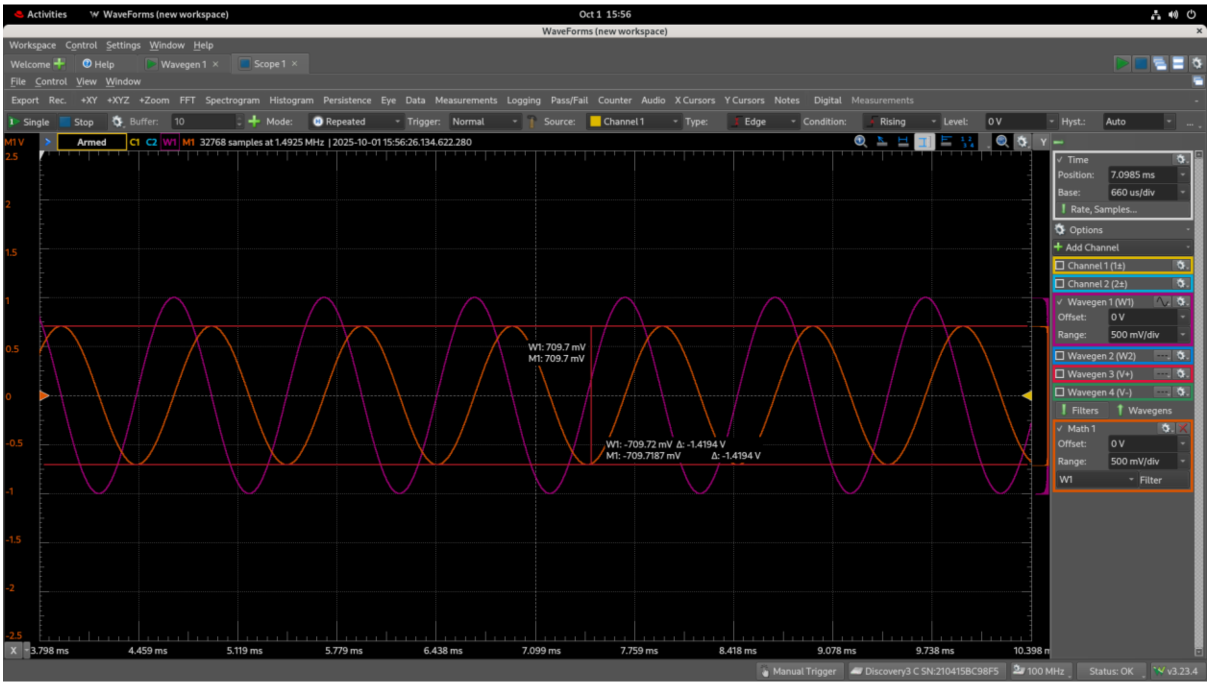


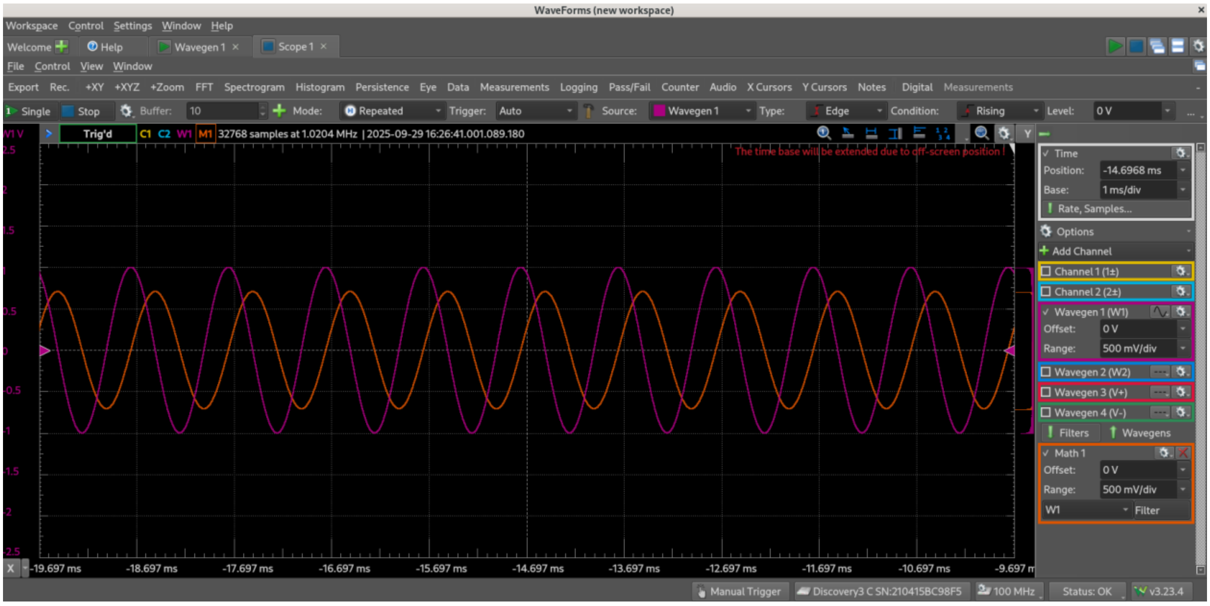
(b) 500 Hz


WaveForms (new workspace)
Armed
32768 samples at 4.7619 MHz | 2025-10-01 15:55:27.416.845.100
W1: 978.3 mV
M1: 978.3 mV
W1: -965.47 mV Δ: -1.9437 V
M1: -965.4731 mV Δ: -1.9437 V
Position: 6.371 ms
Base: 660 us/div
Trigger: Normal
Source: Channel 1

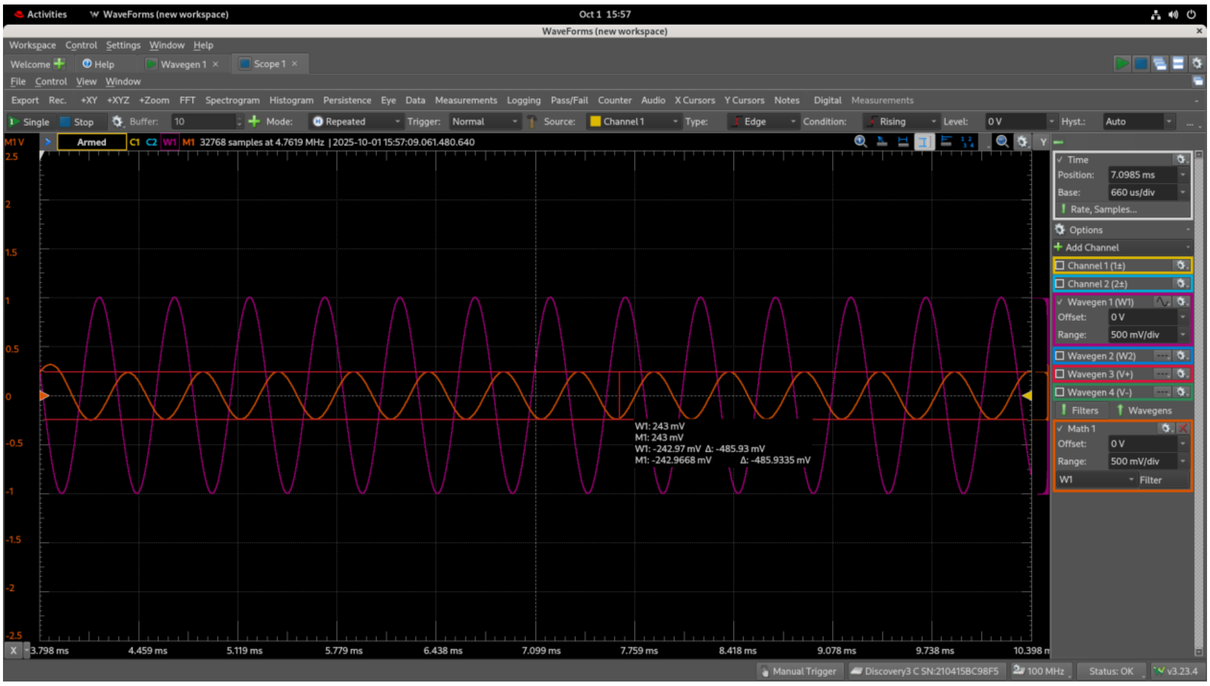

WaveForms (new workspace)
Trig'd
32768 samples at 1.0204 MHz | 2025-09-29 16:26:17.327.129.850
The time base will be extended due to off-screen position!
Position: -14.6968 ms
Base: 1 ms/div
Trigger: Auto
Source: Wavegen 1

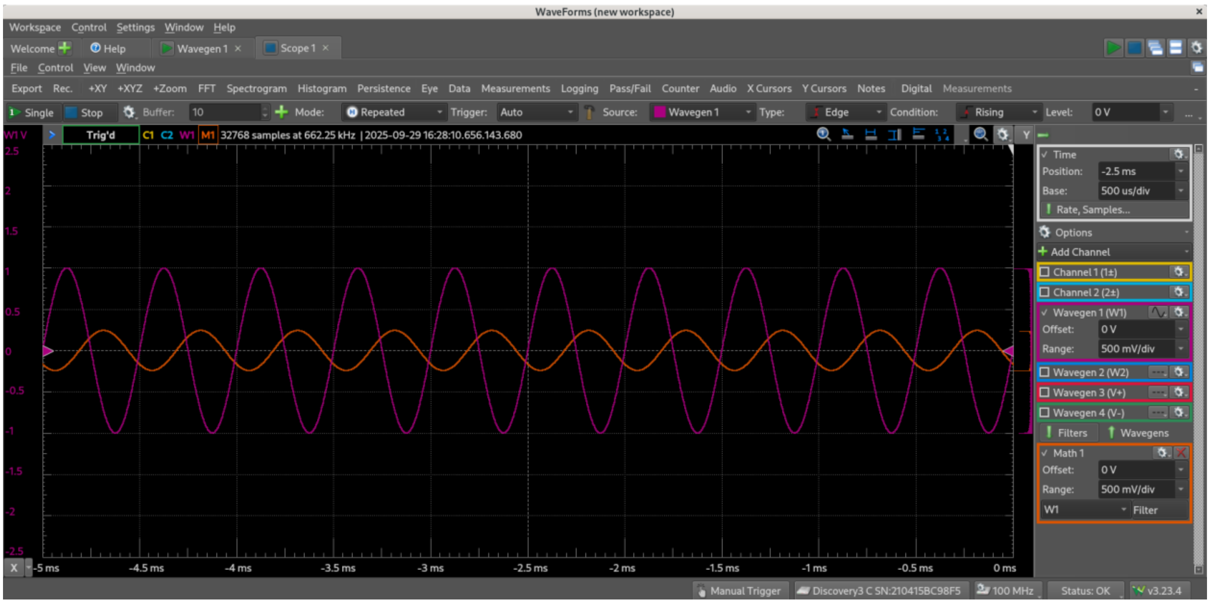
(c) 1 kHz



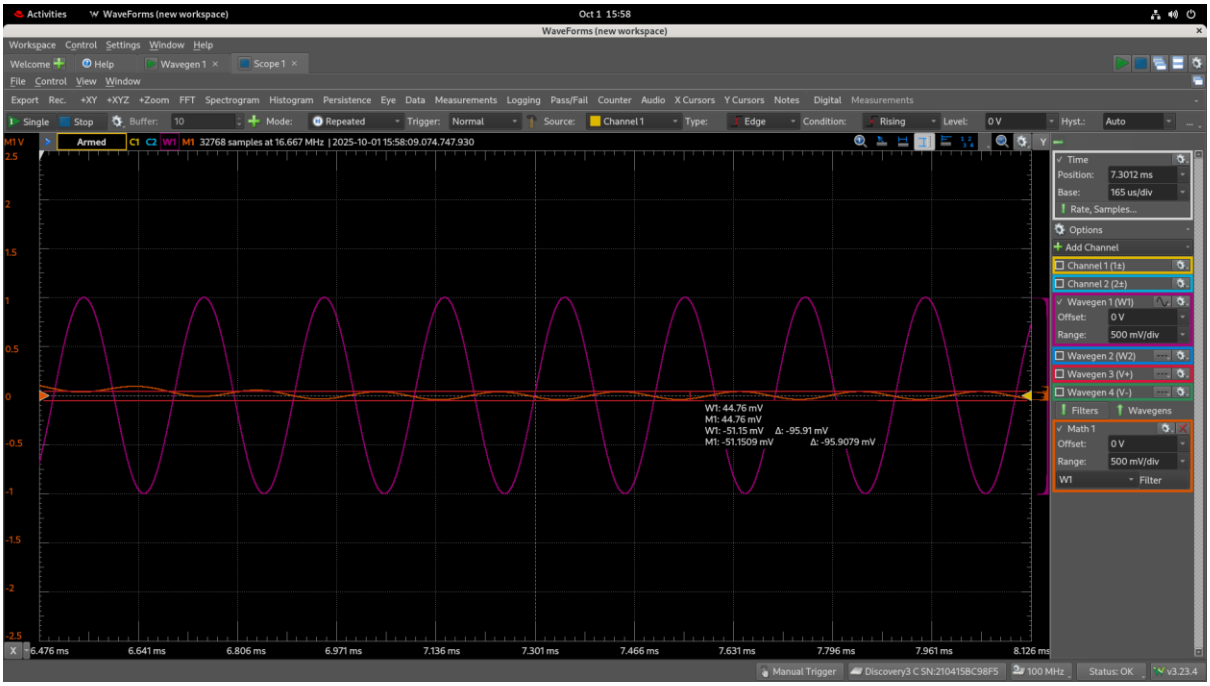


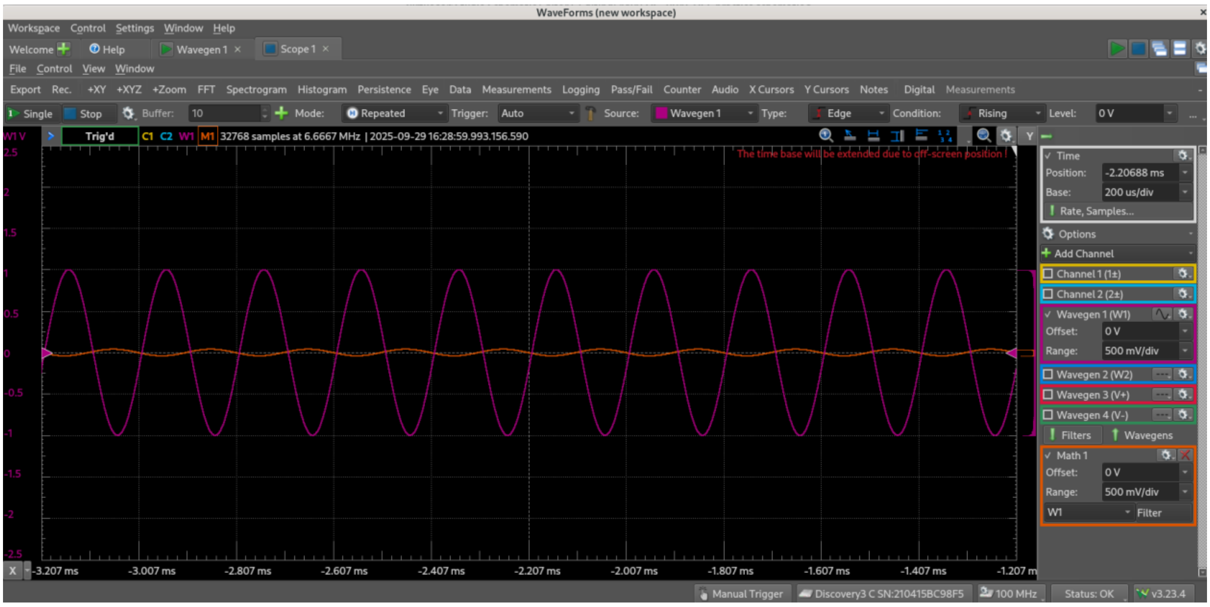
(d) 2 kHz


WaveForms (new workspace)
Armed
32768 samples at 4.7619 MHz | 2025-10-01 15:57:09.061.480.640
W1: 243 mV
M1: 243 mV
W1: -242.97 mV Δ: -485.93 mV
M1: -242.9668 mV Δ: -485.9335 mV
Position: 7.0985 ms
Base: 660 us/div
Manual Trigger
Discovery3 C SN:210415BC98F5
Status: OK

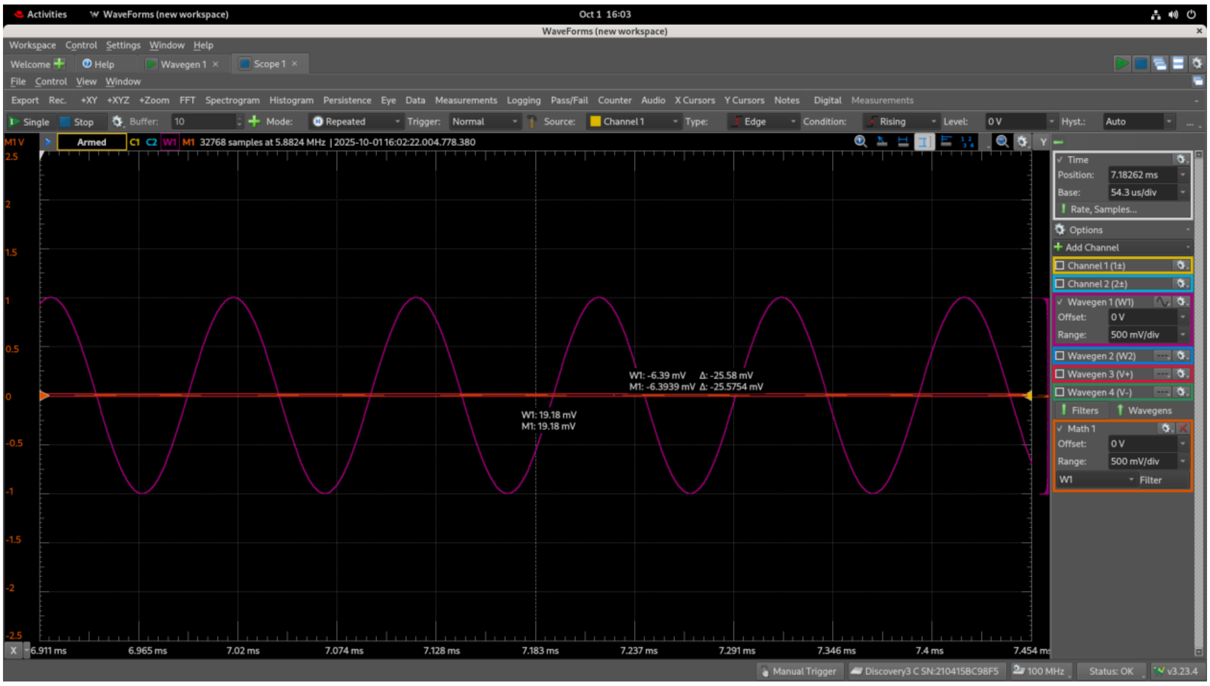

WaveForms (new workspace)
Trig'd
32768 samples at 662.25 kHz | 2025-09-29 16:28:10.656.143.680
Position: -2.5 ms
Base: 500 us/div
Manual Trigger
Discovery3 C SN:210415BC98F5
Status: OK

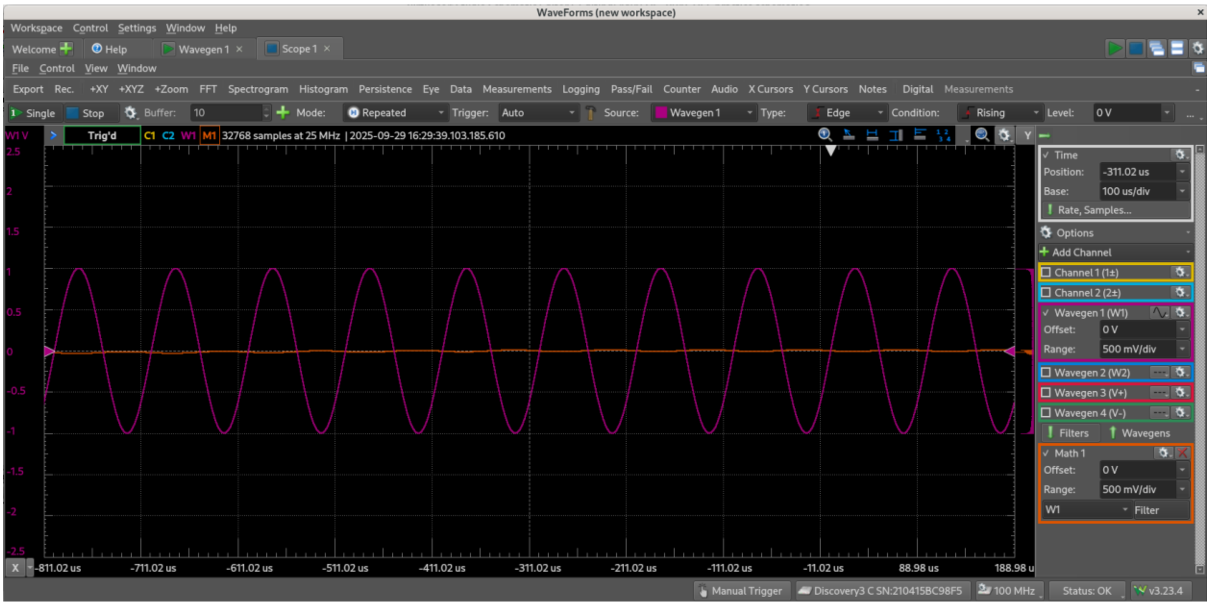
(e) 5 kHz



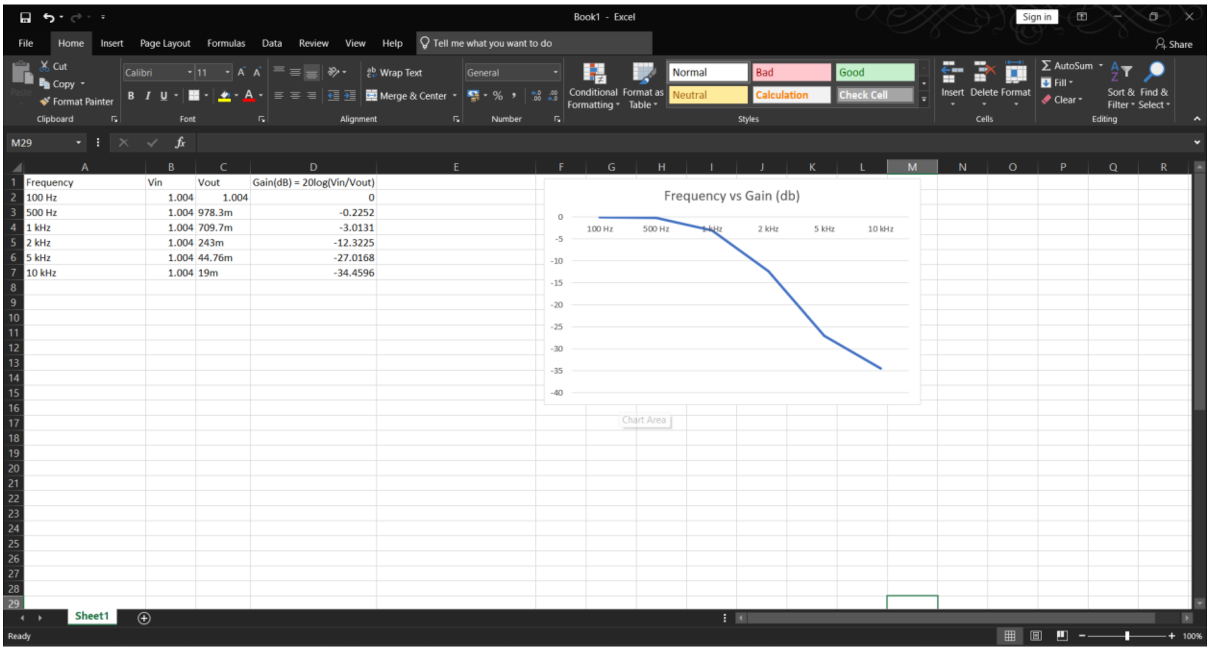


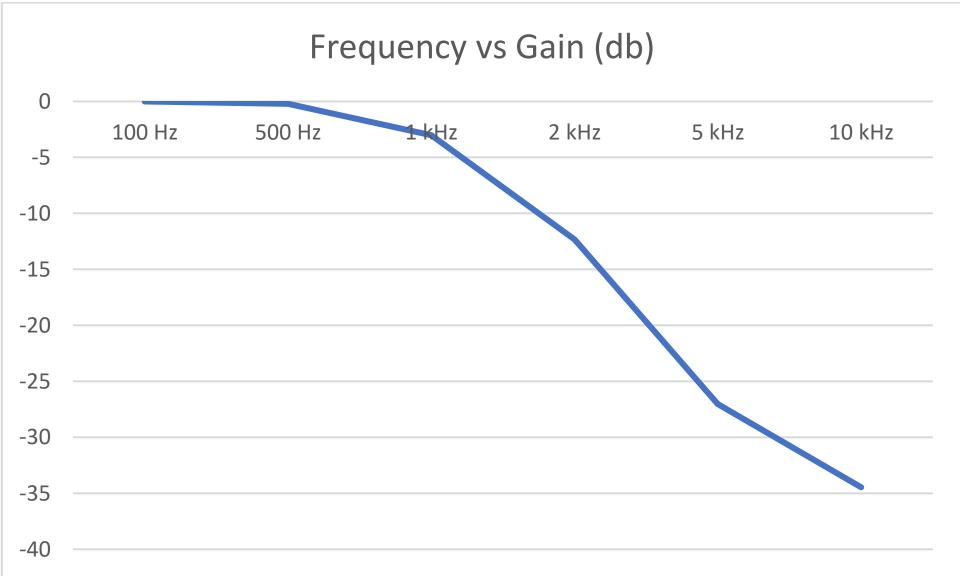
(f) 10 kHz





Frequency	Vin (V)	Vout	Gain(db) = 20log(Vin/Vout)
100 Hz	1.004	1.004 V	0
500 Hz	1.004	978.3mV	-0.2252
1 kHz	1.004	709.7mV	-3.0131
2 kHz	1.004	243mV	-12.3225
5 kHz	1.004	44.76mV	-27.0168
10 kHz	1.004	19mV	-34.4596





Observations for Each Case:

1. 100 Hz

- **Vin = 1.004 V, Vout = 1.004 V, Gain = 0 dB**
- At very low frequencies (well below the filter's cutoff), the capacitor acts like an open circuit. Almost the entire input passes to the output, so the filter behaves like a wire (unity gain).
- **Observation:** Signal passes through unaffected.

2. 500 Hz

- **Vin = 1.004 V, Vout = 998.3 mV, Gain ≈ -0.225 dB**
- Still below cutoff, so attenuation is negligible. The output is slightly less than input due to the capacitor beginning to react.
- **Observation:** Minimal attenuation, response almost flat.

3. 1 kHz

- **Vin = 1.004 V, Vout = 799.7 mV, Gain ≈ -3.01 dB**
- At this frequency, attenuation reaches approximately **-3 dB**, which is the standard definition of the **cutoff frequency (fc)**.
- At cutoff, the output power is half of the input, and the capacitor has equal reactance to the resistor.
- **Observation:** This marks the -3 dB point, identifying the cutoff of the RC filter.

4. 2 kHz

- **Vin = 1.004 V, Vout = 243 mV, Gain ≈ -12.32 dB**
- Now frequency is **above cutoff**. Capacitor reactance has decreased, shunting more of the signal to ground. Output voltage drops significantly.
- **Observation:** Strong attenuation begins; signal is much weaker.

5. 5 kHz

- **Vin = 1.004 V, Vout = 44.76 mV, Gain ≈ -27.02 dB**
- Much higher than cutoff, the capacitor strongly conducts, shorting most of the AC signal to ground.
- **Observation:** Output is very small compared to input, steep attenuation is seen.

6. 10 kHz

- **Vin = 1.004 V, Vout = 19 mV, Gain ≈ -34.46 dB**
- Very high compared to cutoff. The filter strongly attenuates, output signal nearly gone.
- **Observation:** Only a small fraction of the input passes through — consistent with the roll-off trend.

General Behaviour of the RC Low-Pass Filter:

- Below cutoff (100–500 Hz): output ≈ input (flat response).
- At cutoff (≈1 kHz): output drops to **70.7% amplitude (−3 dB)**.
- Above cutoff (2–10 kHz): output reduces steeply, at approximately **−20 dB per decade** slope (the theoretical slope for a 1st-order low-pass filter).
- This matches your plotted response curve — flat at low frequency, dropping after cutoff.