Analog IC

Lab 1

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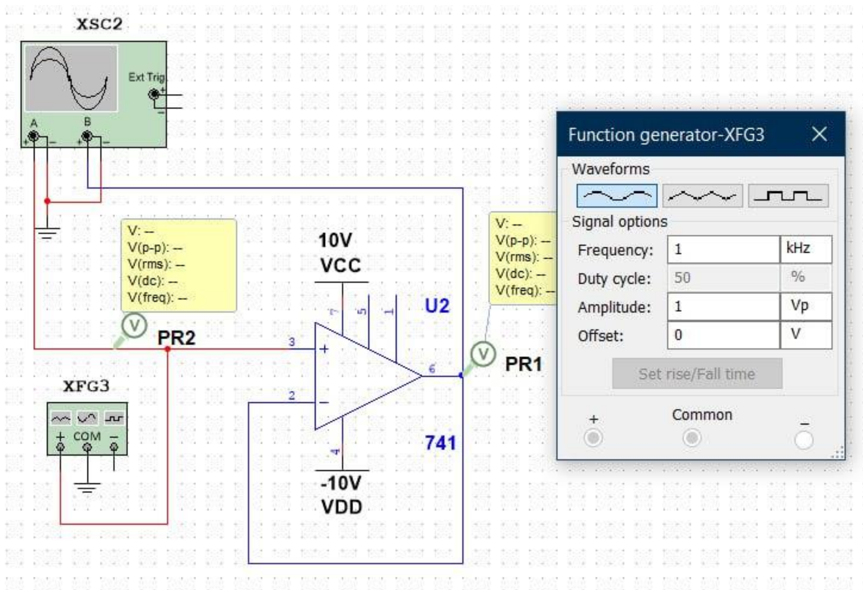
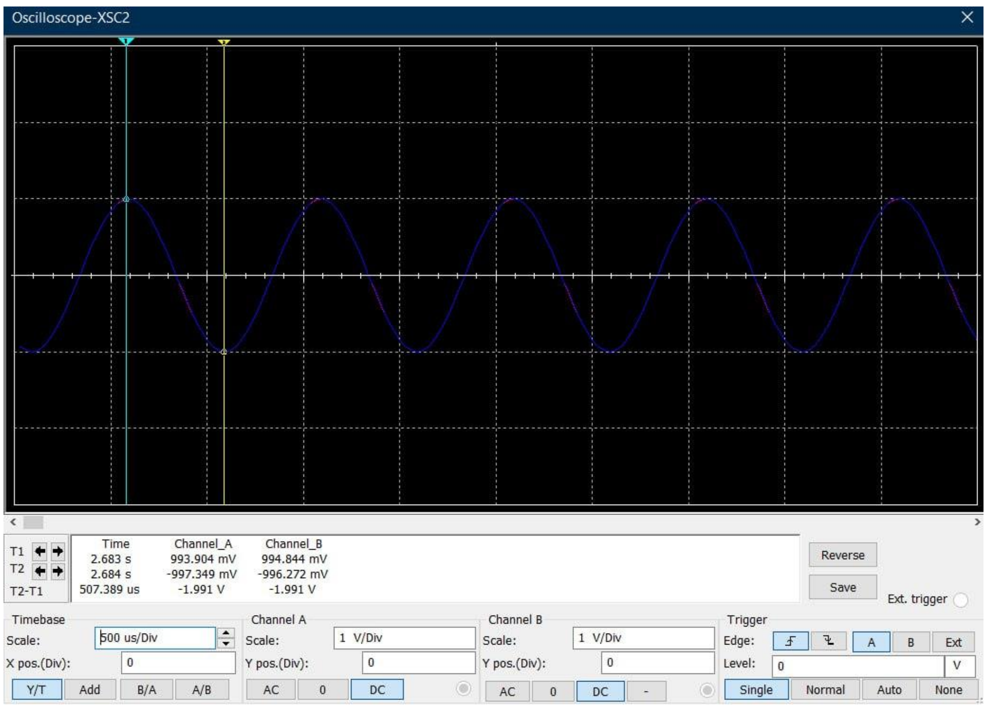
unity gain amplifier:

Circuit:



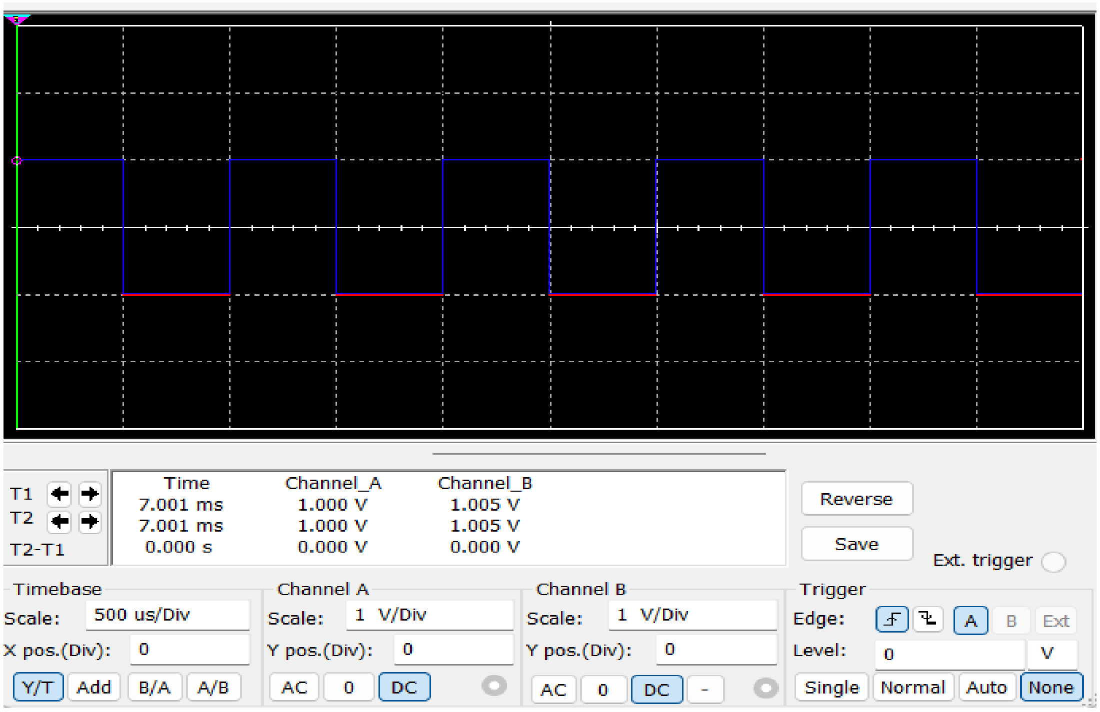


Comment:

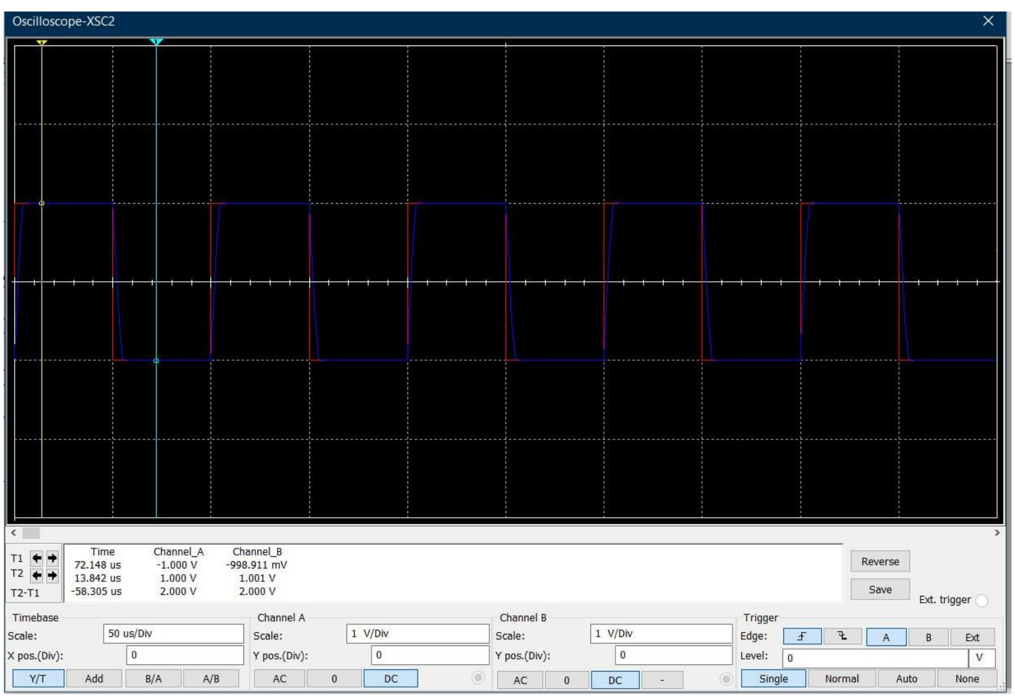
the output voltage signal is identical to the input voltage signal. It doesn't amplify the signal in terms of voltage; rather, it's used to isolate the input signal from the load.

- **Transient Response:**

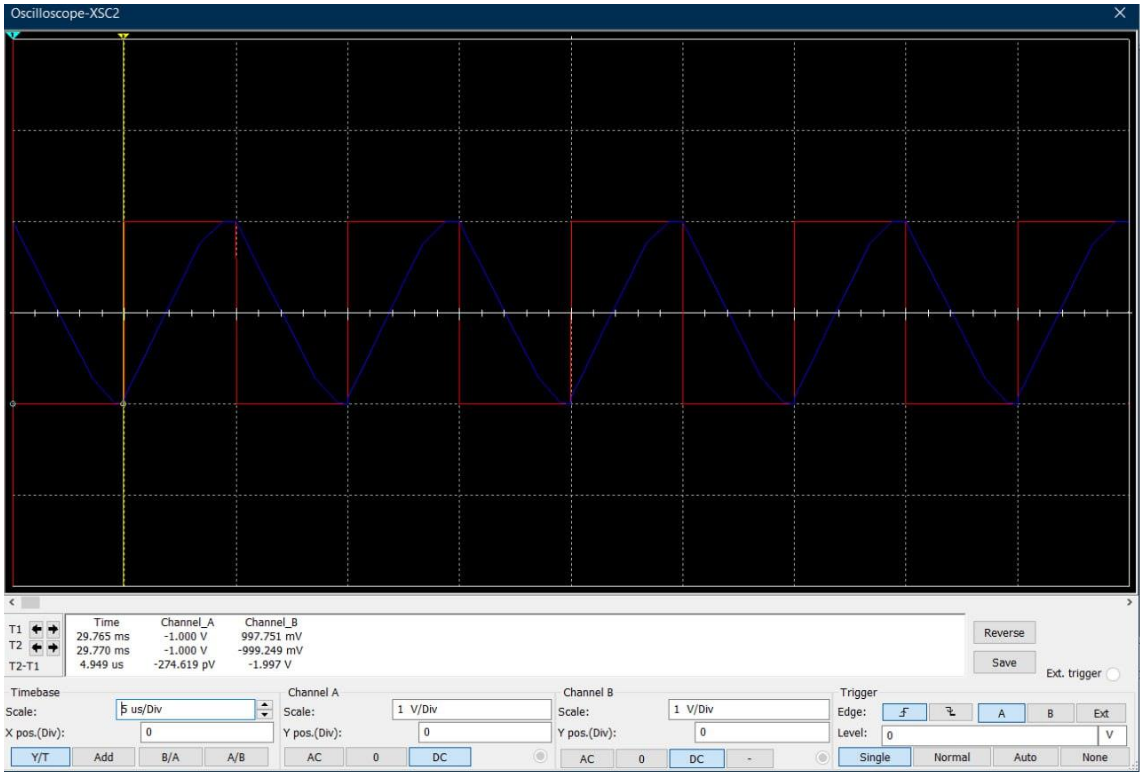
applying input frequency=1kHz:



When applying input frequency=10kHz:



When applying input frequency=100kHz:

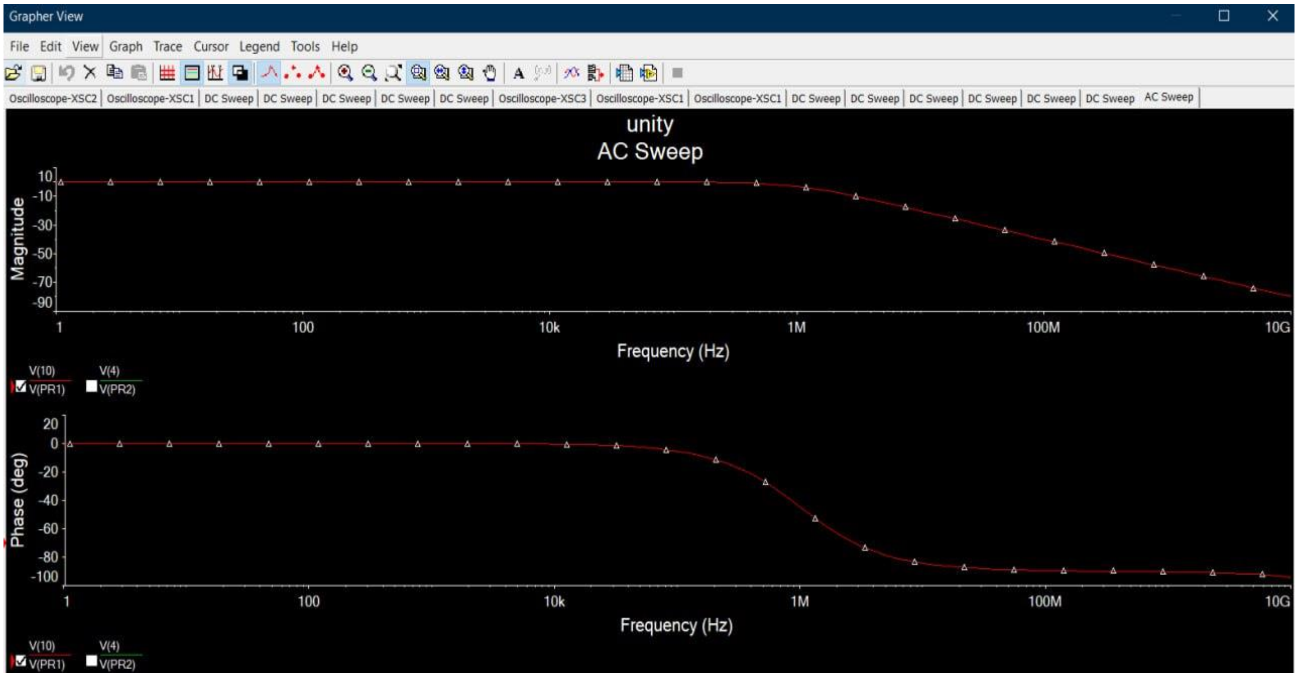


S.NO	Input frequency	(p-p) voltage
1	1kHz	2.01V
2	10kHz	2V
3	100kHz	1.997V

Comment:

At higher frequencies, the transient response of a unity gain amplifier can result in distortion of the output signal, including a decrease in peak-to-peak voltage, rounding of square wave corners, and conversion to a triangular-like waveform due to various factors such as bandwidth limitations, slew rate, and frequency-dependent effects. Theoretically, in an ideal unity gain amplifier with infinite bandwidth and no slew rate limitations, the peak-to-peak voltage of the output signal would remain constant regardless of the frequency of the input signal. This is because a unity gain amplifier is supposed to provide an output voltage that exactly matches the input voltage. However, in practical applications, real-world limitations such as bandwidth constraints and slew rate limitations can cause deviations from this behavior, leading to variations in the peak-to-peak voltage at higher frequencies.

- ## **Frequency Response:**

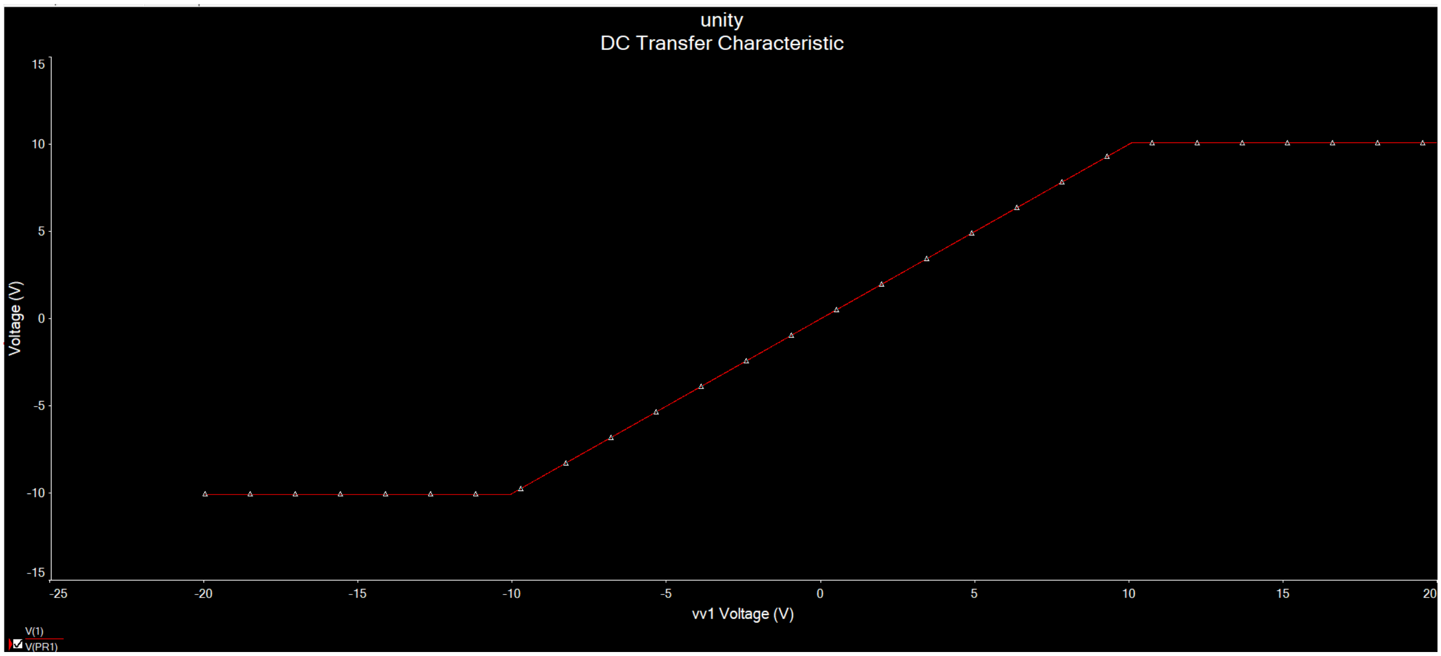


S. NO	Input frequency	Mag. Variation	Phase variation
1	1HZ	0.999964	-5.7E-05
2	100HZ	0.999964	-0.00574
3	1KHZ	0.999963	-0.05738
4	100KHZ	0.994986	-5.71942
5	1GHZ	0.001001	-90.3538
6	10GHZ	9.99E-05	-94.1787

Comment:

As depicted in the figures, an increase in frequency results in a decrease in magnitude and phase variation within the frequency response of the unity gain amplifier. Notably, at a frequency of 1MHz, there is a significant alteration in magnitude, transitioning from a positive to a negative value. Similarly, the phase exhibits a decline from zero degrees to a negative value.

- **DC-characteristics:**



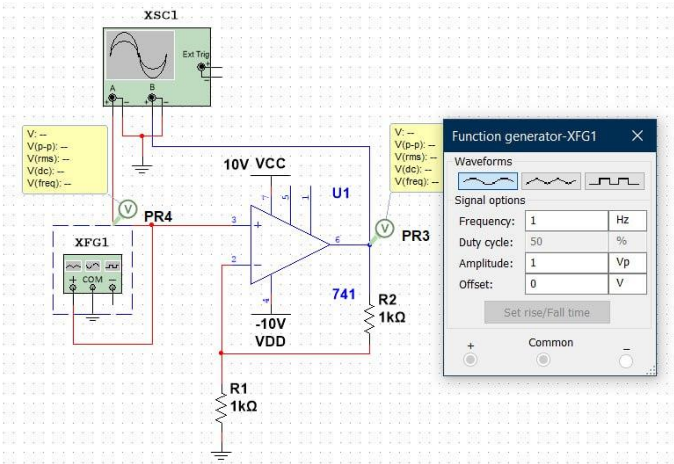
S.NO	Input voltage	Output voltage	Phase variation
1	-20	-9.38533	0
2	-8.69	-8.68996	0
3	-6.04	-6.03997	0
4	3.47	3.469983	0
5	5.8	5.799971	0

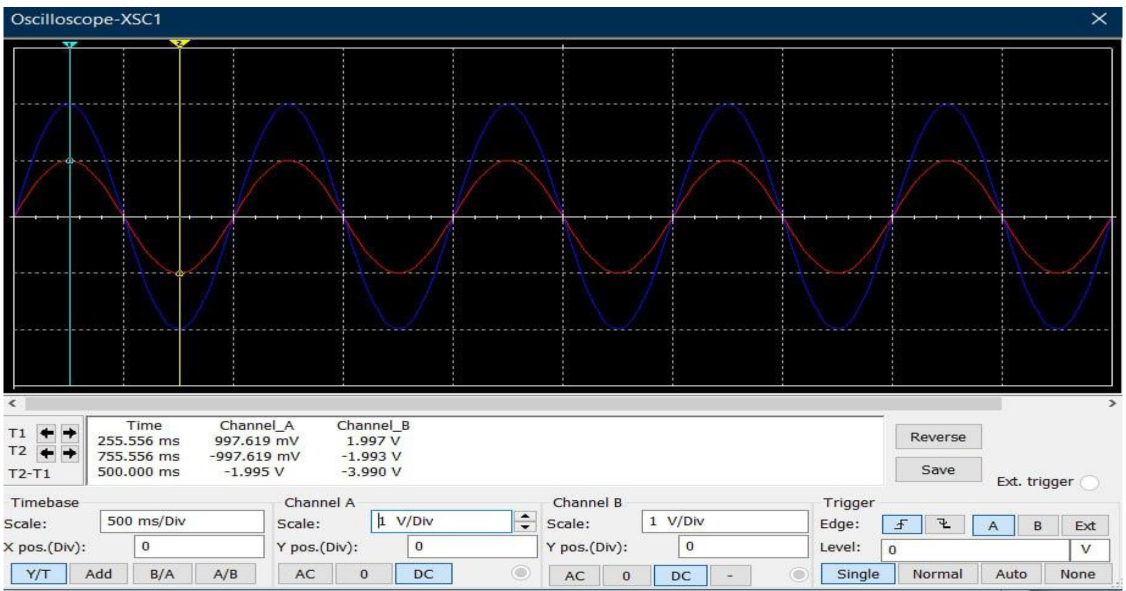
Comment:

DC characteristics of the system. When the input voltage ranges from -20V to 20V, the output voltage increases proportionally with the input voltage. Notably, within the range of -20V to -10V, the output voltage remains constant at -9.38V, after which it linearly increases until it reaches 9.38V when the input voltage ranges from 10V to 20V. Importantly, the output voltage consistently aligns with the direction of the input voltage.

Non inverting amplifier:

Circuit:



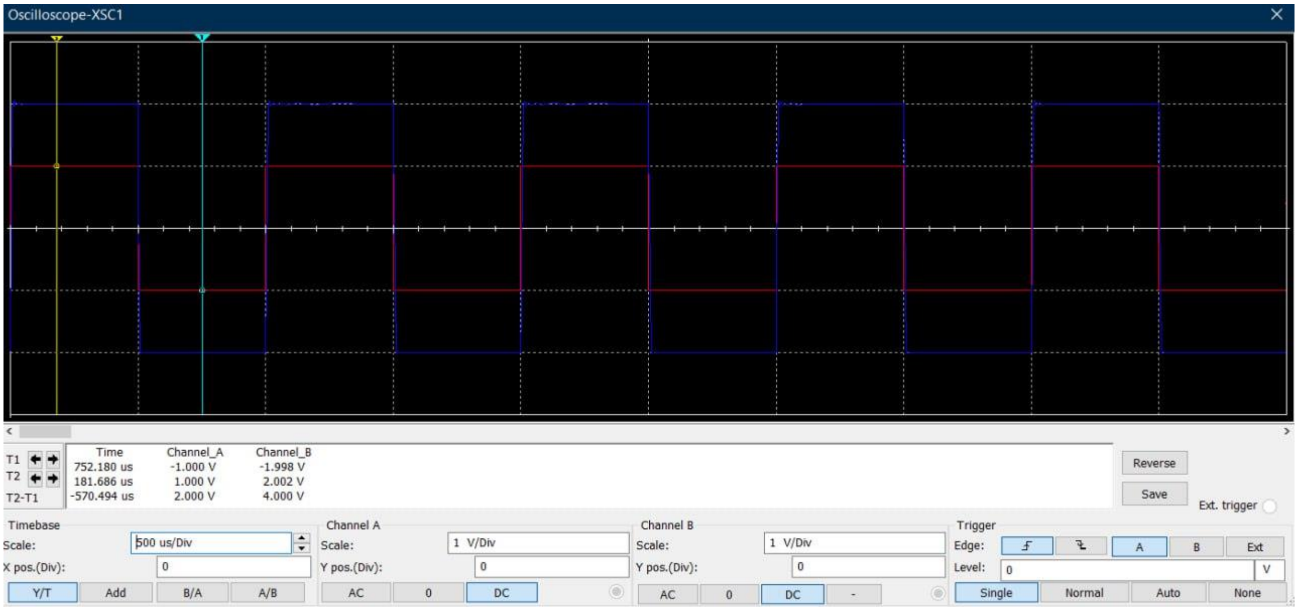


Comment:

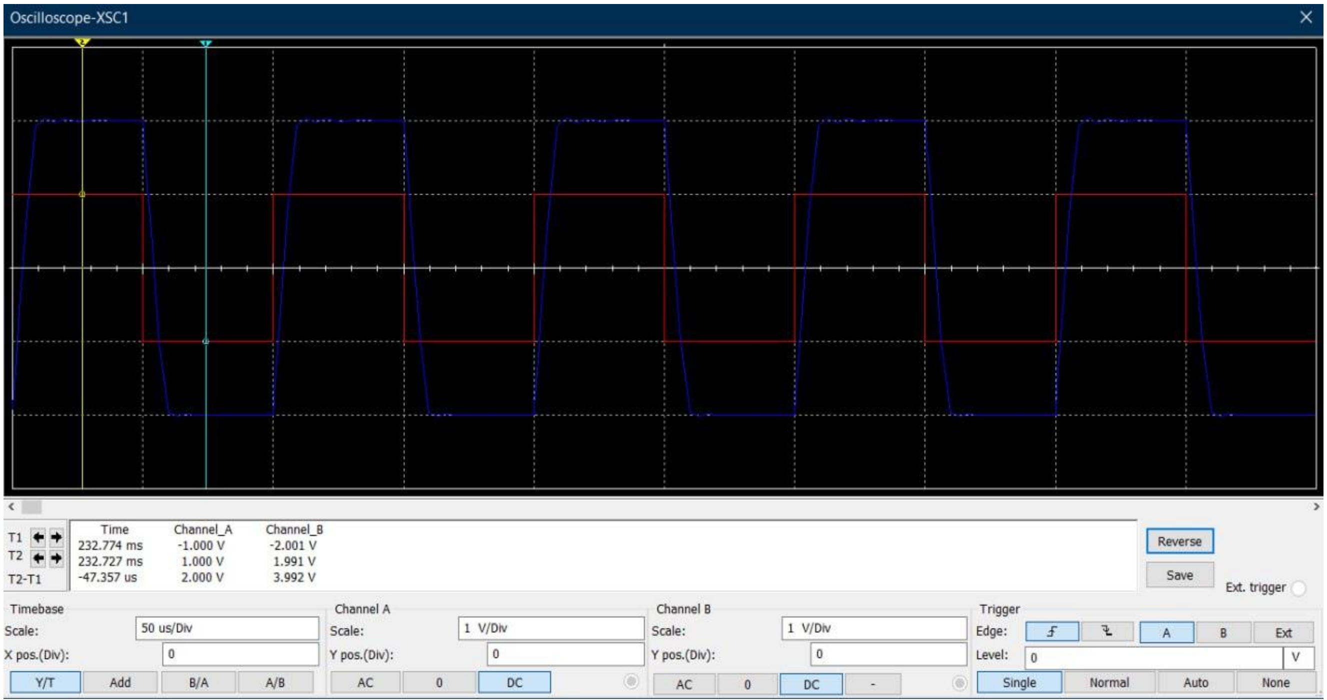
- the output voltage is equal to the input voltage multiplied by the gain (1 + R2/R1). Therefore, the output voltage is not necessarily double the input voltage, as it depends on the ratio of resistances R2 and R1. If R2 is equal to R1, then the gain is 2, and the output voltage would indeed be double the input voltage. However, this is not a general rule and depends on the specific resistor values chosen for R1 and R2.

- **Transient Response:**

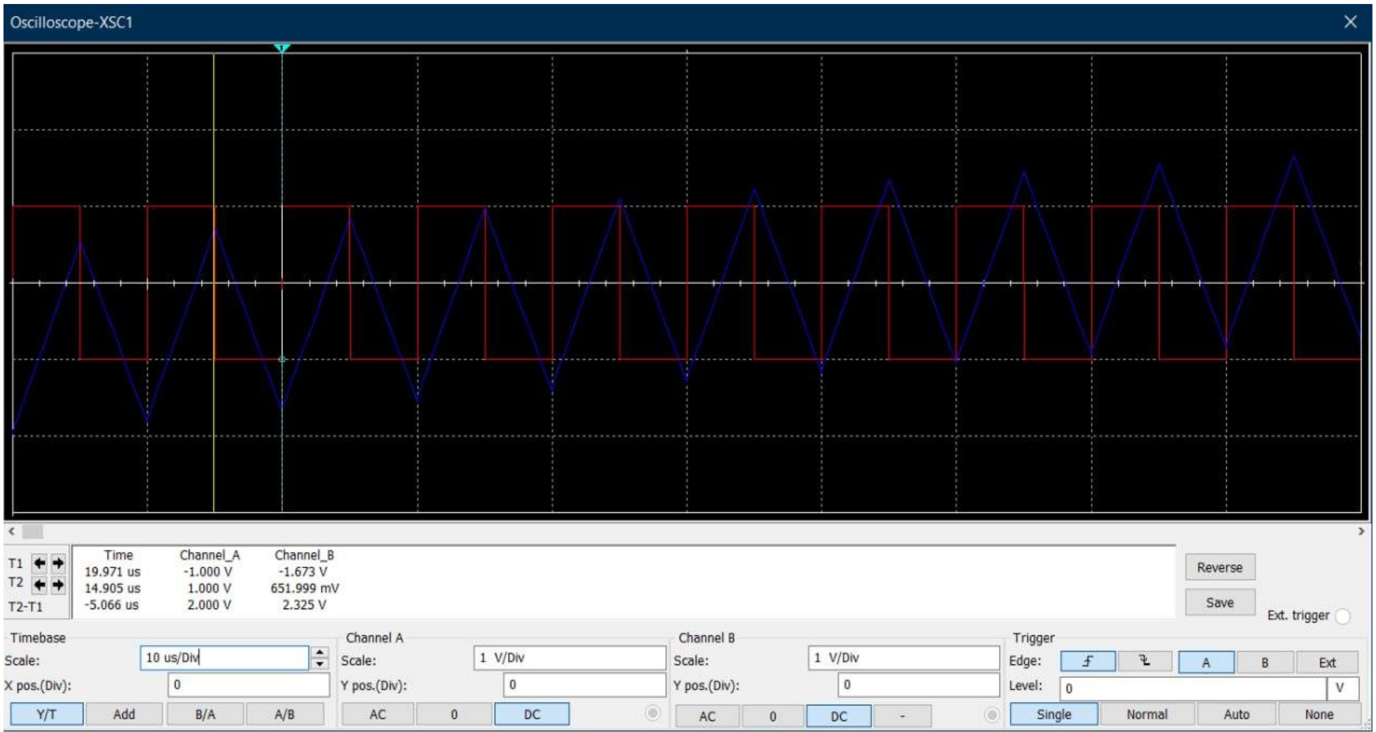
When applying input frequency=1kHz:



When applying input frequency=10KHz:



When applying input frequency=100KHz:

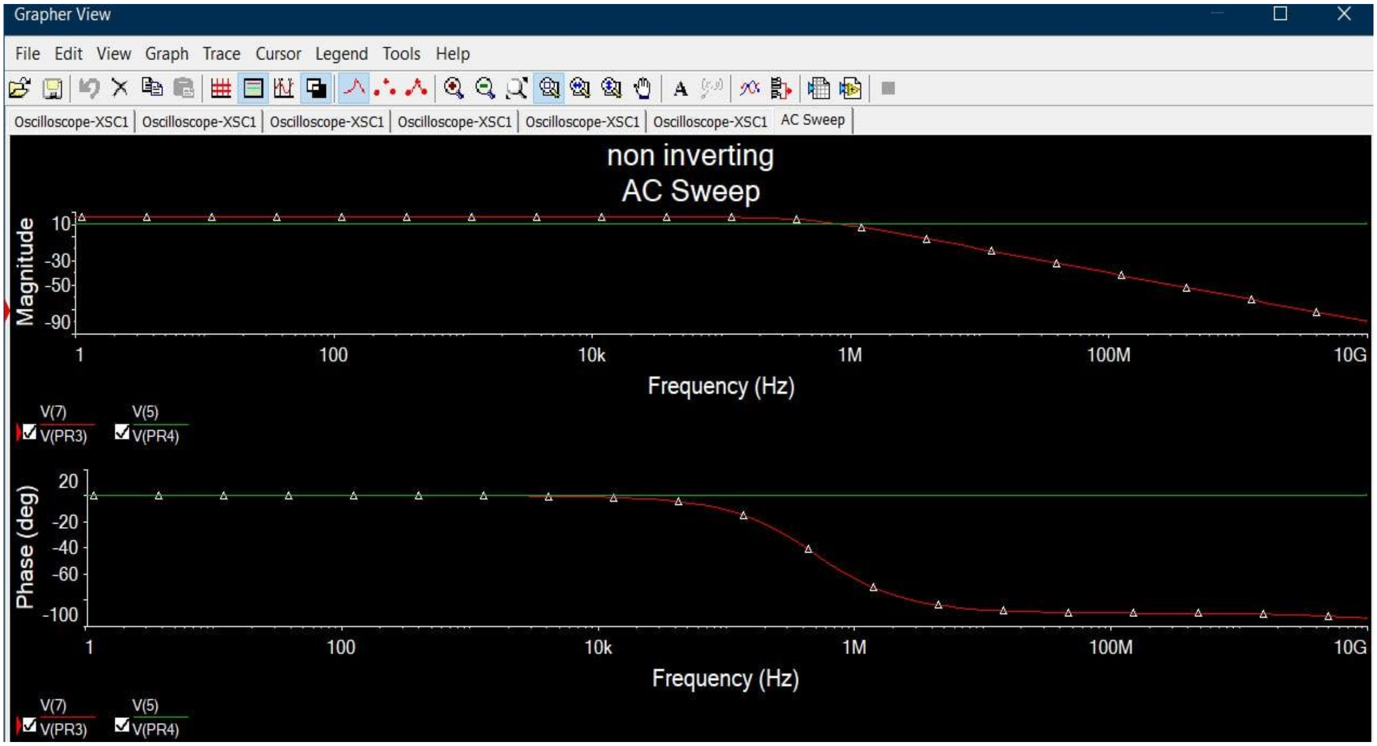


S.NO	Input frequency	(p-p) voltage
1	1kHz	4V
2	10KHz	3.992V
3	100KHz	2.325V

Comment:

Increasing the input frequency can indeed destroy the peak-to-peak voltage of the output signal and cause distortion, often manifesting as a conversion of the square wave into a triangular-like waveform. This distortion is a result of bandwidth limitations, slew rate constraints, and frequency-dependent effects inherent in the non-inverting amplifier circuit.

- **<u>frequency Response:</u>**

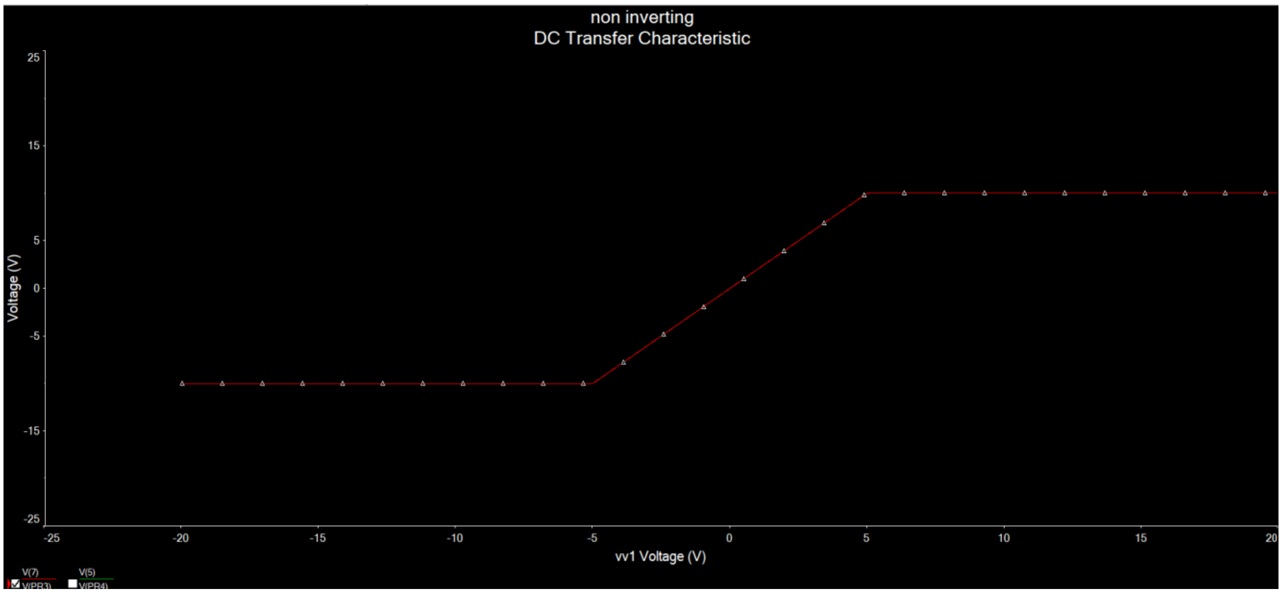


S.NO	Input frequency	Mag, variation	Phase variation
1	1HZ	1.999919	-0.00012
2	100HZ	1.999919	-0.0117
3	1KHZ	1.999915	-0.11698
4	100KHZ	1.959497	-11.539
5	1GHZ	0.000981	-90.3854
6	10GHZ	9.79E-05	-94.1862

<u>Comment:</u>

The figures illustrate that increasing the frequency results in a reduction in both magnitude and phase variation within the system. At a frequency of 1MHz, there is a noticeable shift in magnitude, transitioning from a positive value to a negative value. Similarly, there is a corresponding decrease in phase, shifting from zero degrees to a negative value.

- **DC characteristics:**

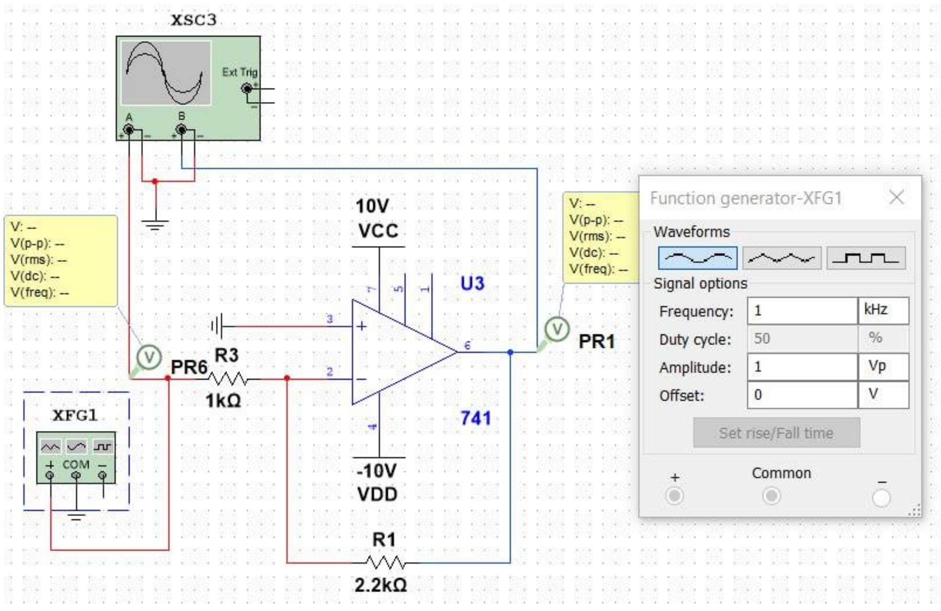


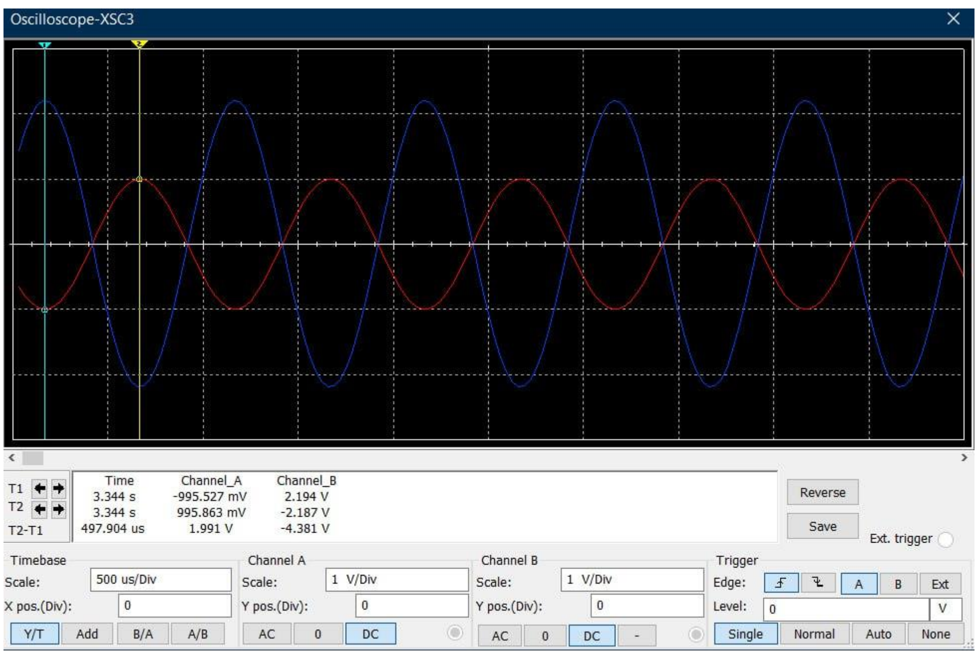
S.NO	Input voltage	Output voltage	Phase variation
1	-20	-9.33958	0
2	-8.69	-9.33613	0
3	-6.04	-9.33337	0
4	3.47	6.93993	0
5	5.8	9.332874	0

Comment:

The input voltage range from -20V to 20V results in an output voltage that increases proportionally with the input voltage. Notably, within the input voltage range of -20V to -5V, the output voltage remains constant at -9.33V. However, beyond -5V to 20V, the output voltage linearly increases until it reaches 9.33V at an input voltage range of 5V to 20V. Importantly, the output voltage consistently aligns with the direction of the input voltage throughout this range.

- **<u>Inverting amplifier:</u>**
  <u>Circuit:</u>



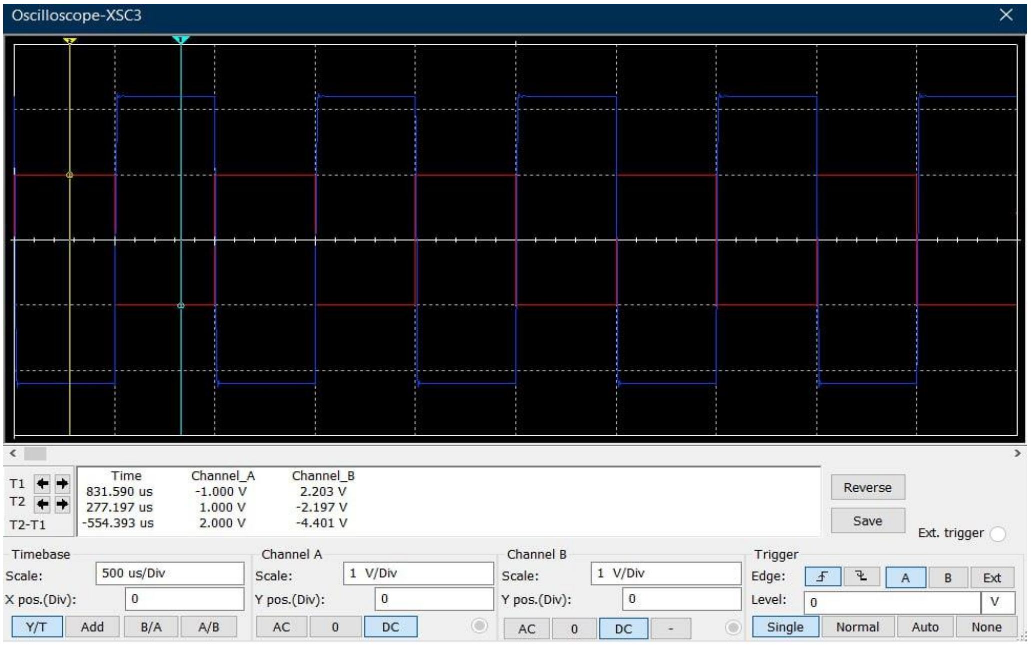


<u>Comment:</u>

that the output of the system is out of phase with respect to its input by 180 degrees. This implies that if the input pulse is positive, the output pulse will be negative, and vice versa. Additionally, the gain (Av) of the system is calculated as -R2/R1, resulting in a value of -2.2, indicating that the output is inverted with a magnification factor of 2.2.

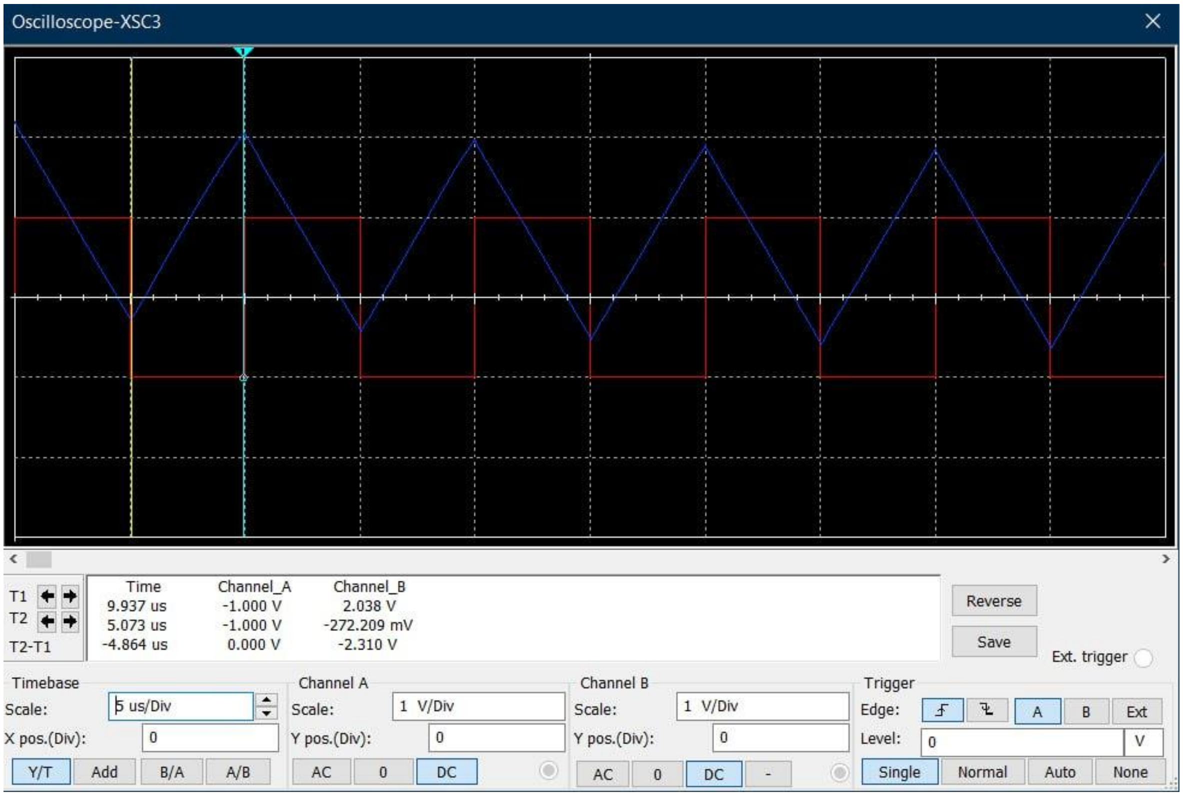
- **Transient Response:**

when applying input frequency=1kHz:



when applying input frequency=10kHz:

when applying input frequency=100kHz:

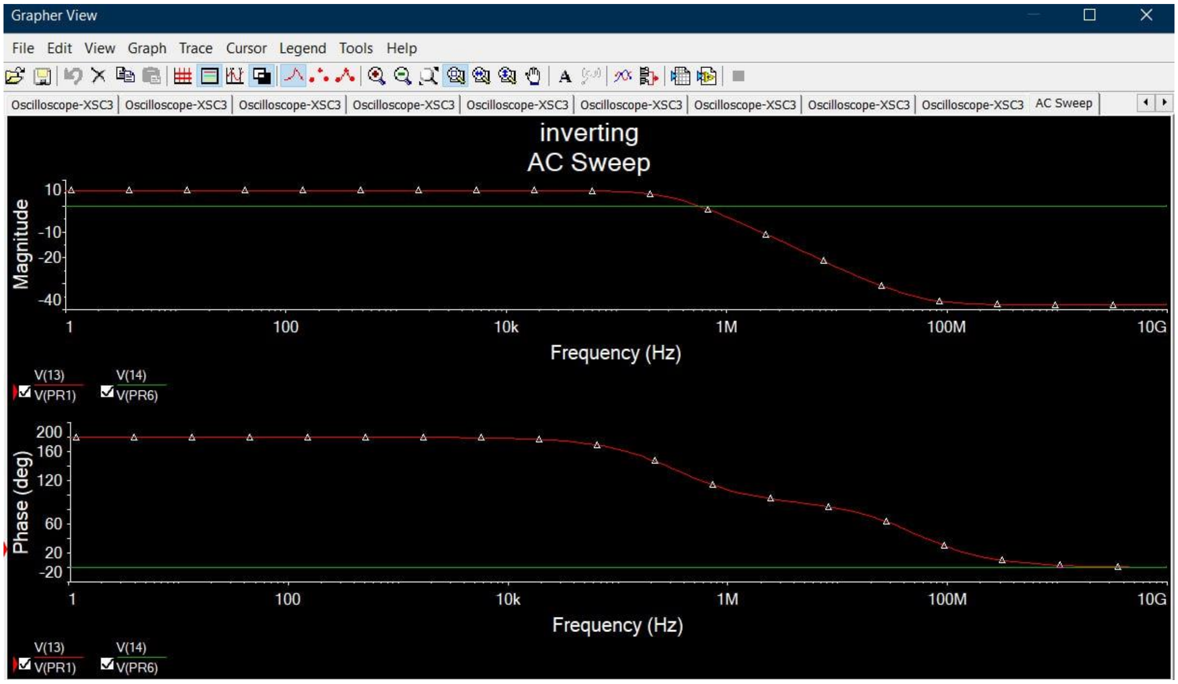


S.NO	Input frequency	(p-p) voltage
1	1kHz	4.401V
2	10KHz	4.396V
3	100KHz	2.310V

Comment:

At 100khz the peak-to-peak voltage decreases.

- **Frequency Response:**

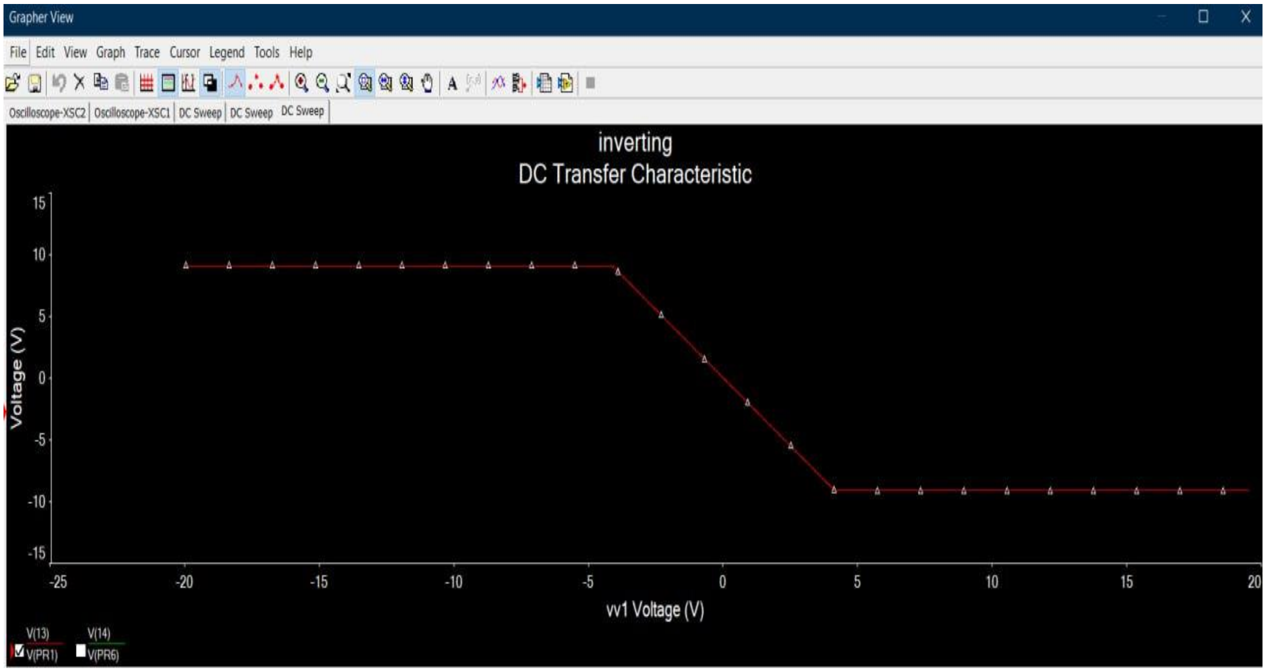


S.NO	Input frequency	Mag. Variation	Phase variation
1	1HZ	1.999969	179.9998
2	100Hz	1.999969	179.9825
3	1KHZ	1.99996	179.8245
4	100KHZ	1.913287	162.9614
5	1GHZ	0.012354	3.062363
6	10GHZ	0.012336	0.305044

Comment:

The figures demonstrate that as the frequency increases, there is a trend of decreasing magnitude and phase variation within the system. At a frequency of 1MHz, there is a notable transition in magnitude from a positive value to a negative value. Similarly, there is a decrease in phase, shifting from a positive value to a negative value.

- ## DC characteristics:

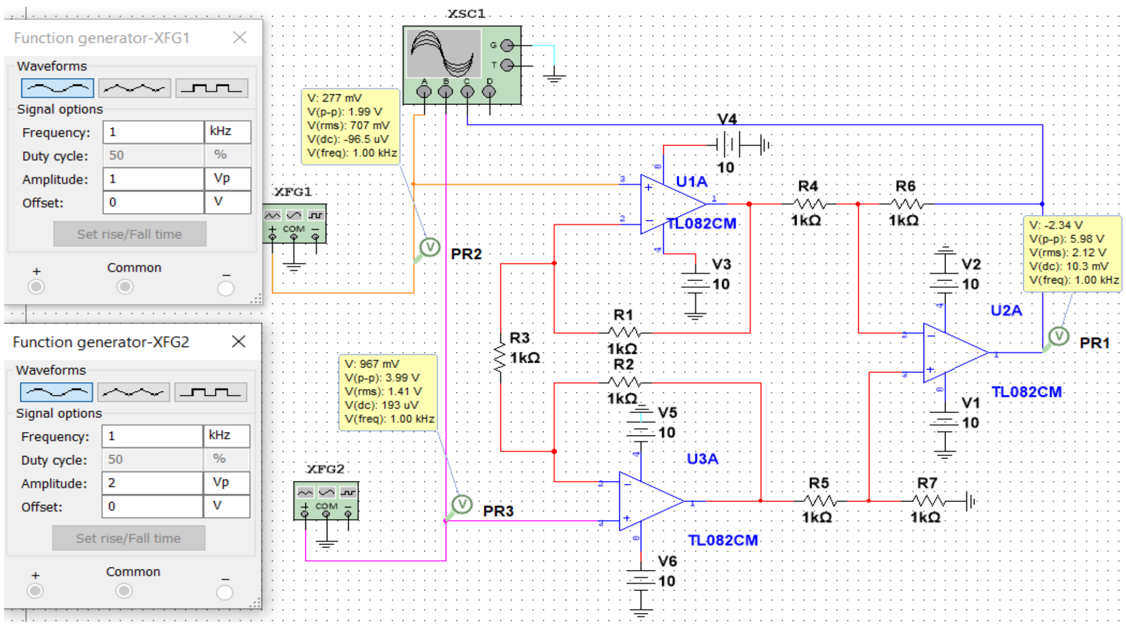


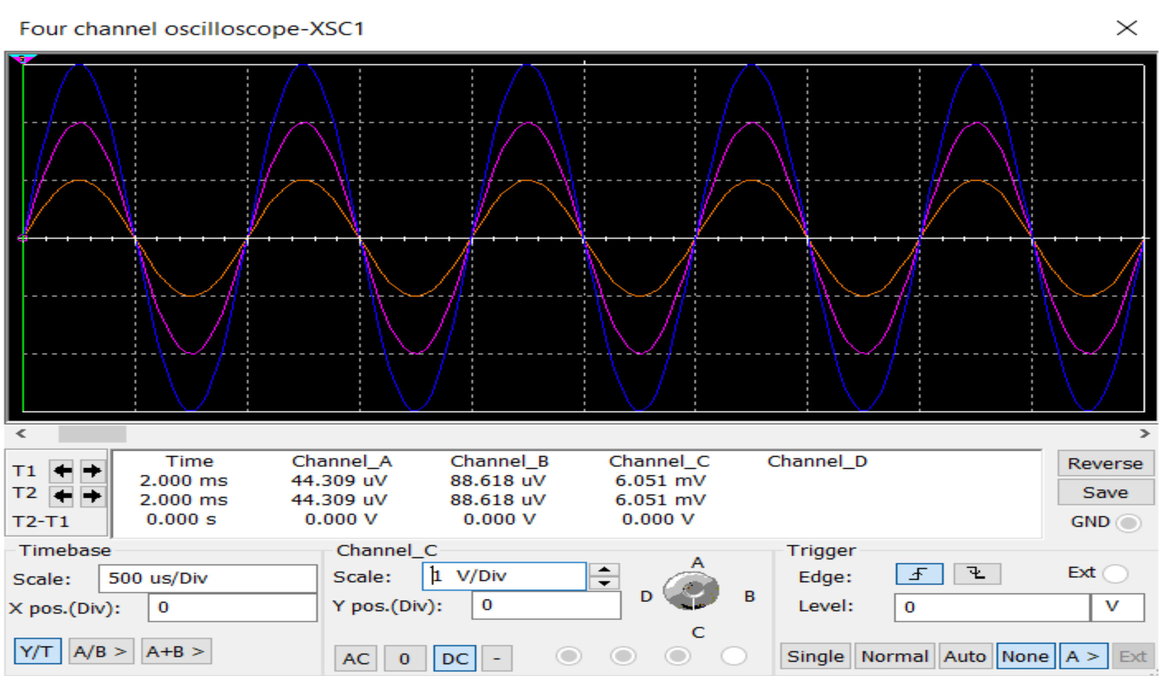
S.NO	Input voltage	Output voltage	Phase variation
1	-20	9.106675	0
2	-10.32	9.111109	0
3	-4.45	9.113468	0
4	-3.06	6.735355	0
5	3.6	-7.9164	0
6	4.86	-9.11331	0

Comment:

When comparing the DC input voltage to the DC output voltage, there is an inversion of sign. In other words, if the DC input voltage is positive, the DC output voltage will be negative, and vice versa.

- ## Instrumentation amplifier using three OP-Amps:
  ## Circuit:



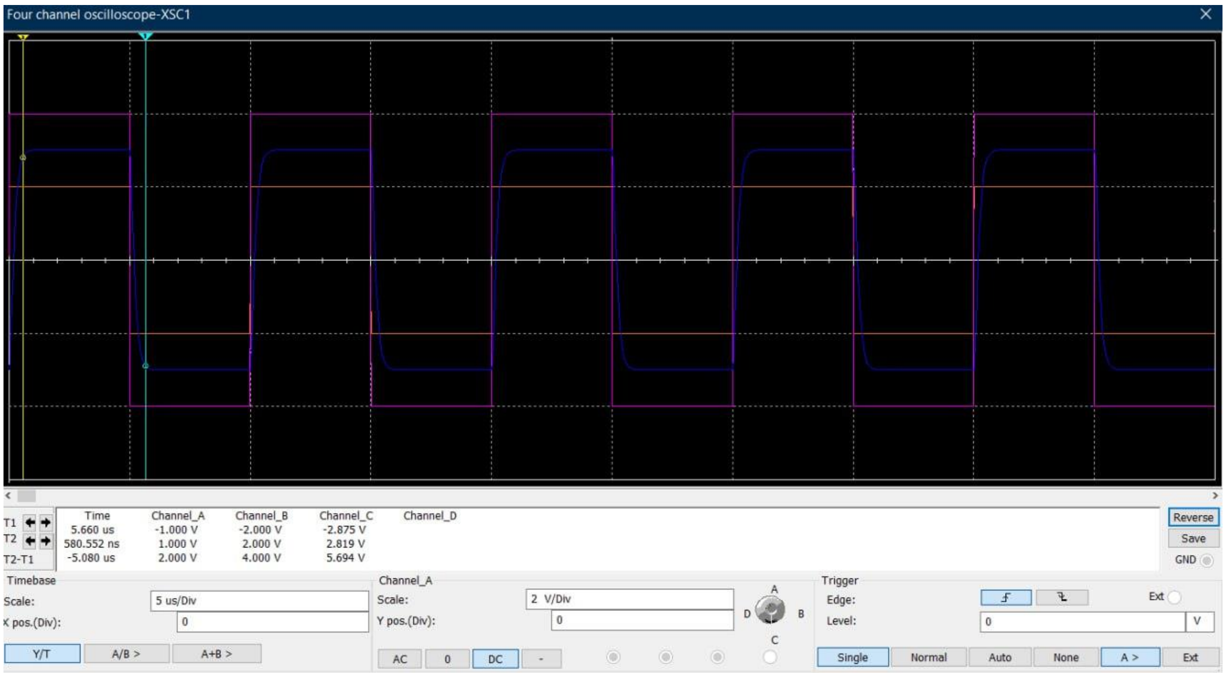


- Voltage gain (Av) = Vo/(V2-V1)= (1 + 2R1/Rg) x R3/R2
- R1=R2=R3=R Rg=n R
- to get gain=3: n=1 Rg=R
- From simulation: if V1=1v V2=2v R=1KΩ Gain=3

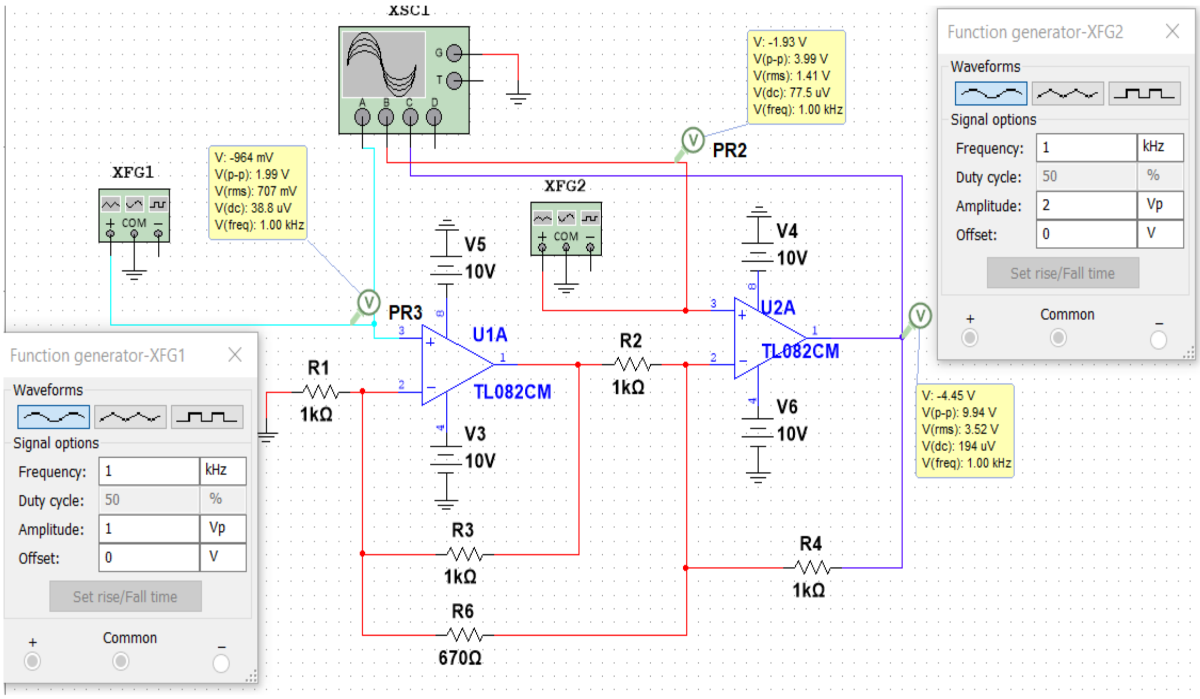
- Vout=3(2-1)=3v   and that we get from simulation
- CMRR=AD/Acm
- CMRR(dB)=20 Log (CMRR)

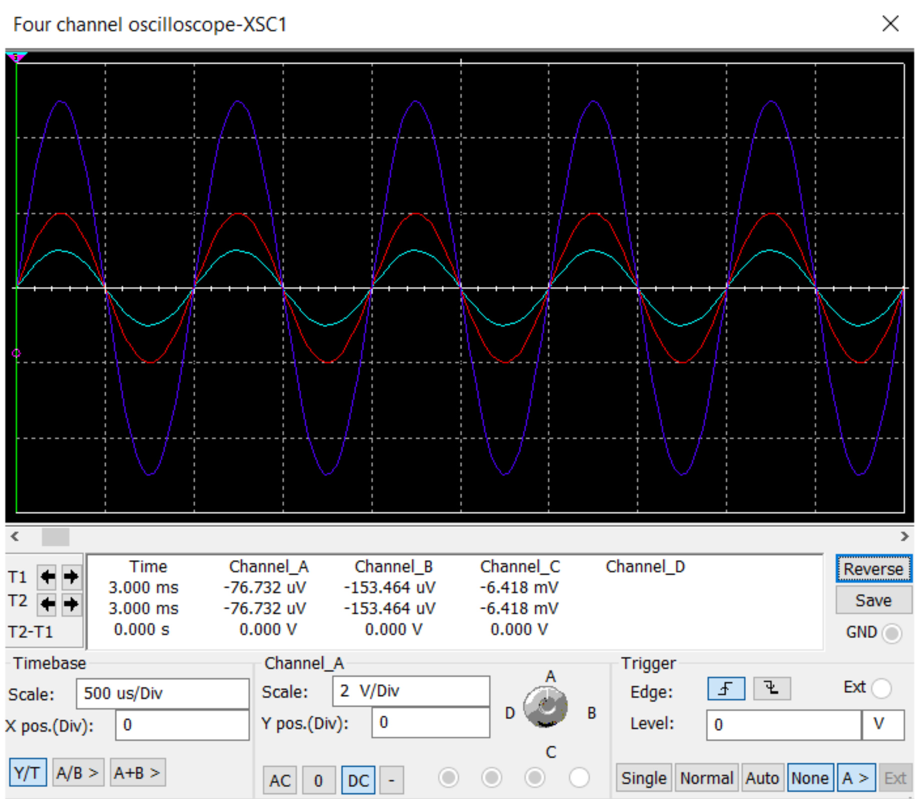
- **Transient response:**

When applying input frequency=100kHz



• Instrumentation amplifier using two OP-Amps:





- Gain=1+R4/R3+2R2/R R1=R2=R3=R4=R Rg=n R
- To get gain=5 5=1+1+2/n
- n=2/3
- if: V1=1v V2=2V R=1KΩ Rg≈670Ω
- Vout=gain*(V2-V1) =1*5=5v and that we get from simulation.
- CMRR=AD/Acm
- CMRR (dB)=20 Log (CMRR)

- **Transient response:**