ANALOG ELECTRONIC CIRCUITS
LAB REPORT-3

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Full Wave Rectifiers

1)TRANSFORMER CHARACTERISATION:

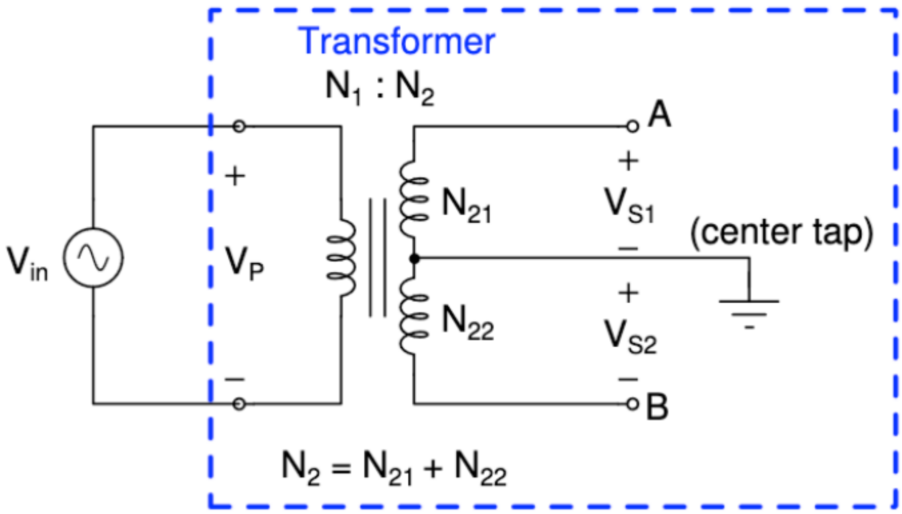


Figure 1: Bridge Rectifier

a)

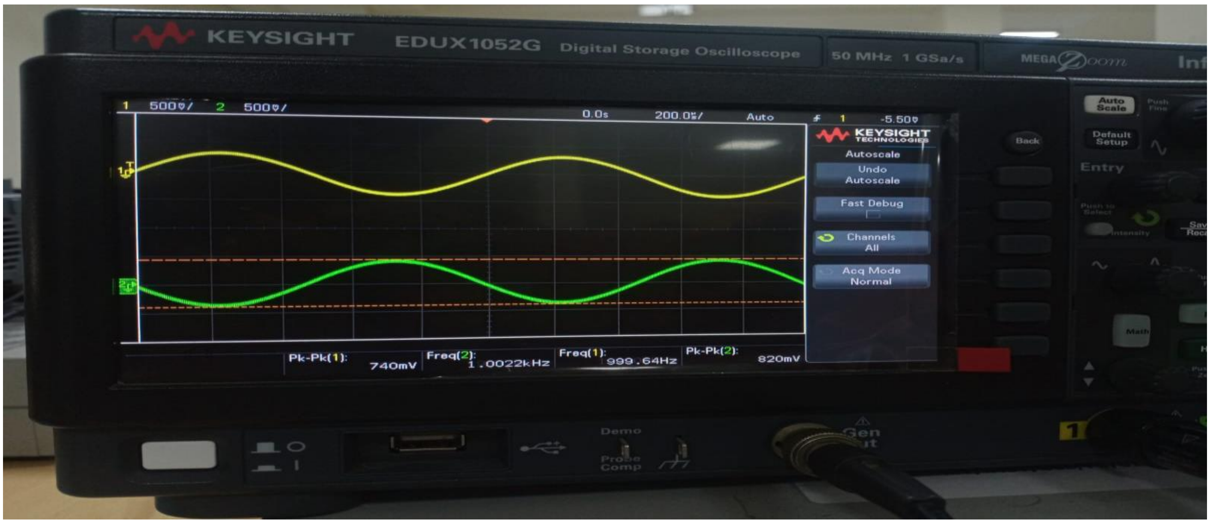
INPUT:

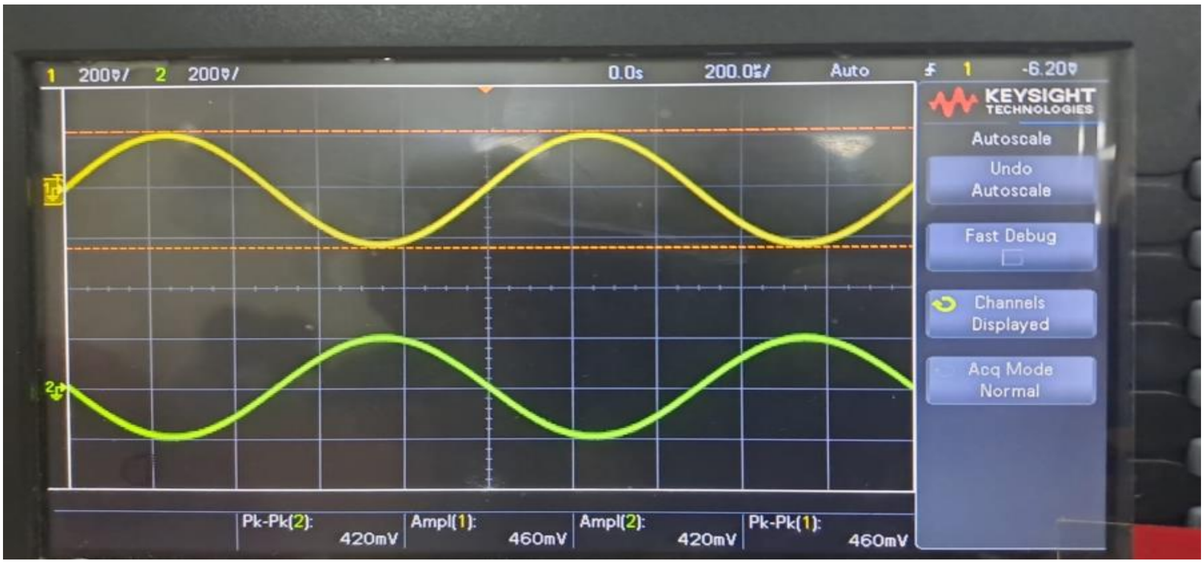
Vin=12Vpp

Frequency=1k Hz

OUTPUT:

We can conclude that from figure:





	Amplitude	Frequency	Phase
Va	460 mV	1k Hz	0 deg
Vb	420 mV	1k Hz	182.91 deg

b)

From the plot of VA and VB obtained:

Amplitude of VA : (Vpp)2 =830mV=VS1

Amplitude of VB : (Vpp)1=830mV=VS2

Frequency of VA=Frequency of VB =1000kHz

Phase Difference between VA and VB is 180 degrees.

Magnitude of Input Vin=12 (Vpp)

Magnitude of final output Vout=|VA-VB|=|VS1+VS2|

=830 + 830

=1660mV

=1.66V

The output voltage VAB =1.6V << input Voltage Vin=12Vpp This drop in the output as compared to the input is because of the transformer with N1:N2 to be the transformed ratio.

N1:N2=Vin :VAB

= 12.4/1.66

= 7.469

=Vprimary :Vsecondary

Actually the input peak-peak voltage was set to be 12 Vpp but the observed output have Vpp=12.4 due to some calibration error or non linearity in the output generated by the DSO.

So 12.4 output was considered while calculating the transformer ratio N1:N2.

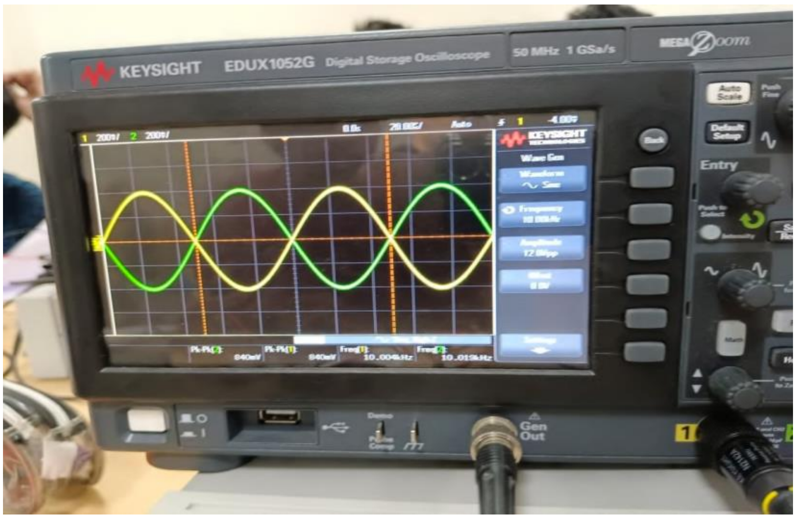
since N1:N2 > 1 so the given transformed is a STEP DOWN transformer.

c)

Variation in output as the input frequency changes:

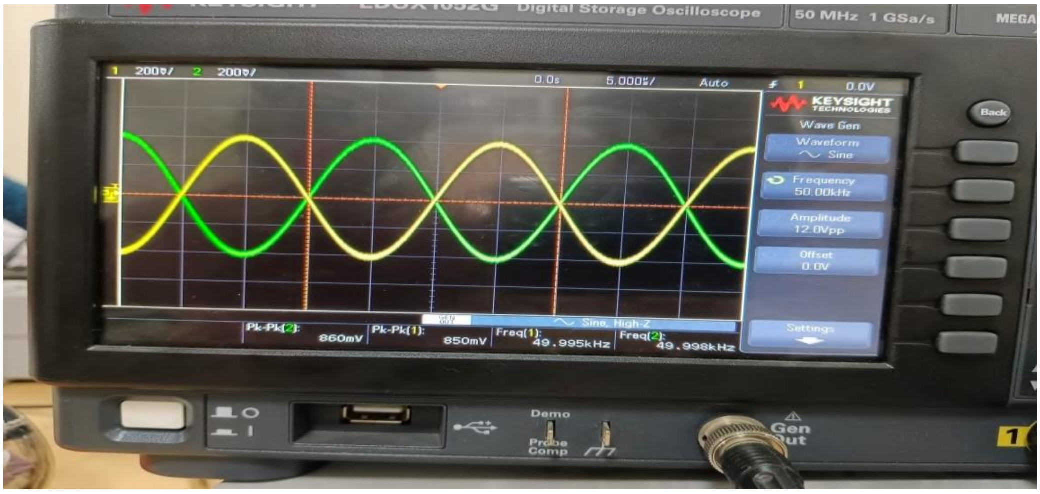
Case1: f=10k Hz

VA=840 mV and VB=840mV with the phase difference to be 180 degrees.



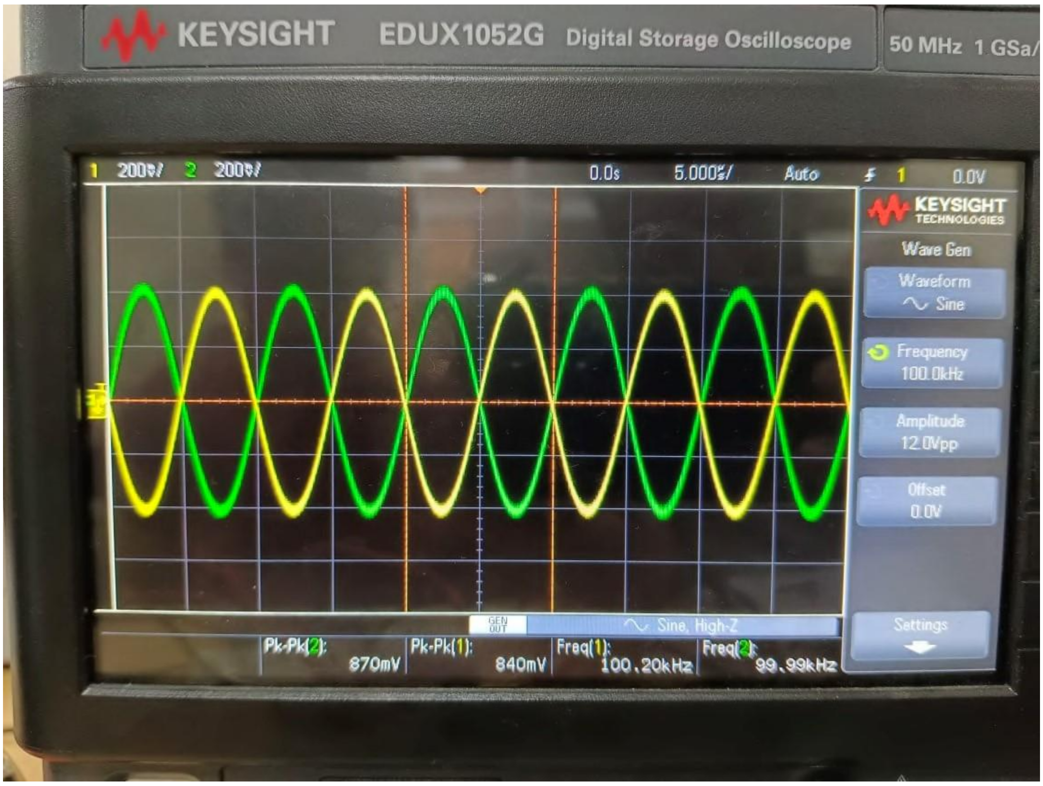
Case2: f=50k Hz

VA=860 mV and VB=850mV, phase difference=180 degree .



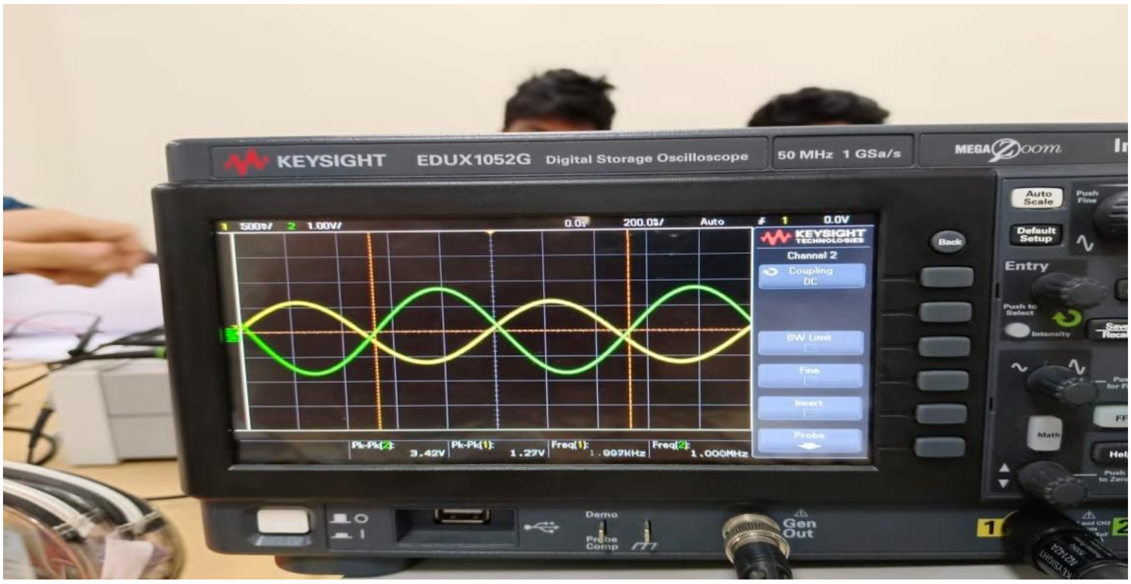
Case3: f=100kHz

VA=870 mV and VB=850mV, phase difference=180 degree.



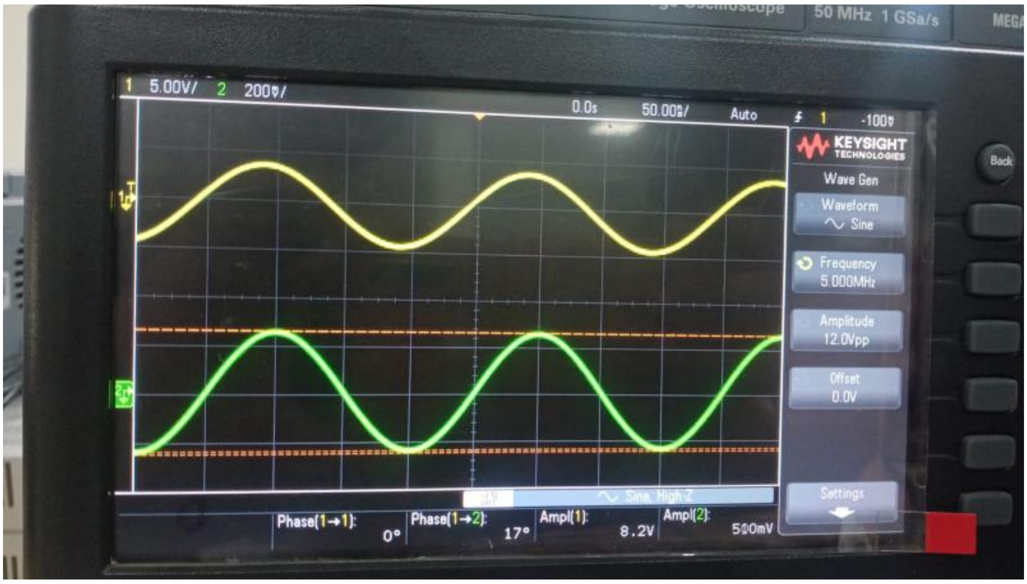
Case4: f=1MHz

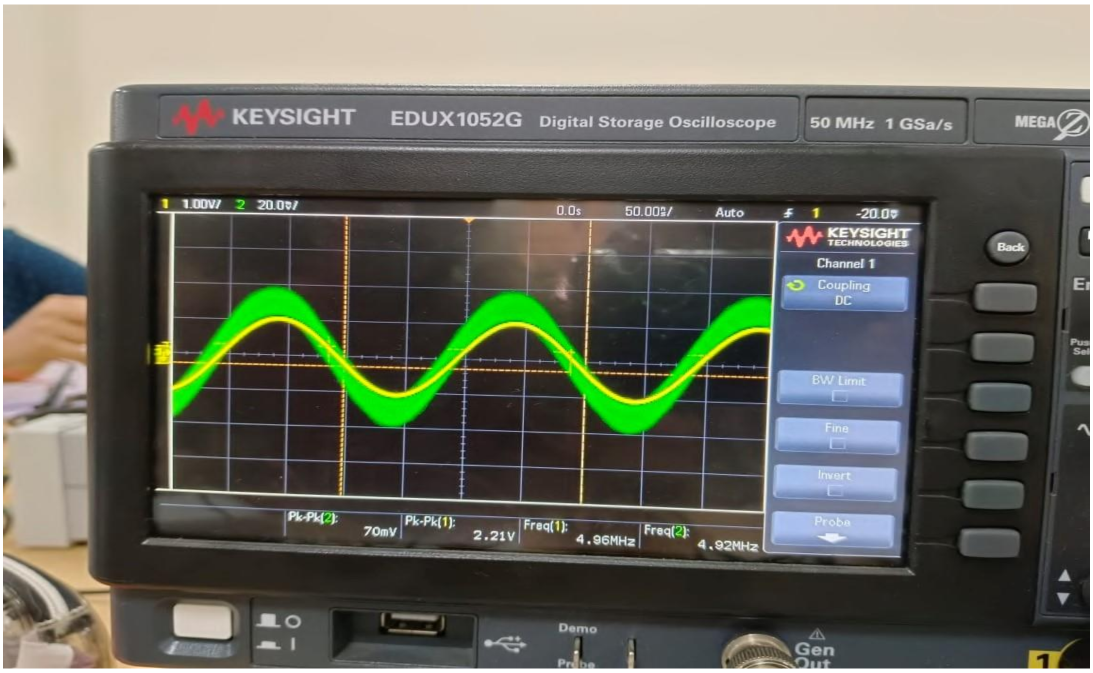
VA=3.42 V and VB=1.27 V, phase difference < 180 degree.



Case5: f=5MHz

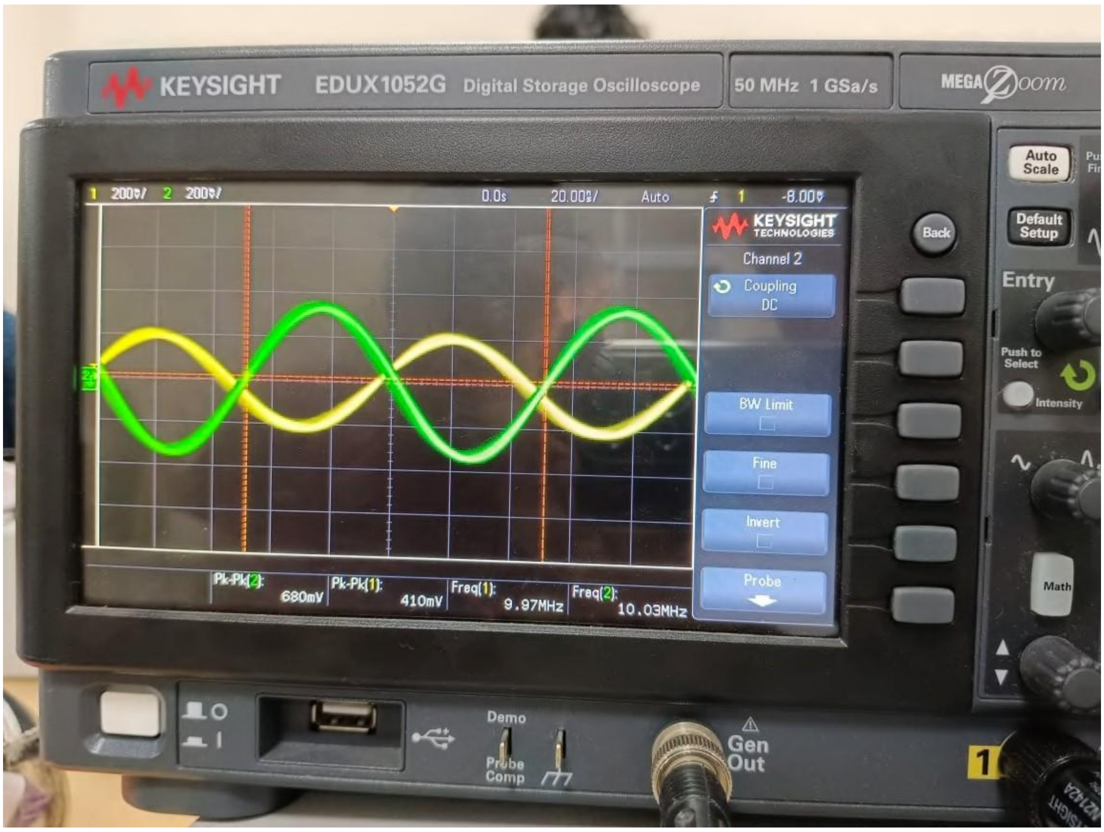
_VA=70mV and VB=2.21 V, phase difference close to 0 degree.





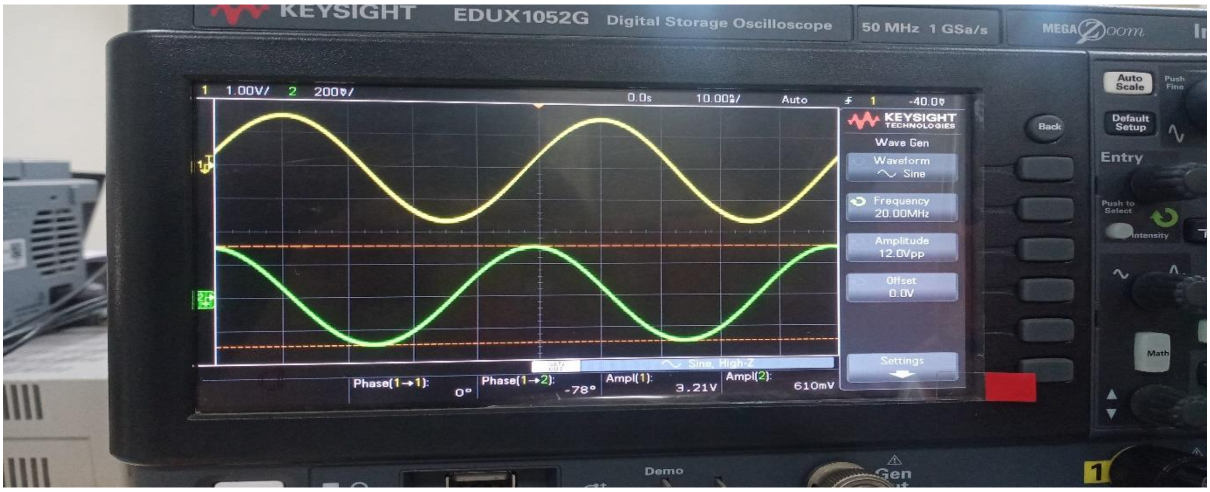
Case6: f=10MHz

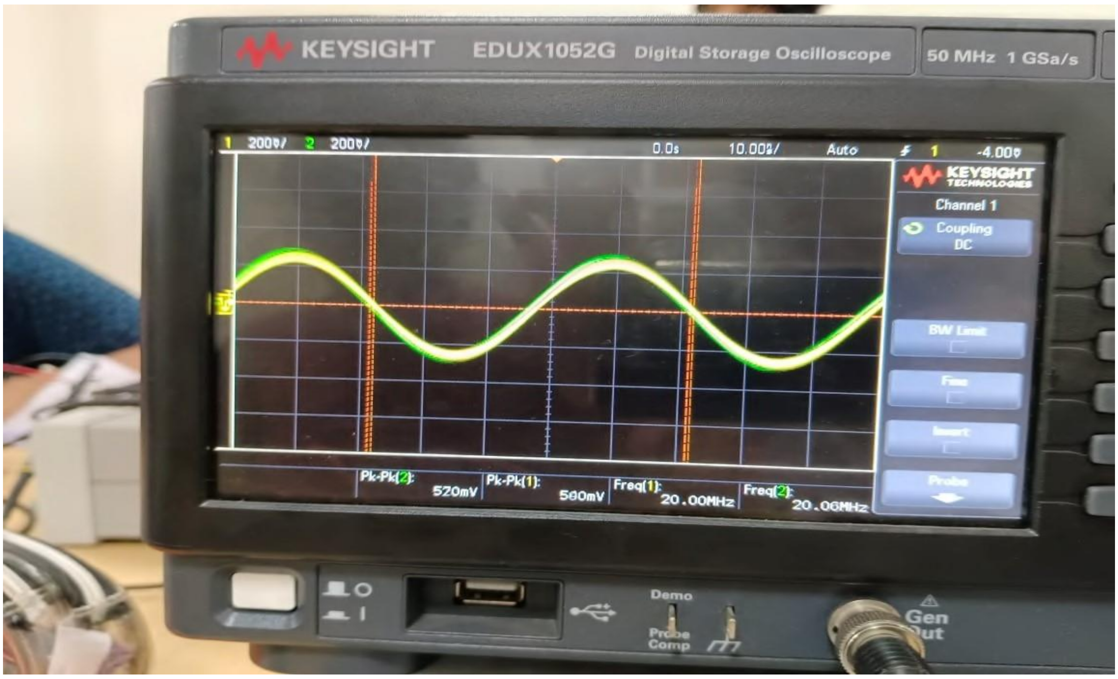
VA=680mV and VB=410mV, phase difference close to 180 degree.



Case7: f=20M Hz

VA=520mV and VB=510mV, phase difference close to 0 degree.





Tabular column containing the following values:

V in (frequency)	Va (Vpp)	Vb(vpp)
10k Hz	**840 mV**	**840 mV**
50k Hz	**860 mV**	**850 mV**
100k Hz	**870 mV**	**850 mV**
1M Hz	**3.42 V**	**1.27 V**
5M Hz	**70 mV**	**2.21 V**
10M Hz	**680 mV**	**410 mV**
20M Hz	**520 mV**	**510 mV**

d)

As we observed from above table, we can conclude that:

The magnitude of Va increased first and we observe sudden drop in Va and then slight Increase.

The probe wire could be acting like a low pass filter only allowing low frequency inputs to pass through it and attenuating the high frequency inputs.

Every cable has a specific impedance, which is the resistance to the flow of alternating current.

At higher frequencies, the impedance of the cable rises, resulting in signal attenuation or reduction in the signal amplitude.

The limited bandwidth of the input cable could also contribute to the reduction in amplitude with an increase in frequency.

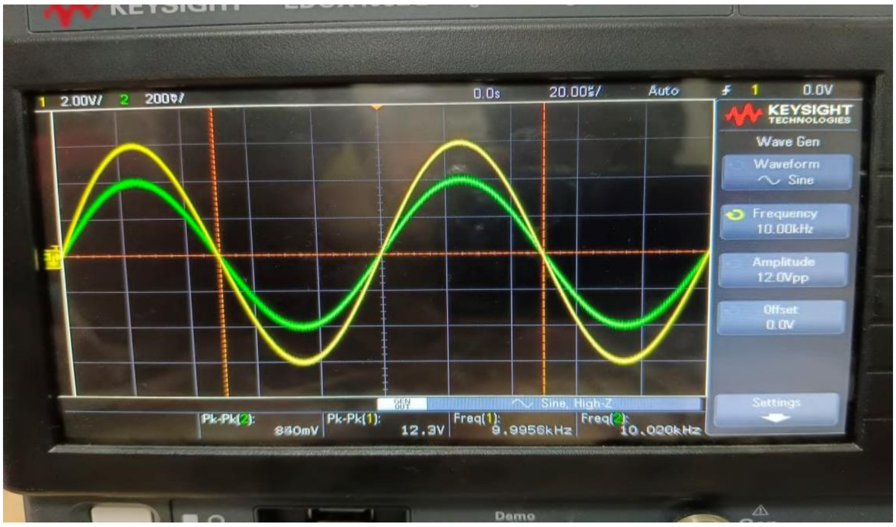
The bandwidth of a cable is the range of frequencies that can pass through the cable with minimal attenuation.

If the input cable's bandwidth is limited, it can cause attenuation at higher frequencies, leading to a reduction in amplitude.

<u>Repeating the experiment by plotting VA in channel 1 and Vp(V input) in channel 2 :</u>

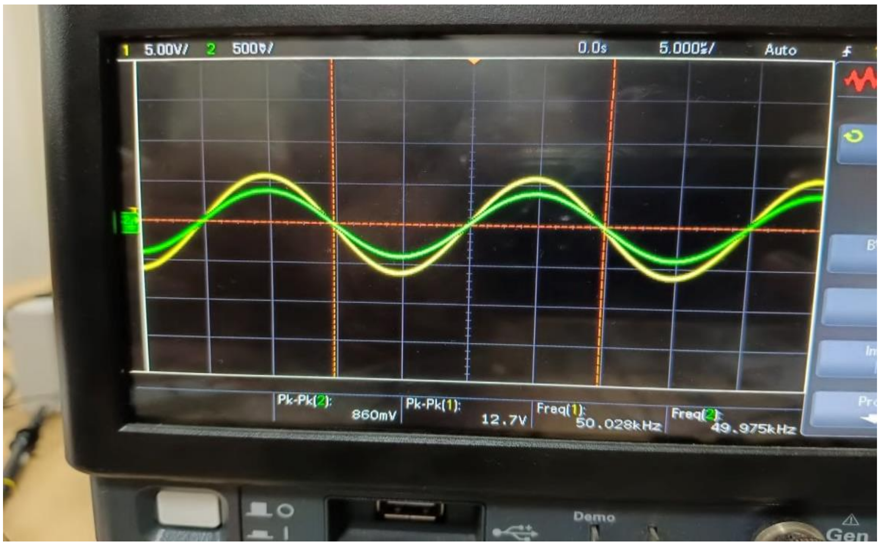
Case1: f=10kHz

VA=840 mV and Vp=12.3V with the phase difference to be 0 degrees.



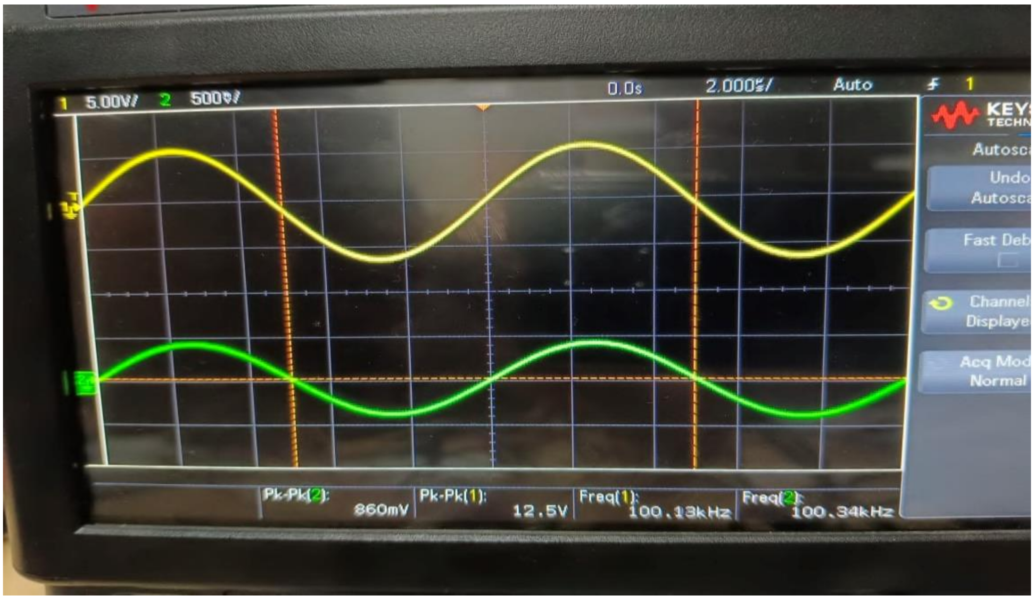
Case2: f=50kHz

VA=860 mV and Vp=12.7V with the phase difference to be 0 degrees.



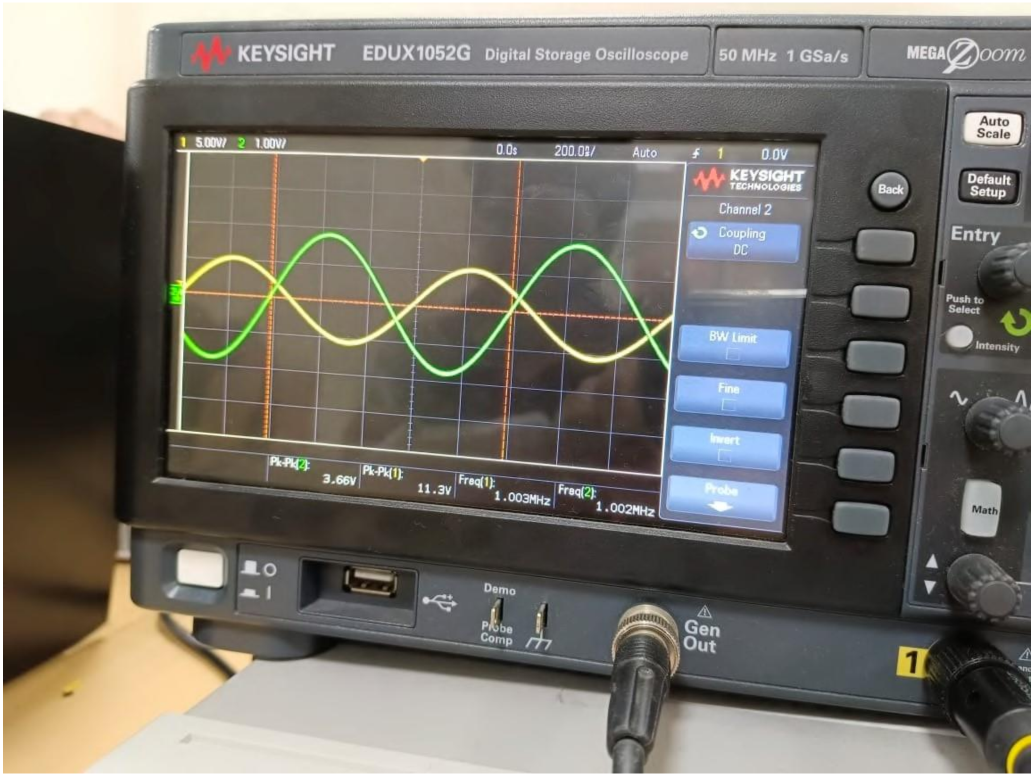
Case3: f=100kHz

VA=860 mV and Vp=12.5V with the phase difference to be 0 degrees.



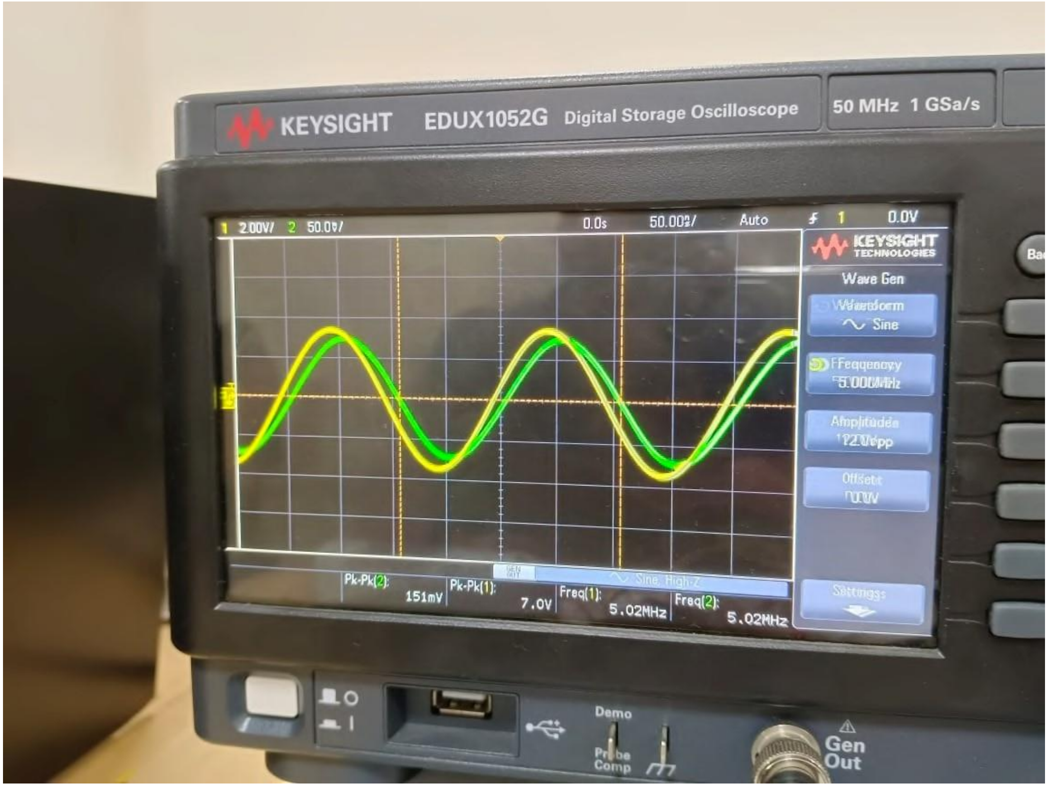
Case4: f=1MHz

VA=3.66V and Vp=11.3V with VA lagging than Vp



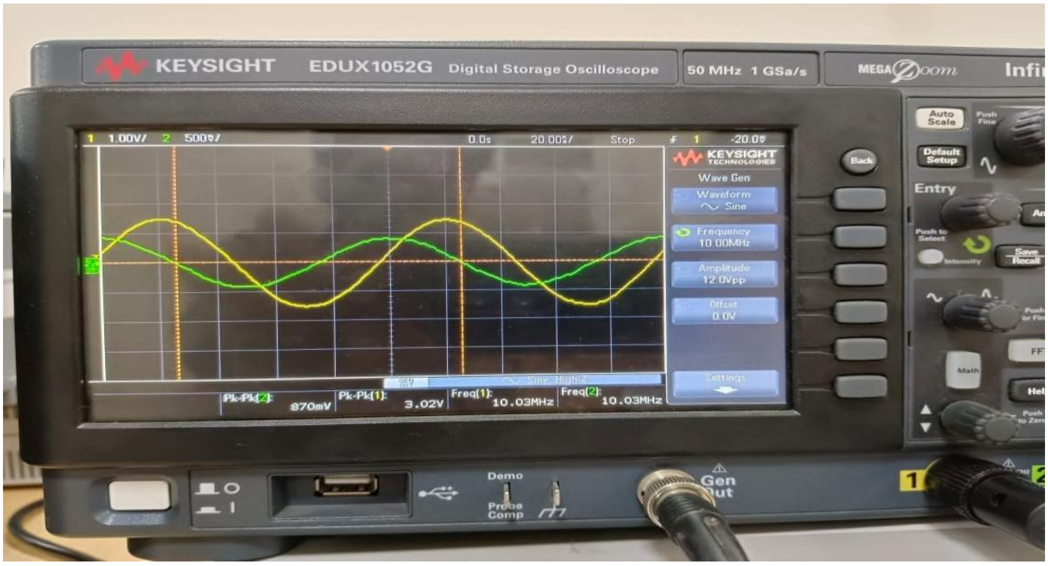
Case5: f=5MHz

VA=151mV and Vp=7V with VA slightly leading than Vp



Case6: f=10MHz

VA=870mV and Vp=3.02V with VA lagging than Vp



Case7: f=20MHz

VA=550mV and Vp=2.48V with VA slightly leading Vp

V in (frequency)	**Va(Vpp)**	**Vp(Vpp)**
10 k Hz	840 mV	12.3 V
50 k Hz	860 mV	12.7 V
100 k Hz	860 mV	12.5 mV
1MHz	3.66 V	11.3 V
5MHz	151 mV	7 V
10MHz	870 mV	3.02 V
20MHz	550 mV	2.48 mV

From above table we can conclude that:

As frequency of input voltage kept increasing there was a gradual decrease in Vp and we can observe sudden Drop in between.

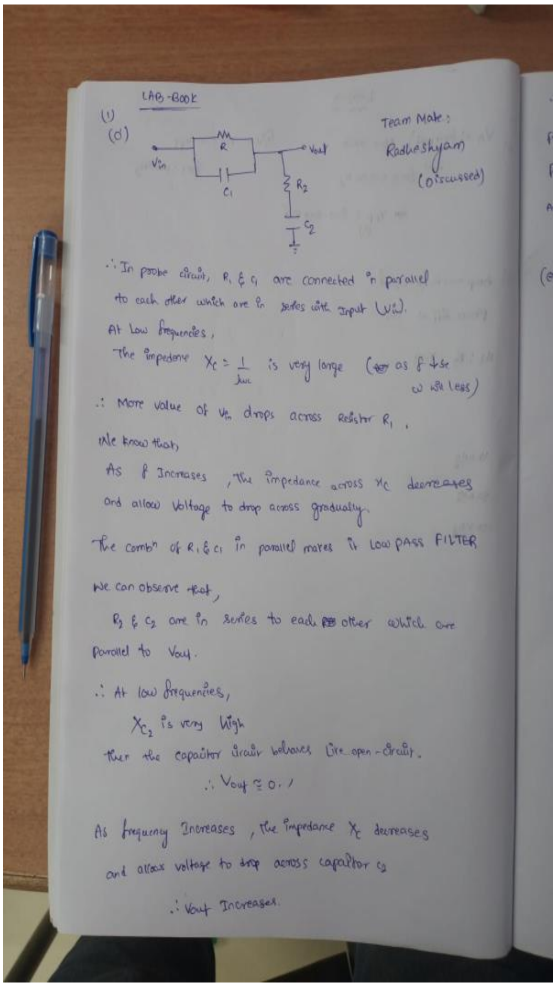
There are several reasons why the output of a step-down transformer may be less than expected when a high-frequency signal is input.

Impedance Mismatch: The signal may be returned back to the source when there is a mismatch in impedance between the transformer and the load. The amplitude of the signal may decrease.

Core Saturation: The transformer core may become saturated by a high-frequency signal, which will lessen its capacity to step down the voltage. The output voltage may decrease as a result of this saturation.

Resonance: The transformer may resonate at a particular frequency, causing a reduction in the output voltage at that frequency.

PART D and E calculation:



LAB-BOOK

(1)

(d)

Team Mate: Radheshyam (Discussed)

∴ In probe circuit, R_1 & C_1 are connected in parallel to each other which are in series with input (V_{in}).

At low frequencies,

The impedance $X_c = \frac{1}{j\omega c}$ is very large (as f ↓se ω will less)

∴ More value of V_{in} drops across Resistor R_1.

We know that,

As f Increases, the impedance across X_c decreases and allow Voltage to drop across gradually.

The combⁿ of R_1 & C_1 in parallel makes it Low PASS FILTER

We can observe that,

R_2 & C_2 are in series to each other which are parallel to V_{out}.

∴ At low frequencies,

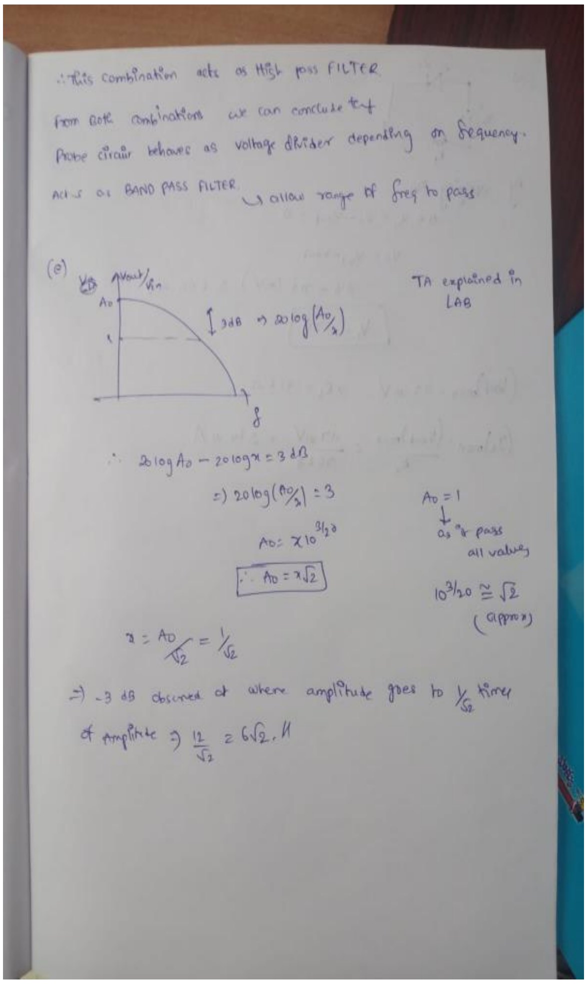
X_{C_2} is very high

then the capacitor circuit behaves like open-circuit.

∴ $V_{out} \simeq 0$.

As frequency Increases, the impedance X_c decreases and allow voltage to drop across capacitor C_2

∴ V_{out} Increases.



∴ This combination acts as High pass FILTER

From both combinations we can conclude that

Probe circuit behaves as voltage divider depending on frequency.

Acts as BAND PASS FILTER ↳ allow range of freq to pass

(e)

3dB → $20\log(A_0/x)$

TA explained in LAB

∴ $20\log A_0 - 20\log x = 3\,dB$

$\Rightarrow 20\log(A_0/x) = 3$

$A_0 = x\,10^{3/20}$

$\boxed{\therefore A_0 = x\sqrt{2}}$

$A_0 = 1$ ↓ as it pass all values

$10^{3/20} \cong \sqrt{2}$ (approx)

$x = \frac{A_0}{\sqrt{2}} = \frac{1}{\sqrt{2}}$

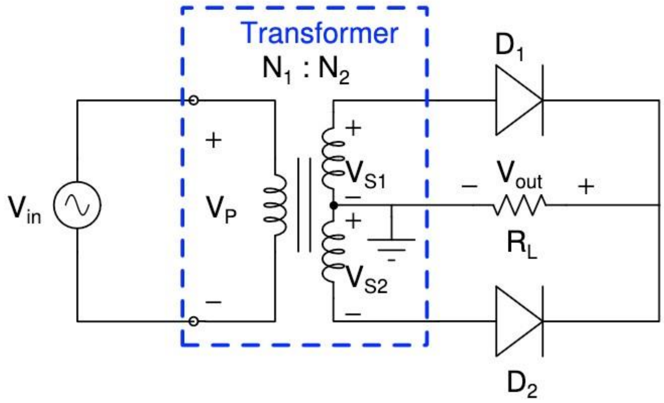
⇒ -3 dB observed at where amplitude goes to $\frac{1}{\sqrt{2}}$ times of Amplitude ⇒ $\frac{12}{\sqrt{2}} = 6\sqrt{2}$. //

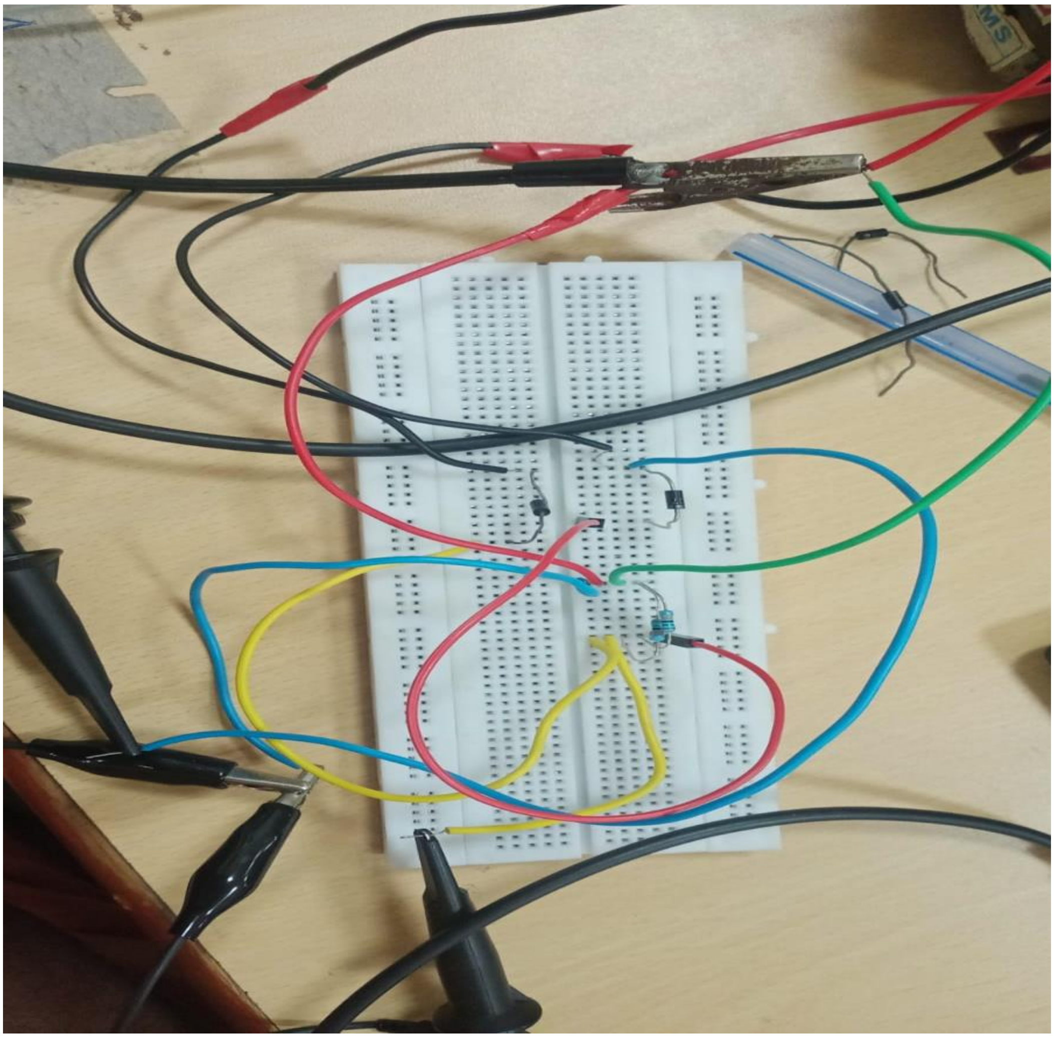
e) -3dB bandwidth can be obtained by the point when the output input voltage drops to 63% of its original Value.

Time constant =RC in the RC .At t=time constant, the Voltage drops in by 63% forming -3dB frequency bandwidth. Vin(max Vpp)=12V, 63% of Vin ~ 7.6 V.

The output voltages Vin shown lowers more than 7.6V at a frequency of 4.4MHz in the input. Thus, the probe wire's -3dB band width is 4.4MHz.

2) Full wave rectifier using centre tapped transformer and two diodes:





a)

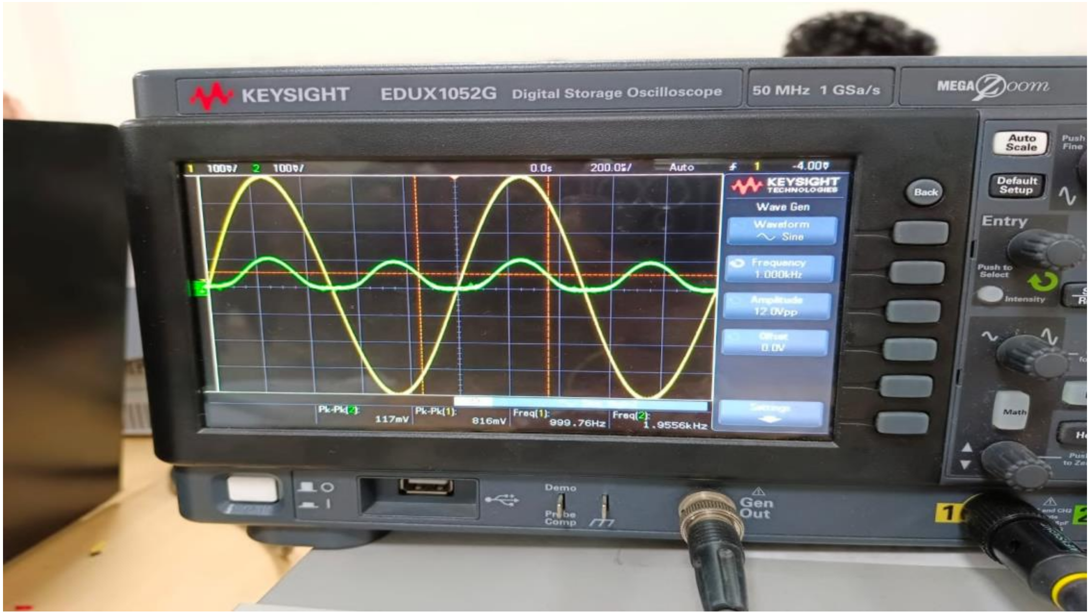
INPUT:

Vin(Vpp)=12 V

Frequency =1k Hz

R=50 k ohm

b) Plot of VS1 and Vout :



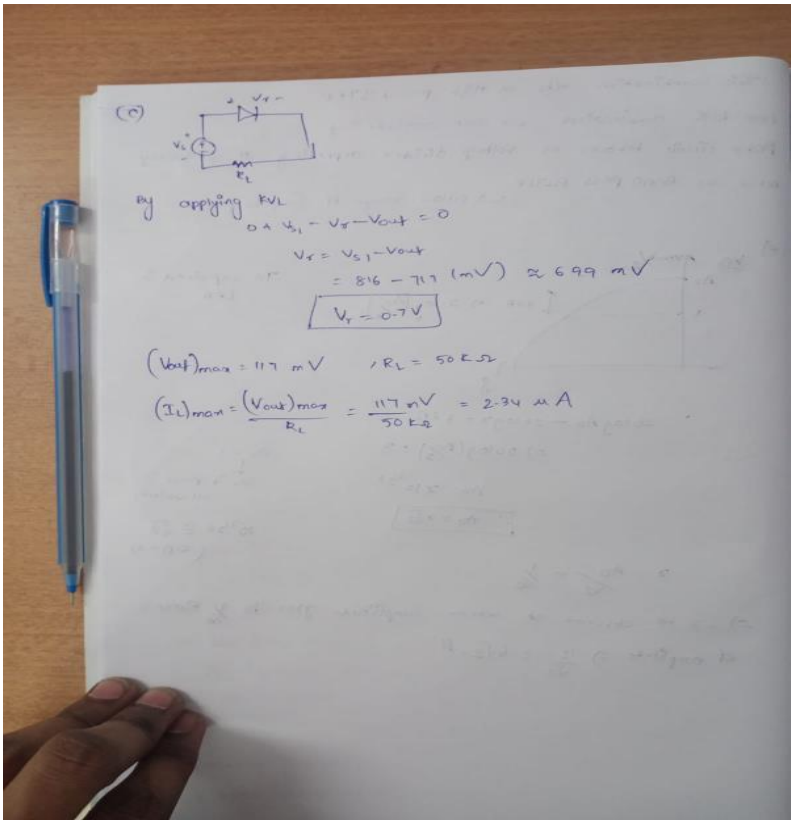
->Full wave rectification observed

Vout plotted on channel 2 and Vs1 plotted on channel 1.

Peak to peak amplitude voltages of Vout and Vs1:

Vout=117mV
Vs1=816mV

c)



(c)

By applying KVL

$V_{s_1} - V_r - V_{out} = 0$

$V_r = V_{s_1} - V_{out}$

$= 816 - 117 \, (mV) \approx 699 \, mV$

$\boxed{V_r = 0.7 V}$

$(V_{out})_{max} = 117 \, mV$, $R_L = 50 \, k\Omega$

$(I_L)_{max} = \frac{(V_{out})_{max}}{R_L} = \frac{117 \, mV}{50 \, k\Omega} = 2.34 \, \mu A$

So, peak current through the resistor is (IL) is 2.34 uA.

d)

Reasons for decrement in Vout amplitude: The significant reduction in output voltage amplitude in a full wave rectifier with center tapped transformer could be due to the fact that the diodes are not able to completely turn on and forward current is too less.

-> This could happen because the diodes have a threshold voltage that must be reached before they start conducting.

-> If the voltage across the diode is not high enough, the diode will not conduct properly.

EXPLANATION of Reason:

->we need to measure the forward bias current through the diode.

->It can be done using a multimeter (in ammeter mode), by connecting the diode in series with the multimeter and a power supply.

->The voltage across the diode should be equal to the forward voltage drop of the diode, which can be found in its datasheet.

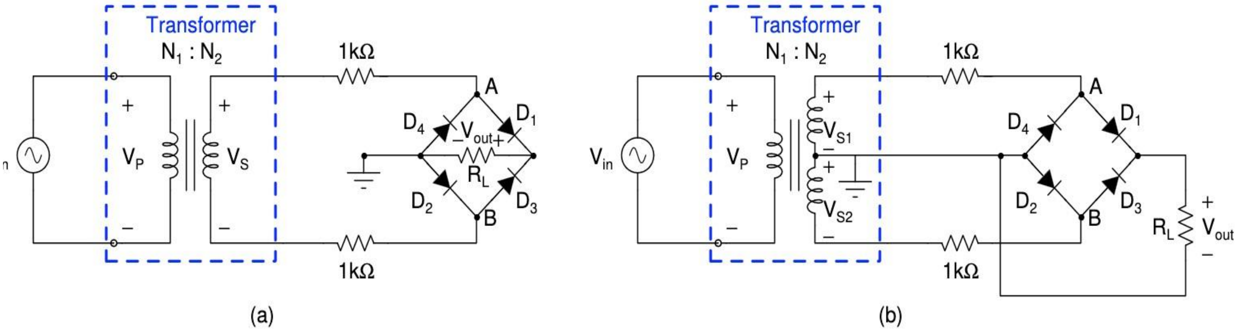
-> If the measured forward bias current is indeed too low, then we can conclude that the diodes are not able to completely turn on and conduct properly.

->In this case, we can try using different diodes with a lower threshold voltage or higher current rating.

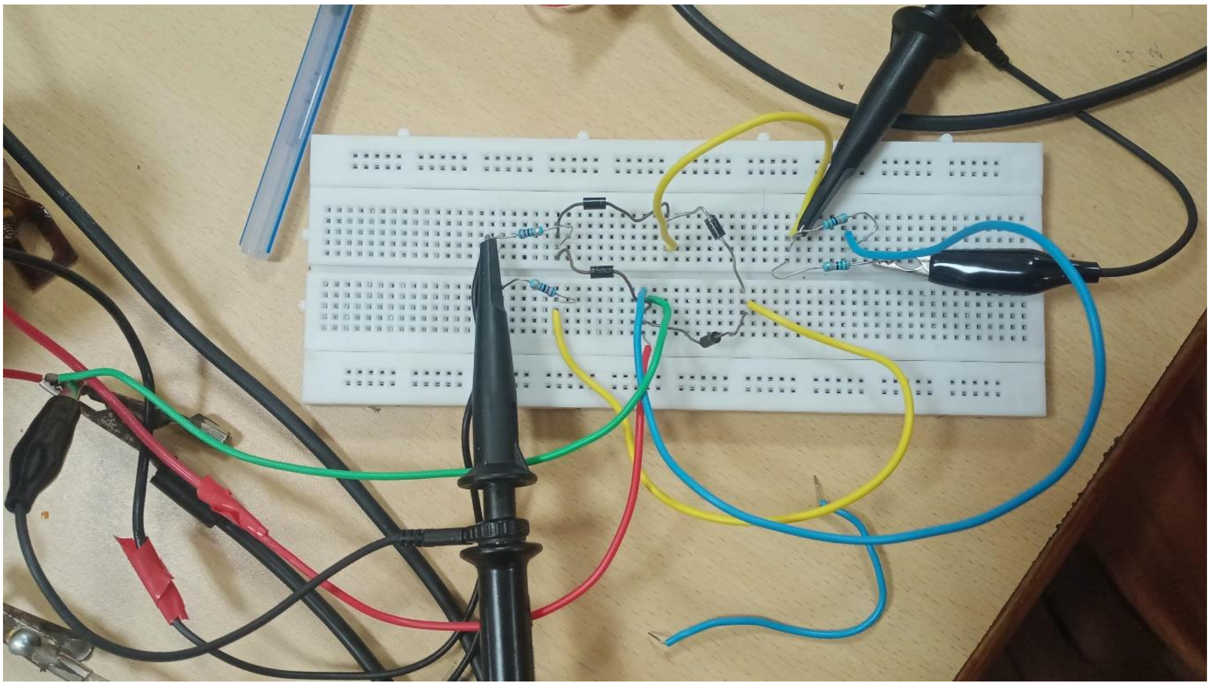
From the diode properties, we calculated the voltage across the diode and found that it was 699 mV, which is close to the diode's V cut in (1N4007).

It says that the diode's complete inability to switch on was the reason for the decreased value of the input to the rectifier circuit (the output from the transformer) following rectification. We can observe that the Vdiode was nearly 7V based on the observed values, which was not expected.

3) Bridge rectifier for full wave rectification:



a)BUILDING OF CIRCUIT:



b)

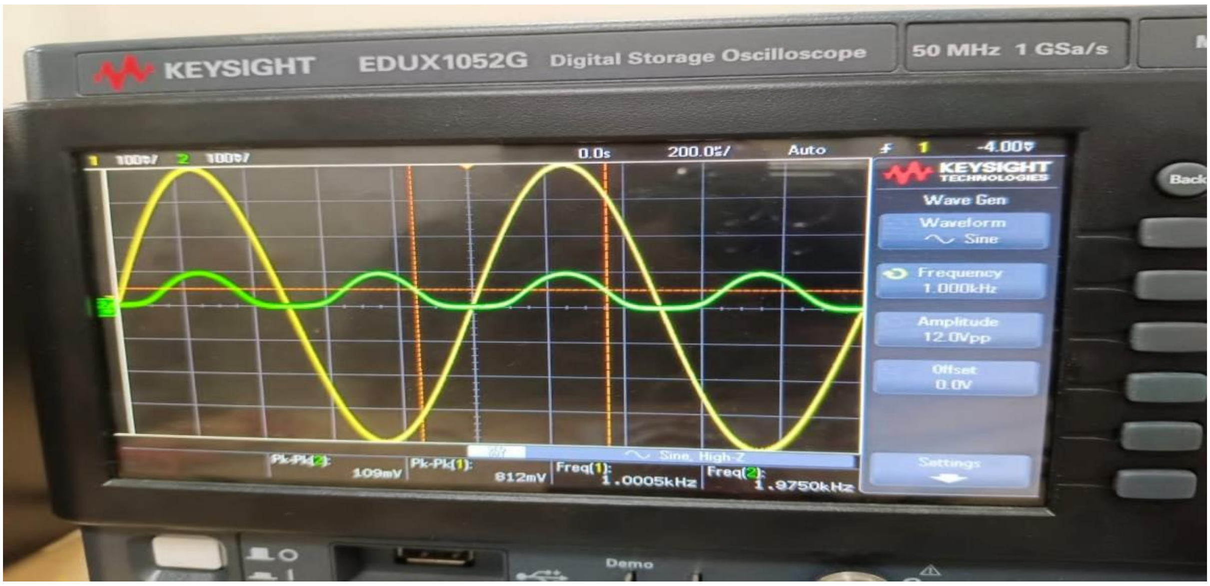
Vin (sinusoidal) :----------

V input(Vpp)=12 V

Frequency=1 k Hz

R=50 k ohm

b) Plot of VS1 and Vout :



Vout plotted on channel 2 and Vs1 plotted on channel 1.

Peak to peak amplitude voltages of Vout and Vs1:

Vout=109mV

Vs1=812mV

RL =50KHz

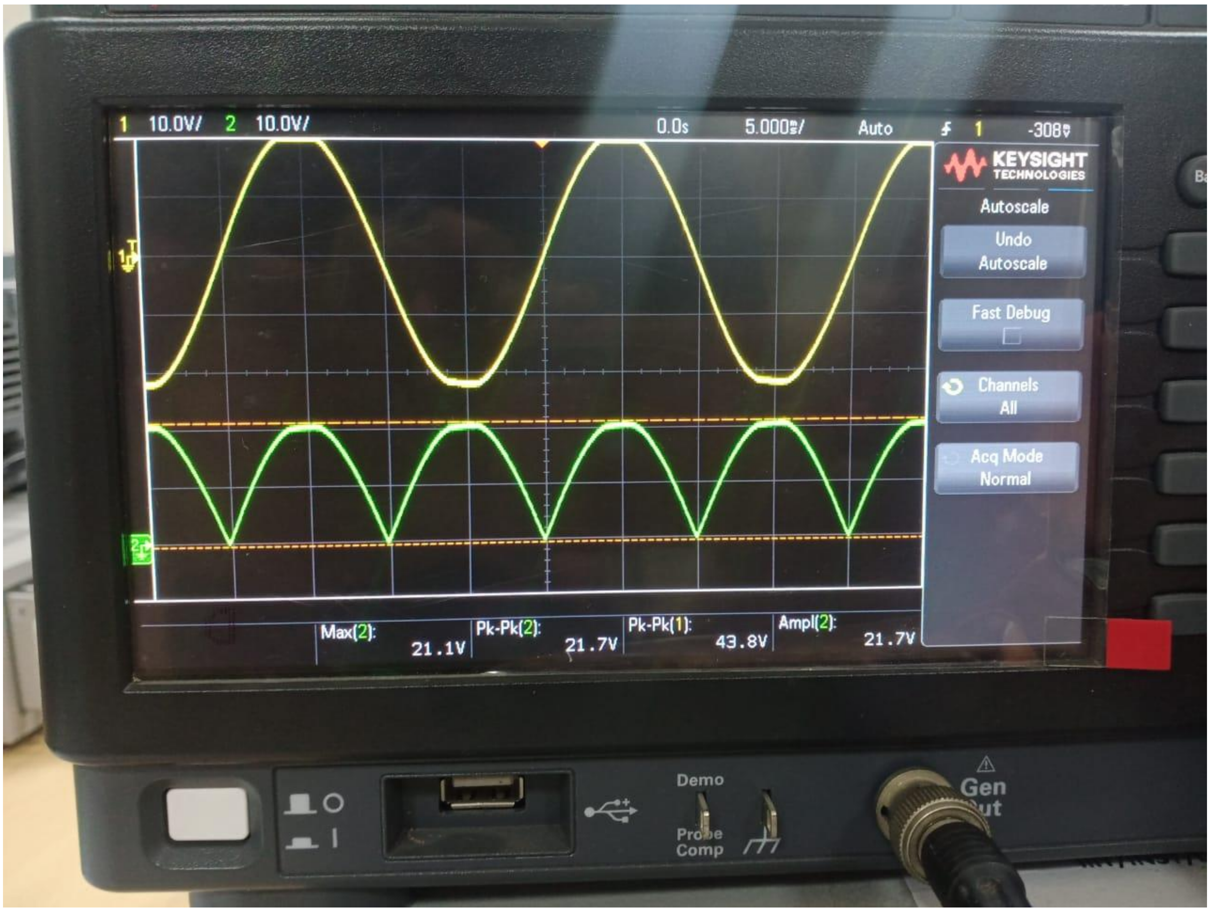
IL (max)= (Vout)max /RL=109mV / 50kHz = 2.18 uA

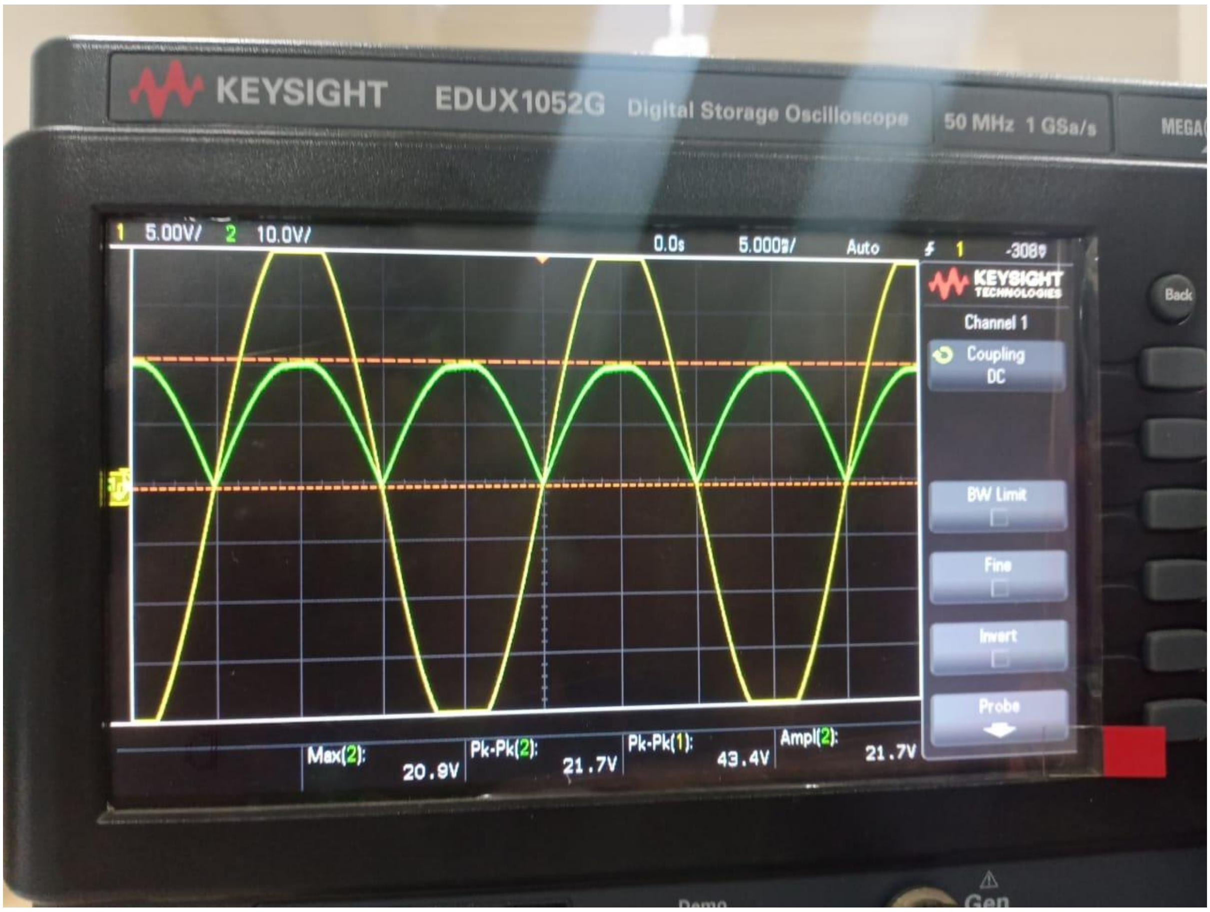
So the peak current through the resistor is 2.18uA.

c) Replacing Vin (Vpp=12V) to Vin (V=220V) ,the wall supply using the transformer plug pins.

Vin~220V, frequency f=50Hz

Plot of VS1 and Vout :





d) As compared to the before situation, the output from the wall supply is less attenuated than the equivalent output from the DSO wave generator input. The forward bias voltage across the diode rises in concert with the input voltage, increasing the diode current value. For the same resistance value, this leads to a higher output voltage. For this reason, the output is less turned off.

CONCLUSION:

When the input voltage increases, the forward bias voltage across the diode also increases, causing a higher current to flow through the diode. This results in a larger output voltage for the same resistance value. As a result, the output is less attenuated in this case