DEVICES AND CIRCUITS LAB REPORT – 6

EXPERIMENT NAME: Basic Operational Amplifier circuits.

ROLL NUMBERS: 200020010, 200020051

<u>Hardware Exercise</u>:

Objectives: To build inverting amplifier, non-inverting amplifier, differentiator and integrator using Op-Amps.

Equipment/Components Required:

1. OP-Amp µA 741

2. Resistors of suitable values

3. Capacitors of suitable values

4. Regulated power supply

5. Arbitrary Function Generator

6. Digital Storage Oscilloscope

Observations:

Inverting Amplifier:

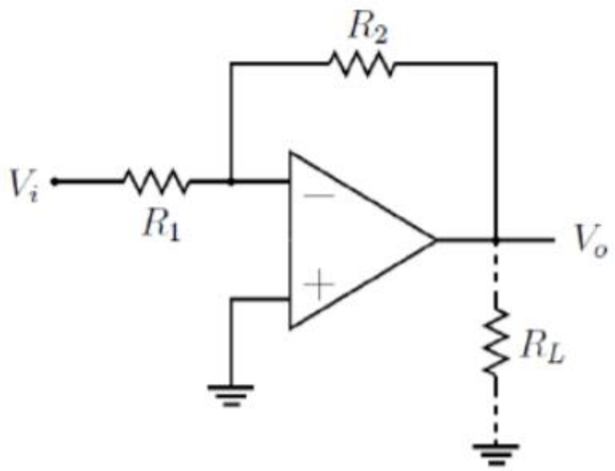
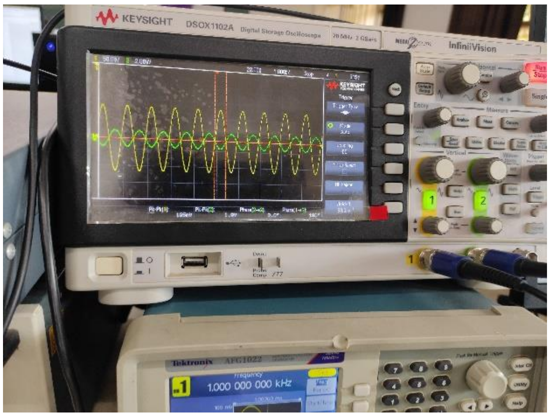


Figure 1. Circuit of an inverting Amplifier

1. We wired up the inverting amplifier circuit shown in the figure 1, with R1 =1 k, R2=10 k. We connected the supply (±15 V) and applied a sinusoidal input with a peak of 0.1V and frequency 1 kHz. We observed Vi and Vo on the oscilloscope that the magnitude of Vo is a sinusoidal with peak of 1V and phase of 180 with input which is same as we expected.



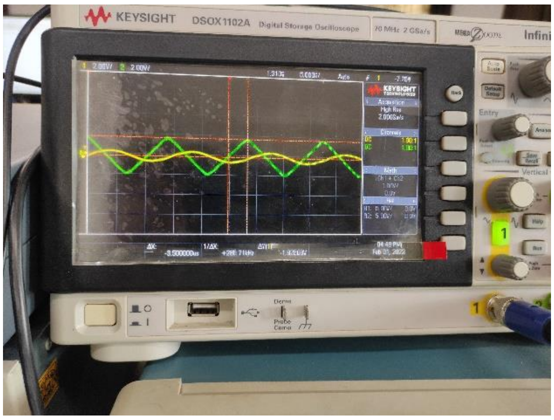
2. Now we increased the input amplitude from 0.1V to 2 V, and observed the output waveform. We observed that there is clipping in output waveform.

3. Now by keeping the input amplitude at 0.5 V we increased the frequency until the output waveform becomes triangular. From the waveform we calculated the slew rate which is 0.52 and from data sheet we can observe that slew rate is 0.5 which is equal to the value that we got.
4. For slew rate:

For slew rate $\Delta x = 3.5 \times 10^{-6}$

$\Delta y = 1.825$

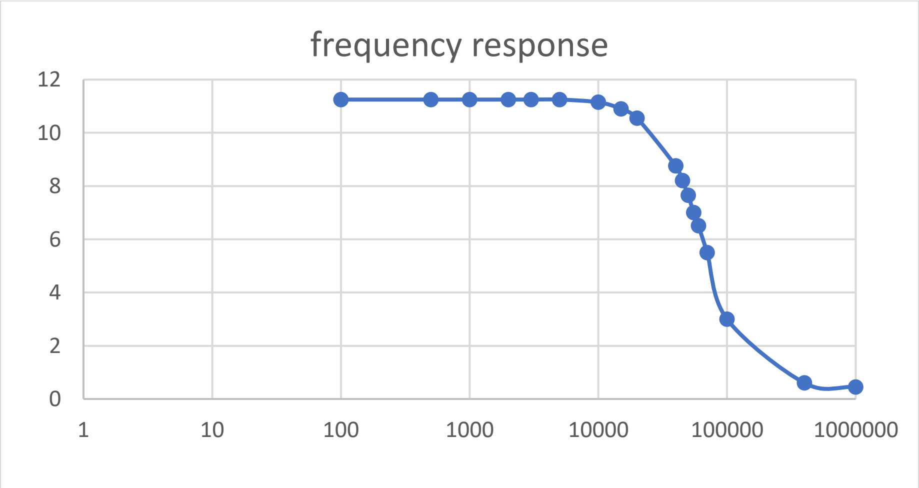
$$\frac{\Delta y}{\Delta x} = 0.52 \times 10^{6} \ V/s = 0.52 \ V/\mu s$$



5. We recorded the gain of the amplifier versus frequency for 100 Hz < f < 1MHz.We got the value as given below:

Table:

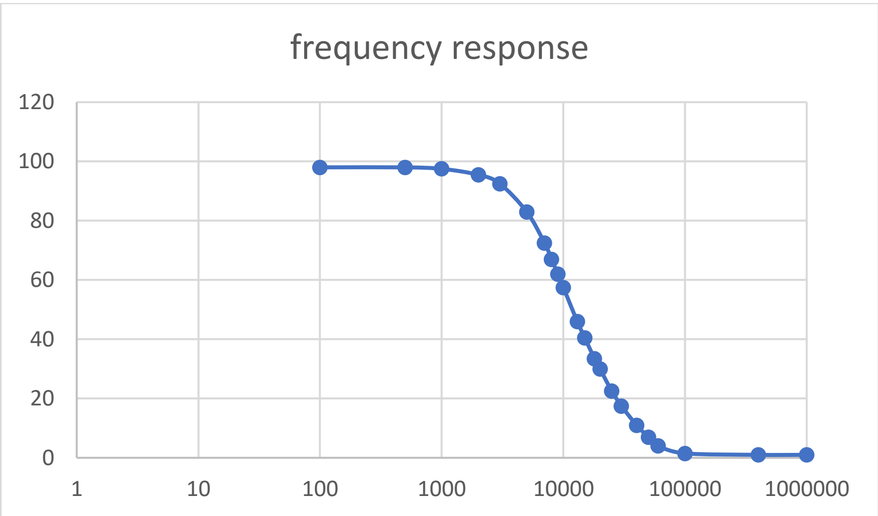
Frequency	Vin(p-p)	Vout(p-p)	Gain
100	0.2	1.96	9.8
500	0.2	1.95	9.75
1000	0.2	1.95	9.75
2000	0.2	1.95	9.75
3000	0.2	1.95	9.75
5000	0.2	1.95	9.75
10000	0.2	1.93	9.65
15000	0.2	1.88	9.4
20000	0.2	1.83	9.15
40000	0.2	1.54	7.7
45000	0.2	1.45	7.25
50000	0.2	1.35	6.75
55000	0.2	1.26	6.3
60000	0.2	1.17	5.85
70000	0.2	0.98	4.9
100000	0.2	0.5	2.5
400000	0.2	0.07	0.35
1000000	0.2	0.04	0.2



6. We recorded the frequency response (same as Step 4) for R1 =1 k, R2 =100 k. We got the values as given below.

Frequency	Vin	Vout	Gain
100	0.2	19.6	98
500	0.2	19.6	98
1000	0.2	19.5	97.5
2000	0.2	19.1	95.5
3000	0.2	18.5	92.5
5000	0.2	16.6	83
7000	0.2	14.5	72.5
8000	0.2	13.4	67
9000	0.2	12.4	62
10000	0.2	11.5	57.5
13000	0.2	9.2	46
15000	0.2	8.1	40.5
18000	0.2	6.7	33.5
20000	0.2	6	30
25000	0.2	4.5	22.5
30000	0.2	3.5	17.5
40000	0.2	2.2	11
50000	0.2	1.4	7
60000	0.2	0.8	4
100000	0.2	0.3	1.5
400000	0.2	0.2	1
1000000	0.2	0.2	1

Graph:



Non-Inverting Amplifier:

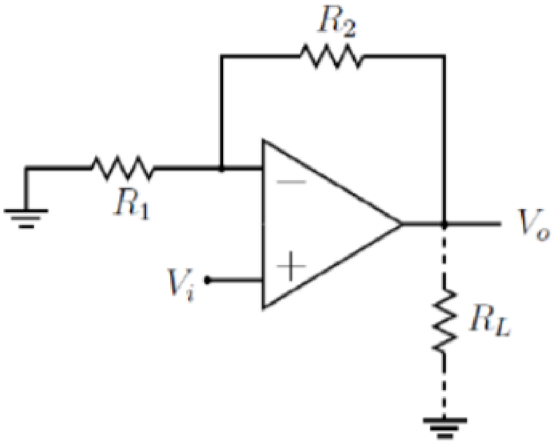
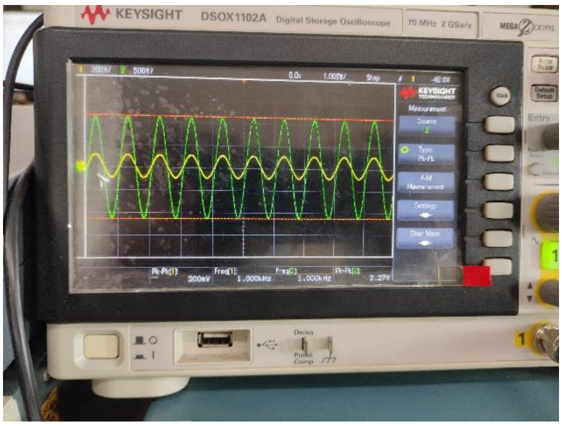
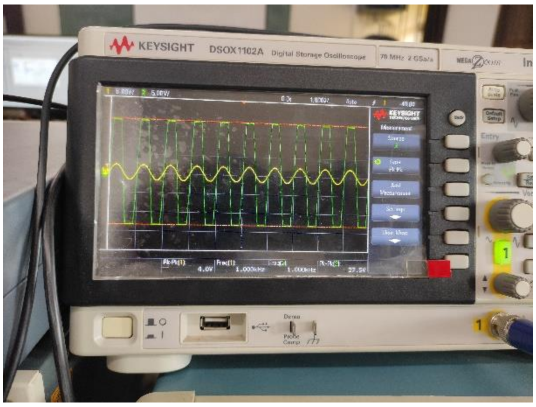


Figure 2. Circuit of a non-inverting Amplifier

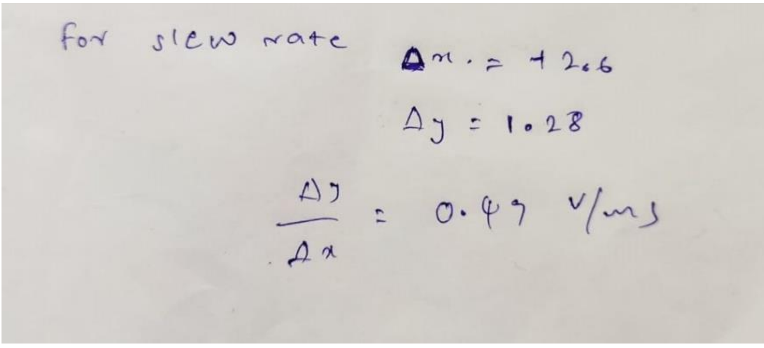
1. 1. We wired up the non- inverting amplifier circuit shown in the figure 2, with R1 =1 k, R2 =10 k. We connected the supply (±15 V) and applied a sinusoidal input with a peak of 0.1V and frequency 1 kHz. We observed Vi and Vo on the oscilloscope that the magnitude of Vo is a sinusoidal with peak of 1.1V and phase of 0 with input which is same as we expected.

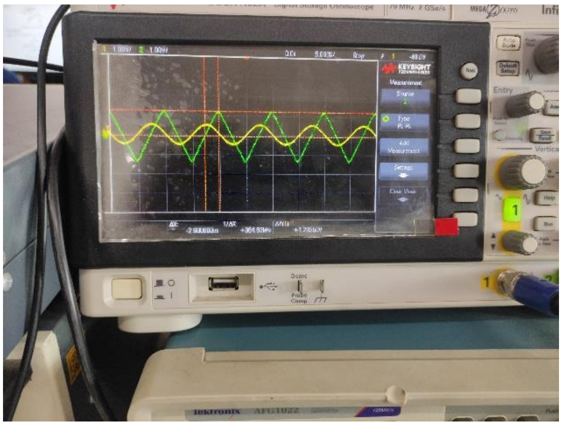


2. Now we increased the input amplitude from 0.1V to 2 V, and observed the output waveform. We observed that there is clipping in output waveform.



3. Now by keeping the input amplitude at 0.5 V we increased the frequency until the output waveform becomes triangular. From the waveform we calculated the slew rate which is 0.49 and from data sheet we can observe that slew rate is 0.5 which is equal to the value that we got.

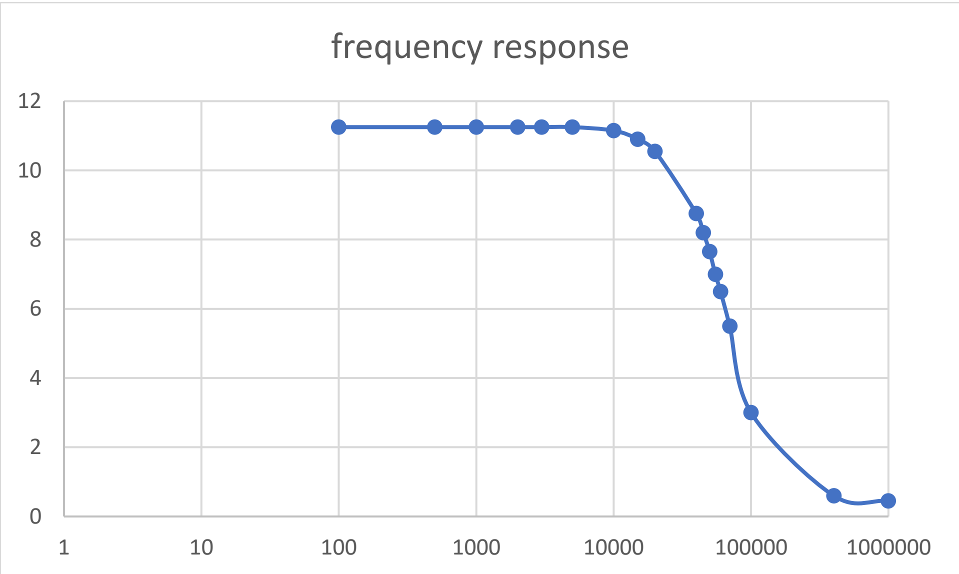




4. We recorded the gain of the amplifier versus frequency for 100 Hz < f < 1MHz.We got the value as given below:

Table:

Frequency	Vin	Vout	Gain
100	0.2	2.25	11.25
500	0.2	2.25	11.25
1000	0.2	2.25	11.25
2000	0.2	2.25	11.25
3000	0.2	2.25	11.25
5000	0.2	2.25	11.25
10000	0.2	2.23	11.15
15000	0.2	2.18	10.9
20000	0.2	2.11	10.55
40000	0.2	1.75	8.75
45000	0.2	1.64	8.2
50000	0.2	1.53	7.65
55000	0.2	1.4	7
60000	0.2	1.3	6.5
70000	0.2	1.1	5.5
100000	0.2	0.6	3
400000	0.2	0.12	0.6
1000000	0.2	0.09	0.45

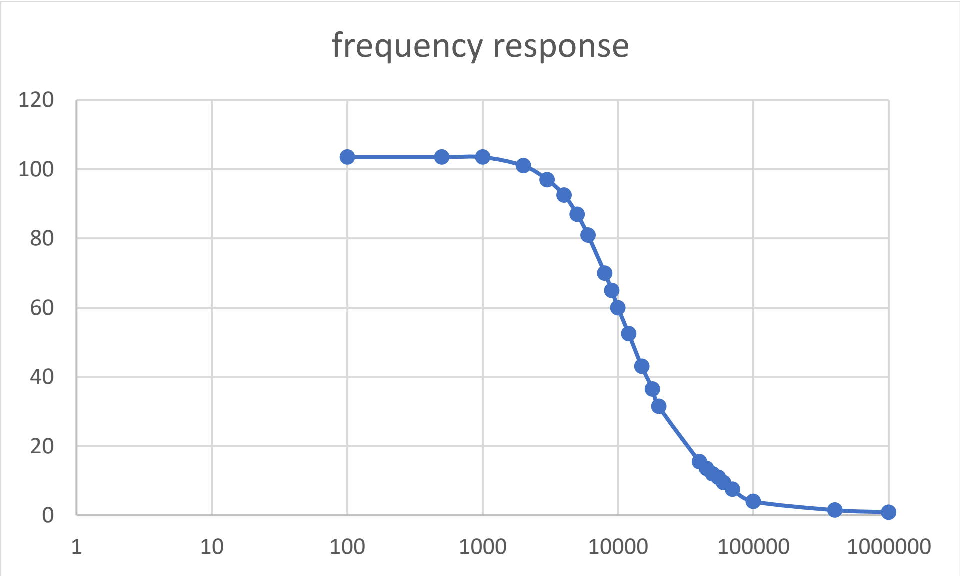


5. We recorded the frequency response (same as Step 4) for R1 =1 k, R2 =100 k. We got the values as given below.

Table:

Frequency	Vin	Vout	Gain
100	0.2	20.7	103.5
500	0.2	20.7	103.5
1000	0.2	20.7	103.5
2000	0.2	20.2	101
3000	0.2	19.4	97
4000	0.2	18.5	92.5
5000	0.2	17.4	87
6000	0.2	16.2	81
8000	0.2	14	70
9000	0.2	13	65
10000	0.2	12	60
12000	0.2	10.5	52.5
15000	0.2	8.6	43
18000	0.2	7.3	36.5
20000	0.2	6.3	31.5
40000	0.2	3.1	15.5
45000	0.2	2.7	13.5
50000	0.2	2.4	12
55000	0.2	2.2	11
60000	0.2	1.9	9.5
70000	0.2	1.5	7.5
100000	0.2	0.8	4
400000	0.2	0.3	1.5
1000000	0.2	0.18	0.9

Graph:



Integrator:

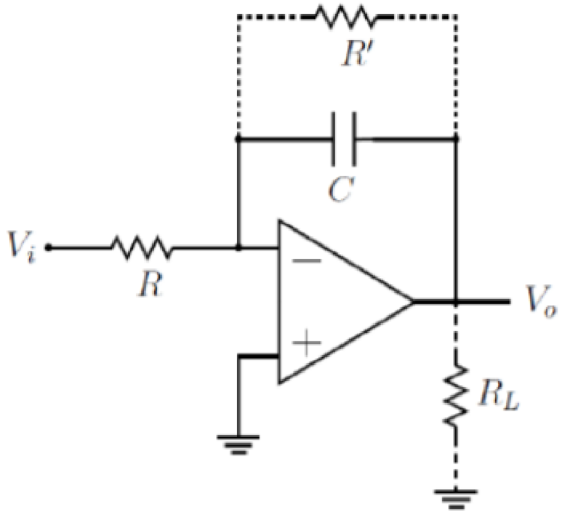
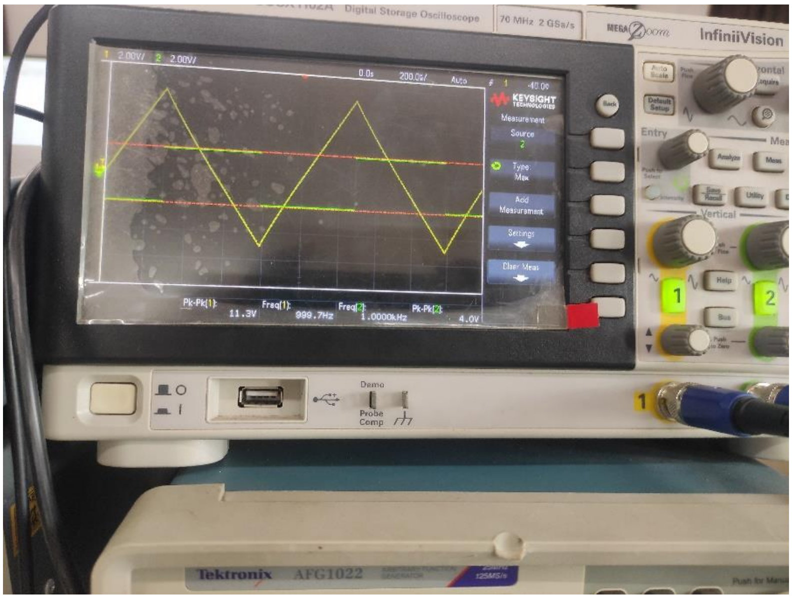
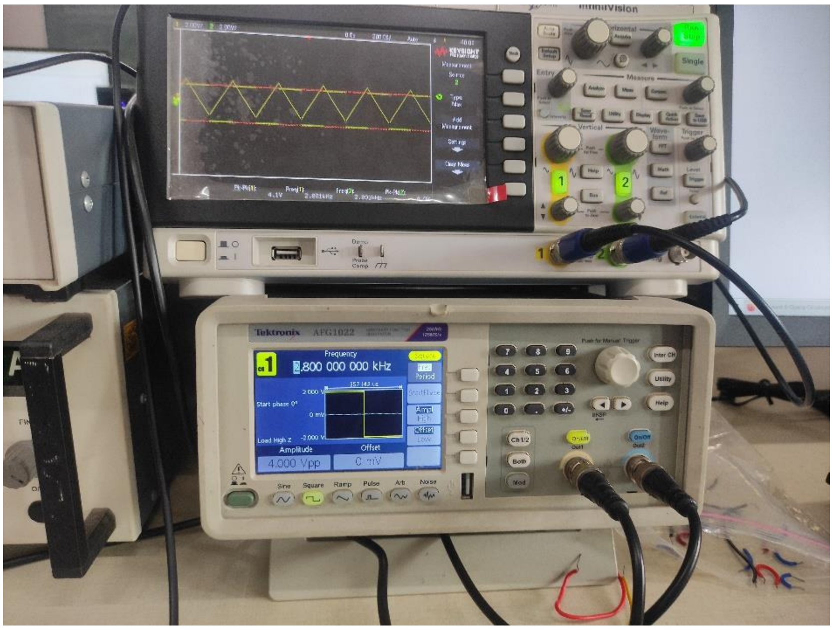


Figure 3. Circuit of an integrator

1. We wired up the integrator circuit shown in the figure 3 with R=10 k, C =0.01 µF, R' =470 k. We verified that, with a square wave input (±2 V, 1 kHz), the output voltage is triangular.

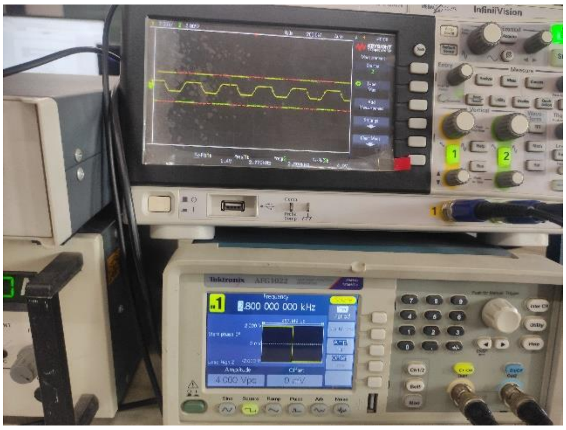


2. With a square wave input output waveform is triangular. We computed that at frequency of 2.8kHz input square wave of ±2V will produce an output voltage going from −2V to +2 V.

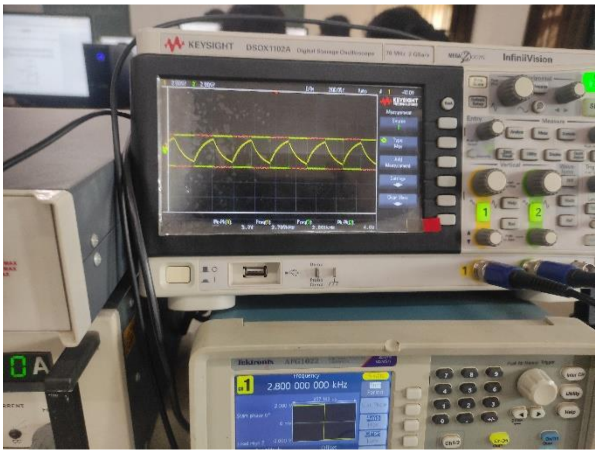


3. when we increase the resistance in the pot the time constant will increase and it leads to get the output as waves ,when we match RC value as the input frequency then the output will be same as the expected output which is triangular waves

For low resistance in pot:



For high resistance in pot:



Differentiator:

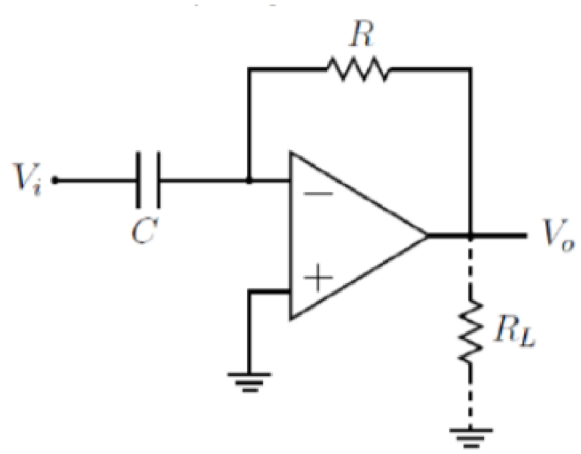
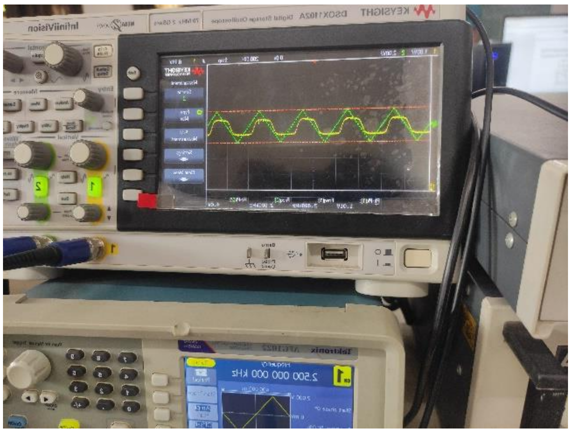


Figure 4. Circuit of a differentiator

1. For the differentiator circuit shown in the figure 4 with a triangular wave input (±2 V, 2.5 kHz), R=10 k, C =0.01 µF, We expect a output of square wave.

2. We wired up the circuit and observed that Vo(t) is square wave. It it close to our expectation with some kind of distortion in the output

3. We connected a small capacitor C′ =0.001 μF in parallel with R, and observed that Vo(t) is square wave with smooth edges



Discussion:

200020051: In lab 6 we did practicals on operational amplifiers, we got detail insight of how opamps works and its frequency response and we explored lot regarding oscilloscope, regarding how to measure the graph and how to change the resolution and no problems are there in todays lab.

200020010: Today in lab 6 we have done hardware excercise of operational Amplifiers. We understood how to build inverting amplifier, non-inverting amplifier, differentiator and integrator using Op-Amps. In hardware excercise we understood how to connect Op-amps with loads and power supply and with the help of oscilloscope , DSO we could find the gain of amplifiers. Also we understood how differentiator and integrator works which is built by op-amps.