Lab Report

Lab Session-5

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Experiment 1:

AIM:

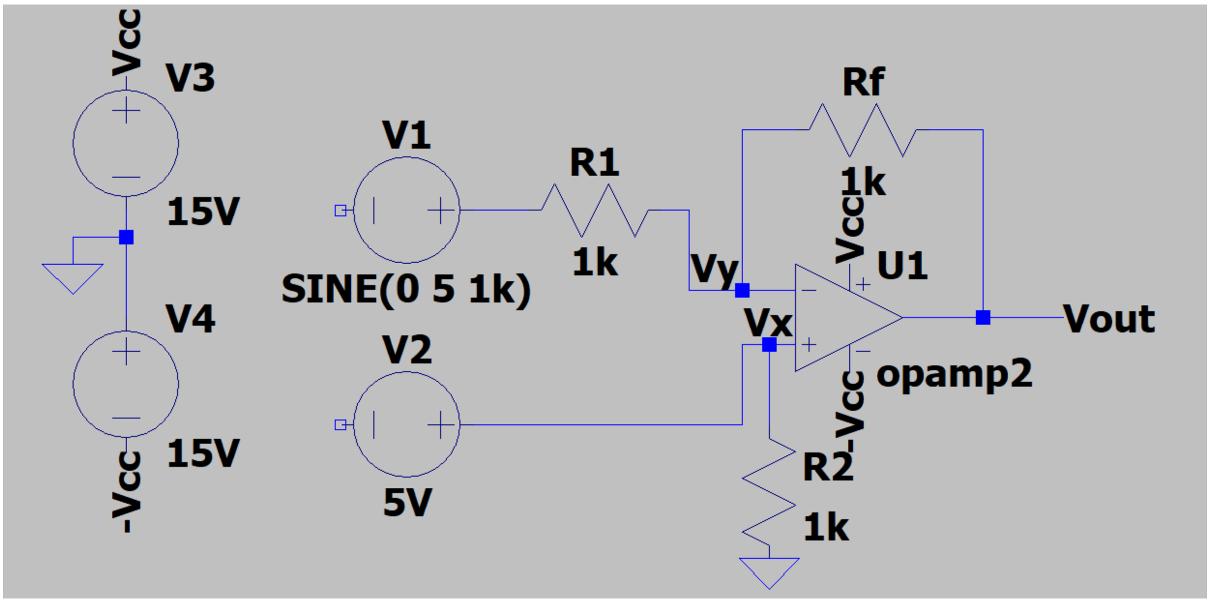
Using an Op-amp to create a circuit that gives a linear combination of the input voltages as its input.

COMPONENTS:

Resistors, Function Generator, Oscilloscope, Breadboard, wires, DC power source, IC -LM741.

THEORY:

The Op-amp can be combined with some resistors to have a linear combination of the input voltage as the output. The co-efficient in the expression is made by adjusting the ratio of the resistors.



Deriving for the output voltage obtained at PIN 6 of the op amp.

Here we assume R2 as the resistance connected to non-inverting terminal (+) of the op-amp.

Vx = $\frac{V2}{R2+R3}R3.$

By using the concept of virtual ground

Vy = Vx

V1 - ($\frac{V1-Vx}{R1}$)$(R1\ +\ Rf)$

V1 - (V1 - Vx)(1 + $\frac{Rf}{R1}$) $= Vout$

V1 - V1(1 + $\frac{Rf}{R1}$) + Vx(1 + $\frac{Rf}{R1}$) $= Vout$

V1 - V1(1 + $\frac{Rf}{R1}$) + $\frac{V2}{R2+R3}R3\left(1+\frac{Rf}{R1}\right) = Vout$

$\frac{V2}{R2+R3}R3\left(1\ +\ \frac{Rf}{R1}\right)$ - V1$\frac{Rf}{R1} = Vout$

V2 $\frac{R3}{R3+R2}\left(1\ +\ \frac{Rf}{R1}\right)$ - V1$\left(\frac{Rf}{R1}\right)$=Vout

Here our aim is to obtain the linear expression Vout=2(V2) - V3

So, we set

$$\frac{Rf}{R1} = 1\ or\ Rf = R1$$

$$\frac{R3}{R3+R2}\left(1+\frac{Rf}{R1}\right)=2$$

$$\frac{R3}{R3+R2}\left(1+\frac{1}{1}\right)=2$$

$$\frac{R3}{R3+R2} = 1$$

R3 = R3 + R2

R2 = 0

So, we take Rf = R1 = 1k

And we take R3 = 1k.

By using resistors of above resistance values, we obtain a circuit which takes in 2 inputs: 1] DC voltage of 5 volt.

: 2] sinusoidal input of frequency 1k

As output, we expect the sinusoidal input to have a phase change of 180 degrees as it is given at the inverting (-) input, i.e., a completely upside-down version of the sine wave is expected. Also, the output sine wave is expected to shifted upwards by 10 V due to the input DC voltage of 5V.

Vout(theoretical) = 2(V2) - V3

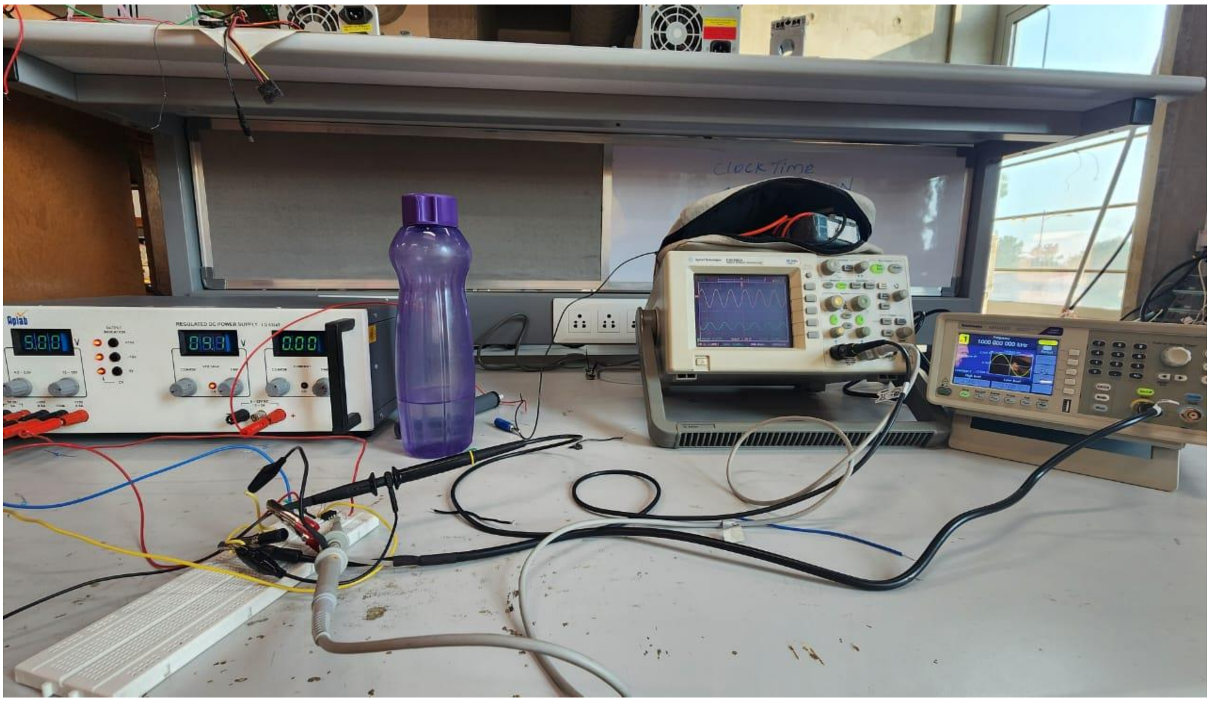
$$=2*5 - \sin(2\pi ft)$$

$$=10 - \sin(2\pi ft)$$

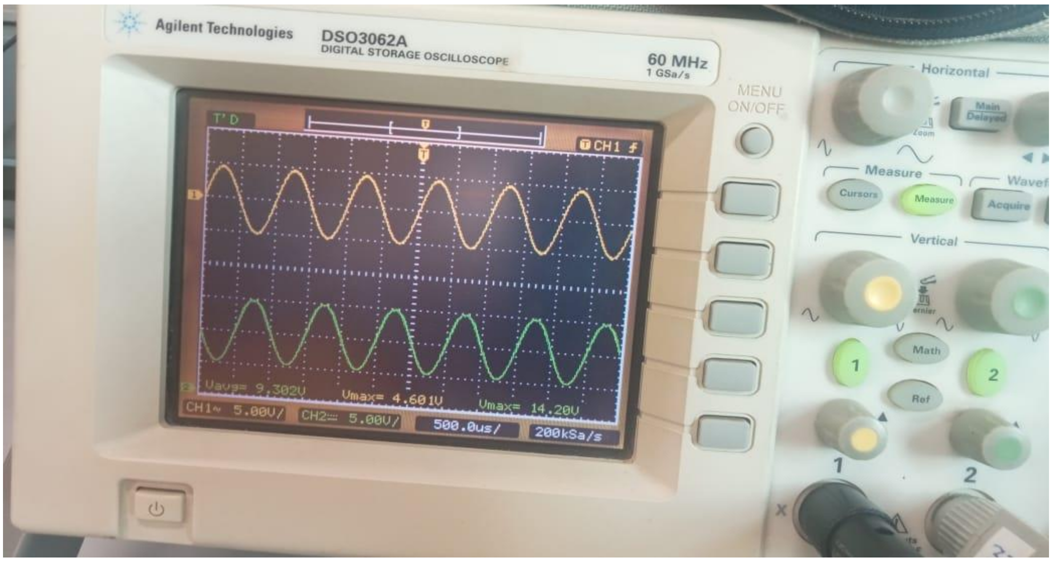
Generally, we consider the Vpp value of the input sine wave to calculate the final Vpp value for the output. Moreover, we expect to see an inverted sine wave on the oscilloscope display.

PROCEDURE:

We set the circuit onto the breadboard by looking at the circuit diagram. We exercise so that connections are tight and secure and that the components do not touch each other in the air.



OUTCOME AND CALCULATIONS



V1 = 5V , Yellow graph → V3 , green graph → Vout

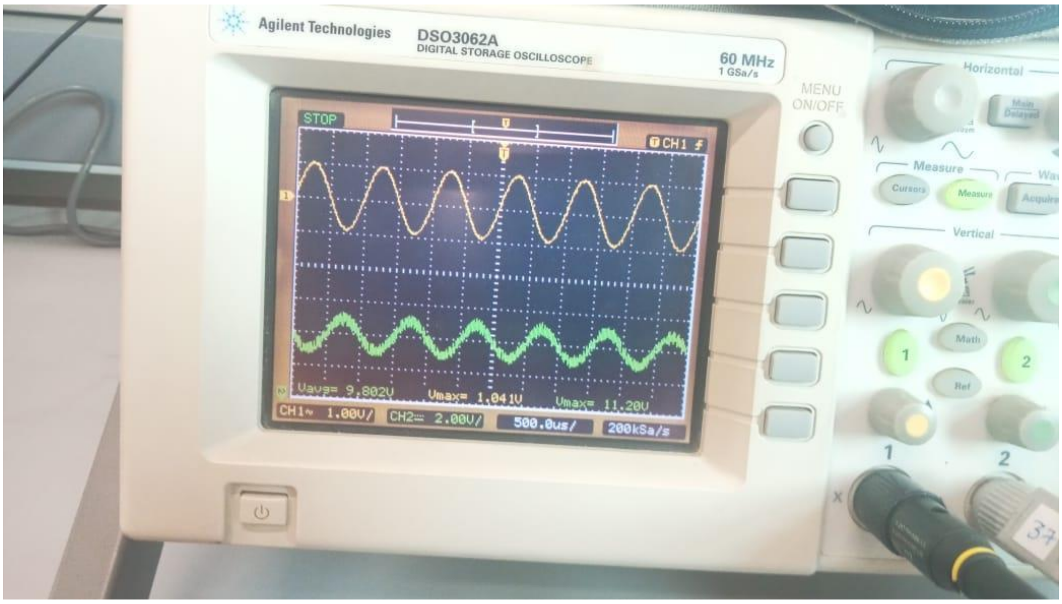
Here, Vout = 2V1 – V3

= 2(5) – (-4.6)

= 14.6 V

Theoretical: 14.6 V

Experimental: 14.2V



V1 = 5V , Yellow graph → V3 , green graph → Vout

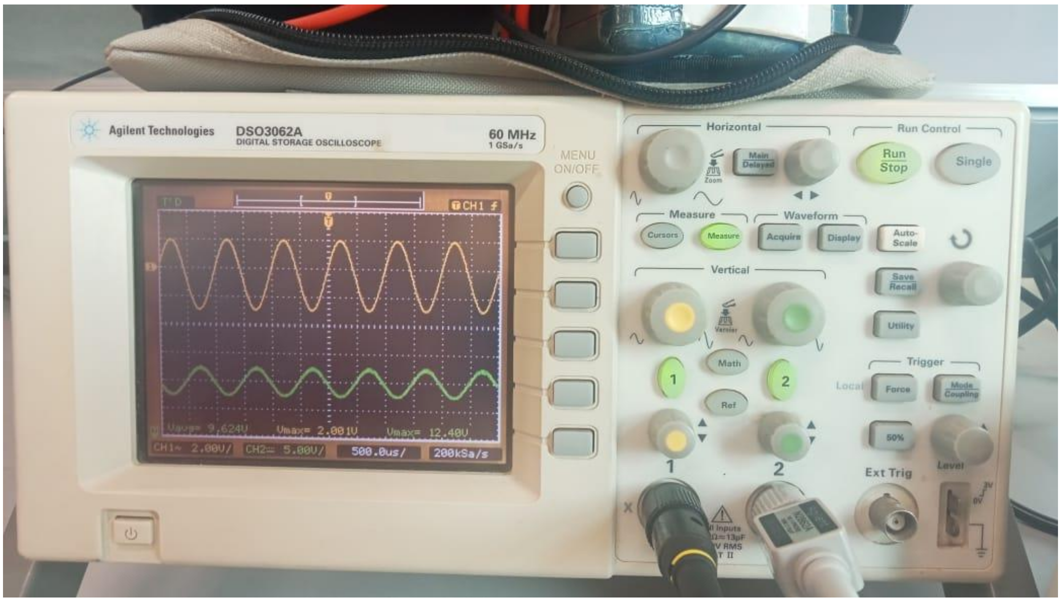
Here, Vout = 2V1 – V3

= 2(5) – (-1.04)

= 11.4 V

Theoretical: 11.4 V

Experimental: 11.2V



V1 = 5V , Yellow graph → V3 , green graph → Vout

Here, Vout = 2V1 – V3

= 2(5) – (-2.001)

= 12.001 V

Theoretical: 12.001 V

Experimental: 12.4 V

Experiment-2:

AIM:

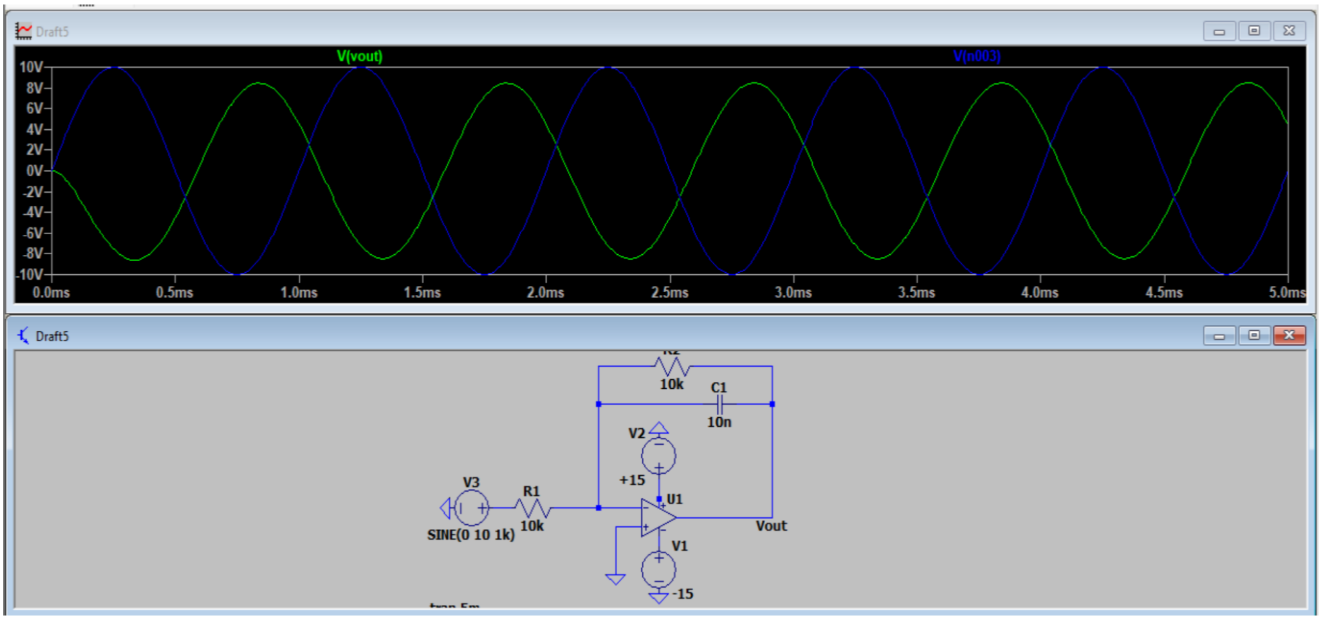
To create an integrator circuit using an op-amp that gives an output that is the integrated version of the given input waveform

COMPONENTS:

Resistors, Function Generator, Oscilloscope, Breadboard, wires, DC power source, IC -LM741**,** Capacitor

THEORY:

The integrator circuit outputs the integral of the input signal over a frequency range based on the circuit time constant and the bandwidth of the amplifier.



Here 15V offset is given to the power the op-amp represented by Vcc and -Vcc.

$\text{I1} = \text{V2/R1(Current through R1)}$

$\text{I2} = \text{Vout/R2(Current through R2)}$

$\text{Ic} = \text{(V2/R1+Vout/R2) (Current through a capacitor)}$

$\text{Ic} = C\,\frac{dVc}{dt} = \text{c}\frac{d(-Vout)}{dt}$

$\frac{V2}{R1} + \frac{Vout}{R2} = -\text{c}\frac{dVout}{dt}$

Vout = $\frac{1}{RC}\int \frac{V2}{R1} + \frac{Vout}{R2}$dt.

Here R2 is given a very large resistance value, for example, 100k. So, if we approximate $\frac{Vout}{R2}$ as zero.

Vout = $\frac{1}{RC}\int_0^t \frac{V2}{R1}\,dt$

Here V2 = Vin.

Vout = $\frac{1}{RC}\int_0^t \frac{Vin2}{R1}\,dt$

Hence, we get the output voltage waveform as the integrated form of the input voltage waveform.

Using the oscilloscope, We get the input waveform's integrated waveform.

We set the frequency of the input waveform as 1k Hz.

As observed from the oscilloscope,

When input is

(i)sine wave, $\int sinx\ dx = -cosx$

Output is cos wave

(ii)square wave

Output is a triangular wave

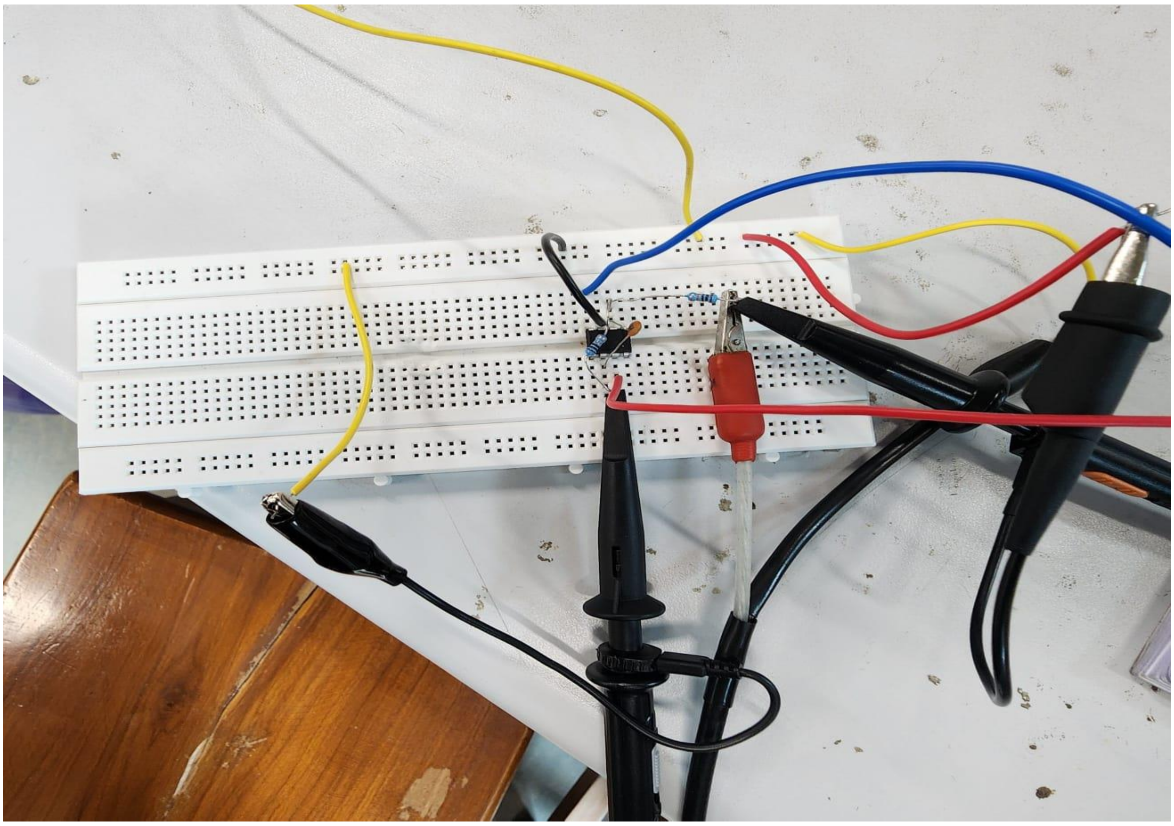
(ii)ramp wave

Output is a parabolic wave

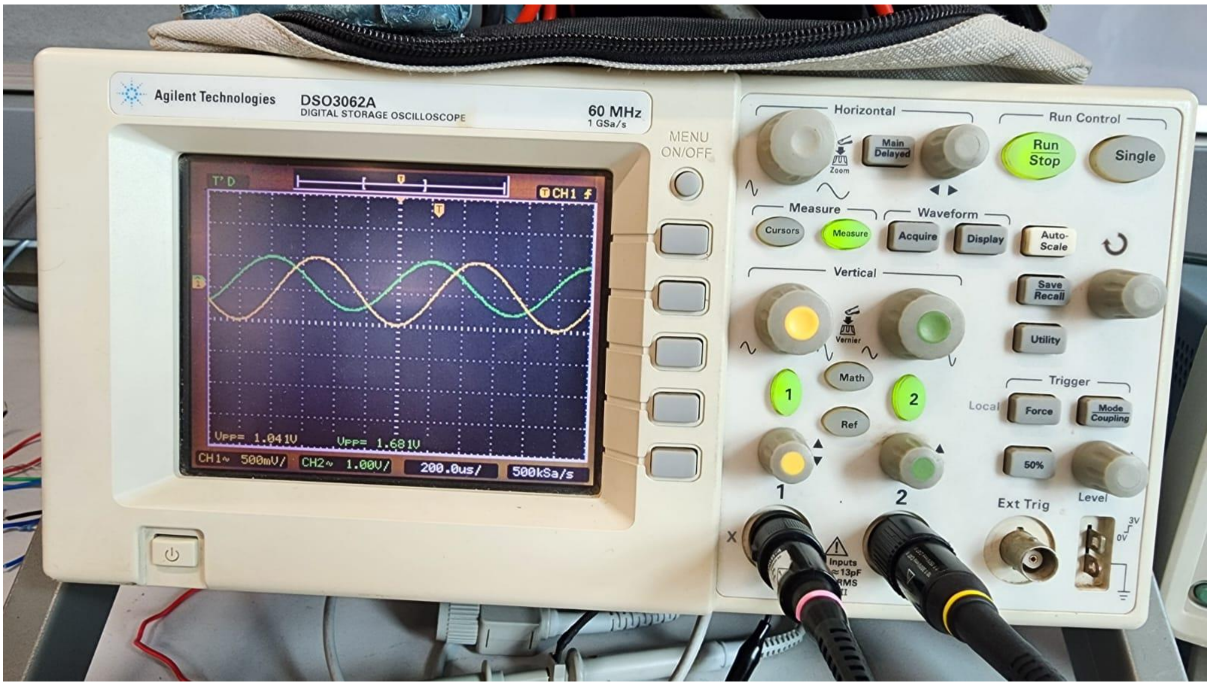
Thus, we see that the op-amp is working as an integrator.

PROCEDURE:

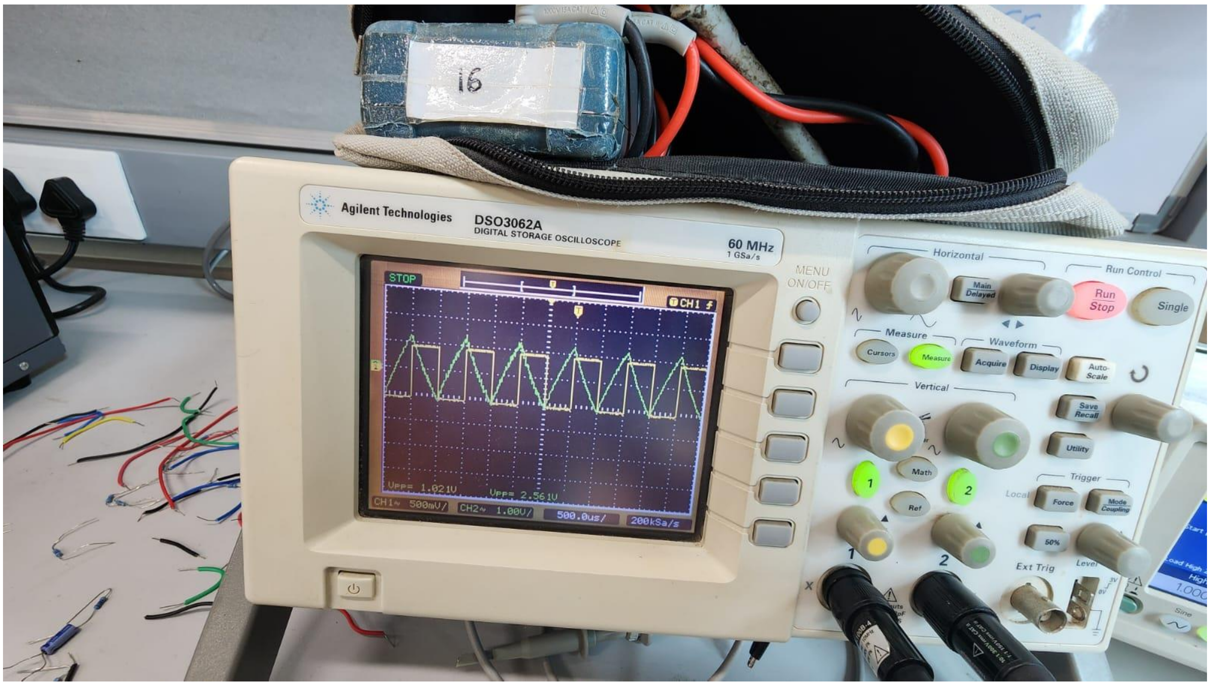
We set up the circuit onto the breadboard using resistors of 100k and 10k and a capacitor of value 10nF. We power the op-amp using a 15V DC power source. We check the oscilloscopes and function generator to see if they are working correctly. We set the frequency of the input waveform as 1k Hz. We attach the oscilloscope probe(output) to pin6 of the op-amp and another oscilloscope probe(input) to the input voltage pin. We then see the output waveform on the oscilloscope to get an integrated version of the input waveform.



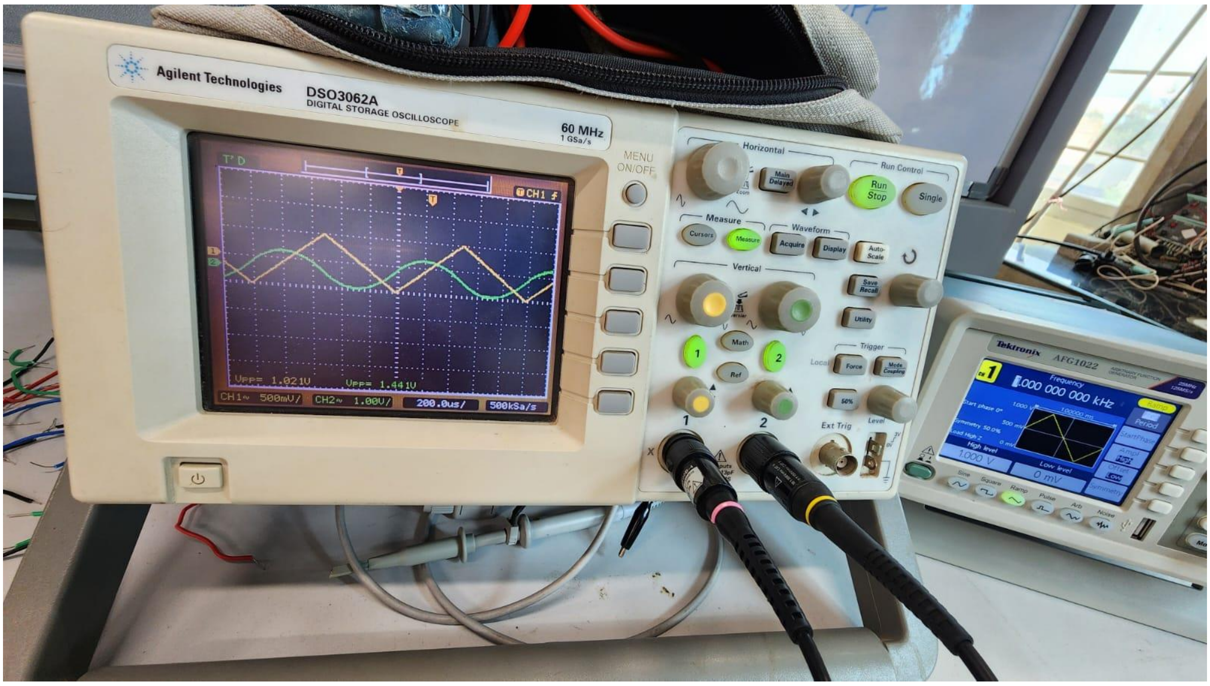
Input – sine wave, output – cos wave



Input – square wave, output - triangular wave



Input – ramp wave, output - parabolic wave



Experiment-3:

AIM:

To design a half wave precision rectifier and produce rectified output for different input wave.

COMPONENT:

IC -LM741(operational amplifier), IN4007(diode), DC bench power supply, function generator, oscilloscope, breadboard, wires, 10K load resistor.

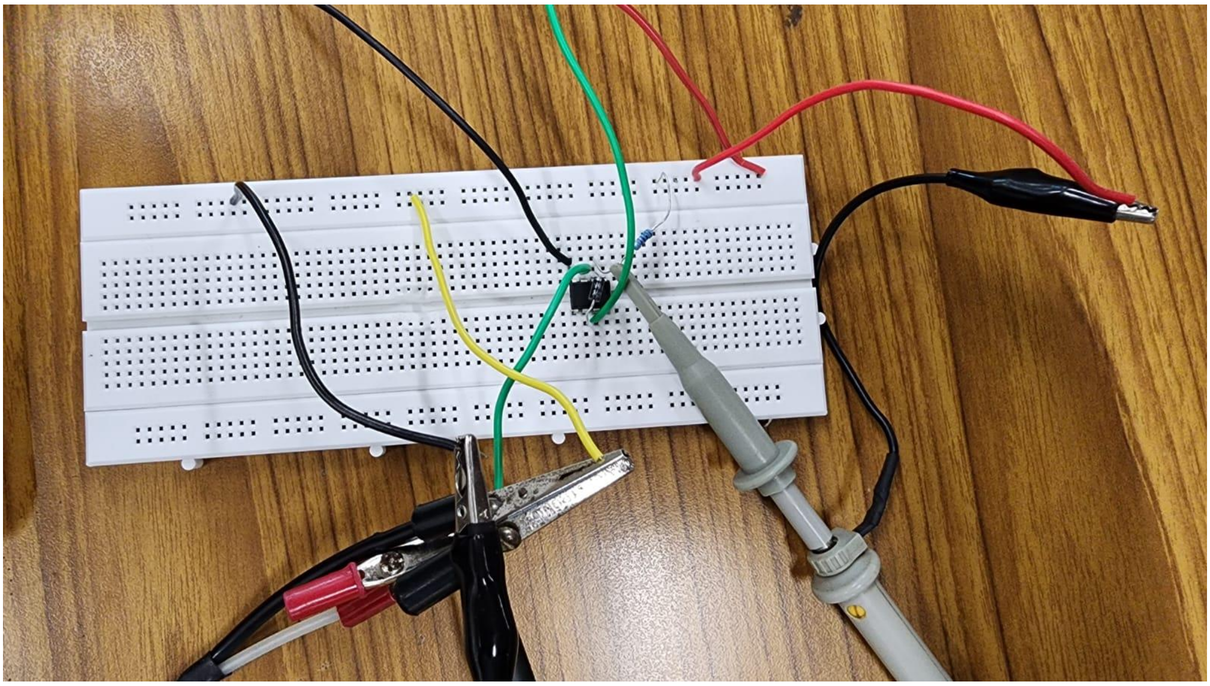
THEORY:

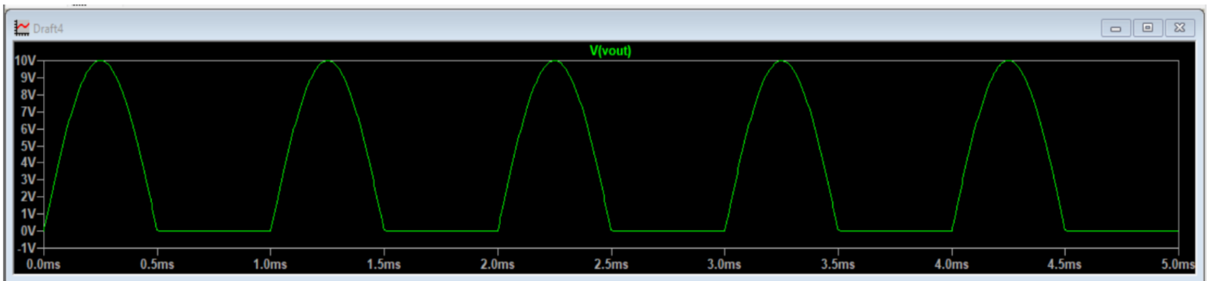
A Precision rectifier is a configuration used to rectify AC voltages i.e, voltage drop for some interval of time across the output for every cycle. The precision rectifier configuration is achieved by forward biasing the diode to the non inverting pin (2) of the IC741. In an ideal diode the voltage difference across is always 0.7 V. This difference is maintained by non-inverting amplification done by IC741.

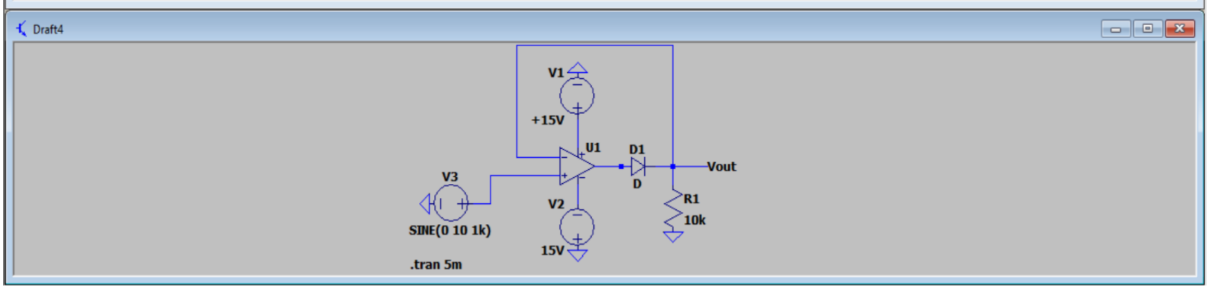
When the input AC voltage is negative, diode becomes reversed biased, the circuit becomes open, and output is zero voltage.

When the input AC voltage is positive, diode becomes forward biased, and the current flows through the circuit. The connected non-inverting IC741 regulates the voltage across diode to such that the difference across it is always 0.7 volts.

This is done because the diode cannot rectify forward AC drop of <0.7 volts.







PROCEDURE:

We set the circuit on to the breadboard by looking at the above circuit diagram. The diode was connected across pin 2 to pin 6 of the IC741 for a non inverting amplification, a load resistor of 10k is connected from cathode of diode to ground. We send an input sinusoidal and ramp voltage source using the function generator at pin number 3. We also set connect the DC power source at +/- 15V. We also set up a common ground for all the devices. Using the oscilloscope probes, we display the input and output voltages on the oscilloscope.

When input AC voltages is sinusoidal and ramp respectively,

We can see that for every cycle for negative voltage, the output voltage is zero. Thus, the output is rectified.