EXPERIMENT NO. 7

AIM : To study Integrator circuit using OP-AMP

TOOLS USED : Virtual Lab

THEORY :

Operational Amplifier commonly known as Op-Amp, is a linear elcectronic device having three terminals, two high impedence input and one output terminal. Op-Amp can perform multiple function when attached to diffrent feedback combinations like resistive, capacitive or both. Generally it is used as voltage amplifier and the output voltage of the Op-Amp is the diffrence between the voltages at its two input terminals.

Op-Amp shows some properties that make it an ideal amplifier, its open loop gain and input impedance is infinite (i.e., practically very high), Output impedance and offset voltage is zero(i.e., practically very low) and bandwidth is infinite(i.e., practically limitted to frequency where its gain become unity).

The Integrator : It is a circuit designed with Op-Amp in such a way that it performs the mathametical Integration operation, its output is proportional to the amplitude and time duration of the input applied. The integrator circuit layout is same as a inverting amplifier but the feedback resistor is replaced by a capacitor which make the circuit frequency dependent. In this case the circuit is derived by the time duration of input applied which results in the charging and discharging of the capacitor. Initially when the voltage is applied to integrator the uncharged capacitor allows maximum current to pass through it and no current flows through the Op-Amp due to the presence of virtual ground, the capacitor starts to charge at the rate of RC time constant and its impedence starts to increase with time and a potential diffrence is develops accross the capacitor resulting in charging current to decrease.This results in the ratio of capacitor's impedance and input resistance increasing causing a linearly increasing ramp output voltage that continues to increase until the capacitor becomes fully charged.

PROCEDURE :

- Connect the components as mentioned below: L1-L7 or L1-L3, L3-L7, L4-L5, L11-L8, L12-L6, L8-L9, L4-L10.(For eg. click on 1 and then drag to 3 and so on.)
- Click on 'Check Connection' button to check the connections.
- If connected wrong click on 'Delete all connection' button to erase all the connections.
- Set the resistance(R) and the capacitance (C) (Intially set R=10 $k\Omega$ and C=0.1 μF).
- Click on 'ON' button to start th experiment.
- Click on 'Square Wave' button to generate input waveform.
- Click on 'Oscilloscope' button to get the output waveform.
- Vary the Amplitude, Frequency, volt/div using the controllers.
- Click on "Dual" button to observe both the waveform.
- Channel 1 shows the input square waveform, Channel 2 shows the output waveform.
- Repeat the experiment by applying 'Sine wave' as input.
- Click on 'Sine Wave' button to generate input waveform.
- Click on 'Oscilloscope' button to get the output waveform.

- Vary the Amplitude, Frequency, volt/div using the controllers.
- Click on ”Dual” button to observe both the waveform.
- Channel 1 shows the input sine waveform, Channel 2 shows the output waveform.

EXPERIMENTAL SETUP

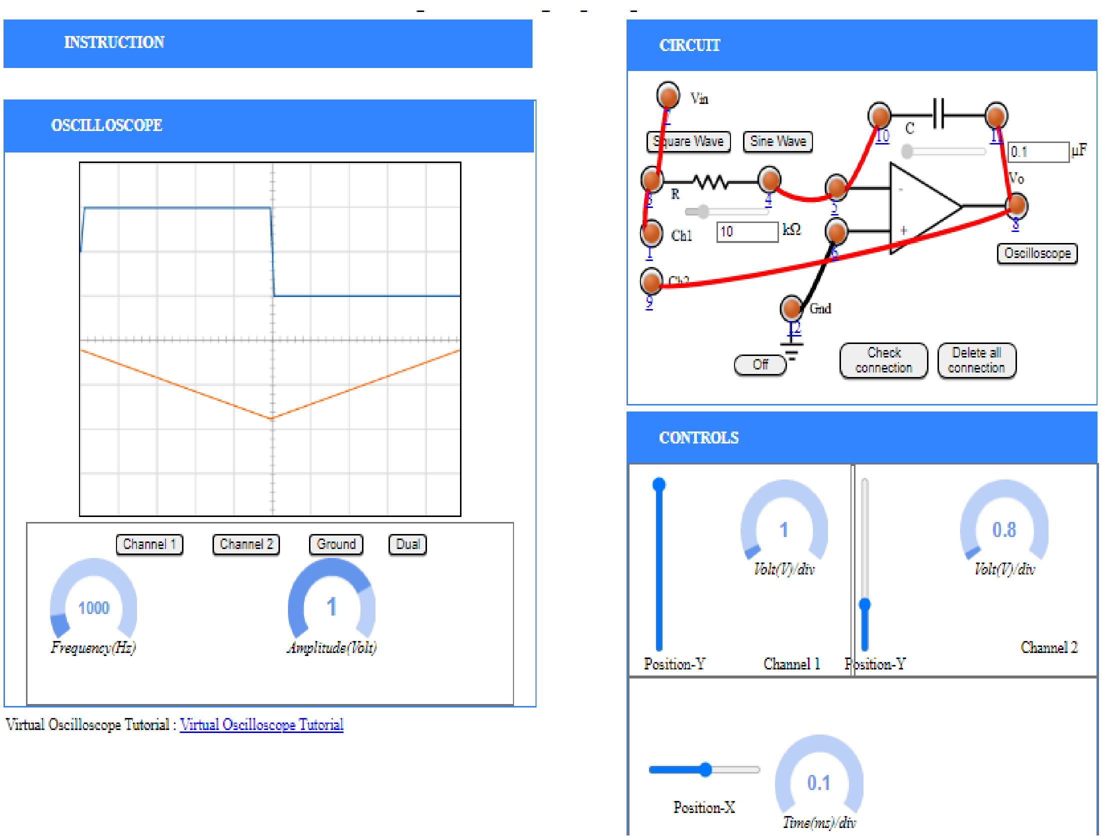

Figure 7: Integrator using OP-AMP with its output waveform

RESULT :

The circuit of Integrator using OP-AMP is simulated in virtual lab and necessary graphs are plotted and observed on CRO.

EXPERIMENT NO. 8

AIM : To study Voltage regulator using operational amplifier to produce output of 12V.

TOOLS USED : Virtual Lab

THEORY :

A voltage regulator is an integrated circuit (IC) that provides a constant fixed output voltage regardless of a change in the load or input voltage. It can do this many ways depending on the topology of the circuit within, but for the purpose of keeping this project basic, we will mainly focus on the linear regulator. A linear voltage regulator works by automatically adjusting the resistance via a feedback loop, accounting for changes in both load and input, all while keeping the output voltage constant.

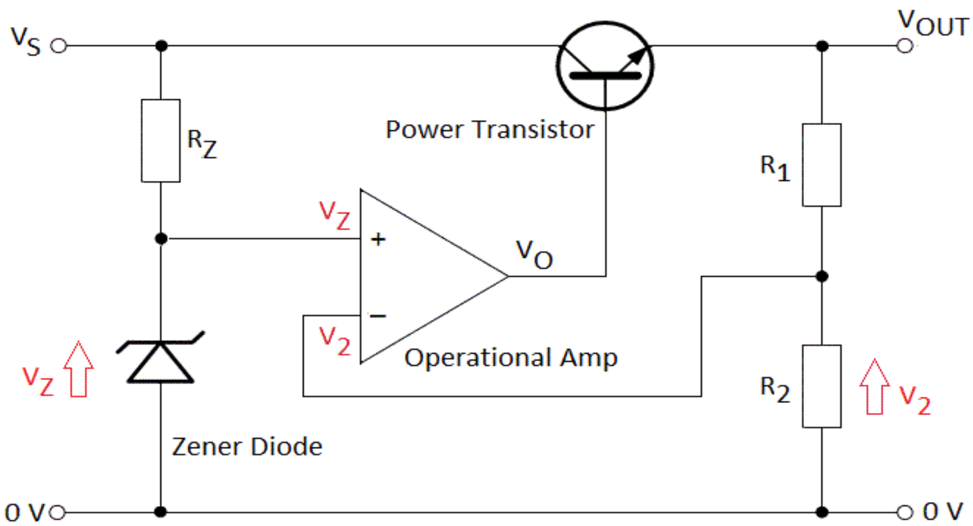

Figure 8: Series Voltage Regulator using OP-AMP

Electronic voltage regulators utilize solid-state semiconductor devices to smooth out variations in the flow of current. In most cases, they operate as variable resistances; that is, resistance decreases when the electrical load is heavy and increases when the load is lighter.

Voltage regulators find their applications in computers, alternators, power generator plants where the circuit is used to control the output of the plant. Voltage regulators may be classified as electromechanical or electronic. It can also be classified as AC regulators or DC regulators. All electronic voltage regulators will have a stable voltage reference source which is provided by the reverse breakdown voltage operating diode called zener diode. The main reason to use a voltage regulator is to maintain a constant dc output voltage. It also blocks the ac ripple voltage that cannot be blocked by the filter. A good voltage regulator may also include additional circuits for protection like short circuits, current limiting circuit, thermal shutdown, and overvoltage protection.

PROCEDURE :

- Connect the probes and mentioned below:
- L1-L2,L3-L4,L4 & L5 to CRO knobs.
- Click on the "check" button to check if the connections are right.
- Once you make sure that the connections are right, you may vary the input voltage from 7.5V to 35V and calculate the output voltage.
- Click on "Add to table" button to add the readings to the table.

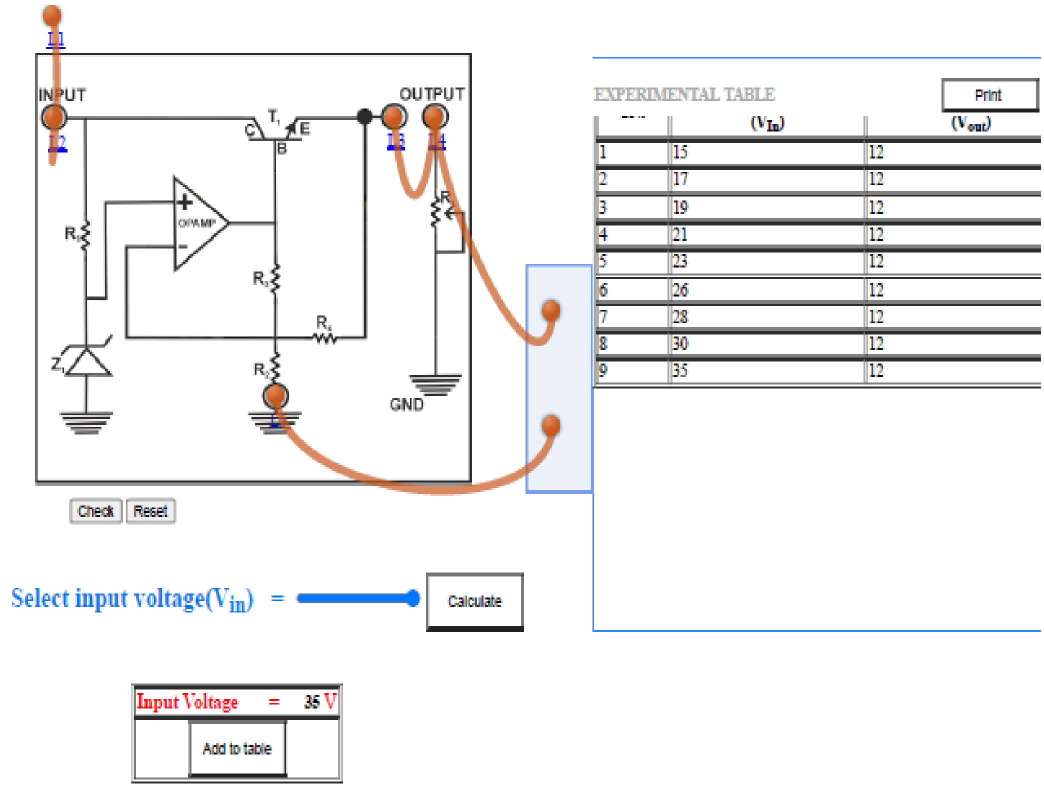

Figure 9: Series Voltage Regulator with recorded output

RESULT :

The circuit of Series voltage regulator using OP-AMP to produce 12 V, 500 mA output is simulated in virtual lab observed and recorded the output.

EXPERIMENT NO. 9

AIM : To analyse Wein bridge oscillator using operational Amplifier.

TOOLS USED : Virtual Lab

THEORY :

It is the commonly used audio frequency oscillator which employs both positive and negative feedback. The feedback signal is connected in the non-inverting input terminal so that the amplifier is working in non-inverting mode. The Wien bridge circuit is connected between amplifier input terminal and output terminal. The bridge has a series RC network in one arm and a parallel RC network in the adjoining arm. In the remaining two arms of the bridge, resistor R1 and Rf are connected. The phase angle criterion for oscillation is that the total phase shift around the circuit must be zero. This condition occurs when bridge is balanced. At resonance, the frequency of oscillation is exactly the resonance frequency of balanced Wien bridge and is given by

$$f_o = \frac{1}{2\pi RC}$$

At this frequency, the gain required for sustained oscillation is 3. It is provided by the non-inverting amplifier with

$$\text{Gain} = 1 + \frac{R_f}{R_1} = 3$$

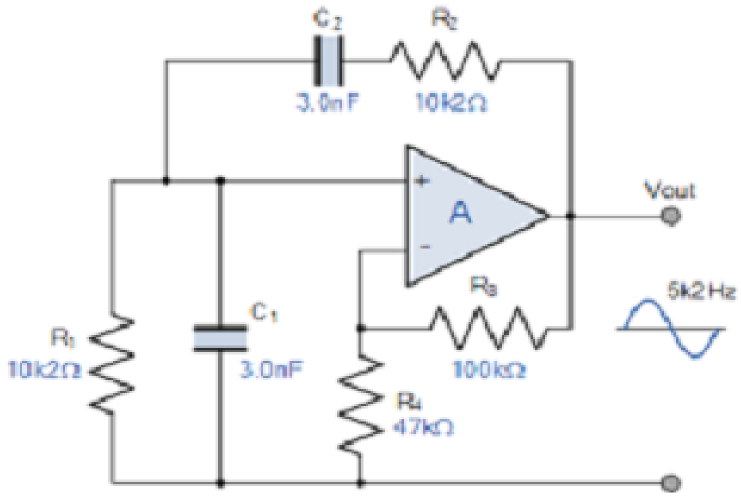

Figure 10: Series Voltage Regulator using OP-AMP

Effect of variation of resistance and capacitance on frequency

The frequency of the oscillator varies with the variation in capacitance. It is inversely proportional to the capacitance. In other words, the frequency decreases with the increase in capacitance and vice versa. The variation in resistance has a similar effect on the frequency of the oscillator.

PROCEDURE :

- Connect the output terminals to the cro.(L1-L2,L3-L4)
- Click on the "check" button to check if the connections are right.
- Once you make sure that the connections are right, you may vary the resistance and calculate the output frequency
- Increase the resistance from 0.3 $K\Omega$ to 300 $K\Omega$.
- Click on "Add to table" button to add the reading to the table. Observe the waveform in the graph.

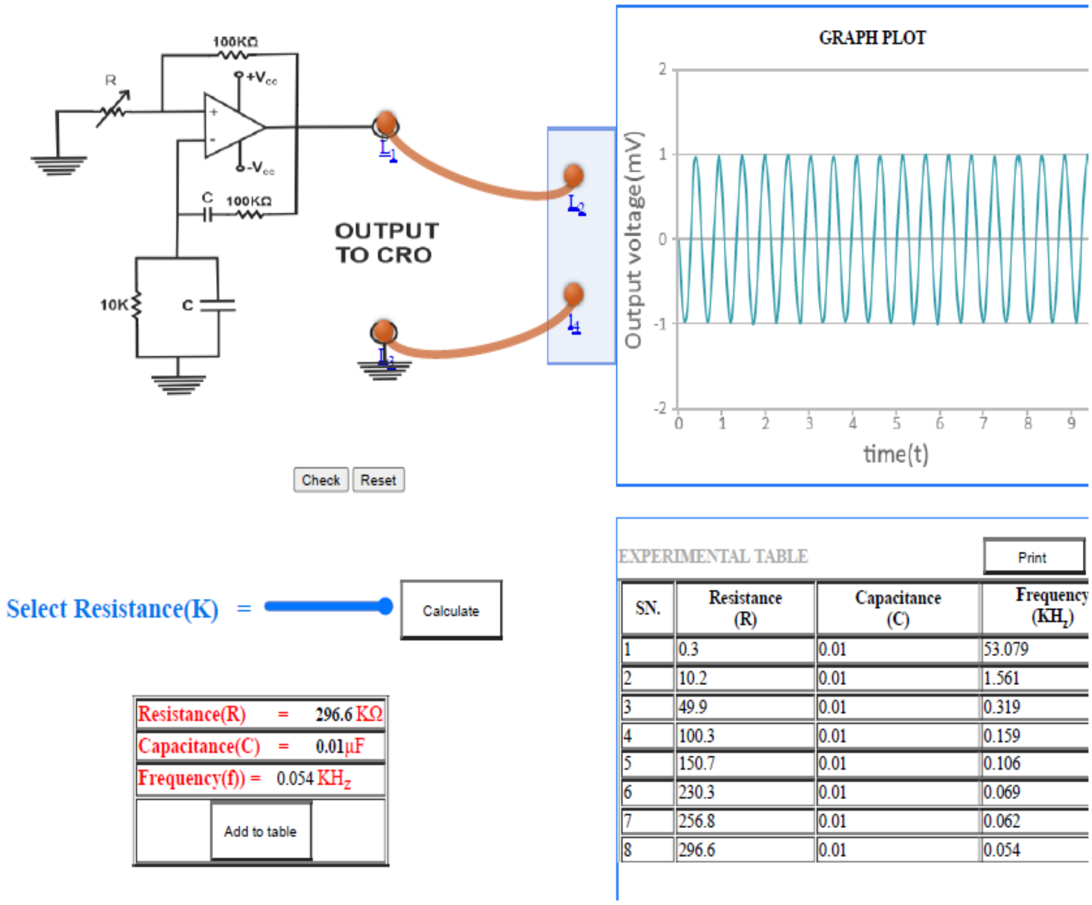

Figure 11: Wein Bridge Oscillator using OP-AMP Simulation with recorded output frequency

RESULT :

The circuit of Wein Bridge Oscillator using OP-AMP is simulated in virtual lab and necessary waveforms observed and the frequency for various values of Resistances are recorded.

EXPERIMENT NO. 10

AIM : To study voltage to current converter.

TOOLS USED : Virtual Lab

THEORY :

In most of the cases we get the output of measuring devices in the form of voltage. It is not good to transmit this output voltage to the destination directly. Due to addition of noise and wire impedance the output voltage may get corrupted. So in such cases we have convert that voltage into current form. So let us see voltage to current converter.

Op-amp is implemented to simply convert the voltage signal to corresponding current signal. The Op-amp used for this purpose is IC LM741. This Op-amp is designed to hold the precise amount of current by applying the voltage which is essential to sustain that current through out the circuit. The output current is given by -

$$I_o = \frac{V_{in}}{R}$$

Following circuit shows the voltage to current converter using operational amplifier. It consist of simple resistance connected to the inverting and non inverting terminals of op amp.

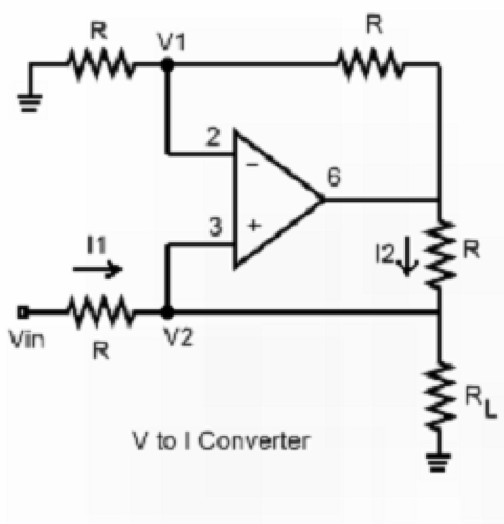

Figure 12: Voltage to Current Converter

PROCEDURE :

- Connect the probes and mentioned below:
  L1-L2,L3-L5,L4-L6.
- Click on the "check" button to check if the connections are right.
- Once you make sure that the connections are right, you may vary the input voltage from 1V to 15V and calculate the output current by pressing "Calculate" button.
- Click on "Add to table" button to add the reading to the table. Observe the reading on ammeter for each value oof input voltage.

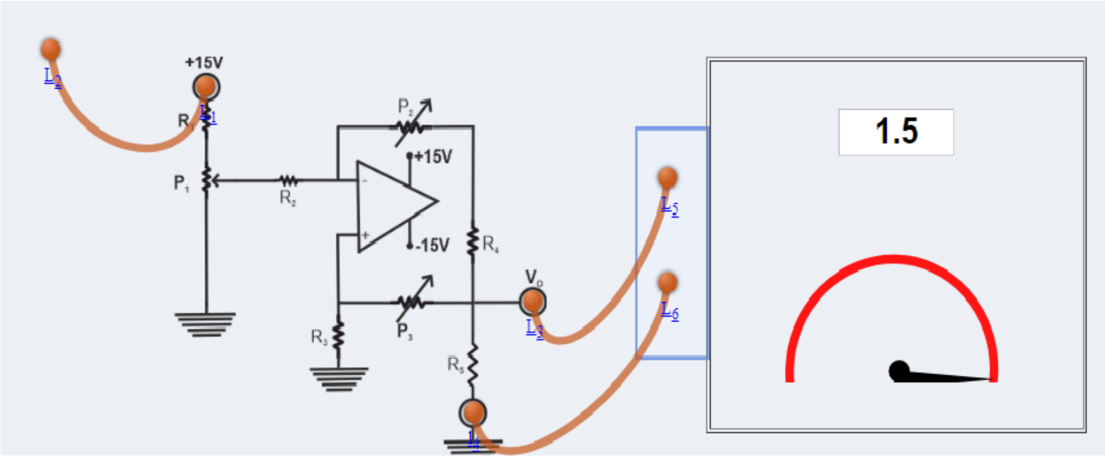

Figure 13: Voltage to Current Converter Circuit

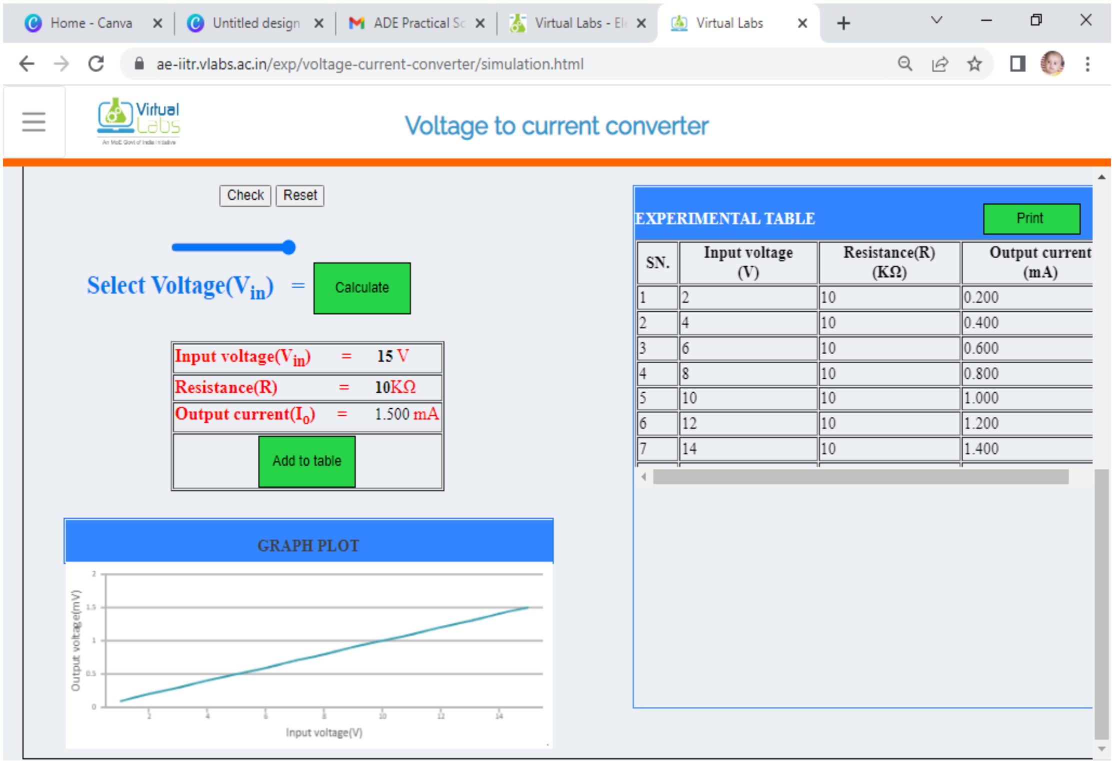

Figure 14: Recorded output for Voltage to Current Converter

RESULT :

The circuit of Voltage to Current Converter using OP-AMP is simulated in virtual lab and current for various values of input voltage are recorded and graph of input Voltage across output current is plotted.