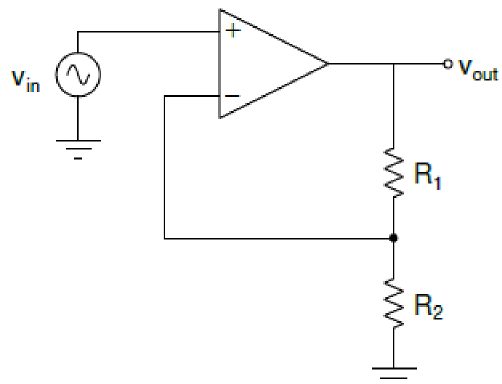
Experiment-9
Opamp Circuits

1. VTC for opamp in negative and positive feedback configurations:

(1a) Negative feedback configuration:

- Schematic view of the circuit:

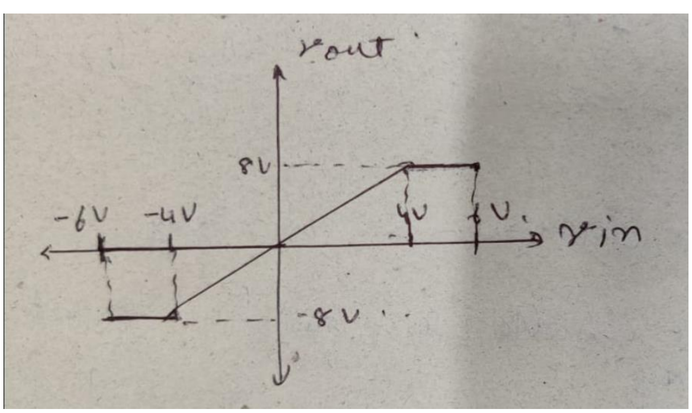


- Type of feedback -> Negative.
- Given:

  R_1=R_2=10Kohm.

  V_{DD} = +8V and -8V.

  Vin = Sine wave with frequency 100Hz and VPP 12V (Amplitude 6V).
- Plot expected:



- Plot obtained:

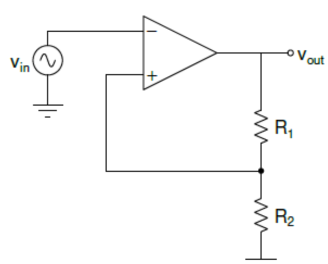
- Explanation:

  We know that VDD = 8V, and Vin varies from -6V to 6V.

  In non-saturation mode because of the negative feedback path $V^+ = V^-$, When Vin is -6V the output voltage will be equal to $-V_{DD}$, the voltage between the 2 resistors will be $-V_{DD}/2$. After the input voltage is slightly less than $-V_{DD}/2$, and till the point it is only slightly greater than $V_{DD}/2$ the graph indicates linear gain in the circuit equal to $A(V^+ - V^-)$, and again after the point $V^+ - V^-$ equals $V_{DD}/2$ the output will scale up to V_{DD}.

(1b) Positive feedback configuration:

- Schematic view of the circuit:

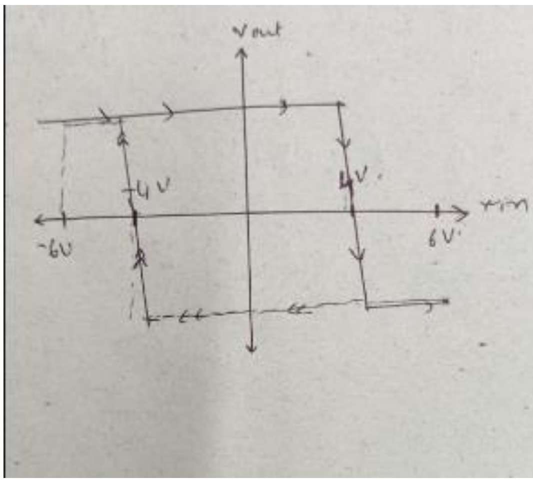


- Type of feedback -> Positive.
- Given:

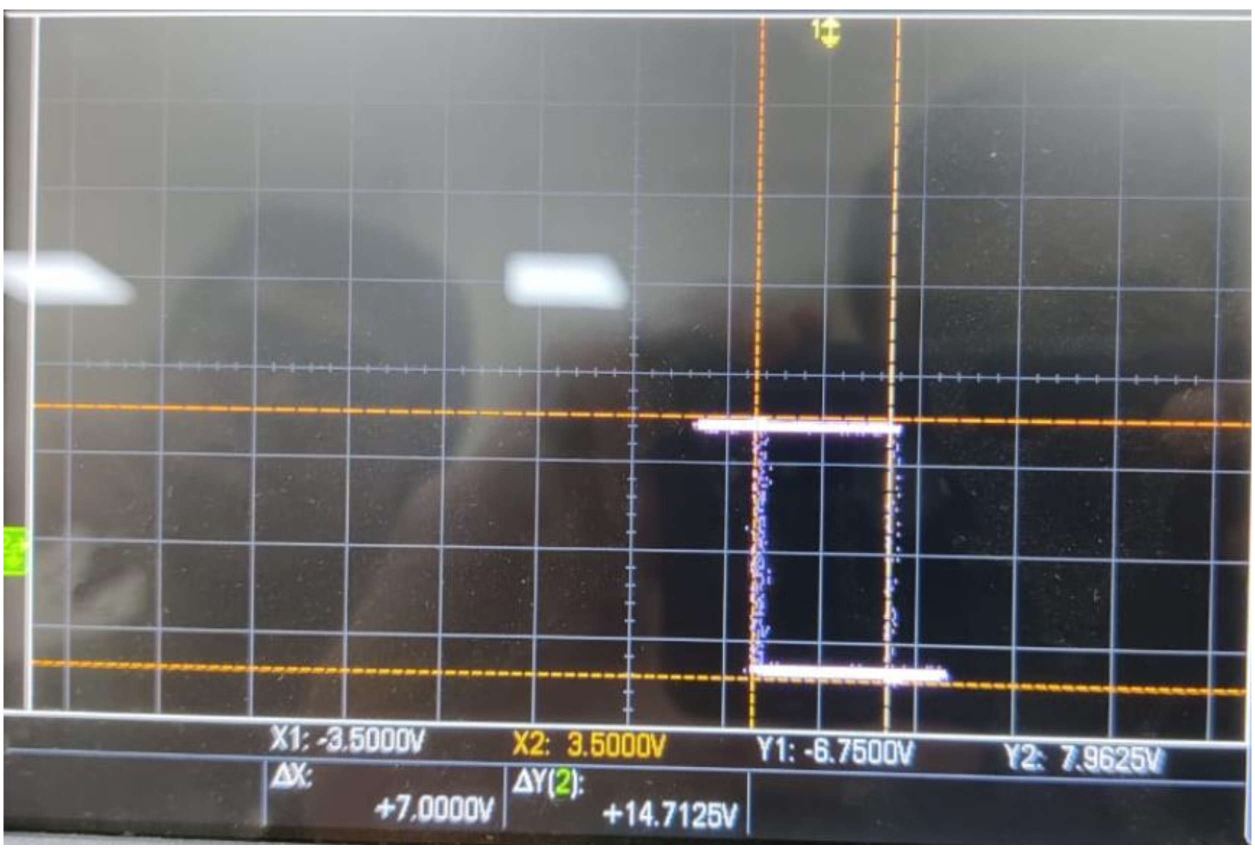
  R_1=R_2=10Kohm.

  V_{DD} = +8V and -8V.

  Vin = Sine wave with frequency 100Hz and VPP 12V (Amplitude 6V).
- Plot expected:



- Plot obtained:



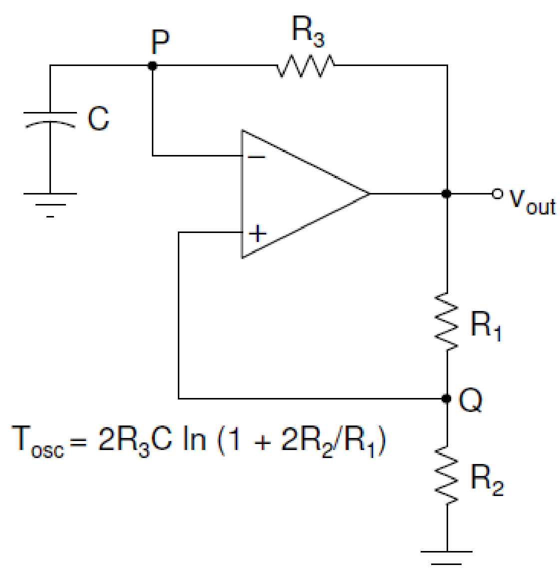
- Explanation:

  First, we will note that the circuit will be in saturation only when V^- and V^+ are nearly equal, when V^- is -6V, the output Vout will be +8V and the potential between 2 resistors wil be +4V, therefore for V^- from -6V to +4V the output will be +4v, and from V- little less than 4V to little more than 4V the opamp will be in saturation and the output will follow $A(V^+ - V^-)$ and again after this point the opamp is in non-saturation mode, and this time as $V^- > V^+$ the circuit will be -8V. There will be an opposite curcve when the Vin variation is taken from +6V to -6V.

- As explained above the positive feedback circuit will give an hysteresis curve, the explanation is given above.

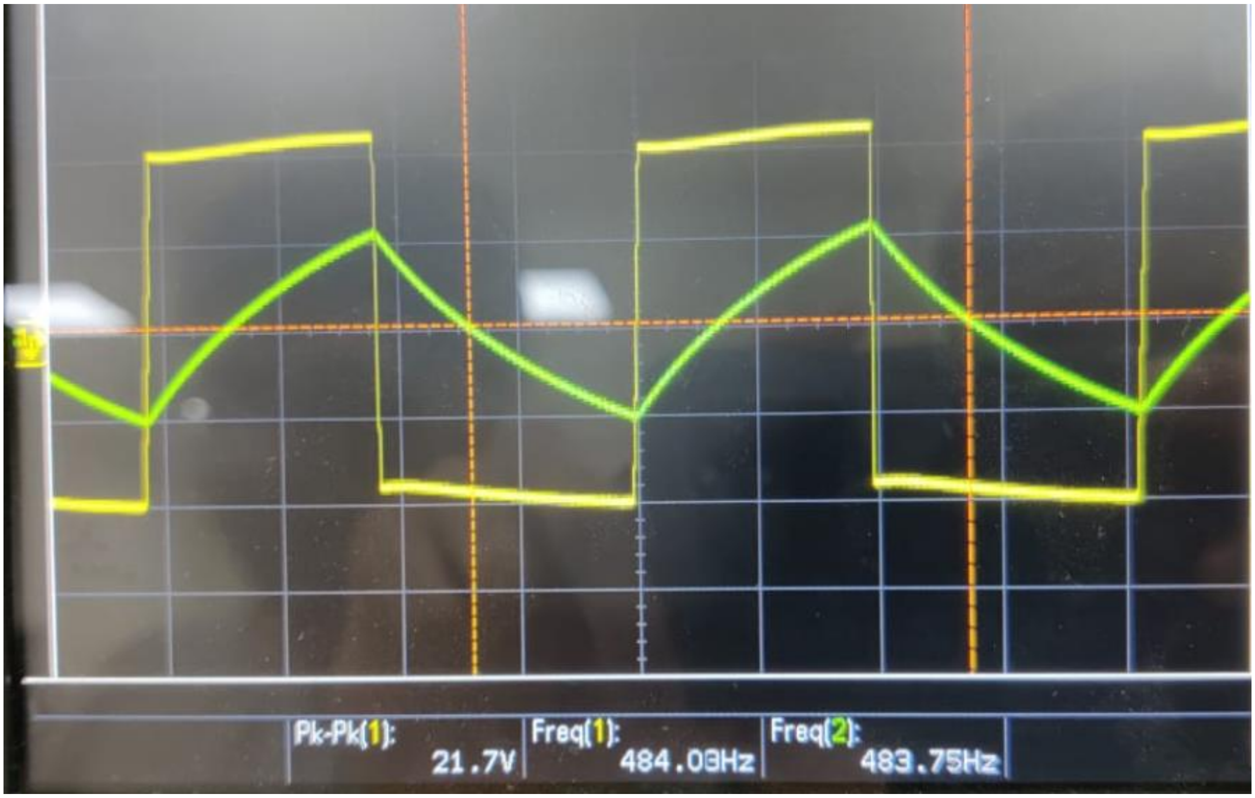
2. RC Oscillator (+ve feedback example)

- Schematic view of the circuit:

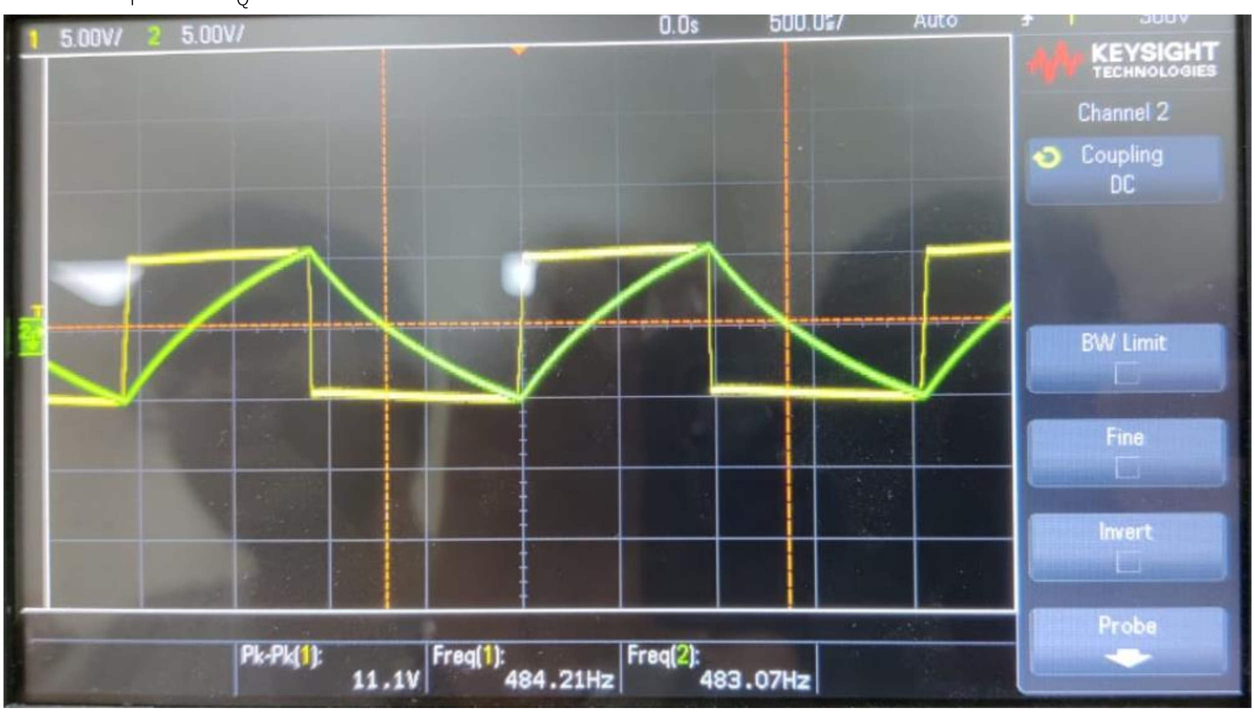


- Given: $R_1 = R_2 = 10\ k\Omega$, supply voltages =12 V, $R_3 = 1\ k\Omega$ and $C = 1\ \mu F$.

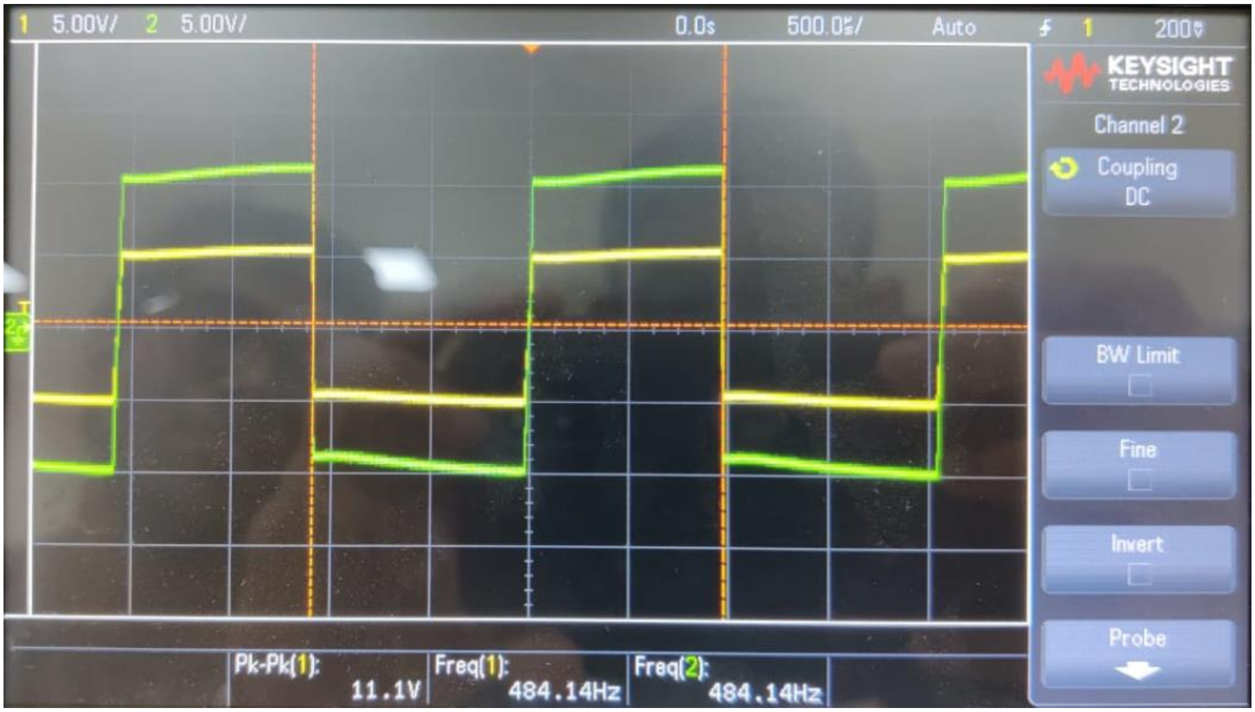
- Plot of V_P and Vout



- Plot of V_P and V_Q



- Plot of V_P and V_Q



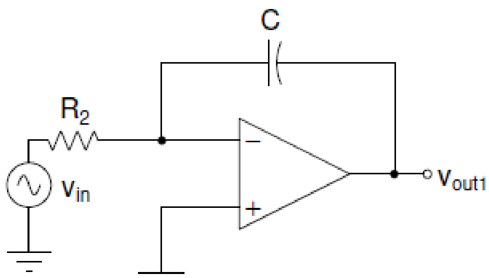
- Explanation:

  Consider the opamp in saturation initially, so initially the difference between the input voltages of opamp is very less, and the output will be $A(V^+ - V^-)$, the output will be of range of some 10's of volt's, and so the potential between the 2 resistors will also be of order of Volt's. Now the potential between the 2 resistors is given to opamp as input at V^+, and as the difference between V^+ and V^- is high, so opamp will always stay in non-saturation mode. The opamp can be though as a battery of 12V for the time when Vp is less than 6V, and after that it will be replaced by a battery of -12V. When opamp is 12V battery, the capacitor will charge and the potential at V_P will increase till VP is 6v, and after that opamp is replaced with battery of -6V, and the capacitor will discharge.

- Observed value of frequency: 484Hz.
- Calculated value of frequency: 455.1196Hz

3. Integrator (-ve feedback example)

(a) Schematic view of the circuit:

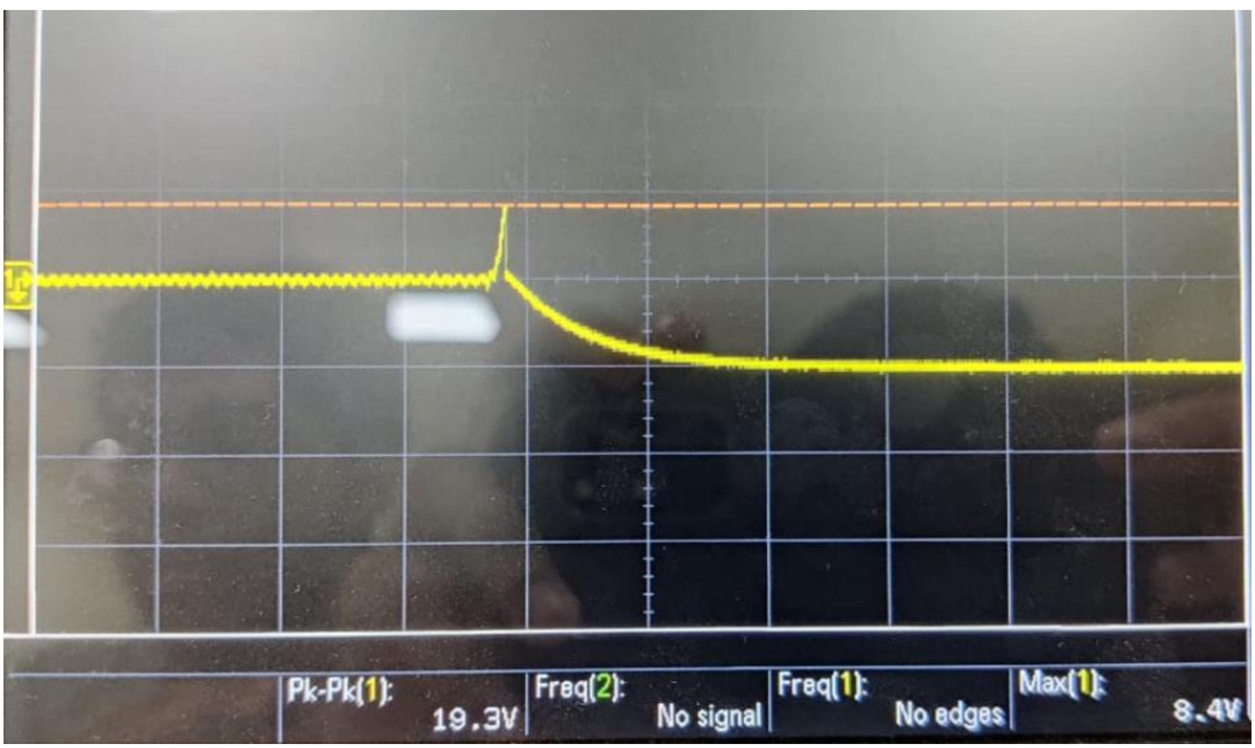


(a)

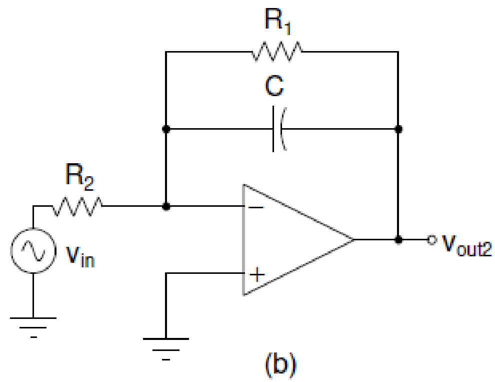
- Given Vin is 0, R_2 is 1Kohm.

As the circuit is in negative feedback, the circuit is saturated, therefore the two input terminals of opamp are shorted, and as the no current will flow through the opamp, current flows through capacitor and R2 only. The initial current is due to DC offset of opamp combined with non-ideal behavior of opamp.

- Plot of output:

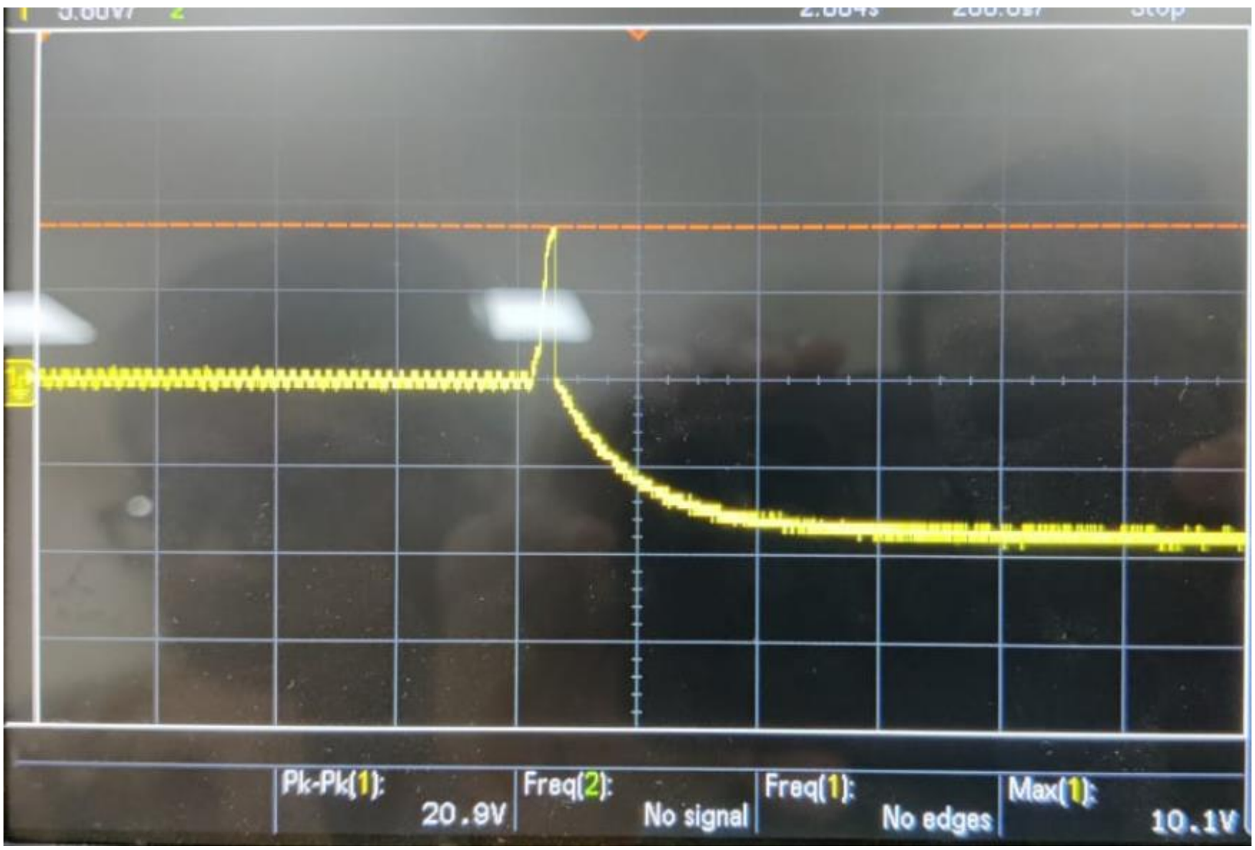


(b) Schematic view of the circuit:



When Vin is 0, the circuit will again saturate,

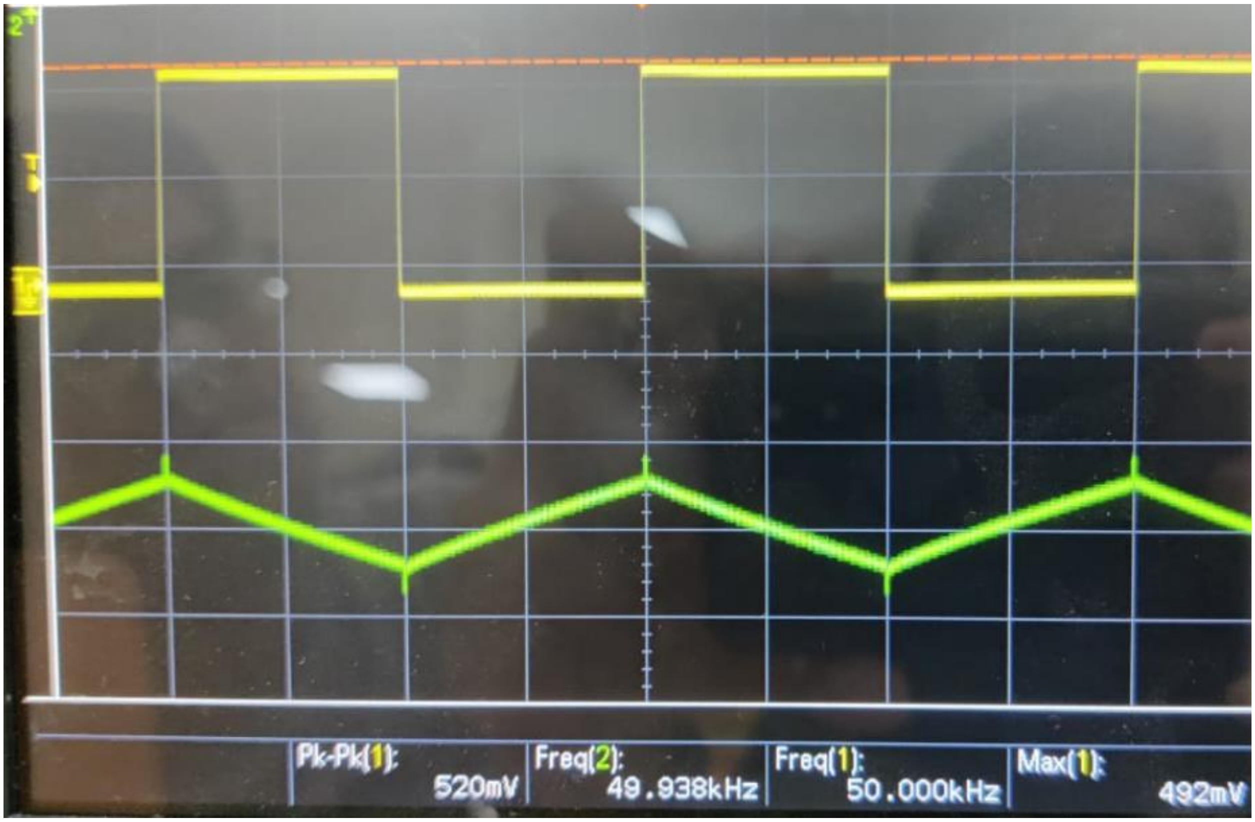
- Plot:



(c)

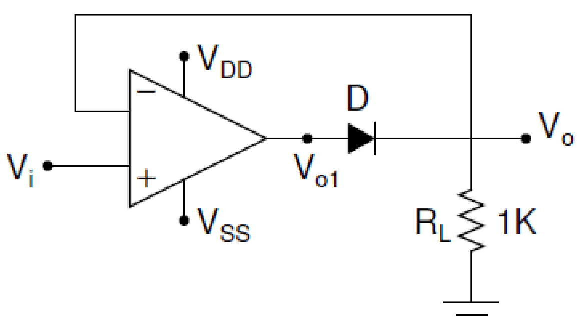
When we are given with input square wave, the circuit (b) will perform integrator action on the signal. The flat line in the square wave will be outputted as a straight line with some slope.

- Plot:



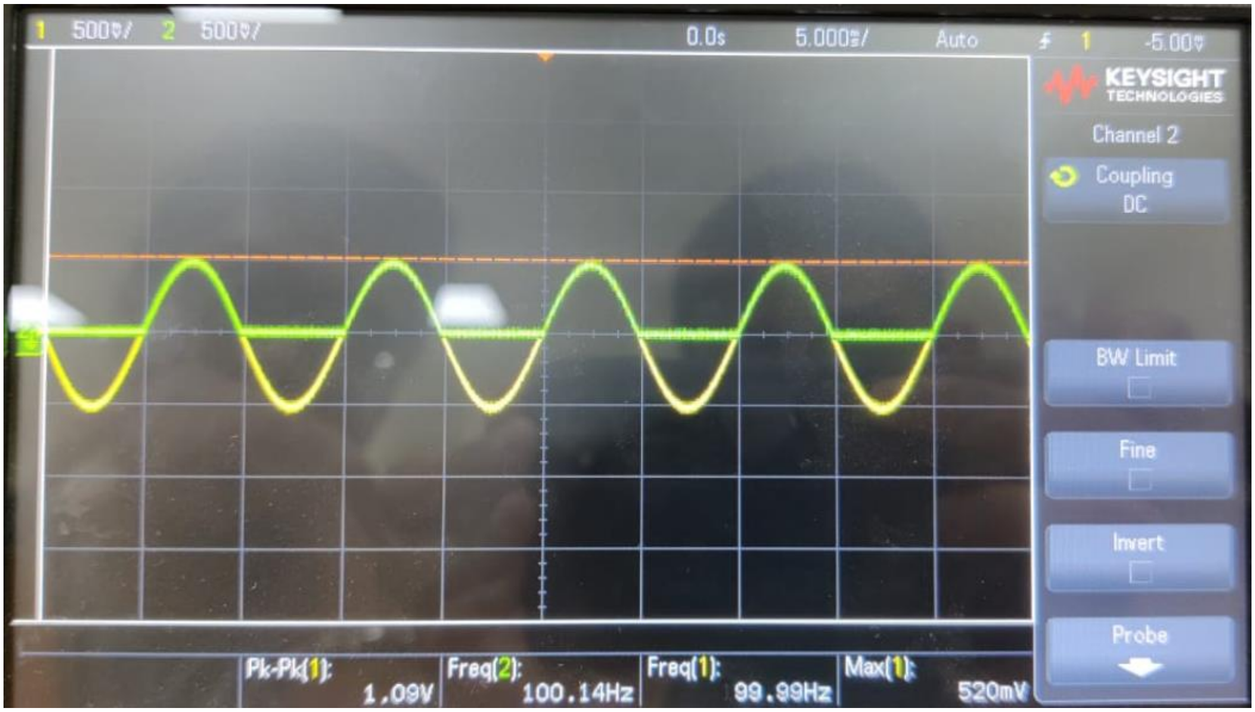
4.Precision half-wave rectifier (-ve feedback example)

- Schematic view of the circuit:

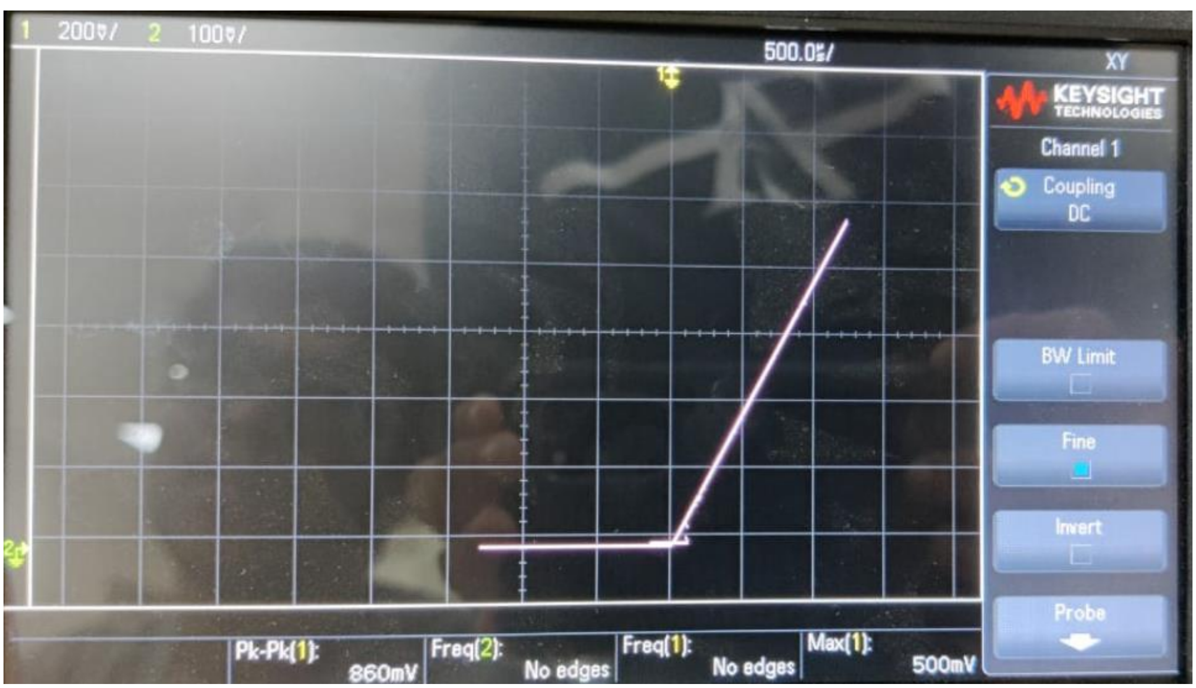


Given: Vi ->Vpp = 1V, frequency:100Hz. V_{DD} = 12V.

- Plot:



- X-Y characteristic



The difference between the normal diode and this circuit is that here the effect of Vcut-of is reduced and the diode starts conducting very near to the positive value of input. The effect of V cut-off is not that significant because the input is slightly amplified at the output of the opamp, so instead of Vi as the input of diode the input to diode is amplified Vi.