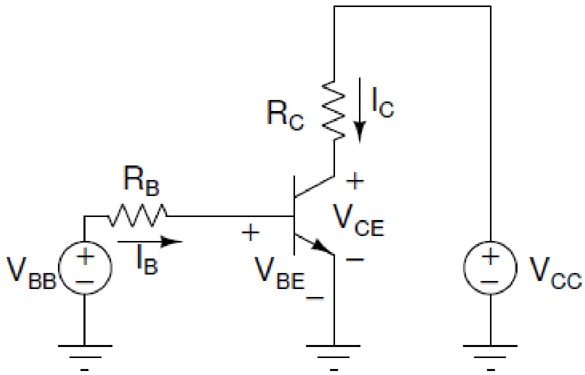
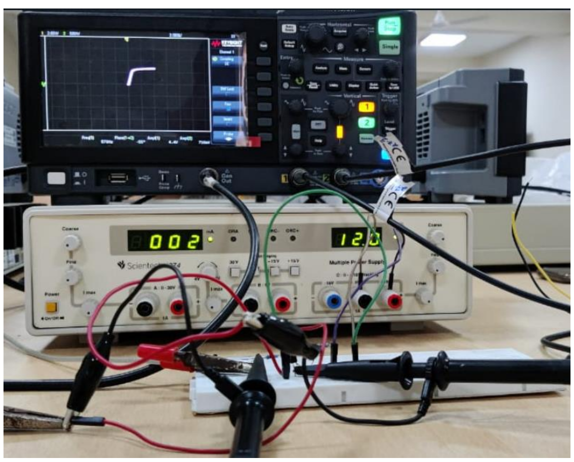
Experiment-4
BJT characterization

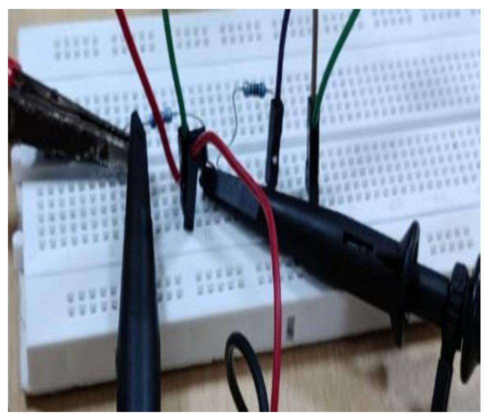
1. BJT Characterization

   Schematic view of Circuit:



Circuit:





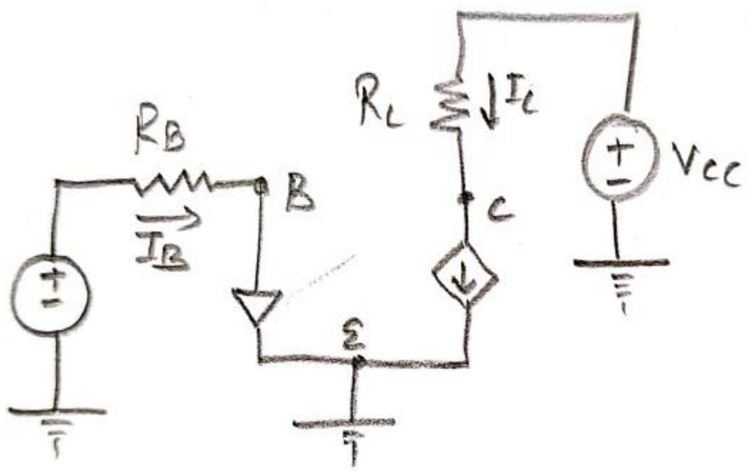
Plotting V_{BE} (CH2) (Y-axis) vs V_{BB} (CH1) (X-ais) for V_{BB} = 0 V to V_{BB} = 4 V.

V_{BB} = {0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1, 1.2, 1.4, 1.6, 1.8, 2, 3 and 4} V.

Also plotting V_{BB}(X-axis) vs V_{CE}(Y-axis)

Plots(V_{BE} (CH2) (Y-axis) vs V_{BB} (CH1) (X-ais)):

The large signal model of the above circuit:

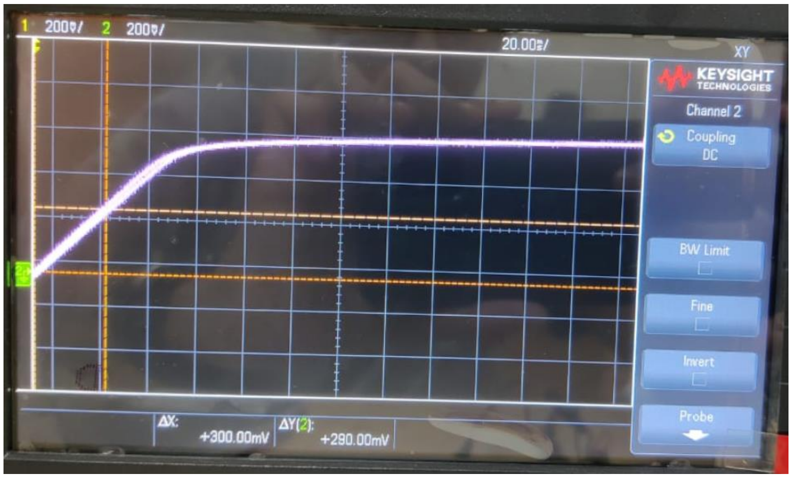


For **V_{BE} (CH2) (Y-axis) vs V_{BB} (CH1) (X-ais)** plot initially when we increase VBB from 0 to cut in voltage of the model diode, the diode hasn't reached its cut-in voltage and passes very low current hence there is no loss across R_B because the current is very small, therefore V_B will nearly be equal to $V_{BB.}$

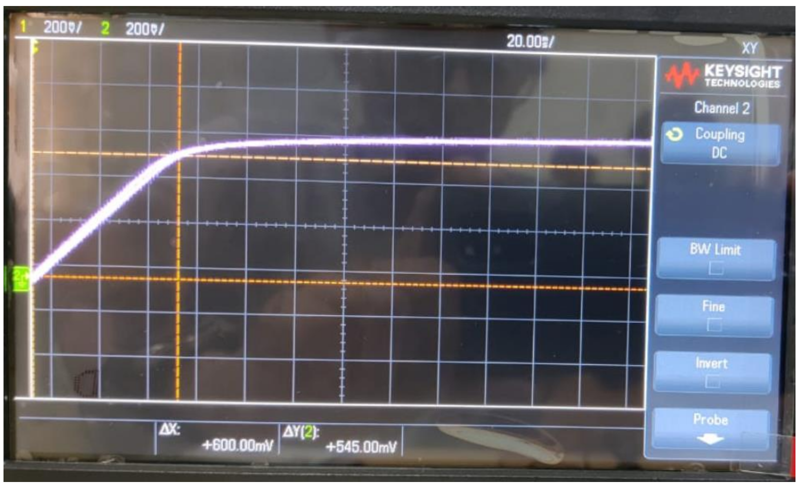
After V_{BB} reaches cut in voltage the voltage across diode which is equal to V_{BE} is nearly constant to cut in voltage.

Hence such plot is achieved.

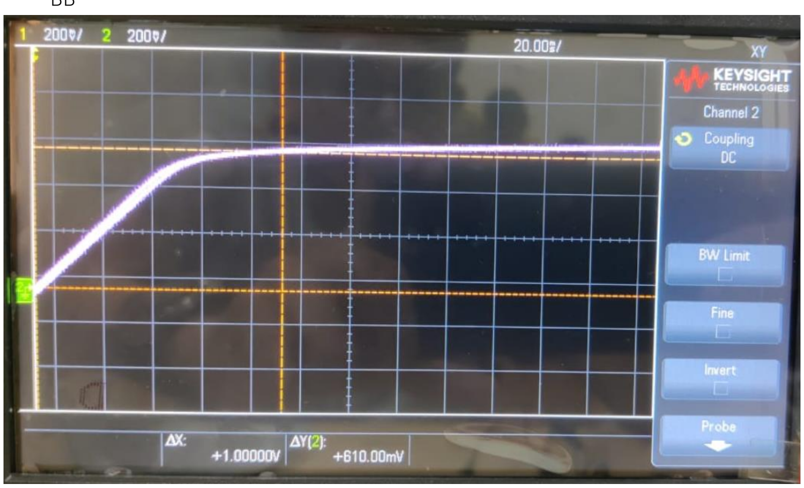
1.$V_{BB} = 0.3V$



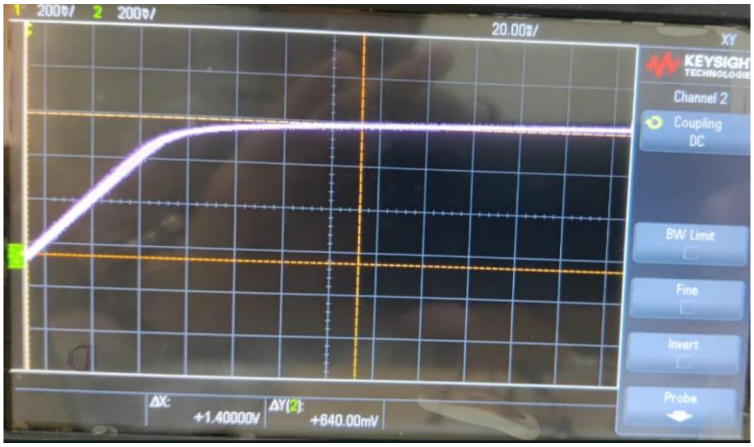
2.$V_{BB} = 0.6V$



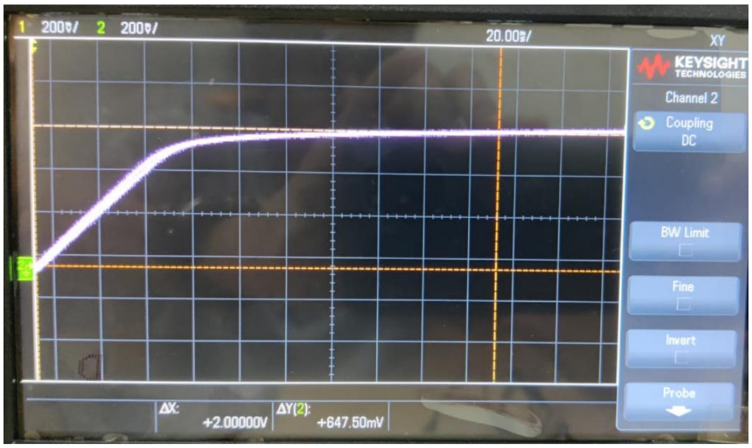
3.$V_{BB} = 1V$



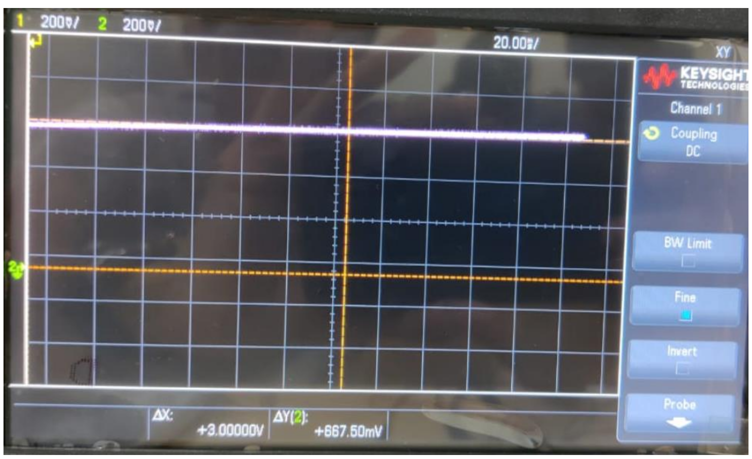
4. $V_{BB} = 1.4V$



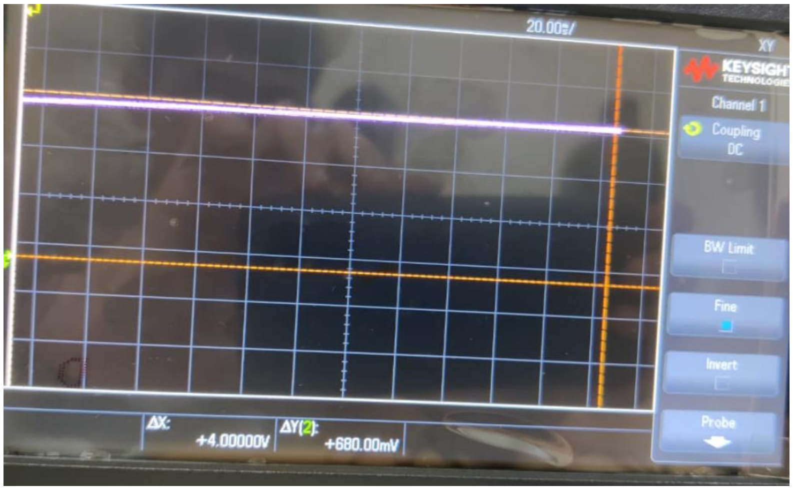
5. $V_{BB} = 2V$



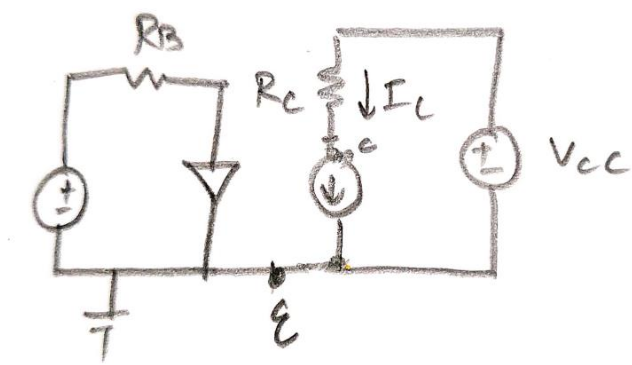
6. $V_{BB} = 3V$



6. $V_{BB} = 4V$

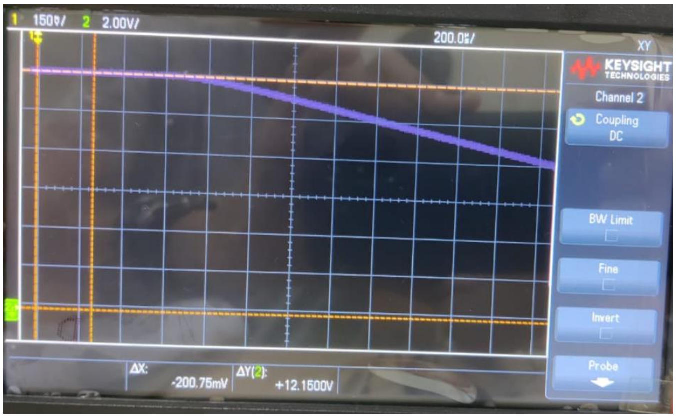


Plotting V_{BB}(X-axis) vs V_{CE}(Y-axis):

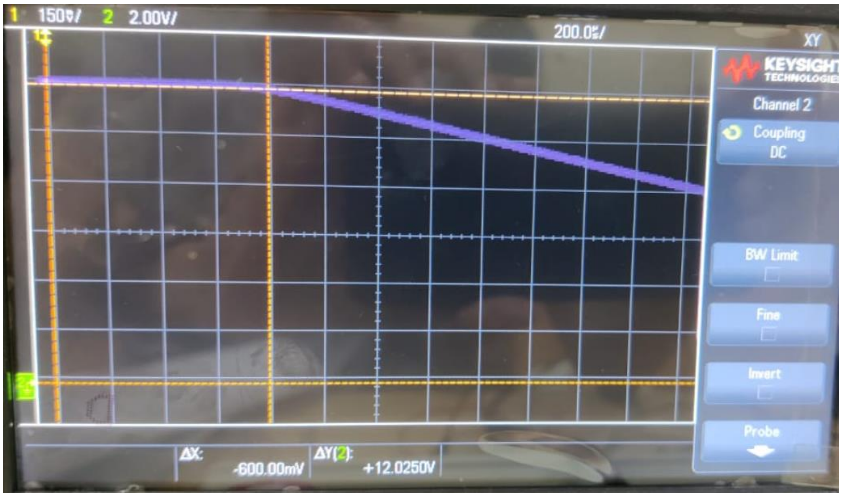


Explaining the plot of **V_{BB}(X-axis) vs V_{CE}(Y-axis).** In the large signal model as seen above when VBB is low, VBE is equal to VBB which are very low, as a result the VBE is also low, because of which Ic is also not significant, not producing much loss across the Rc resistance, therefore the collector emitter voltage will be Vcc.
At higher values of VBB the VBE value also increases(after sometime nearly constant), because increasing VBE the Ic current value also increases, producing greater potential loss across the Rc, hence decreasing the value of Vc.

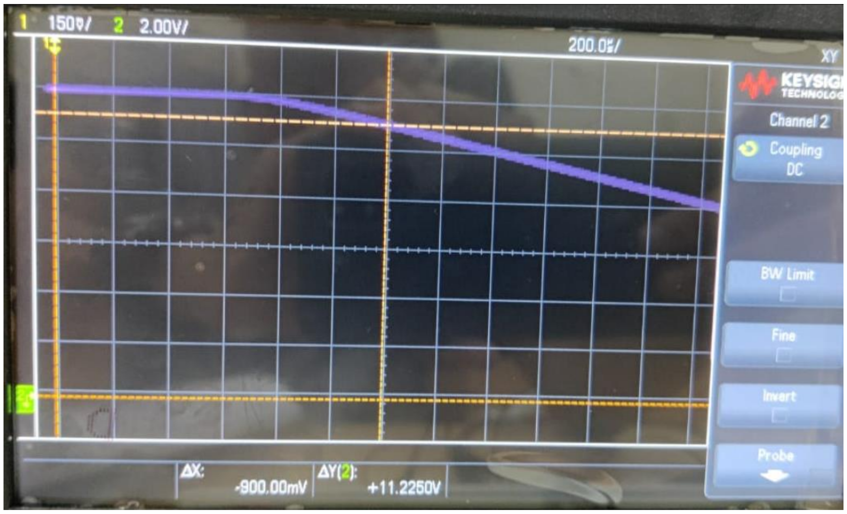
1. $V_{BB} = 0.2V$



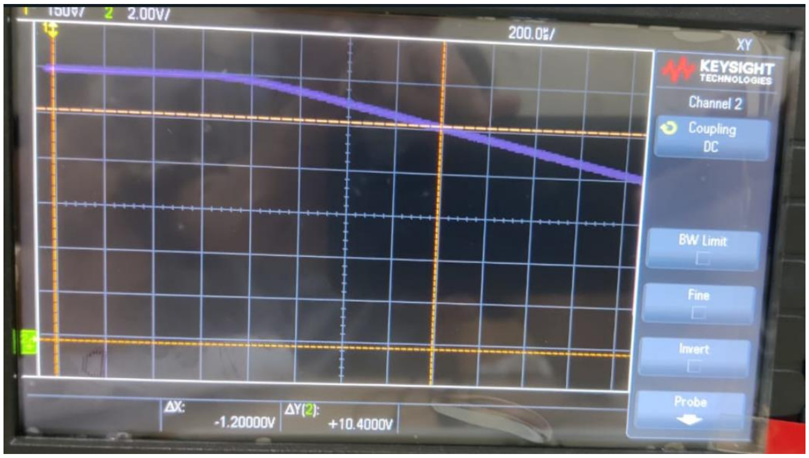
2. $V_{BB} = 0.6V$



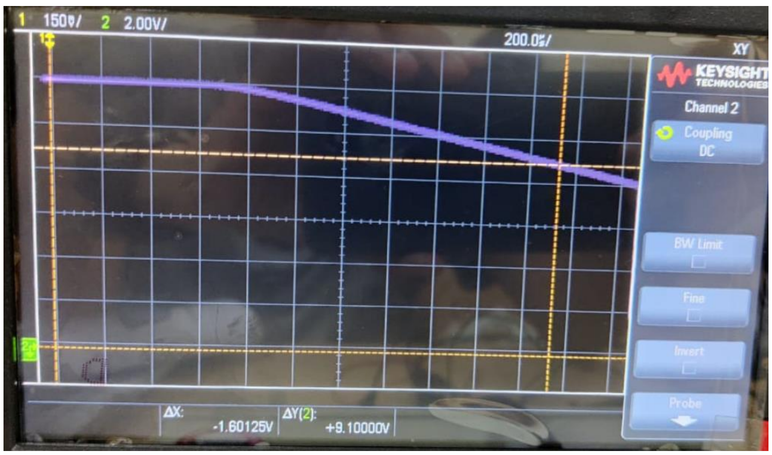
3. $V_{BB} = 0.9V$



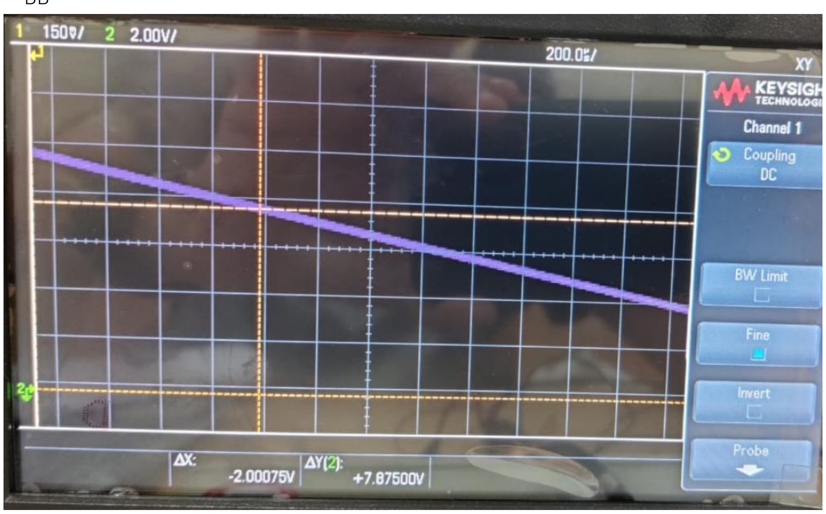
4. $V_{BB} = 1.2V$



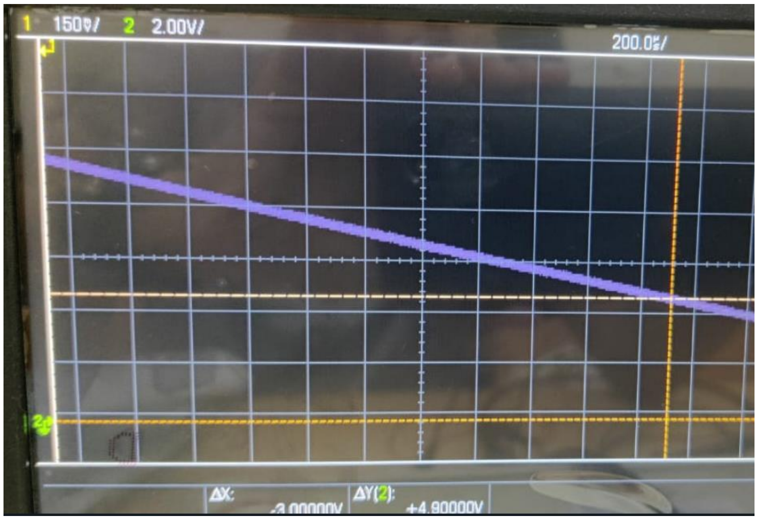
5. $V_{BB} = 1.6v$



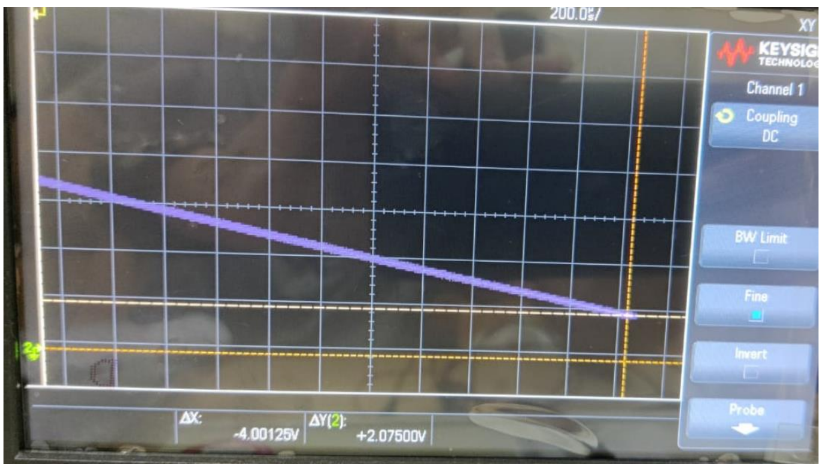
6. $V_{BB} = 2V$



7. $V_{BB} = 3V$



8. $V_{BB} = 4V$



Tabulating the found values and finding currents and β.

$$I_B = \frac{V_{BB} - V_{BE}}{R_B}, \; I_C = \frac{V_{CC} - V_{CE}}{R_C}$$

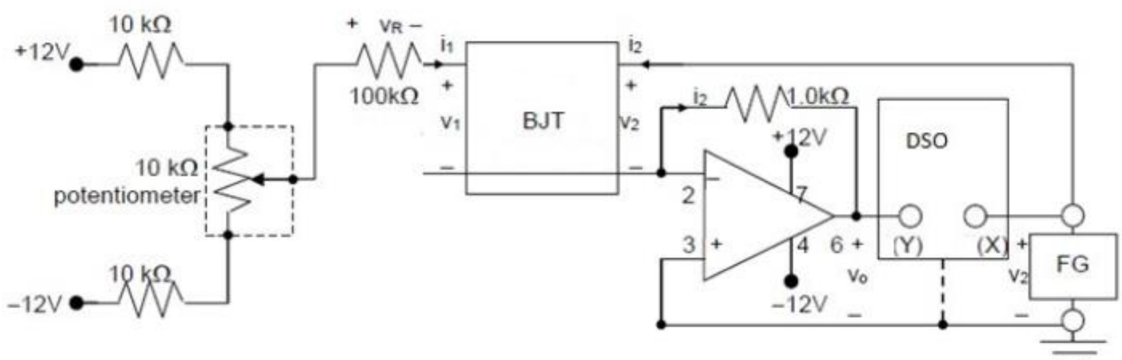
Vcc = 12.3 V

V_{BB} (V)	V_{BE} (mV)	I_B (A)	V_{CE} (V)	I_C	β	Mode
0.2	190	1e-006	12.15	0.00015	150	Active
0.3	290	1e-006	12.15	0.00015	150	Active
0.4	380	2e-006	12.15	0.00015	150	Active
0.5	482	1.8e-006	12.15	0.00015	150	Active
0.6	545	5.5e-006	12.025	0.00019	34.544	Active

0.7	582	1.18e-005	11.8	0.0002	16.9492	Active
0.8	595	2.05e-005	11.525	0.000475	23.1707	Active
0.9	602	2.98e-005	11.225	0.000775	26.0067	Active
1	610	3.9e-005	10.925	0.001075	27.5641	Active
1.2	627.5	5.72e-005	10.400	0.0016	27.972	Active
1.4	640	7.6e-005	9.725	0.002275	29.9342	Active
1.6	642.5	9.57e-005	9.100	0.0029	30.303	Active
1.8	647.5	0.00011525	8.450	0.00355	30.8026	Active
2	647.5	0.00013525	7.875	0.004125	30.4991	Active
3	667.5	0.00023325	4.900	0.0071	30.4394	Active
4	680	0.000332	2.0750	0.009925	29.8946	Saturation

2. BJT Output Characteristics (I_C vs V_{CE})

Schematic view of the circuit:



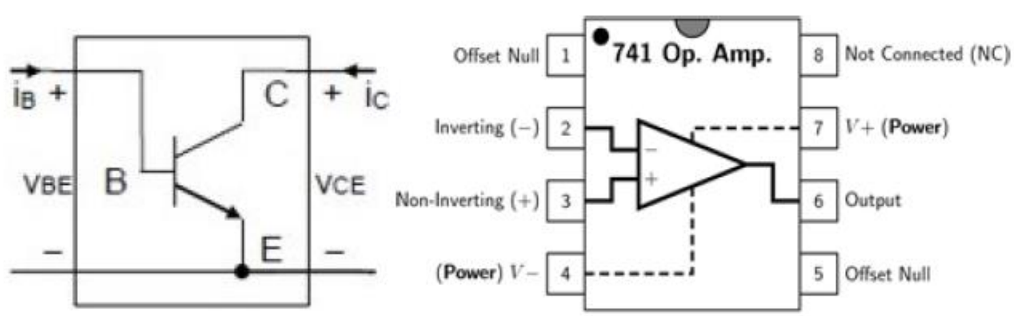
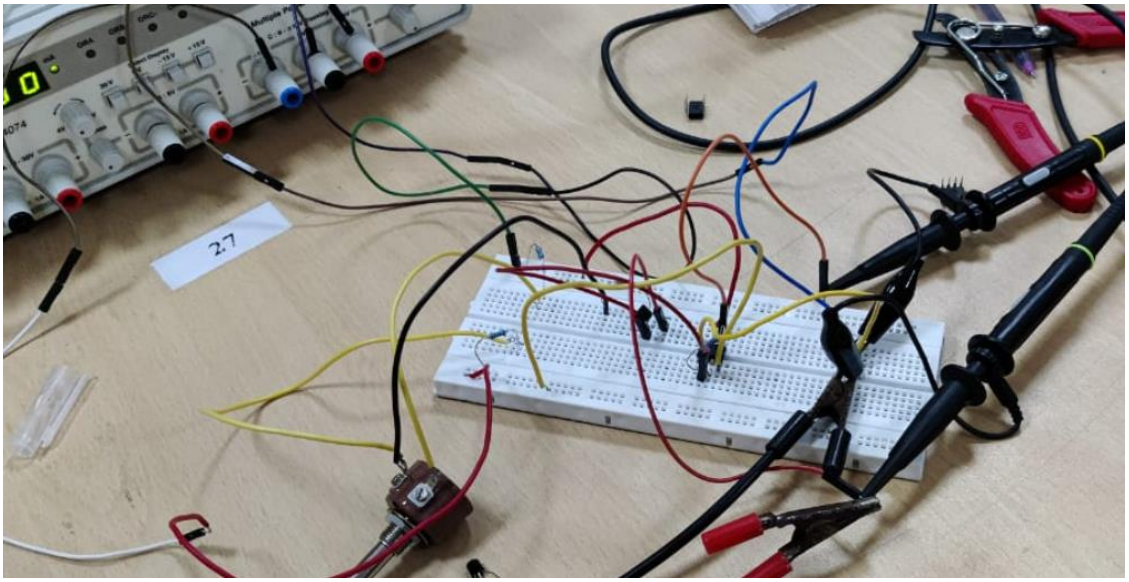
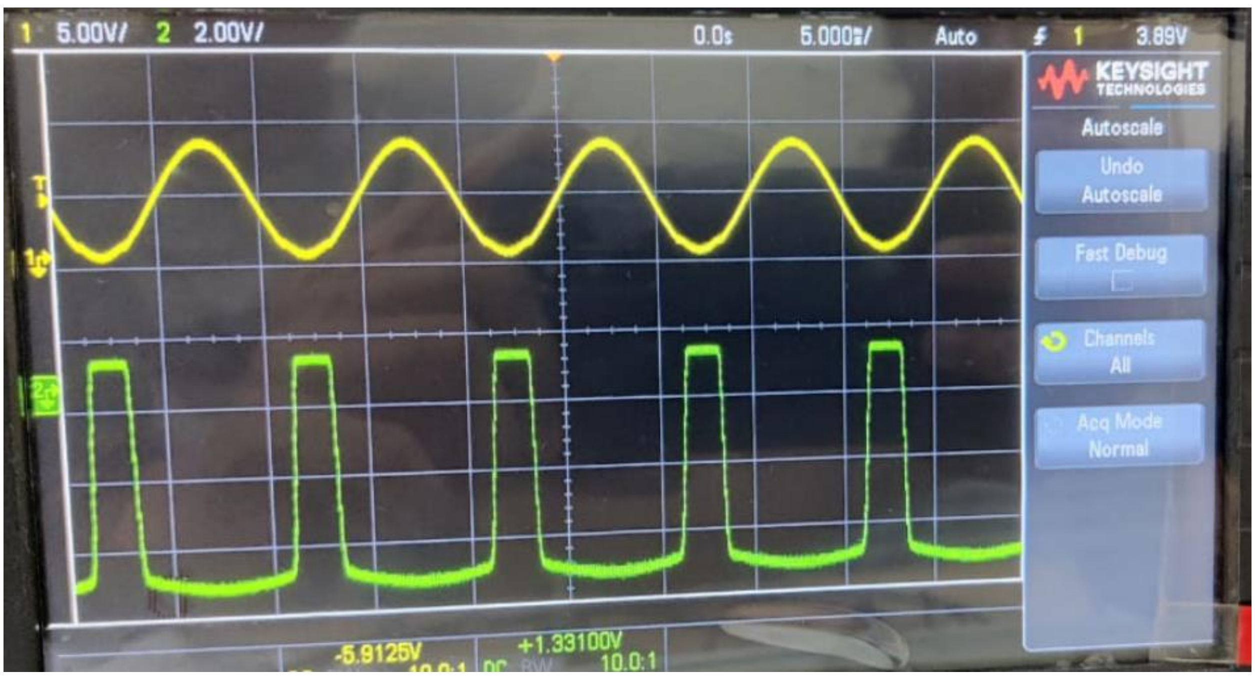


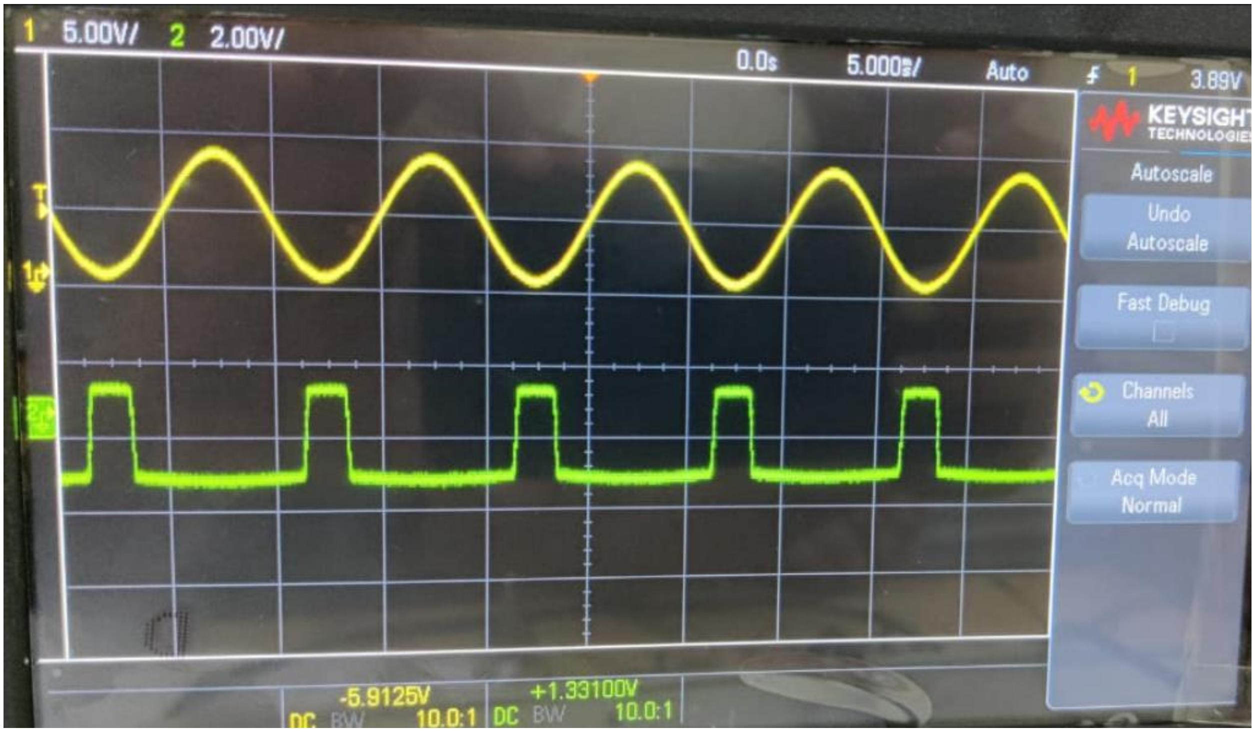
Figure 3: (a) NPN BJT, (b) opamp pin configuration

Circuit:



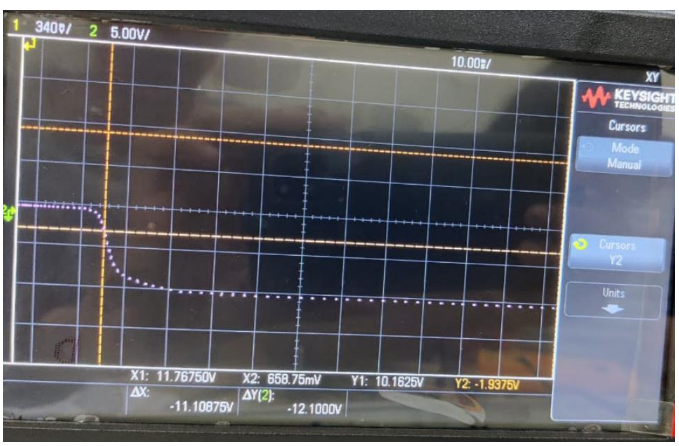
Plots on the OSC of $V_2(V_{CE})$ and V_O:





$V_2 = V_{CE}$ and V_0 ($\propto -I_C$) are found using OSC, we are plotting V_{CE} vs Vo x-y characteristic on OSC and measuring its value at different V_{BB} values. As we cannot measure all the V_{CE} and V_{BB}, we are measuring only two values, one in saturation and one in active region.

We will see different values of V_{CE} and Vbe, by varying Vbb using potentiometer, we will also be measuring the values of Vbe using a multimeter.



The x-y characteristic plot comes as shown above, before cut in voltage, i.e in saturation region the V_0 ($\propto -I_C$) increases as V_{CE} increase, but after crossing the cut in voltage the value of V_0 ($\propto -I_C$) is constant because collector current does not depend on V_{CE}, it only depends on V_{BE}. On increasing the value of V_{BB}, the magnitude of active region V_0 ($\propto -I_C$) because Ic increases with increase in V_{BE}, and increase in V_{BB} increases V_{BE}.

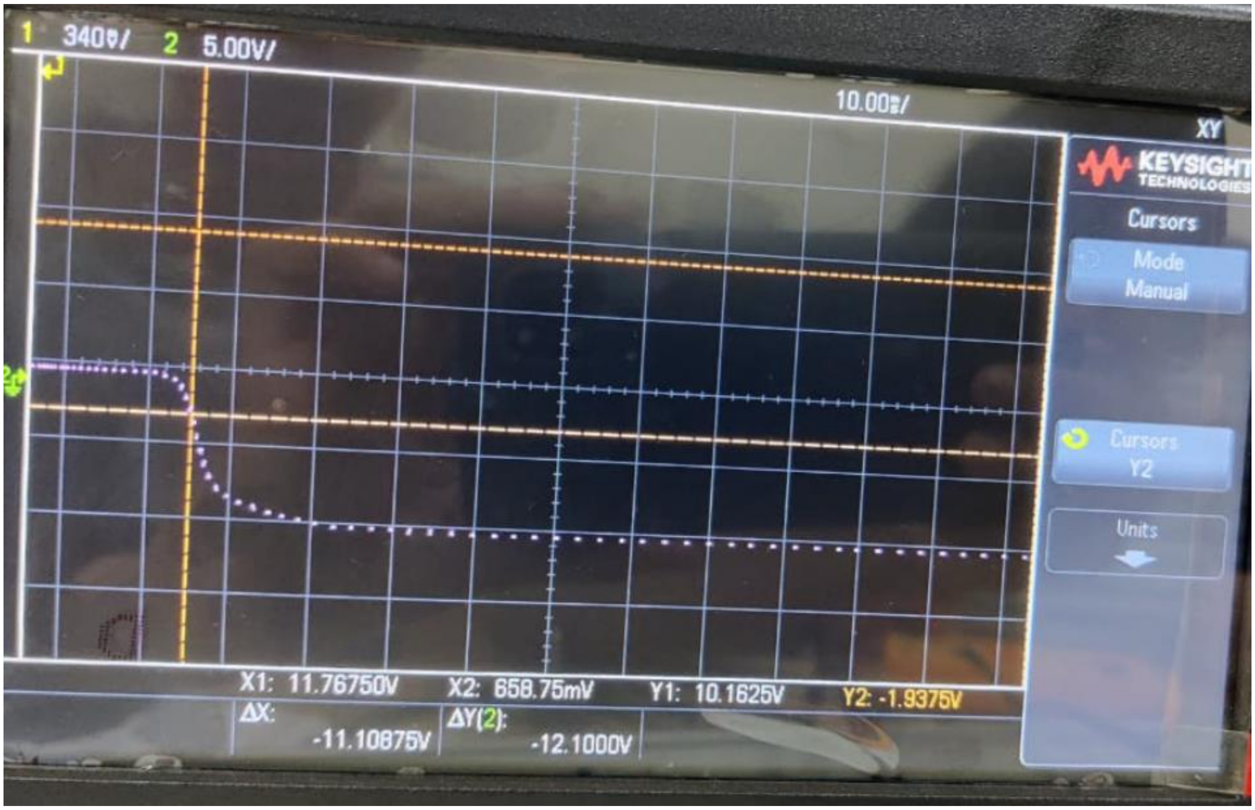
Plots and multimeter readings:

We will be measuring value of Vo at V_{CE} = 658.75mV(saturation region) and V_{CE} = 4V(Active region).

1. VBB = 4V

VBE:

Vo(saturation region):



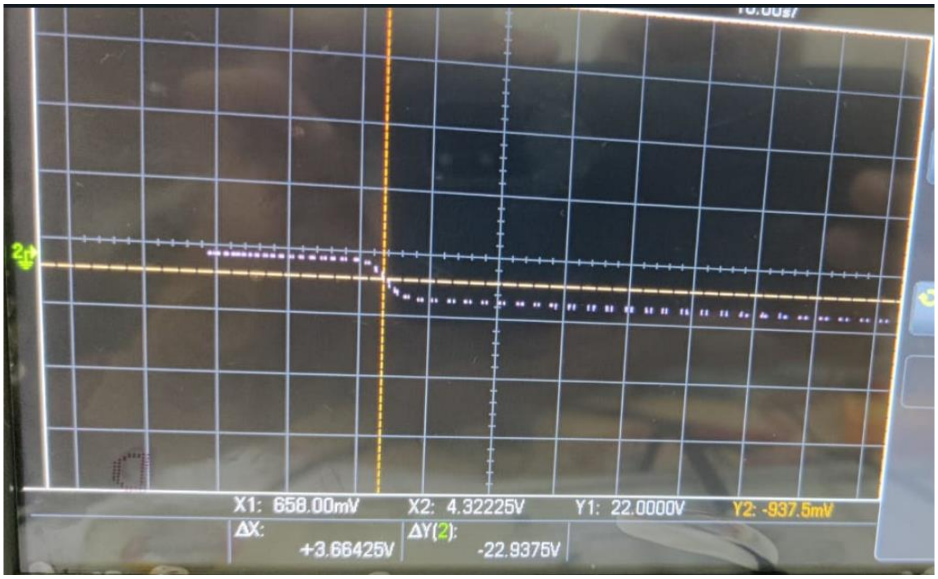
Vo (Active region):

I forgot to take an image in this region for VBB = 4V.

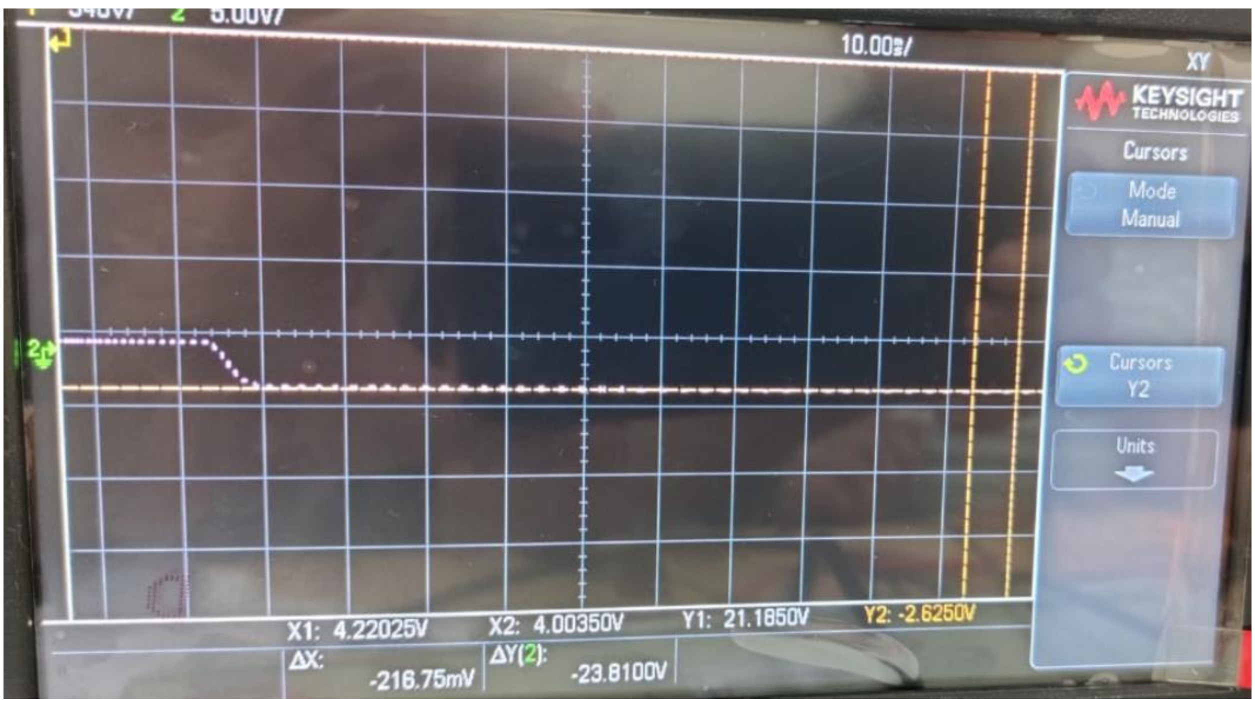
2. VBB = 2V

VBE:

Vo(saturation region):

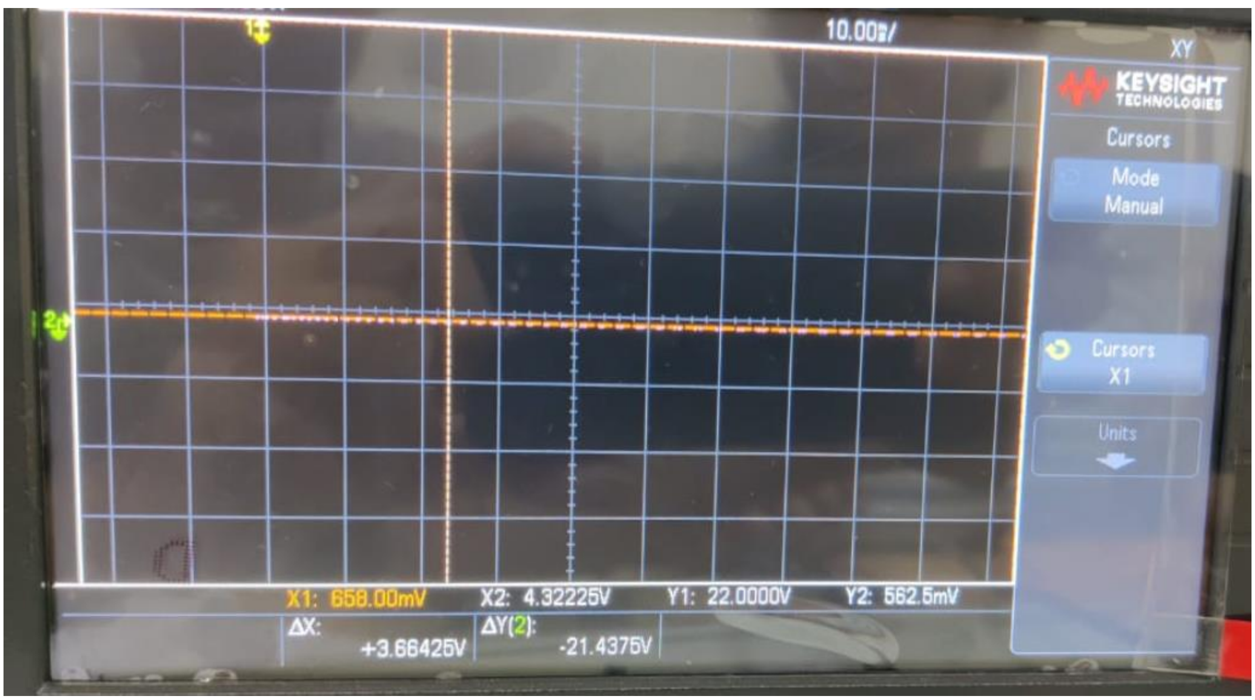


Vo(Active region):

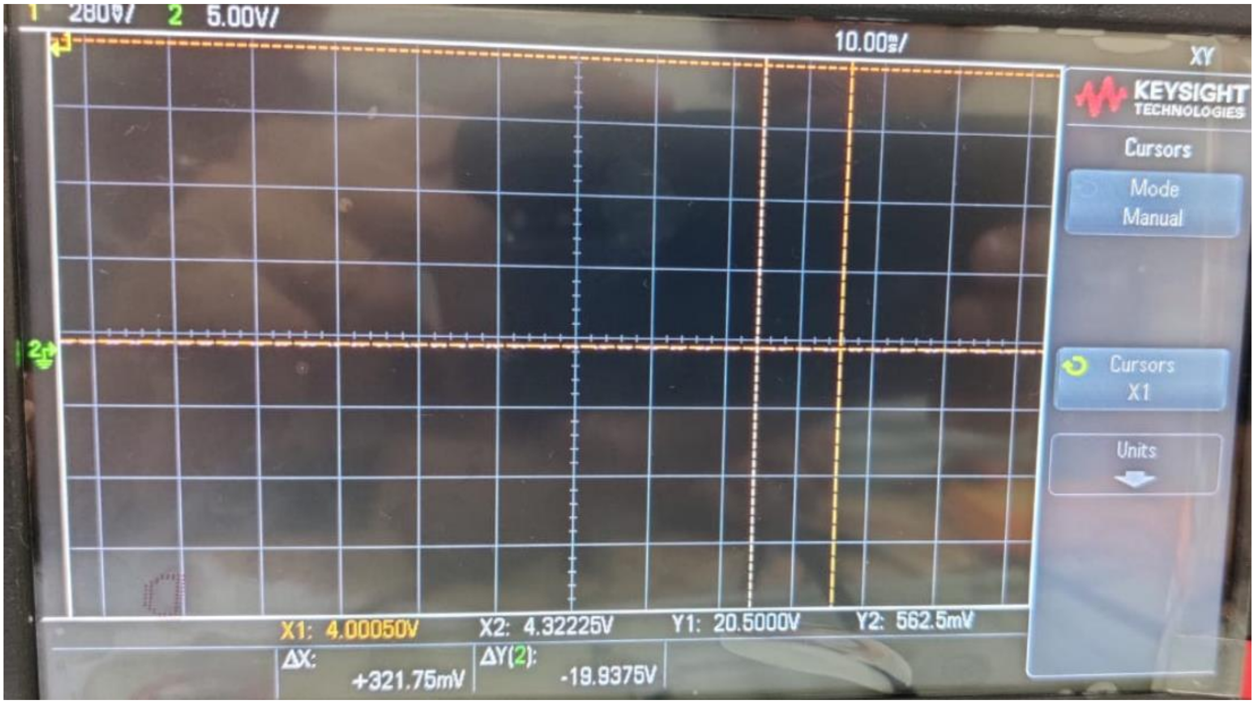


3. Vbb = 1V

Vo(saturation region):

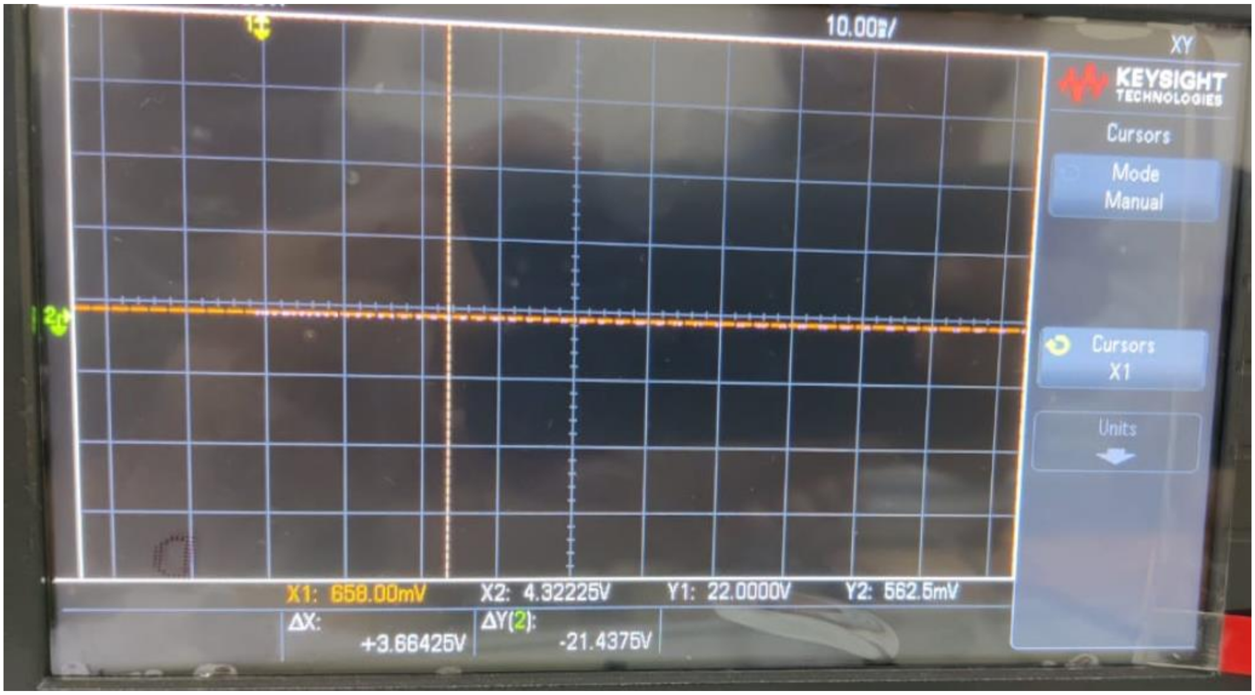


Vo(Active region):

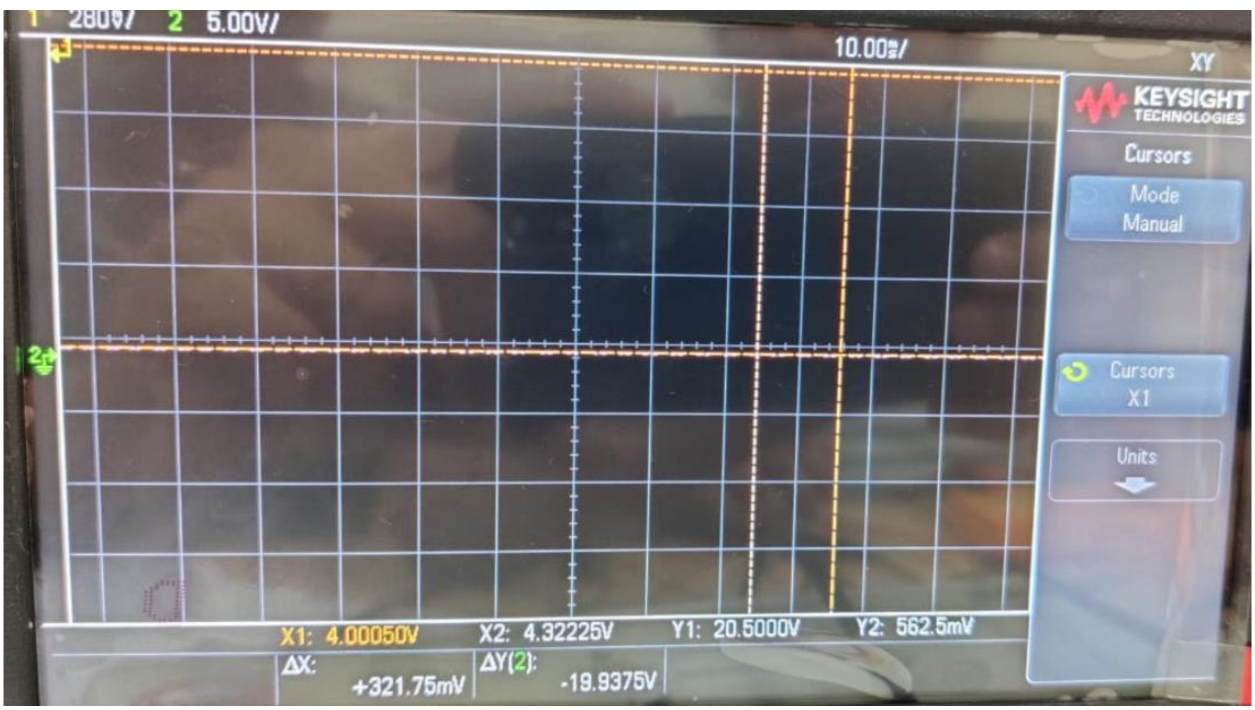


1. Vbb = 0.5V

Vo(saturation region):

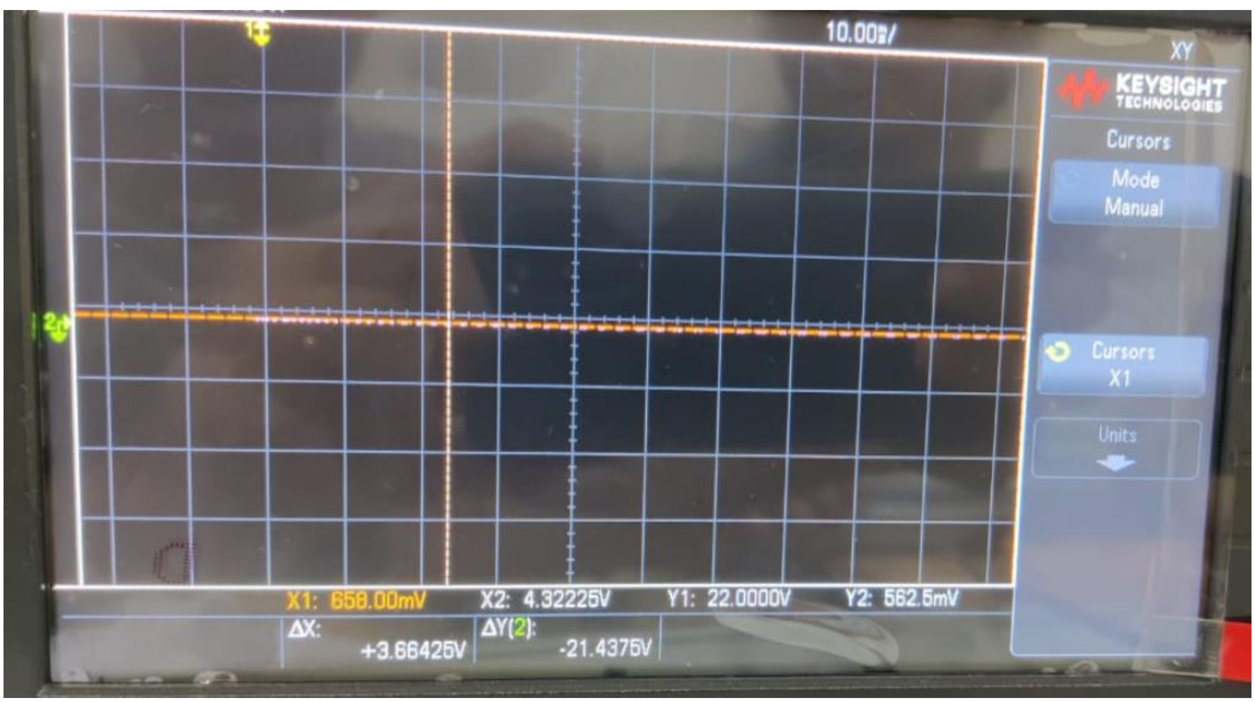


Vo(Active region):

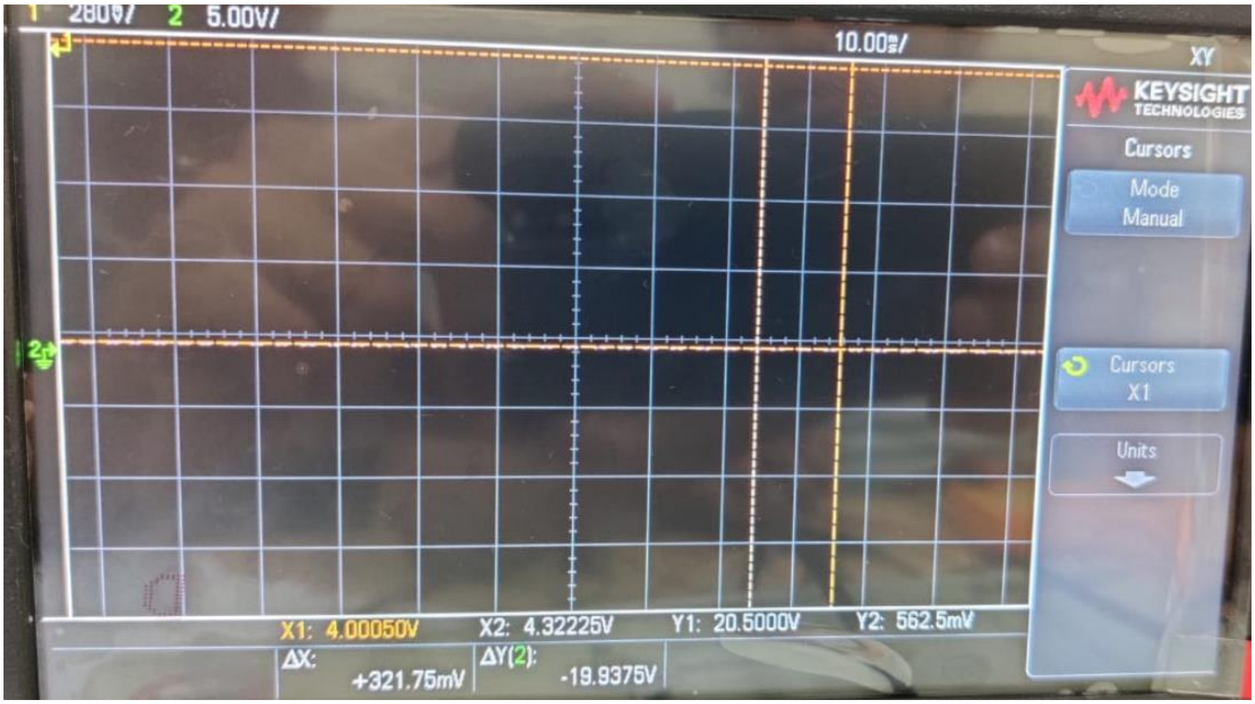


1. Vbb = 0.2V

Vo(saturation region):



Vo(Active region):



$V_{BB} - I_B R = V_{BE}$

$I_B = V_{BB} - V_{BE} /R$

$R = 100K\,\Omega$.

V_{BB}	V_{BE}	I_B (A)	V_{CE} Saturation mode	V_O Saturation mode	I_C Saturation mode	V_{CE} Active mode	V_O Active mode
4V	0.60V	3.4e-005	658.75mV	-1.9375V	1.9375mA	4V	-9.25V
2V	0.56V	1.44e-005	658.75mV	-937.5mV	937.5uA	4V	-2.6250V
1V	0.25V	7.5e-006	658.75mV	-562.5mV	562.5uA	4V	-582.5mV
0.5V	0.06V	4.4e-006	658.75mV	-562.5mV	562.5uA	4V	-582.5mV
0.2V	-0.11V	3.1e-006	658.75mV	-562.5mV	562.5uA	4V	-582.5mV

B (I_C/I_B) (Saturation region).
5.698
65.104
75
127.841
181.452