MP309

Experiment 5

Study of basic properties of Operational Amplifier: Inverting and Non-Inverting Amplifiers

Name :- Patel Mihir Hemantkumar

Roll no. :- I18PH037

Part 1 :-Inverting Operational Amplifier

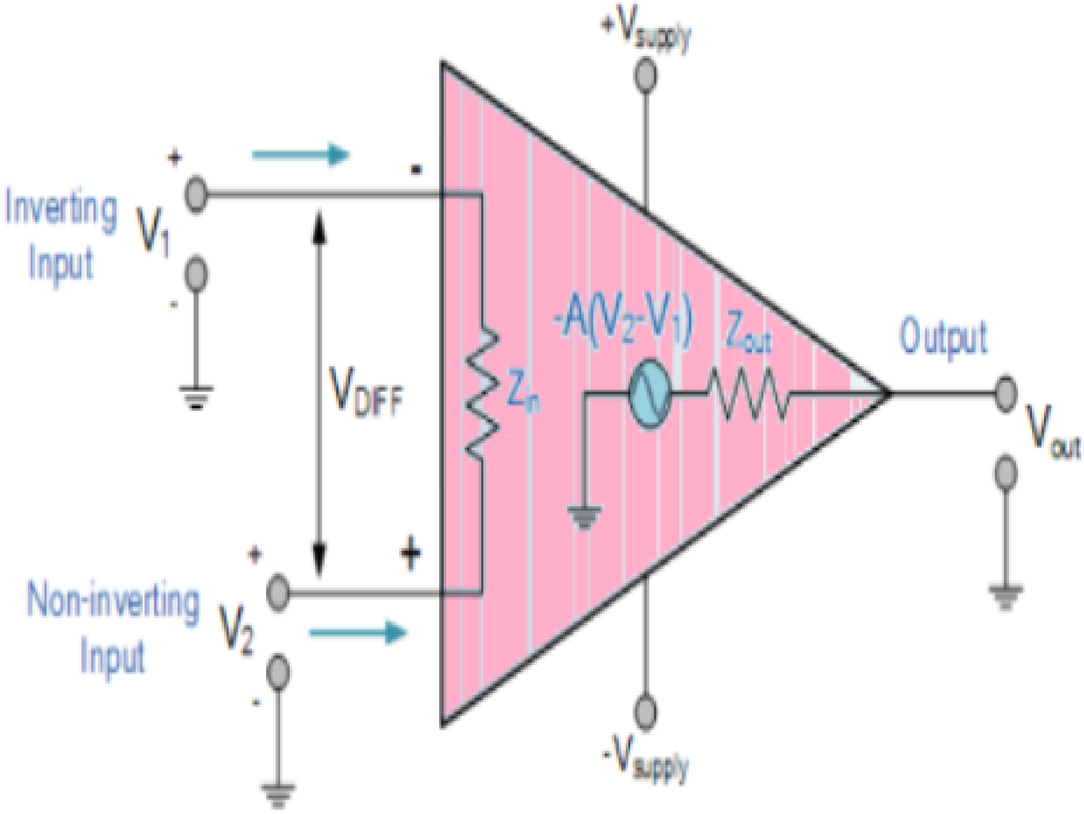

Figure 1: Operational Amplifier

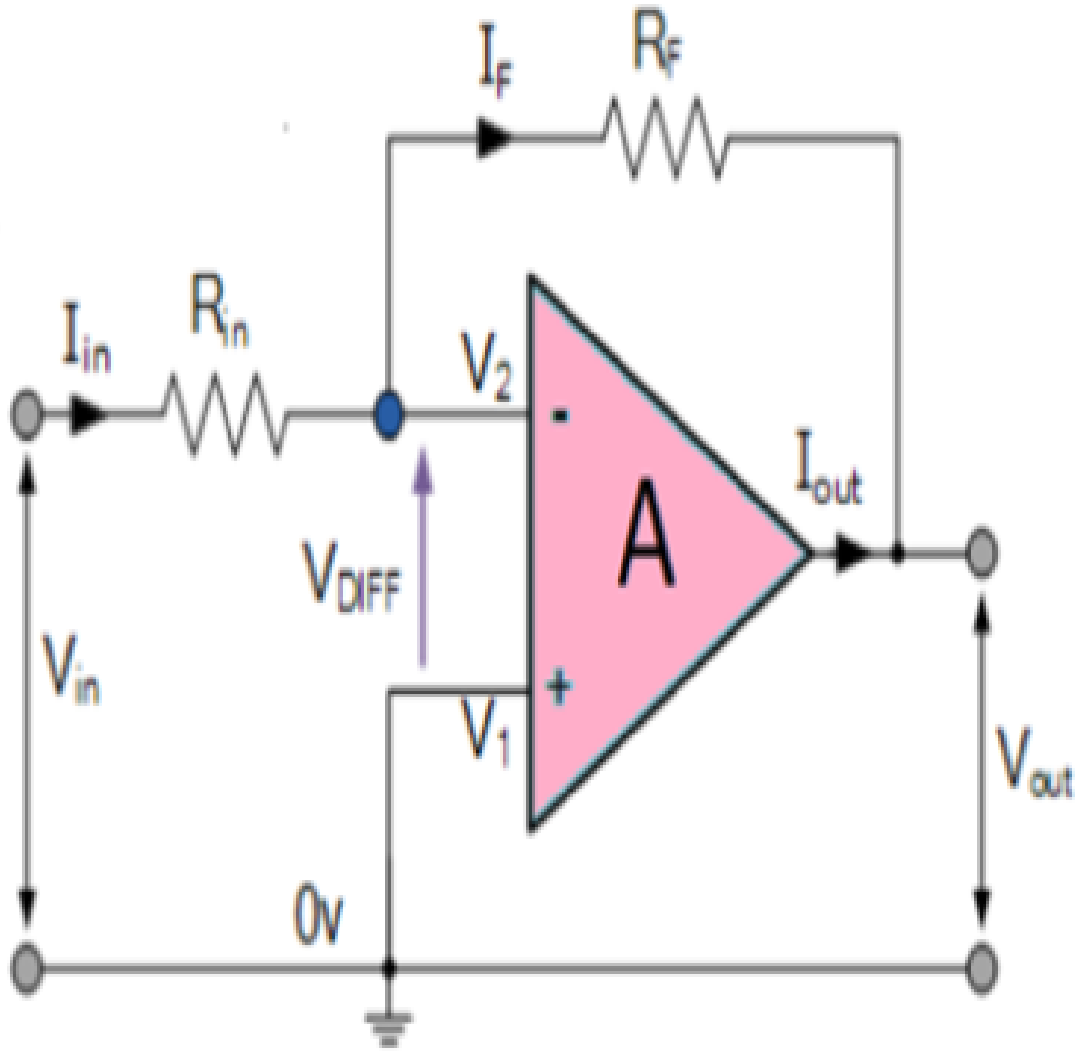

Figure 2: Inverting Operational Amplifier Circuit Diagram

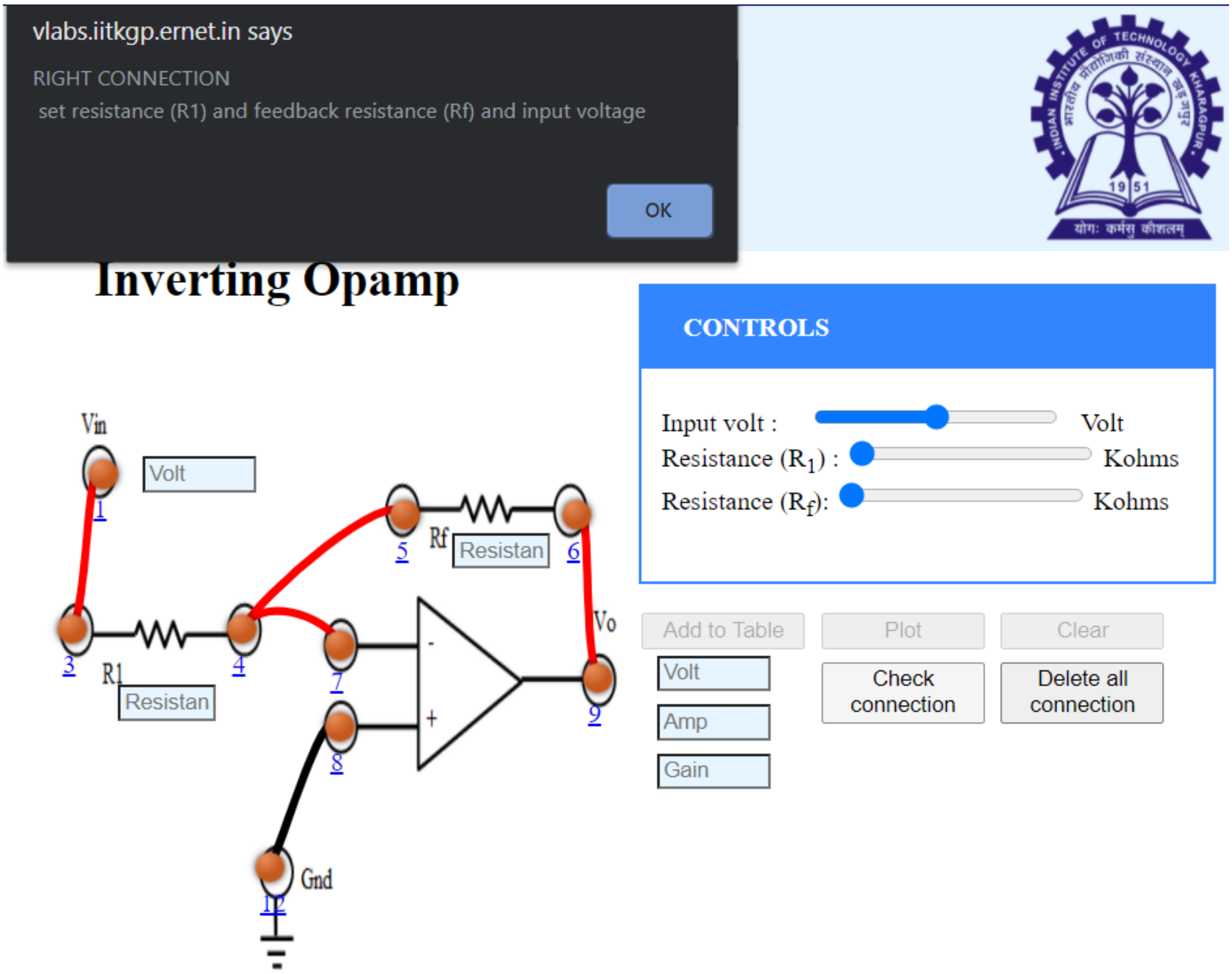

Figure 3: Connections

Input Voltage (V)	Output Voltage (V)	Current (mA)
-15	30	-0.0882
-13	26	-0.0765
-11	22	-0.0647
-9	18	-0.0529
-7	14	-0.0412
-5	10	-0.0294
-3	6	-0.0176
-1	2	-0.00588
1	-2	0.00588
3	-6	0.0176
5	-10	0.0294
7	-14	0.0412
9	-18	0.0529
11	-22	0.0648
13	-26	0.0765
15	-30	0.0882

Figure 4: Observation table for $R_i = 5K\Omega$ and $R_f = 10K\Omega$

X axis: 1unit = 2V, Y axis: 1unit = 5V

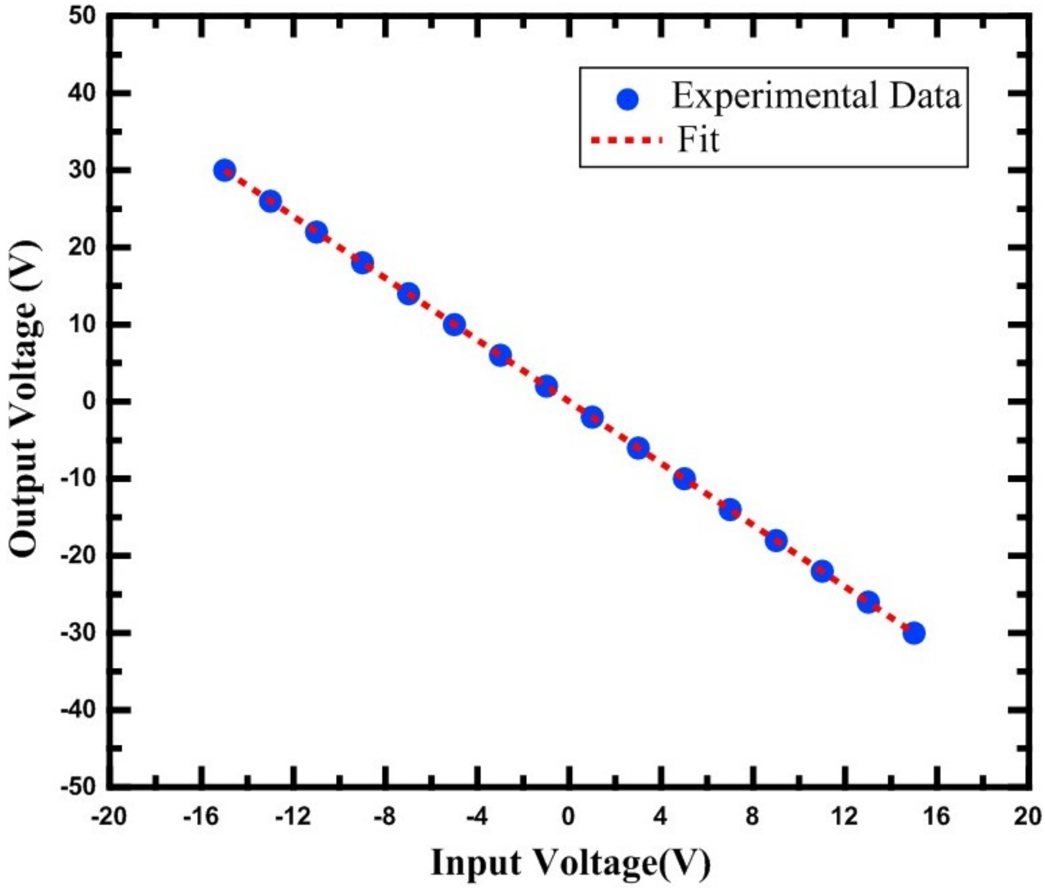

Figure 5: Graph for $R_i = 5K\Omega$ and $R_f = 10K\Omega$

The close loop gain (A_{cl}) is given by :- A_{cl}=V_{out}/V_{in} =$-R_f/R_i$

1. $A_{cl} = V_{out}/V_{in} = 30V/(-15)V = -2$

2. $A_{cl} = -R_f/R_i = -(10K\Omega/5K\Omega) = -2$

3. $V_{out} = -(R_f/R_i) * V_{in}$

For $V_{in} = -5V$
$V_{out} = -(10K\Omega/5K\Omega) * -5V = 10V$

Input Voltage (V)	Output Voltage (V)	Current (mA)
-15	30	-0.0441
-13	26	-0.0382
-11	22	-0.0324
-9	18	-0.0265
-7	14	-0.0206
-5	10	-0.0147
-3	6	-0.00882
-1	2	-0.00294
1	-2	0.00294
3	-6	0.00882
5	-10	0.0147
7	-14	0.0206
9	-18	0.0265
11	-22	0.0324
13	-26	0.0382
15	-30	0.0441

Figure 6: Observation table for $R_i = 10K\Omega$ and $R_f = 20K\Omega$

X axis: 1unit = 2V, Y axis: 1unit = 5V

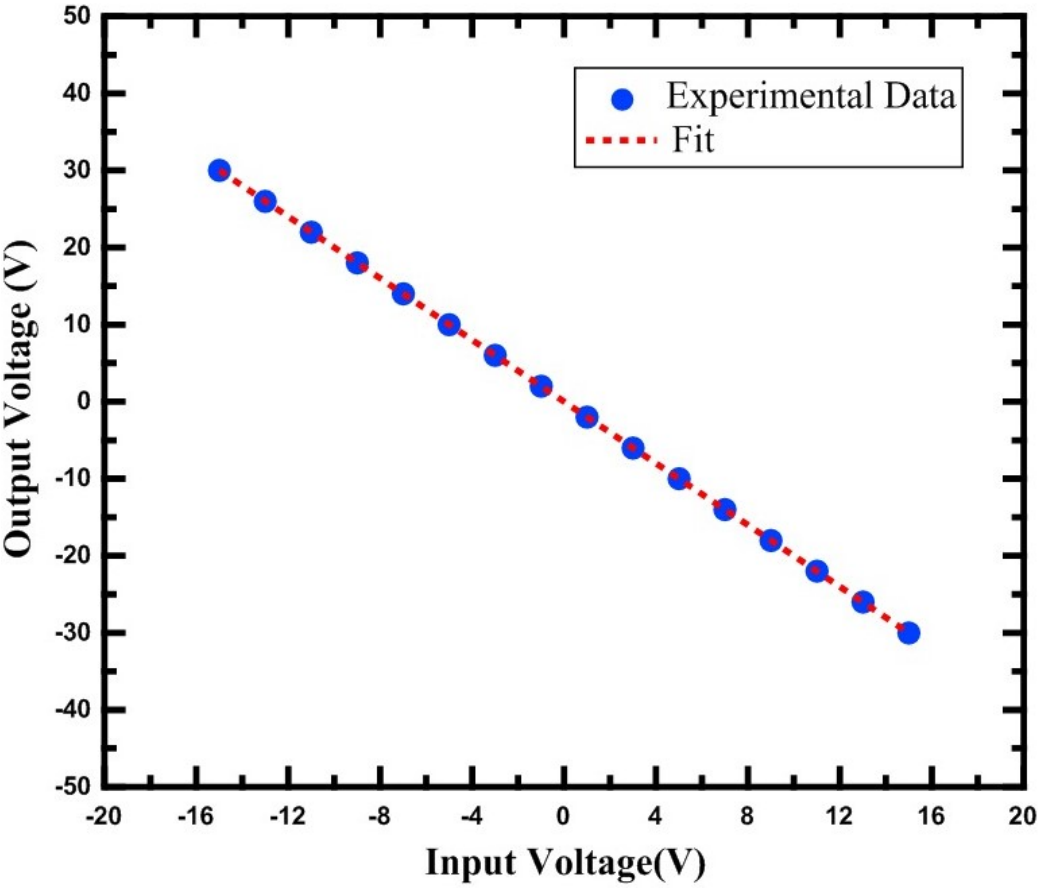

Figure 7: Graph for $R_i = 10K\Omega$ and $R_f = 20K\Omega$

The close loop gain (A_{cl}) is given by :- A_{cl}=V_{out}/V_{in} =$-R_f/R_i$

1. $A_{cl} = V_{out}/V_{in} = 30V/(-15)V = -2$

2. $A_{cl} = -R_f/R_i = -(20K\Omega/10K\Omega) = -2$

3. $V_{out} = -(R_f/R_i) * V_{in}$

For $V_{in} = -3V$
$V_{out} = -(20K\Omega/10K\Omega) * -3V = 6V$

Input Voltage (V)	Output Voltage (V)	Current (mA)
-15	30	-0.0294
-13	26	-0.0255
-11	22	-0.0216
-9	18	-0.0176
-7	14	-0.0137
-5	10	-0.0098
-3	6	-0.00588
-1	2	-0.00196
1	-2	0.00196
3	-6	0.00588
5	-10	0.0098
7	-14	0.0137
9	-18	0.0176
11	-22	0.0216
13	-26	0.0255
15	-30	0.0294

Figure 8: Observation table for $R_i = 15K\Omega$ and $R_f = 30K\Omega$

X axis: 1unit = 2V, Y axis: 1unit = 5V

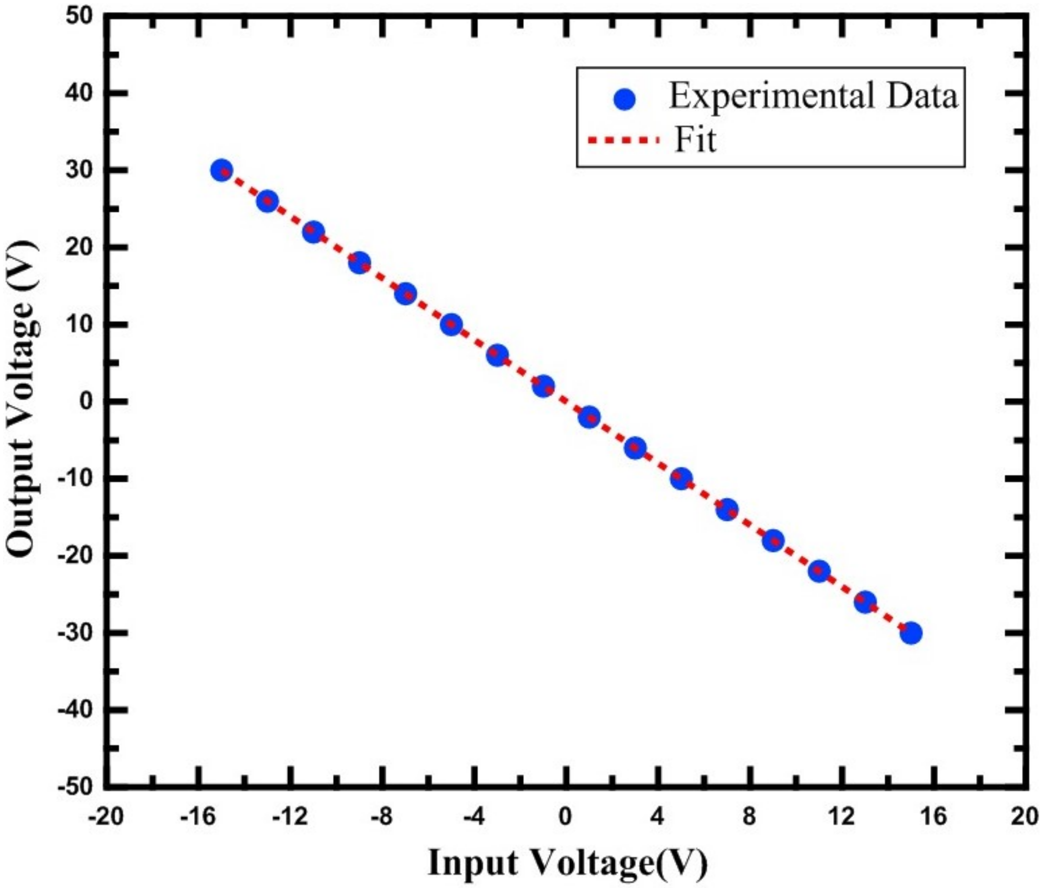

Figure 9: Graph for $R_i = 15K\Omega$ and $R_f = 30K\Omega$

The close loop gain (A_{cl}) is given by :- A_{cl}=V_{out}/V_{in} =$-R_f/R_i$

1. $A_{cl} = V_{out}/V_{in} = 30V/(-15)V = -2$

2. $A_{cl} = -R_f/R_i = -(30K\Omega/15K\Omega) = -2$

3. $V_{out} = -(R_f/R_i) * V_{in}$

For $V_{in} = 11V$
$V_{out} = -(30K\Omega/15K\Omega) * 11V = -22V$

Input Voltage (V)	Output Voltage (V)	Current (mA)
-15	30	-0.02205
-13	26	-0.01913
-11	22	-0.01618
-9	18	-0.01323
-7	14	-0.0103
-5	10	-0.00735
-3	6	-0.0044
-1	2	-0.00147
1	-2	0.00147
3	-6	0.0044
5	-10	0.00735
7	-14	0.0103
9	-18	0.01323
11	-22	0.0162
13	-26	0.01913
15	-30	0.02205

Figure 10: Observation table for $R_i = 20K\Omega$ and $R_f = 40K\Omega$

X axis: 1unit = 2V, Y axis: 1unit = 5V

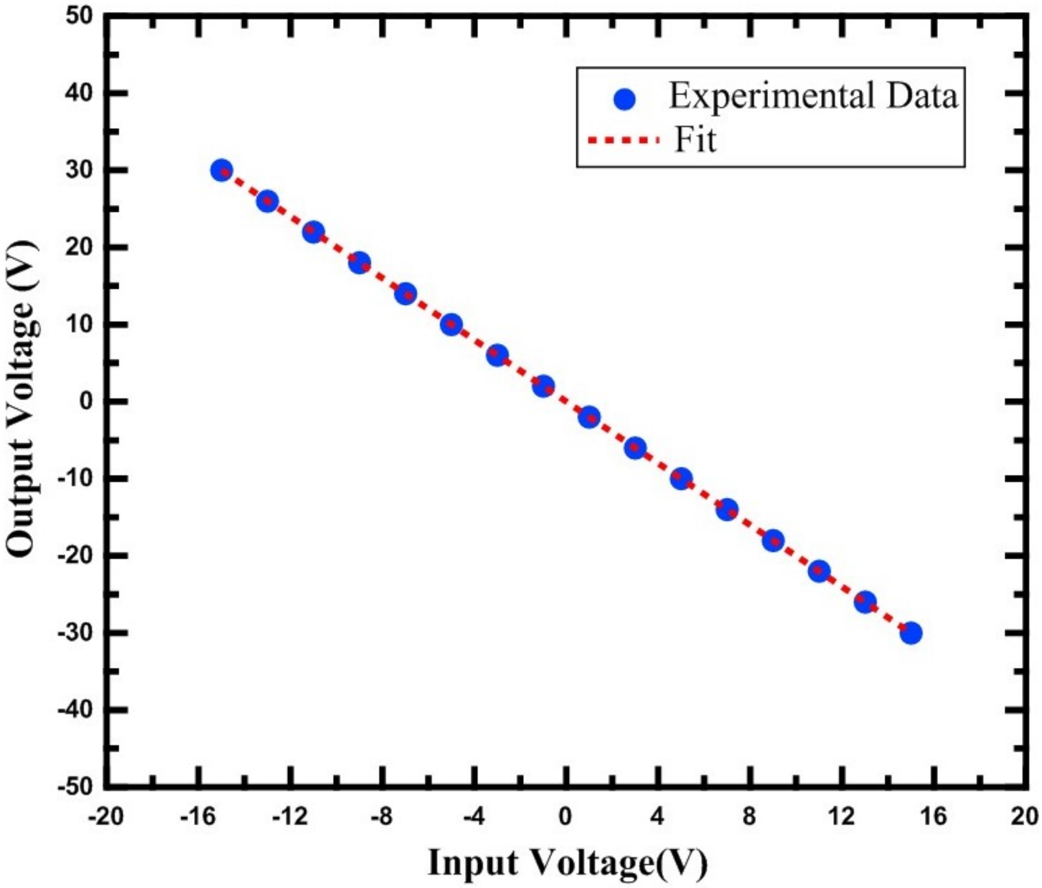

Figure 11: Graph for $R_i = 20K\Omega$ and $R_f = 40K\Omega$

The close loop gain (A_{cl}) is given by :- A_{cl}=V_{out}/V_{in} =$-R_f/R_i$

1. $A_{cl} = V_{out}/V_{in} = 30V/(-15)V = -2$

2. $A_{cl} = -R_f/R_i = -(40K\Omega/20K\Omega) = -2$

3. $V_{out} = -(R_f/R_i) * V_{in}$

For $V_{in} = -5V$
$V_{out} = -(40K\Omega/20K\Omega) * -5V = 10V$

Input Voltage (V)	Output Voltage (V)	Current (mA)
-15	30	-0.01764
-13	26	-0.0153
-11	22	-0.01294
-9	18	-0.01058
-7	14	-0.00824
-5	10	-0.00588
-3	6	-0.00352
-1	2	-0.00118
1	-2	0.00118
3	-6	0.00352
5	-10	0.00588
7	-14	0.00824
9	-18	0.01058
11	-22	0.01296
13	-26	0.0153
15	-30	0.01764

Figure 12: Observation table for $R_i = 25K\Omega$ and $R_f = 50K\Omega$

X axis: 1unit = 2V, Y axis: 1unit = 5V

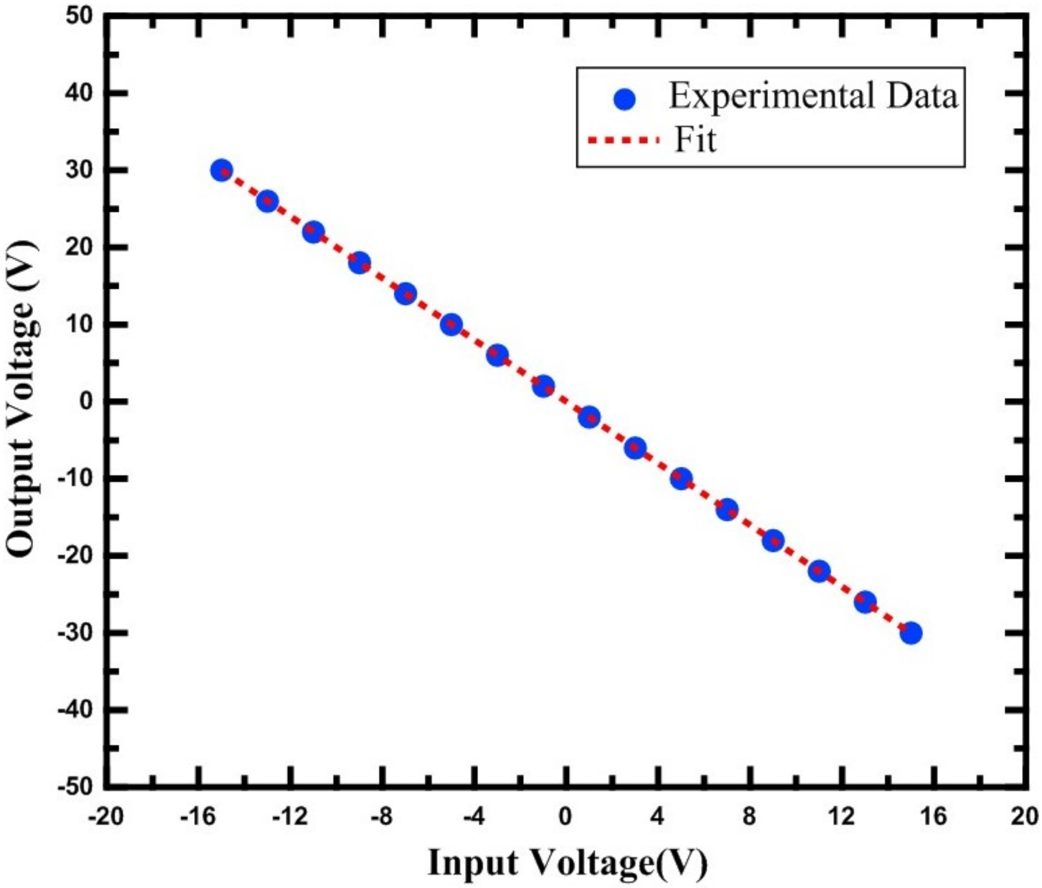

Figure 13: Graph for $R_i = 25K\Omega$ and $R_f = 50K\Omega$

The close loop gain (A_{cl}) is given by :- A_{cl}=V_{out}/V_{in} =$-R_f/R_i$

1. $A_{cl} = V_{out}/V_{in} = 30V/(-15)V = -2$

2. $A_{cl} = -R_f/R_i = -(50K\Omega/25K\Omega) = -2$

3. $V_{out} = -(R_f/R_i) * V_{in}$

For $V_{in} = -1V$
$V_{out} = -(50K\Omega/25K\Omega) * -1V = 2V$

Input Voltage (V)	Output Voltage (V)	Current (mA)
-15	30	-0.0147
-13	26	-0.01275
-11	22	-0.01078
-9	18	-0.00882
-7	14	-0.00687
-5	10	-0.0049
-3	6	-0.00293
-1	2	-0.00098
1	-2	0.00098
3	-6	0.00293
5	-10	0.0049
7	-14	0.00687
9	-18	0.00882
11	-22	0.0108
13	-26	0.01275
15	-30	0.0147

Figure 14: Observation table for $R_i = 30K\Omega$ and $R_f = 60K\Omega$

X axis: 1unit = 2V, Y axis: 1unit = 5V

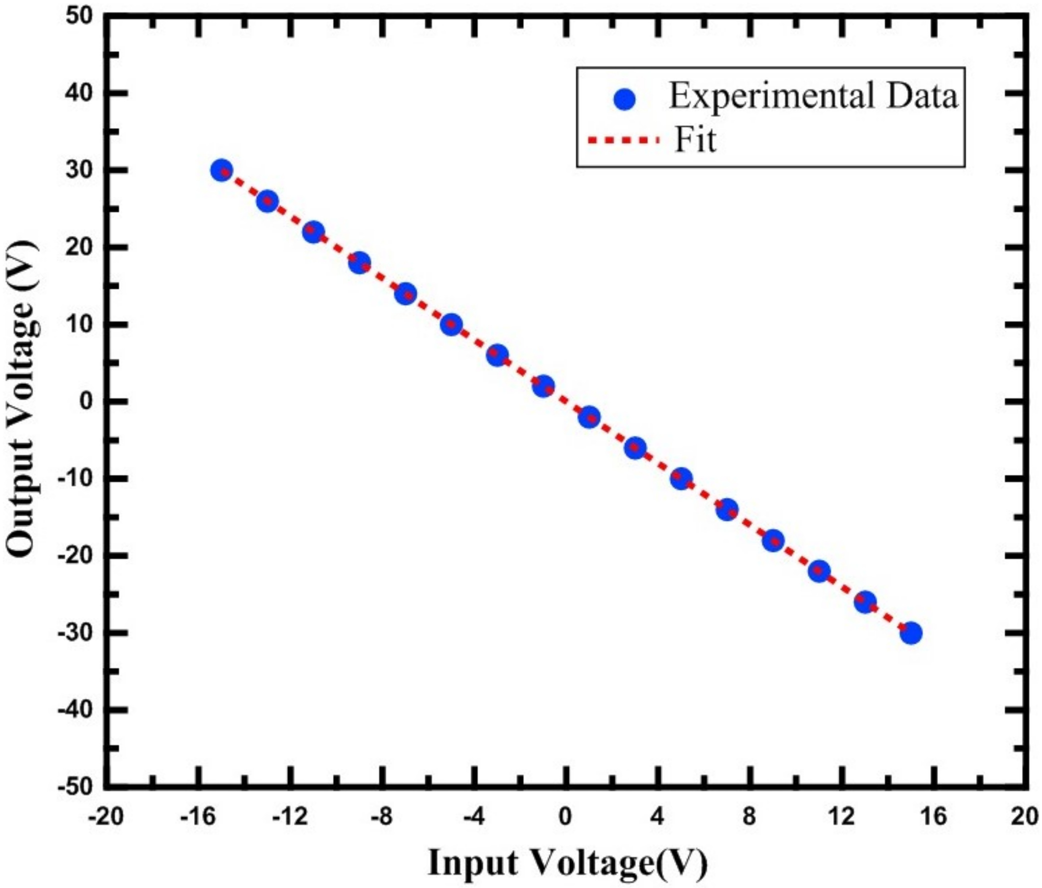

Figure 15: Graph for $R_i = 30K\Omega$ and $R_f = 60K\Omega$

The close loop gain (A_{cl}) is given by :- A_{cl}=V_{out}/V_{in} =$-R_f/R_i$

1. $A_{cl} = V_{out}/V_{in} = 30V/(-15)V = -2$

2. $A_{cl} = -R_f/R_i = -(60K\Omega/30K\Omega) = -2$

3. $V_{out} = -(R_f/R_i) * V_{in}$

For $V_{in} = 5V$
$V_{out} = -(60K\Omega/30K\Omega) * 5V = -10V$

Input Voltage (V)	Output Voltage (V)	Current (mA)
-15	30	-0.0126
-13	26	-0.01093
-11	22	-0.00924
-9	18	-0.00756
-7	14	-0.00589
-5	10	-0.0042
-3	6	-0.00251
-1	2	-0.00084
1	-2	0.00084
3	-6	0.00251
5	-10	0.0042
7	-14	0.00589
9	-18	0.00756
11	-22	0.00926
13	-26	0.01093
15	-30	0.0126

Figure 16: Observation table for $R_i = 35K\Omega$ and $R_f = 70K\Omega$

X axis: 1unit = 2V, Y axis: 1unit = 5V

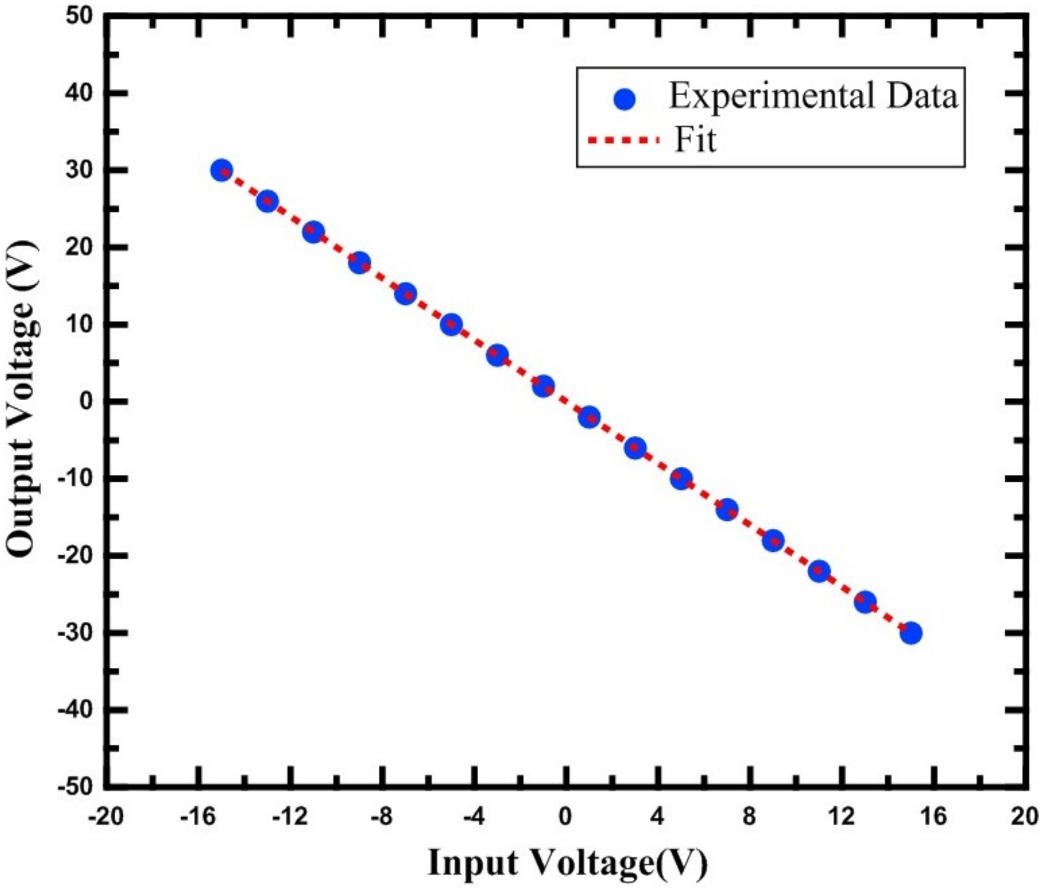

Figure 17: Graph for $R_i = 35K\Omega$ and $R_f = 70K\Omega$

The close loop gain (A_{cl}) is given by :- A_{cl}=V_{out}/V_{in} =$-R_f/R_i$

1. $A_{cl} = V_{out}/V_{in} = 30V/(-15)V = -2$

2. $A_{cl} = -R_f/R_i = -(70K\Omega/35K\Omega) = -2$

3. $V_{out} = -(R_f/R_i) * V_{in}$

For $V_{in} = -3V$
$V_{out} = -(70K\Omega/35K\Omega) * -3V = 6V$

Input Voltage (V)	Output Voltage (V)	Current (mA)
-15	30	-0.01103
-13	26	-0.00956
-11	22	-0.00809
-9	18	-0.00661
-7	14	-0.00515
-5	10	-0.00368
-3	6	-0.0022
-1	2	-0.00074
1	-2	0.00074
3	-6	0.0022
5	-10	0.00368
7	-14	0.00515
9	-18	0.00661
11	-22	0.0081
13	-26	0.00956
15	-30	0.01103

Figure 18: Observation table for $R_i = 40K\Omega$ and $R_f = 80K\Omega$

X axis: 1unit = 2V, Y axis: 1unit = 5V

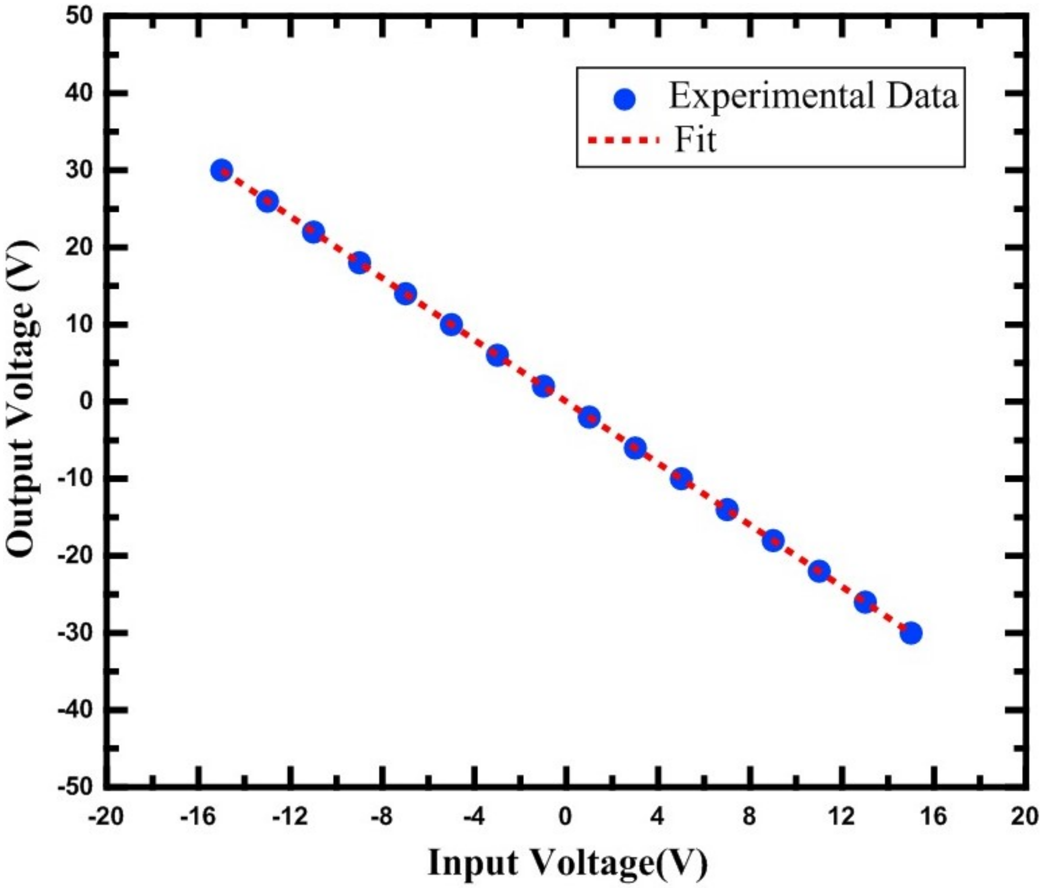

Figure 19: Graph for $R_i = 40K\Omega$ and $R_f = 80K\Omega$

The close loop gain (A_{cl}) is given by :- A_{cl}=V_{out}/V_{in} =$-R_f/R_i$

1. $A_{cl} = V_{out}/V_{in} = 30V/(-15)V = -2$

2. $A_{cl} = -R_f/R_i = -(80K\Omega/40K\Omega) = -2$

3. $V_{out} = -(R_f/R_i) * V_{in}$

For $V_{in} = -5V$
$V_{out} = -(80K\Omega/40K\Omega) * -5V = 10V$

Input Voltage (V)	Output Voltage (V)	Current (mA)
-15	30	-0.0098
-13	26	-0.0085
-11	22	-0.00719
-9	18	-0.00588
-7	14	-0.00458
-5	10	-0.00327
-3	6	-0.00196
-1	2	-0.00065
1	-2	0.00065
3	-6	0.00196
5	-10	0.00327
7	-14	0.00458
9	-18	0.00588
11	-22	0.0072
13	-26	0.0085
15	-30	0.0098

Figure 20: Observation table for $R_i = 45K\Omega$ and $R_f = 90K\Omega$

X axis: 1unit = 2V, Y axis: 1unit = 5V

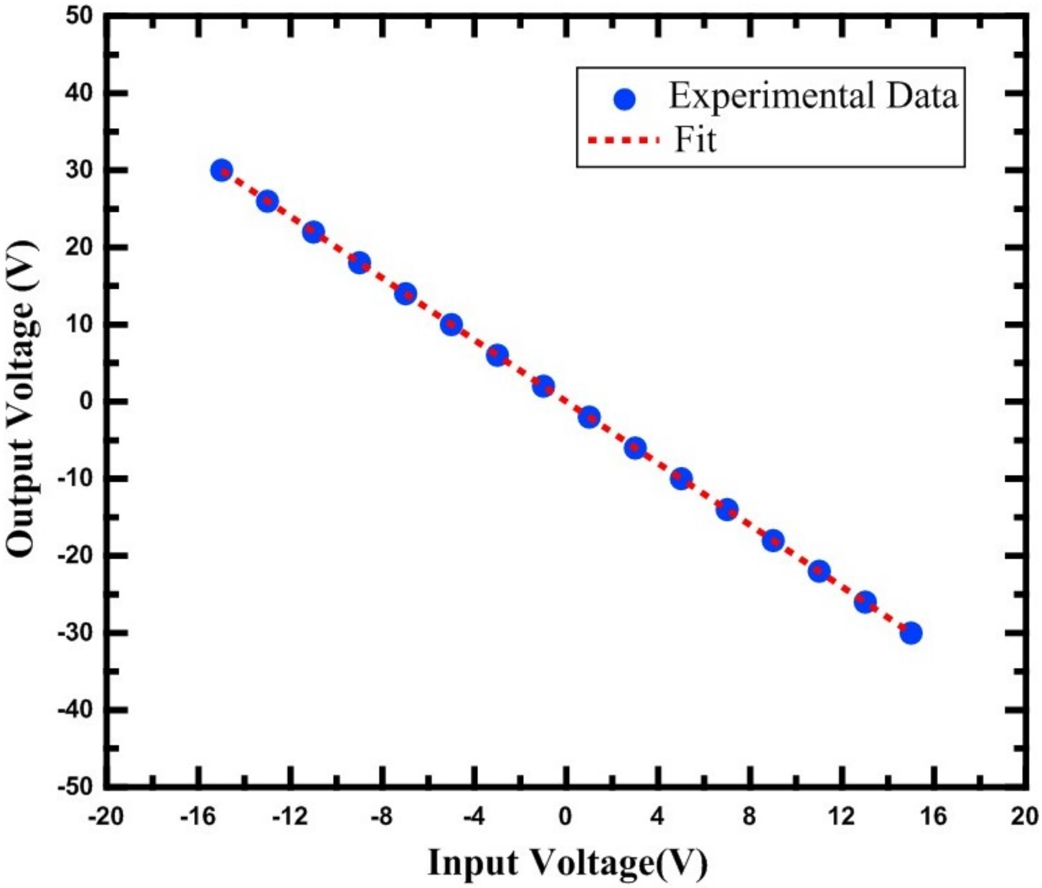

Figure 21: Graph for $R_i = 45K\Omega$ and $R_f = 90K\Omega$

The close loop gain (A_{cl}) is given by :- A_{cl}=V_{out}/V_{in} =$-R_f/R_i$

1. $A_{cl} = V_{out}/V_{in} = 30V/(-15)V = -2$

2. $A_{cl} = -R_f/R_i = -(90K\Omega/45K\Omega) = -2$

3. $V_{out} = -(R_f/R_i) * V_{in}$

For $V_{in} = -9V$
$V_{out} = -(90K\Omega/45K\Omega) * -9V = 18V$

Input Voltage (V)	Output Voltage (V)	Current (mA)
-15	30	-0.00882
-13	26	-0.00765
-11	22	-0.00647
-9	18	-0.00529
-7	14	-0.00412
-5	10	-0.00294
-3	6	-0.00176
-1	2	-0.00059
1	-2	0.00059
3	-6	0.00176
5	-10	0.00294
7	-14	0.00412
9	-18	0.00529
11	-22	0.00648
13	-26	0.00765
15	-30	0.00882

Figure 22: Observation table for $R_i = 50K\Omega$ and $R_f = 100K\Omega$

X axis: 1unit = 2V, Y axis: 1unit = 5V

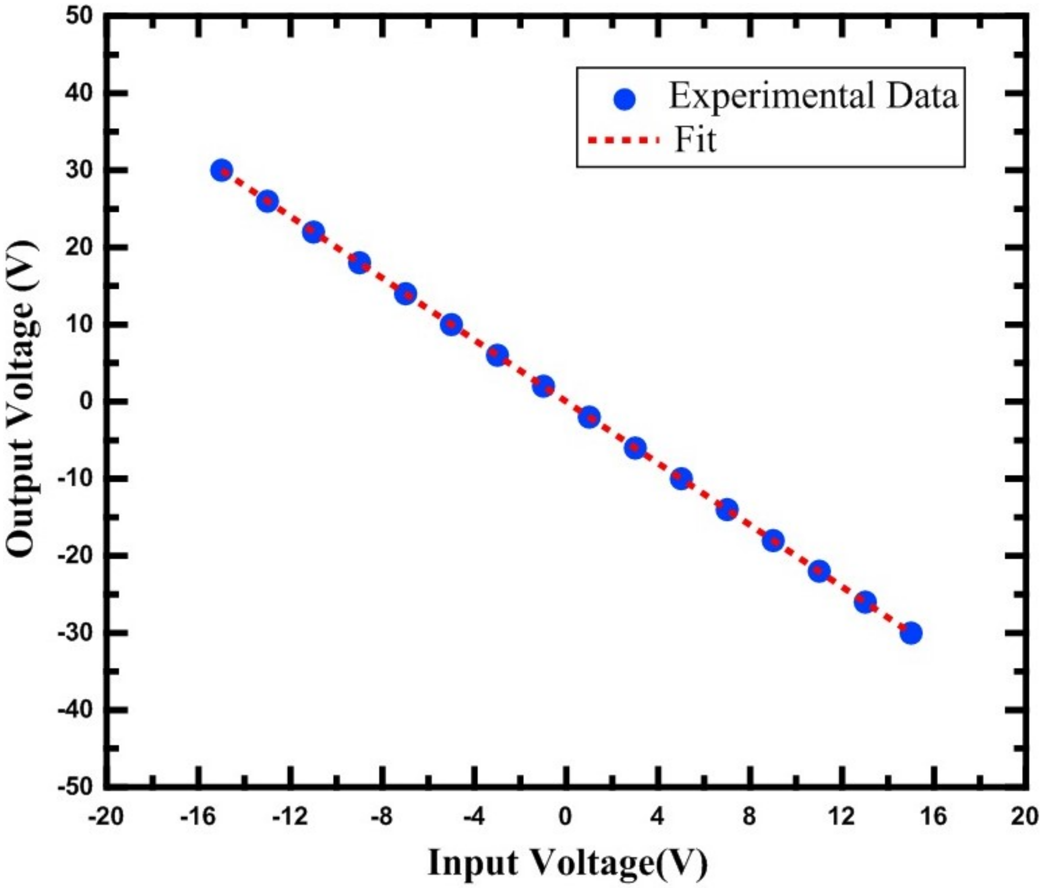

Figure 23: Graph for $R_i = 50K\Omega$ and $R_f = 100K\Omega$

The close loop gain (A_{cl}) is given by :- A_{cl}=V_{out}/V_{in} =$-R_f/R_i$

1. $A_{cl} = V_{out}/V_{in} = 30V/(-15)V = -2$

2. $A_{cl} = -R_f/R_i = -(100K\Omega/50K\Omega) = -2$

3. $V_{out} = -(R_f/R_i) * V_{in}$

For $V_{in} = -7V$
$V_{out} = -(100K\Omega/50K\Omega) * -7V = 14V$

Study of basic properties of Operational Amplifier: Inverting and Non-Inverting Amplifiers

Part 2 :- Non - Inverting Operational Amplifier

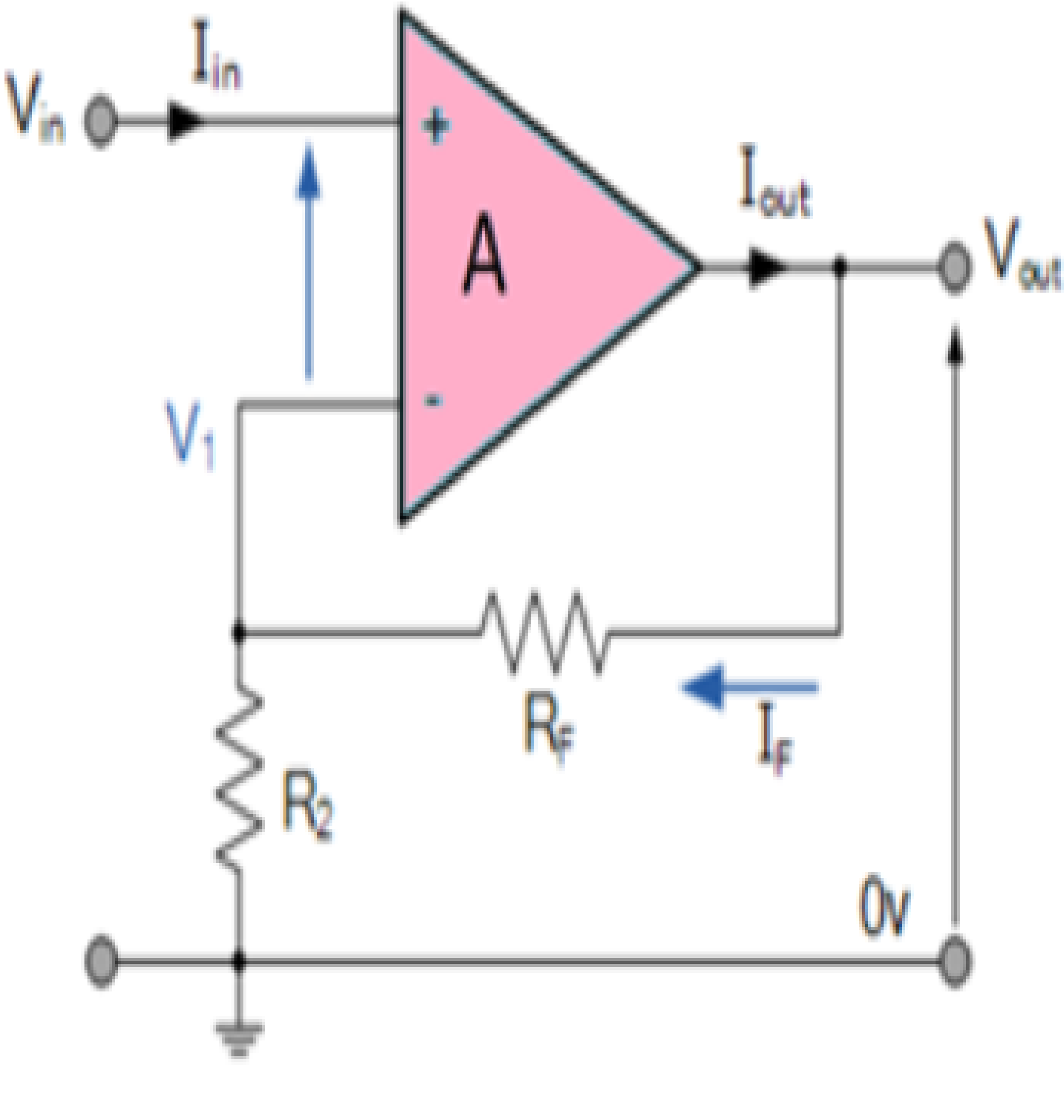

Figure 1: Non - Inverting Operational Amplifier Circuit Diagram

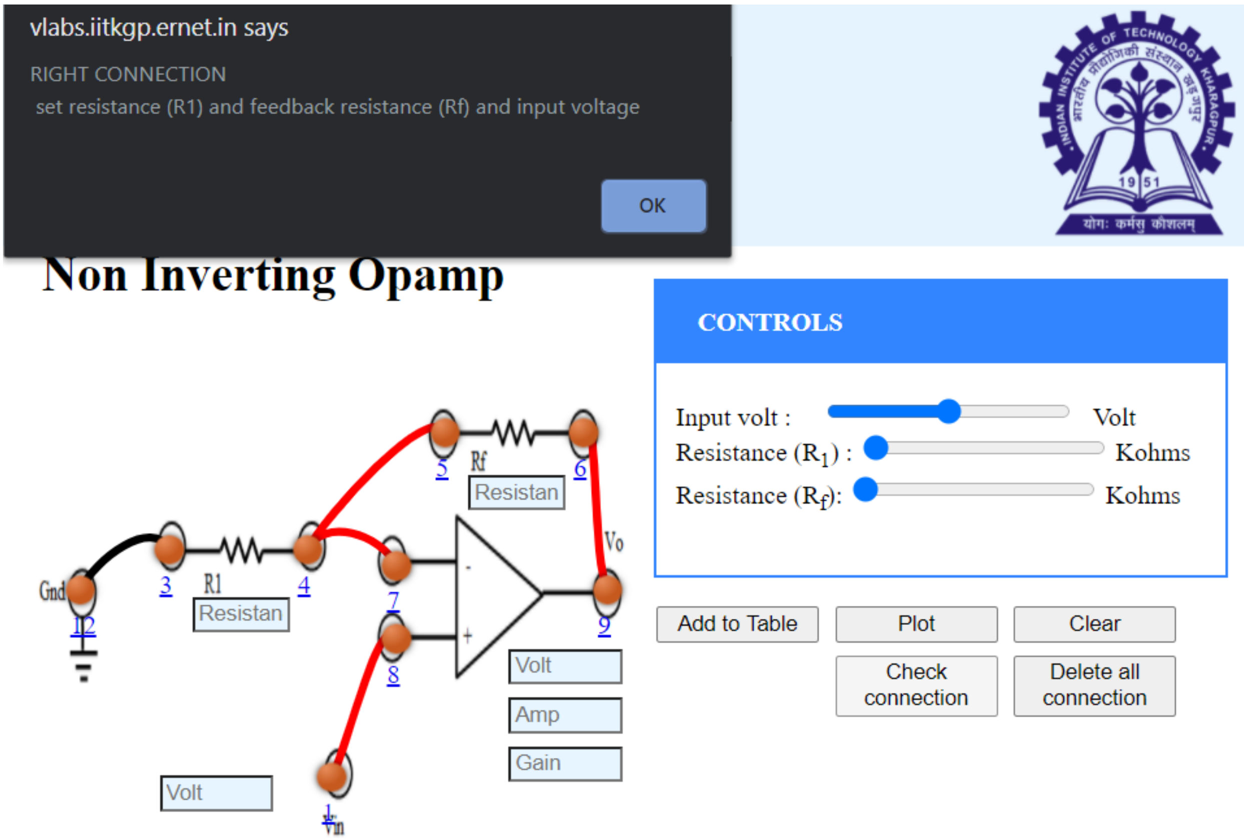

Figure 2: Connections

Input Voltage (V)	Output Voltage (V)	Current (mA)
-15	-45	NaN
-13	-39	NaN
-11	-33	NaN
-9	-27	NaN
-7	-21	NaN
-5	-15	NaN
-3	-9	NaN
-1	-3	NaN
1	3	0.0255
3	9	0.0765
5	15	1.01
7	21	1.41
9	27	1.82
11	33	2.22
13	39	2.63
15	45	3.03

Figure 3: Observation table for $R_i = 5K\Omega$ and $R_f = 10K\Omega$

X axis: 1unit = 2V, Y axis: 1unit = 5V

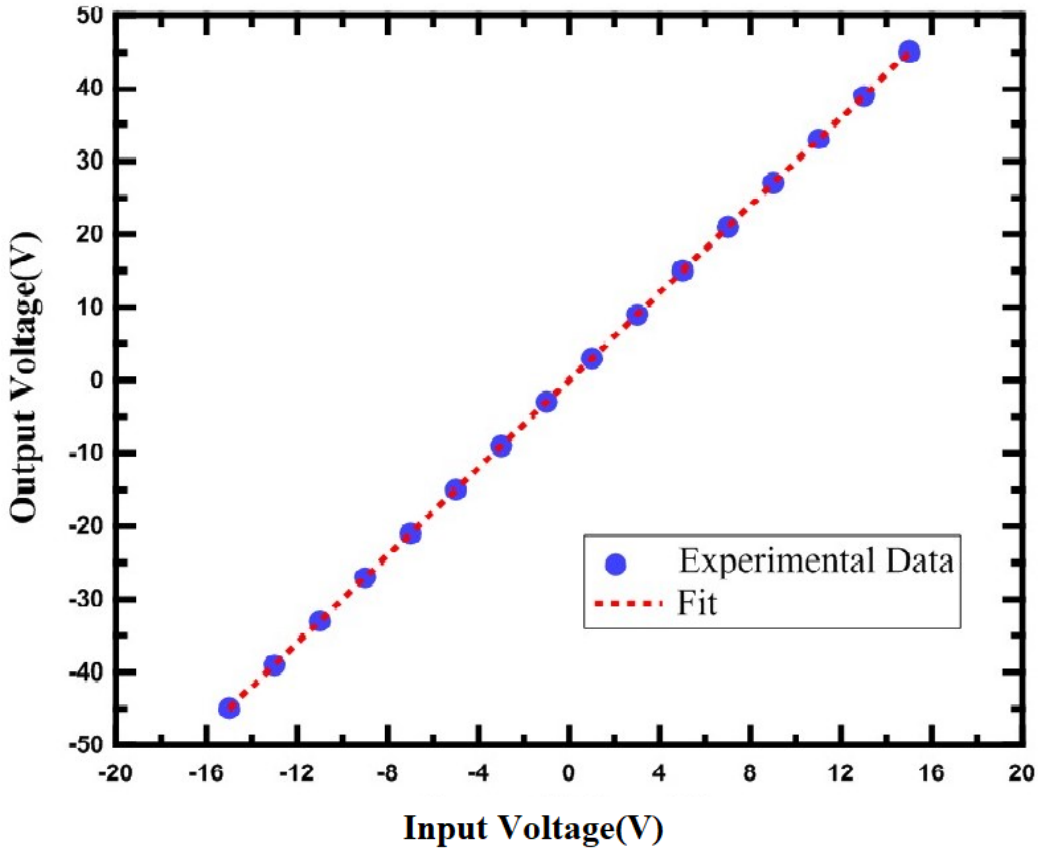

Figure 4: Graph for $R_i = 5K\Omega$ and $R_f = 10K\Omega$

The close loop gain (A_{cl}) is given by :- A_{cl}=V_{out}/V_{in} =$1 + R_f/R_i$

1. $A_{cl} = V_{out}/V_{in} = -45V/(-15)V = 3$

2. A_{cl} =$1 + R_f/R_i = (1 + 10K\Omega/5K\Omega) = 3$

3. $V_{out} = V_{in} * (1 + R_f/R_i)$

For $V_{in} = -3V$
$V_{out} = -3V * (1 + 10K\Omega/5K\Omega) = -9V$

Input Voltage (V)	Output Voltage (V)	Current (mA)
-15	-45	NaN
-13	-39	NaN
-11	-33	NaN
-9	-27	NaN
-7	-21	NaN
-5	-15	NaN
-3	-9	NaN
-1	-3	NaN
1	3	0.0127
3	9	0.0382
5	15	0.505
7	21	0.707
9	27	0.909
11	33	1.11
13	39	1.31
15	45	1.51

Figure 5: Observation table for $R_i = 10K\Omega$ and $R_f = 20K\Omega$

X axis: 1unit = 2V, Y axis: 1unit = 5V

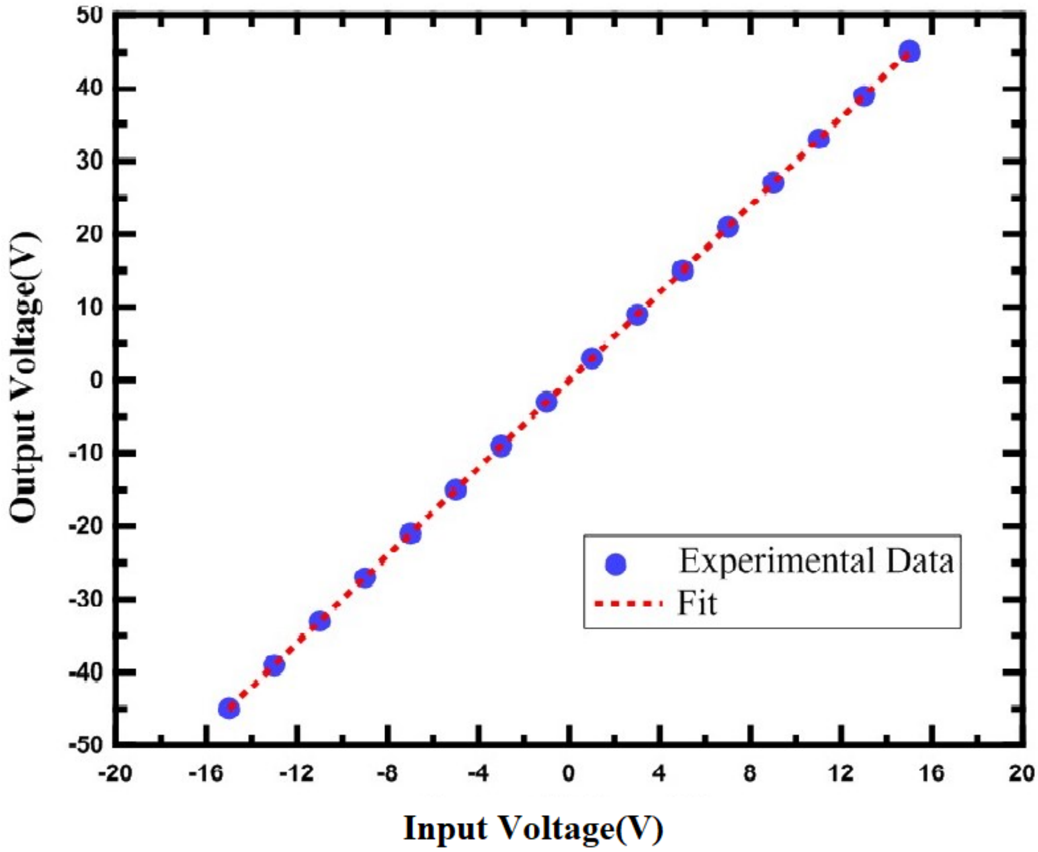

Figure 6: Graph for $R_i = 10K\Omega$ and $R_f = 20K\Omega$

The close loop gain (A_{cl}) is given by :- A_{cl}=V_{out}/V_{in} =$1 + R_f/R_i$

1. $A_{cl} = V_{out}/V_{in} = -39V/(-13)V = 3$

2. A_{cl} =$1 + R_f/R_i = (1 + 20K\Omega/10K\Omega) = 3$

3. $V_{out} = V_{in} * (1 + R_f/R_i)$

For $V_{in} = -9V$
$V_{out} = -9V * (1 + 20K\Omega/10K\Omega) = -27V$

Input Voltage (V)	Output Voltage (V)	Current (mA)
-15	-45	NaN
-13	-39	NaN
-11	-33	NaN
-9	-27	NaN
-7	-21	NaN
-5	-15	NaN
-3	-9	NaN
-1	-3	NaN
1	3	0.0085
3	9	0.0255
5	15	0.337
7	21	0.471
9	27	0.606
11	33	0.741
13	39	0.875
15	45	1.01

Figure 7: Observation table for $R_i = 15K\Omega$ and $R_f = 30K\Omega$

X axis: 1unit = 2V, Y axis: 1unit = 5V

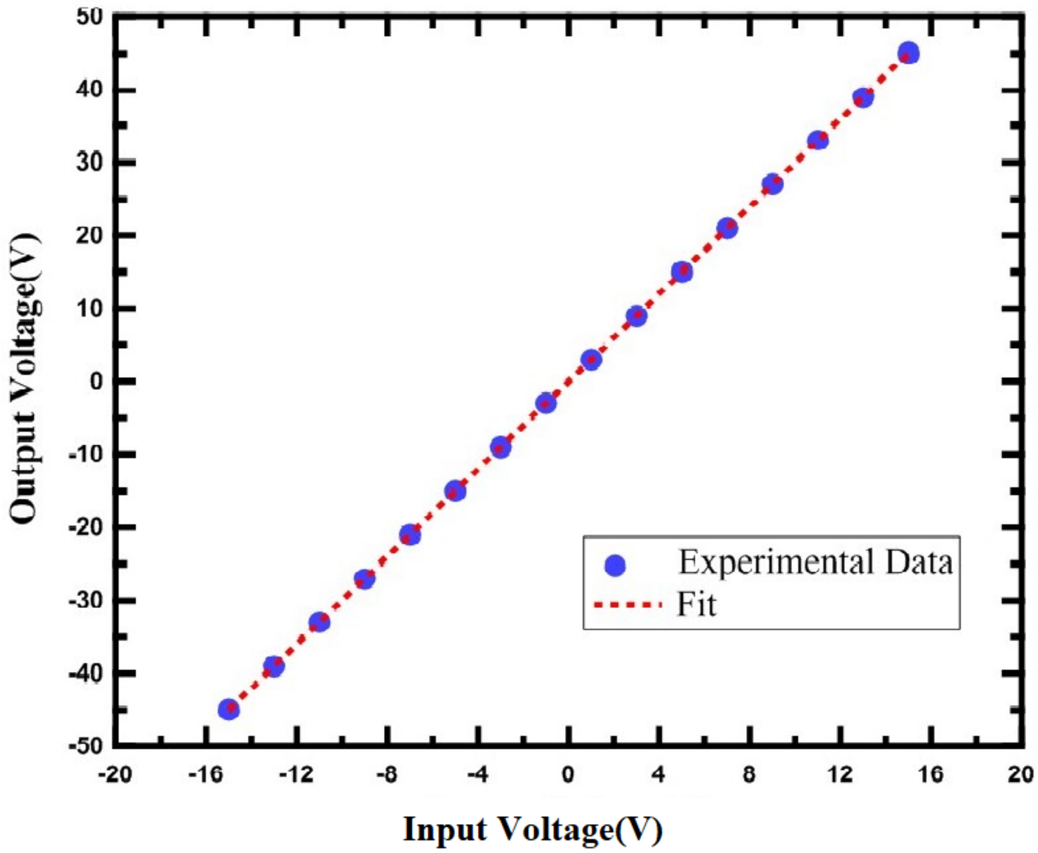

Figure 8: Graph for $R_i = 15K\Omega$ and $R_f = 30K\Omega$

The close loop gain (A_{cl}) is given by :- A_{cl}=V_{out}/V_{in} =$1 + R_f/R_i$

1. $A_{cl} = V_{out}/V_{in} = -33V/(-11)V = 3$

2. A_{cl} =$1 + R_f/R_i = (1 + 30K\Omega/15K\Omega) = 3$

3. $V_{out} = V_{in} * (1 + R_f/R_i)$

For $V_{in} = -7V$
$V_{out} = -7V * (1 + 30K\Omega/15K\Omega) = -21V$

Input Voltage (V)	Output Voltage (V)	Current (mA)
-15	-45	NaN
-13	-39	NaN
-11	-33	NaN
-9	-27	NaN
-7	-21	NaN
-5	-15	NaN
-3	-9	NaN
-1	-3	NaN
1	3	0.0064
3	9	0.0191
5	15	0.2525
7	21	0.3525
9	27	0.455
11	33	0.555
13	39	0.6575
15	45	0.7575

Figure 9: Observation table for $R_i = 20K\Omega$ and $R_f = 40K\Omega$

X axis: 1unit = 2V, Y axis: 1unit = 5V

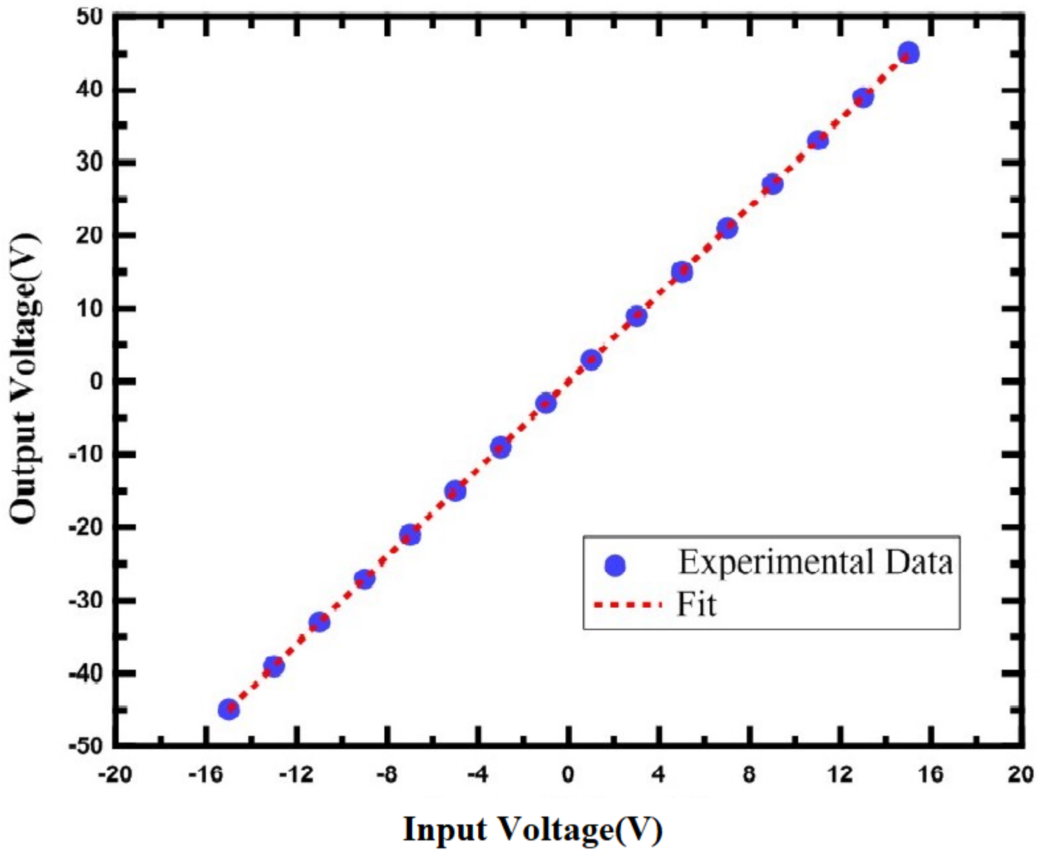

Figure 10: Graph for $R_i = 20K\Omega$ and $R_f = 40K\Omega$

The close loop gain (A_{cl}) is given by :- A_{cl}=V_{out}/V_{in} =$1 + R_f/R_i$

1. $A_{cl} = V_{out}/V_{in} = -27V/(-9)V = 3$

2. A_{cl} =$1 + R_f/R_i = (1 + 40K\Omega/20K\Omega) = 3$

3. $V_{out} = V_{in} * (1 + R_f/R_i)$

For $V_{in} = 5V$
$V_{out} = 5V * (1 + 40K\Omega/20K\Omega) = 15V$

Input Voltage (V)	Output Voltage (V)	Current (mA)
-15	-45	NaN
-13	-39	NaN
-11	-33	NaN
-9	-27	NaN
-7	-21	NaN
-5	-15	NaN
-3	-9	NaN
-1	-3	NaN
1	3	0.0051
3	9	0.0153
5	15	0.202
7	21	0.282
9	27	0.364
11	33	0.444
13	39	0.526
15	45	0.606

Figure 11: Observation table for $R_i = 25K\Omega$ and $R_f = 50K\Omega$

X axis: 1unit = 2V, Y axis: 1unit = 5V

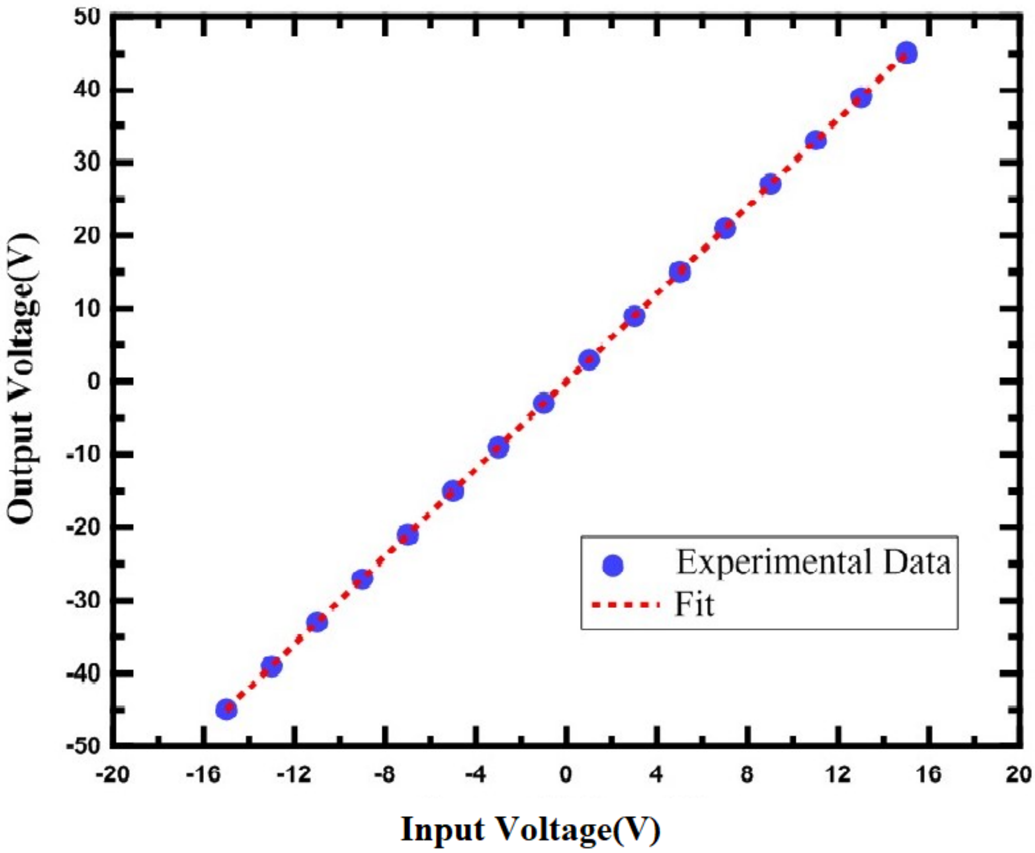

Figure 12: Graph for $R_i = 25K\Omega$ and $R_f = 50K\Omega$

The close loop gain (A_{cl}) is given by :- A_{cl}=V_{out}/V_{in} =$1 + R_f/R_i$

1. $A_{cl} = V_{out}/V_{in} = -21V/(-7)V = 3$

2. A_{cl} =$1 + R_f/R_i = (1 + 50K\Omega/25K\Omega) = 3$

3. $V_{out} = V_{in} * (1 + R_f/R_i)$

For $V_{in} = 3V$
$V_{out} = 3V * (1 + 50K\Omega/25K\Omega) = 9V$

Input Voltage (V)	Output Voltage (V)	Current (mA)
-15	-45	NaN
-13	-39	NaN
-11	-33	NaN
-9	-27	NaN
-7	-21	NaN
-5	-15	NaN
-3	-9	NaN
-1	-3	NaN
1	3	0.0043
3	9	0.0128
5	15	0.1683
7	21	0.235
9	27	0.3033
11	33	0.37
13	39	0.4383
15	45	0.505

Figure 13: Observation table for $R_i = 30K\Omega$ and $R_f = 60K\Omega$

X axis: 1unit = 2V, Y axis: 1unit = 5V

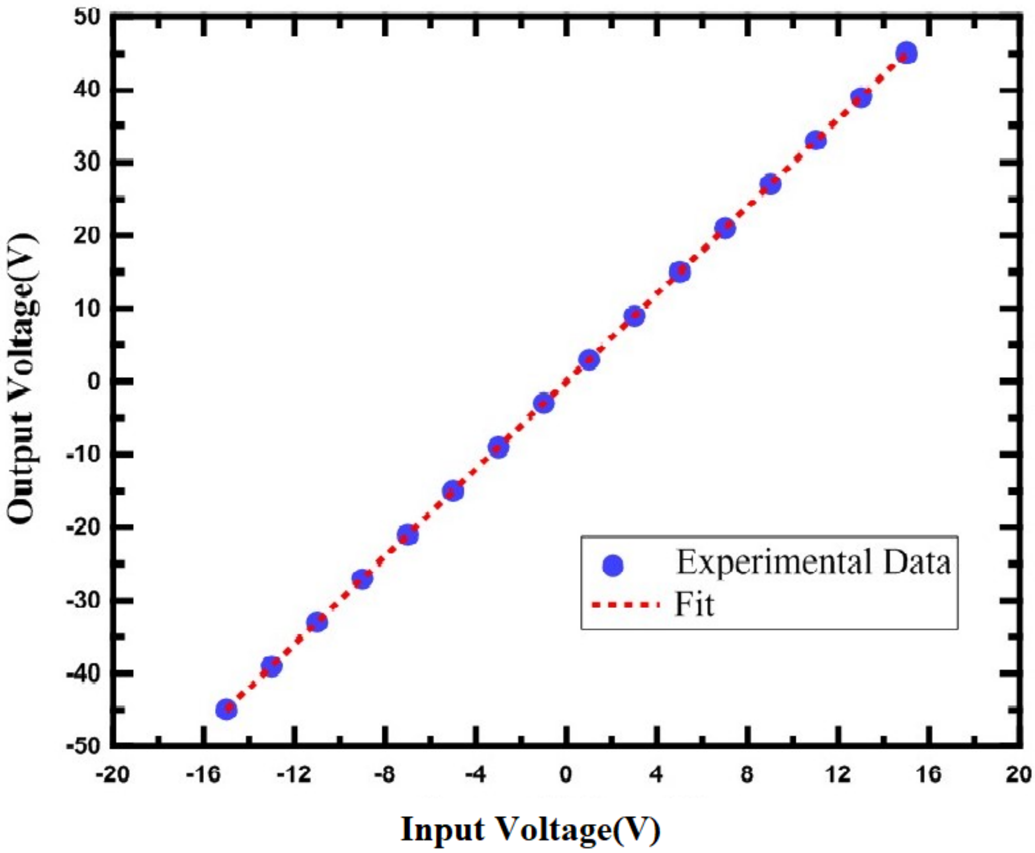

Figure 14: Graph for $R_i = 30K\Omega$ and $R_f = 60K\Omega$

The close loop gain (A_{cl}) is given by :- A_{cl}=V_{out}/V_{in} =$1 + R_f/R_i$

1. $A_{cl} = V_{out}/V_{in} = -15V/(-5)V = 3$

2. A_{cl} =$1 + R_f/R_i = (1 + 60K\Omega/30K\Omega) = 3$

3. $V_{out} = V_{in} * (1 + R_f/R_i)$

For $V_{in} = -13V$
$V_{out} = -13V * (1 + 60K\Omega/30K\Omega) = -39V$

Input Voltage (V)	Output Voltage (V)	Current (mA)
-15	-45	NaN
-13	-39	NaN
-11	-33	NaN
-9	-27	NaN
-7	-21	NaN
-5	-15	NaN
-3	-9	NaN
-1	-3	NaN
1	3	0.0036
3	9	0.0109
5	15	0.1443
7	21	0.2014
9	27	0.26
11	33	0.3171
13	39	0.3757
15	45	0.4329

Figure 15: Observation table for $R_i = 35K\Omega$ and $R_f = 70K\Omega$

X axis: 1unit = 2V, Y axis: 1unit = 5V

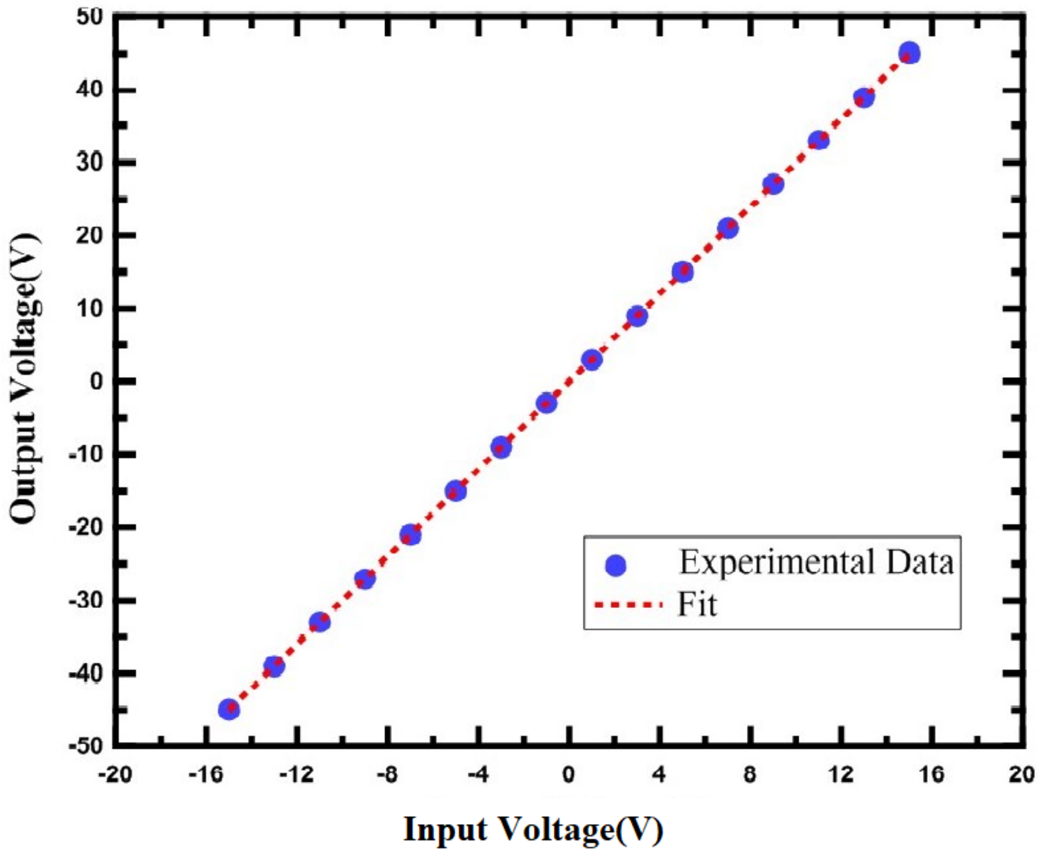

Figure 16: Graph for $R_i = 35K\Omega$ and $R_f = 70K\Omega$

The close loop gain (A_{cl}) is given by :- A_{cl}=V_{out}/V_{in} =$1 + R_f/R_i$

1. $A_{cl} = V_{out}/V_{in} = -9V/(-3)V = 3$

2. A_{cl} =$1 + R_f/R_i = (1 + 70K\Omega/35K\Omega) = 3$

3. $V_{out} = V_{in} * (1 + R_f/R_i)$

For $V_{in} = 11V$
$V_{out} = 11V * (1 + 70K\Omega/35K\Omega) = 33V$

Input Voltage (V)	Output Voltage (V)	Current (mA)
-15	-45	NaN
-13	-39	NaN
-11	-33	NaN
-9	-27	NaN
-7	-21	NaN
-5	-15	NaN
-3	-9	NaN
-1	-3	NaN
1	3	0.0032
3	9	0.0096
5	15	0.1263
7	21	0.1763
9	27	0.2275
11	33	0.2775
13	39	0.3288
15	45	0.3788

Figure 17: Observation table for $R_i = 40K\Omega$ and $R_f = 80K\Omega$

X axis: 1unit = 2V, Y axis: 1unit = 5V

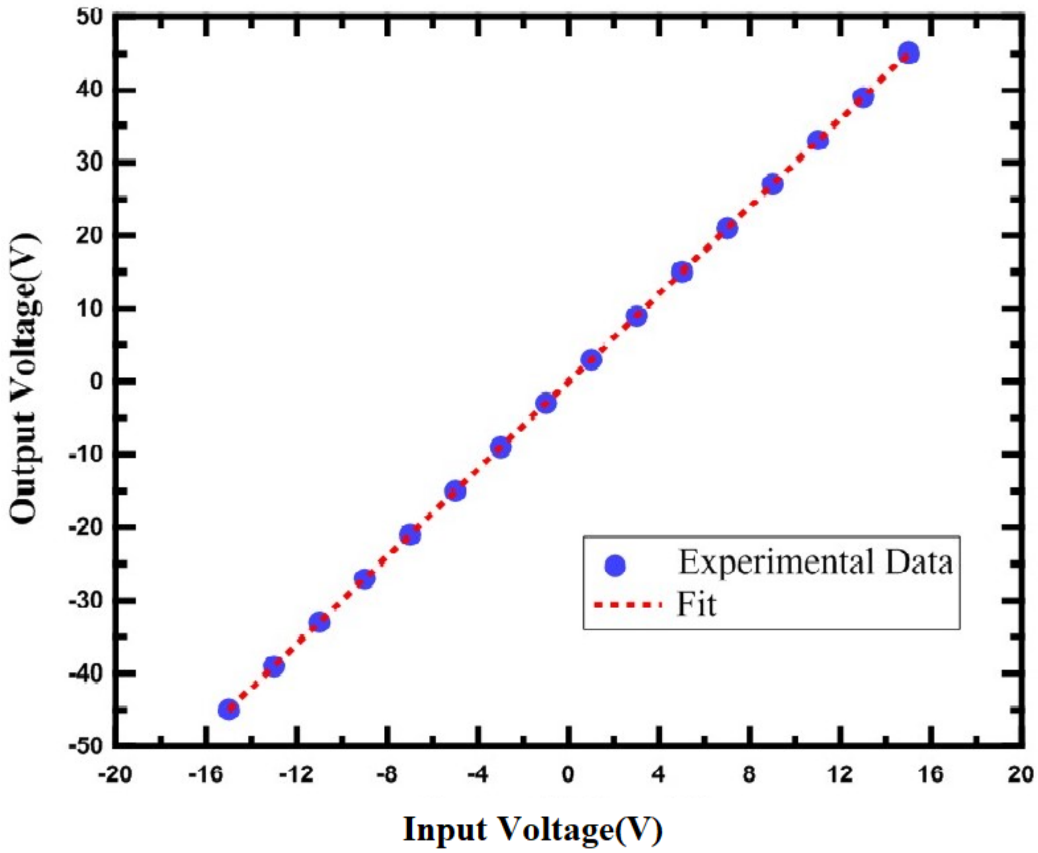

Figure 18: Graph for $R_i = 40K\Omega$ and $R_f = 80K\Omega$

The close loop gain (A_{cl}) is given by :- A_{cl}=V_{out}/V_{in} =$1 + R_f/R_i$

1. $A_{cl} = V_{out}/V_{in} = -3V/(-1)V = 3$

2. A_{cl} =$1 + R_f/R_i = (1 + 80K\Omega/40K\Omega) = 3$

3. $V_{out} = V_{in} * (1 + R_f/R_i)$

For $V_{in} = -11V$
$V_{out} = -11V * (1 + 80K\Omega/40K\Omega) = -33V$

Input Voltage (V)	Output Voltage (V)	Current (mA)
-15	-45	NaN
-13	-39	NaN
-11	-33	NaN
-9	-27	NaN
-7	-21	NaN
-5	-15	NaN
-3	-9	NaN
-1	-3	NaN
1	3	0.0028
3	9	0.0085
5	15	0.1122
7	21	0.1567
9	27	0.2022
11	33	0.2467
13	39	0.2922
15	45	0.3367

Figure 19: Observation table for $R_i = 45K\Omega$ and $R_f = 90K\Omega$

X axis: 1unit = 2V, Y axis: 1unit = 5V

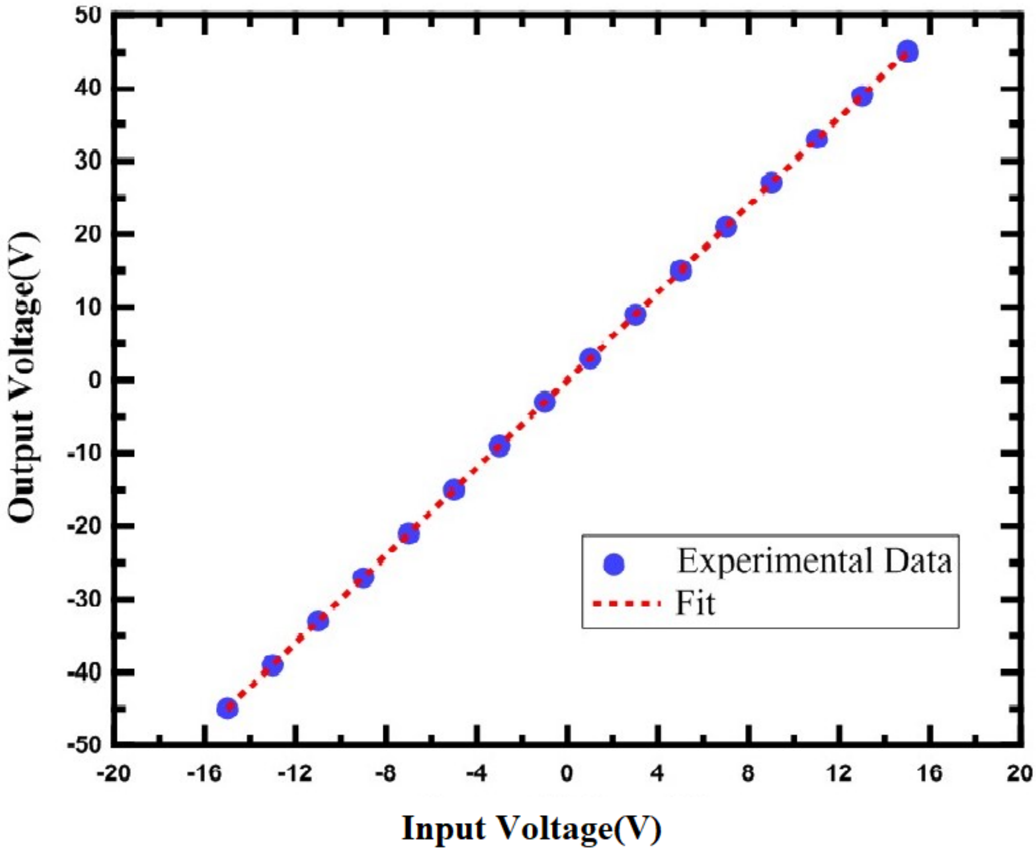

Figure 20: Graph for $R_i = 45K\Omega$ and $R_f = 90K\Omega$

The close loop gain (A_{cl}) is given by :- A_{cl}=V_{out}/V_{in} =$1 + R_f/R_i$

1. $A_{cl} = V_{out}/V_{in} = 27V/9V = 3$

2. A_{cl} =$1 + R_f/R_i = (1 + 90K\Omega/45K\Omega) = 3$

3. $V_{out} = V_{in} * (1 + R_f/R_i)$

For $V_{in} = -3V$
$V_{out} = -3V * (1 + 90K\Omega/45K\Omega) = -9V$

Input Voltage (V)	Output Voltage (V)	Current (mA)
-15	-45	NaN
-13	-39	NaN
-11	-33	NaN
-9	-27	NaN
-7	-21	NaN
-5	-15	NaN
-3	-9	NaN
-1	-3	NaN
1	3	0.0026
3	9	0.0077
5	15	0.101
7	21	0.141
9	27	0.182
11	33	0.222
13	39	0.263
15	45	0.303

Figure 21: Observation table for $R_i = 50K\Omega$ and $R_f = 100K\Omega$

X axis: 1unit = 2V, Y axis: 1unit = 5V

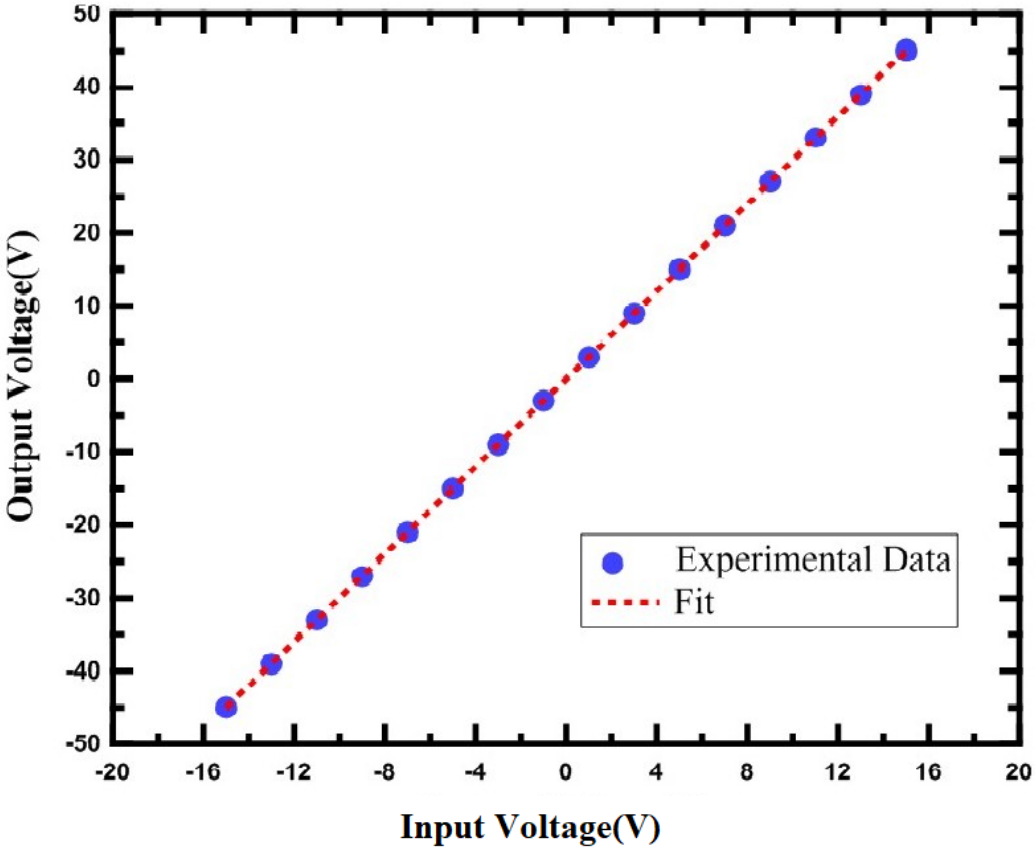

Figure 22: Graph for $R_i = 50K\Omega$ and $R_f = 100K\Omega$

The close loop gain (A_{cl}) is given by :- A_{cl}=V_{out}/V_{in} =$1 + R_f/R_i$

1. $A_{cl} = V_{out}/V_{in} = 33V/11V = 3$

2. A_{cl} =$1 + R_f/R_i = (1 + 100K\Omega/50K\Omega) = 3$

3. $V_{out} = V_{in} * (1 + R_f/R_i)$

For $V_{in} = 15V$
$V_{out} = 15V * (1 + 100K\Omega/50K\Omega) = 45V$