Experiment 02: Study of Transistor Characteristics

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1 Aim

To obtain the input and output characteristics of a transistor in CE configuration.

2 Theory

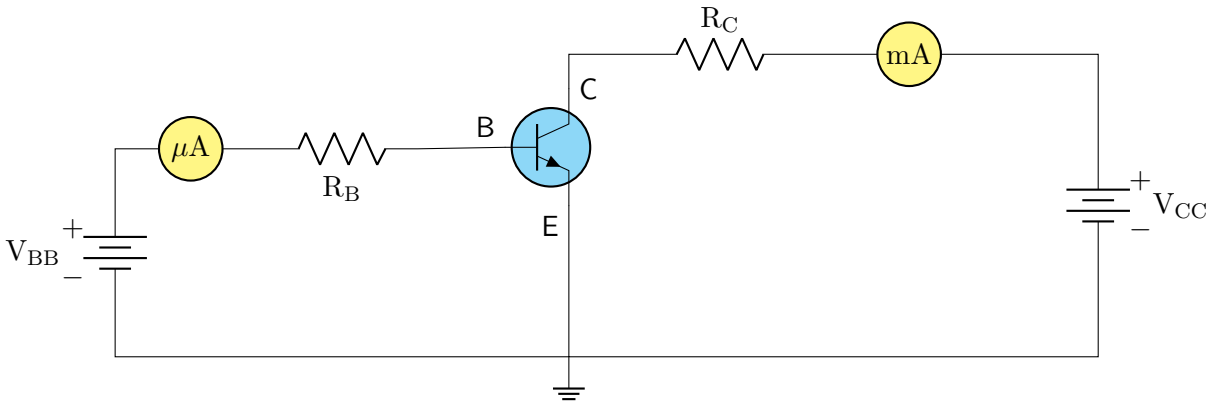

Figure 1: Circuit diagram of a common emitter configuration of a NPN transistor

2.1 Bipolar Junction Transistor (BJT)

It has been seen

2.2 Common Emitted Configuration of BJT

Hello world!

3 Data and Calculations

3.1 Input Characteristics

The following tables show the data obtained for the input characteristics of the transistor in CE configuration. The data was obtained by varying the base voltage V_{BB} from 0 to 1.2 V in steps of 0.1 V. The collector voltage V_{CC} was kept constant at almost 2V. The base current I_B and collector current I_C were measured for each value of V_{BB}. The base-emitter voltage V_{BE} and collector-emitter voltage V_{CE} were also measured for each value of V_{BB}. The data was obtained for two different values of V_{CC} - 2 V and 3 V.

V_{BB} (V)	V_{BE} (V)	I_B (mA)	I_C (mA)	V_{CC} (V)	V_{CE} (V)
0	0.036	0	0	2	2
0.1	0.178	0	0	2	2
0.2	0.251	0	0	2	2
0.3	0.378	0	0	2	2
0.4	0.449	0	0	2	2
0.5	0.589	3	5	2	2
0.6	0.655	28	4.7	2	2
0.7	0.698	91	16.3	2	2
0.8	0.729	182	32.6	2	2
0.9	0.738	226	41.1	2	2
1	0.762	338	61.6	2	2
1.1	0.778	414	76.1	2	2
1.2	0.792	499	92.3	2	2

V_{BB} (V)	V_{BE} (V)	I_B (mA)	I_C (mA)	V_{CC} (V)	V_{CE} (V)
0	0.038	0	0	3	3
0.1	0.19	0	0	3	3
0.2	0.259	0	0	3	3
0.3	0.355	1	0	3	3
0.4	0.466	1	0	3	3
0.5	0.607	9	1.6	3	3
0.6	0.642	27	5	3	3
0.7	0.684	88	16.2	3	3
0.8	0.71	158	29.4	3	3
0.9	0.729	242	45.9	3	3
1	0.749	334	64.8	3	3
1.1	0.767	449	87.2	3	3
1.2	0.765	468	93	3	3

We plotted the I_B vs. V_{BE} graph for the two values of V_{CC} and obtained the following graphs.

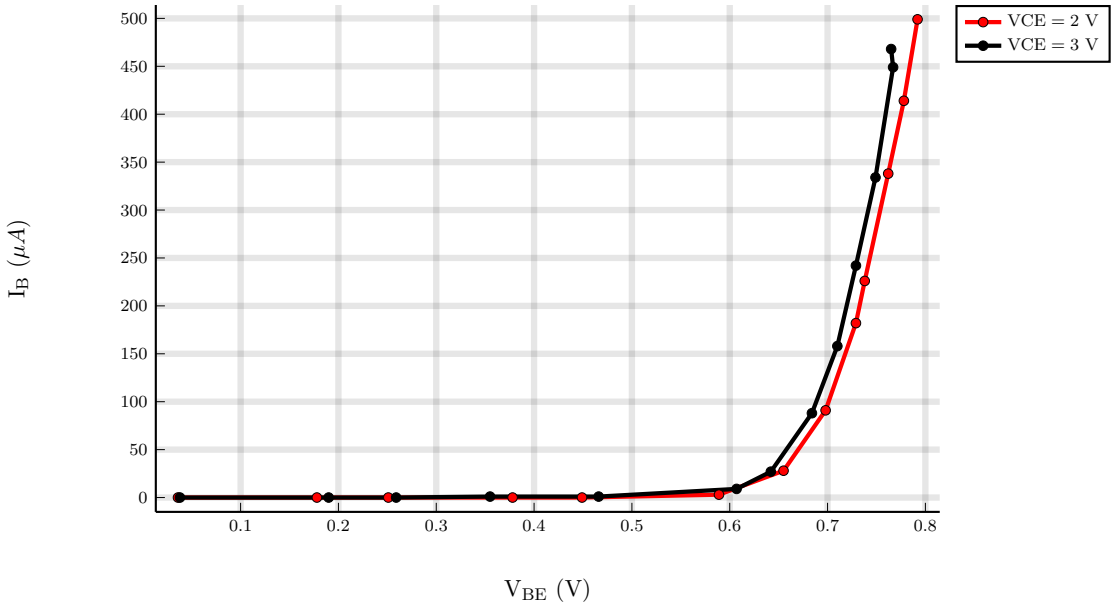

Figure 2: Input characteristics of a BJT transistor

We note that the input characteristics for the two values of V_{CC} are opposite of what is expected. The curve for $\mathrm{V_{CE}} = 3\mathrm{V}$ should be below that of $\mathrm{V_{CE}} = 2\mathrm{V}$. This can be due to the values being very close to each other, so these could not be clearly distinguished and hence the error.

3.2 Output Characteristics

The following tables show the data obtained for the output characteristics of the transistor in CE configuration. The data was obtained by varying the base voltage V_{CC}. The base voltage V_{BB} was kept constant at almost $0.5\mathrm{V}$. The collector current I_C and collector-emitter voltage V_{CE} were measured. The data was obtained for three different values of I_B = 25 µA, 30 µA and 40 µA.

V_{BB} (V)	I_B (µA)	V_{CC} (V)	V_{CE} (mV)	I_C (µA)
0.5	25	0.0	0.004	10
0.5	25	0.5	0.04	506
0.5	25	1.0	0.057	922
0.5	25	1.5	0.069	1308
0.5	25	2.0	0.081	1784
0.5	25	2.5	0.099	2390
0.5	25	3.0	0.107	2880
0.5	25	3.5	0.127	3350
0.5	25	4.0	0.15	3780
0.6	25	4.2	0.172	3960
0.6	25	4.4	0.2	4150
0.6	25	4.6	0.228	4340
0.6	25	4.8	0.42	4350
0.6	25	4.7	0.349	4380
0.6	25	5.0	0.49	4340
0.6	25	5.2	0.696	4460
0.6	25	5.5	0.978	4460

Table 1: Data obtained for output characteristics at I_B = 25 µA

V_{CC} (V)	V_{BB} (V)	I_B (μA)	V_{CE} (mV)	I_C (μA)
0	0.5	30	0.007	37
0.1	0.5	30	0.02	166
0.2	0.5	30	0.022	214
0.3	0.5	30	0.028	331
0.4	0.5	30	0.03	362
0.5	0.5	30	0.037	513
0.6	0.5	30	0.04	610
0.7	0.5	30	0.043	671
0.8	0.5	30	0.045	737
0.9	0.5	30	0.049	829
1	0.5	30	0.05	884
1.1	0.5	30	0.054	1016
1.2	0.5	30	0.058	1118
1.3	0.5	30	0.062	1294
1.4	0.5	30	0.063	1296
1.5	0.5	30	0.064	1335
1.8	0.5	30	0.072	1599
2	0.5	30	0.073	1770
3	0.5	30	0.098	2950
3.5	0.6	30	0.11	3420
4	0.6	30	0.122	3850
4.5	0.6	30	0.139	4350
4.6	0.6	30	0.14	4430
4.8	0.6	30	0.156	4630
4.9	0.6	30	0.166	4690
5	0.6	30	0.198	4820
5.5	0.6	30	0.27	5070
5.6	0.6	30	0.42	5110
5.8	0.6	30	0.58	5130
6	0.6	30	0.89	5090

Table 2: Data obtained for output characteristics at $I_B = 30$ μA

V_{BB} (V)	I_B (μA)	V_{CC} (V)	V_{CE} (mV)	I_C (μA)
0.5	40	0.0	0.004	12
0.5	40	1.0	0.04	866
0.5	40	2.0	0.061	1724
0.5	40	3.0	0.08	2890
0.5	40	4.0	0.094	3740
0.6	40	5.0	0.109	4730
0.6	40	6.0	0.134	5730
0.6	40	6.5	0.147	6180
0.6	40	7.0	0.167	6700
0.6	40	7.2	0.188	6850
0.6	40	7.4	0.388	6890
0.6	40	7.6	0.533	6900
0.6	40	8.0	0.921	7000

Table 3: Data obtained for output characteristics at $I_B = 40$ μA

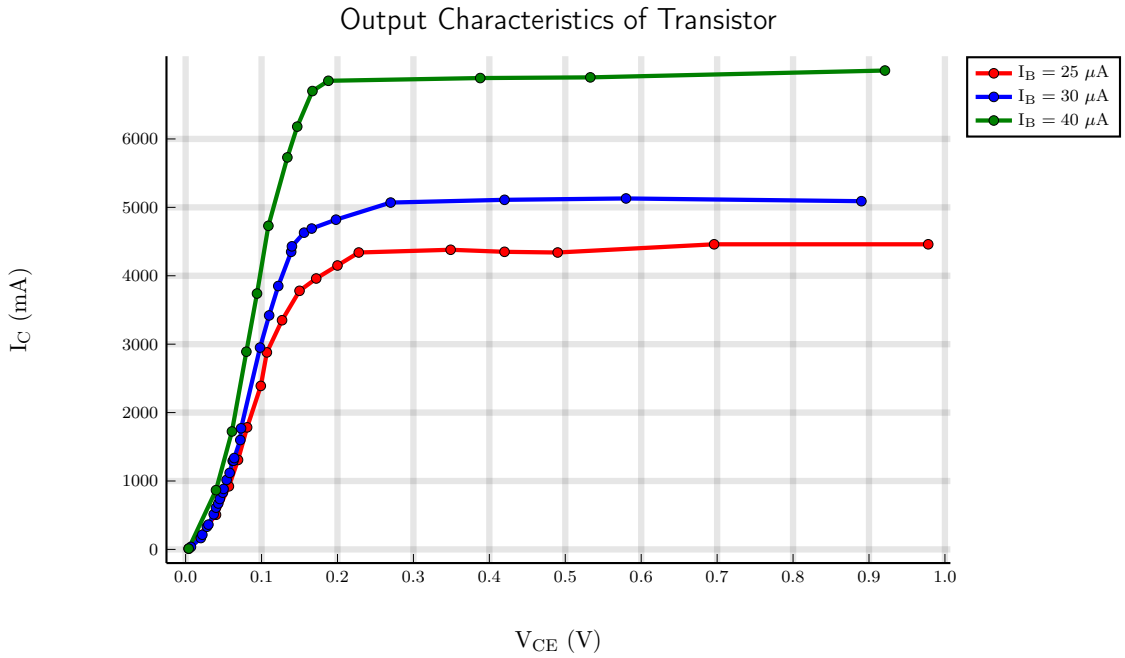

Figure 3: Output characteristics of BJT

We see that the collector current I_C initially increases steeply with the increase in V_{CE} but reaches saturation and remains almost constant after a certain value of the voltage.

4 Sources of Error

5 Discussion and Conclusion