Sub-Group: A-7
Experiment 2: Study of Transistor Characteristics

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1 Aim

To study input and output charecterestics of a common-emmiter configuration of a npn BJT transistor.

2 Theory

Transistors are a very common and useful device in modern days. It is used as oscillators, amplifiers, gates and many other instruments. One of the common type transistors are bipolar junction transistor. This bipolar junction transistor is a sandwich of semiconducting materials. In an npn transistor there is a p-type semiconductor in between two n-type semiconductors. And in a pnp transistor there is a n-type semiconductor in between two p-type semiconductors. In this experiment, we are going to study the input and output characteristics of npn semiconductors.

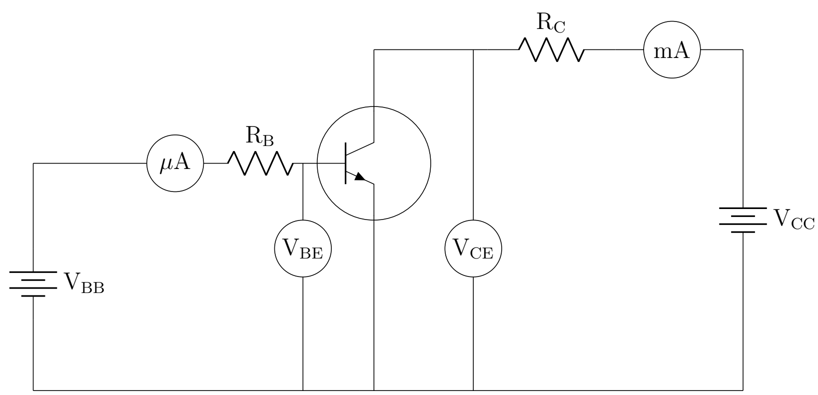
In an npn semiconductor, out of the two n-type semiconductors one of them is very heavily doped and the other is larger in size and lightly doped compared to the other n-type. The heavily doped semiconductor is called Emitter. The comparatively lightly doped semiconductor is called Collector. The p-type semiconductor is generally very thin and very lightly doped. There are two pn junctions present in the transistor - base emitter junction and the collector base junction. Normally when used as an amplifier, the base emitter junction is kept in forward bias and the collector base junction is kept in reverse bias. So, due to the forward bias of the base emitter junction electrons go from emitter to the base, this electrons get affected by the reverse bias of the collector base junction and as the base is very thin and lightly doped most of the electrons go to the collector. So the emitter current is almost equal to the collector current. It is actually slightly more than the emitter current. We define a parameter α as

$$\mathrm{I_C} = \alpha \mathrm{I_E}.$$

α is slightly smaller than 1. We can write also $\mathrm{I_E} = \mathrm{I_C} + \mathrm{I_B}$. So if we define β as $\mathrm{I_C} = \beta \mathrm{I_B}$ then we can write

$$\beta = \frac{\alpha}{(1-\alpha)}$$

Now as the transistor is a three terminal device one of the terminals has to be considered as a common terminal while studying input or output characteristics. Depending on the terminal we can define three types of configuration - common emitter configuration, common base, common collector configuration. This experiment concerns only common emitter configuration. For studying three terminal devices two sets

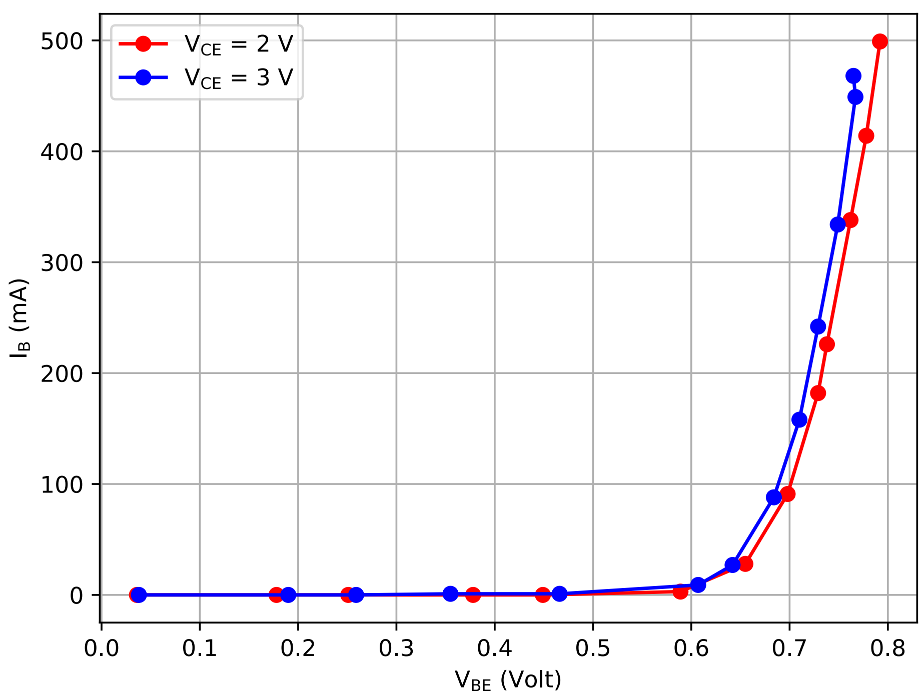


of characteristics are necessary. Input characteristics is the study of dependency of input current (I_B) and base emitter voltage (V_{BE}) while keeping the collector current (I_C) fixed and the output characteristics is the study of collector current(I_C) and base collector voltage (V_{CE}) fixed while keeping the base current (I_B) fixed.

3 Data and Calculation

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

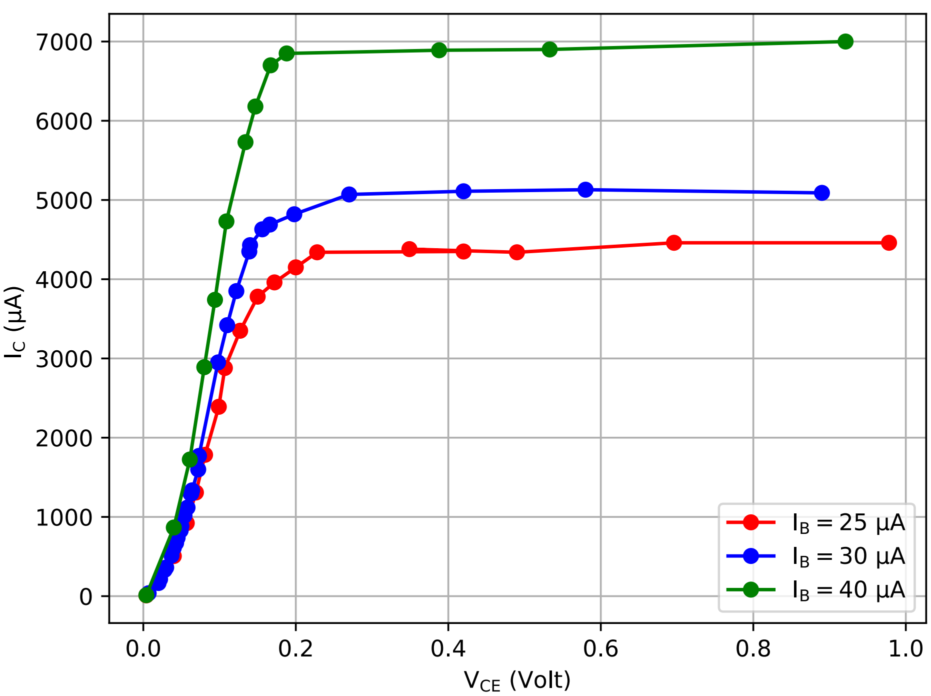
V_{BB} (V)	V_{BE}(V)	I_B(mA)	I_C(mA)	V_{CC}(V)	V_{CE}(V)
0	0.038	0	0	3	3
0.1	0.19	0	0	3	3
0.2	0.259	0	0	3	3
0.3	0.355	1	0	3	3
0.4	0.466	1	0	3	3
0.5	0.607	9	1.6	3	3
0.6	0.642	27	5	3	3
0.7	0.684	88	16.2	3	3
0.8	0.71	158	29.4	3	3
0.9	0.729	242	45.9	3	3
1	0.749	334	64.8	3	3
1.1	0.767	449	87.2	3	3
1.2	0.765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



V_{CC} (V)	V_{CE} (mV)	I_C (μA)	I_B (μA)	V_{BB} (V)
0	0.004	10	25	0.5
0.5	0.04	506	25	0.5
1	0.057	922	25	0.5
1.5	0.069	1308	25	0.5
2	0.081	1784	25	0.5
2.5	0.099	2390	25	0.5
3	0.107	2880	25	0.5
3.5	0.127	3350	25	0.5
4	0.15	3780	25	0.5
4.2	0.172	3960	25	0.6
4.4	0.2	4150	25	0.6
4.6	0.228	4340	25	0.6
4.8	0.42	4350	25	0.6
4.7	0.349	4380	25	0.6
5.2	0.696	4460	25	0.6
5.5	0.978	4460	25	0.6

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

V_{CC} (V)	V_{CE} (mV)	I_C (μA)	I_B (μA)	V_{BB} (V)
0	0.004	12	40	0.5
1	0.04	866	40	0.5
2	0.061	1724	40	0.5
3	0.08	2890	40	0.5
4	0.094	3740	40	0.5
5	0.109	4730	40	0.6
6	0.134	5730	40	0.6
6.5	0.147	6180	40	0.6
7	0.167	6700	40	0.6
7.2	0.188	6850	40	0.6
7.4	0.388	6890	40	0.6
7.6	0.533	6900	40	0.6
8	0.921	7000	40	0.6



4 Conclusion