Aim ↬ To study the input and output characteristics of a Bipolar Junction Transistor connected in a Common Base configuration.

Equipment Required ↬

Bipolar Junction Transistor, Resistance, Power supply, Ammeter, Voltmeter, Breadboard and connecting wires.

Theory ↬

A Bipolar Junction Transistor (BJT) is a three-terminal semiconductor device used for amplification and switching, comprising three regions: the emitter, the base, and the collector. BJTs come in two types, NPN and PNP, with the primary difference being the polarity of the voltages and the direction of the currents. In a common base (CB) configuration, the base terminal is common to both the input and the output circuits. The input signal is applied between the emitter and the base, and the output is taken from the collector and the base.

The input characteristics of a BJT in CB configuration describe the relationship between the emitter current (I_E) and the base-emitter voltage (V_{BE}) for various levels of collector-base voltage (V_{CB}). These characteristics are observed by varying V_{BE} and measuring I_E while keeping V_{CB} constant. In the forward active region, the emitter-base junction is forward-biased, resulting in a large change in I_E for a small change in V_{BE}.

The output characteristics describe the relationship between the collector current (I_C) and the collector-base voltage (V_{CB}) for different levels of emitter current (I_E). These are obtained by varying V_{CB} and measuring I_C while keeping I_E constant. In the active region, the emitter-base junction is forward-biased and the collector-base junction is reverse-biased, resulting in I_C being largely independent of V_{CB} and primarily determined by I_E. The saturation region occurs when V_{CB} is low, and both junctions are forward-biased, leading to improper amplification. The cutoff region is when both junctions are reverse-biased, and the transistor is in the off state with minimal current flow.

The common base configuration is characterized by high voltage gain, low input impedance, and high output impedance. The input impedance is low because the input is applied to the forward-biased emitter-base junction, while the output impedance is high due to the reverse-biased collector-base junction. The current gain (α), which is the ratio of the collector current to the emitter current ($\propto = \frac{I_C}{I_E}$), is typically less than 1 but very close to 1.

The common base configuration is used in applications requiring high-frequency operation, impedance matching, and voltage gain without current gain. The primary objectives of studying the input and output characteristics of a BJT in this configuration are to plot the input characteristic curves (I_E vs. V_{BE} for different values of V_{CB}) and the output characteristic curves (I_C vs. V_{CB} for different values of I_E). Understanding these characteristics is essential for designing and analyzing circuits using BJTs in the common base configuration.

Circuit Diagram ↬

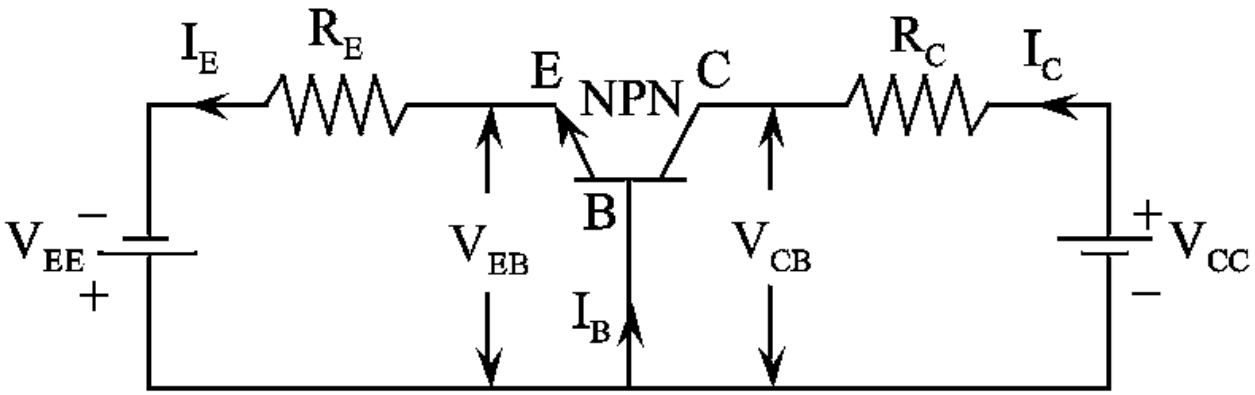

Fig 1. npn transistor in common base configuration

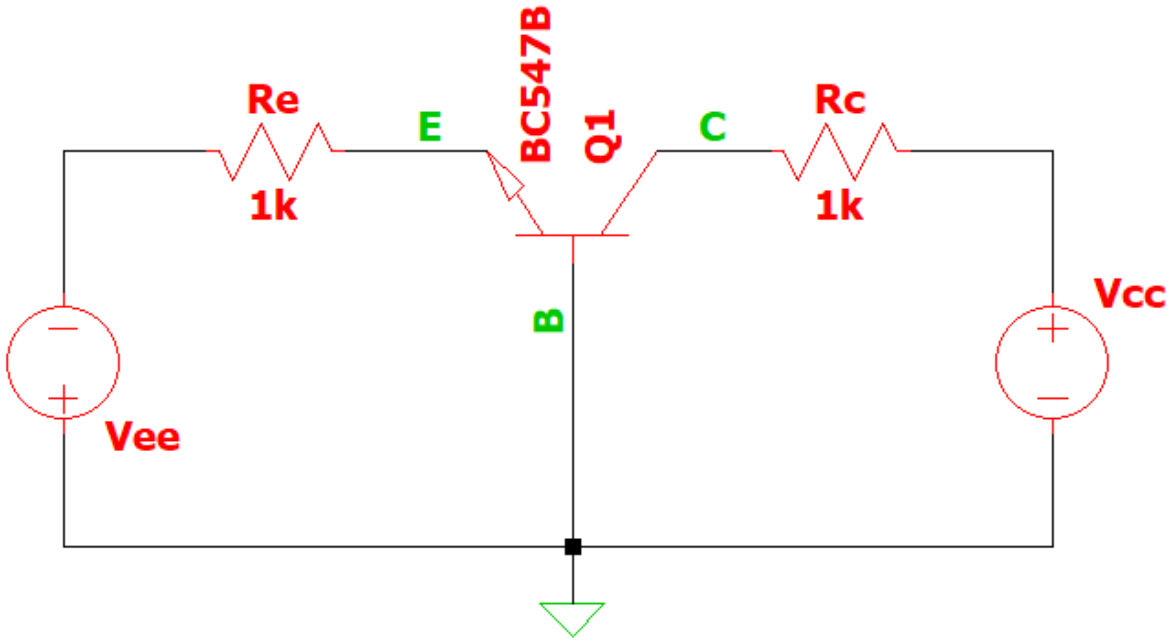

Fig 2. Circuit in LTSpice

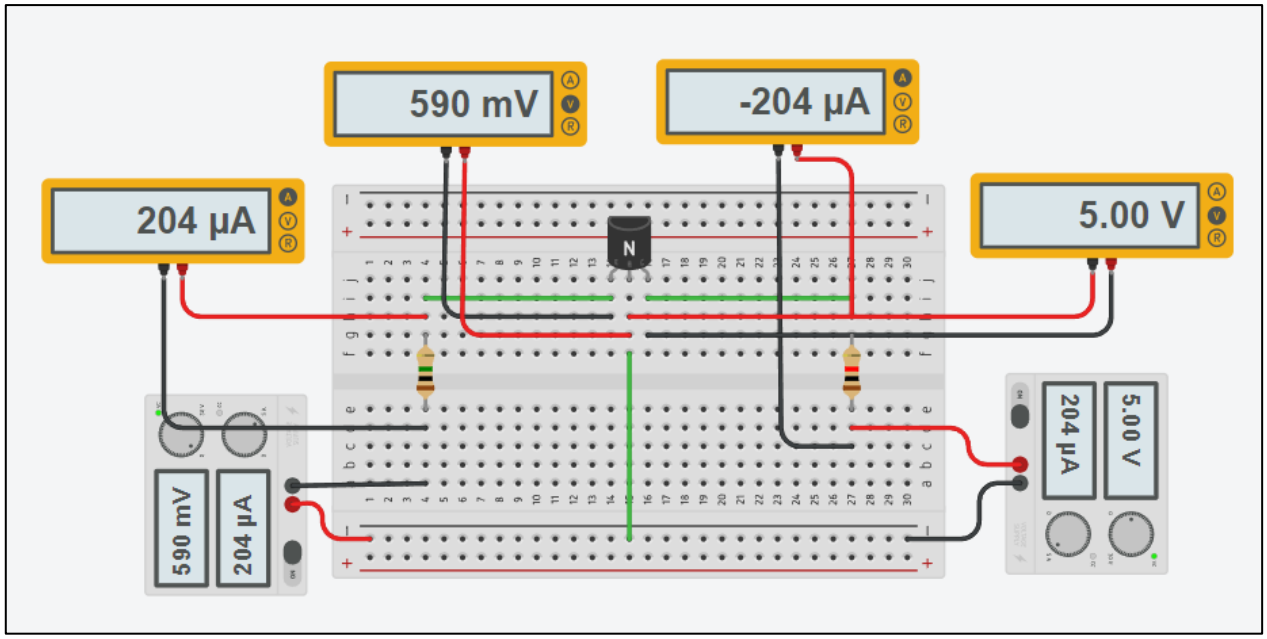

Fig 4. Circuit in TinkerCad

Observation Table ↬

➢ Input Characteristics ↪

S.No.	Vee(V)	Vcc = 0V		Vcc = 5V		Vcc = 10V	
		Ie(µA)	Vbe(V)	Ie(µA)	Vbe(V)	Ie(µA)	Vbe(V)
1	0.1	0	0.1	0	0.1	0	0.1
2	0.2	0	0.2	0	0.2	0	0.2
3	0.3	0	0.29	0	0.29	0	0.29
4	0.4	0.11	0.39	0.12	0.39	0.13	0.39
5	0.5	4.26	0.49	4.55	0.49	4.83	0.49
6	0.6	43.55	0.55	44.81	0.55	46	0.55
7	0.8	203	0.59	205	0.59	207	0.59
8	1.0	386	0.61	388	0.61	390	0.61
9	1.5	842	0.66	866	0.63	868	0.63
10	2.0	1315	0.68	1354	0.65	1356	0.64

➢ Output Characteristics ↪

S.No.	Vcc(V)	Vee = 2V		Vee = 5V		Vee = 10V	
		Ic(mA)	Vcb(V)	Ic(mA)	Vcb(V)	Ic(mA)	Vcb(V)
1	0	0.75	-0.75	0.81	-0.805	0.83	-0.831
2	0.1	0.85	-0.74	0.91	-0.804	0.93	-0.829
3	0.2	1.03	-0.73	1.10	-0.803	1.13	-0.828
4	0.5	1.18	-0.68	1.30	-0.801	1.33	-0.827
5	0.8	1.22	-0.42	1.59	-0.798	1.62	-0.826
6	1	1.22	-0.22	1.79	-0.796	1.83	-0.825
7	2	1.22	0.78	2.78	-0.782	2.82	-0.822
8	5	1.22	3.78	4.17	0.825	5.80	-0.805
9	8	1.22	6.78	4.17	3.825	8.75	-0.750
10	10	1.22	8.78	4.17	5.825	9.14	0.862

Graphs ↬

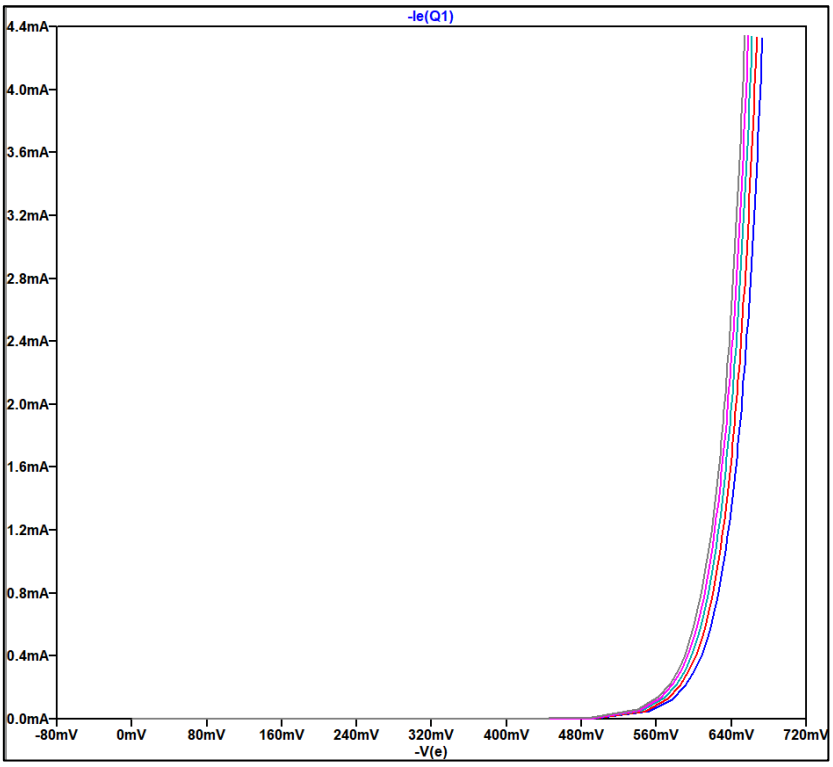

Fig 6. Input Characteristics

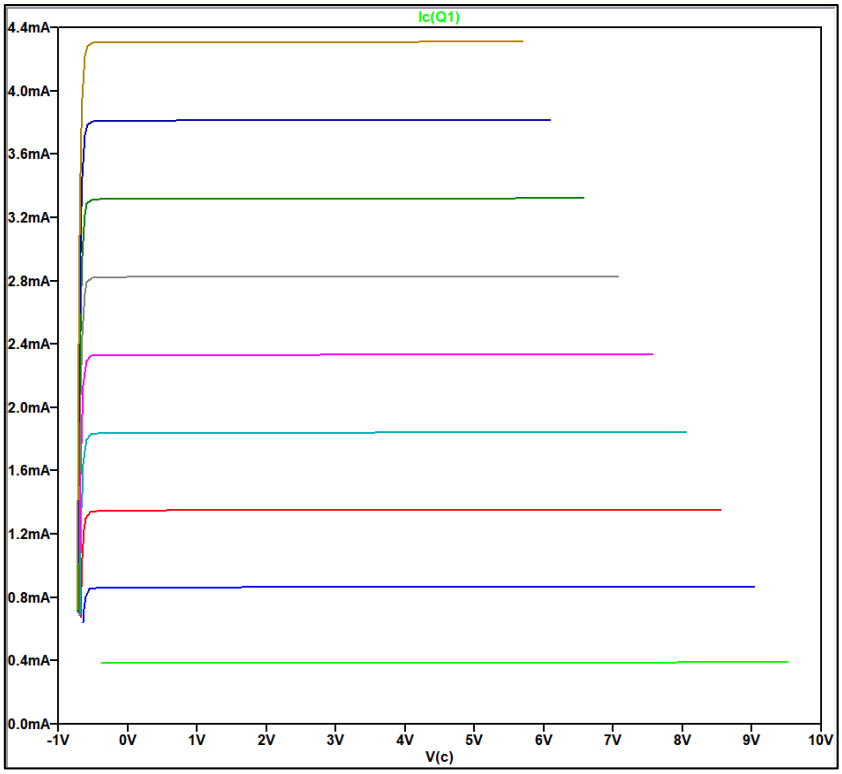

Fig 7. Output Characteristics

Result ↬

The experiment revealed that in a common base configuration, the emitter current I_E increased significantly with base-emitter voltage V_{BE} while keeping the collector-base voltage V_{CB} constant. The collector current I_C remained relatively stable across various V_{CB} levels for fixed I_E, indicating I_C is controlled mainly by I_E. These results confirm the expected behaviour of high voltage gain, low input impedance, and high output impedance, validating the theoretical predictions for the common base configuration of a BJT.

Conclusion ↬

Successfully performed the experiment and matched the result with the simulation result.

Precautions ↬

- While doing the experiment, do not exceed the ratings of the transistor. This may lead to damage to the transistor.
- Connect the Voltmeter and Ammeter in the correct polarities as shown in the circuit diagram.
- Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.