Aim ↬ To study the input and output characteristics of a Bipolar Junction Transistor connected in a Common Emitter 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 emitter (CE) configuration, the emitter terminal is common to both the input and the output circuits. The input signal is applied between the base and the emitter, and the output is taken from the collector and the emitter.

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

The output characteristics describe the relationship between the collector current (I_C) and the collector-emitter voltage (V_{CE}) for different levels of base current (I_B). These are obtained by varying V_{CE} and measuring I_C while keeping I_B constant. In the active region, the base-emitter junction is forward-biased and the collector-base junction is reverse-biased, leading to I_C being largely independent of V_{CE} and primarily determined by I_B. The saturation region occurs when V_{CE} is low, and both junctions are forward-biased, causing I_C to increase significantly. The cutoff region is when the base-emitter junction is not forward-biased, resulting in minimal current flow.

The common emitter configuration is characterized by high current gain, moderate voltage gain, and moderate input and output impedances. The current gain (β), which is the ratio of the collector current to the base current ($\beta = \frac{I_C}{I_E}$), is typically greater than 1, making this configuration useful for amplification purposes. The voltage gain is influenced by the load resistance in the collector circuit.

The common emitter configuration is widely used in applications requiring amplification of signals due to its high current gain and moderate voltage 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_B vs. V_{BE} for different values of V_{CE}) and the output characteristic curves (I_C vs. V_{CE} for different values of I_B). Understanding these characteristics is crucial for designing and analyzing amplifier circuits using BJTs in the common emitter configuration.

Circuit Diagram ↬

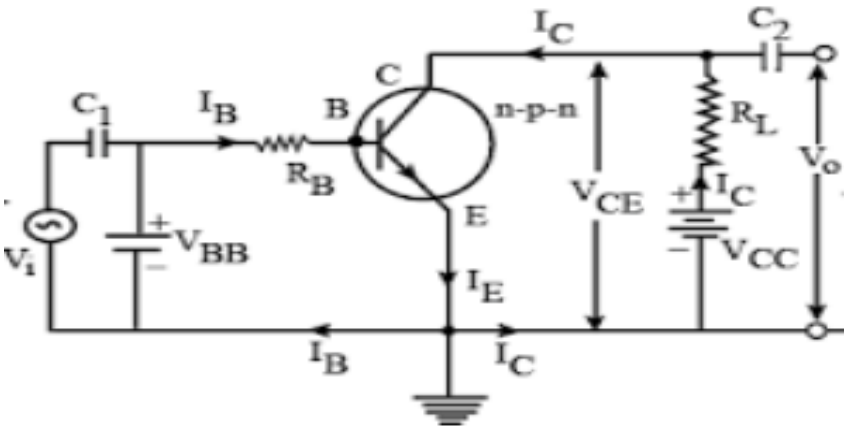

Fig 1. npn transistor in common emitter configuration

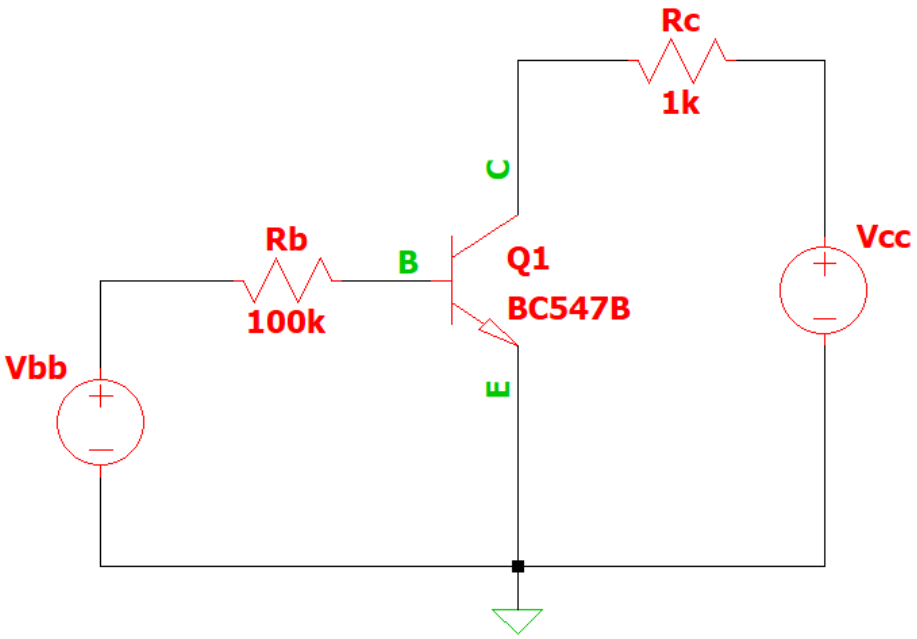

Fig 2. Circuit in LTSpice

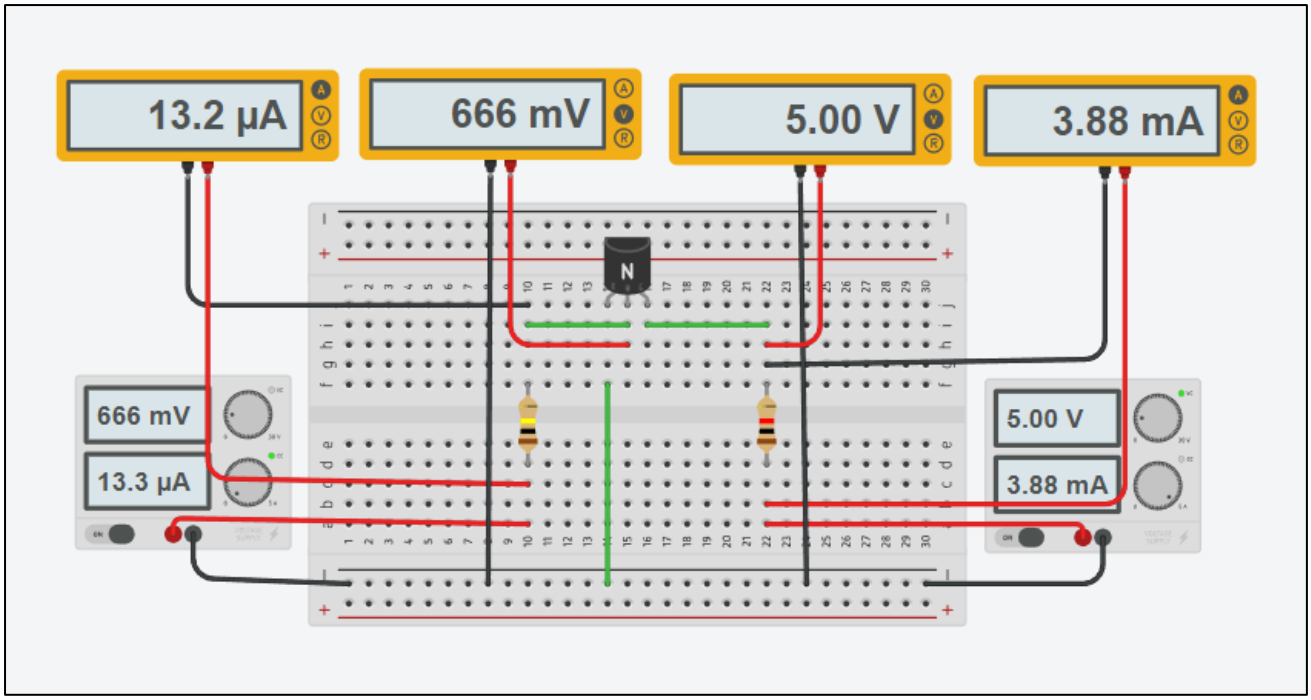

Fig 4. Circuit in TinkerCad

Observation Table ↬

➢ Input Characteristics ↪

S.No.	Vbb(V)	Vcc = 0V		Vcc = 5V		Vcc = 10V	
		Ib(µA)	Vbe(V)	Ib(µA)	Vbe(V)	Ib(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	0.3	0	0.3	0	0.3
4	0.4	0.02	0.4	0	0.4	0	0.4
5	0.5	0.33	0.47	0.02	0.5	0.01	0.5
6	0.6	1.01	0.50	0.28	0.57	0.28	0.57
7	0.8	2.72	0.53	1.80	0.62	1.80	0.62
8	1.0	4.56	0.54	3.61	0.64	3.60	0.64
9	1.5	9.36	0.56	8.38	0.66	8.37	0.66
10	2.0	14.24	0.57	13.25	0.68	13.25	0.67

➢ Output Characteristics ↪

S.No.	Vcc(V)	Vbb = 1V		Vbb = 1.5V		Vbb = 2V	
		Ic(μA)	Vce(V)	Ic(mA)	Vce(V)	Ic(mA)	Vce(V)
1	0	3.18	0.003	0.01	0.006	0.01	0.008
2	0.1	33.23	0.067	0.04	0.053	0.05	0.047
3	0.2	102.44	0.098	0.12	0.076	0.14	0.066
4	0.5	354.90	0.145	0.39	0.108	0.41	0.095
5	0.8	605.43	0.195	0.67	0.127	0.69	0.110
6	1	691.21	0.309	0.86	0.137	0.88	0.118
7	2	692.42	1.308	1.81	0.195	0.14	0.149
8	5	692.42	4.308	2.08	2.920	3.51	1.488
9	8	692.42	7.308	2.08	5.920	3.51	4.488
10	10	692.42	9.308	2.08	7.920	3.51	6.488

Graphs ↬

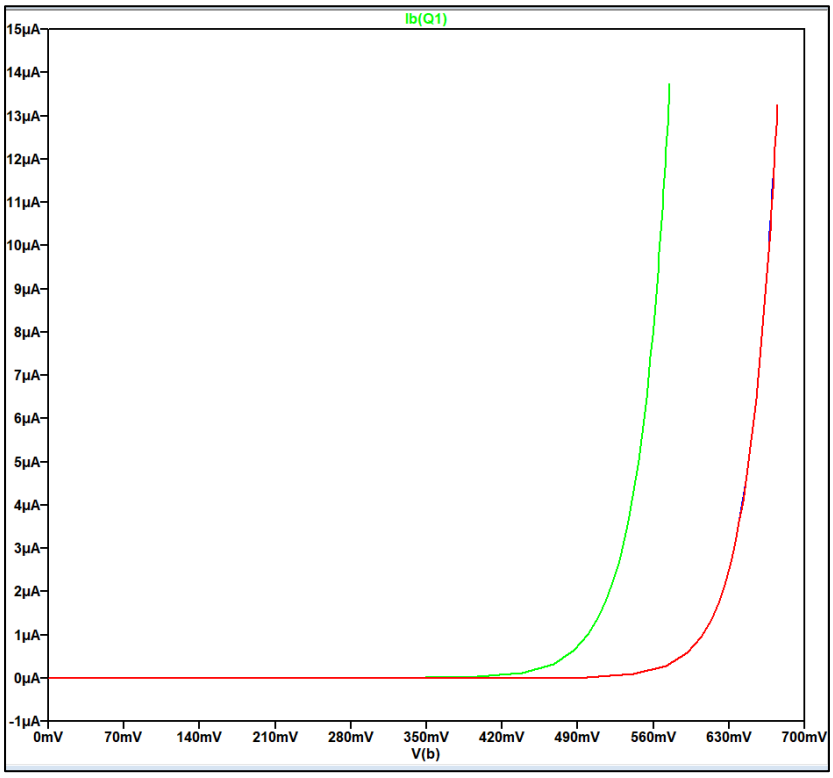

Fig 6. Input Characteristics

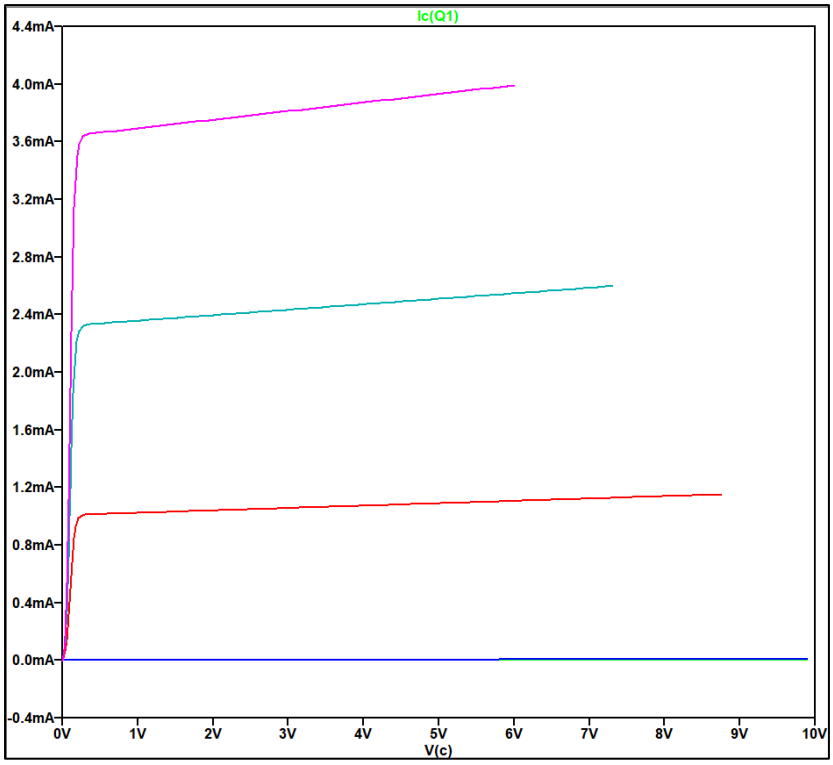

Fig 7. Output Characteristics

Result ↬

The experiment revealed that in a common emitter configuration, the base current (I_B) increased significantly with base-emitter voltage (V_{BE}) while keeping the collector-emitter voltage (V_{CE}) constant. The collector current (I_C) showed a notable increase with V_{CE} at low values and then stabilized at higher V_{CE} levels for a fixed I_B, indicating that I_C is primarily controlled by I_B. These results confirm the expected behaviour of high current gain, moderate voltage gain, and moderate input and output impedances, validating the theoretical predictions for the common emitter 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.