

Experiment 4

Aim:

Study of input and output characteristics of CE BJT (Common Emitter Bipolar Junction Transistor) amplifier using LTSpice.

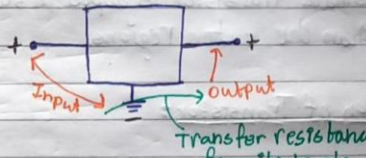
Tools and Apparatus:

LTSpice, Transistor, Resistors, Voltage Source

Theory and Design:

• TRANSISTOR: (Transfer + Resistor)

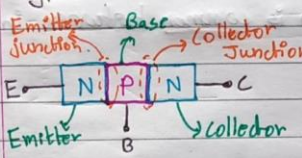
→ Transistor is transfer of resistance from one port to another port.
 → Device having 3 ports and 2 junctions.



→ Transistor acts as two pn junction diodes attached back-to-back.

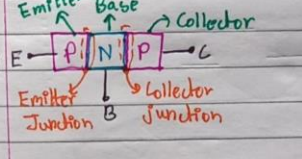
→ Types:

① NPN: (N-type Emitter, P-type Base, N-type Collector)



3 ports:
 ① Collector
 ② Emitter
 ③ Base

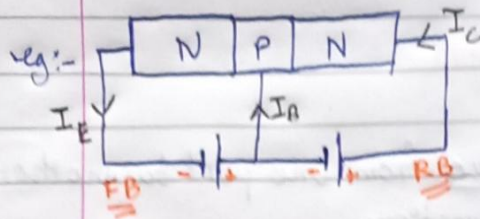
② PNP: (P-type Emitter, N-type Base, P-type Collector)



2 junctions:
 ① Emitter junction
 ② Collector junction

→ 4 ways to bias: (Region of Operation)

	Emitter Junction	Collector Junction	Region of Operation
1.	FB	RB	Active Region
2.	FB	FB	Saturation Region
3.	RB	RB	Cut off Region
4.	RB	FB	Reverse Active Region



→ Active Region

$$I_E = I_C + I_B, \quad I_C = \beta I_B, \quad -I_C \gg I_B$$

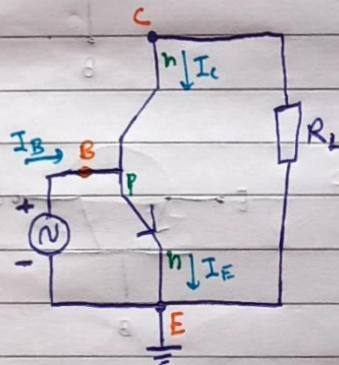
\downarrow mA \downarrow μ A \uparrow 50 to 200

* I_B is very small. Transistor is doped in such a way that middle region is thinner than the outer regions.

→ Configuration of Transistor :

- ① Common Emitter
- ② Common Collector
- ③ Common Base

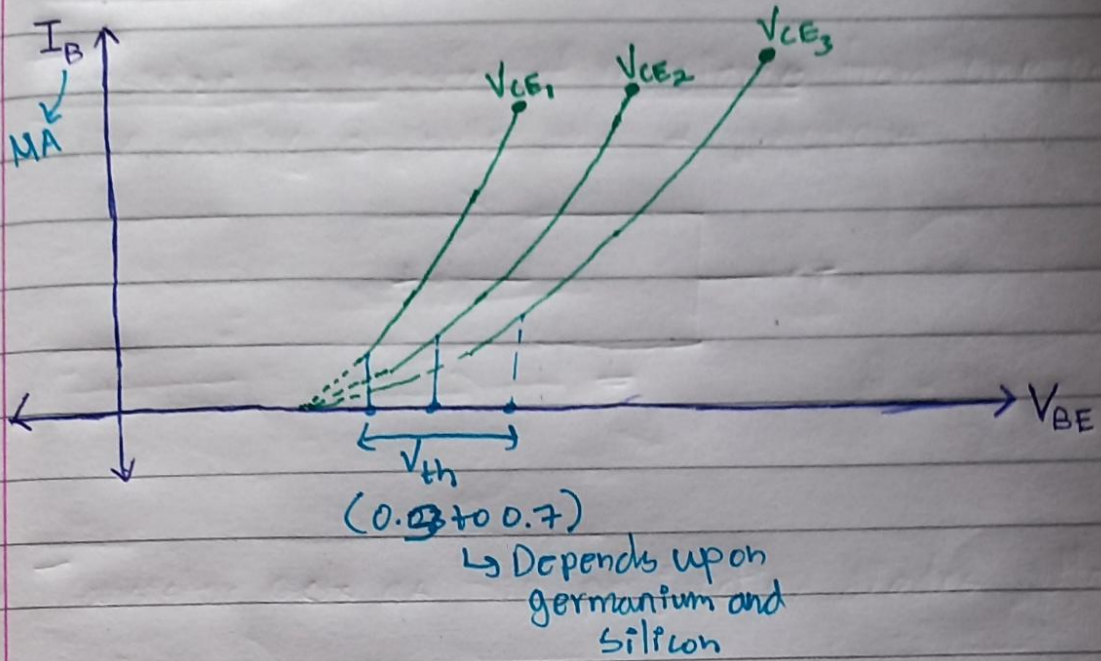
Decided by the terminal which is common between input supply and output supply.



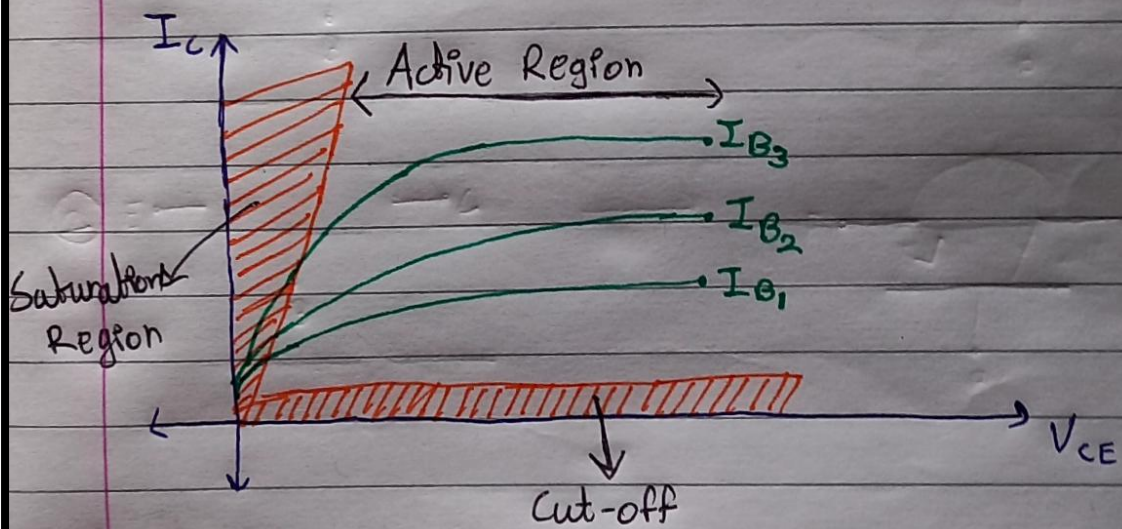
Common Emitter Configuration
(Active Region)

→ Transistor can be used as switch, amplifier and oscillator.

→ Input Characteristics :

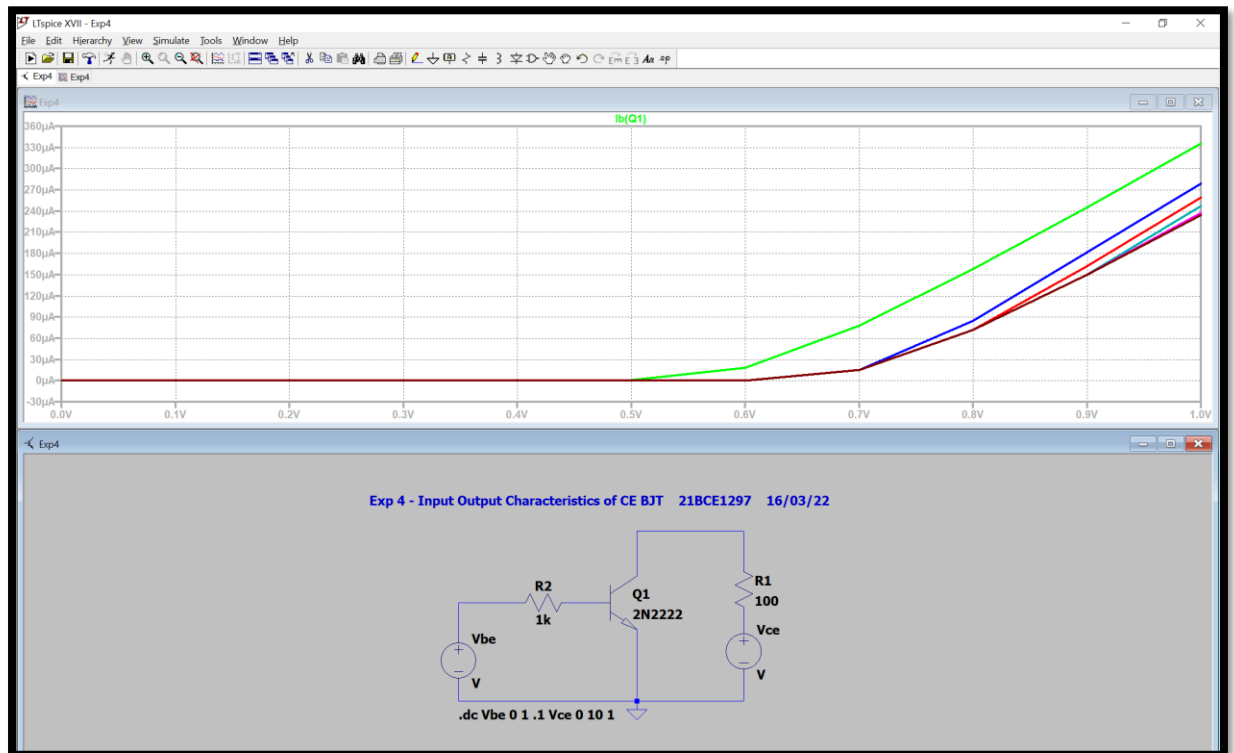


→ Output Characteristics :

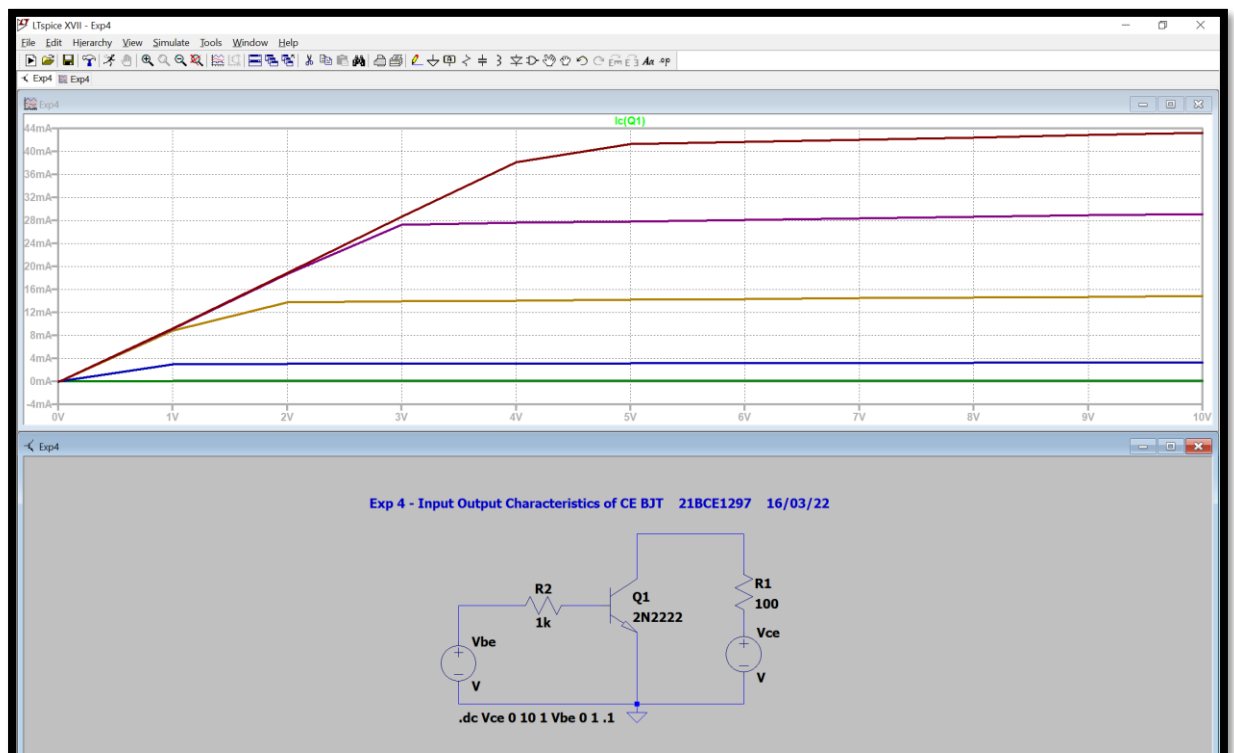


Simulation Results:

1. Input Characteristics



2. Output Characteristics



Conclusion:

1. Input Characteristics:

a. For V_{CE1} (Green)

- i. $V_{BE1} = 800 \text{ mV} \rightarrow I_{B1} = 157.87 \mu\text{A}$
- ii. $V_{BE2} = 900 \text{ mV} \rightarrow I_{B2} = 244.98 \mu\text{A}$
- iii. Change in $V_{BE} = 100 \text{ mV}$, Change in $I_B = 87.11 \mu\text{A}$
- iv. $\frac{\Delta I_B}{\Delta V_{BE}} = 0.87$

b. For $I_B = 210 \mu\text{A}$

- i. $V_{CE1} \rightarrow V_{BE1} = 859.84 \text{ mV}$ (Green)
- ii. $V_{CE2} \rightarrow V_{BE2} = 929.04 \text{ mV}$ (Blue)
- iii. $V_{CE3} \rightarrow V_{BE3} = 949.23 \text{ mV}$ (Red)

2. Output Characteristics:

a. For $V_{CE} = 7\text{V}$

- i. $I_{B5} \rightarrow I_C = 42.07 \text{ mA}$ (Brown)
- ii. $I_{B4} \rightarrow I_C = 28.37 \text{ mA}$ (Purple)
- iii. $I_{B3} \rightarrow I_C = 14.47 \text{ mA}$ (Yellow)

Inferences:

1. Transistors transfer resistance.
2. Transistors can be used as amplifiers ($I_C \gg I_B$).
3. Select npn transistor
4. Keep first source in DC Sweep as V_{BE} for input characteristics and as V_{CE} for output characteristics.
5. While plotting graph, click on the respective transistor terminal and not the wire.
6. Connect all wires properly.