Experiment No: 4

Characteristics of BJT in Common Emitter Configuration

Aim: To plot the Characteristics of a BJT in Common Emitter Configuration.

Components:

Name	Quantity
Transistor BC 107	1
Resistor 1K Ω	1

Equipment:

Name	Range	Quantity
Bread Board		1
Regulated power supply	0-30V	2
Digital Ammeter	0-200mA/0-200μA	1
Digital Voltmeter	0-20V	2
Connecting Wires		

Specifications:

For Transistor BC 107:

- Max Collector Current= 0.1A
- V_{ceo} max= 50V
- V_{EB0} = 6V
- V_{CB0} = 50V
- Collector power dissipation = 500mW
- Temperature Range = -65 to +150 ^{0}C
- h_{fe} = 110 - 220

Theory:

A BJT is called as Bipolar Junction Transistor and it is a three terminal active device which has emitter, base and collector as its terminals. It is called as a bipolar device because the flow of current through it is due to two types of carriers i.e., majority and minority carriers.

A transistor can be in any of the three configurations viz, Common base, Common emitter and Common Collector.

The relation between $\boldsymbol{\alpha}$ **, β , γ of CB, CE, CC are**

$$\boldsymbol{\alpha} = \frac{\boldsymbol{\beta}}{\mathbf{1}+\boldsymbol{\beta}} \qquad \boldsymbol{\beta} = \frac{\boldsymbol{\alpha}}{\mathbf{1}-\boldsymbol{\alpha}} \qquad \boldsymbol{\gamma} = \mathbf{1}+\boldsymbol{\beta} = \frac{\mathbf{1}}{\mathbf{1}-\boldsymbol{\alpha}}$$

In CE configuration base will be input node and collector will be the output node .Here emitter of the transistor is common to both input and output and hence the name common emitter configuration.

The collector current is given as

$$I_C = \beta I_B + 1 + \beta I_{CO}$$

Where I_{CO} is called as reverse saturation current

A transistor in CE configuration is used widely as an amplifier. While plotting the characteristics of a transistor the input voltage and output current are expressed as a function of input current and output voltage.

i.e, $V_{BE} = f (I_B, V_{CE})$ and

$I_C = f (I_B, V_{CE})$

Transistor characteristics are of two types.

Input characteristics:- Input characteristics are obtained between the input current and input voltage at constant output voltage. It is plotted between V_{BE} and I_B at constant V_{CE} in CE configuration

Output characteristics:- Output characteristics are obtained between the output voltage and output current at constant input current. It is plotted between V_{CE} and I_C at constant I_B in CE configuration

The different regions of operation of the BJT are

Emitter Junction	Collector Junction	Region	Application
RB	RB	CUTT OFF	OFF SWITCH
FB	FB	SATURATION	ON SWITCH
FB	RB	ACTIVE	AMPLIFIER
RB	FB	REVERSE ACTIVE	ATTENUATOR

Circuit Diagram:

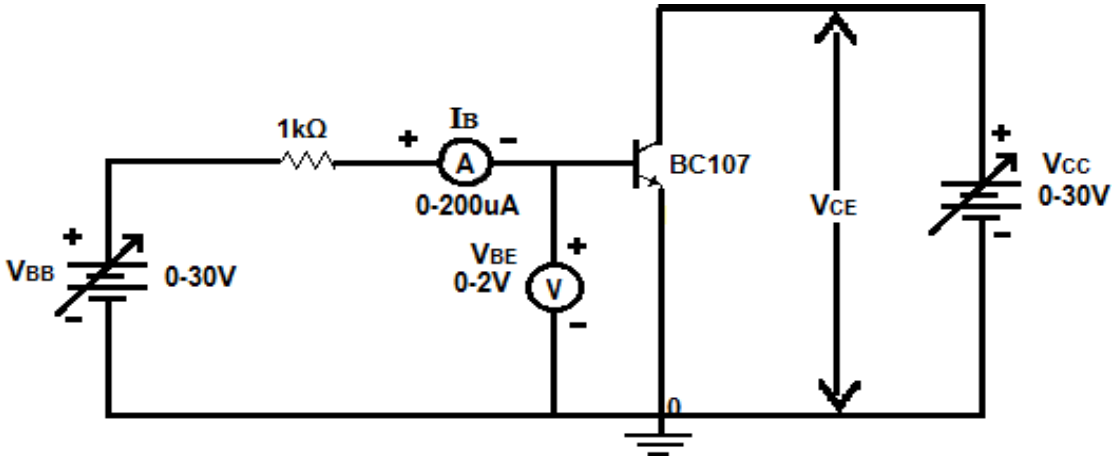


Fig. 1: Input Characteristics

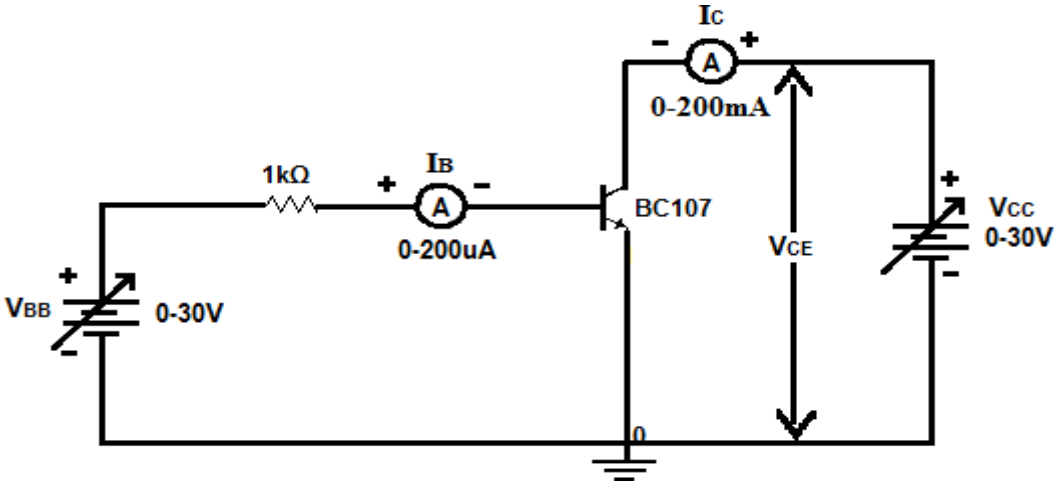
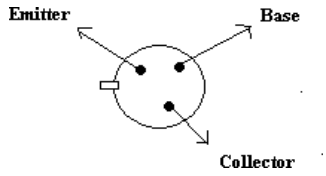


Fig. 2: Output Characteristics

Pin assignment of Transistor:



Procedure:

Input Characteristics:

1) Connect the circuit as shown in fig.(1). Adjust all the knobs of the power supply to their minimum positions before switching the supply on.
2) Adjust the V_{CE} to 0 V by adjusting the supply $V_{CC.}$
3) Vary the supply voltage V_{BB} so that V_{BE} varies in steps of 0.1 V from 0 to 0.5 V and then in steps of 0.02 V from 0.5 to 0.7 V. In each step note the value of base current I_B.
4) Adjust V_{CE} to 1, 2V and repeat step-3 for each value of $V_{CE.}$
5) Plot a graph between V_{BE} and I_B for different values of V_{CE}. These curves are called input characteristic

Output Characteristics:

1) Connect the circuit as shown in fig. (2). All the knobs of the power supply must be at the minimum position before the supply is switched on.
2) Adjust the base current I_B to 20 µA by adjusting the supply V_{BB}.
3) Vary the supply voltage V_{CC} so that the voltage V_{CE} varies in steps of 0.2 V from 0 to 2 V and then in steps of 1 V from 2 to 10 V. In each step the base current should be adjusted to the present value and the collector current I_C should be recorded.
4) Adjust the base current at 40, 60 µA and repeat step-3 for each value of I_B.
5) Plot a graph between the output voltage V_{CE} and output current I_C for different values of the input current I_B. These curves are called the output characteristics.

Observations:

Input Characteristics

V_{CE} = 0V		V_{CE} = 2V	
V_{BE}(V)	I_B(µA)	V_{BE}(V)	I_B(µA)

Output Characteristics

I_B = 20µA		I_B = 40µA		I_B = 60µA	
V_{CE}(V)	I_C(mA)	V_{CE}(V)	I_C(mA)	V_{CE}(V)	I_C(mA)

Graph:

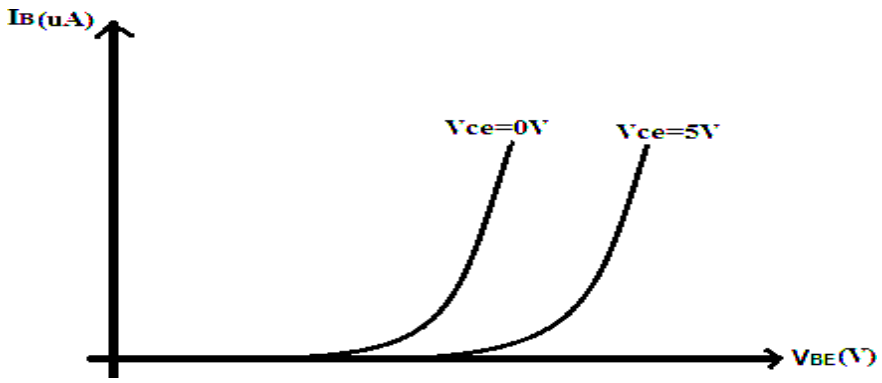


Fig. 3: Input Characteristics

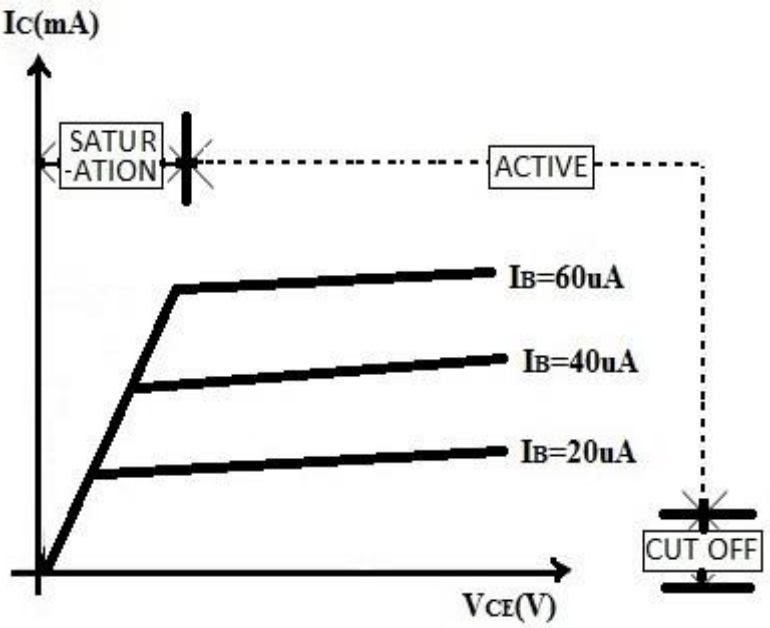


Fig. 4: Output Characteristics

Precautions:

1. While performing the experiment do not exceed the ratings of the transistor. This may lead to damage the transistor.
2. Connect voltmeter and ammeter in correct polarities as shown in the circuit diagram.
3. Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.
4. Make sure while selecting the emitter, base and collector terminals of the transistor.

Results:

Input and output Characteristics of a BJT in Common Emitter Configuration are studied.

Viva Questions

1. What is transistor?

Ans: A transistor is a semiconductor device used to amplify and switch electronic signals and electrical power. It is composed of semiconductor material with at least three terminals for connection to an external circuit. The term transistor was coined by John R. Pierce as a portmanteau of the term "transfer resistor".

2. Write the relation between α, β and γ?

Ans: $\alpha = \frac{\beta}{1+\beta}$ $\beta = \frac{\alpha}{1-\alpha}$ $\gamma = 1 + \beta = \frac{1}{1-\alpha}$

3. What is the range of α ?

Ans: The important parameter is the common-base current gain, α. The common-base current gain is approximately the gain of current from emitter to collector in the forward-active region. This ratio usually has a value close to unity; between 0.98 and 0.998.

4. Why is α is less than unity?

Ans: It is less than unity due to recombination of charge carriers as they cross the base region.

5. Input and output impedance equations for CB configuration?

Ans: $h_{ib}=V_{EB}/I_E, 1/h_{ob}=V_{CB}/I_C$

6. Can we replace transistor by two back to back connected diodes?

Ans: No, because the doping levels of emitter (heavily doped), base(lightly doped) and collector(doping level greater than base and less than emitter) terminals are different from p and n terminals in diode.

7. For amplification CE is preferred, why?

Ans: Because amplification factor beta is usually ranges from 20-500 hence this configuration gives appreciable current gain as well as voltage gain at its output on the other hand in the Common Collector configuration has very high input resistance(~750K Ω) & very low output resistance(~25 Ω) so the voltage gain is always less than one & its most important application is for impedance matching for driving from low impedance load to high impedance source

8. To operate a transistor as amplifier, emitter junction is forward biased and collector junction is reverse biased, why?

Ans: Voltage is directly proportional to Resistance. Forward bias resistance is very less compared to reverse bias. In amplifier input forward biased and output reverse biased so voltage at output increases with reverse bias resistance.

9. Which transistor configuration provides a phase reversal between the input and output signals?

Ans: Common emitter configuration (180 DEG)

10. What is the range if β?

Ans: β usually ranges from 20-5