Experiment No: 5

Characteristics of a BJT in Common Emitter Configuration

Aim:

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

Components:

Name	Quantity
Transistor BC 107/BC 543	1
Resistor 1KΩ or 33KΩ	1

Equipment:

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

Specifications:

For Transistor BC 107:

- Max Collector Current= 0.1A
- V_{CEO} max= 50V

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 **, β ,** γ **of CB, CE, CC are**

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

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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.

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

J_E	**J_C**	**REGION**	**APPLICATION**
RB	RB	CUTT OFF	OFF SWITCH
FB	FB	SATURATION	ON SWITCH
FB	RB	ACTIVE	AMPLIFIER
RB	FB	REVERSE ACTIVE	ATTENUATOR

The Hybrid model of BJT and its typical values are as shown

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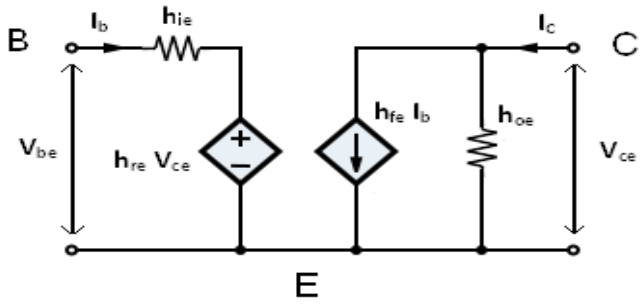

Parameter	Typical value
h_{ie}	1.1 $K\ \Omega$
h_{re}	250 μ
h_{fe}	50
h_{oe}	25 μ℧

The basic circuit diagram for studying input and output characteristics is shown in the circuit diagrams.

Circuit Diagram:

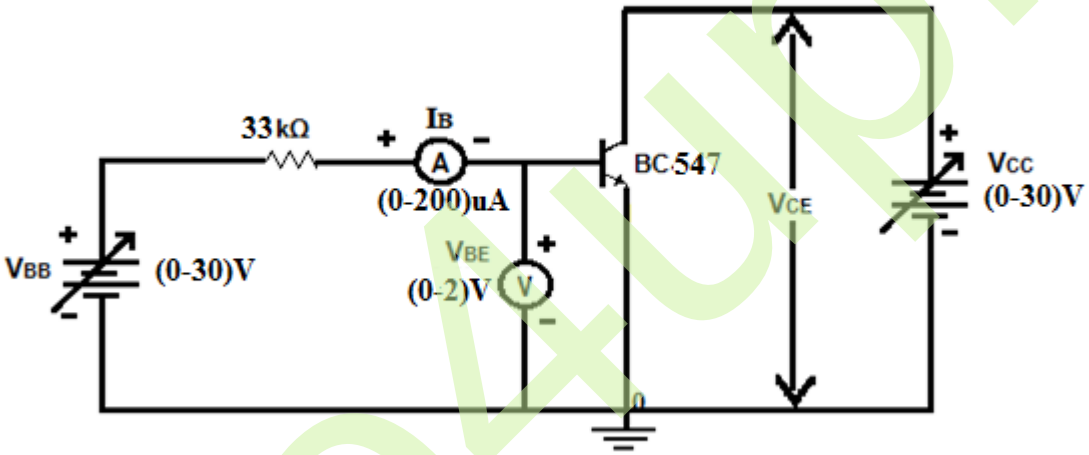

Fig.(1) - Input Characteristics:

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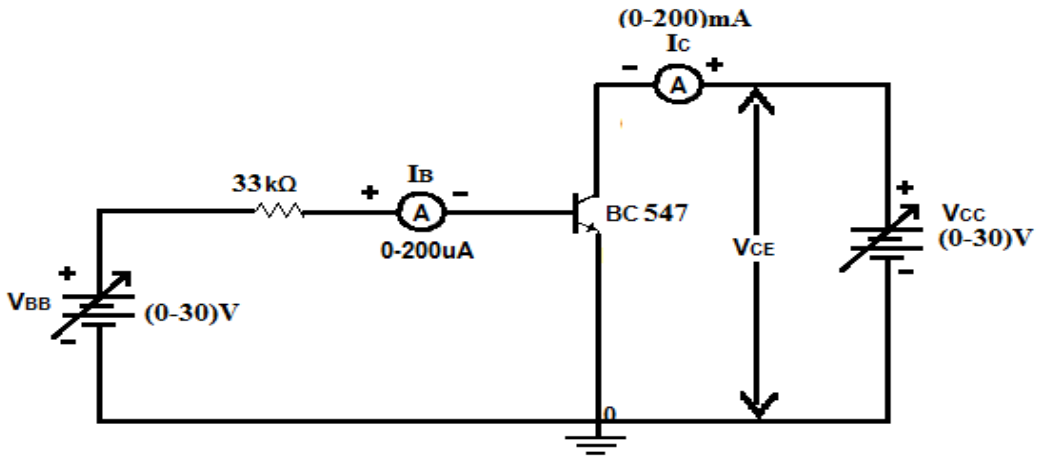
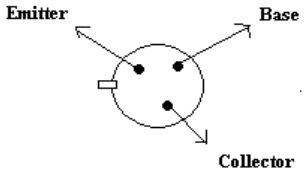


Fig. (2) - Output Characteristics

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 characteristics

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.

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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:

Table .(1) Input Characteristics

V_{CE} = 0V		V_{CE} = 4V	
V_{BE}(V)	I_B(µA)	V_{BE}(V)	I_B(µA)

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

Graph:

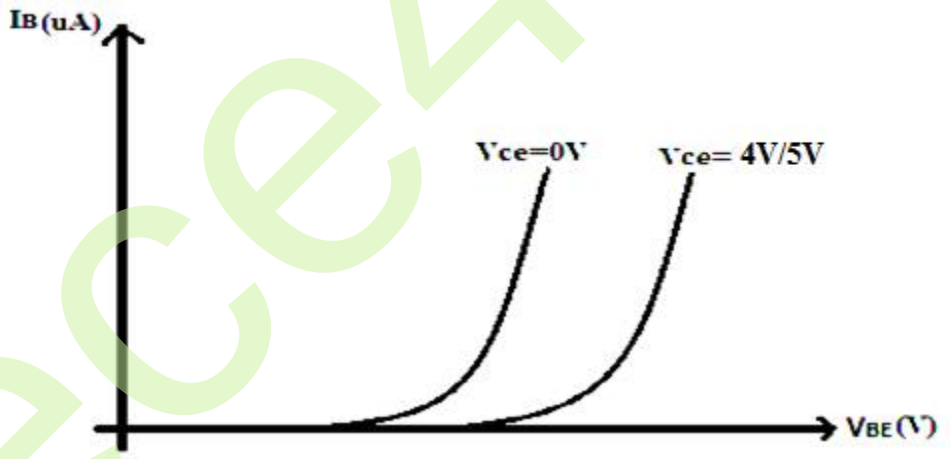

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Fig.(3). Input Characteristics

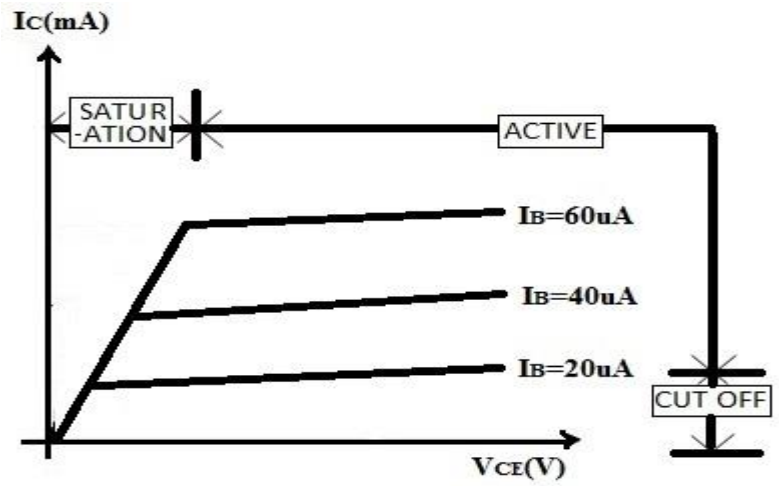

Fig.(4). Output Characteristics

Calculations from Graph:

1. **Input Impedance (h_{ie}):** It is ratio of input base voltage (V_{BE}) to the change in input base current(I_B) with the output collector voltage (V_{CE}) kept constant. It is the slope of the input characteristics I_B vs V_{BE} .

   Therefore, $$hie = \frac{\Delta V_{BE}}{\Delta I_B}, \; V_{CE} \text{ Constant} \quad (\Omega)$$

2. **Reverse voltage gain (h_{re}) :**It is the ratio of the change in the input base voltage (V_{BE}) and the corresponding change in output collector(I_C) voltage with constant input base current(I_B).It is the slope of V_{BE} vs V_{CE} curve.

   $$hre = \frac{\Delta V_{BE}}{\Delta V_{CE}}, \; I_B \text{ constant}$$

   Therefore,

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3.Forward Current Gain (h_{fe}): It is the ratio of the change in the output collector current(I_C) to the corresponding change in the input base current (I_B) keeping output collector voltage (V_{CE}) constant. It is the slope of Ic vs I_B curve .

Therefore,

$$hfe = \frac{\Delta Ic}{\Delta I_B}, \; V_{CE} \text{ Constant}$$

4.Output Admittance (h_{oe}): It is the ratio of change in the output collector current (I_c) to the corresponding change in the output collector voltage(V_{CE}) with the input base current (I_B) kept constant. It is the slope of the output characteristics V_{CE} vs I_c

Therefore,

$$hoe = \frac{\Delta Ic}{\Delta V_{CE}}, \; I_B \text{ constant} \qquad (\mho)$$

Inference:

1. Medium input and output resistances.
2. Smaller values if $\mathbf{V_{CE}}$ comes earlier cut-in-voltage.
3. Increase in the value of $\mathbf{I_B}$ causes saturation of the transistor of an earlier voltage.

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.

Result:

1. Input and output Characteristics of a BJT in Common Emitter Configuration are studied.
2. Measured the h-parameters of a BJT in Common Emitter Configuration.

Viva Questions:

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

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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.

2. 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(~750KΩ) & very low output resistance(~25Ω) 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

3. 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.

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

Ans: Common emitter configuration (180 DEG)

5. What is the range if β?

Ans: Beta is usually ranges from 20-500

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