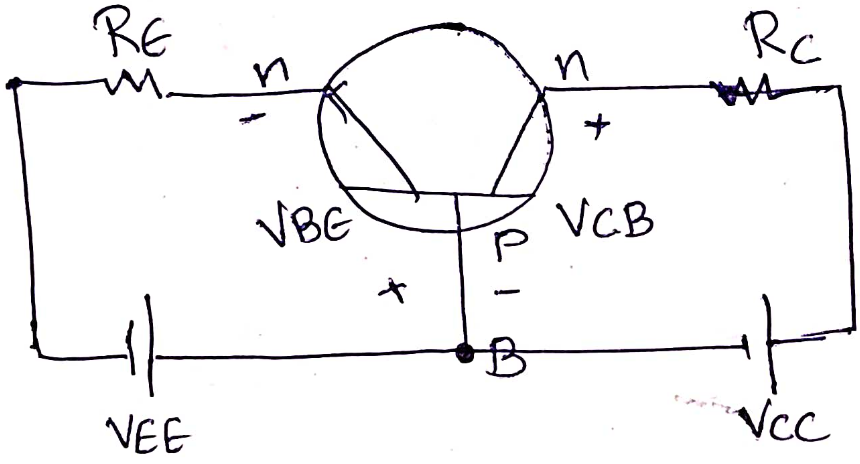
* BJT Configurations:-

The Transistor can be connected in a Circuit in the following 3 configurations.

1. Common base configuration.
2. Common Emitter configuration.
3. Common collecter configuration.

* Common base configuration:-

The common base npn transistor configuration as shown in fig.



→ In this configuration input is applied between Emitter and base and output is taken from the Collector and base.

→ Here, base of transistor is common to both input and output circuits and hence the name common base configuration.

we know that

$$\boxed{I_E = I_C + I_B}$$

→ we know that

$$I_C = \alpha I_E + \underline{I_{CO}}$$

$$I_C = \alpha I_E + \underline{I_{CBO}}$$ (Reverse saturation current in CB when emitter is opened)

$\therefore$ $I_C = \alpha I_E$ (I_{CBO} is small)

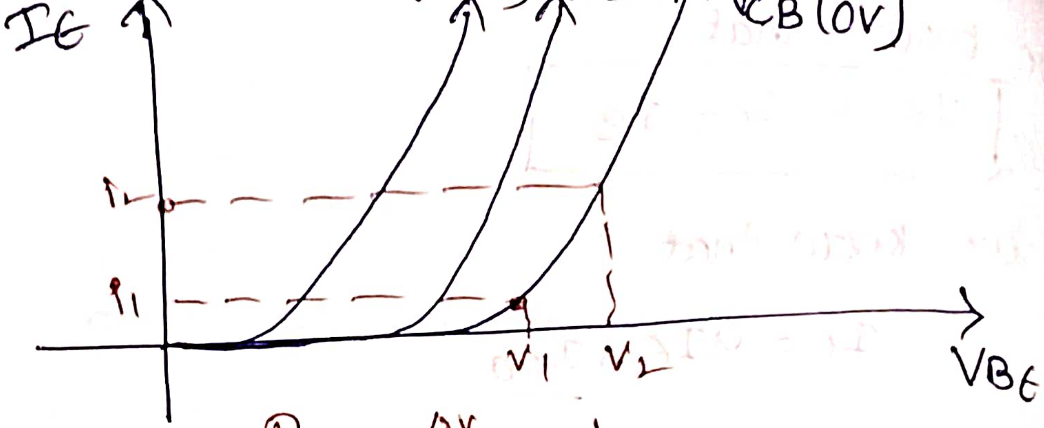
$$\therefore \boxed{\alpha = \frac{I_C}{I_E}}$$

$\therefore$ current gain in common base configuration

* **input characteristics:-** (I_E, V_{BE}) (V_{CB} constant)

→ To determine the input characteristics, the collector-base voltage is kept constant at zero volts and the emitter current I_E is increased from zero in suitable equal steps by increasing V_{BE}.

→ when V_{CB} is equal to zero and emitter-base junction is forward biased as shown in the characteristics, the junction behaves as a forward biased diode so that emitter current I_E increases rapidly with small increases in emitter-base voltage V_{BE}.

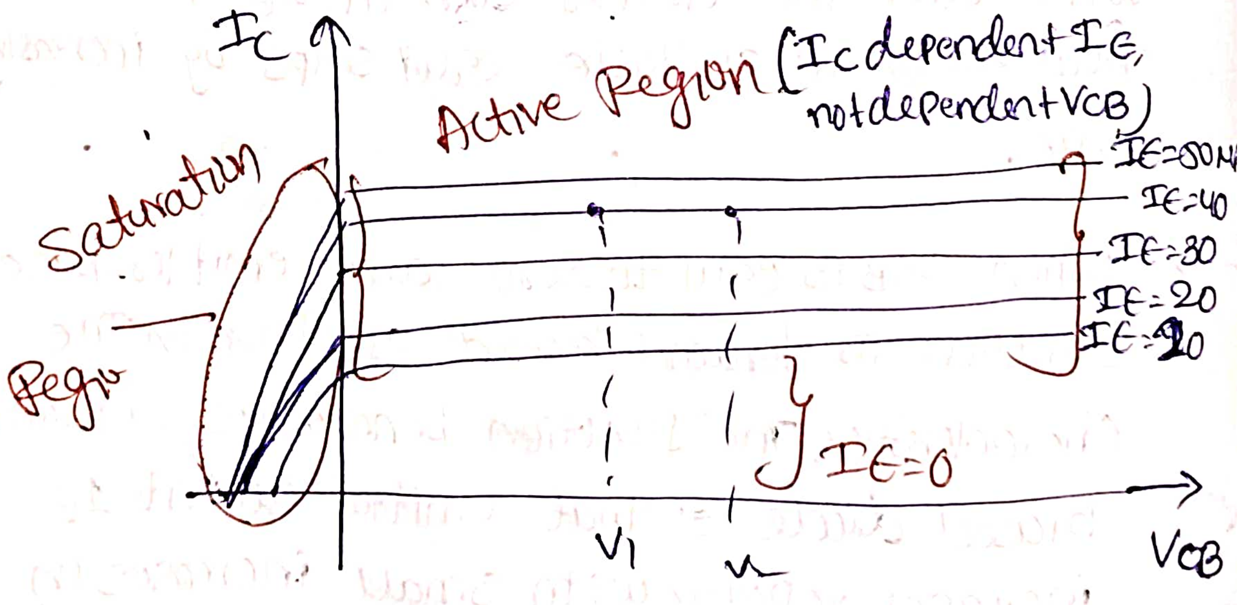


$R_{in} = \frac{\Delta V}{\Delta I}$ = Less

→ when VCB is increased keeping VBE constant the width of the base region will decrease. This effect results in an increase of IE. Therefore, the curves shift towards the left as VCB is increased

Output Characteristics:- (I_C, V_{CB}) (I_E Constant)

→ The relation between I_C and V_{CB} keeping I_E constant is called output characteristics of common base transistor.



$R_o = \frac{\Delta V_{CB}}{\Delta I_C}$ = high value.

→ we know that

$$I_C = \alpha I_E + I_{CO}$$

$$I_C = \alpha I_E + I_{CBO}$$

we know that

$$I_C = \alpha (I_C + I_B) + I_{CBO} \qquad I_E = I_C + I_B$$

$$I_C [1-\alpha] = \alpha I_B + I_{CBO}$$

$$\boxed{I_C = \frac{\alpha}{1-\alpha} I_B + \frac{I_{CBO}}{1-\alpha}}$$

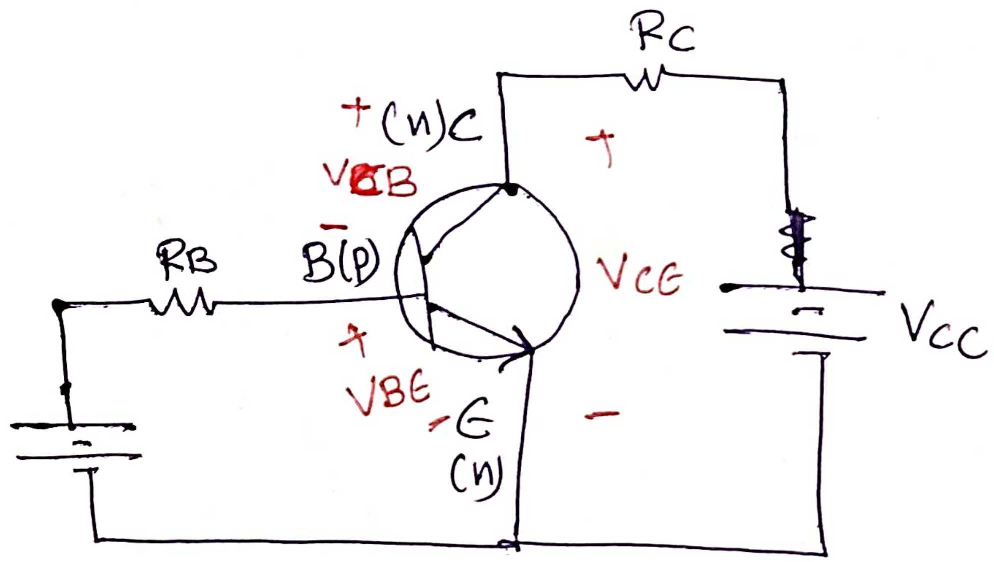
* Common Emitter Configuration:-

→ In this configuration input is applied between base and emitter and output is taken from collector and emitter.

→ Here, emitter of the transistor is common to both input and output circuits and hence the name common emitter configuration.

→ Common emitter configuration npn transistor. As shown in fig.

→ The input voltage in the CE configuration is the base-emitter voltage (V_{BE}) and the output voltage is the collector-emitter voltage. The i/p current is I_B and the output current is I_C.



* Current Relations in CE Configuration

→ we know that, In CB configuration

$$I_C = \alpha I_E + I_{CBO}$$

$$\therefore I_C - I_{CBO} = \alpha I_E$$

$$\frac{I_C}{\alpha} - \frac{I_{CB}}{\alpha} = I_E \quad \text{— (1)}$$

we know that $I_E = I_C + I_B$ — (2)

sub eq (2) in (1)

$$\frac{I_C}{\alpha} - \frac{I_{CBO}}{\alpha} = I_C + I_B$$

$$\frac{I_C}{\alpha} - I_C = I_B + \frac{I_{CBO}}{\alpha}$$

$$I_C\left[\frac{1}{\alpha} - 1\right] = I_B + \frac{I_{CBO}}{\alpha}$$

$$\therefore \boxed{I_C = I_B\left[\frac{\alpha}{1-\alpha}\right] + \frac{I_{CBO}}{1-\alpha}}$$

⇒ we know that $\beta =$

⇒ The β_{dc} is the ratio of out put current I_C and input current I_B in common emitter configuration. It is common emitter amplification factor

$$\therefore \beta = \frac{I_C}{I_B}$$

⇒ we know that $I_E = I_C + I_B \Rightarrow I_B = I_E - I_C$

$$\therefore \beta = \frac{I_C}{I_E - I_C}$$

$$\beta = \frac{I_C / I_E}{\ldots - I_C / I_E} \qquad \left(\because \alpha = \frac{I_C}{I_E}\right)$$

$$\therefore \boxed{\beta = \frac{\alpha}{1-\alpha}}$$

we know that $\alpha = \frac{I_C}{I_E}$ and $I_E = I_C + I_B$.

$$\therefore \alpha = \frac{I_C}{I_C + I_B}$$

Dividing the numerator and denominator by I_B

$$\alpha = \frac{I_C/I_B}{\frac{I_C}{I_B} + 1} = \frac{\beta}{1+\beta}$$

$$\therefore \boxed{\alpha = \frac{\beta}{1+\beta}}$$

* we know that

$$I_C = \alpha I_E + I_{CBO}$$

$$I_C = \alpha (I_C + I_B) + I_{CBO}$$

$$I_C = \alpha I_C + \alpha I_B + I_{CBO}$$

$$I_C [1-\alpha] = \alpha I_B + I_{CBO}$$

$$I_C = \frac{\alpha}{1-\alpha} I_B + \frac{1}{1-\alpha} I_{CBO}$$

$$I_C = \beta I_B + \frac{1}{1-\alpha} I_{CBO}$$

$$\boxed{I_C = \beta I_B + (1+\beta) I_{CBO}}$$

$$\boxed{I_C = \beta I_B + I_{CEO}}$$

$$\beta = \frac{\alpha}{1-\alpha} \Rightarrow \frac{\beta}{\alpha}$$

$$\alpha = \beta - \beta\alpha$$

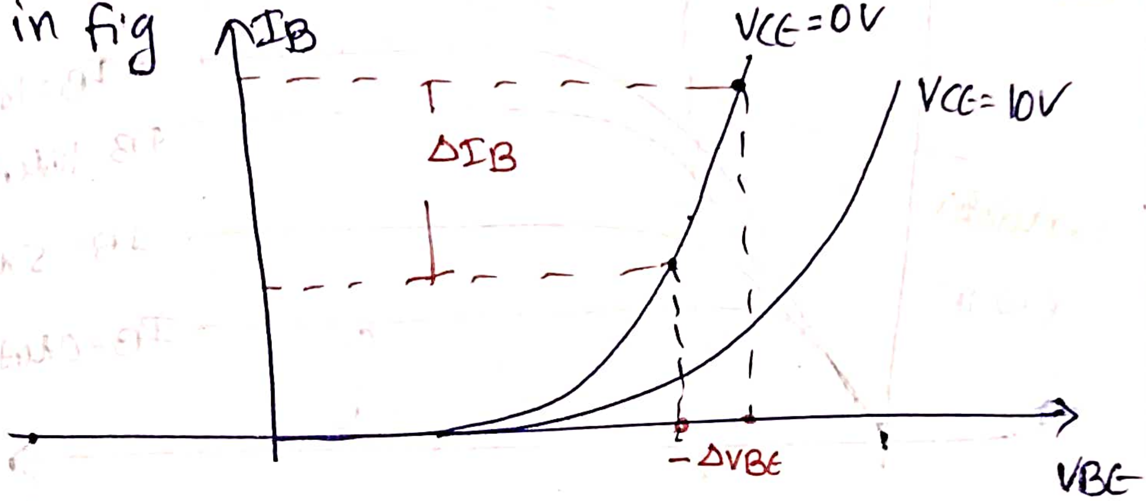
$$\alpha(1+\beta) = \beta$$

$$\frac{\beta}{\alpha} = 1+\beta$$

* input characteristics:-

→ It is the curve between input voltage V_{BE} and input current I_B at constant collector-emitter voltage V_{CE}. The base current is taken along y-axis and base emitter voltage V_{BE} is taken along x-axis.

→ The i/p and o/p characteristics curve as shown in fig



→ The input Resistance is the ratio of change in base-emitter voltage (ΔV_{BE}) to the resulting change in base current (ΔI_B) at constant collector emitter voltage V_{CE}.

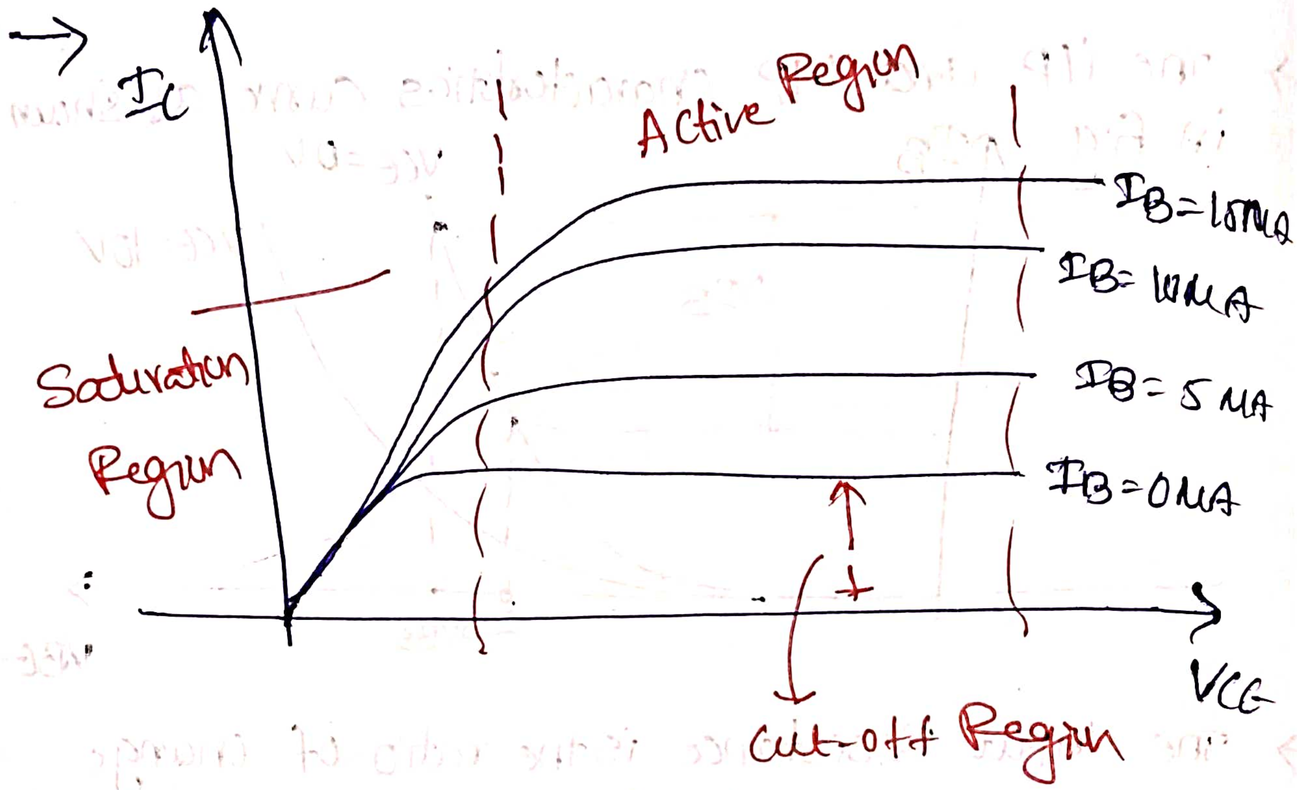
$$\therefore \quad R_i = \frac{\Delta V_{BE}}{\Delta I_B}$$

→ The value of R_i in CE configuration is greater than the value of R_i in CB configuration.

→ $\boxed{V_{CE} = V_{CB} + V_{BE}}$

* Output Characteristics:-

1. This Characteristics shows the relation between the Collector current I_C and Collector Voltage V_{CE}, for Various fixed Valued of I_B.



4.7.3 Common Collector Configuration

- In this configuration, input is applied between base and collector and output is taken from emitter and collector.
- Here, collector of the transistor is common to both input and output circuits and hence the name common collector configuration. It is also known as **emitter follower** configuration.

- Common collector connections for both npn and pnp transistors are shown in Fig. 4.7.12 (a) and (b), respectively.

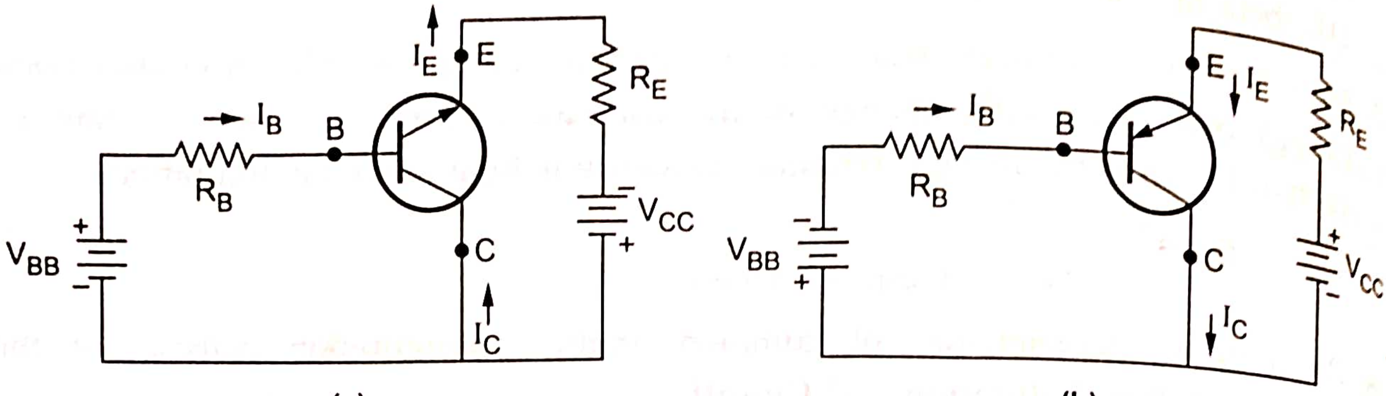


Fig. 4.7.12 Common collector configurations

4.7.3.1 Current Relations in CC Configuration

We know that

$$I_E = I_B + I_C = I_B + \alpha_{dc} I_E + I_{CBO}$$

$$\therefore \quad I_E(1-\alpha_{dc}) = I_B + I_{CBO}$$

$$\therefore \quad I_E = \frac{I_B}{1-\alpha_{dc}} + \frac{I_{CBO}}{1-\alpha_{dc}}$$

We know that

$$\beta_{dc} = \frac{\alpha_{dc}}{1-\alpha_{dc}}$$

$$\therefore \quad 1+\beta_{dc} = 1+\frac{\alpha_{dc}}{1-\alpha_{dc}} = \frac{1-\alpha_{dc}+\alpha_{dc}}{1-\alpha_{dc}} = \frac{1}{1-\alpha_{dc}}$$

$$\therefore \quad I_E = I_B(1+\beta_{dc}) + I_{CBO}(1+\beta_{dc})$$

Neglecting I_{CBO} we have

$$I_E = I_B(1+\beta_{dc})$$

$\therefore$ Current gain in CC configuration is given by

$$\gamma = \frac{I_E}{I_B} = (1+\beta_{dc}) = 1+\frac{\alpha_{dc}}{1-\alpha_{dc}} = \frac{1}{1-\alpha_{dc}}$$

4.7.3.2 Common Collector Input Characteristics

- The input characteristics of CC configuration is a graph of input current I_B (base current) versus input voltage V_{CB} (collector base voltage) at constant V_{CE}.
- The base current is taken along Y-axis and collector base voltage V_{CB} is taken along X-axis.

- Fig. 4.7.13 shows the input characteristics of a typical transistor in common-collector configuration.
- The common collector input characteristics are quite different from either common base or common emitter input characteristics. This difference is due to the fact that the input voltage V_{CB} is largely determined by the level of collector to emitter voltage V_{CE}.

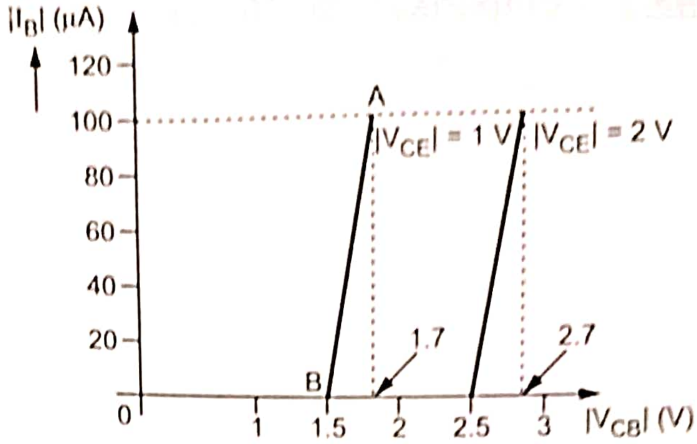


Fig. 4.7.13 Input characteristics of transistor in CC configuration

- Looking at Fig. 4.7.13 we can write,

$$V_{CE} = V_{CB} - V_{BE}$$

or

$$V_{CB} = V_{CE} + V_{BE}$$

- In CC configuration input junction is BC and it is reversed biased so input resistance in CC configuration is very high.

4.7.3.3 Common Collector Output Characteristics

- It is the curve between emitter current I_E and collector to emitter voltage V_{CE} at constant base current I_B.
- The emitter current is taken along Y-axis and collector to emitter voltage along X-axis.
- Fig. 4.7.14 shows the output characteristics of a typical transistor in common collector configuration.

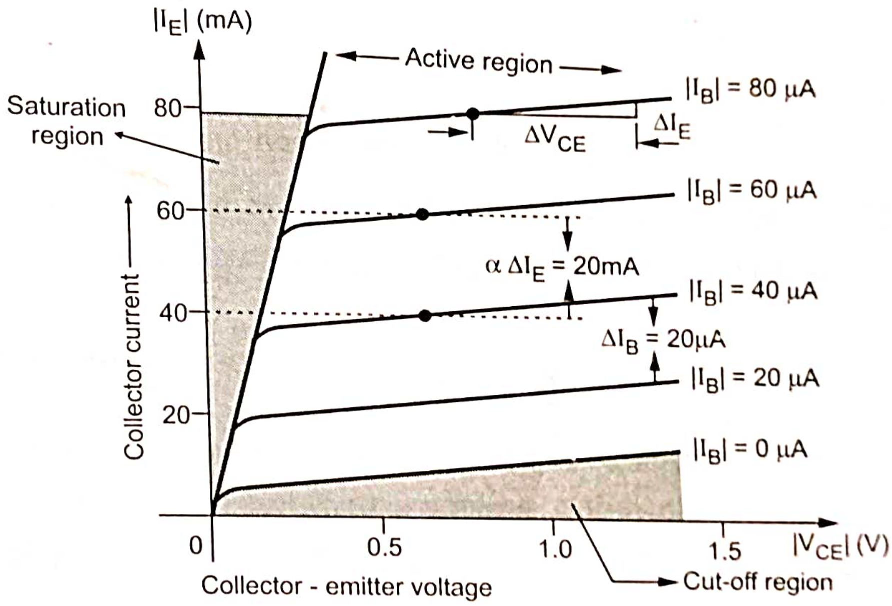


Fig. 4.7.14 Output characteristics of the transistor in CC configuration

- Since, I_C is approximately equal to I_E, the common collector output characteristics are practically similar to those of the common emitter output characteristics.