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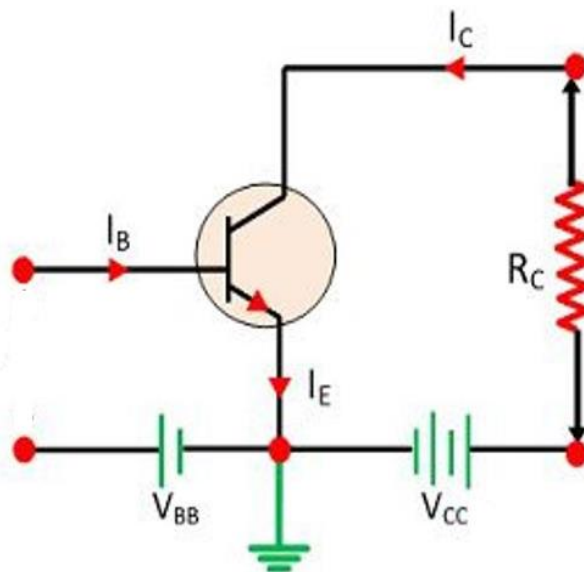
Topic:

Transistor: Characteristics of CB, CE and CC Configurations. Active, Cut-off & Saturation regions

TRANSISTOR

Characteristics of CB, CE and CC Configurations: A junction transistor has got three terminals-emitter, base and collector as well as it can be used as a two-port network with one of three terminals common to both input and output. Therefore, we have three different configuration or mode of connection of transistor.

- (i) **Common Emitter (CE) Mode:** When the emitter of a transistor is common to both input and output circuits, the transistor is called common emitter configuration (CE) or grounded emitter mode.
- (ii) **Common base (CB) Mode:** When the base of a transistor is common to both input and output circuits, the transistor is called common emitter configuration (CE) or grounded emitter mode.
- (iii) **Common collector (CC) Mode:** When the collector terminal of a transistor is common to both input and output circuits, the transistor is called common emitter configuration (CE) or grounded emitter mode.

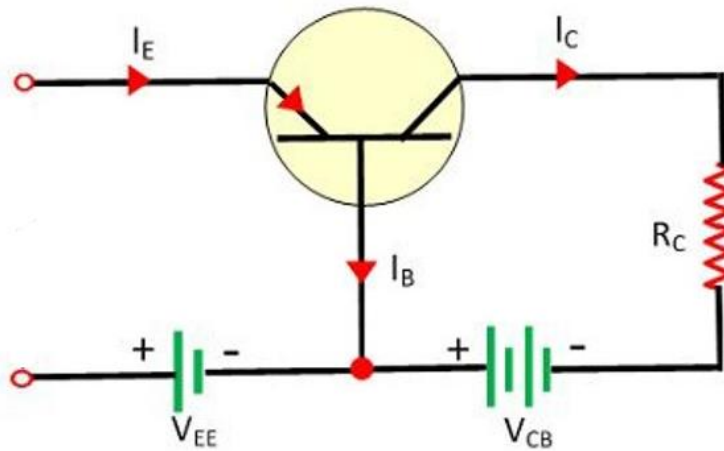


n-p-n Transistor with Common Emitter (CE) Configuration

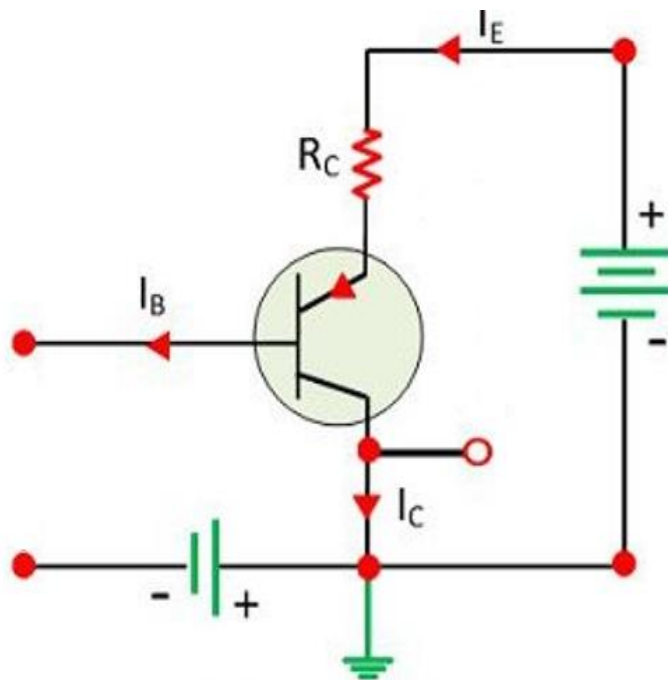
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n-p-n Transistor with Common Base (CB) Configuration

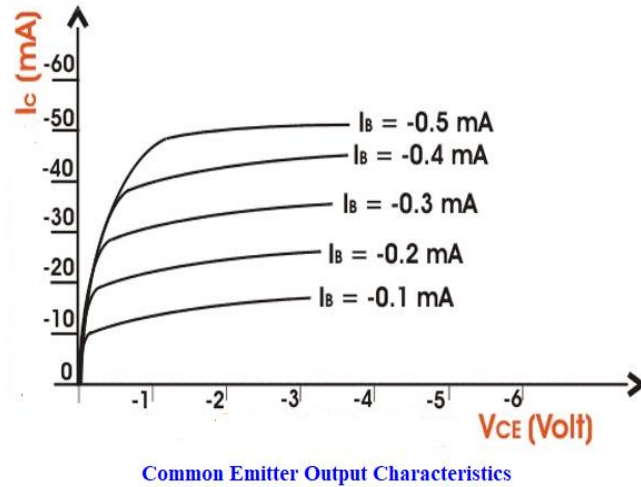
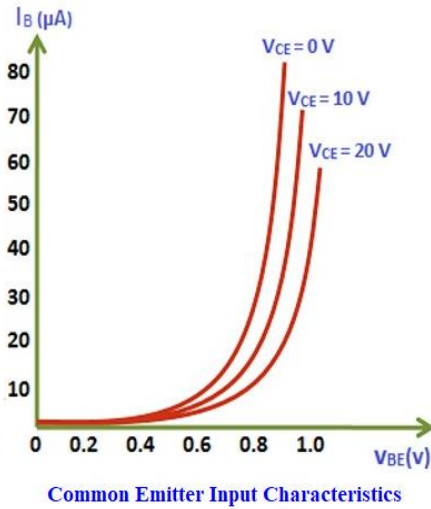


n-p-n Transistor with Common Collector (CC) Configuration

Common Emitter Input and Output Characteristics

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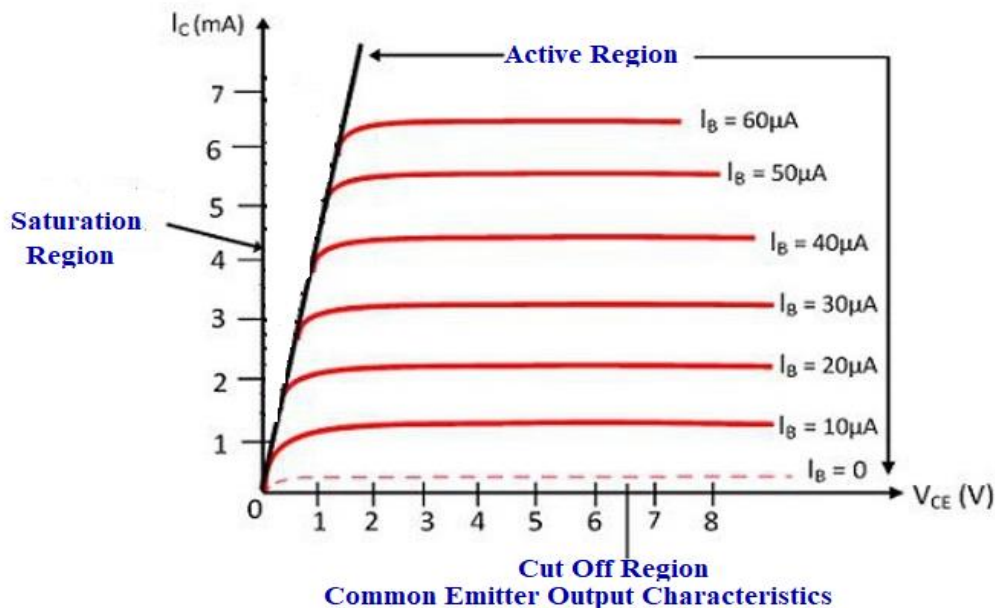


(i) Common Emitter Input Characteristics

For Common Emitter (CE)input Characteristics, we plot $I_B (\mu A)$ vs V_{BE} (Volt) where Collector to Emitter voltage (V_{CE}) become constant. The characteristics curve are similar to that of forward biased p-n junction diode. For, constant V_{BE} , I_B decreases with increase in V_{CE} . Increase in V_{CE} decreases the effective base width. As a result, the recombination base current decreases.

(ii) Common Emitter Output Characteristics

For Common Emitter (CE)input Characteristics, we plot I_C (mA) vs V_{CE} (Volt) where the base current (I_B) become constant. Here, we get three region-(i) Active (ii) Saturation (iii) Cut-off Region.



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Active Region:

In active region, the emitter base junction is forward bias and the collector base junction is reverse bias. This region is from, right to the ordinate $V_{CE} = V_{CEsat}$ and above the characteristics for $I_B = 0$. In this region the curves are straight and equispaced. In this region I_C increases rapidly with V_{CE} by considering the relation,

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

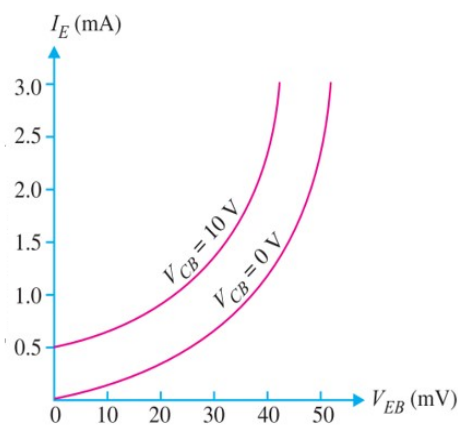
Cut off Region:

The cut off region is defined, $I_E = 0$, $I_B = -I_{CBO}$ and $I_C = I_{CBO}$. In cut off region, the emitter base junction is reverse bias and the collector base junction is reverse bias.

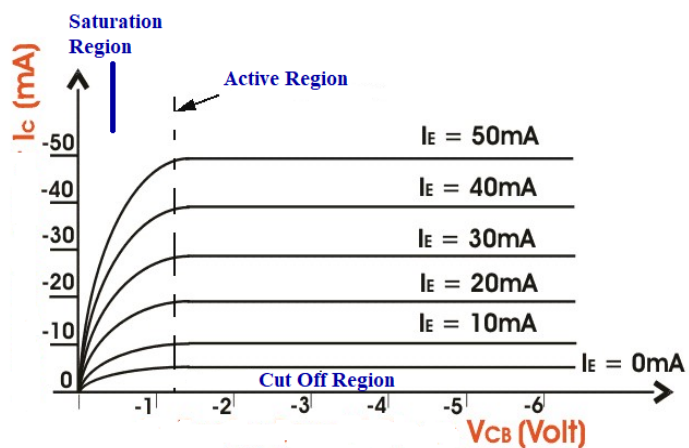
Saturation Region:

In saturation region, the emitter base junction is forward bias and the collector base junction is forward bias by at least the cut in voltage. This region is from, left of the ordinate $V_{CE} = V_{CEsat}$ where all the curves merge and fall rapidly towards origin is the saturation region. In this region, the collector current becomes almost independent of base current, for a given load and collector supply.

Common Base Input and Output Characteristics



Common Base Input Characteristics



Common Base Output Characteristics

(i) Common Base Input Characteristics

For Common Base (CB) input Characteristics, we plot I_E (mA) vs V_{EB} (Volt) where Collector to Base voltage (V_{CB}) become constant. The characteristics curve are similar to that of forward biased p-n junction diode. For, constant V_{EB} , I_E increases with increase in V_{CB} . Increase in V_{CB} increases the width of the depletion region of the collector base junction increases. This the effective base width.

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(ii) Common Base Output Characteristics

For Common Base (CB) input Characteristics, we plot I_C (mA) vs V_{CB} (Volt) where the emitter current (I_E) become constant. Here, we get three region-(i) Active (ii) Saturation (iii) Cut-off Region.

Active Region:

In active region, the emitter base junction is forward bias and the collector base junction is reverse bias. At the lower end of the active region, $I_E = 0$ and the collector current is simply I_{CBO} . Now, I_E , increases above zero, the I_C is given by

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

In this region, the I_C is almost independent of V_{CB}

Cut off Region:

The cut off region is defined the region right to the ordinate $V_{CB} = 0$ and below the characteristics for $I_E = 0$, is Cut-off region. In cut off region, the emitter base junction is reverse bias and the collector base junction is reverse bias.

Saturation Region:

In saturation region, the emitter base junction is forward bias and the collector base junction is forward bias. This region is from, left of the ordinate $V_{CB} = 0$ and above the characteristics $I_E = 0$ is the saturation region.

Frequently Asked Questions:

1. With proper circuit symbol, explain CE, CB, CC mode input and output characteristics of transistor.

Numerical:

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References:

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- (ii) Electronics-Fundamental & Applications- Author- P.C. Rakshit & D. Chattopaddhayay, Published by New Age. (2018 Ed.).
- (iii) <https://circuitglobe.com/> (Images are taken only for class teaching)
- (iv) <https://instrumentationtools.com/> (Images are taken only for class teaching)
- (v) <https://www.physics-and-radio-electronics.com/> (Images are taken only for class teaching)
- (vi) <https://www.quora.com/> (Images are taken only for class teaching)

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(vii) <https://www.researchgate.net/>*(Images are taken only for class teaching)*