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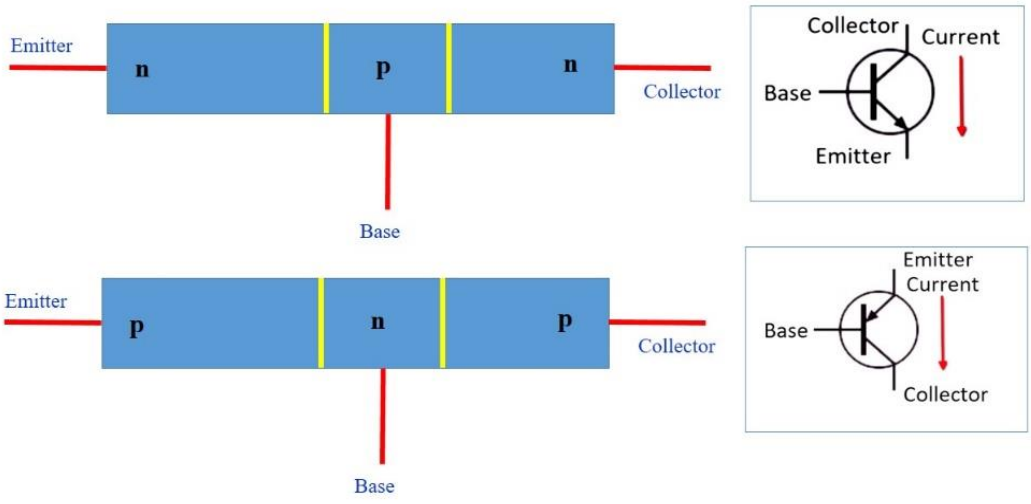
Topic:

Transistor: n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC Configurations. Current gains α and β Relations between α and β. Load Line analysis of Transistors. DC Load line and Q-point.

TRANSISTOR

N-P-N Transistor: We know that a transistor is a semiconductor device applied for switching or amplification purpose. Junction transistor is two type-(i) n-p-n (ii) p-n-p.If a layer of p-type material is sandwich between two n-type layers, the transistor is called n-p-n transistor.

P-N-P Transistor: Whereas, a layer of n-type material is sandwich between two p-type layers, the transistor is called p-n-p transistor.



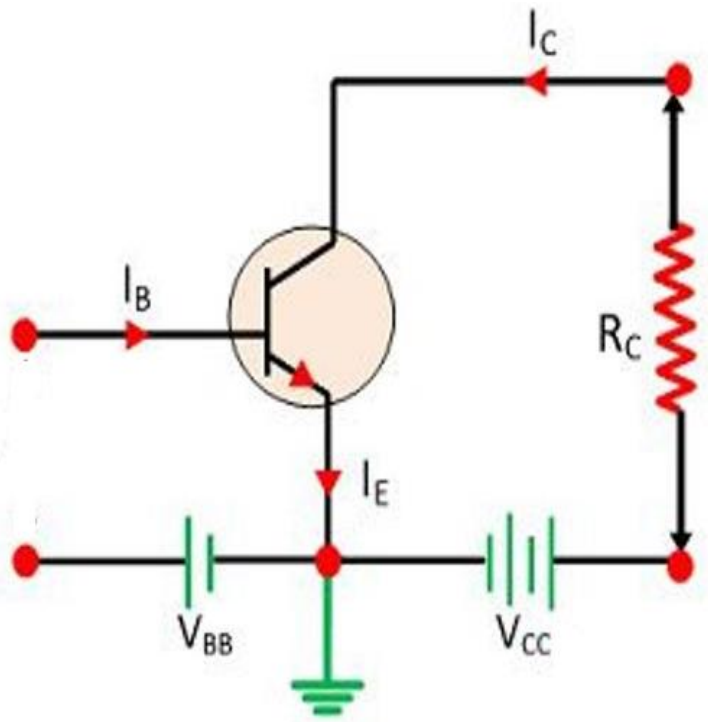
Characteristics of CB, CE and CC Configurations:A junction transistor has got three terminals-emitter, base and collector as well as it can be used as a two-port network

with one 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 baseof 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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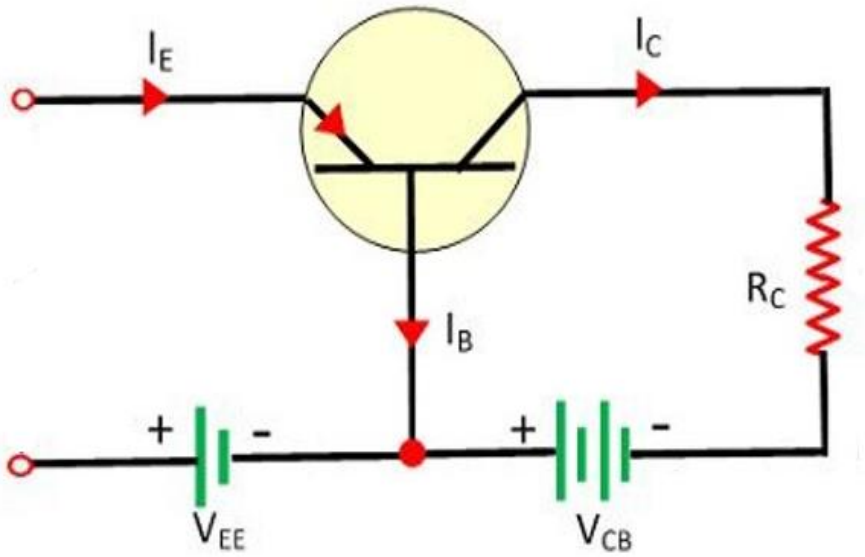
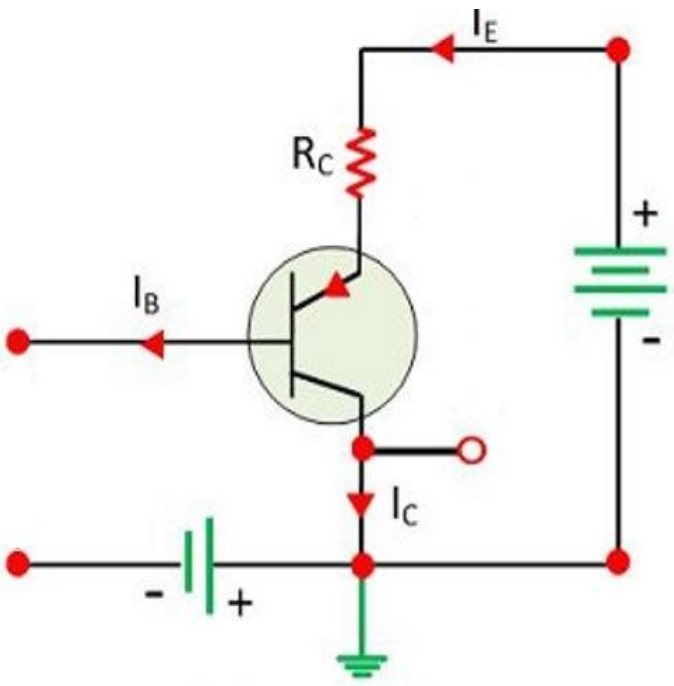


n-p-n Transistor with Common Base (CB) Configuration



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

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Transistor (α and β) and Current Gain: The collector current consists of two components, the collector to base reverse saturation current and the predominant portion representing a part of the emitter current reaching the collector. Therefore,

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

Where, $[\alpha = transistor\ alpha]$

$$\alpha_{dc} = \frac{I_C}{I_E}$$

If we take I_{CBO} is very very less than I_c

Therefore, $I_c = \alpha I_E$

$$\alpha_{ac} = \frac{\Delta I_C}{\Delta I_E} \Big| V_{CB=Constant}$$

We know that, $I_E = I_B + I_C$

Therefore, $I_c = \frac{\alpha}{1-\alpha} I_B + \frac{1}{1-\alpha} I_{CBO}$

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

Therefore, $\beta = \frac{\alpha}{1-\alpha}$ [This is the relation between α and β]

$$\beta_{dc} = \frac{I_C}{I_B} = h_{FE}$$

$$\beta_{ac} = \frac{\Delta I_C}{\Delta I_B} \Big| V_{CE=Constant} = h_{fe}$$

Transistor Load Line & Q-point:

For better operation and stability of circuit of transistor we have to require the determination of the collector current for various collector-emitter voltages.It can be done by load line analysis.

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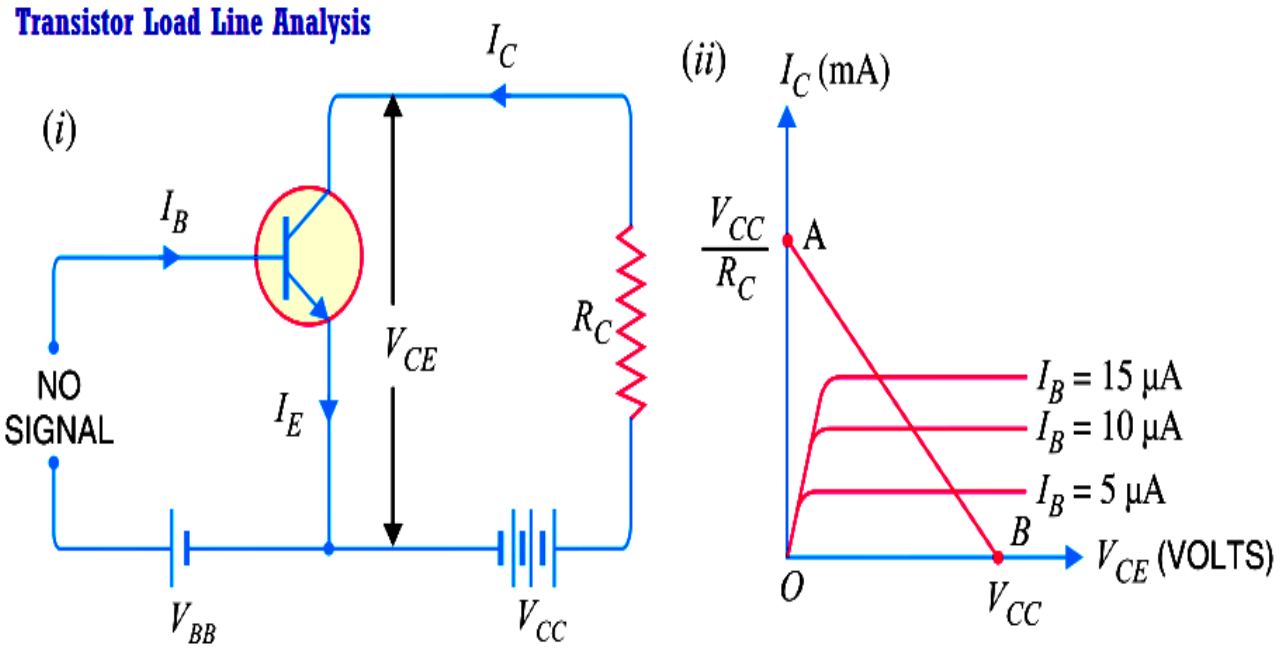
The resistance R_C connected to the transistor circuit is called load or load resistance therefore, the line is called the load line.



From the analysis of circuit,

$$V_{CC} = I_C R_C + V_{CE}$$

This equation represent a straight line in V_{CE}-I_C plane. It is called d.c load line. To find the **Q**-point this d.c. load line is plotted on the output characteristics curves as a line connecting the points **(0,** $\frac{V_{CC}}{R_C}$**) and (**V_{CC} **,** I_C**).** The coordinates of the points intersecting the load line and the characteristics curve to a fixed value of input current gives the actual d.c. value of collector current (I_C) flowing through the circuit and the d.c. value of collector to emitter voltage (V_{CE})operating across the transistor. The point is called **Q-point**.

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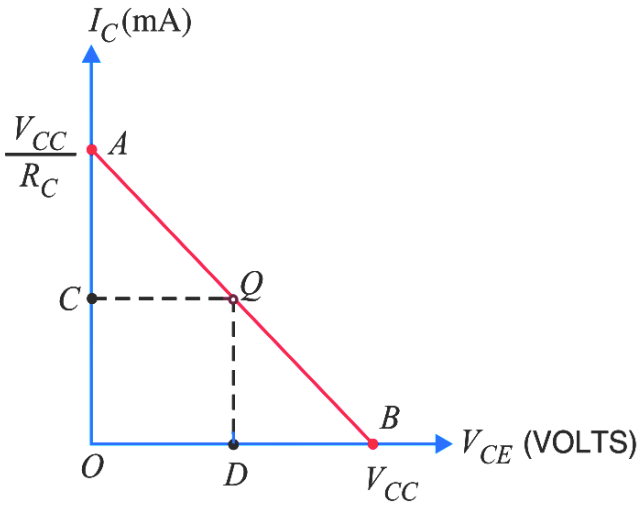

Frequently Asked Questions:

1. *Draw the circuit symbol and diagram of n-p-n and p-n-p transistor.*
2. *With proper circuit symbol, explain CE, CB,CC mode of p-n-p and n-p-n transistor.*
3. *With proper circuit diagram explain load line and Q-point*
4. *Explain* $\beta_{dc}, \beta_{ac}, \alpha_{dc}, \alpha_{ac}$.
5. ***Prove the relation:*** (i) $I_c = \frac{\alpha}{1-\alpha} I_B + \frac{1}{1-\alpha} I_{CBO}$

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

Frequently Asked Questions:

Solved Problems and Problems in exercise of Fundamental Principles of Electronics, Author B.Ghosh,

References:

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