EEE-2103: Electronic Devices and Circuits

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Common-Base Configuration

Alpha (α)

Current gain in CB configuration.

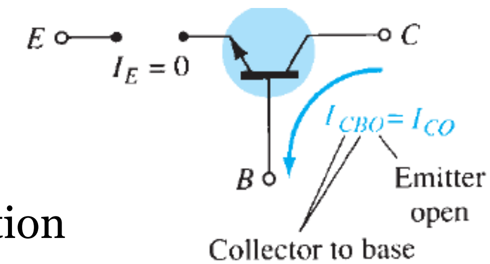
$\alpha = I_C/I_E$

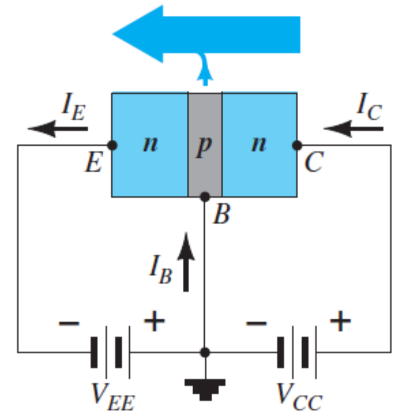
$\approx 1 = 0.9 \sim 0.998$

I_C and I_E = levels of current at point of operation

α is defined solely for majority carriers →

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





Common-Emitter Configuration

Most frequently encountered configuration

CE configuration →

emitter is common to both input and output

common to both base and collector

Two sets of characteristics →

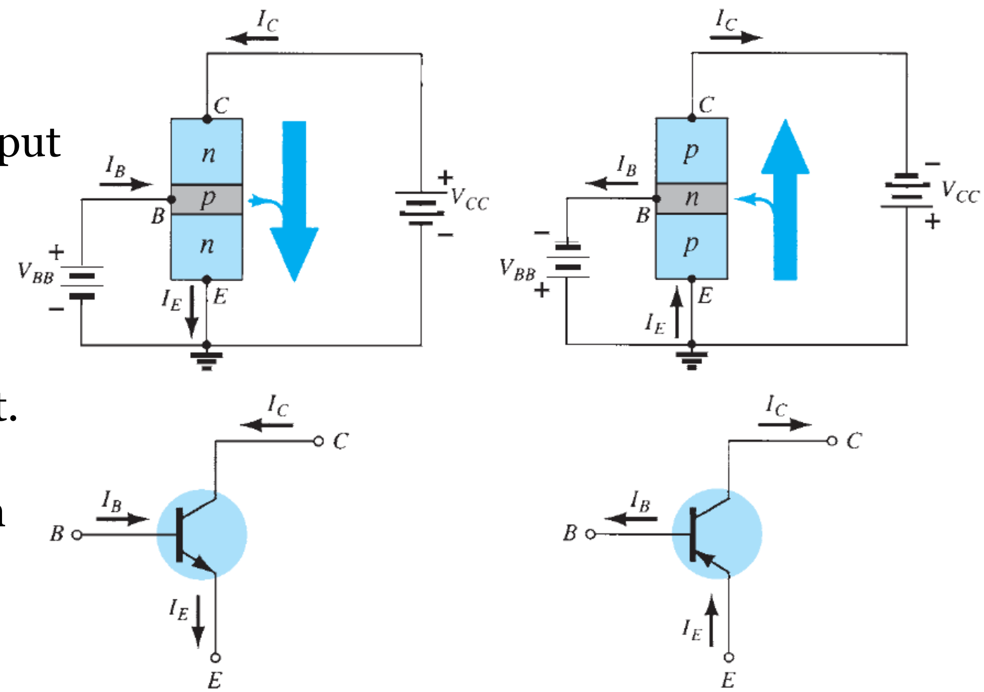
one for input or base-emitter circuit

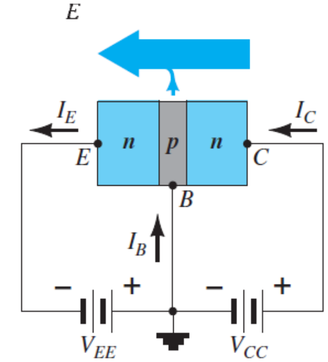
one for output or collector-emitter circuit.

Current relations for common-base configuration are applicable →

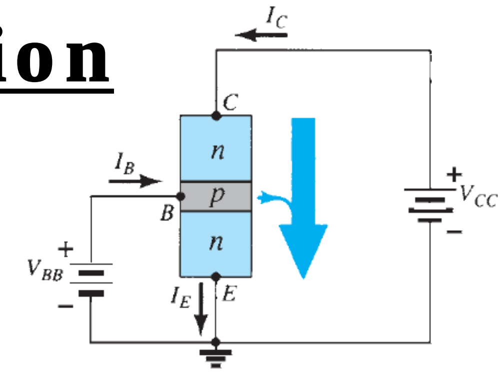
$I_E = I_C + I_B$

$I_C = \alpha I_E$





Common-Emitter Configuration

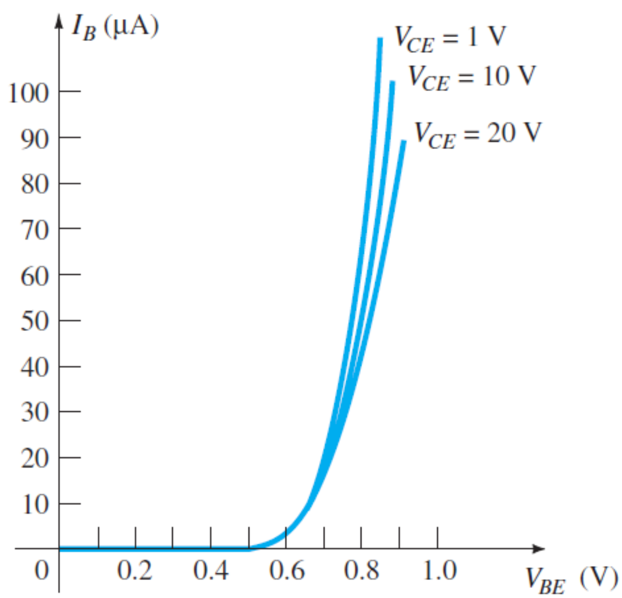


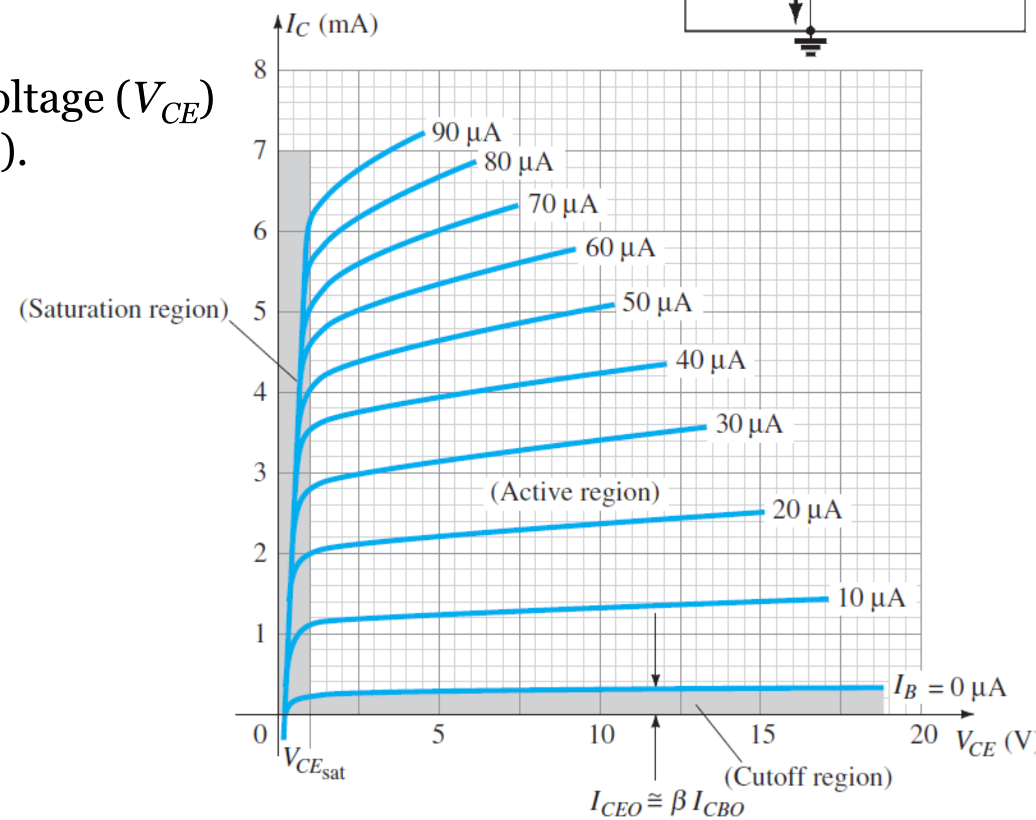
Input characteristics →

input current (I_B) versus input voltage (V_{BE})
range of values of output voltage (V_{CE}).

Output characteristics →

output current (I_C) versus output voltage (V_{CE})
range of values of input current (I_B).





Common-Emitter Configuration

Output characteristics →

V_{CE} influences I_C

Active region →

region in which curves for I_B are nearly straight and equally spaced.

base-emitter junction is forward-biased, collector-base junction is reverse-biased.

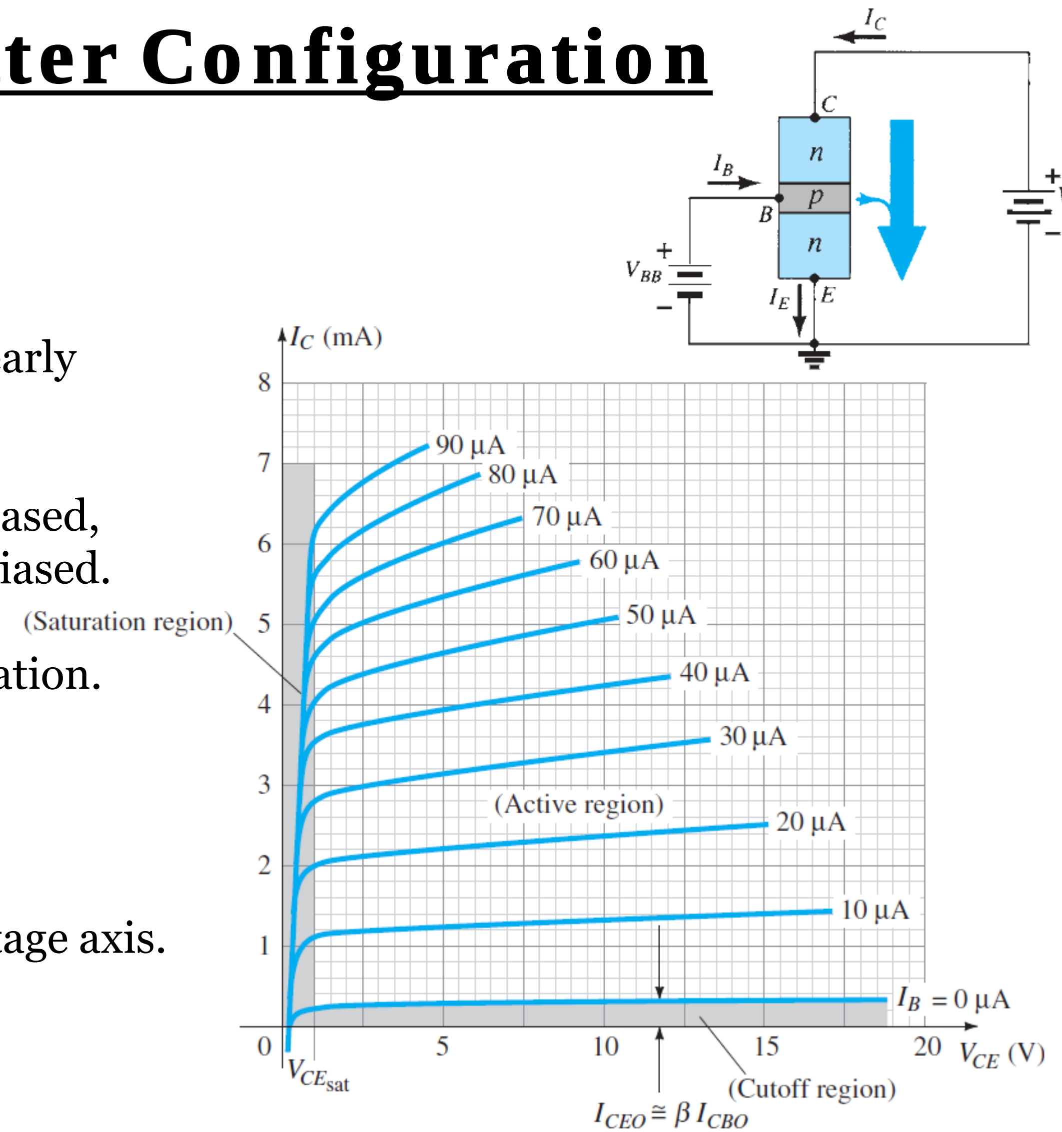
voltage, current, or power amplification.

Cutoff region →

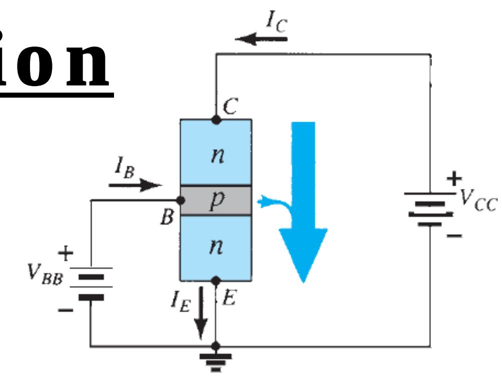
$I_C \neq 0$ when $I_B = 0$.

CB configuration →

$I_E = 0$, $I_C = I_{CO}$, curve $I_E = 0$ == voltage axis.



Common-Emitter Configuration



Cutoff region →

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

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

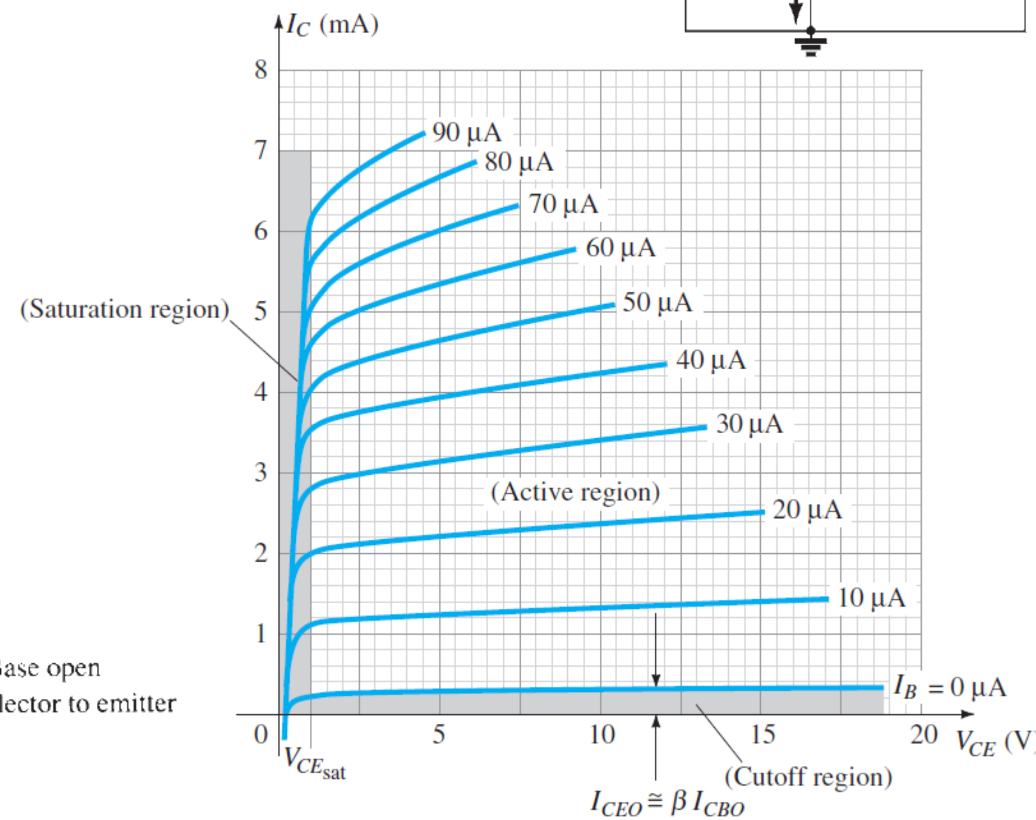
$I_B = 0$ and $\alpha = 0.996$

$$I_C = \frac{\alpha(0)}{1-\alpha} + \frac{I_{CBO}}{1-0.996} = 250 I_{CBO}$$

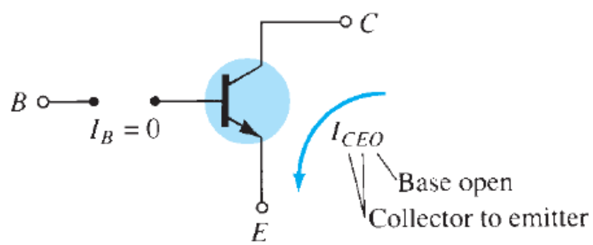
$$I_C = I_{CEO} = \left.\frac{I_{CBO}}{1-\alpha}\right|_{I_B=0\ \mu A}$$

If $I_{CBO} = 1\ \mu A$, $I_B = 0$ A →

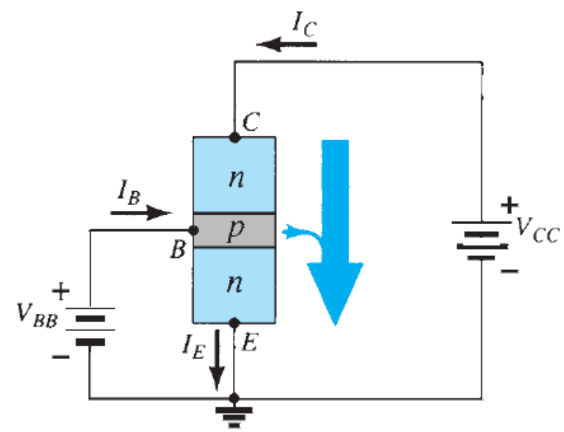
$I_C = 250(1\ \mu A) = 0.25$ mA



region below $I_B = 0$ mA is to be avoided if undistorted output signal is required.



Common-Emitter Configuration



Beta (β):

Common-emitter, forward-current, amplification factor.

$\beta = I_C/I_B \approx$ 50 to over 400

referred to as h_{FE}

[h = hybrid equivalent circuit]

Relationship between β and α:

$\beta = I_C/I_B \rightarrow I_B = I_C/\beta$

$\alpha = I_C/I_E \rightarrow I_E = I_C/\alpha$

$I_E = I_C + I_B$

$I_C/\alpha = I_C + I_C/\beta \rightarrow 1/\alpha = 1 + 1/\beta$

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

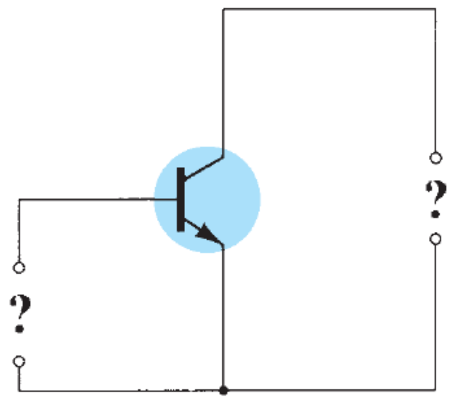
$\alpha = \frac{\beta}{\beta+1}$ and $\beta = \frac{\alpha}{1-\alpha}$

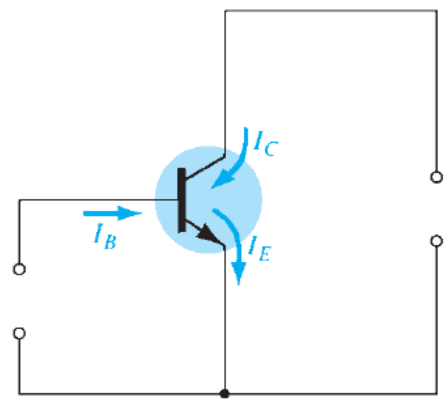
$I_C = \beta I_B$

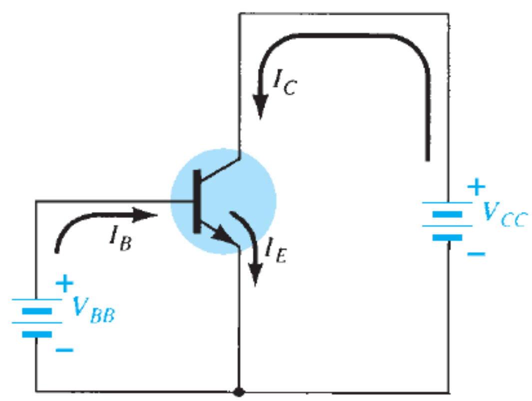
$I_E = I_C + I_B = \beta I_B + I_B = (\beta + 1)I_B$

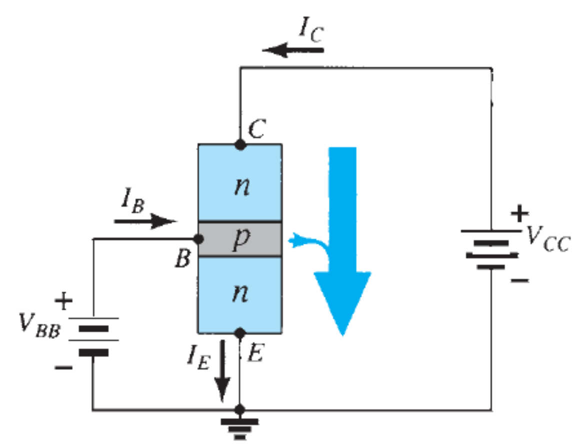
Common-Emitter Configuration

Biasing in active region:









Common-Collector Configuration

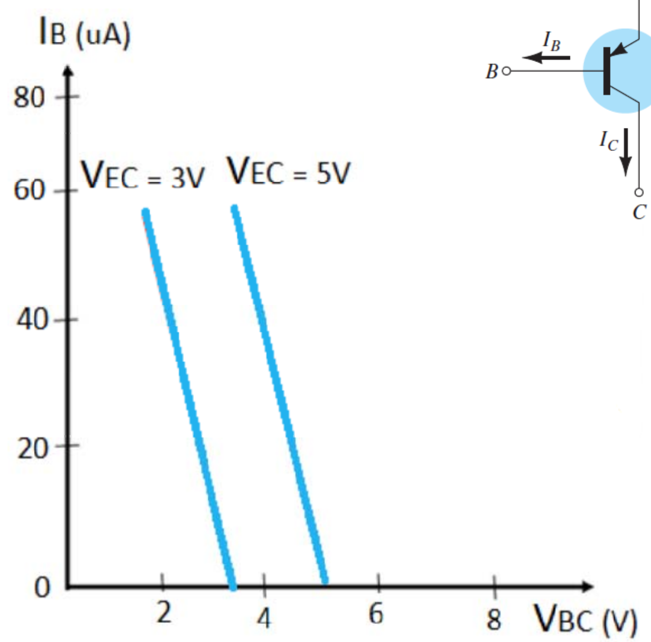
Used for impedance-matching purposes.
High input impedance and low output impedance.

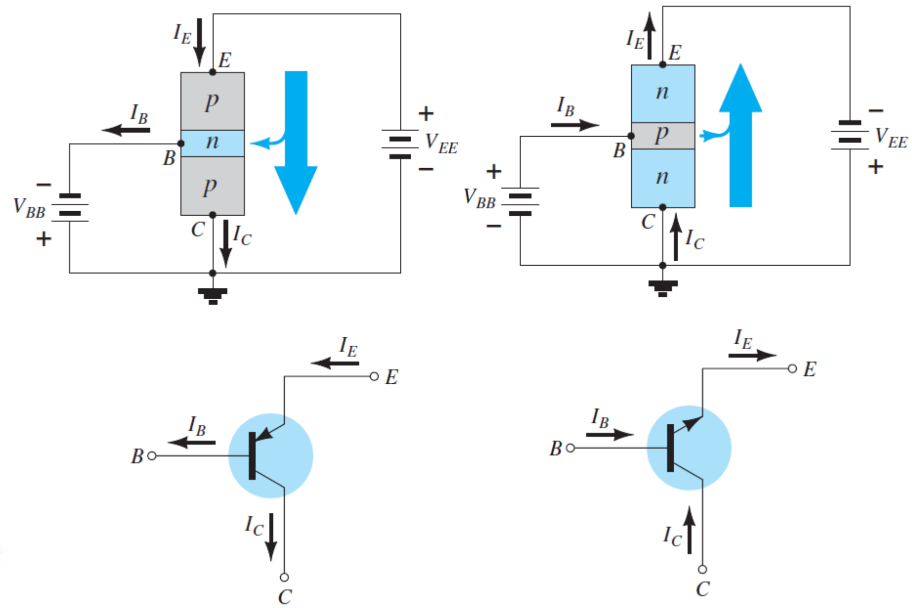
Input characteristics →

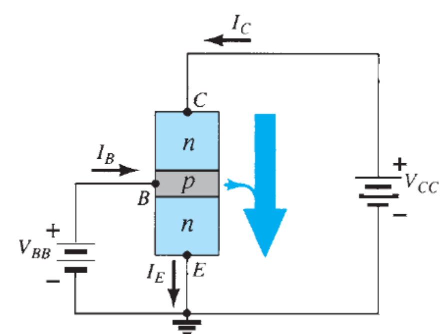
I_B decreases as V_{BC} is increased

Drop in I_B is delayed if V_{EC} is increased

$V_{EC} = V_{EB} + V_{BC} \rightarrow V_{EB} = V_{EC} - V_{BC}$
Increasing V_{BC} with V_{EC} = const.
Reduces $V_{EB} \rightarrow$ reduces I_B







Common-Collector Configuration

Output characteristics of CC configuration = Output characteristics for CE configuration.

Output characteristics → plot of I_E versus V_{CE} range of values of I_B.

$$I_C = \alpha I_E \rightarrow I_C \approx I_E \; [\alpha \approx 1]$$