University of Anbar
College of Engineering
Dept. of Electrical Engineering

Fundumantal of Electronic I

Second Class

Chapter 3 : BJT Transistors
Lec03_p2

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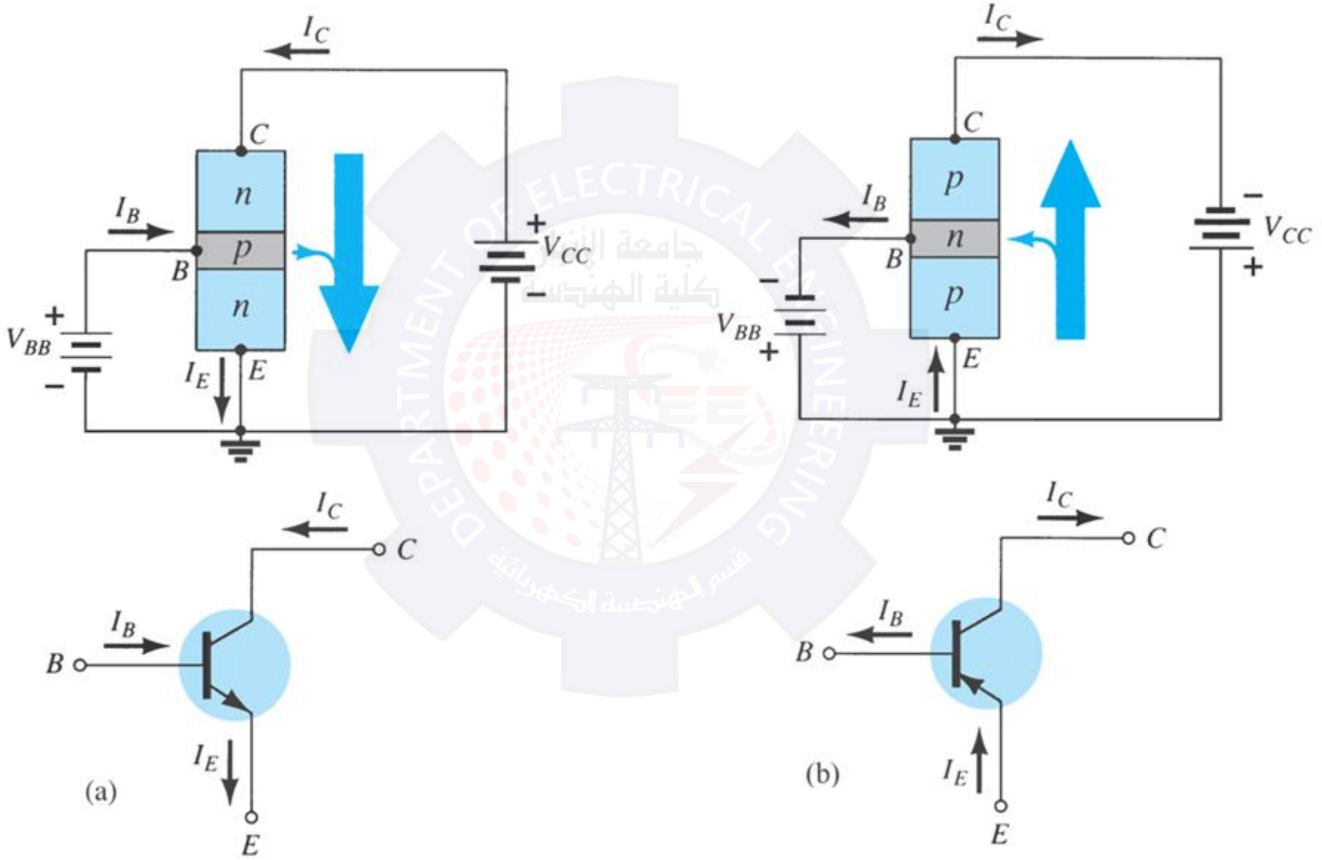
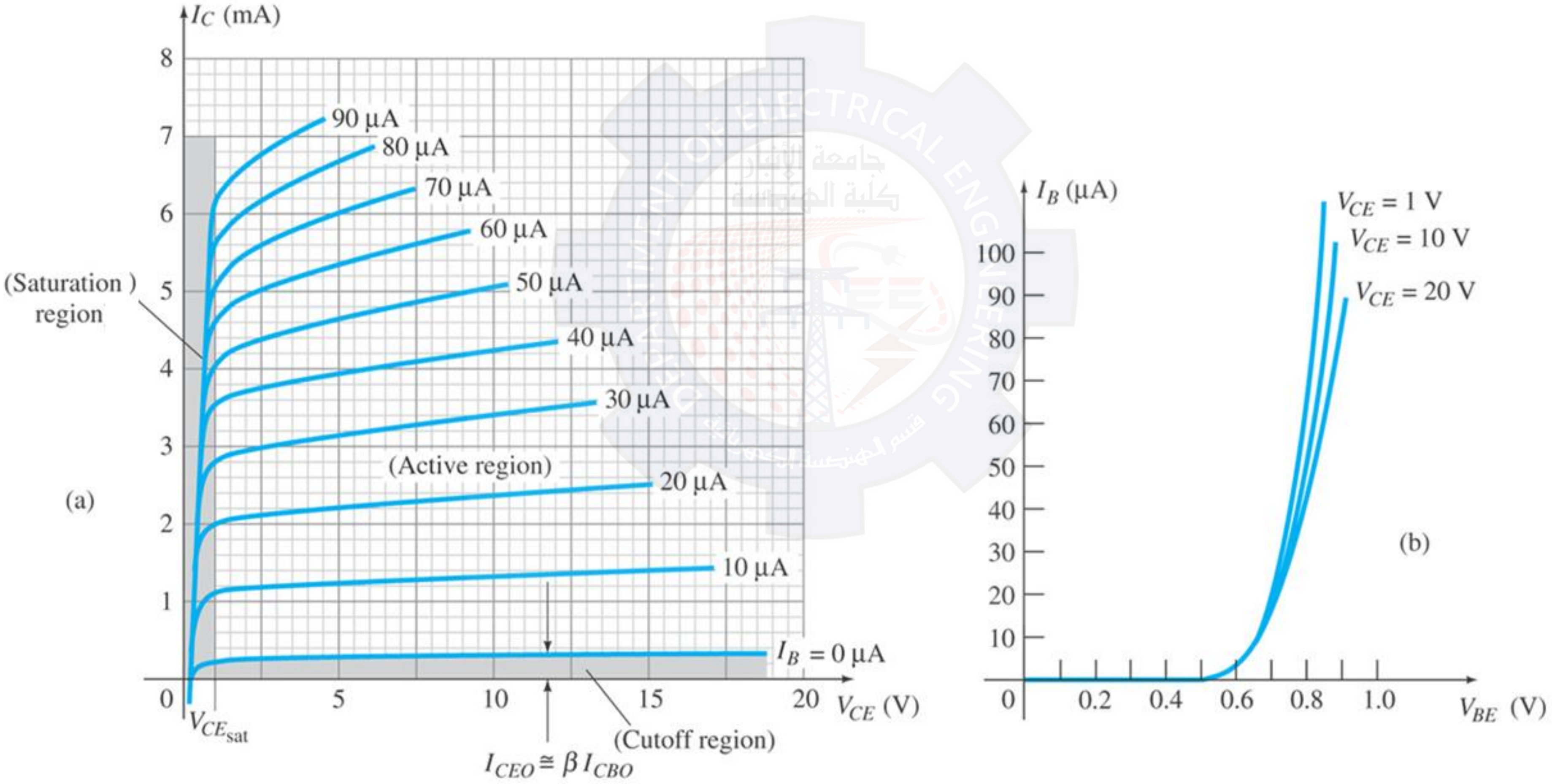
Common–Emitter Configuration



•The emitter is common to both input (base-emitter) and output (collector-emitter).
•The input is on the base and the output is on the collector.

Common-Emitter Characteristics



(a) collector characteristics; (b) base characteristics.

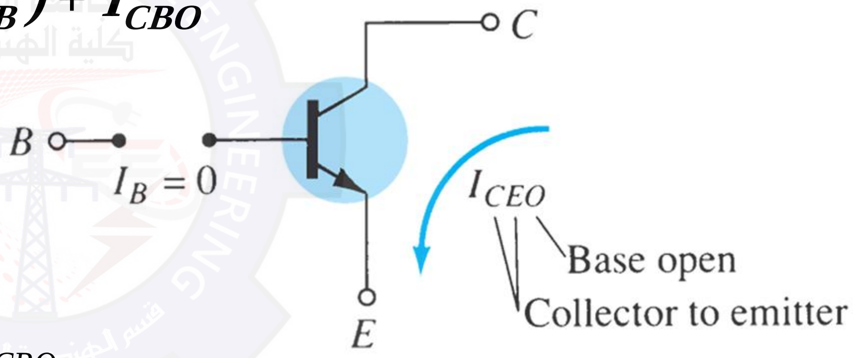
Common-Emitter Amplifier Currents

$I_C = \alpha I_E + I_{CBO}$ **where I_{CBO} = minority collector current**

I_{CBO} is usually so small that it can be ignored, except in high power transistors and in high temperature environments.

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

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



For I_B=0, and take $\alpha = 0.996$,

$$I_C = \frac{\alpha(0\text{ A})}{1-\alpha} + \frac{I_{CBO}}{1-0.996} = \frac{I_{CBO}}{1-0.996} = \frac{I_{CBO}}{0.004} = 250 I_{CBO}$$

If I_{CBO} were 1 μA, the resulting collector current with I_B=0 A would be 250(1 μA) =0.25 mA, as reflected in the characterestics.

When I_B = 0 µA the transistor is in cutoff, but there is some minority current flowing called I_{CEO}.

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

Beta (β)

β represents the amplification factor of a transistor. (β is sometimes referred to as h_{fe}, a term used in transistor modeling calculations)

In DC mode:

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

For practical devices β is typically 50 to over 400.

In AC mode:

$$\beta_{ac} = \frac{\Delta I_C}{\Delta I_B}\bigg|_{V_{CE}=\text{constant}}$$

Beta (β)

Determining β from a Graph

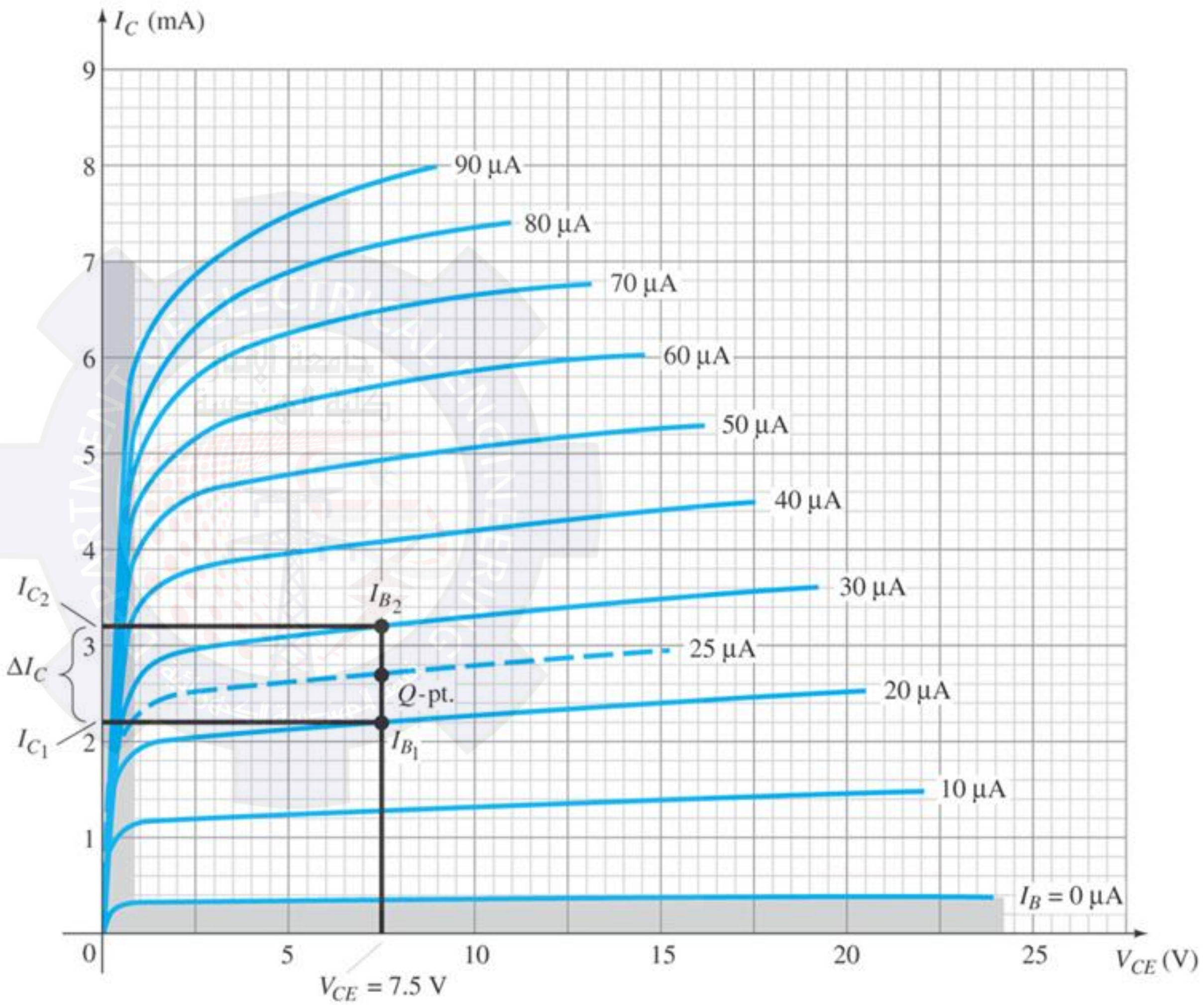
$$\beta_{AC} = \frac{(3.2\,\text{mA} - 2.2\,\text{mA})}{(30\,\mu\text{A} - 20\,\mu\text{A})}$$

$$= \frac{1\,\text{mA}}{10\,\mu\text{A}}\bigg|_{V_{CE}=7.5}$$

$$= 100$$

$$\beta_{DC} = \frac{2.7\,\text{mA}}{25\,\mu\text{A}}\bigg|_{V_{CE}=7.5}$$

$$= 108$$



β_{ac} and β_{dc} are usually reasonably close and are often used interchangeably.

Beta (β)

Relationship between amplification factors β and α :-

$$\text{using } \beta = \frac{I_C}{I_B} \ , \ \alpha = \frac{I_C}{I_E}$$

$$\textit{and} \qquad I_E = I_C + I_B$$

$$\frac{I_C}{\alpha} = I_C + \frac{I}{\beta} \rightarrow \frac{1}{\alpha} = 1 + \frac{1}{\beta}$$

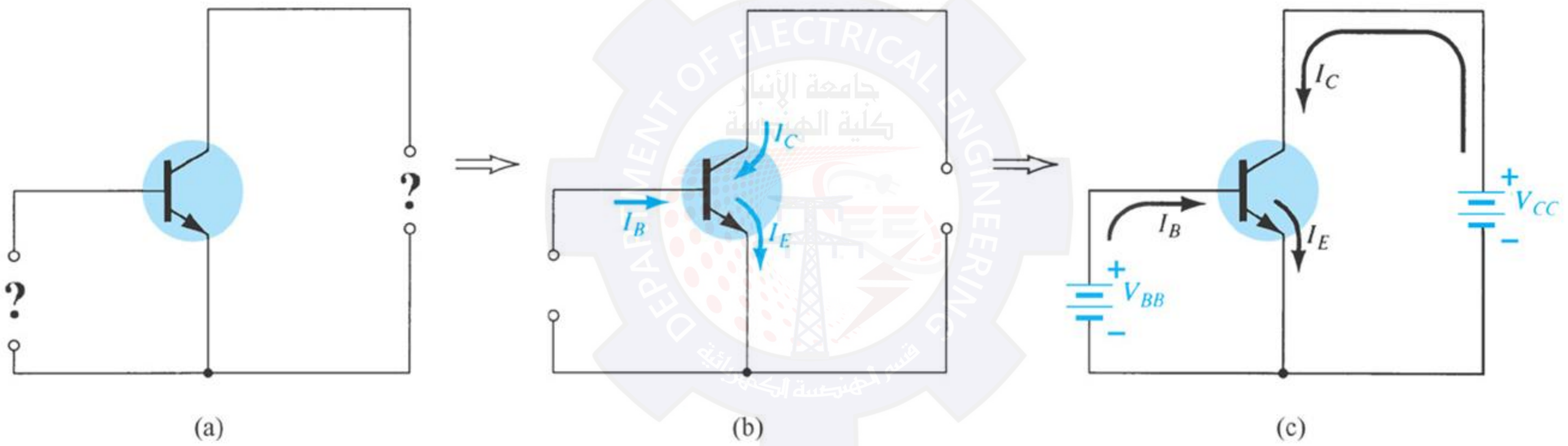
$$\beta = \alpha\beta + \alpha = (\beta + 1)\alpha$$

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

Relationship Between Currents

$$\boxed{\mathbf{I_C = \beta I_B}} \quad , \ I_E = I_C + I_B = \beta I_B + I_B \ , \quad \boxed{\mathbf{I_E = (\beta + 1) I_B}}$$

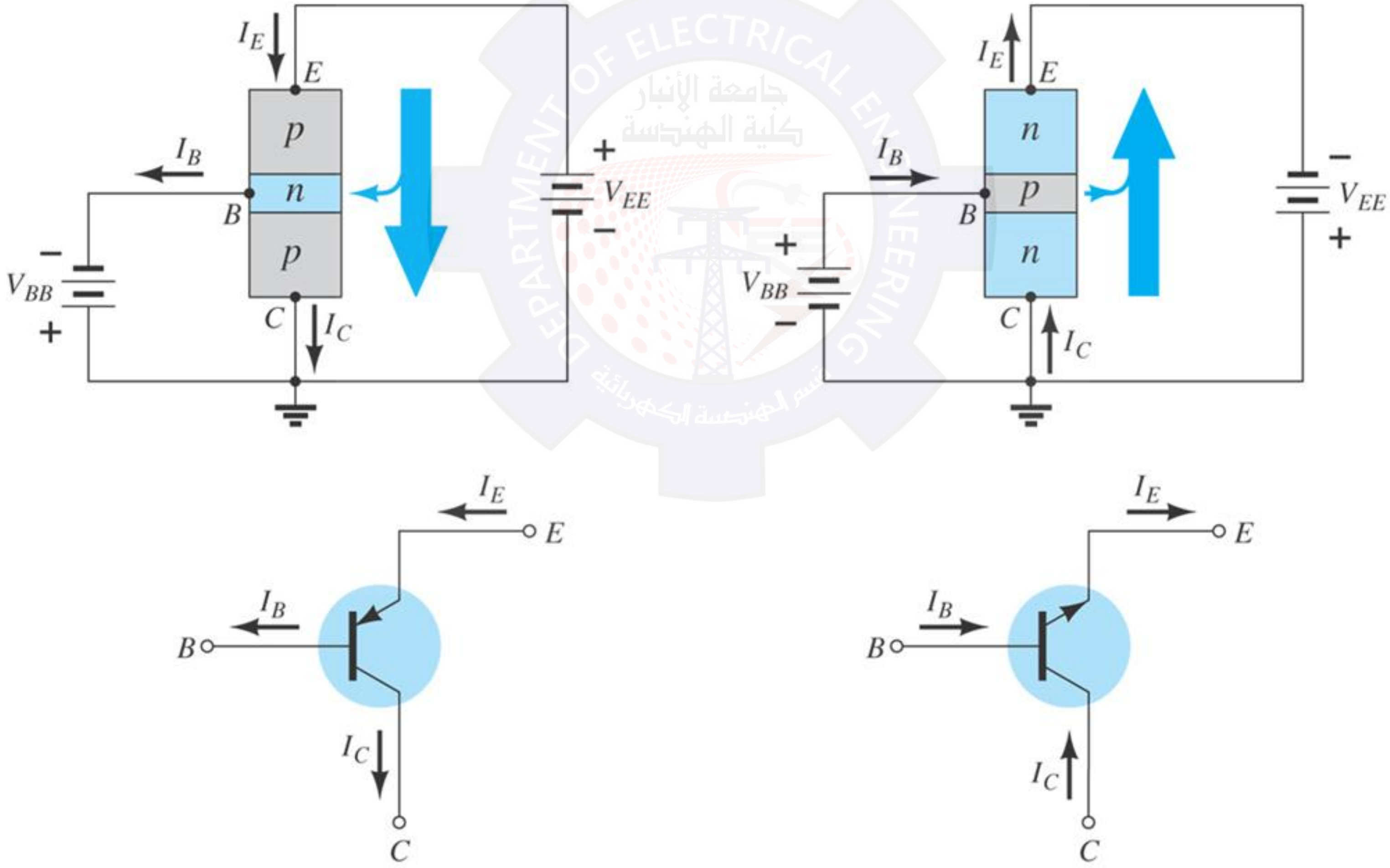
Biasing



Determining the proper biasing arrangement for a common-emitter ***npn*** transistor configuration.

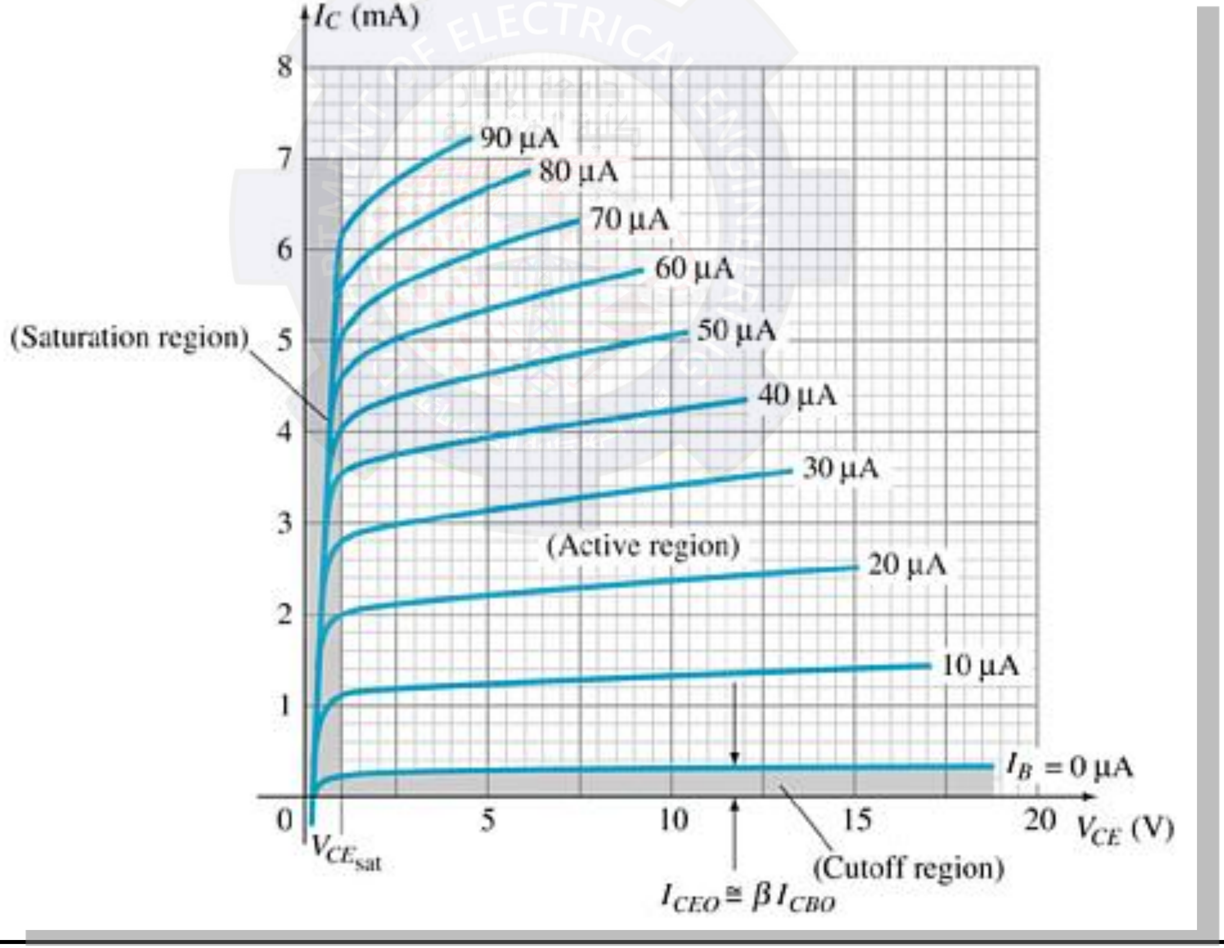
Common–Collector Configuration

The input is on the base and the output is on the emitter.



Common–Collector Configuration

The characteristics are similar to those of the common-emitter configuration, except the vertical axis is I_E.

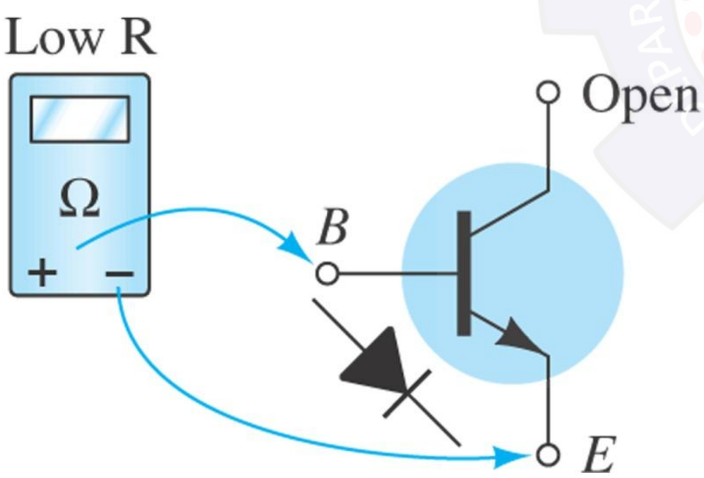


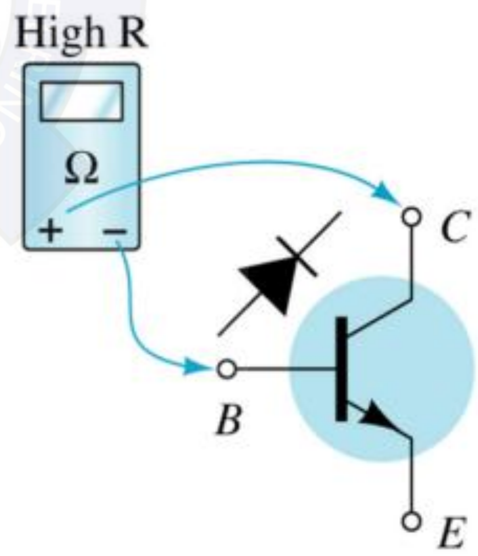
Transistor Testing

- DMM

  Some DMMs measure β_{DC} or h_{FE}.

- Ohmmeter





Checking the forward-biased base-to-emitter junction of an npn transistor.

Checking the reverse-biased base-to-collector junction of an npn transistor.

(a) (b) (c)

Various types of general-purpose or switching transistors:
(a) low power; (b) medium power; (c) medium to high power.