# ELECTRONICS DEVICES AND CIRCUITS

## OBJECTIVE

# BJT

# Common-Emitter Configuration

- It is called common-emitter configuration since :

  **- emitter is common or reference to both input and output terminals.**

  **- emitter is usually the terminal closest to or at ground**

  potential.
- Almost amplifier design is using connection of CE due to the high gain for current and voltage.
- Two set of characteristics are necessary to describe the behavior for CE ;input (base terminal) and output (collector terminal) parameters.

# Proper Biasing common-emitter configuration in active region

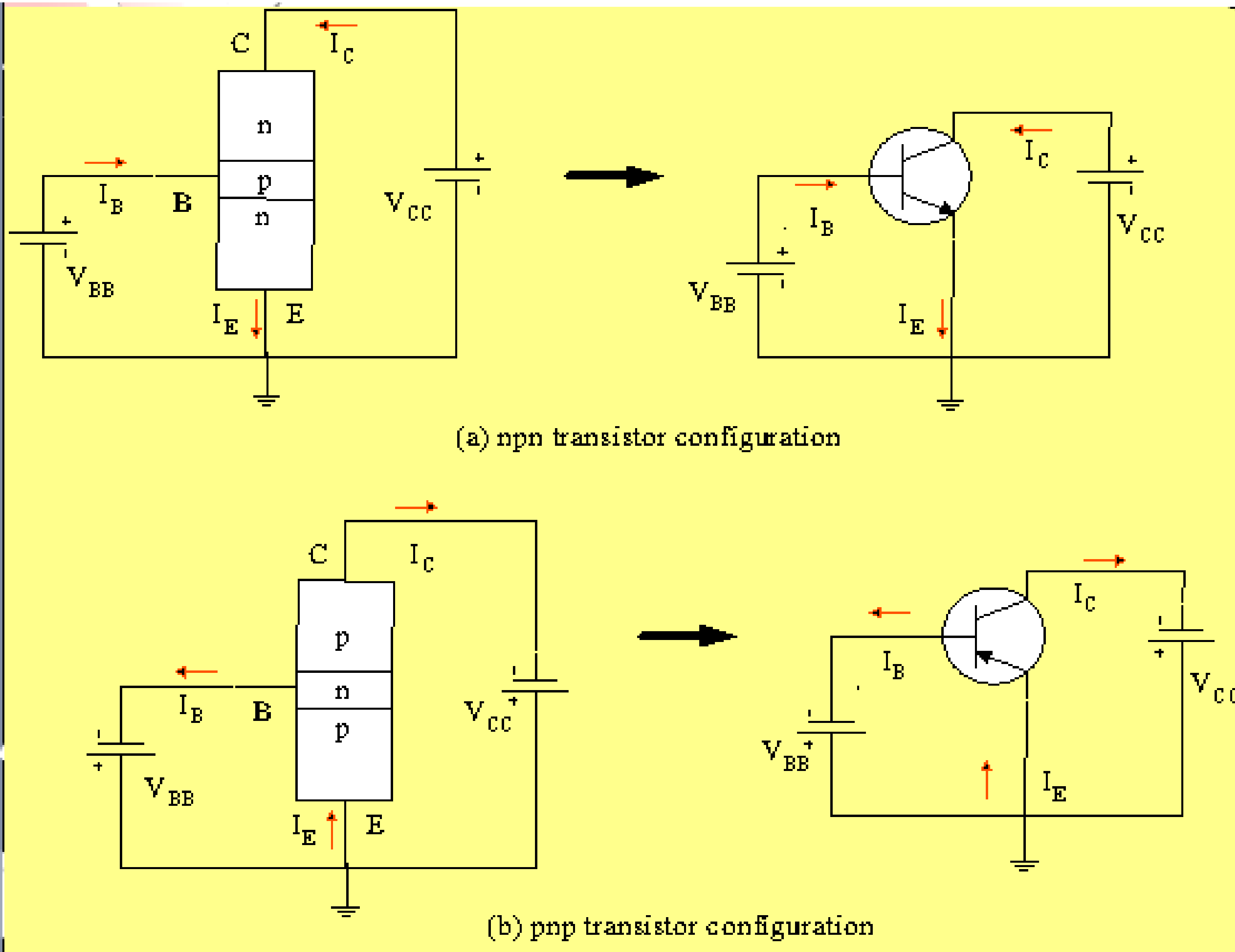
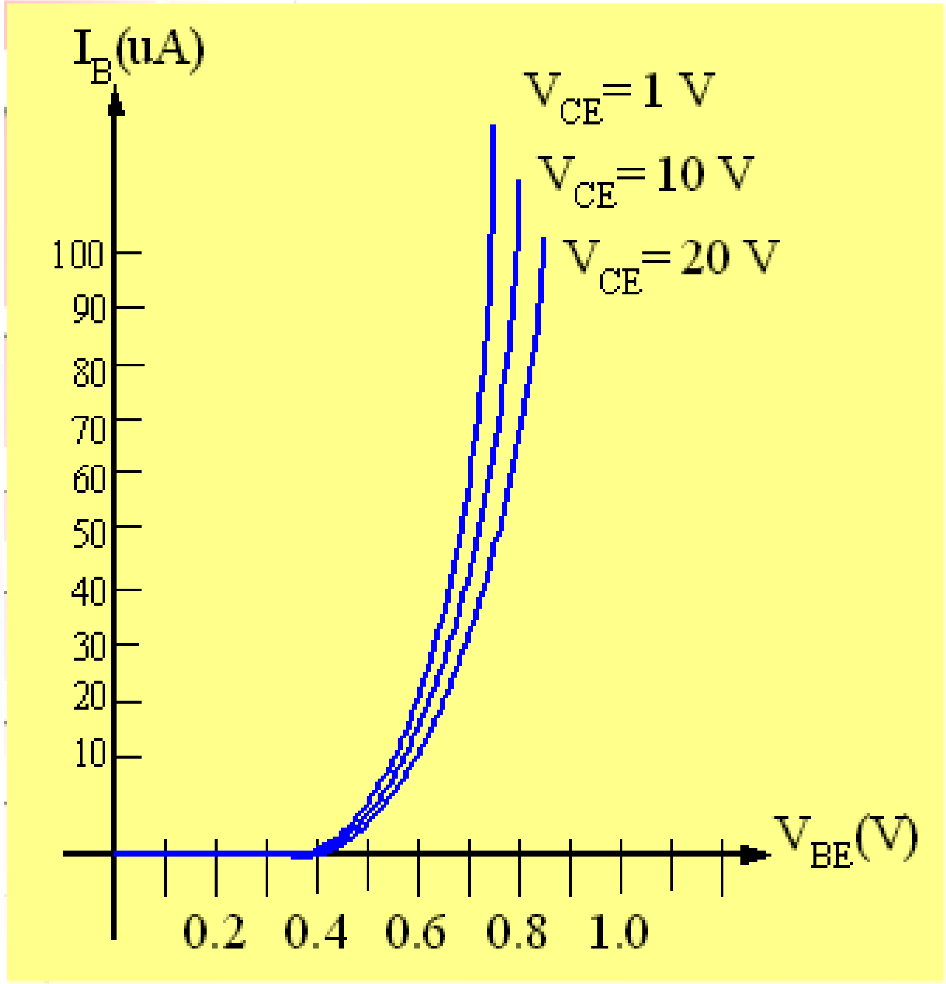


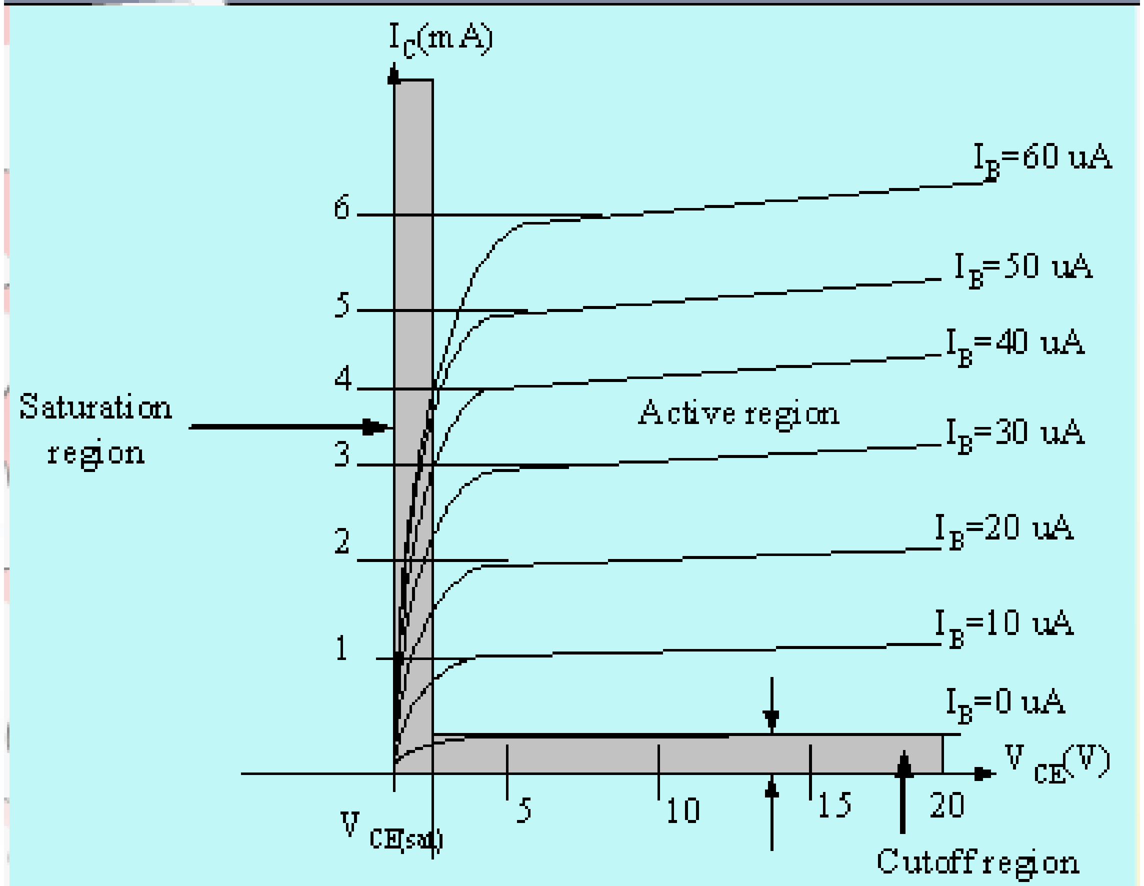

Fig 4.7 : Common-emitter configuration

$$I_E = I_C + I_B$$




Input characteristics for a common-emitter NPN transistor

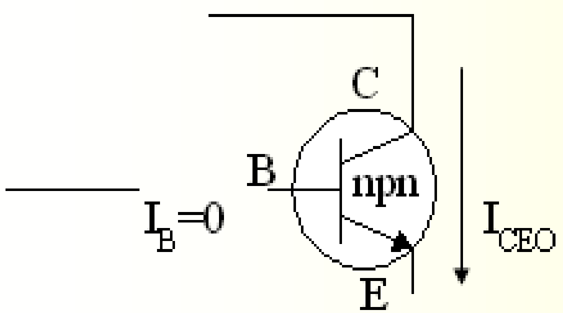
- $I_B$ is microamperes compared to miliamperes of $I_C$.
- $I_B$ will flow when $V_{BE}$ > 0.7V for silicon and 0.3V for germanium
- Before this value $I_B$ is very small and no $I_B$.
- Base-emitter junction is forward bias
- Increasing $V_{CE}$ will reduce $I_B$ for different values.

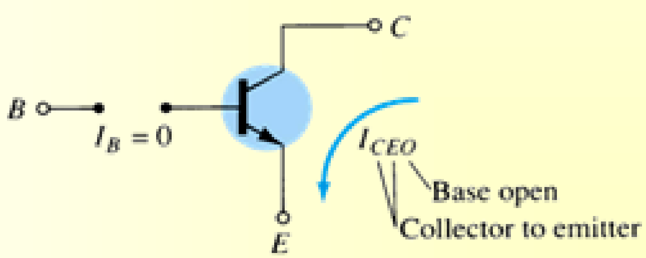



Output characteristics for a common-emitter npn transistor

- For small $V_{CE}$ ($V_{CE} < V_{CESAT}$, $I_C$ increase linearly with increasing of $V_{CE}$
- $V_{CE} > V_{CESAT}$ $I_C$ not totally depends on $V_{CE}$ → constant $I_C$
- $I_B$(uA) is very small compare to $I_C$ (mA). Small increase in $I_B$ cause big increase in $I_C$
- $I_B$=0 A → $I_{CEO}$ occur.
- Noticing the value when $I_C$=0A. There is still some value of current flows.

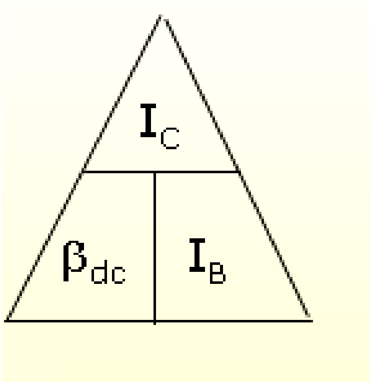
| Active region | Saturation region | Cut-off region |
|---|---|---|
| • B-E junction is forward bias<br>• C-B junction is reverse bias<br>• can be employed for voltage, current and power amplification | • B-E and C-B junction is forward bias, thus the values of $I_B$ and $I_C$ is too big.<br>• The value of $V_{CE}$ is so small.<br>• Suitable region when the transistor as a logic switch.<br>• NOT and avoid this region when the transistor as an amplifier. | • region below $I_B = 0 \mu A$ is to be avoided if an undistorted o/p signal is required<br>• B-E junction and C-B junction is reverse bias<br>• $I_B = 0$, $I_C$ not zero, during this condition $I_C = I_{CEO}$ where is this current flow when B-E is reverse bias. |



# Beta (β) or amplification factor

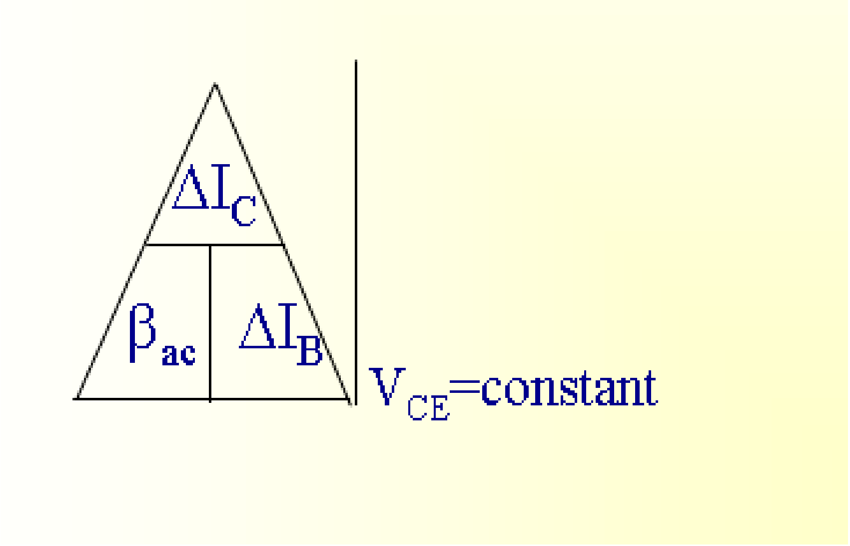
- The ratio of dc collector current (IC) to the dc base current (IB) is dc beta (βdc ) which is dc current gain where IC and IB are determined at a particular operating point, Q-point (quiescent point).
- It's define by the following equation:




$$30 < \beta_{dc} < 300 \rightarrow \text{2N3904}$$

- On data sheet, $\beta_{dc}=h_{FE}$ with $h$ is derived from ac hybrid equivalent cct. FE are derived from forward-current amplification and common-emitter configuration respectively.

- For ac conditions an ac beta has been defined as the changes of collector current ($I_C$) compared to the changes of base current ($I_B$) where $I_C$ and $I_B$ are determined at operating point.
- On data sheet, $\beta_{ac}=h_{fe}$
- It can defined by the following equation:



# Relationship analysis between α and β

CASE 1

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

subtitute equ. $I_C = \beta I_B$ into (1) we get

$$\underline{\underline{I_E = (\beta + 1) I_B}}$$

CASE 2

$$\text{known} : \alpha = \frac{I_C}{I_E} \Rightarrow I_E = \frac{I_C}{\alpha} \qquad (2)$$

$$\text{known} : \beta = \frac{I_C}{I_B} \Rightarrow I_B = \frac{I_C}{\beta} \qquad (3)$$

subtitute (2) and (3) into (1) we get,

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