ELECTRONICS DEVICES AND CIRCUITS

SECTION - C

TRANSISTORS

OBJECTIVE

BJT

CE Configuration

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

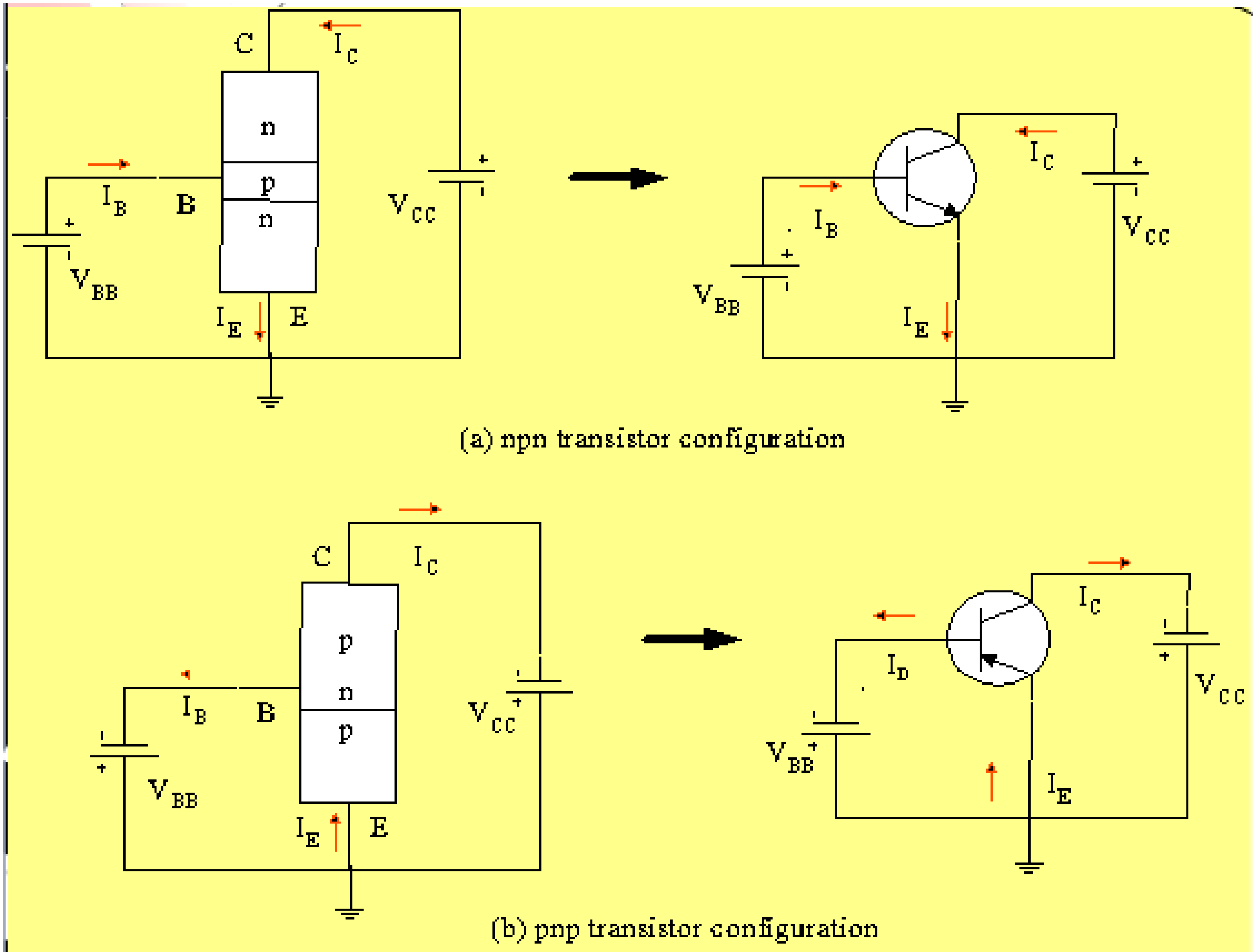
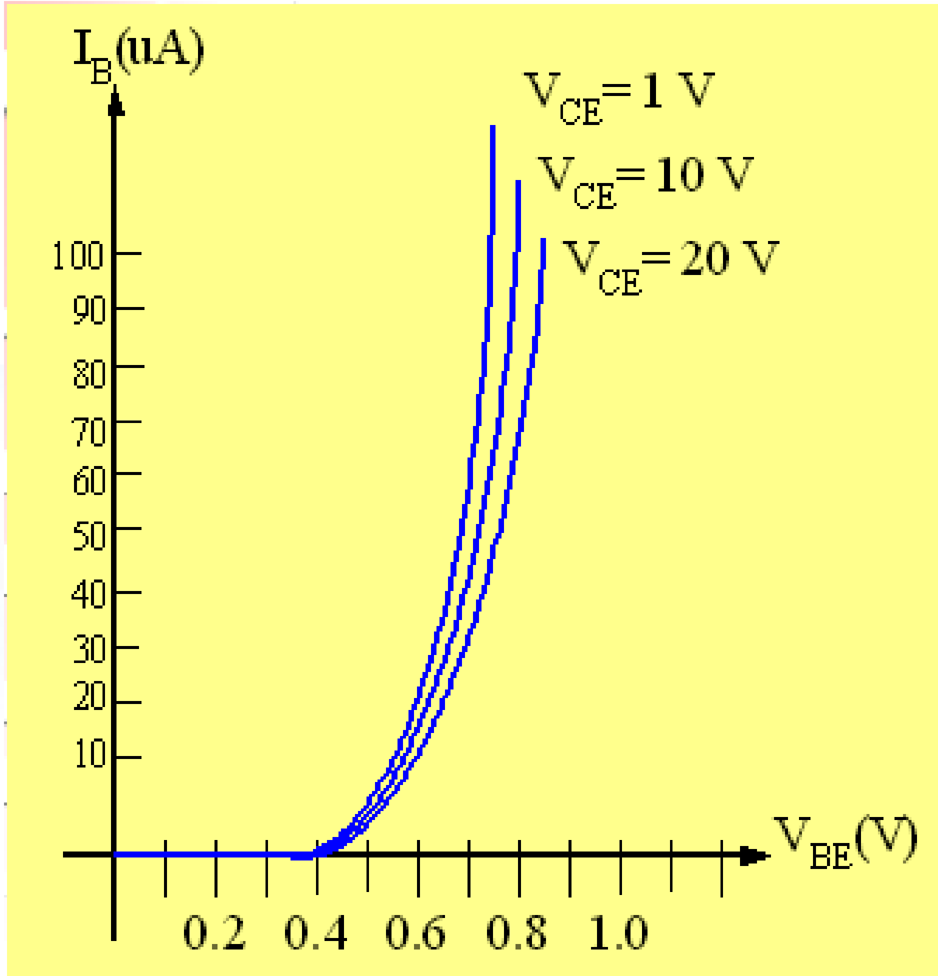


Fig 4.7 : Common-emitter configuration

$I_E = I_C + I_B$

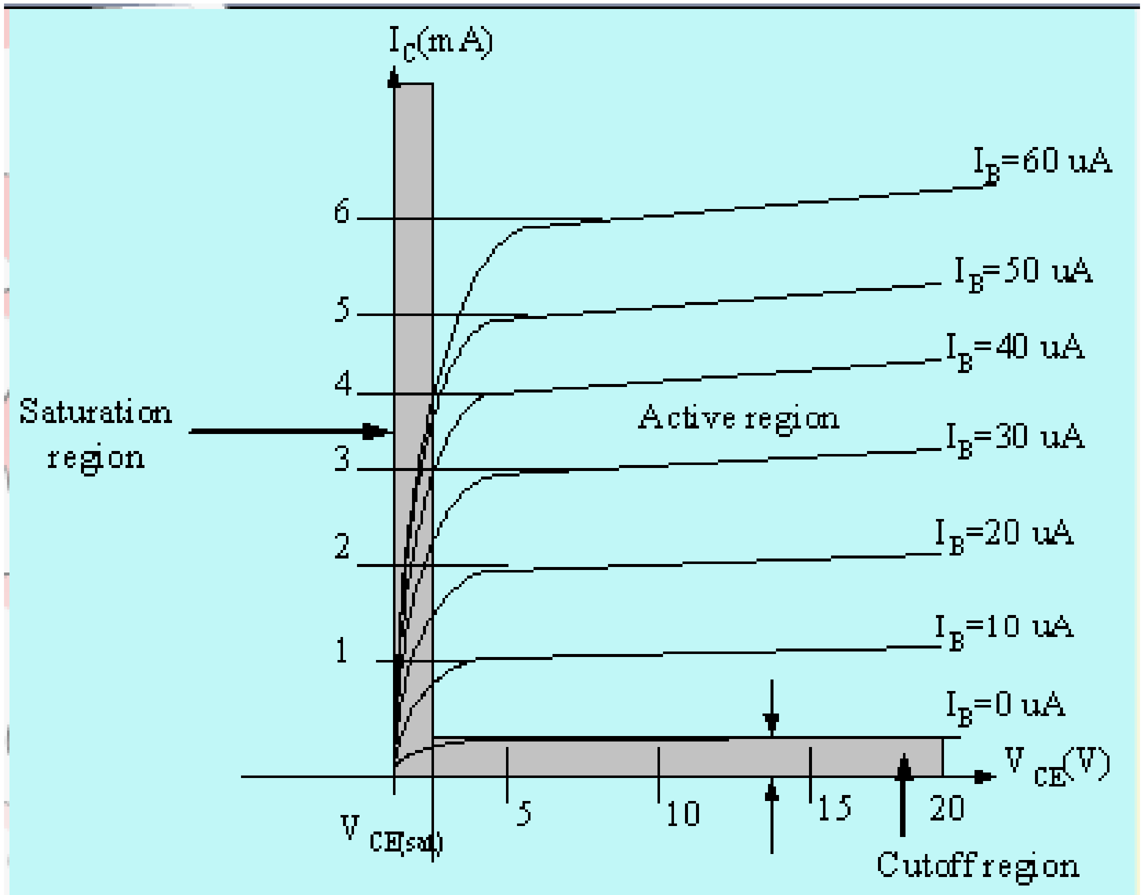


Input characteristics for a common-emitter NPN transistor

- 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

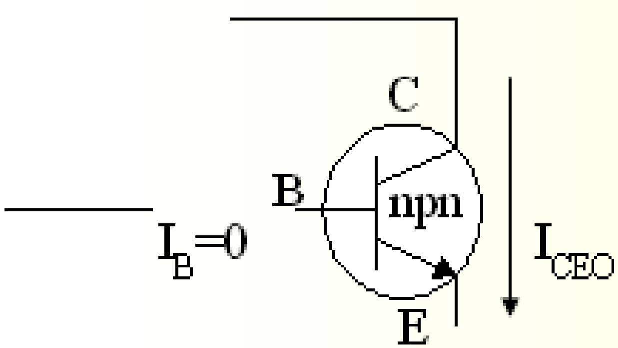
  for different values.

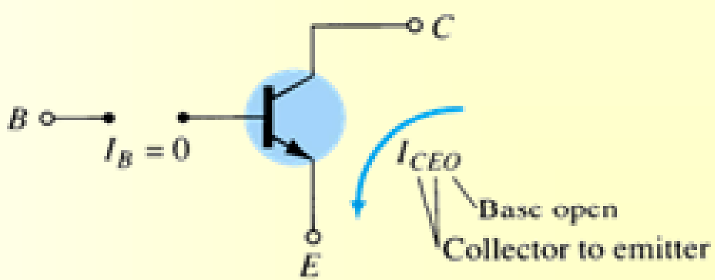


Output characteristics for a common-emitter npn transistor

- 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 • C-B junction is reverse bias • 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. • The value of V_{CE} is so small. • Suitable region when the transistor as a logic switch. • 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 • B-E junction and C-B junction is reverse bias • $I_B = 0$, I_C not zero, during this condition $I_C = I_{CEO}$ where is this current flow when B-E is reverse bias.

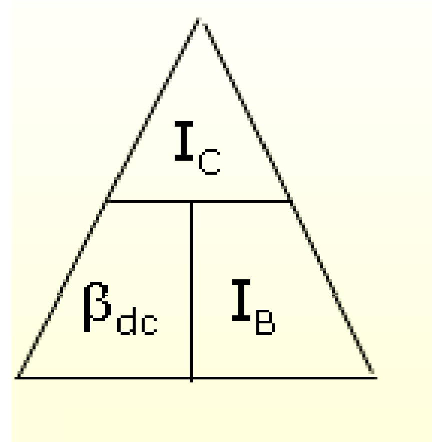




Beta (β) or amplification factor

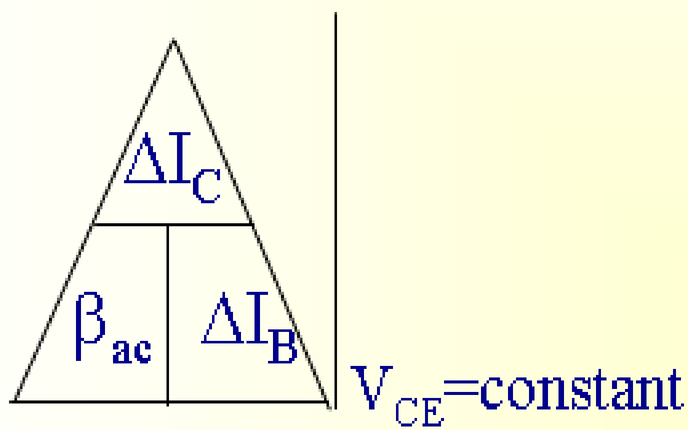
- The ratio of dc collector current (IC) to the dc base current (IB) is dc beta (βdc) which is dc current gain where IC and IB are determined at a particular operating point, Q-point (quiescent point).
- It's define by the following equation:

$$30 < \beta dc < 300 \rightarrow 2N3904$$



- 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,

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