Topic:- α, β and γ of the Transistor And Relation Between Them.

(UG-III)

The parameters α, β and γ of the transistor ~~are nothing~~ are nothing but they are the ratio of output current to the input current with common base, emitter and collector terminals respectively. Let us discuss one by one.

α - parameter

For α - parameter, we take common-base - configuration of the transistor as shown in fig (1).

Here the input signal is applied between emitter and base while the output is taken from collector and base. The base is common to input and output circuits.

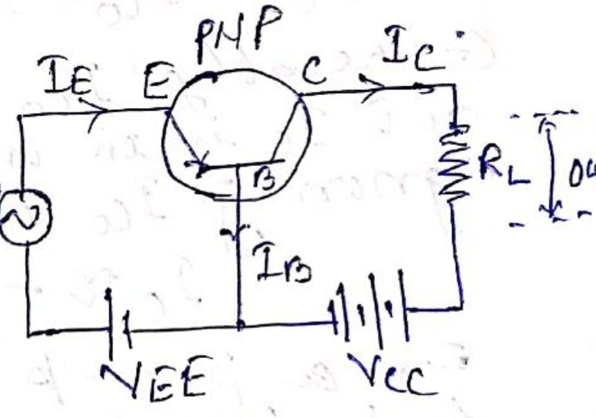


Fig (1)

When no signal is applied, then the ratio of the collector current to the emitter current is called dc alpha (α_{dc} or α) of a transistor.

i.e $\alpha_{dc} = \alpha = \frac{-I_C}{I_E}$ $\longrightarrow (1)$ (-ve sign shows that I_E flows into trans. while I_C flows out of

α of a transistor is a measure of the quality of a transistor. Higher is the value of α, better is the transistor in the sense that collector current approaches the emitter current. α is also called as "emitter current amplification factor."

When signal is applied, the ratio of change in collector current to the change in emitter current at constant collector base voltage is defined as current amplification factor

$$\alpha_{ac} = -\frac{\Delta I_C}{\Delta I_E} \longrightarrow (2)$$

β-parameter

This is also known as base current amplification factor, so we have to take emitter as common between base and collector (common-emitter configuration) as shown in fig (2). Here, the input signal is applied between base and emitter and the output is taken from collector & emitter.

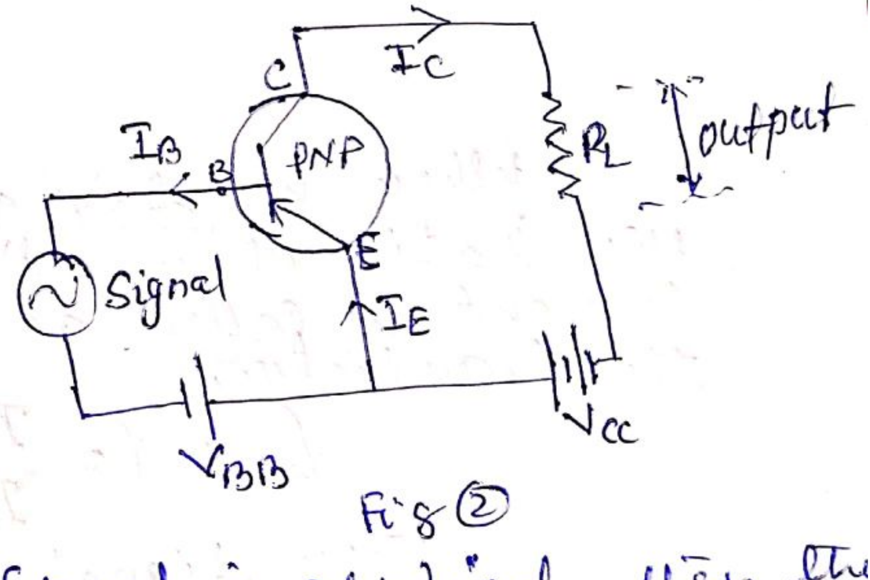


Fig (2)

When no signal is applied, then the ratio of collector current to the base current is called dc beta (β_{dc} or β) of a transistor

i.e $\beta = \frac{I_C}{I_B} \longrightarrow (3)$

When signal is applied, the ratio of change in collector current to the change in base current is defined as base current amplification factor. i.e $\beta_{ac} = \beta = \frac{\Delta I_C}{\Delta I_B}$

γ-parameter

To define γ-parameter of the transistor, common-collector configuration of it is considered as shown in fig ③. In this configuration, the input signal is applied between base and collector and the output is taken from the emitter.

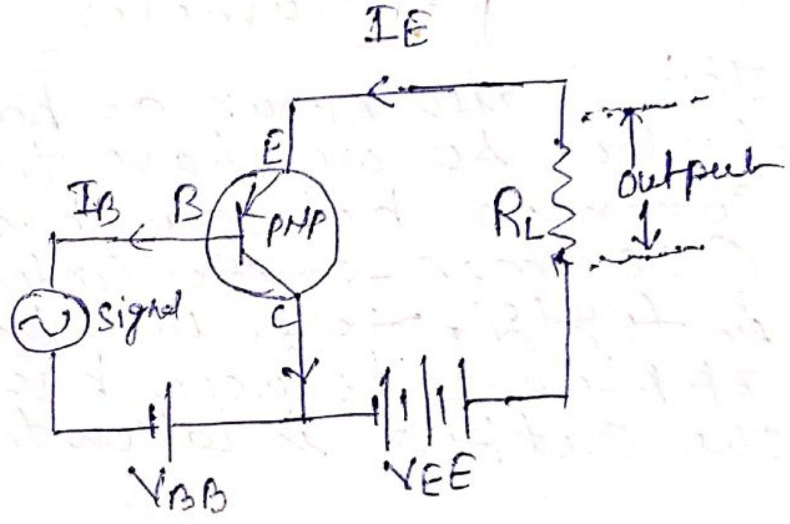


Fig ③

When no signal is applied, then the ratio of emitter current to the base current is called as dc gamma γ_{dc} or γ of the transistor.

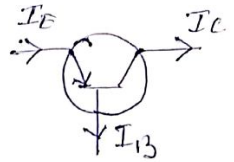
$$\gamma_{dc} \text{ or } \gamma = \frac{I_E}{I_B} \quad \text{------} (5)$$

When signal is applied, then the ratio of change in emitter current to the change the base current is known as current amplication factor γ_{ac} or γ.

$$\gamma = \frac{\Delta I_E}{\Delta I_B} \longrightarrow (6)$$

Relation Between α and β:—

Applying Krichhoff's current law in fig (1), we have



$$I_E = I_B + I_C$$

$$\therefore -I_C = I_B - I_E$$

or, $$-\frac{I_C}{I_E} = \frac{I_B}{I_E} - 1 = \frac{I_B}{I_C}\cdot\frac{I_C}{I_E} - 1 = -\frac{\alpha}{\beta} - 1$$

or, $$-\alpha = + \frac{\alpha}{\beta} - 1$$

Taking only magnitude of α but not direction i.e $\alpha = \frac{I_C}{I_E}$.

$$\therefore 1 - \alpha = \frac{\alpha}{\beta}$$

$$\therefore \beta = \frac{\alpha}{1-\alpha} \rightarrow (7)$$

or, $\cancel{\frac{\alpha}{\beta} + 1 = -\alpha}$

or, $\cancel{\frac{\alpha}{\beta} + \alpha = -1}$

or, $\cancel{\left(\frac{1}{\beta} + 1\right)\alpha = -1}$

or, $\cancel{\frac{(1+\beta)}{\beta}\cdot\alpha = -1}$

$\therefore$ $\cancel{\beta =}$

Eq^n (7) is the required relation between α & β.

Relation between α and γ

We know that $\gamma = \frac{I_E}{I_B}$ and $\alpha = \frac{I_C}{I_E}$

$\therefore$ ~~from eq^n~~ Also, $I_B = I_E - I_C$

$$\therefore \text{Now } \gamma = \frac{I_E}{I_B} = \frac{I_E}{I_E - I_C} = \frac{1}{1 - \frac{I_C}{I_E}} = \frac{1}{1-\alpha} \rightarrow (8)$$

Eq^n (8) gives relation between α & γ.

Relation between β & γ

From eq^n (7) & (8), we have $\gamma = \frac{1}{1-\alpha} = (1+\beta)$