COMMON EMITTER CONGIGURATION

Output Characteristic:

The output characteristic is the curve between V_{CE} and I_C for various values of I_B. For fixed value of I_B and is shown in **fig. 3**. For fixed value of I_B, I_C is not varying much dependent on V_{CE} but slopes are greater than CE characteristic. The output characteristics can again be divided into three parts.

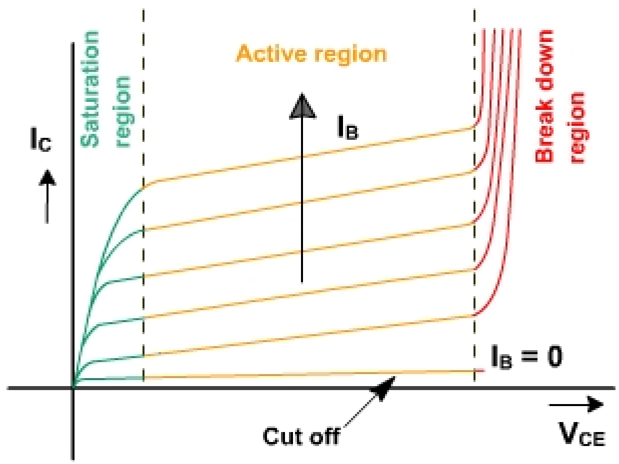

Fig. 3

(1) Active Region:

In this region collector junction is reverse biased and emitter junction is forward biased. It is the area to the right of V_{CE} = 0.5 V and above I_B= 0. In this region transistor current responds most sensitively to I_B. If transistor is to be used as an amplifier, it must operate in this region.

$$I_E = I_C + I_B$$

Since, $I_C = I_{Co} + \alpha_{dc} I_E$

$$I_C = I_{Co} + \alpha_{dc}(I_C + I_B)$$

or $(1-\alpha_{dc})I_C = \alpha_{dc} I_B + I_{CO}$

or $$I_C = \left(\frac{\alpha_{dc}}{1-\alpha_{dc}}\right) I_B + \left(\frac{1}{1-\alpha_{dc}}\right) I_{CO}$$

Let, $\beta_{dc} = \dfrac{\alpha_{dc}}{1-\alpha_{dc}}$

$\therefore I_C = (1+\beta_{dc})I_{CO} + \beta_{dc} I_B$

β_{dc} is defined as current gain of the transistor is given by

$$\beta_{dc} = \frac{I_C - I_{CO}}{I_B + I_{CO}}$$

If a_{dc} is truly constant then I_C would be independent of V_{CE}. But because of early effect, a_{dc} increases by 0.1% (0.001) e.g. from 0.995 to 0.996 as V_{CE} increases from a few volts to 10V. Then b_{dc} increases from 0.995 / (1-0.995) = 200 to 0.996 / (1-0.996) = 250 or about 25%. This shows that small change in a reflects large change in b. Therefore the curves are subjected to large variations for the same type of transistors.

(2) Cut Off:

Cut off in a transistor is given by $I_B = 0$, $I_C = I_{CO}$. A transistor is not at cut off if the base current is simply reduced to zero (open circuited) under this condition,

$I_C = I_E = I_{CO} / (1-\alpha_{dc}) = I_{CEO}$

The actual collector current with base open is designated as I_{CEO}. Since even in the neighborhood of cut off, a_{dc} may be as large as 0.9 for Ge, then $I_C = 10\ I_{CO}$(approximately), at zero base current. Accordingly in order to cut off transistor it is not enough to reduce I_B to zero, but it is necessary to reverse bias the emitter junction slightly. It is found that reverse voltage of 0.1 V is sufficient for cut off a transistor. In Si, the a_{dc} is very nearly equal to zero, therefore, $I_C = I_{CO}$. Hence even with $I_B = 0$, $I_C = I_E = I_{CO}$ so that transistor is very close to cut off.

In summary, cut off means $I_E = 0$, $I_C = I_{CO}$, $I_B = -I_C = -I_{CO}$, and V_{BE} is a reverse voltage whose magnitude is of the order of 0.1 V for Ge and 0 V for Si.

Reverse Collector Saturation Current I_{CBO}:

When in a physical transistor emitter current is reduced to zero, then the collector current is known as I_{CBO} (approximately equal to I_{CO}). Reverse collector saturation current I_{CBO} also varies with temperature, avalanche multiplication and variability from sample to sample. Consider the circuit shown in **fig. 4**. V_{BB} is the reverse voltage applied to reduce the emitter current to zero.

$I_E = 0$, $I_B = -I_{CBO}$

If we require, $V_{BE} = - 0.1$ V

Then $- V_{BB} + I_{CBO} R_B < - 0.1$ V

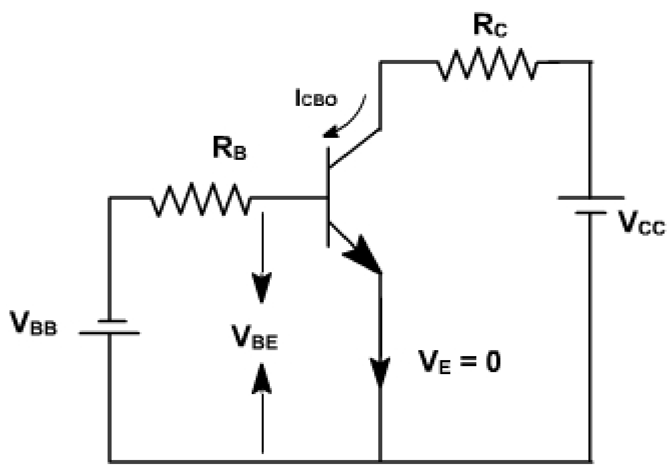

Fig. 4

If R_B = 100 K, I_{CBO} = 100 m A, Then V_{BB} must be 10.1 Volts. Hence transistor must be capable to withstand this reverse voltage before breakdown voltage exceeds.

(3).Saturation Region:

In this region both the diodes are forward biased by at least cut in voltage. Since the voltage V_{BE} and V_{BC} across a forward is approximately 0.7 V therefore, $V_{CE} = V_{CB} + V_{BE} = - V_{BC} + V_{BE}$ is also few tenths of volts. Hence saturation region is very close to zero voltage axis, where all the current rapidly reduces to zero. In this region the transistor collector current is approximately given by V_{CC} / R_C and independent of base current. Normal transistor action is last and it acts like a small ohmic resistance.

common emitter current gain

Large Signal Current Gain β_{dc} :-

The ratio I_c / I_B is defined as transfer ratio or large signal current gain b_{dc}

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

Where I_C is the collector current and I_B is the base current. The b_{dc} is an indication if how well the transistor works. The typical value of b_{dc} varies from 50 to 300.

In terms of h parameters, b_{dc} is known as dc current gain and in designated h_{fE} ($b_{dc} = h_{fE}$). Knowing the maximum collector current and b_{dc} the minimum base current can be found which will be needed to saturate the transistor.

$$I_{C(max)} = \frac{V_{CC} - V_{CE(sat)}}{R_C} = I_{C(sat)}$$

$$I_{B(min)} = \frac{I_{C(sat)}}{\beta_{dc}}$$

This expression of b_{dc} is defined neglecting reverse leakage current (I_{CO}).

Taking reverse leakage current (I_{CO}) into account, the expression for the b_{dc} can be obtained as follows:

b_{dc} in terms of a_{dc} is given by

$$\beta_{dc} = \frac{\alpha_{dc}}{1-\alpha_{dc}}$$

$$= \frac{\frac{I_C - I_{CO}}{I_E}}{1-\frac{I_C - I_{CO}}{I_E}} = \frac{I_C - I_{CO}}{I_E - I_C + I_{CO}}$$

$$= \frac{I_C - I_{CO}}{I_B + I_{CO}}$$

Since, $I_{CO} = I_{CBO}$

$$\therefore \beta_{dc} = \frac{I_C - I_{CBO}}{I_B + I_{CBO}}$$

Cut off of a transistor means $I_E = 0$, then $I_C = I_{CBO}$ and $I_B = - I_{CBO}$. Therefore, the above expression b_{dc} gives the collector current increment to the base current change form cut off to I_B and hence it represents the large signal current gain of all common emitter transistor.