[C] Topic:- Characteristic Curve of a Transistor

UG-III (Electronics)

Graphical forms of the relations among the various current and voltage variables of a transistor with some parameter are known as characteristic curves. There are ~~two~~ two types of the characteristics; static or dynamic depending upon whether the source of energy is d.c or a.c. source. Further, by considering any two as independent variables, it is possible to draw different families of characteristic curves. However, only two sets of characteristic curves, namely input and output characteristic curves will be discussed.

The plot of the input current against the input voltage with the output voltage as a parameter for a particular mode of operation gives the input characteristics for that mode. A similar plot for the output current against output voltage with input current as a parameter gives the output characteristics. And, the variation of output variables with respect to input variables gives us "transfer characteristics".

A transistor can be connected in three configurations known as common base configuration (C.B), common emitter configuration (C.E) and common collector configuration (C.C). In this way, approx, there are ~~twelve~~ thirty six characteristics. Among these curves CE-mode are of practical importance.

CE < static < input / output
CE < Dynamic (~~common~~) < input / output
$\times 3 = 18$

Again $18 \times 2 = 36$

3 for CE, CB & CC.

Here 2 is for PNP & NPN.

CHARACTERISTICS OF COMMON EMITTER CIRCUIT:—

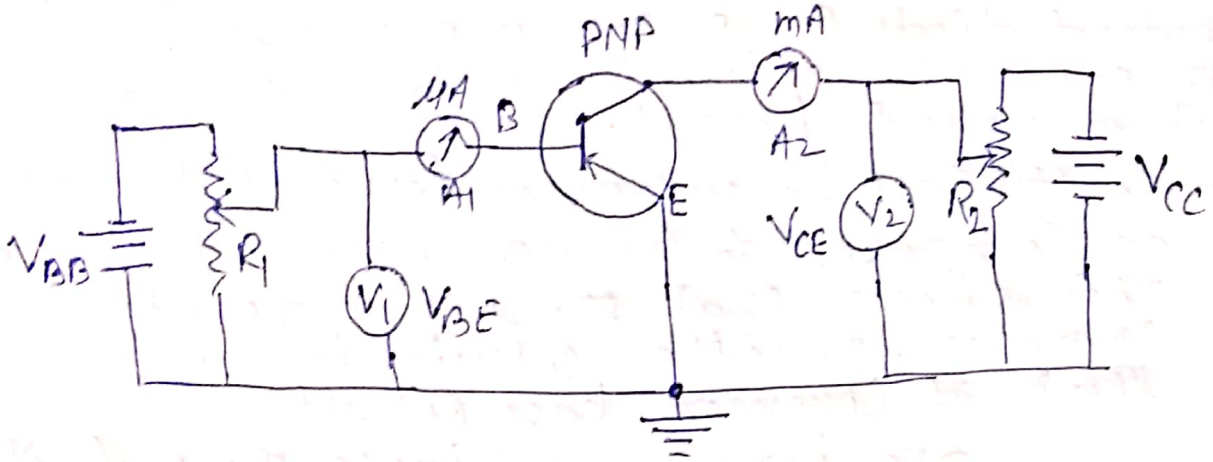
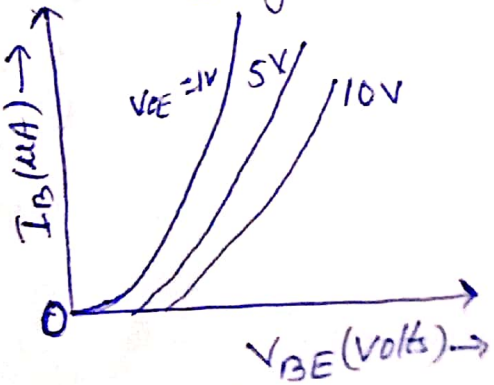


Fig (1)

Fig (1) shows the circuit arrangement for plotting the static characteristics of ~~the~~ a PNP transistor in common emitter configuration. In the circuit, the battery V_{BB} provides forward bias to emitter-base junction with the help of potential divider R_1. The voltmeter V_1 measures the base-emitter voltage V_{BE}. The micro-ammeter A_1 measures the base current I_B. A battery V_{cc} is connected between collector & emitter through a potential divider R_2. The positive terminal of the battery is connected to emitter while the negative terminal is connected to the collector so that the collector is reverse-biased. The voltmeter V_2 measures the collector-emitter voltage V_{CE} and the milli-ammeter A_2 measures the collector current.

Input Characteristics

For plotting the input characteristic, the collector emitter voltage V_{CE} is kept fixed. The base emitter voltage V_{BE} is varied with the help of potential divider R_1 and the base current I_B is noted for each value of V_{BE}. A graph of I_B against V_{BE} is drawn. The curve so obtained is known as "input characteristics". The experiment is repeated for other fixed values of V_{CE}. The input characteristic is shown in fig (2).



The following points are noted from the characteristics:-

(i) The characteristic resembles that of a forward-biased diode curve. This is expected because the base-emitter section of transistor is a diode and it is forward-biased.

(ii) In this case, I_B increases less rapidly with V_{BE} as compared to common-base configuration. This shows that the input resistance of common-emitter circuit is higher than that of common-base circuit.

The input resistance r_i is denoted by

$$r_i = \left.\frac{\Delta V_{BE}}{\Delta I_B}\right|_{V_{CE}=\text{Constant}}$$

Output characteristics

For plotting output characteristics, the base current I_B, ~~represents~~ is kept fixed. With the help of potential devider R_2, the value of V_{CE} is varied in steps and the collector current I_C is noted for each value of V_{CE}. A graph of I_C against V_{CE} is drawn. The curve so obtained is known as "output characteristics". The experiement is repeated for different values of I_B. Fig (2) shows the output characteristics

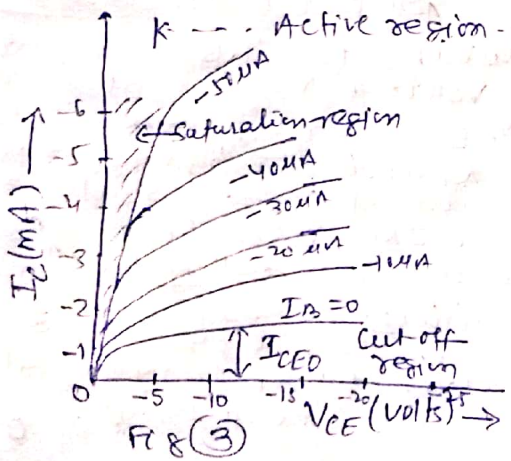


Fig (3)

The following conclusions are drawn:

(i) In the active region, for small values of base current, the effect of collector voltage over collector current is small while for large base current values this effect increases. Also, the collector current is larger than base current. i.e the current gain is greater than unity.

(ii) When V_{CE} has very low value, the change in base current I_B does not produce a corresponding change in collector current I_C. ~~This~~ This is the Saturation region.

(iii) In the cut off region, a small amount of collector current flows even when base current $I_B=0$. This is called I_{CEO}. Since main collector current is zero, the transistor is said to be Cutoff.

(iv) The output resistance is given by

$$r_o = \left.\frac{\Delta V_{CE}}{\Delta I_C}\right|_{I_B=\text{Constan}}$$

Objective.

1. The input static characteristic of CE connected transistor gives its..... resistance.
   Ans:- input
2. If in a CE connected transistor $I_B=0$, then V_{CE} = ?
   Ans:- V_{CC}.
3. In a transistor β may be expressed in terms of α as .....
   Ans. $\left(\frac{\alpha}{1-\alpha}\right)$