DEPARTMENT OF PHYSICS

MAR THOMA COLLEGE FOR WOMEN, PERUMBAVOOR

TRANSISTOR CE CHARACTERISTICS

Aim To plot the input and output characteristics of an NPN transistor in common emitter configuration and to find out the a) Dynamic input resistance b) Dynamic output resistance and c) Common emitter current gain.

Components and equipments required Transistor, voltmeters, ammeters, rheostats, dc sources, bread board and CRO.

Theory Transistor can be connected in a circuit in any one of the three different configurations namely; common emitter, common base and common collector. Common emitter (CE) configuration is the most frequently used configuration because it provides voltage, current and power gain more than unity.

The name CE is because the emitter of the transistor is common to the input and output circuits. Input signal is applied across the base and emitter, and the output is taken across the collector and the emitter. CE configuration is also called grounded emitter configuration.

Dynamic input resistance Dynamic input resistance can be calculated from the input characteristic curves. It is given by the ratio of small change in base to emitter voltage to corresponding change in base current; keeping collector to emitter voltage constant.

$$\text{i.e.,}\quad r_i = \frac{\Delta V_{BE}}{\Delta I_B} \quad \text{keeping } V_{CE} \text{ constant.}$$

Dynamic output resistance Dynamic output resistance can be calculated from the output characteristic curves. It is given by the ratio of small change in collector to emitter voltage to corresponding change in collector current, keeping base current constant.

$$r_o = \frac{\Delta V_{CE}}{\Delta I_C} \quad \text{keeping } I_B \text{ constant.}$$

Common emitter current gain β It is the ratio of the change in collector current to the corresponding change in base current, keeping the collector to emitter voltage constant.

$$\beta = \frac{\Delta I_C}{\Delta I_B} \quad \text{keeping } V_{CE} \text{ constant.}$$

Another designation for β is h_{FE}. The current gain in Common Base configuration α is related to β as $\beta = \alpha/(1-\alpha)$ and $\alpha = \beta/(1+\beta)$. α is always less than unity. It is evident that as α approaches unity, value of β rises rapidly.

DEPARTMENT OF PHYSICS

MAR THOMA COLLEGE FOR WOMEN, PERUMBAVOOR

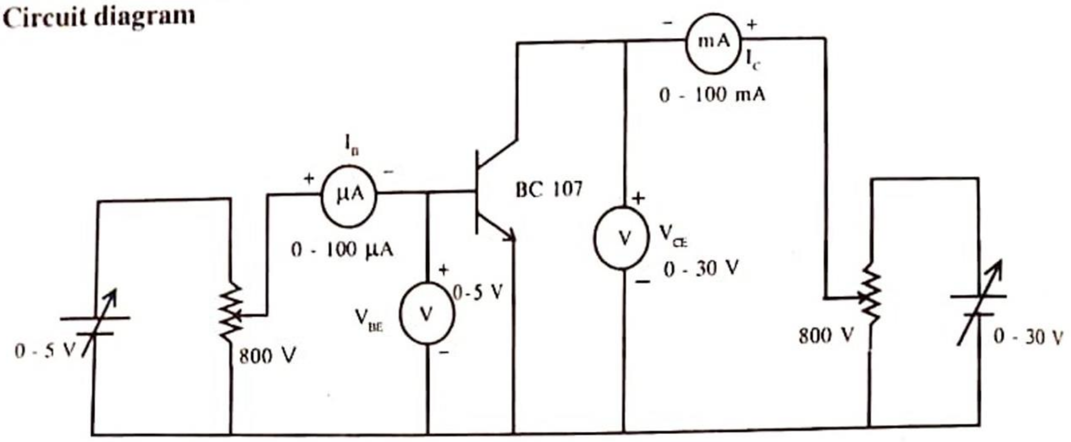
Procedure Input characteristics

1. Identify the leads of an NPN transistor and test the transistor using a multimeter. Set up the circuit as shown in figure and verify the connections using the multimeter.
2. Switch ON the power supplies keeping the rheostat at minimum position. Switch off collector to emitter supply or make it 0 V.
3. Note down the base current for different values of base to emitter potential varying it from 0 V to 1 V in steps of 0.1 V adjusting the rheostat.
4. Repeat step no. 3 for different values of collector to emitter voltage, say 3 V and 6 V.
5. Draw the characteristics on a graph sheet with V_{BE} on X-axis and I_B on Y-axis.
6. Calculate dynamic input resistance taking the ratio of change in V_{BE} to the resulting change in I_B at any point, say, 10 μA.

Procedure Output characteristics

1. Switch ON the power supplies keeping the rheostats at minimum position.
2. Switch OFF input voltage source or reduce it to make $I_B = 0$ V. Note the value of I_C for different values of V_{CE} from 0 to 10 V in steps of 0.5 V. I_C will be almost zero.
3. Fix the base current I_B at a definite value (say 10 μA) by adjusting input rheostat. Note the value of I_C for different values of V_{CE} from 0 to 10 V in steps of 0.5 V. Repeat for other values of base current (say 20 μA and 30 μA).
4. Plot the output characteristics with V_{CE} on x-axis and I_C on y-axis.
5. Calculate the dynamic output resistance taking the ratio of change in V_{CE} to the resulting change in I_C at any point, say, 10 mA.
6. Calculate common emitter current gain β using its expression.

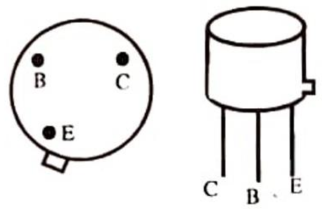
Circuit diagram



BC 107 Transistor details. It is a silicon low frequency transistor

Maximum ratings: V_{CB}= 50 V , V_{CE} = 45 V , V_{EB} = 6 V, I_C = 100 mA

Nominal ratings: V_{CE} = 5 V, I_C = 2 mA, h_{FE} = 100 to 500.



Observation Input characteristics

$V_{CE} = 0$ V		$V_{CE} = 3$ V		$V_{CE} = 6$ V	
I_B (μA)	V_{BE} (V)	I_B (μA)	V_{BE} (V)	I_B (μA)	V_{BE} (V)

$$r_i = \frac{\Delta V_{BE}}{\Delta I_B} = \ldots\ldots..$$

Output Characteristics

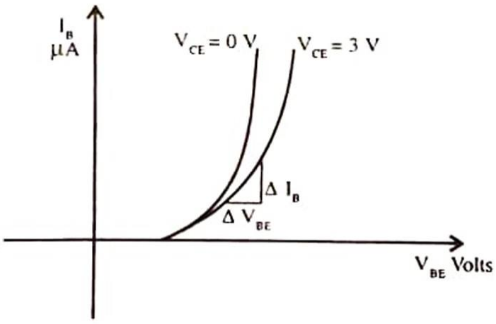
$I_B = 10\,\mu A$		$I_B = 20\,\mu A$		$I_B = 30\,\mu A$	
I_C (mA)	V_{CE} (V)	I_C (mA)	V_{CE} (V)	I_C (mA)	V_{CE} (V)

$$r_o = \frac{\Delta V_{CE}}{\Delta I_C} = ..$$

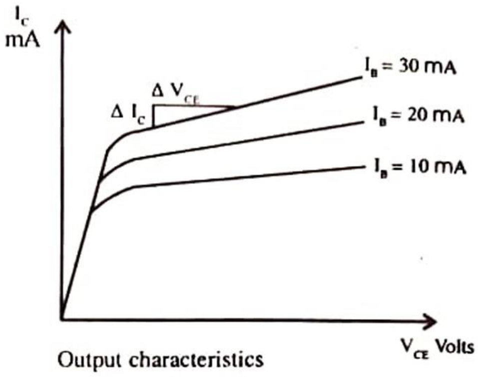
$$\beta = \frac{\Delta I_C}{\Delta I_B} = \ldots\ldots$$

45

Graph



Input characteristics



Output characteristics

Result Dynamic input resistance = ...V
Dynamic output resistance = ...V
Common emitter current gain β = ...

Reference

Electronics Lab Manual Volume I, K.A. Navas, **Rajath Publishers**