Bsc-II, Paper-IV, Group-B.

Bipolar Transistor characteristics :-

For a Common emitter Configuration of a transistor I_B and V_{CE} are taken as independent variables. Since V_{BE} is a function of I_B and V_{CE} and also I_C is another function of I_B and V_{CE}.

then $V_{BE} = f(I_B, V_{CE})$ —— (1)

and $I_C = f(I_B, V_{CE})$ —— (2)

If a curve represents the variables of the dependent variables V_{BE} or I_C with one of the two independent variables then the curve is called the characteristic of the transistor.

Expanding eqn (1) & (2) by Taylor's theorem and Neglecting higher orders, we can write,

$$dV_{BE} = \left(\frac{\delta V_{BE}}{\delta I_B}\right)_{V_{CB}} dI_B + \left(\frac{\delta V_{BE}}{\delta V_{CE}}\right)_{I_B} dV_{CE}$$

$$dI_C = \left(\frac{\delta I_C}{\delta I_B}\right)_{V_{CB}} dI_B + \left(\frac{\delta I_C}{\delta V_{CE}}\right)_{I_B} dV_{CE}$$

The partial derivatives of the above two equations define the hybrid-parameters (h-parameters) of the transistor of this Configuration. Thus,

(i) Input impedance $(h_{ie}) = \left(\frac{\delta V_{BE}}{\delta I_B}\right)_{V_{CE}}$

(ii) Reverse voltage ratio $(h_{re}) = \left(\frac{\delta V_{BE}}{\delta I_B}\right)_{I_B}$.

Teacher's Signature :

(iii) Forward current transfer ratio (h_{fe}) = $\left(\frac{\partial I_C}{\partial I_B}\right)_{V_{CE}}$

(iv) output admittance (h_{oe}) = $\left(\frac{\partial I_C}{\partial V_{CE}}\right)_{I_B}$.

Similarly, for the common base configuration of a transistor I_E and V_{CB} are taken as independent variables.
since V_{EB} is a function of I_E and V_{CB} and also I_C is a function of I_E and V_{CB},

$$V_{BE} = f(I_E, V_{CB}) \quad \text{—— (3)}$$

$$I_C = f(I_E, V_{CB}) \quad \text{—— (4)}$$

each of the above equations represents two sets of characteristic curves. Expanding eqn (3) & (4) by Taylor's theorem and Neglecting higher orders,

$$dV_{EB} = \left(\frac{\partial V_{EB}}{\partial I_E}\right)_{V_{CB}} dI_E + \left(\frac{\partial V_{EB}}{\partial V_{CB}}\right)_{I_E} dV_{CB}$$

$$dI_C = \left(\frac{\partial I_C}{\partial I_E}\right)_{V_{CB}} dI_E + \left(\frac{\partial I_C}{\partial V_{CB}}\right)_{I_E} dV_{CB}$$

The partial derivatives of the above two equations

i) Input impedance (h_{ib}) = $\left(\frac{\partial V_{EB}}{\partial I_E}\right)_{V_{CB}}$.

(ii) Reverse voltage ratio (h_{rb}) = $\left(\frac{\partial V_{EB}}{\partial V_{CB}}\right)_{I_E}$

(iii) forward current transfer ratio (h_{fb}) = $\left(\frac{\partial I_C}{\partial I_E}\right)_{V_{CB}}$

(iv) output admittance (h_{ob}) = $\left(\frac{\partial I_C}{\partial V_{CB}}\right)_{I_E}$