Deepak kumar
09619011722
IIOT-B2

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Analog Assignment-2

Q Transistor Hybrid Parameter Model of Common Emitter.

Sol: The transistor hybrid parameter model of common emitter (CE) is a two-port network model that describes the electrical behaviour of a transistor in CE configuration. The two ports are the input port and the output port, which are represented by the base and collector terminals of the transistor respectively.

The four hybrid parameters are:
h_{ie} : input impedance, h_{oe} : output admittance
h_{re} : Reverse voltage gain, h_{fe} : forward current gain

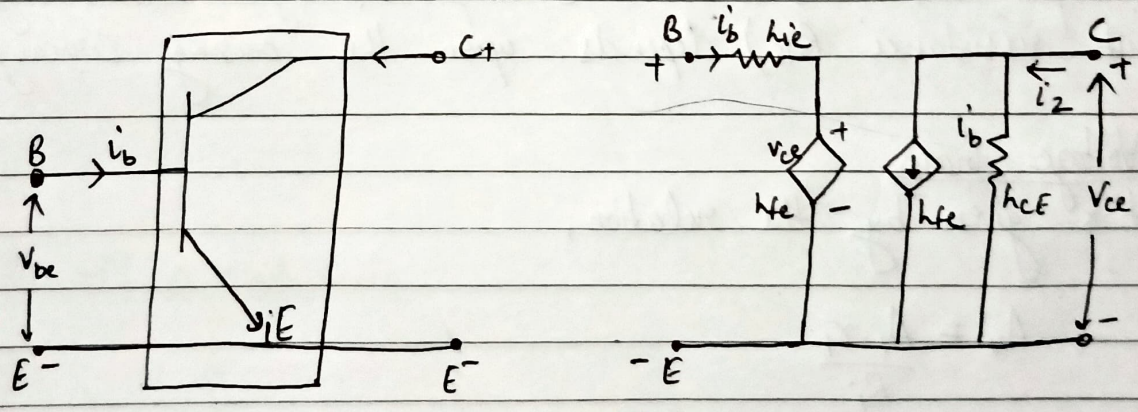

fig: Hybrid Equivalent for CE Transistor

→ The input voltage (V_{be}) and the output current i_c are given by:

$$V_{be} = h_{ie} \cdot i_b + h_{re} \cdot V_c$$
$$i_c = h_{fe} \cdot i_b + h_{oe} \cdot V_c$$

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→ Hybrid Expressions

(i) Current Gain (A_i)

It is given by the relation

$$A_i = -\left(\frac{h_{fe}}{1 + h_{oe} \cdot r_L}\right).$$

where r_L is the A.C. load resistance. Its value is equal to the parallel combination of R_c and R_L.

(ii) Input Resistance (R_i)

$$R_i = h_{ie} + h_{re} \cdot A_i \cdot r_L = h_{ie} - \frac{h_{re} \cdot h_{fe}}{h_{oe} + 1/r_L}.$$

The input resistance of the the amplifier stage (called stage input resistance R_{is}) depends upon the biasing arrangement.

(iii) Voltage Gain

It is given by the relation,

$$A_V = \frac{A_i \cdot r_l}{R_i}$$

The voltage gain, in terms of h-parameter, is given by:

$$A_V = \frac{h_{fe} \cdot r_l}{h_{ie} + \Delta h \cdot r_L} = \frac{-h_{fe}}{R_i\left(h_{oe} + \frac{1}{r_L}\right)}$$

where, $\Delta h = h_{ie} \cdot h_{oe} - h_{re} \cdot h_{fe}$

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(iv) Output Resistance

The resistance looking into the amplifier output terminals is :

$$R_o = \frac{(R_s + h_{ie})}{R_s \cdot h_{oe} + \Delta h}$$

where R_s = Resistance of the source.

→ The output resistance of the stage,

$$R_{oe} = \frac{R_o}{r_L}$$

(v) Overall voltage Gain

$$A_{ve} = \frac{A_v \cdot R_{is}}{R_s + R_{is}}$$

(vi) Overall current Gain

$$A_{ie} = \frac{A_i \cdot R_s}{R_s + R_{is}}$$

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Q2 A transistor used in CE arrangement has the following set of parameters, when the d.c. operating point in $V_{CE} = 10$ volts and $I_C = 1mA$:

$h_{ie} = 2000\Omega$, $h_{oe} = 10^{-4}S$; $h_{re} = 10^{-3}$; $h_{fe} = 50$.

Determine

(i) input impedance (ii) Current gain (iii) Voltage gain

The a.c. load seen by the transistor is $r_L = 600\Omega$.

Sol: (i) Input impedance is given by:

$$R_i = h_{ie} - \frac{h_{re} \cdot h_{fe}}{h_{oe} + \frac{1}{r_L}} = 2000 - \frac{50 \times 10^{-3}}{10^{-4} + \frac{1}{600}}$$

$$= 2000 - \frac{50 \times 10^{-3}}{1.77 \times 10^{-3}} = 2000 - 28.248$$

$$\boxed{R_i = 1971.75\Omega} \text{ Ans}$$

(ii) Current gain, $A_i = \frac{h_{fe}}{1 + h_{oe} \times r_L} = \frac{50}{1 + 600 \times 10^{-4}}$

$$\boxed{A_i = 47.169} \text{ Ans}$$

(iii) Voltage gain, $A_v = \frac{-h_{fe}}{R_i\left(h_{oe} + \frac{1}{r_L}\right)} = \frac{-50}{1971.75\left(10^{-4} + \frac{1}{600}\right)}$

$$\boxed{A_v \simeq -14.4} \text{ Ans}$$

The -ve sign indicates that there is 180° phase shift between input and output. The output signal is 14.4 times greater than input.

Spiral