the coupling capacitors C_1 and C_2 and bypass capacitor C_3 were chosen to have a very small reactance at the frequency of application.

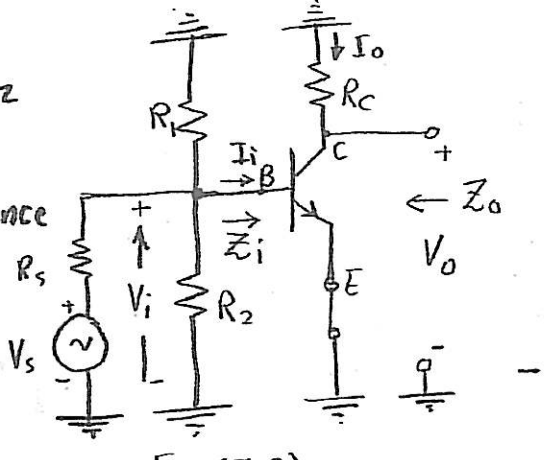


Fig (5-2)

The network of Fig (2-1) following removal of the dc supply and insertion of the short-circuit equivalent for the capacitors

* It is important to define the ac equivalent parameters of interest such as Z_i, Z_o, I_i and I_o

voltage gain $= \frac{V_o}{V_i}$

Current gain $= \frac{I_o}{I_i}$

input impedance $= Z_{in}$

output impedance $= Z_o$

* Transistor equivalent model will be introduced to complete the ac analysis of the network of Fig (5-3).

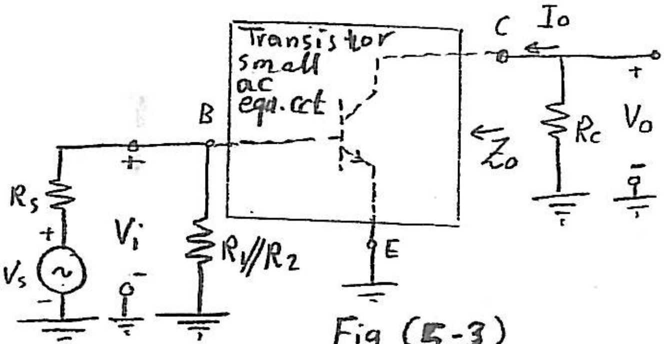


Fig (5-3).

Circuit of Fig (5-3) redrawn for small-signal ac analysis

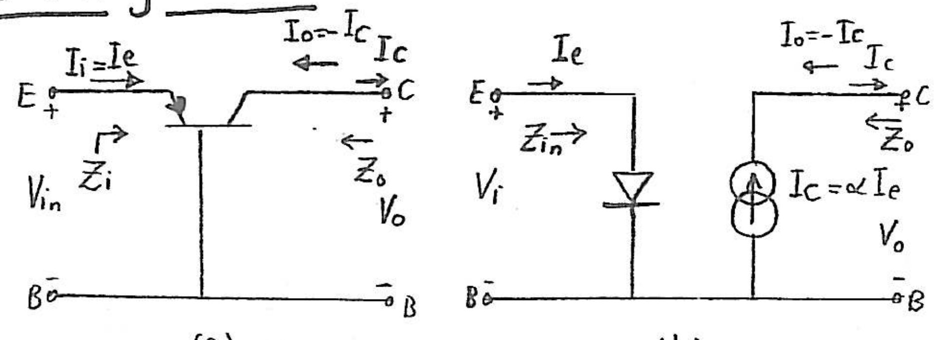
③ The re transistor Model:

* The re model for the CB, CE and CC BJT transistor configurations will now be introduced

Common-base Configuration

Fig (5-4)

Common-base BJT transistor re model for the configuration of (a)



* The transistor (CB) has been replaced by the r_e model which replaced by a single diode between emitter and base terminals and controlled current source between base and collector terminals.

* For the ac response, the diode can be replaced by its equivalent ac response. Recall ac resistance of a diode can be determined by the equation $r_{ac} = \frac{26\,mV}{I_D\,mA}$, where I_D is the dc current through the diode.

$$r_e = \frac{26\,mV}{I_E} \qquad (5\text{-}1)$$

* For the common-base configuration typical values of $Z_i = r_e$ range from a few ohms to a maximum of about $50\,\Omega$.

$Z_o \cong \infty\ \Omega$

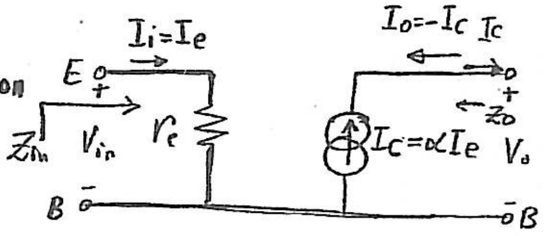


Fig (5-5)
Common base r_e equ. cct.

* In general, for the Common-base configuration the input impedance is relatively small and the output impedance quite high.

* In general, for the Common-base configuration voltage gain will now be determined for the network of Fig 5-6

$V_o = -I_o R_L = -(-I_c) R_L = \alpha I_e R_L$

$V_i = I_i Z_i = I_e Z_i = I_e r_e$

$$A_V = \frac{V_o}{V_i} = \frac{\alpha I_e R_L}{I_e r_e} = \frac{\alpha R_L}{r_e} \cong \frac{R_L}{r_e}$$

$$A_i = \frac{I_o}{I_i} = \frac{-I_e}{I_e} = \frac{-\alpha I_e}{I_e} = -\alpha \cong -1$$

V_i and V_o are inphase for C.B.C

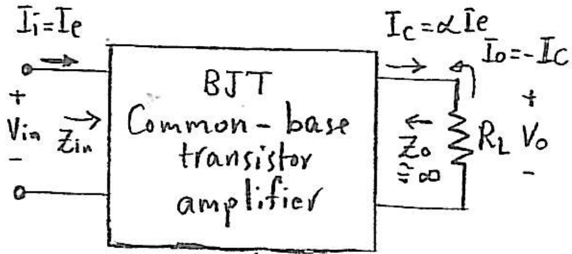


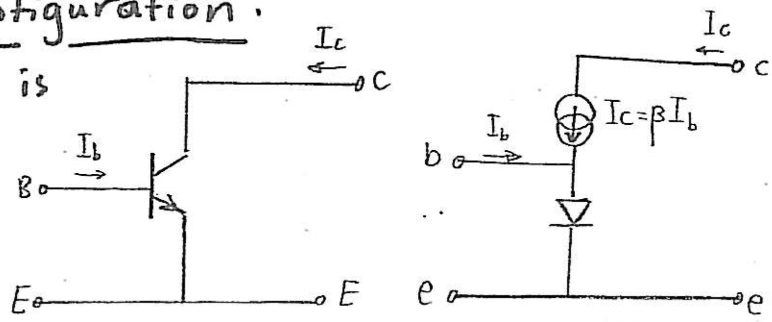
Fig (5-6)
Defining $A_V = \frac{V_o}{V_i}$ for C.B.C

Electronics I

Common - Emitter Configuration.

* The emitter terminal is common between the input and output ports of the amplifier.

$$I_C = \beta I_b \quad \text{----} (5\text{-}2)$$



(a) (b)

Fig (5-7)

a) C-E BJT transistor
b) approximate model for the Con uration of (a).

The current through the diode is:

$$I_e = I_c + I_b = \beta I_b + I_b$$

$$I_e = (\beta + 1) I_b \quad \text{---} (5\text{-}3)$$

$$Z_i = \frac{V_i}{I_i} = \frac{V_{be}}{I_b} = \frac{(\beta+1) I_b r_e}{I_b} = (\beta+1) r_e \cong \beta r_e \quad \text{----} (5\text{-}4)$$

* For C.E.C, typical values of Z_i defined by βr_e range from few hundred ohms to the kilohm range, with maxima of about 6kΩ to 7kΩ.

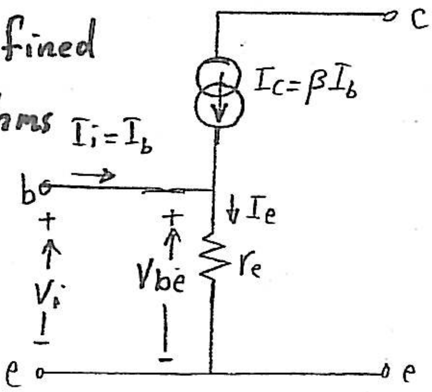


Fig (5-8)
Determining Z_i using t approximate model

* For the output impedance, the c/cs of interest are the output set of Fig (5-9).

for C.E.C, typical values of Z_o are in the range of 40kΩ to 50kΩ.

* For the model of Fig (5-10), if the applied signal is set to Zero.

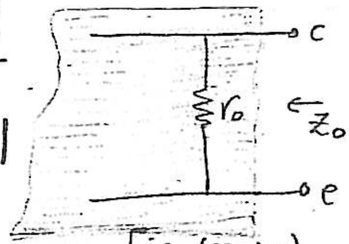


Fig (5-10)

the current I_c is Indicating r_o in the transistor equv. cct. OA and the output impedance is

$$Z_o = r_{o_{C\cdot E}} \quad \text{------} (5-5)$$

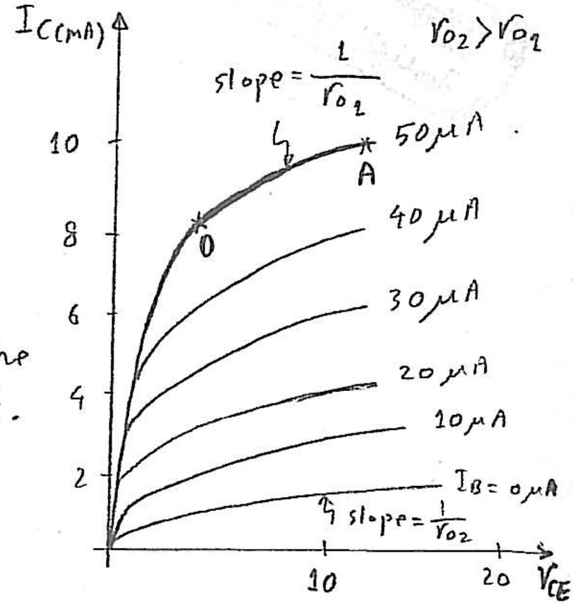


Fig (5-9) Defining r_o for the C.E.C

* For the defined direction of I_o and polarity of V_o,

$$V_o = -I_o R_L = -I_c R_L$$
$$= -\beta I_b R_L$$
$$V_i = I_i Z_i = I_b \beta r_e$$
$$A_v = \frac{V_o}{V_i} = -\frac{\beta I_b R_L}{\beta I_b r_e}$$

$$\boxed{A_v = -\frac{R_L}{r_e}} \quad \text{------} (5-6)$$

$$A_i = \frac{I_o}{I_i} = \frac{I_c}{I_b} = \frac{\beta I_b}{I_b} = \beta$$

$$\boxed{A_i = \beta} \quad \text{------} (5-7)$$

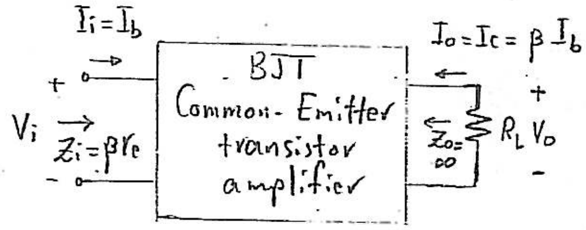


Fig (5-11) Determining the voltage and Current gain for the C.E transistor amplifier

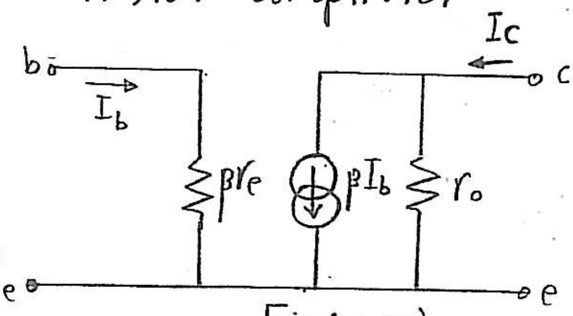


Fig (5-12) r_e model for the C.E transistor configuration

* So $Z_i = \beta r_e$, $I_c = \beta I_b$, $Z_o = r_o$ we find the equivalent model of Fig (5-12)

COMMON-COLLECTOR Configuration :

The model defined for the C.E.C of Fig (5-7) is normally applied rather than defining amodel for the C.C.C.