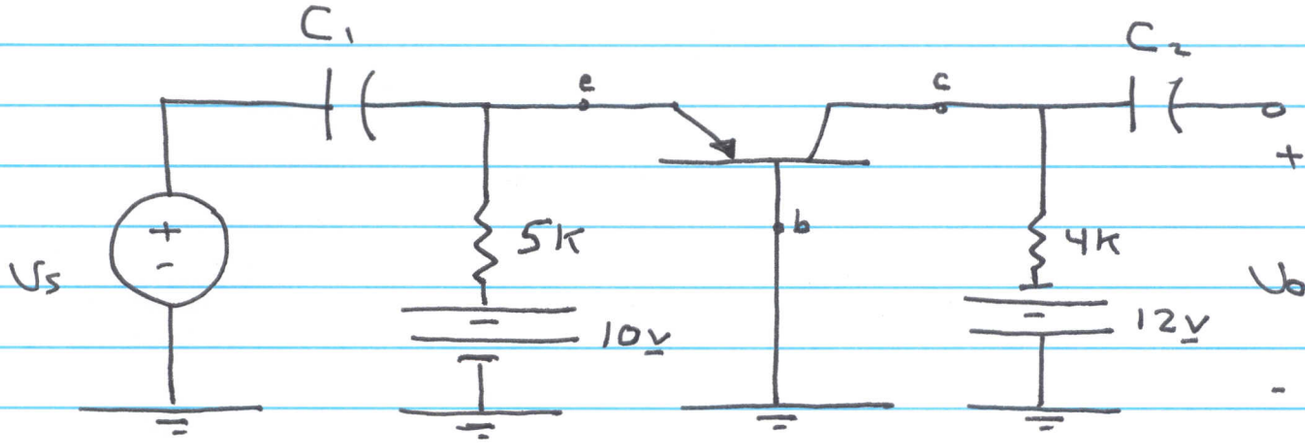
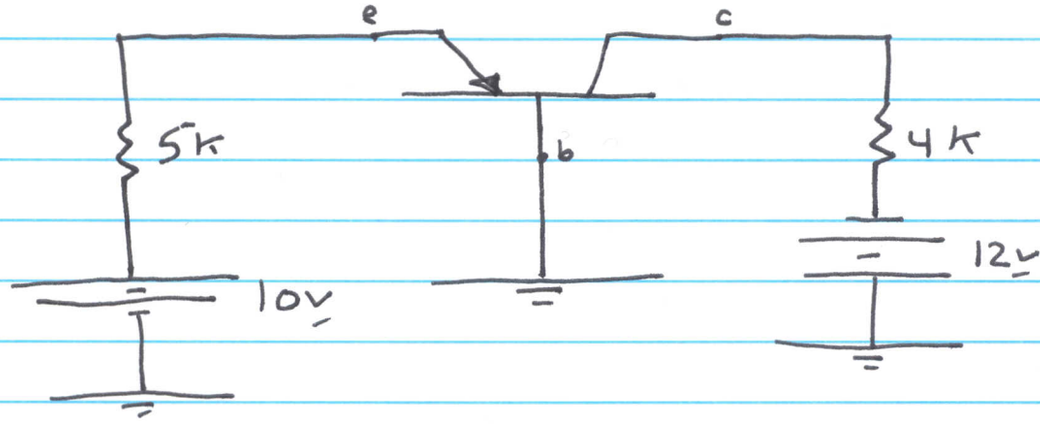
BJT ac amplifiers

1) Common base amplifier



a) Dc Analysis

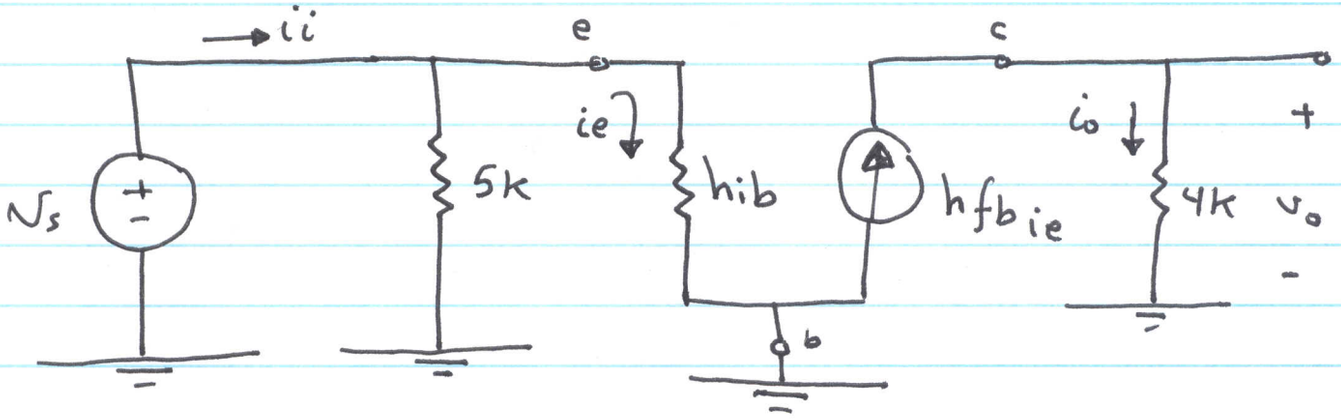


$$I_E = \frac{10 - V_{EB}}{5k} = \frac{10 - 0.7}{5k} = 1.86\,mA$$

$$\therefore h_{ib} = \frac{V_T}{I_{EQ}} = 13.98\,\Omega$$

b) Ac small signal Analysis

ac small signal equivalent circuit



1. Voltage gain: $A_v = \frac{V_o}{V_s}$

$$V_o = h_{fb}\, i_e\, (4k)$$

$$i_e = \frac{V_s}{h_{ib}}$$

$$\therefore A_v = \frac{V_o}{V_s} = \frac{h_{fb}}{h_{ib}}(4k) = 286 > 1$$

V_s is in phase with V_o

2. Current gain: $A_i = \frac{i_o}{i_i}$

$$i_o = h_{fb}\, i_e$$

$$i_e = i_i \frac{5k}{5k + h_{ib}}$$

$$\therefore A_i = h_{fb} \frac{5k}{5k + h_{ib}} < 1$$

3. input impedance : Z_i

Z_i is Rth seen by the source V_s

$$Z_i = \frac{V_s}{i_i}$$

$$i_i = \frac{V_s}{5k} + \frac{V_s}{h_{ib}}$$

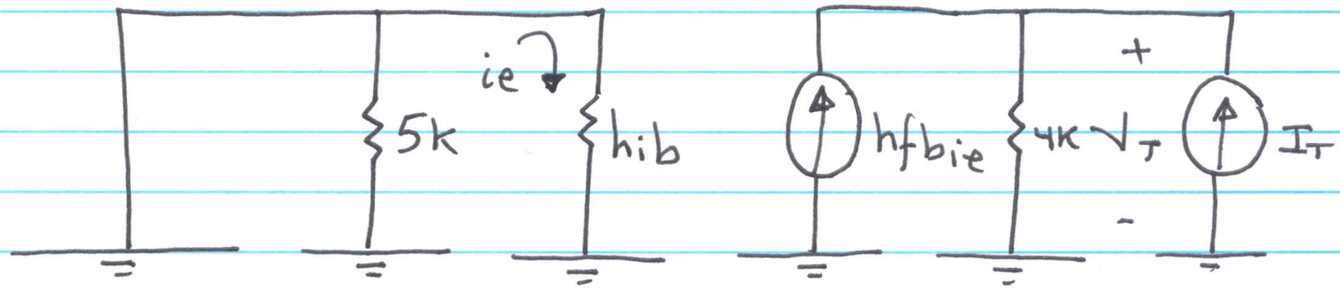
$$\therefore \frac{V_s}{i_i} = 5k \parallel h_{ib} \approx h_{ib}$$

$$\therefore Z_i \approx h_{ib} \quad (\text{very small})$$

4. Output impedance : Z_o

Z_o is Rth seen by the load

$$\therefore Z_o = \left.\frac{V_T}{I_T}\right|_{V_s = 0}$$

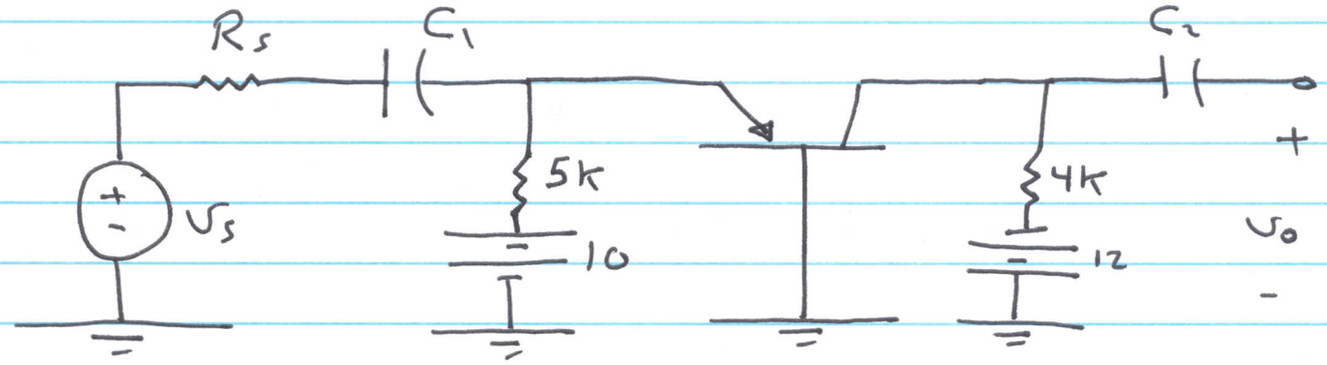


$$I_T = \frac{V_T}{4k} - h_{fb}\, i_e$$

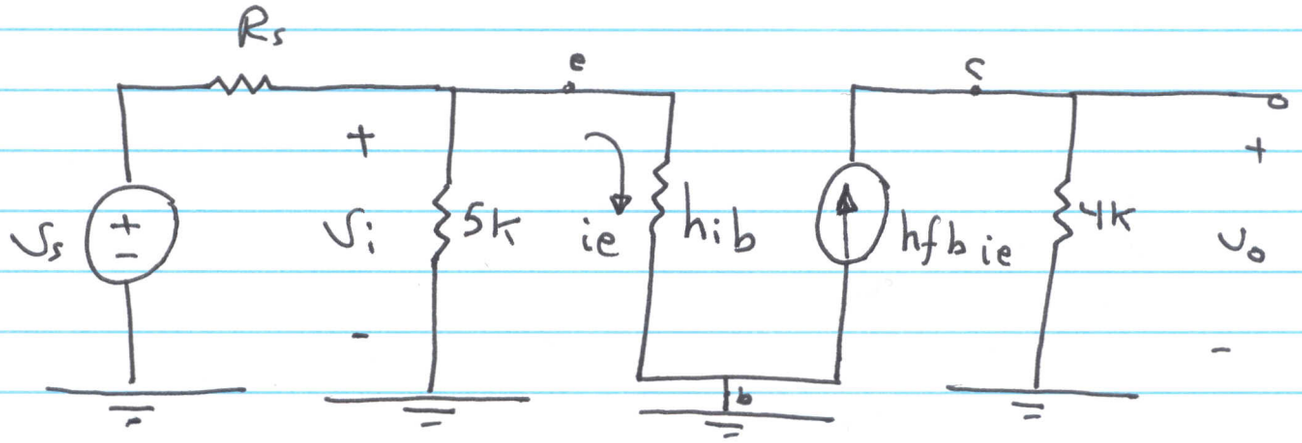
$i_e = 0$

$$\therefore \frac{V_T}{I_T} = 4K \quad (\text{Large})$$

The effect of R_s



ac small signal equivalent circuit



$$V_o = h_{fb}\, i_e\, (4K)$$

$$i_e = \frac{v_i}{h_{ib}}$$

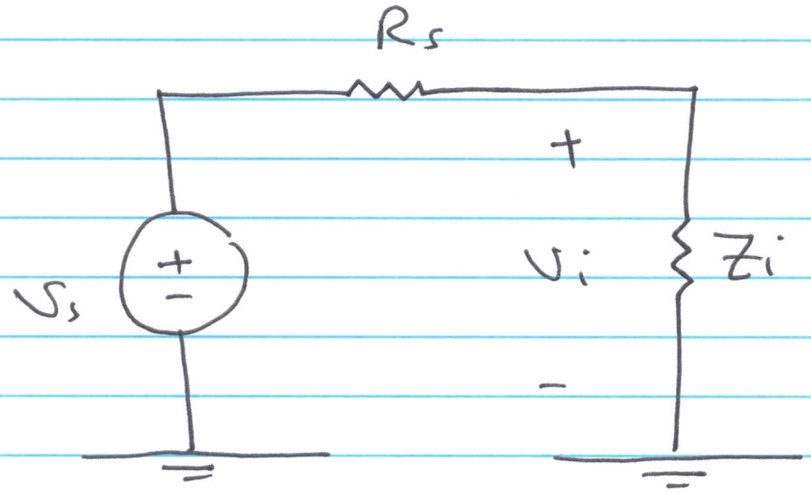
$$V_i = \frac{5K \parallel h_{ib}}{5K \parallel h_{ib} + R_s} V_s$$

$$V_i = \frac{Z_i}{Z_i + R_s} V_s$$

$$\therefore A_{vs} = \frac{V_o}{V_s}$$

$$A_{vs} = \frac{h_{fb}}{h_{ib}} (4k) \frac{Z_i}{Z_i + R_s}$$

$$A_{vs} = \begin{cases} 62.5 & R_s = 50\ \Omega \\ 0.4 & R_s = 10k \end{cases}$$



$$V_o = 286\ V_i$$

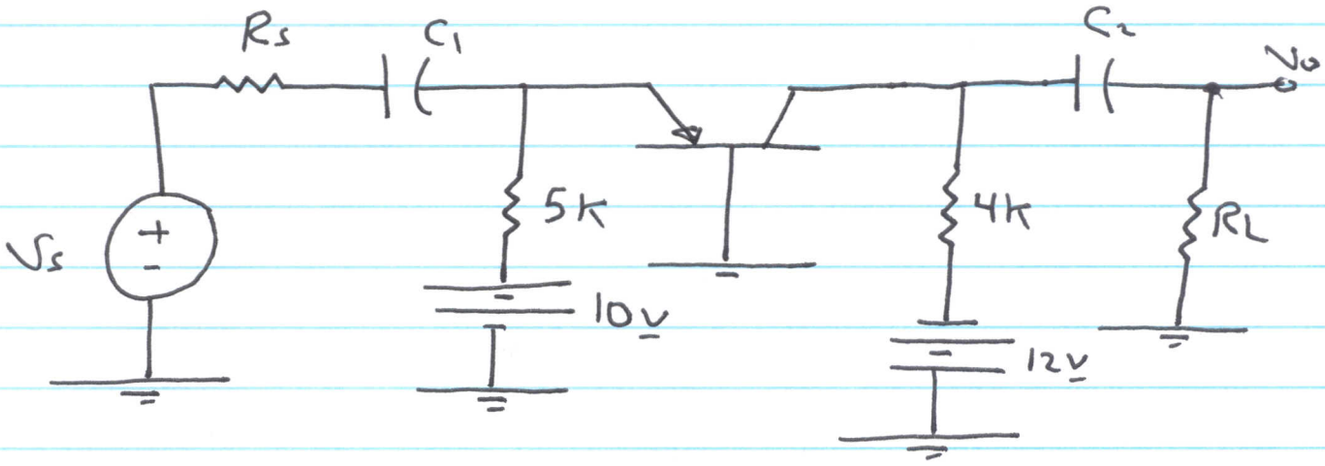
$$V_i = \frac{Z_i}{Z_i + R_s} V_s$$

$$V_o = \frac{Z_i}{Z_i + R_s} \cdot 286\ V_s$$

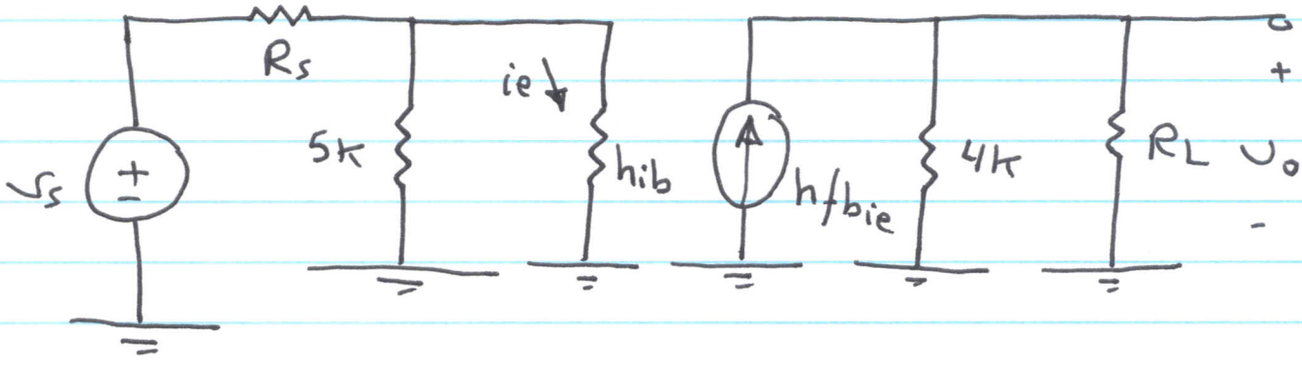
$\therefore$ Z_i must be as large as

Could be

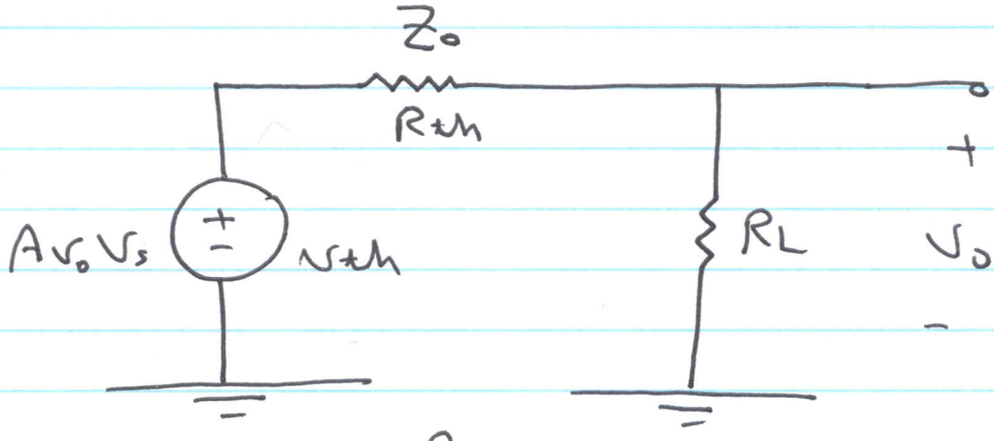
The effect of R_L



ac small signal equivalent CKT



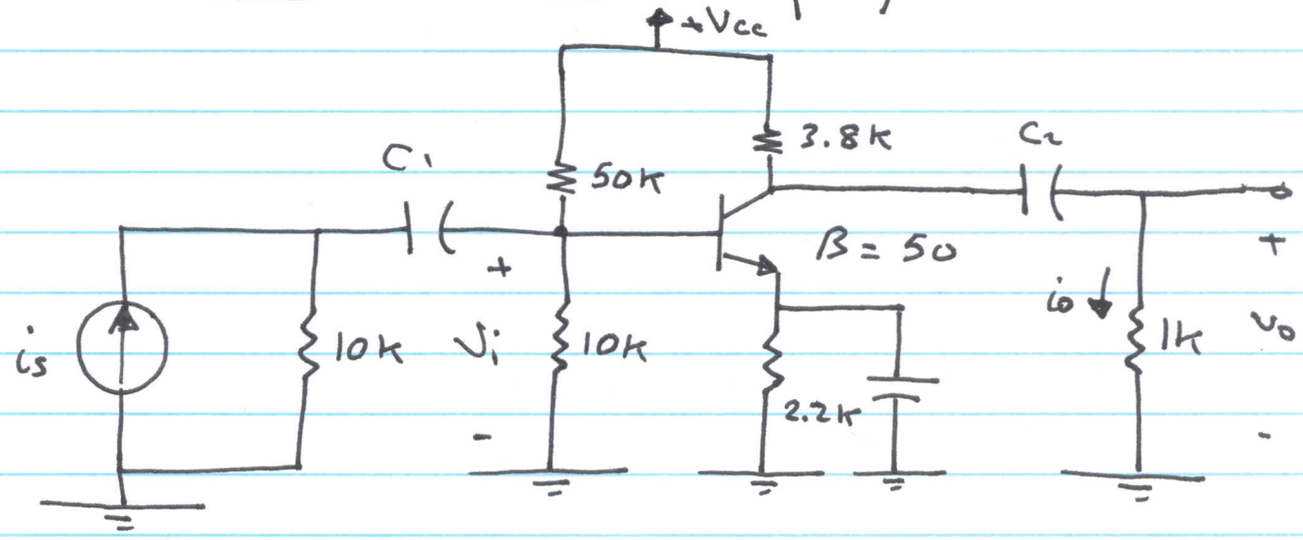
using thevenin's theorm



$$V_o = \frac{R_L}{R_L + Z_o} A_{vo} V_s$$

∴ Zo must be as small as could be.

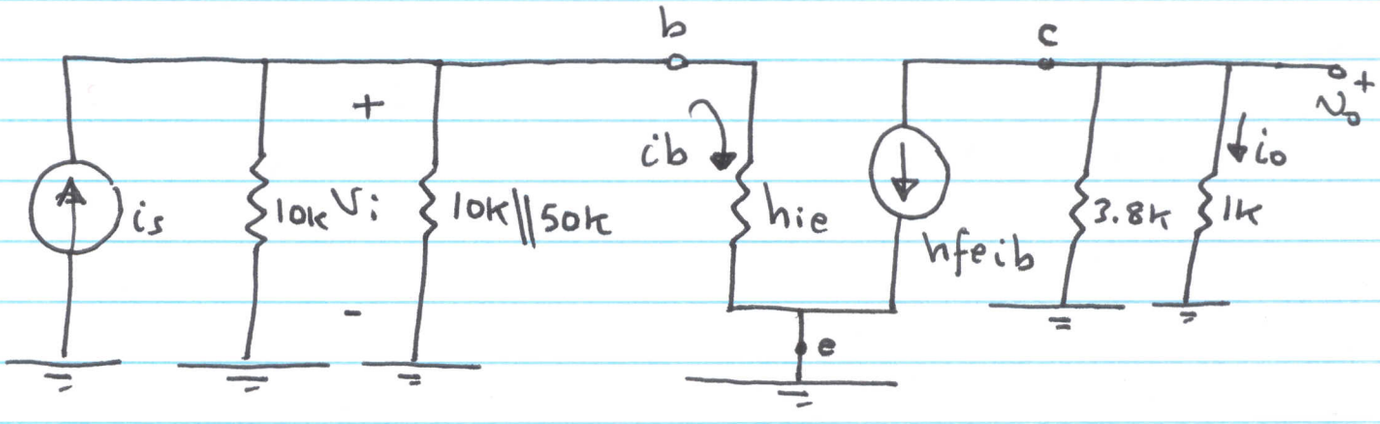
2) Common emitter amplifier :



$h_{ie} = 928\ \Omega$

$h_{fe} = 50$

ac small Signal equivalent circuit :



a) $A_i = \dfrac{i_o}{i_s}$

$$i_o = -h_{fe} i_b \frac{3.8k}{3.8k + 1k}$$

$$i_b = i_s \frac{10k \| 10k \| 50k}{10k \| 10k \| 50k + h_{ie}}$$

$$\therefore A_i = -33$$

b) $A_V = \frac{V_o}{V_i}$

$V_o = - h_{fe}\, i_b \left(1k \| 3.8k\right)$

$i_b = \frac{V_i}{h_{ie}}$

$\therefore A_V = \frac{V_o}{V_i} = -42.7$

c) $Z_i = 10k \| 50k \| h_{ie}$

d) $Z_o = 3.8k$

$|A_V| > 1$

$|A_i| > 1$

Z_i Large

Z_o Large