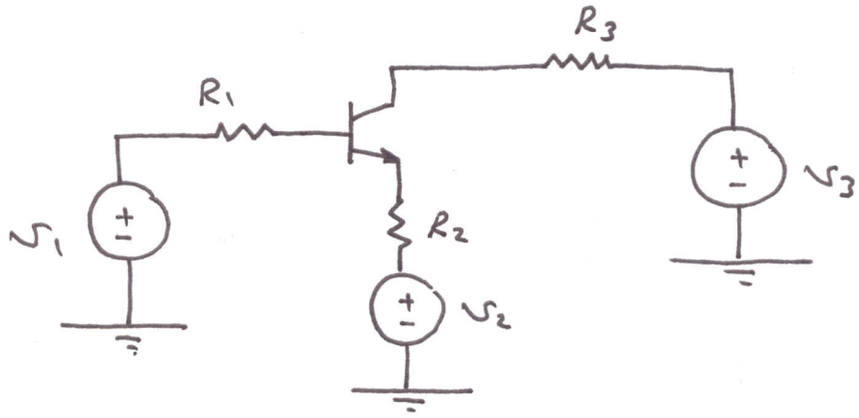
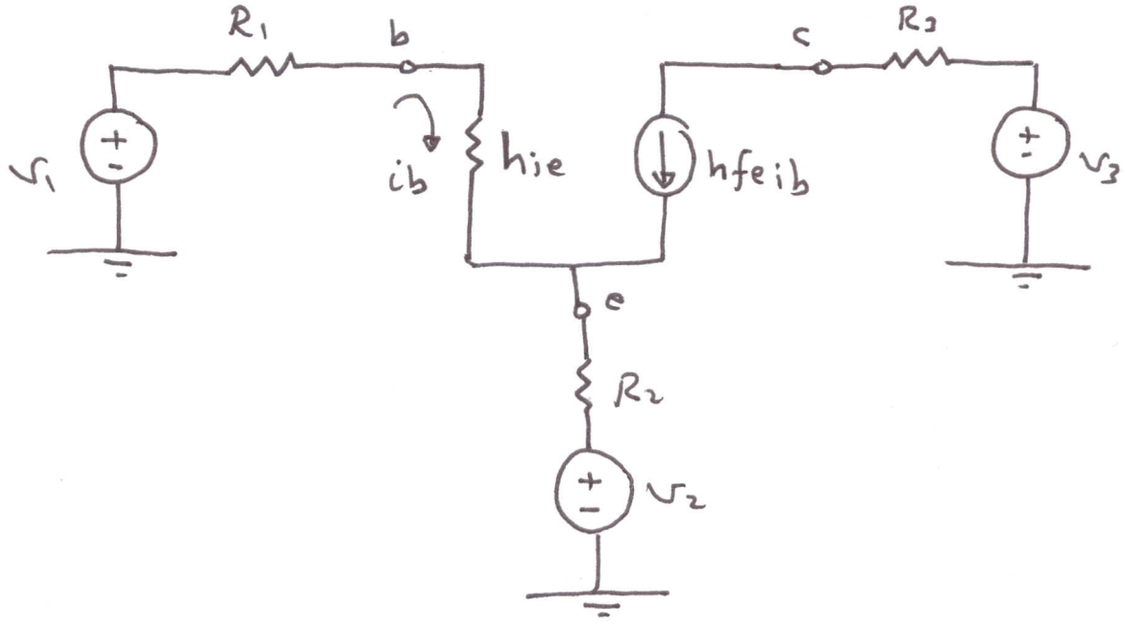
Impedance reflection :

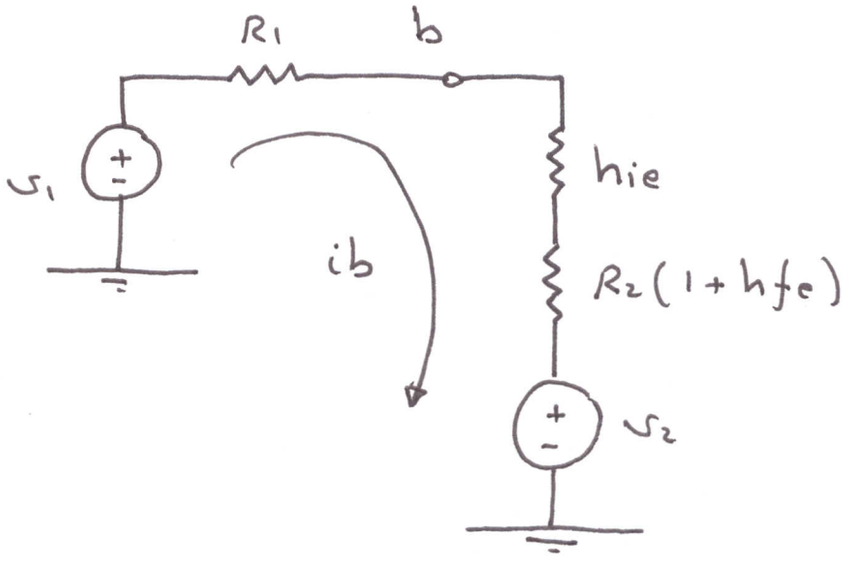


ac Small Signal equivalent circuit :



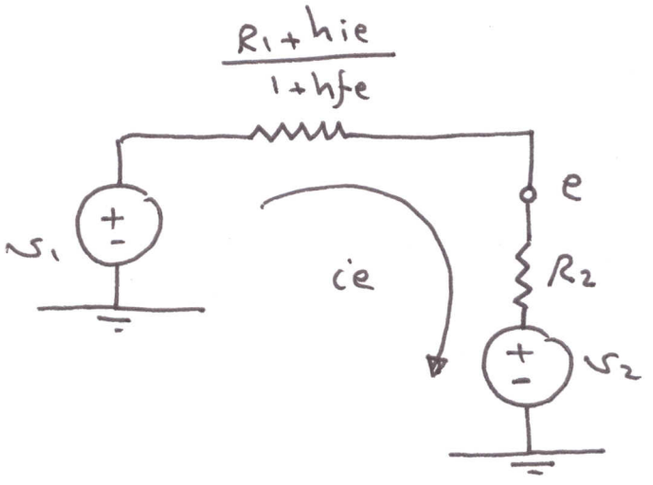
base equivalent circuit

$$ib = \frac{v_1 - v_2}{R_2(1+hfe) + R_1 + hie}$$

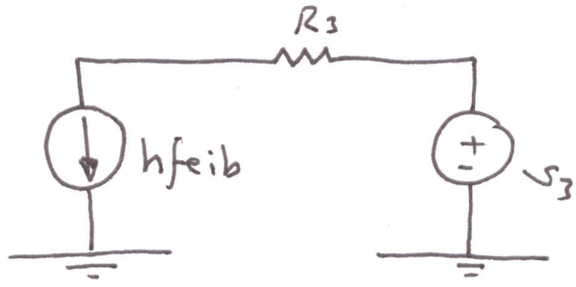


Emitter equivalent circuit

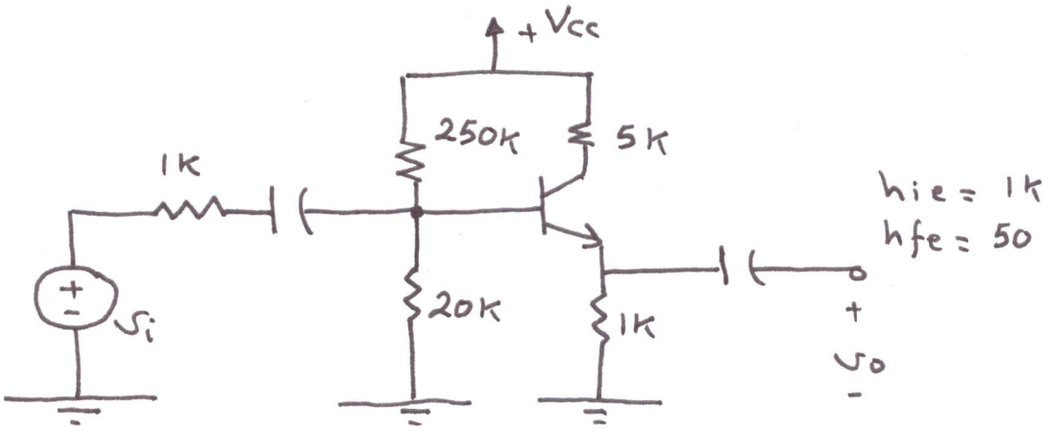
$$ie = \frac{V_1 - V_2}{R_2 + \frac{R_1 + hie}{1 + hfe}}$$



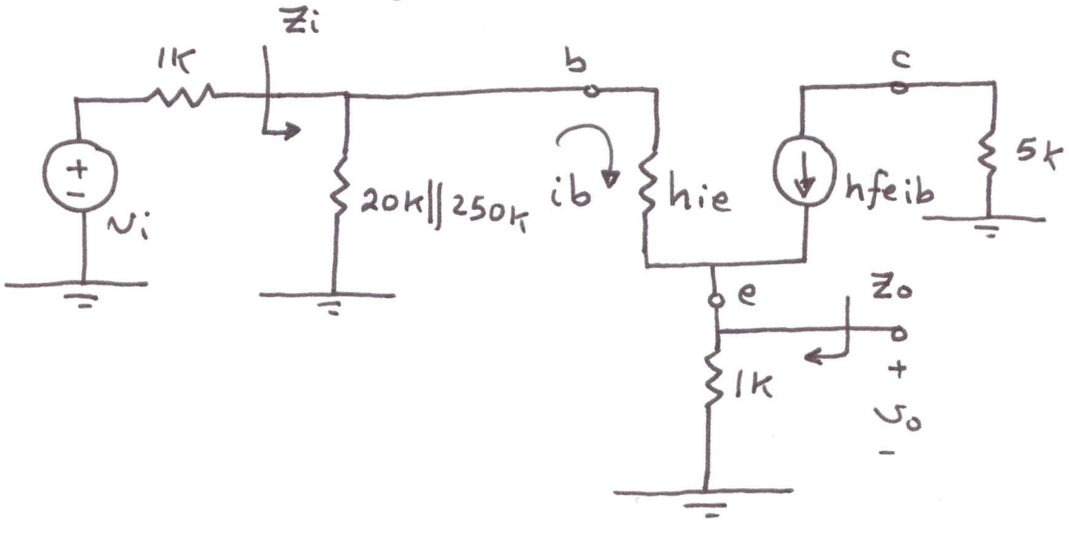
Collector equivalent circuit



3) Common Collector amplifier



ac Small Signal equivalent Circuit :



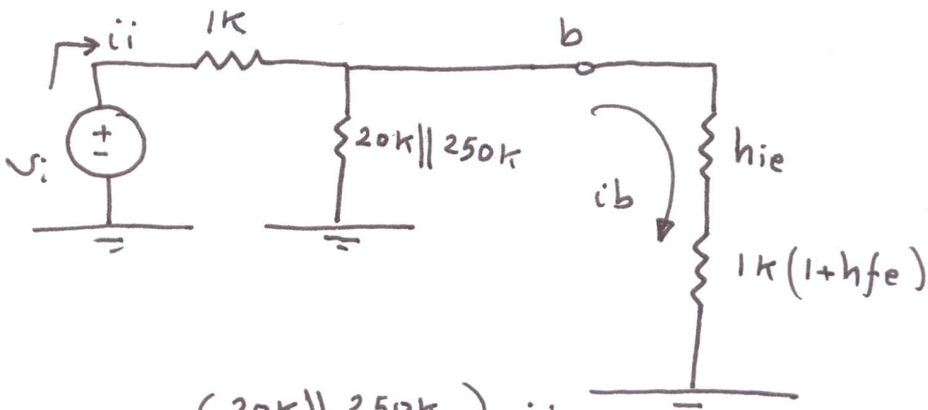
$$A_v = \frac{V_o}{V_i}$$

$$V_o = 1K\ i_e$$

$$i_e = (h_{fe}+1)\, i_b$$

To find i_b ⟶ bare equivalent Circuit

base equivalent Circuit



$$ib = \frac{(20K \parallel 250K)\, ii}{20K \parallel 250K + hie + 1K\,(1+hfe)}$$

$$ii = \frac{Vi}{1K + Zi}$$

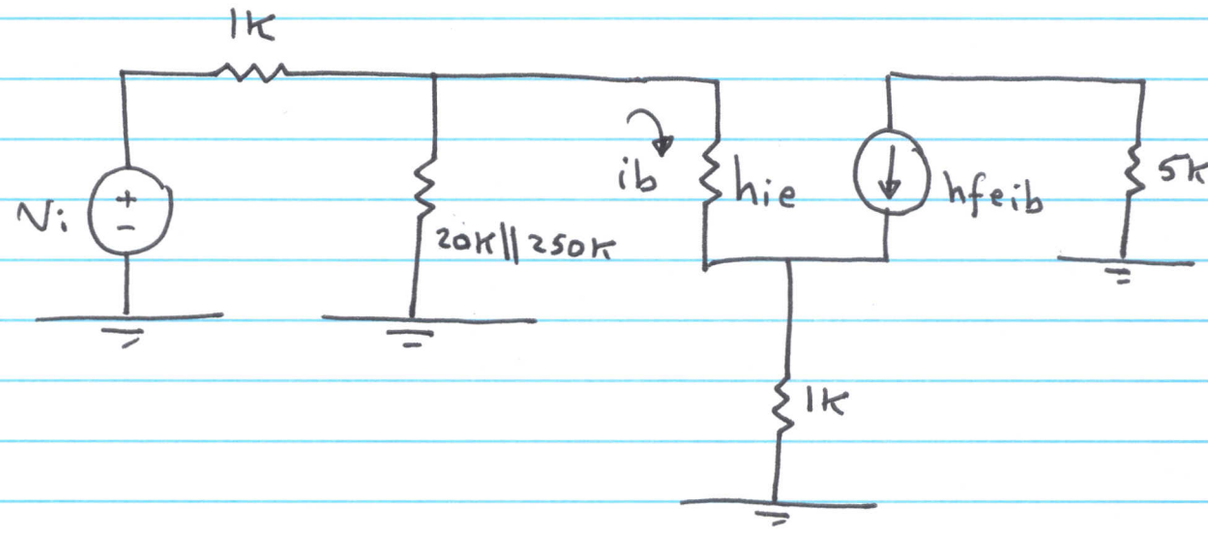
$$ii = \frac{Vi}{1K + [20K \parallel 250K] \parallel [hie + 1K(1+hfe)]}$$

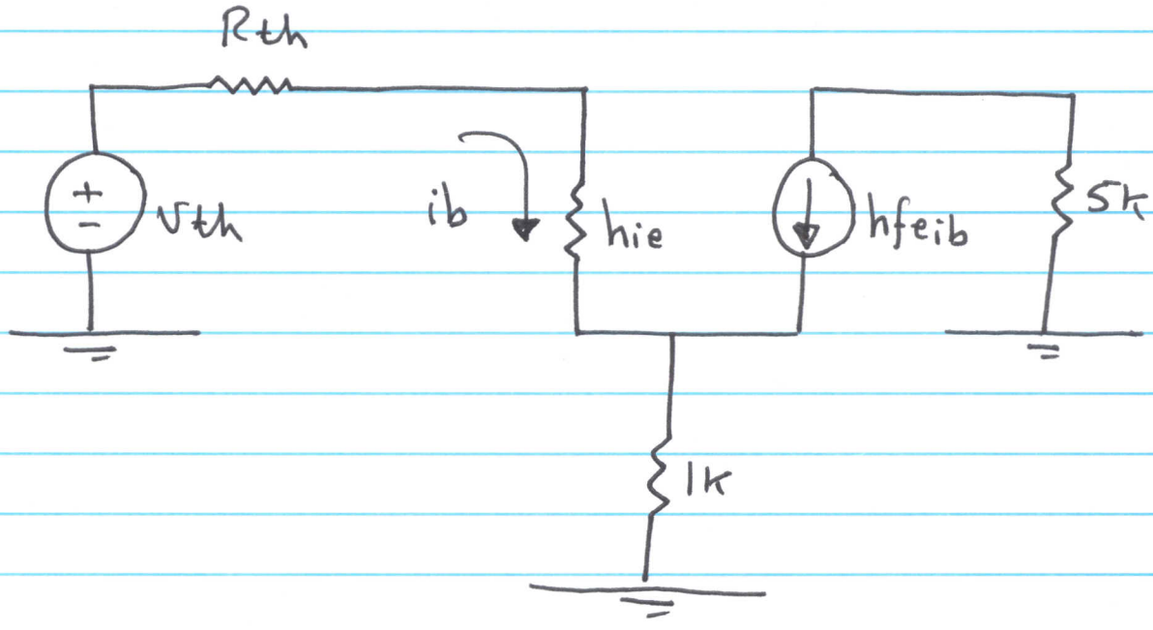
$$Zi = (20K \parallel 250K) \parallel (hie + 1K(1+hfe)) = 13.66K$$

$$Av = \frac{Vo}{Vi} = 0.9149$$

$$Ai = \frac{io}{ii} = 13.9$$

To find Z_o ⟶ emitter equivalent ckt

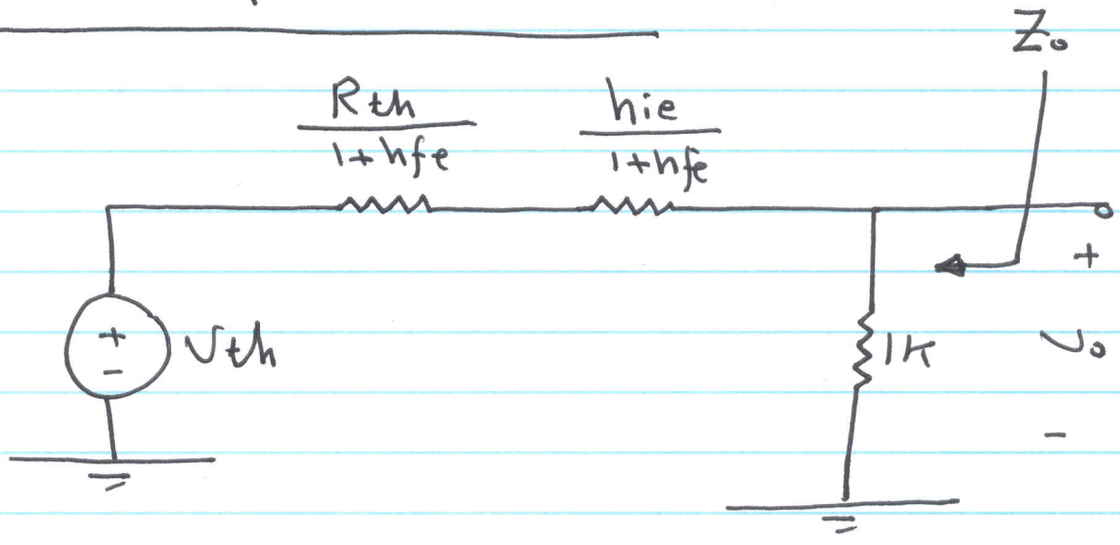




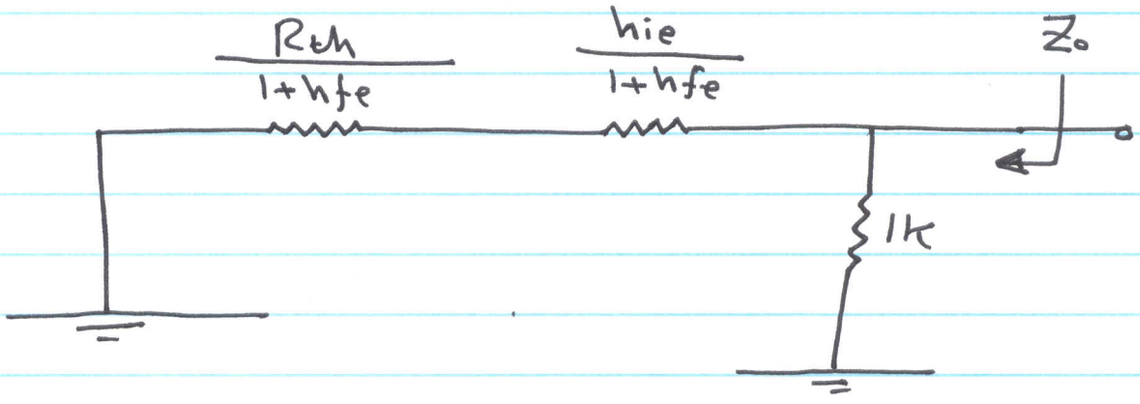
$$R_{th} = 1k \| 20k \| 250k$$

$$V_{th} = \frac{20k \| 250k}{20k \| 250k + 1k} V_i$$

emitter equivalent Circuit



To find Z_o, we set $V_i = 0$, $\therefore V_{th} = 0$



$$Z_o = 1K \left\| \left(\frac{R_{th} + h_{ie}}{1 + h_{fe}} \right) \right.$$

$$Z_o = 1K \left\| \left(\frac{1K \| 20K \| 250K + h_{ie}}{1 + h_{fe}} \right) \right. = 36.8\,\Omega$$

$\therefore$ For Common Collector amplifier

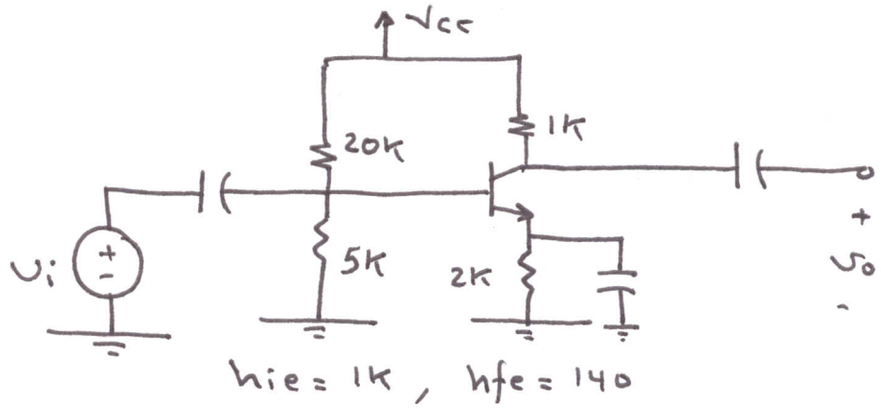
$A_v < 1$; $A_i > 1$

Z_i very Large ; Z_o very small

The Common Collector as a Buffer

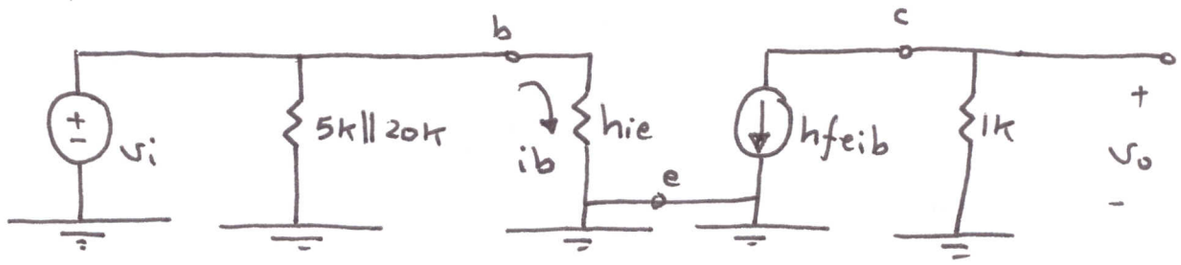
Although the small signal voltage gain of the common collector (emitter follower) is less than 1, it can be used to improve the total voltage gain of a multistage amplifier.

Common emitter amplifier :



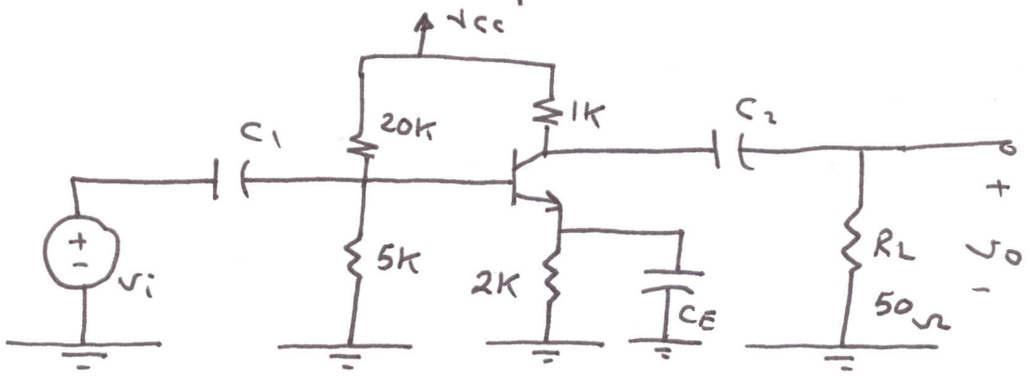
hie = 1K , hfe = 140

ac small Signal equivalent circuit :

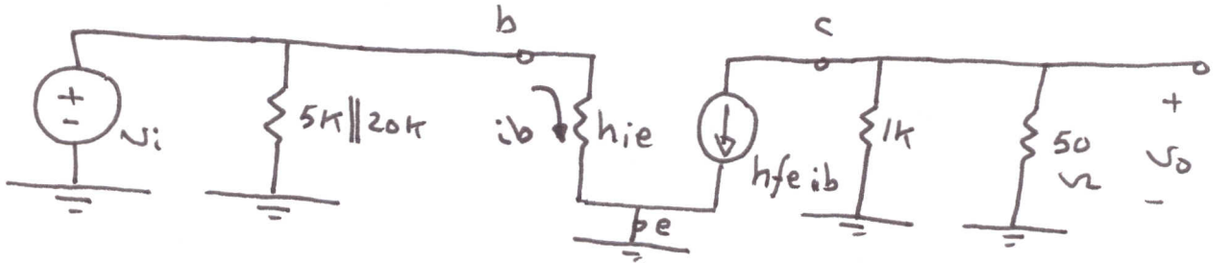


$$A_{V_o} = \frac{V_o}{V_i} = -140$$

Common emitter amplifier with R_L :

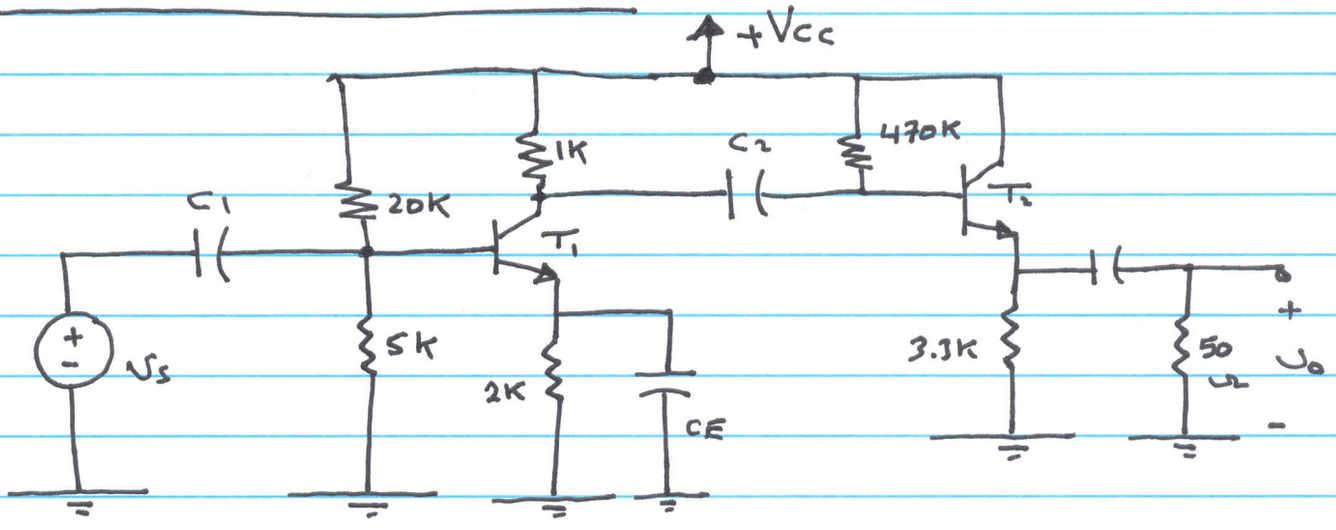


ac Small Signal equivalent Circuit :



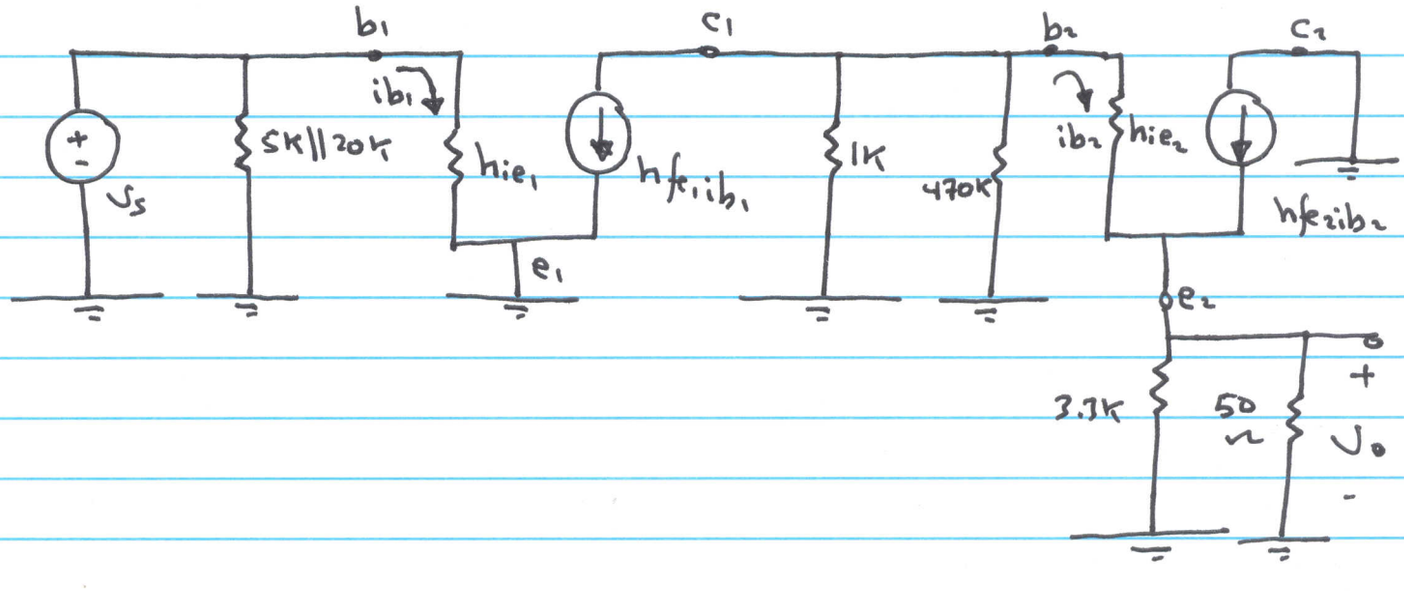
$$A_v = \frac{V_o}{V_i} = -6.67$$

Multistage Amplifier

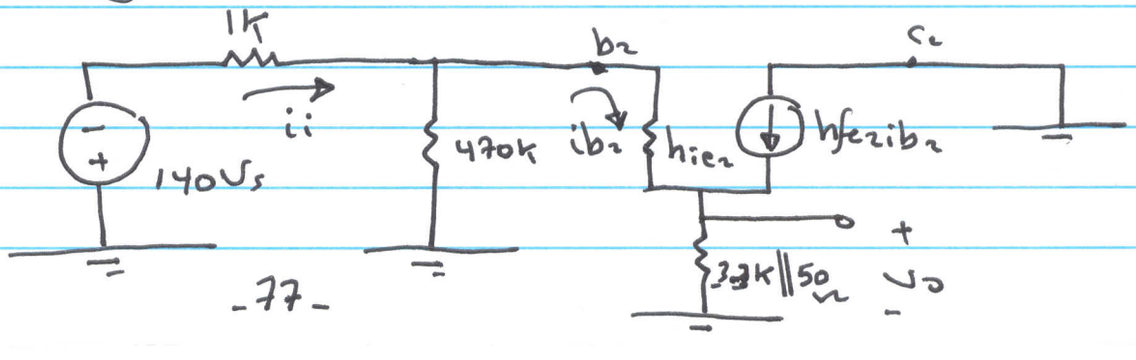


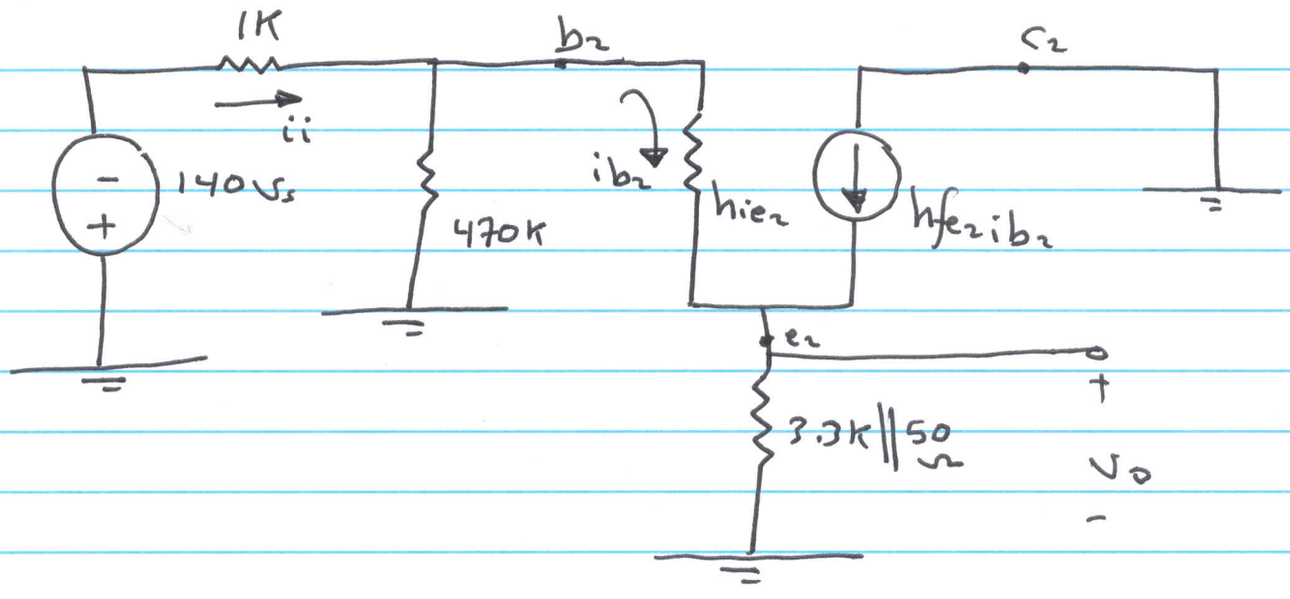
$h_{fe_1} = 140$, $h_{ie_1} = 1K$, $h_{fe_2} = 100$, $h_{ie_2} = 2.24K$

Ac small signal equivalent circuit :



using Thevenin's theorem





$$v_o = (3.3K \| 50_\Omega)(1 + h_{fe_2}) i_{b_2}$$

$$i_{b_2} = i_i \frac{470K}{470K + h_{ie_2} + (3.3K \| 50_\Omega)(1 + h_{fe_2})}$$

$$i_i = \frac{-140\, v_s}{1K + 470K \left\| \left[h_{ie_2} + (3.3K \| 50_\Omega)(1 + h_{fe_2}) \right] \right.}$$

$$\therefore A_v = -85$$