30/10/19

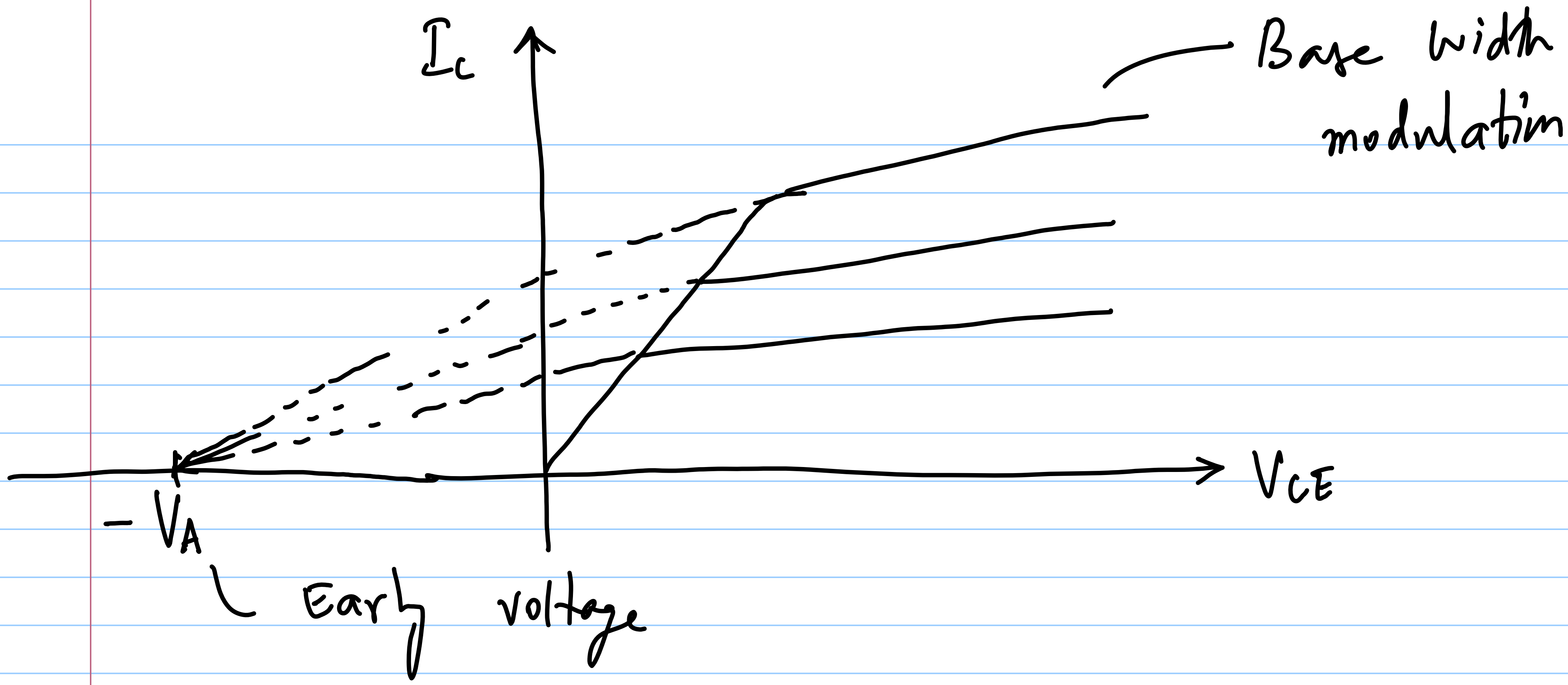
Lec 35

$$g_m = y_{21} = \frac{\partial I_C}{\partial V_{BE}} = \frac{I_C}{V_T}$$

$$y_{11} = \frac{\partial I_B}{\partial V_{BE}} = \frac{1}{\beta}\frac{\partial I_C}{\partial V_{BE}} = \frac{g_m}{\beta}$$

$$r_\pi = \frac{1}{y_{11}} = \beta/g_m$$

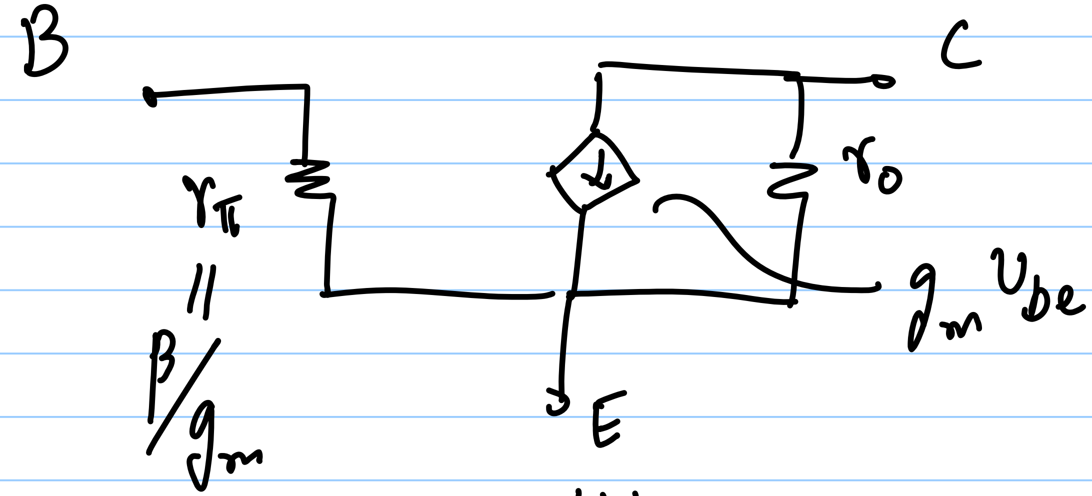
$$y_{12} = 0 \; ; \; y_{22} = ?$$



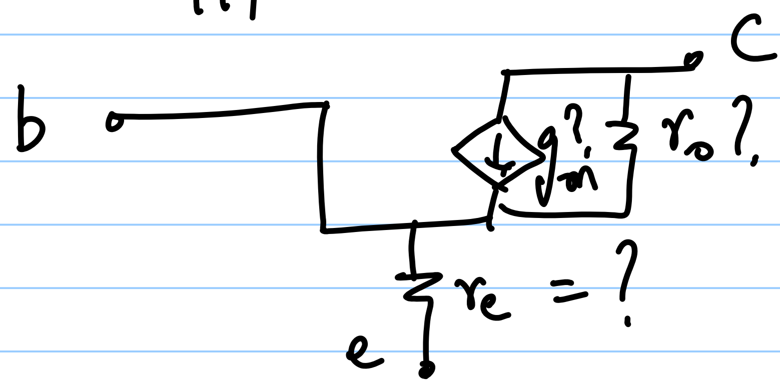
$$I_c = \left[I_s \exp\left(\frac{V_{BE}}{V_t}\right)\right]\left[1 + \frac{V_{CE}}{V_A}\right]$$

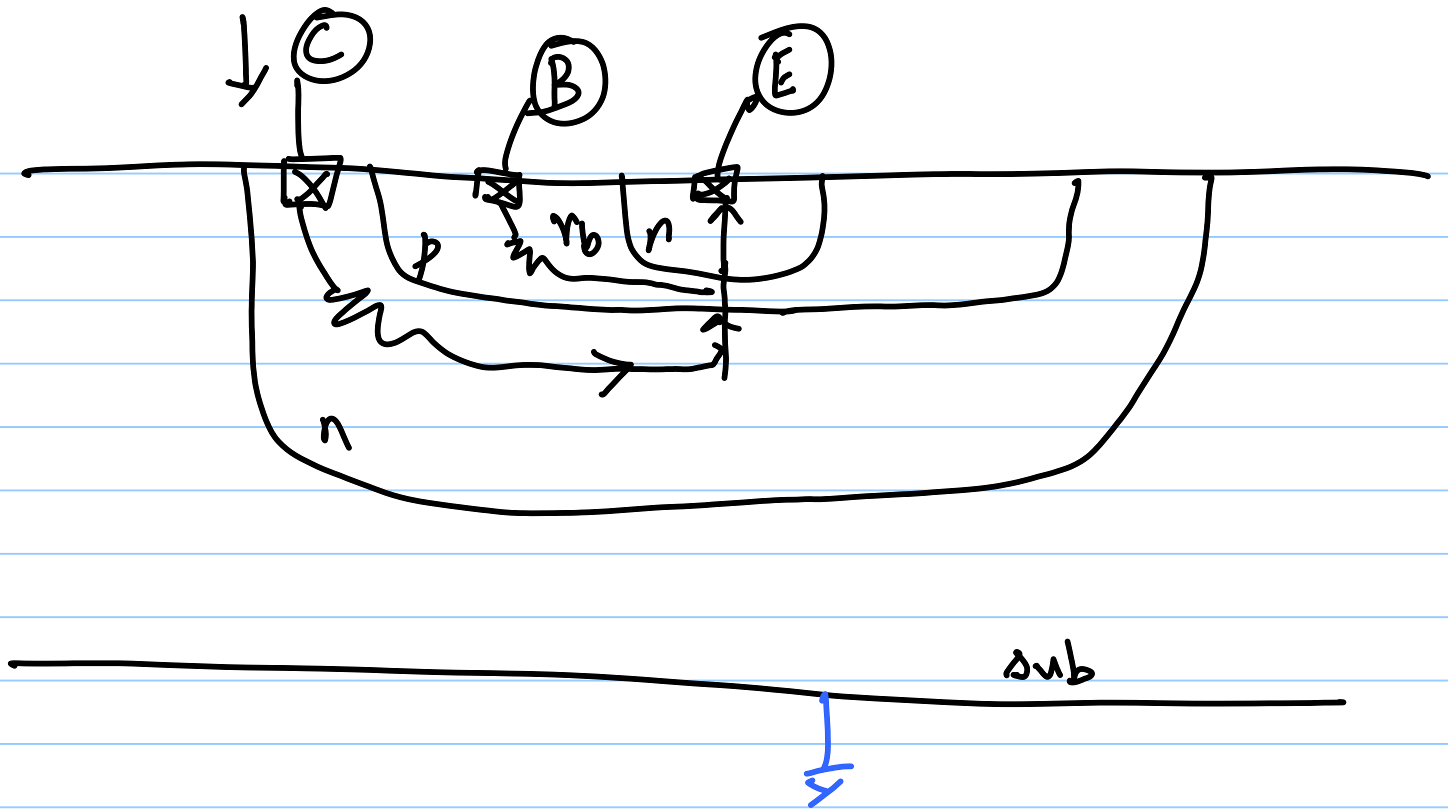
$$y_{22} = \frac{\partial I_c}{\partial V_{CE}} = \frac{I_c}{V_A}$$

Small signal model of BJT

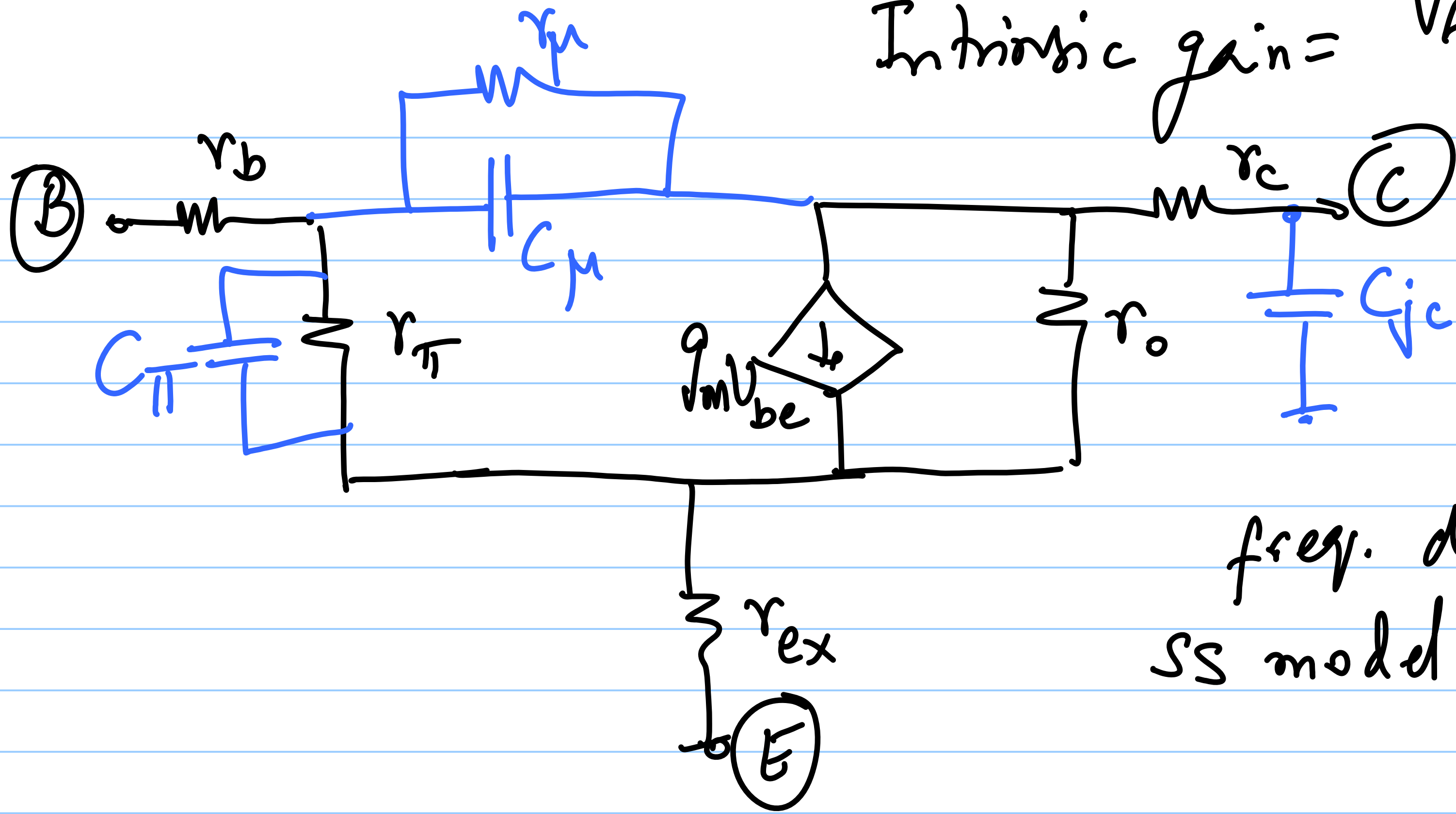


$\equiv$



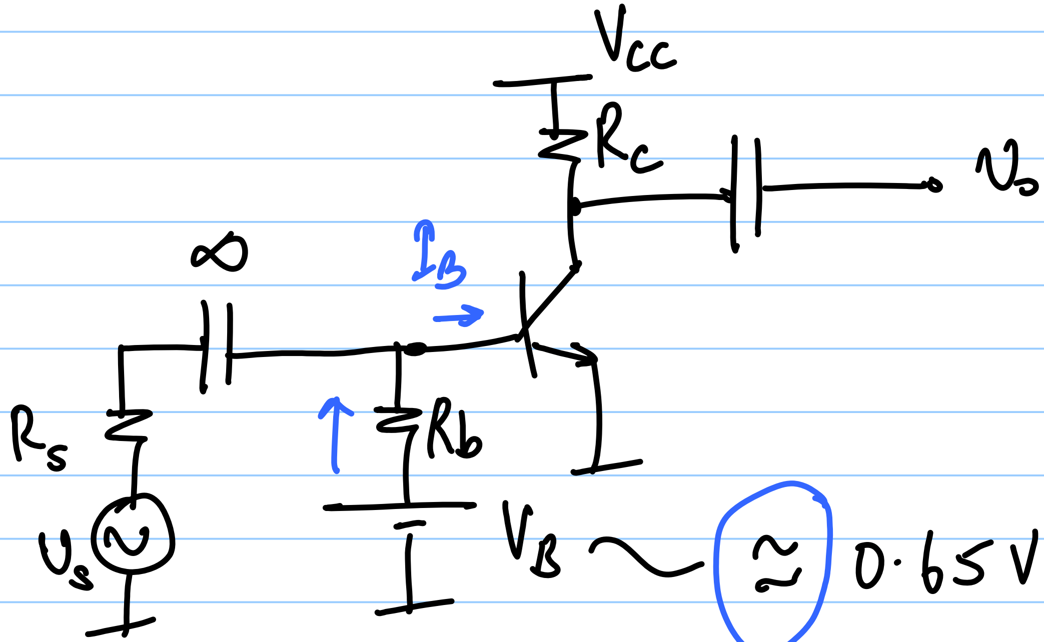

C
B
E
r_b
p
n
n
sub

Intrinsic gain = V_A / V_t

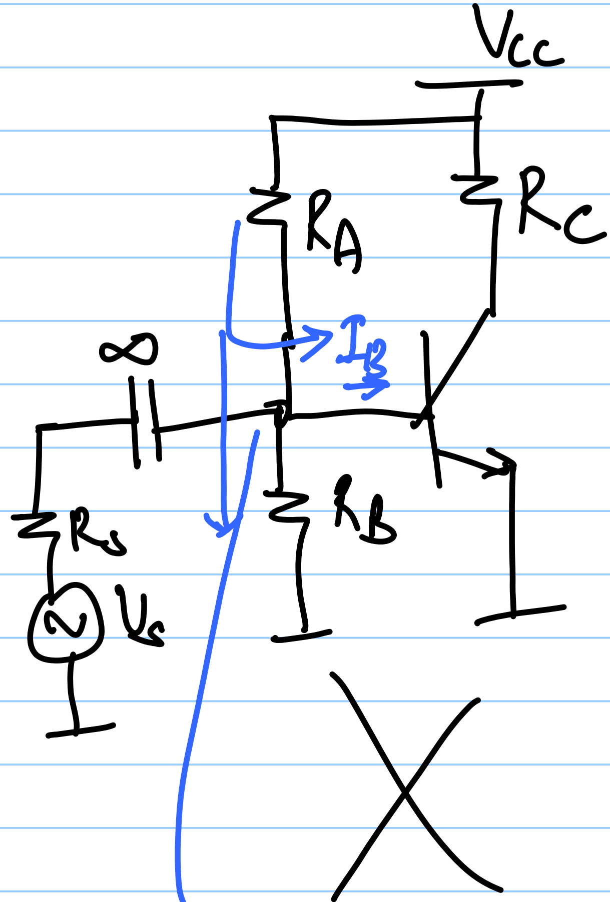


freq. dep.
SS model of BJT

Commm Emitter Amplifier

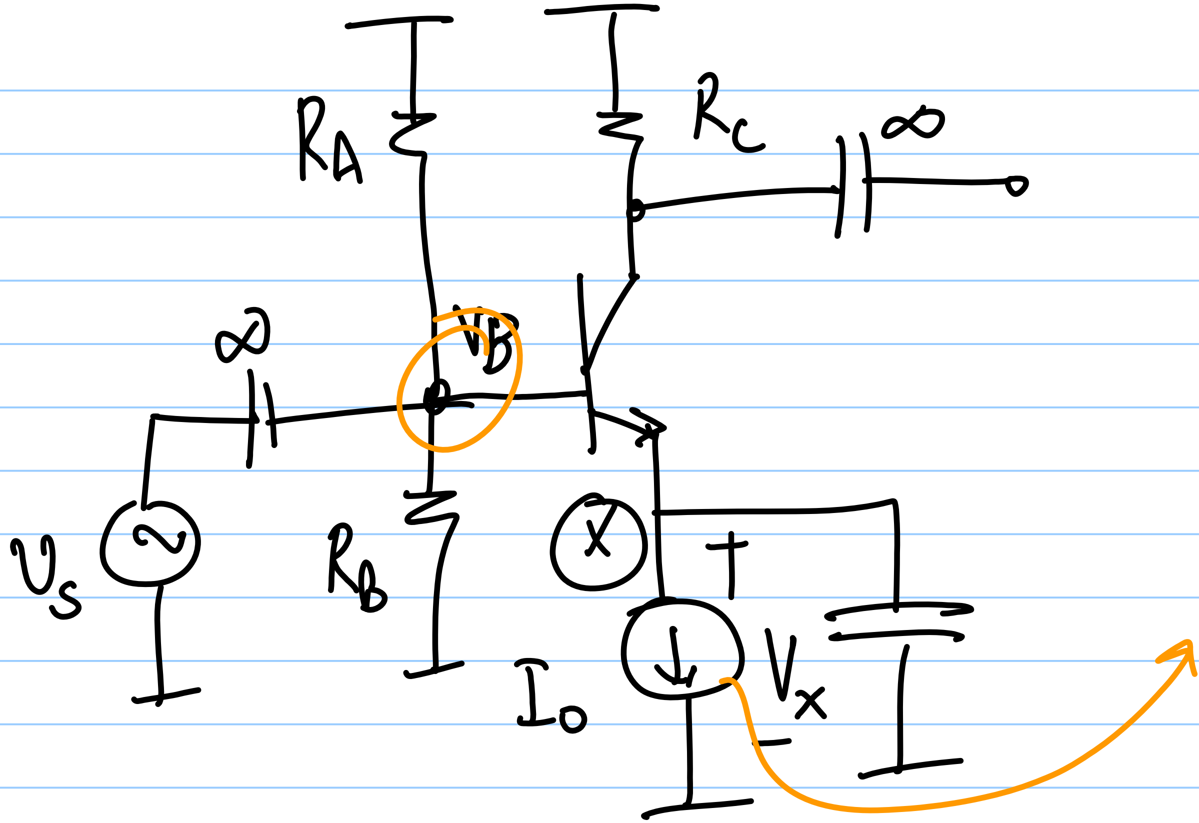


$V_B \sim \approx 0.65\,V$



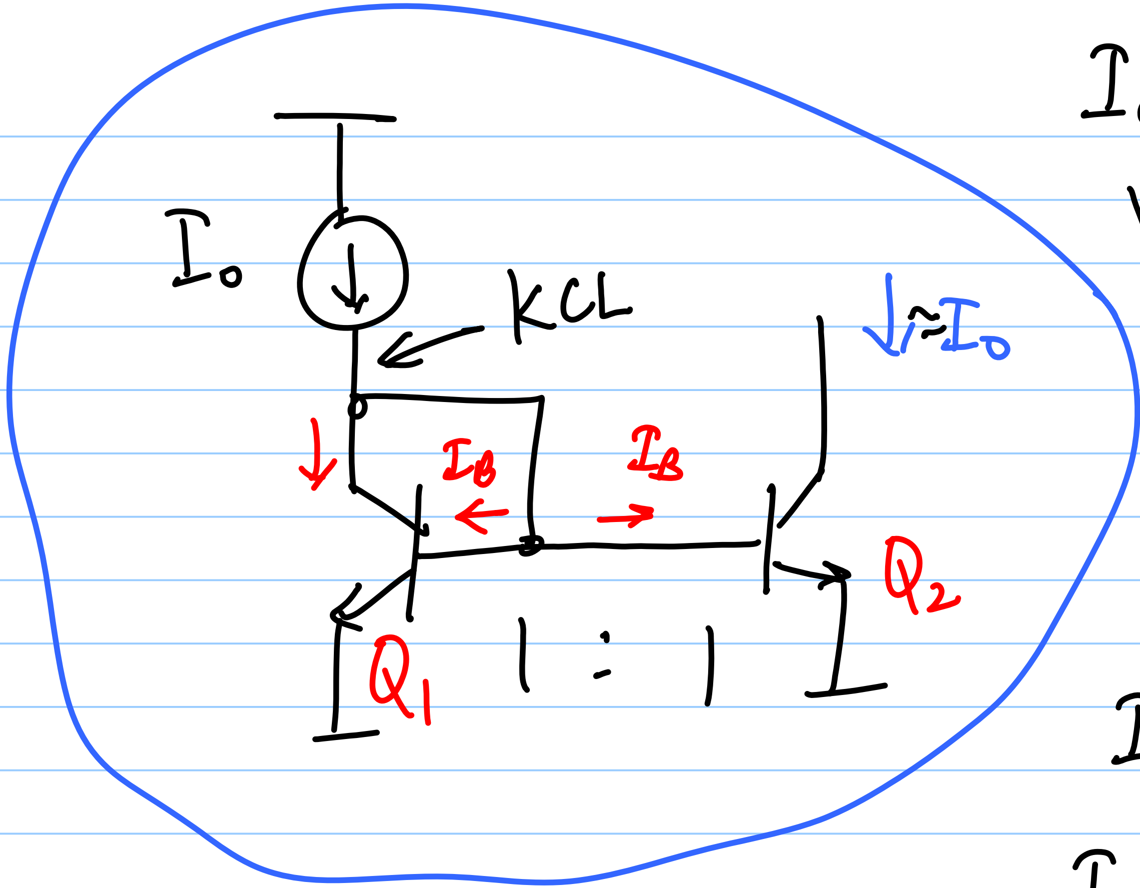
$$\approx \frac{R_B}{R_A + R_B} \cdot V_{cc} \quad \text{if}$$

$$I_B \ll V_{cc} / (R_A + R_B)$$



$V_B = V_x + \underline{\underline{V_{BE}}} \rightarrow I_E = I_o$

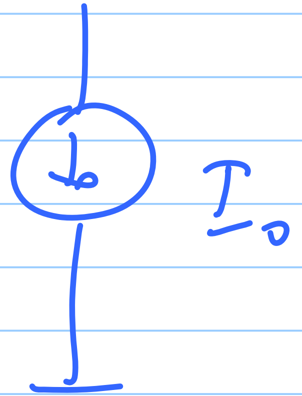
Current mirror



$$I_{C_1} = I_0 - 2I_B$$

$$V_{BE_1} = V_{BE_2}$$

$\equiv$



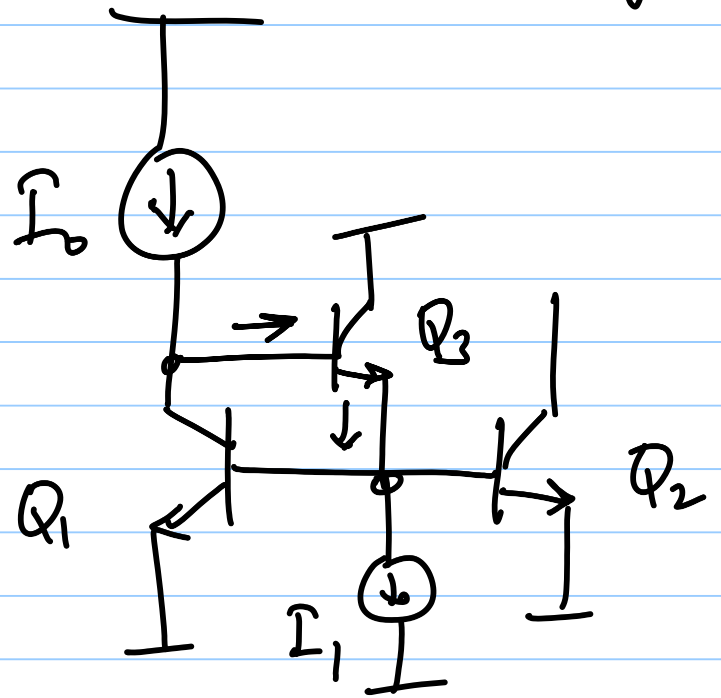
$$I_{C_1} = I_{C_2}$$

$$I_{C_2} = I_0 - 2I_B$$

$$= I_0 - \frac{2I_{C_2}}{\beta}$$

$$I_{C_2} = \frac{I_0}{1 + 2/\beta} \approx \frac{I_0 \cdot \beta}{\beta + 2} \approx I_0 \text{ if } \beta \text{ is large}$$

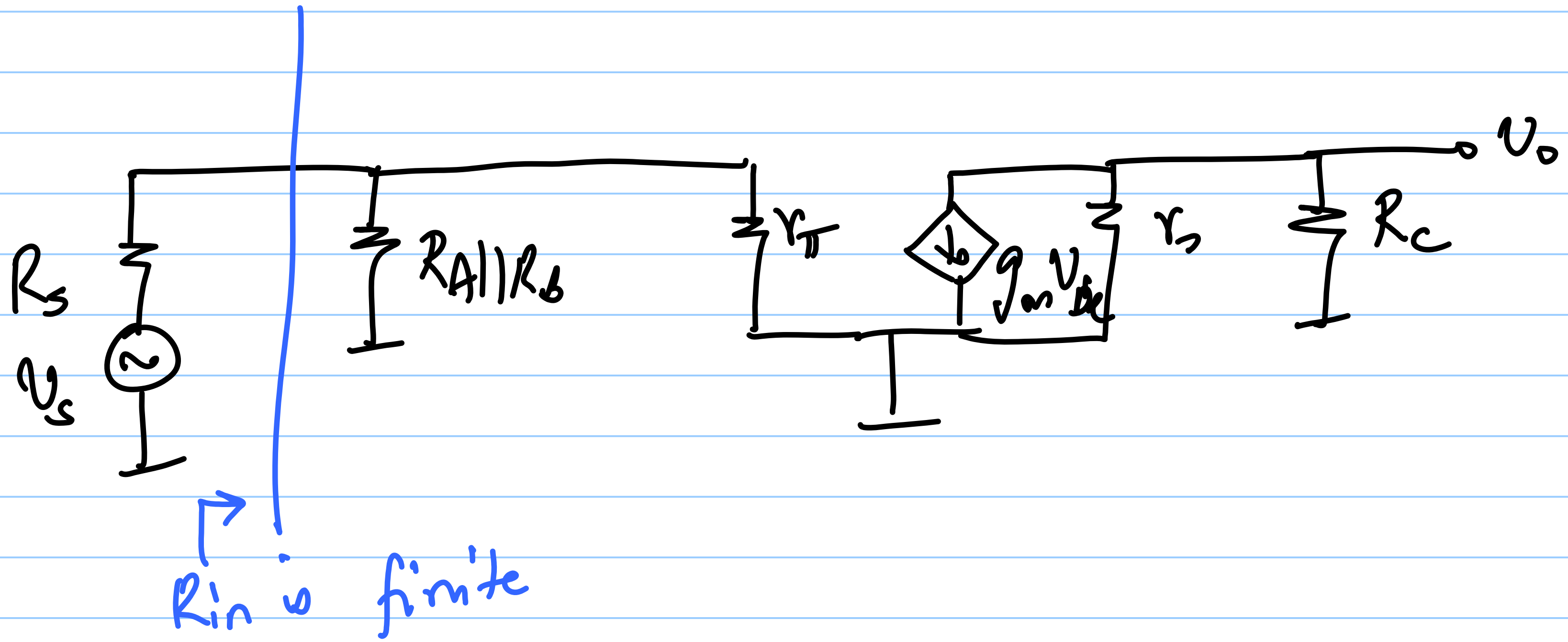
typical $\beta > 100$



$I_{E_3} = I_{B_1} + I_{B_2} + I_1$

$I_{B_3} = \frac{1}{(\beta+1)} \cdot I_{E_3}$

$I_{C_1} = I_o - I_{B_3}$



BJT

$$g_m = \frac{I_C}{V_t}$$

gives more g_m for a given current

MOS

$$g_m = \frac{I_D}{(V_{GS} - V_T)/2}$$