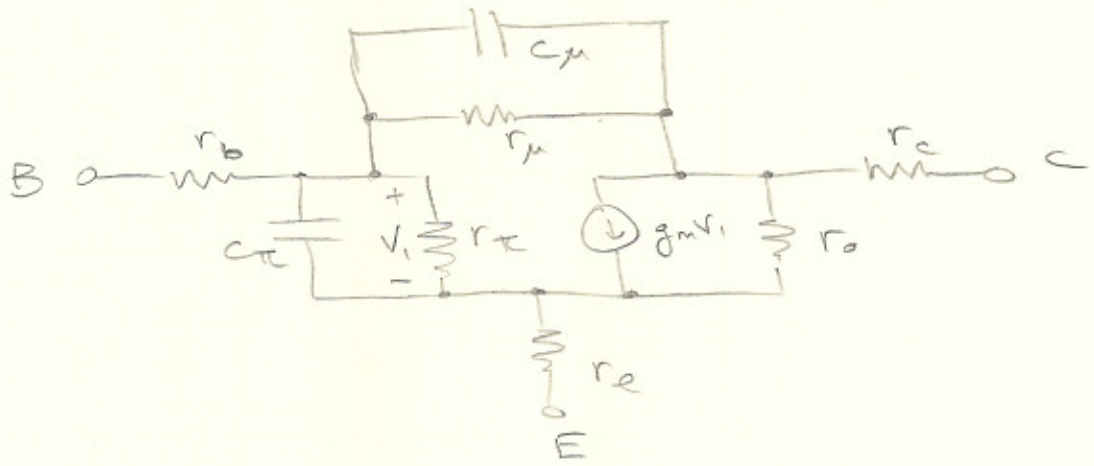
Complete Bipolar transistor model



Continuing w common base....

R_i //

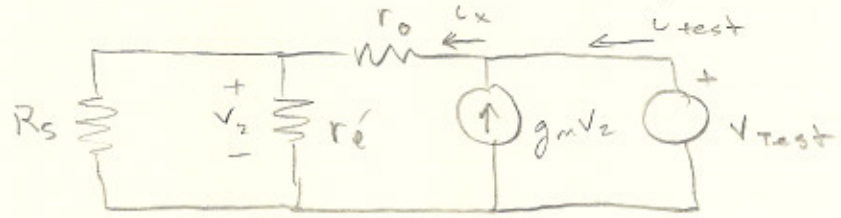
$R_L \to \infty$ $\quad R_i \approx r_\pi // R_E$ } max i/p resistance

$r_e = \frac{\alpha}{g_m}$ (10 Ω)

$r_\pi = \frac{\beta}{g_m}$ (1 KΩ)

normally, common base is R_i is close to r_e

R_o //



$$R_o = \frac{V_{Test}}{i_{test}}$$

$$i_x = \frac{V_{Test}}{r_o + R_s \| r_e'}$$

$$V_2 = \frac{R_s \| r_e'}{r_o + R_s \| r_e'} V_{test.}$$

$$i_{test} = i_x - g_m V_2$$

$$= \frac{V_{Test}}{r_o + R_s \| r_e'} - g_m \frac{R_s \| r_e'}{r_o + R_s \| r_e'} V_{test}$$

$$= \frac{V_{test}}{r_o + R_s \| r_e'} \left[1 - g_m R_s \| r_e' \right]$$

$$\boxed{R_o = \frac{r_o + (R_s \| r_e')}{1 - g_m (R_s \| r_e')}}$$

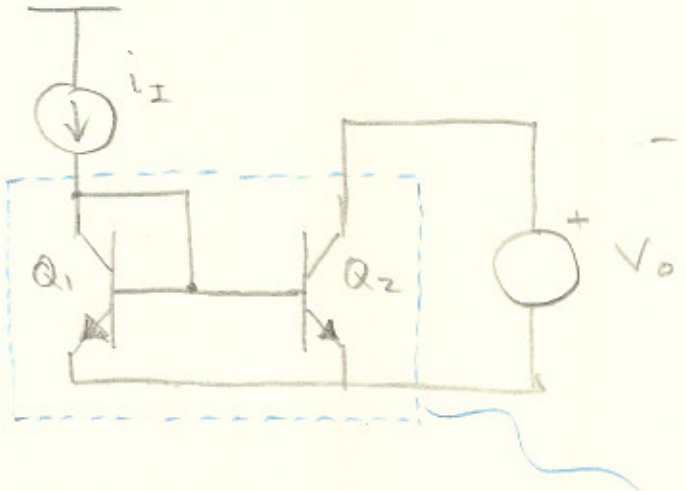
QED

note Common base is used for high o/p impedance.

SUMMARY

	a_v	a_i	R_i	R_o
CE	high $-g_m R_c$	high $\approx \beta$	med $\sim r_\pi$	High r_o
CC	≈ 1	high $\approx \beta$	High $r_\pi + (\beta+1) R_E$	low $\sim r_e + \frac{R_s}{\beta+1}$
CB	High $g_m R_c$	~ 1	low r_e	V. High $K r_o$

Current Mirror



$V_o > V_{CE\,SAT}$

- to keep Q_2 is active region.

current mirror connection

$$i_{C1} \cong I_S e^{\frac{V_{BE}}{V_T}} = i_{C2} \qquad (V_{BE1} = V_{BE2})$$

$$i_I = i_{C1} + i_{B1} + i_{B2} = i_C + \frac{2 i_C}{\beta}$$

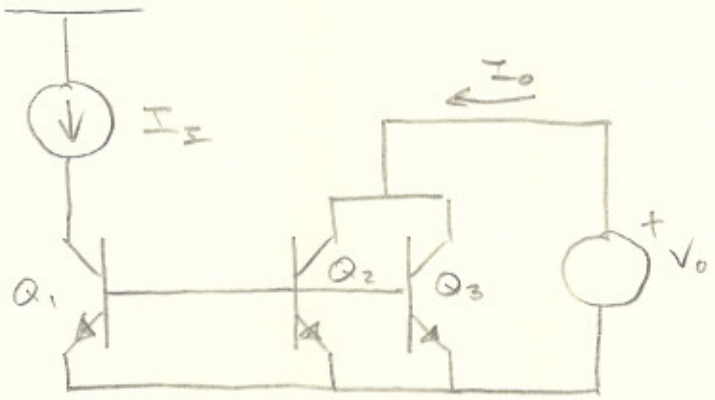
$$i_o = i_C$$

$$i_o = i_I \left(\frac{1}{1 + 2/\beta} \right)$$

$$\frac{1}{1 + 2/\beta} \cong 1 \qquad \text{(if } \beta \text{ is large)}$$

$$i_o \cong i_I$$

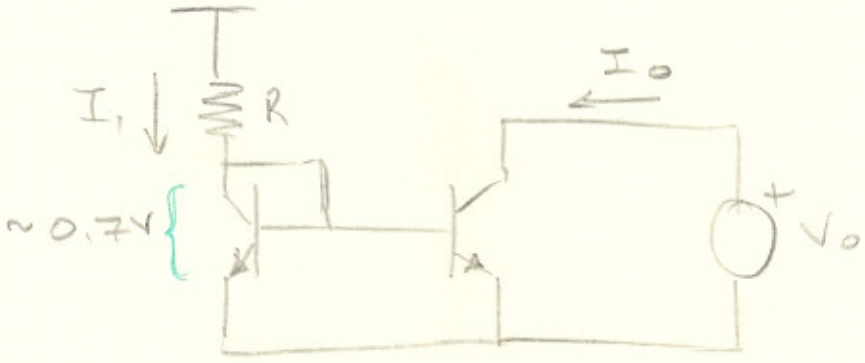
Current Mirror to gain



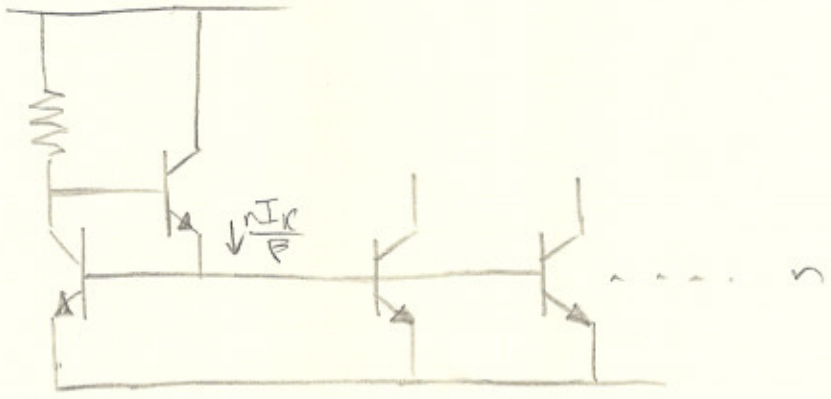
$$Q_1 = Q_2 = Q_3$$

$$I_o \cong 2 I_I$$

Current Generator



Beta Helper



$$I_I = I_c + \frac{I_c}{\beta}$$

$$\frac{I_c}{\beta} = \frac{n I_c}{\beta^2}$$