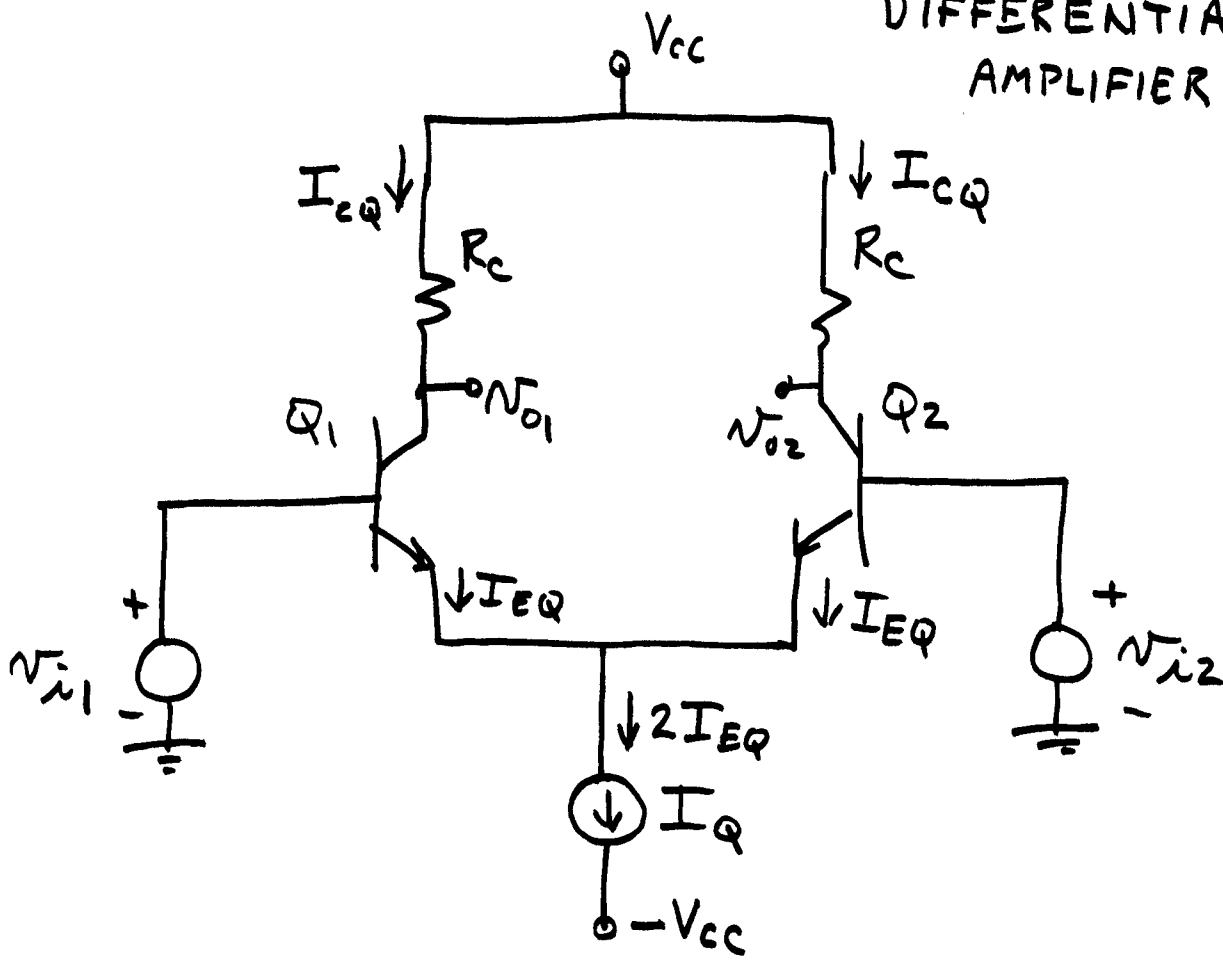
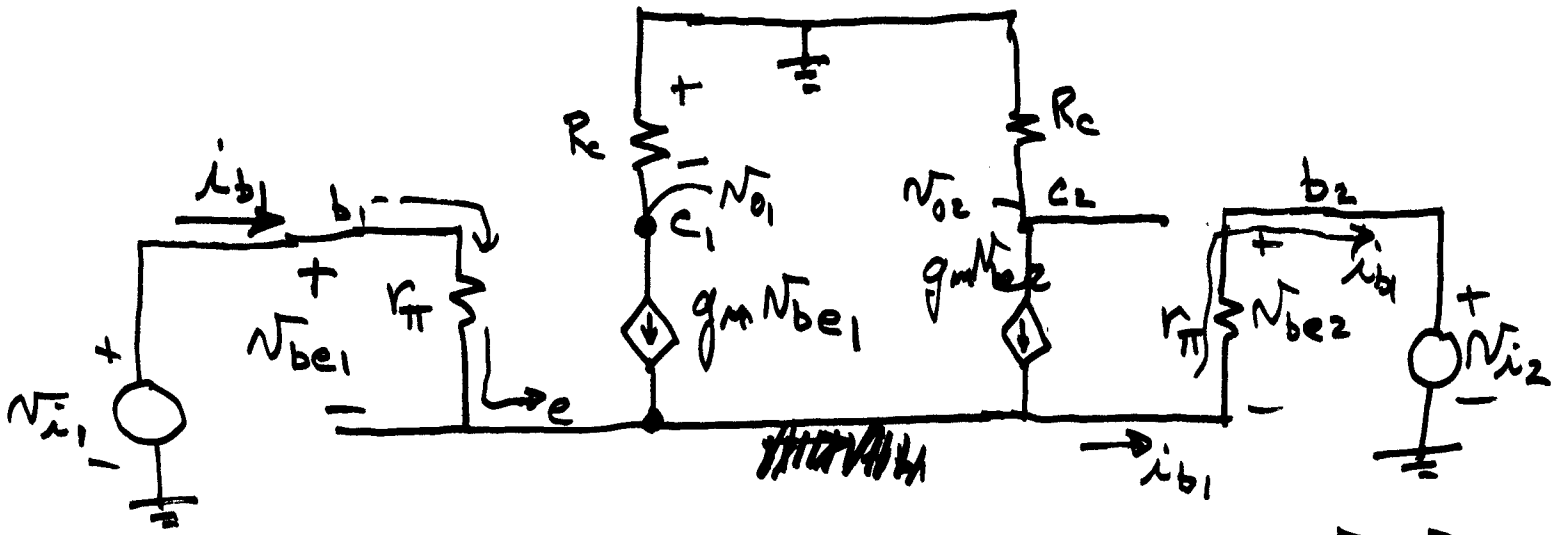


DIFFERENTIAL AMPLIFIER





$$v_{o1} = -g_m v_{be1} R_c \quad v_{o2} = -g_m v_{be2} R_c$$

$$\text{KVL: } \left. \begin{aligned} -v_{i1} + v_{be1} - v_{be2} + v_{i2} &= 0 \\ v_{be1} = i_{b1} r_{\pi} &= -v_{be2} \end{aligned} \right\} 2v_{be1} = v_{i1} - v_{i2}$$

$$\begin{aligned} v_{o1} - v_{o2} &= -g_m v_{be1} R_c - (-g_m v_{be2} R_c) \\ &= -2g_m v_{be1} R_c \end{aligned}$$

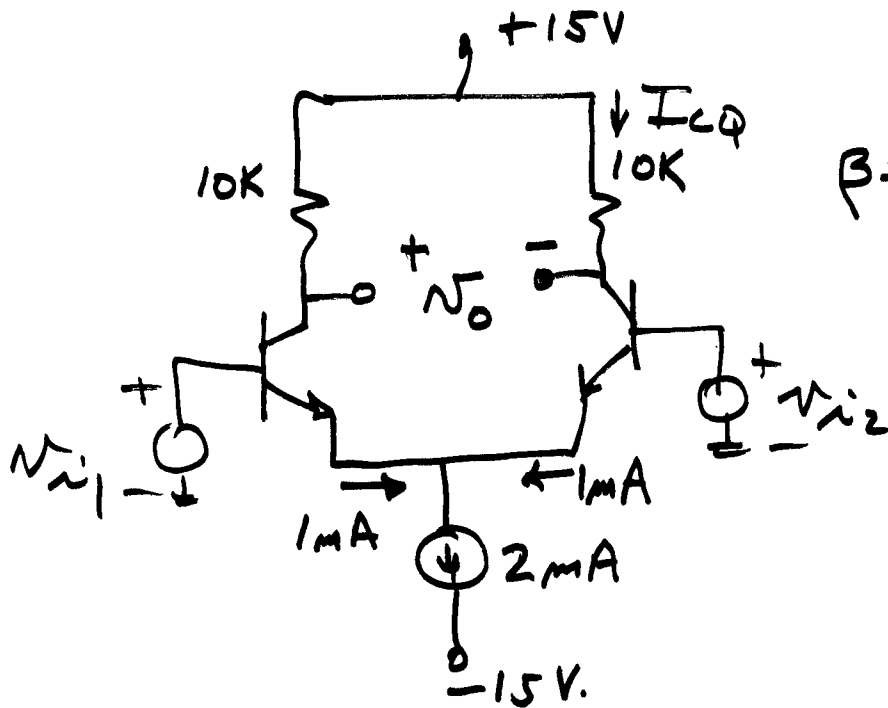
$$v_{o1} - v_{o2} = -g_m (v_{i1} - v_{i2}) R_c$$

$\frac{v_{o1} - v_{o2}}{v_{i1} - v_{i2}} = -g_m R_c = -\frac{I_{CQ} R_c}{V_T}$
--

$$g_m = \frac{I_{CQ}}{V_T}$$

DIFFERENTIAL GAIN

EXAMPLE



$$\beta = 100$$

$$I_{CQ} = \alpha I_{EQ}$$

$$\alpha = \frac{\beta}{1 + \beta} = .99$$

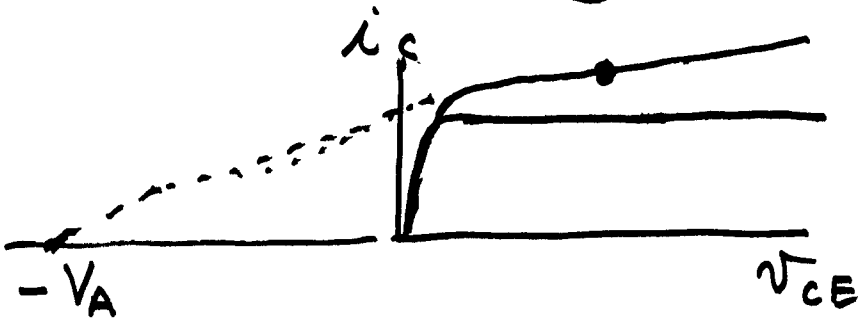
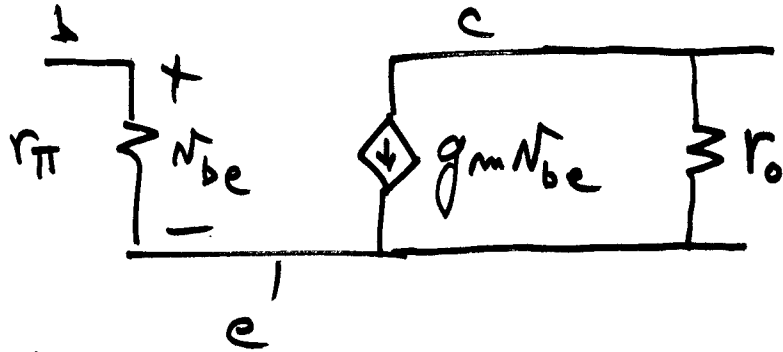
$$I_{CQ} = 0.99 \text{ mA}$$

$$\text{DIFF. GAIN} = A_d = \frac{v_o}{v_{i1} - v_{i2}} = - \frac{I_{CQ} R_c}{V_T}$$

$$A_d = - \frac{(0.99)(10)}{0.026} = -381$$

$$r_{\pi} = \frac{\beta V_T}{I_{CQ}} = \frac{\beta}{g_m}$$

$$g_m = \frac{I_{CQ}}{V_T} = \frac{\beta}{r_{\pi}}$$



$$r_o = \frac{V_A}{I_{CQ}}$$