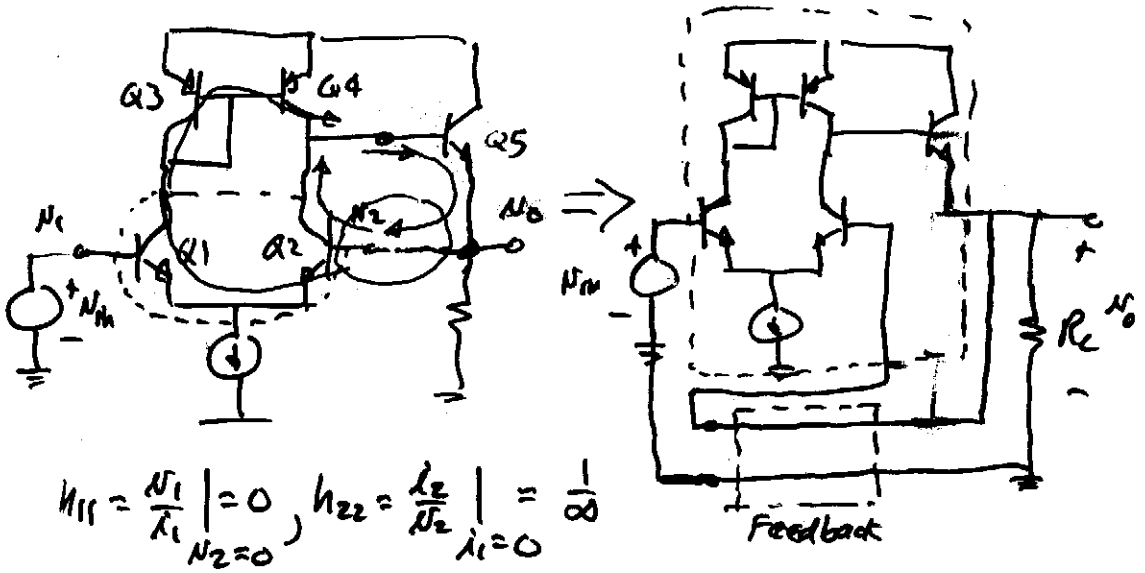
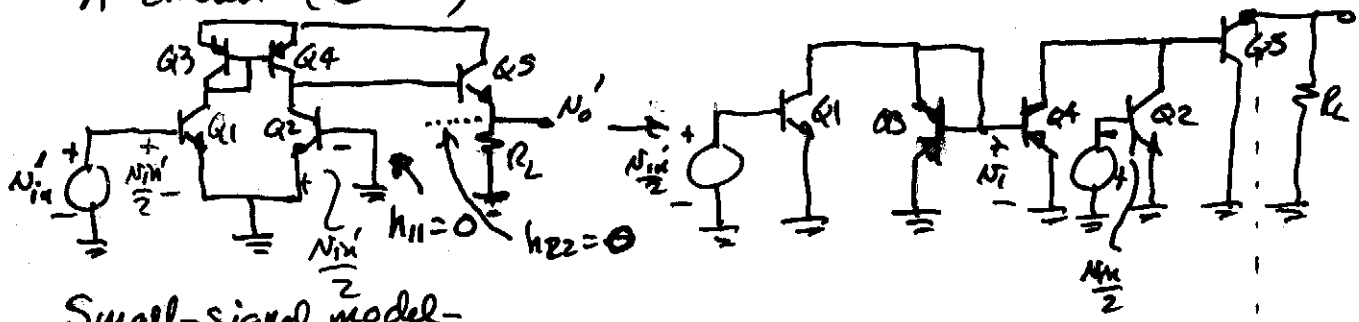
Diff. Amp. –



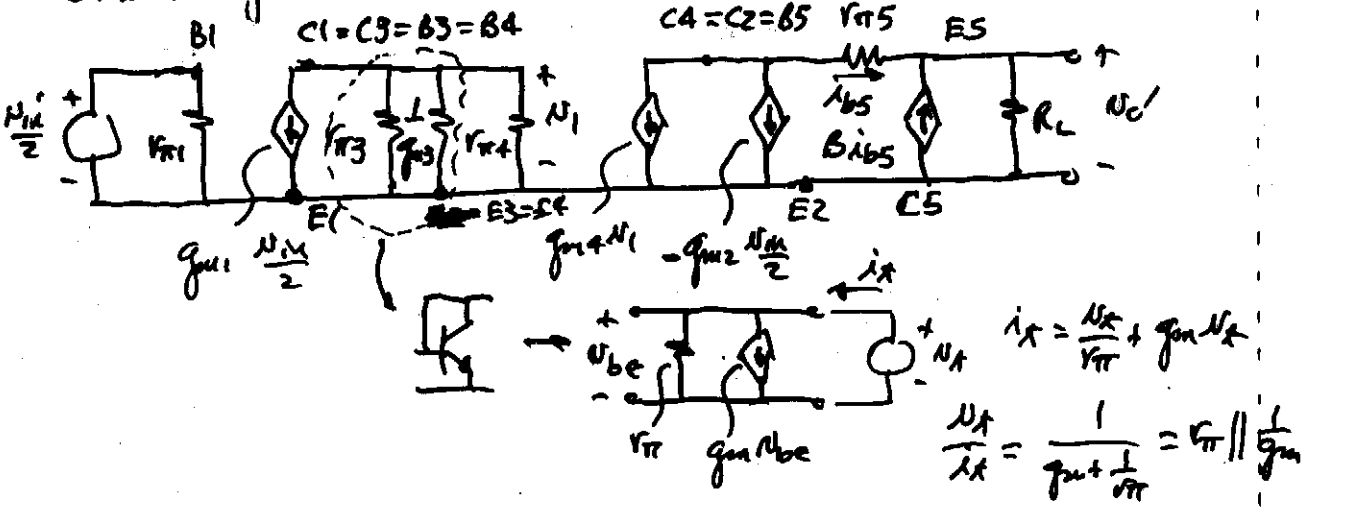
$$h_{11} = \left.\frac{v_1}{i_1}\right|_{v_2=0} = 0, \quad h_{22} = \left.\frac{i_2}{v_2}\right|_{i_1=0} = \frac{1}{\infty}$$

$$h_{12} = \left.\frac{v_1}{v_2}\right|_{i_1=0} = 1 = B$$

A circuit ($B=0$)



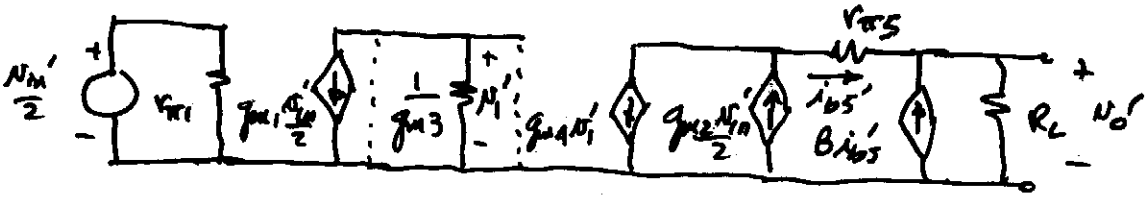
Small-signal model –



$$i_x = \frac{v_x}{r_\pi} + g_m v_x$$

$$\frac{v_x}{i_x} = \frac{1}{g_m + \frac{1}{r_\pi}} = r_\pi \| \frac{1}{g_m}$$

Finally,

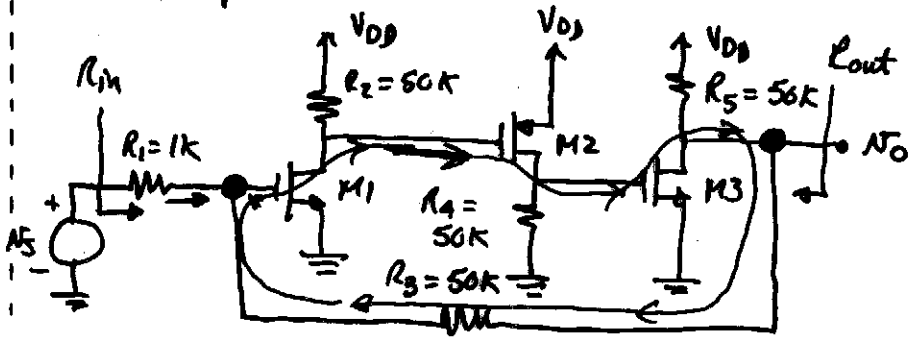


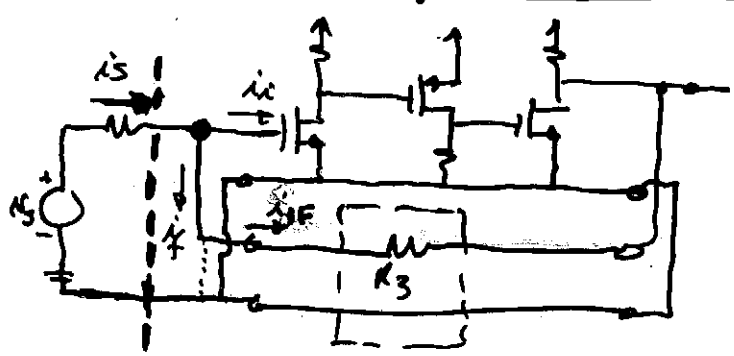
$$N_o' = i_{b5}'(1+\beta)R_L = g_{m1}N_{in}'(1+\beta)R_L$$

Shunt - Shunt

y-parameters → $y_{11} = \left.\frac{i_1}{N_1}\right|_{N_2=0}$, $y_{22} = \left.\frac{i_2}{N_2}\right|_{N_1=0}$, $y_{12} = \left.\frac{i_1}{N_2}\right|_{N_1=0}$

Example –



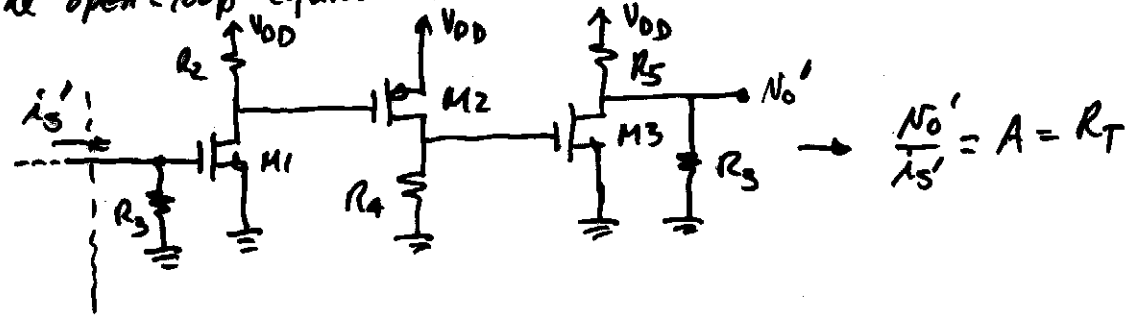


Find $\frac{N_o}{N_S}$, R_{in}, and R_{out} if $g_{m1} = g_{m2} = g_{m3} = 0.2 mA/V$ and $r_{os} = \infty$

$i_i = i_S - i_F$

$y_{11F} = \left.\frac{i_{1F}}{N_{1F}}\right|_{N_2=0} = \frac{1}{R_3} = y_{22F}$ $\quad y_{12F} = \left.\frac{i_{1F}}{N_{2F}}\right|_{N_1=0} = \frac{-1}{R_3} = \beta$

The open-loop equivalent ckt. for A calculation -



$$\frac{N_o'}{i_s'} = A = R_T$$