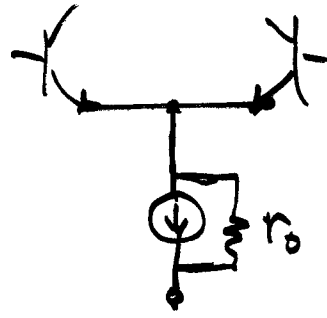
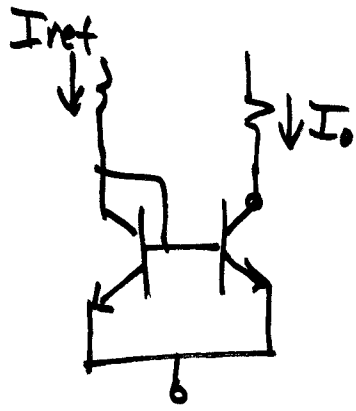
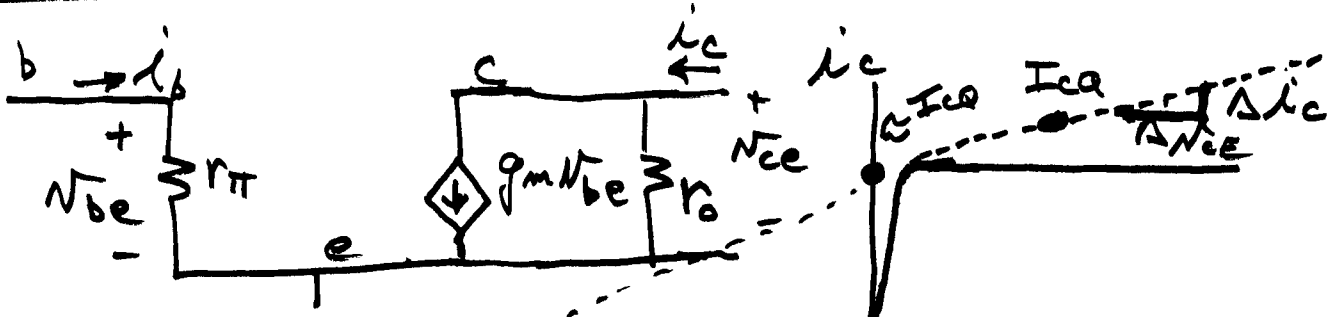
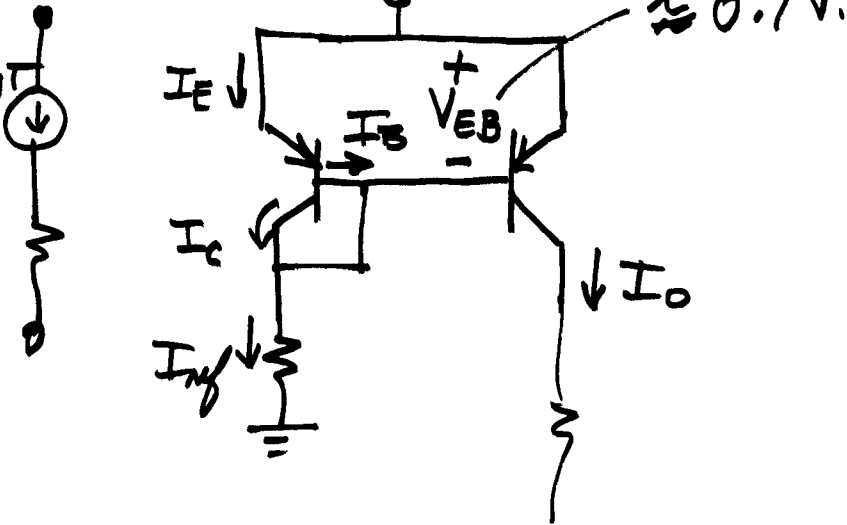


"CURRENT SINK"



CURRENT SOURCE

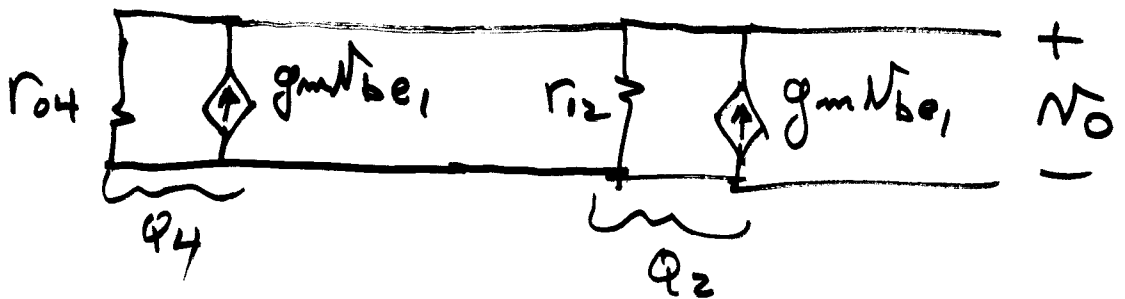
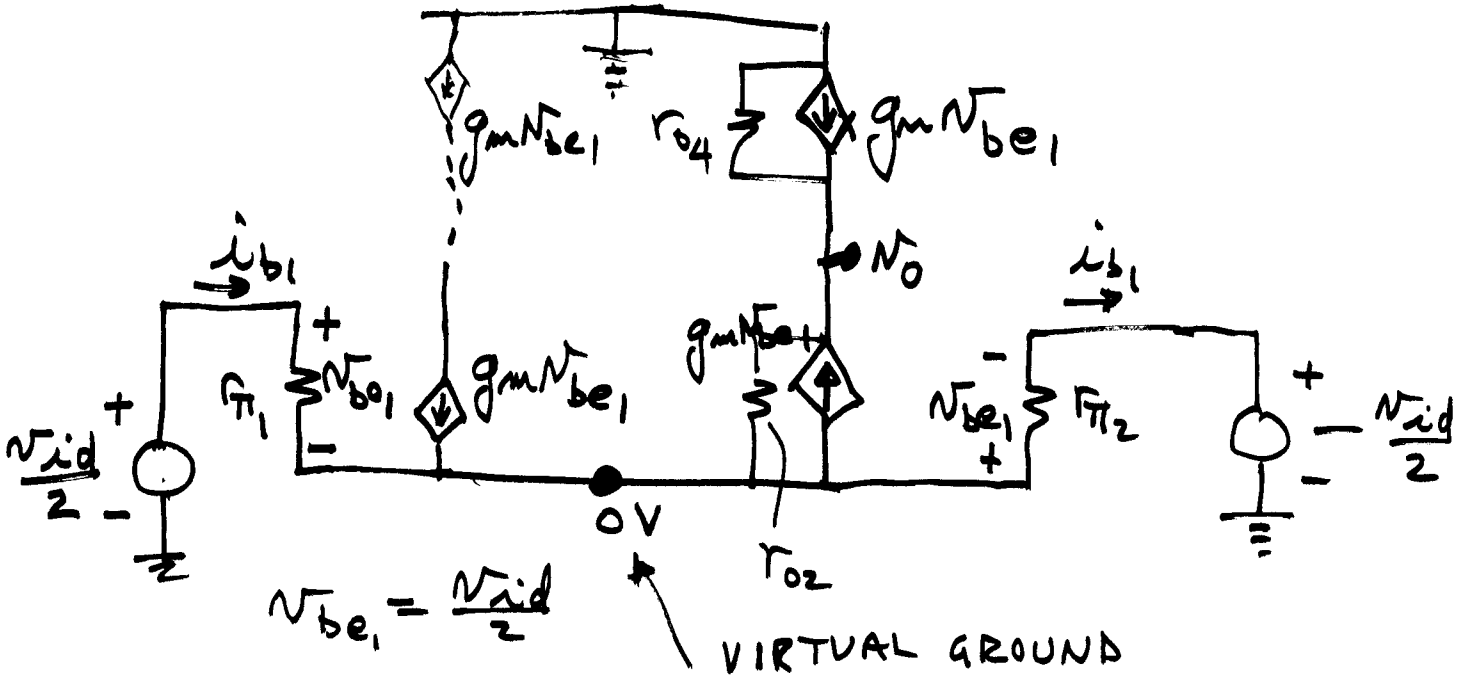
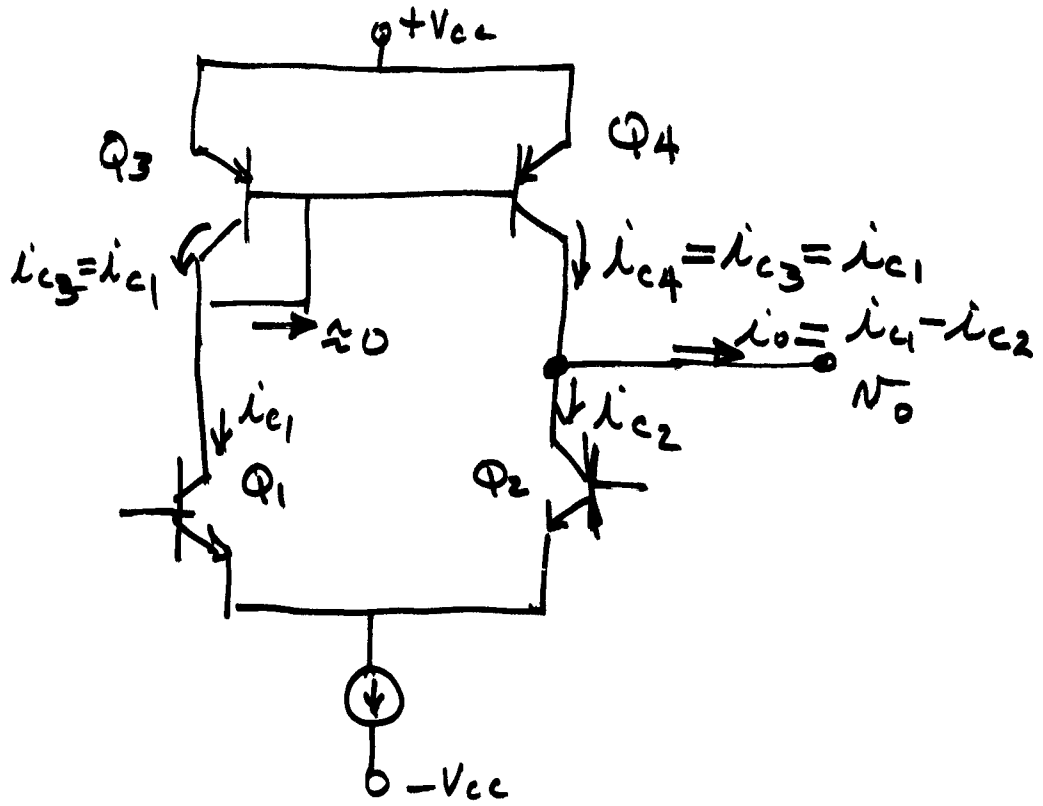


$-V_A$ EARLY VOLTAGE V_{CE}

$$\frac{\Delta I_c}{\Delta V_{CE}} = \frac{1}{r_o} = \frac{I_{CQ}}{V_A}$$

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

ACTIVE LOAD



$$v_o = 2g_m v_{be1} (r_{o4} // r_{o2})$$

$$v_{be1} = \frac{v_{id}}{2}$$

$$\underline{v_o} = 2g_m \left(\frac{v_{id}}{2}\right) (r_{o4} // r_{o2})$$

$$\boxed{\frac{v_o}{v_{id}} = g_m (r_{o4} // r_{o2})} \text{ gain}$$

Example: $I_{CQ} = 0.5 \text{ mA}$

$$V_A = 100$$

$$g_m = \frac{I_{CQ}}{V_T} = \frac{0.5 \text{ mA}}{0.026 \text{ V}} = 19.2 \text{ mA/V}$$

$$r_o = \frac{V_A}{I_{CQ}} = \frac{100}{0.5 \text{ mA}} = 200 \text{ k}$$

$$A_{v_o} = (19.2 \text{ mA/V})(200 \text{ k} // 200 \text{ k}) = 1920$$

$$R_{out} = r_{o2} // r_{o4} = 100 \text{ k}$$