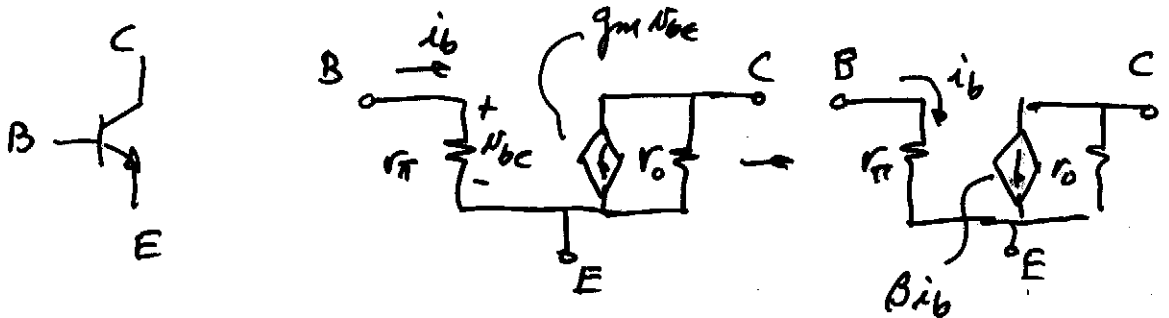
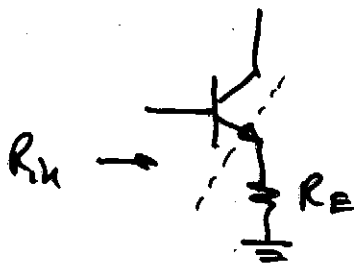


Useful appendix to Chapt. 14

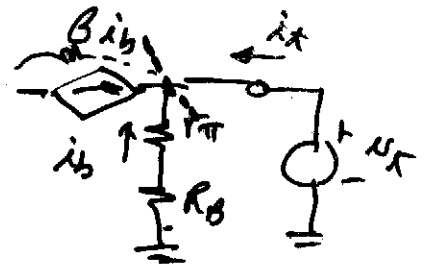
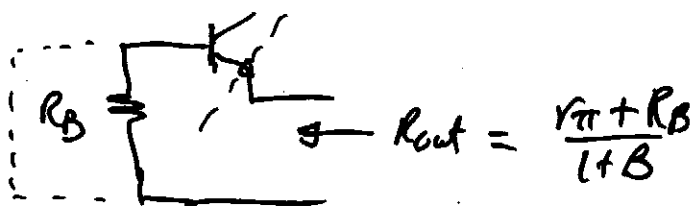
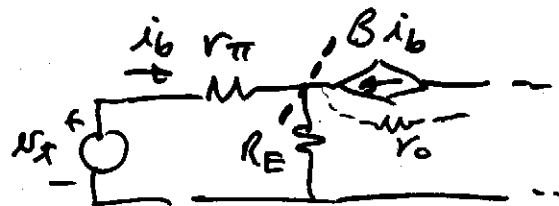


$$g_m v_{\pi} = g_m r_{\pi} i_b = \beta i_b$$

BE impedance reflection



$$R_{in} = r_{\pi} + (1 + \beta) R_E$$



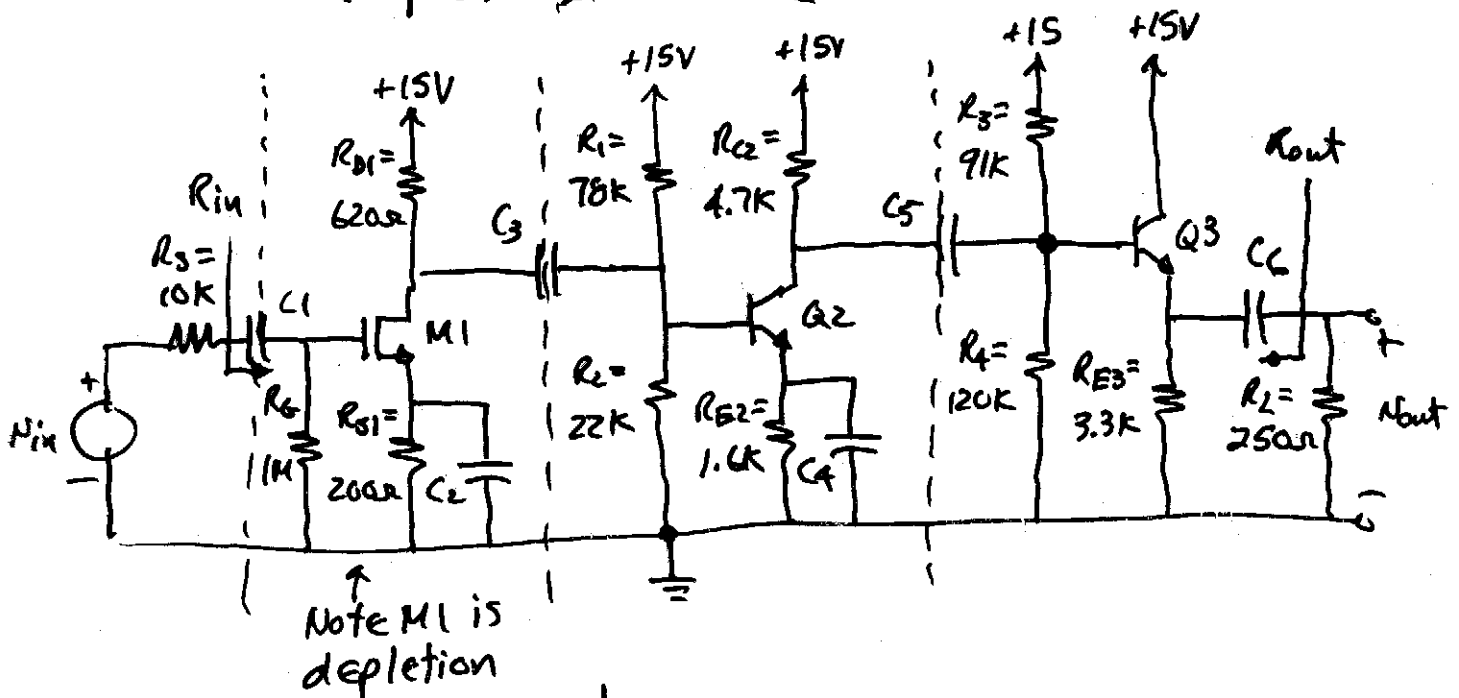
Multiple Stage Amplifiers

Permits optimization of a design to meet the specifications.

Voltage Amplifier Example

Large input resistance
Low output resistance
Large voltage

CS (depletion) - CE - CC



Transistor parameters:

$$M1: K_n = 10 \text{ mA/V}^2, V_{TN} = -2 \text{ V}, \lambda = 0.02 \text{ V}^{-1}$$

$$Q2: \beta_F = 150, V_A = 80 \text{ V}, V_{BE} = 0.6 \text{ V}$$

$$Q3: \beta_F = 80, V_A = 60 \text{ V}, V_{BE} = 0.6 \text{ V}$$

Q point & ss parameters:

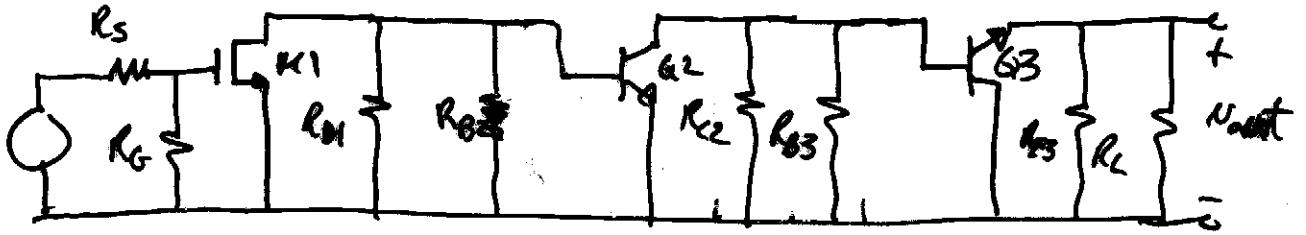
$$M1: I_{D1} = 5 \text{ mA}, V_{D1} = 10.9 \text{ V}, g_{m1} = 10 \text{ mS}, r_{o1} = 12.2 \text{ k}$$

$$Q2: I_{C2} = 1.57 \text{ mA}, V_{CE2} = 5.09 \text{ V}, g_{m2} = 62.8 \text{ mS}, r_{\pi 2} = 2.39 \text{ k}$$

$$Q3: I_{C3} = 1.99 \text{ mA}, V_{CE3} = 8.36 \text{ V}, g_{m3} = 79.6 \text{ mS}$$

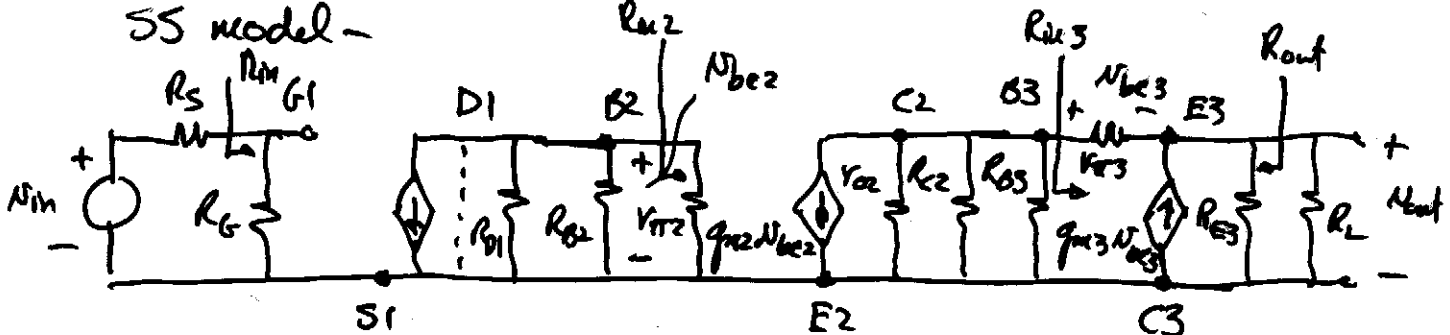
$$r_{\pi 3} = 1 \text{ k}, r_{o3} = 31.4 \text{ k}$$

AC circuit:



$$R_{B2} = R_1 || R_2 = 17.16k \quad R_{B3} = R_3 || R_4 = 51.75k$$

SS model -



$$R_{in3} = V_{\pi 3} + (1 + \beta_3)(R_{E3} || R_L) = 19.82k$$

$$R_{in2} = V_{\pi 2} = 2.39k$$

$$R_{in} = R_G = 1k\Omega$$

$$R_{out} = R_{E3} || \left[\frac{V_{\pi 3} + R_{B3} || R_{C2} || R_{O2}}{1 + \beta_3} \right] = 3.3k || 61.6\Omega = \underline{60.4\Omega}$$

$$\frac{N_{out}}{N_{in}} = ?$$