Ex. 14.6 – Cont'd

Design of a buffer.

3.) Range of I_D?

$R_S = 3K\Omega \rightarrow g_m = 3.78mS$ in order to get a gain of 0.85

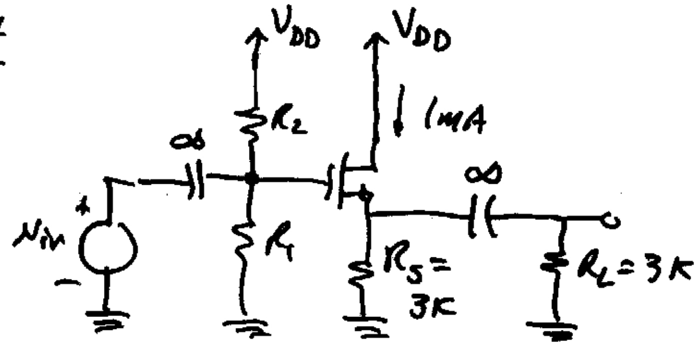
$g_m = \sqrt{2K_N I_{DS}} \rightarrow K_N I_{DS} = \frac{g_m^2}{2} = 7.13 \times 10^{-6}$

K_N generally varies from 0.1 to 20mA/V²

If we choose $K_N = 10mA/V^2$, then $I_{DS} = 0.714mA$

Choose $I_{DS} = 1mA$

4.)



$V_S = 1mA \times 3K = 3V$

$K_N = 10mA/V^2$ and $V_{TN} = 1$, then

$V_{GS} = \sqrt{\frac{2I_{DS}}{K_N}} + V_{TN}$

$\frac{v_{out}}{v_{in}} = \frac{g_m R_S \| R_L}{1 + g_m R_S \| R_L}$

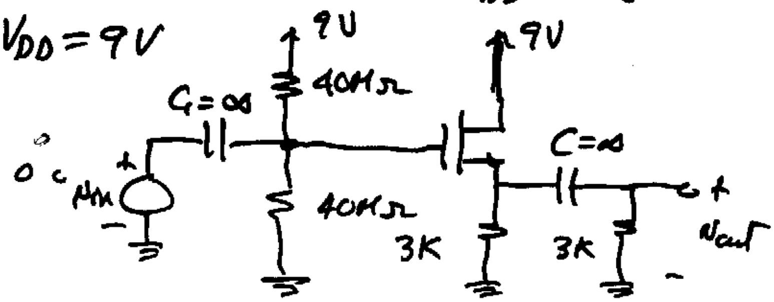
$V_{GS} = \sqrt{\frac{2 \cdot 1mA}{10mA/V^2}} + 1 = 1.45V \rightarrow V_G = V_S + V_{GS} = 4.45V$

5.) Design R_1, R_2 and V_{DD}

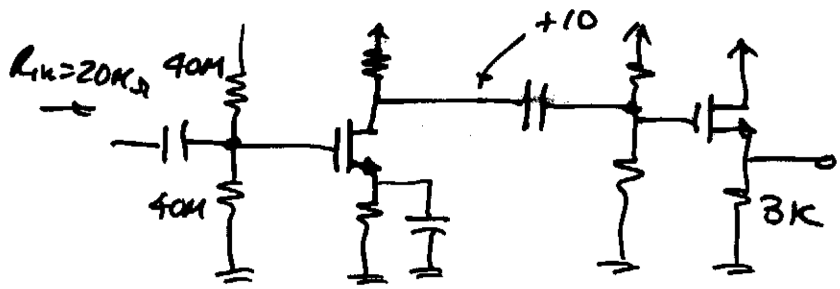
$R_G = R_1 \| R_2 \geq 20M\Omega$ $V_G = V_{DD} \frac{R_1}{R_1 + R_2}$

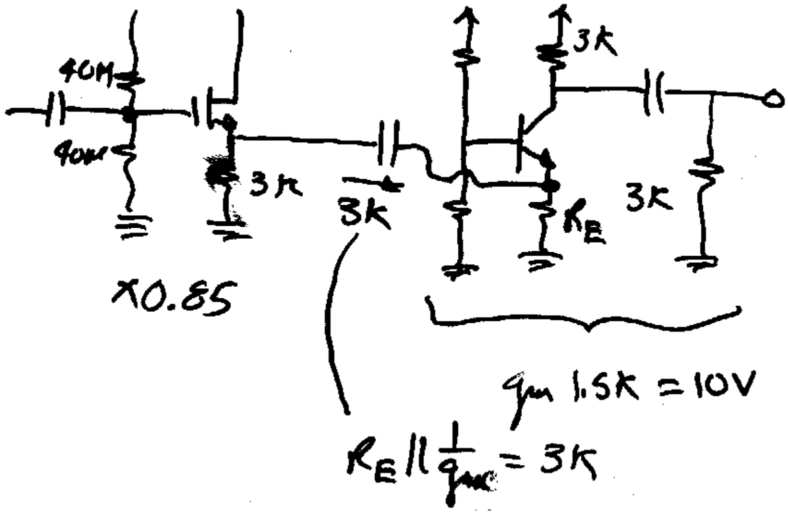
Assume $R_1 = R_2 = 40M\Omega \rightarrow V_{DD} = 2V_G = 8.9V$

Select $V_{DD} = 9V$



What if the amplifier was $R_{in} \geq 20M\Omega$ and $\frac{v_{out}}{v_{in}} = +10\ V/V$?

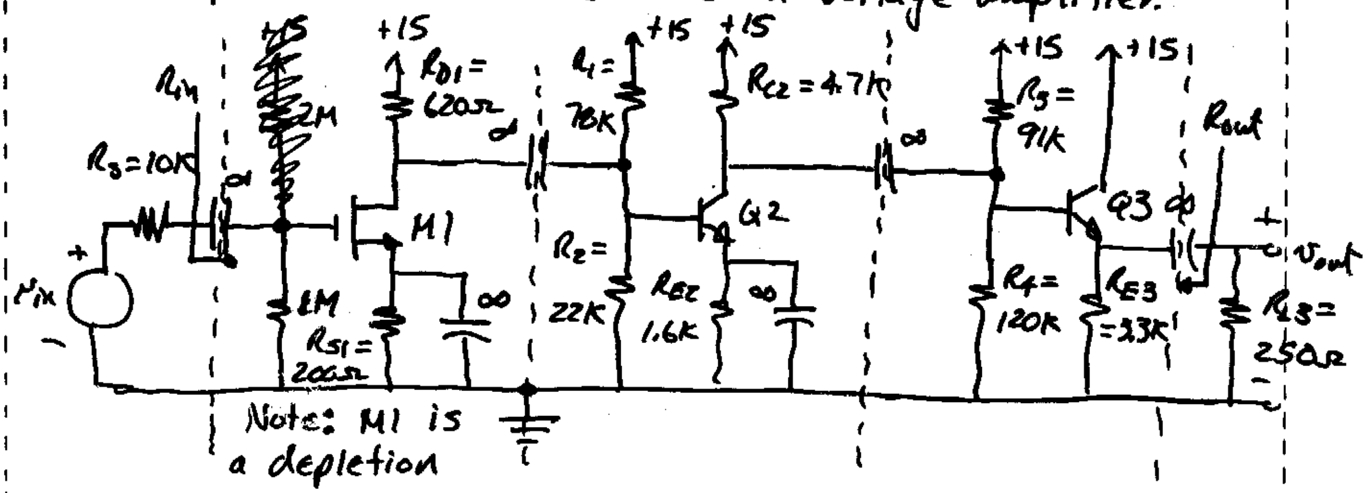




Chapter 15 – Multistage Amplifiers

Using more than 1 transistor gives additional flexibility in meeting a set of amplifier specs.

Example CS–CE–CC → Good voltage amplifier.



Voltage Amplifier – Cont'd

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

Q2: $\beta_F = 150$, $V_{A2} = 80V$, $V_{BE} = 0.6V$

Q3: $\beta_F = 80$, $V_{A3} = 60$, $V_{BE} = 0.6V$

Q points & small-signal model parameters –

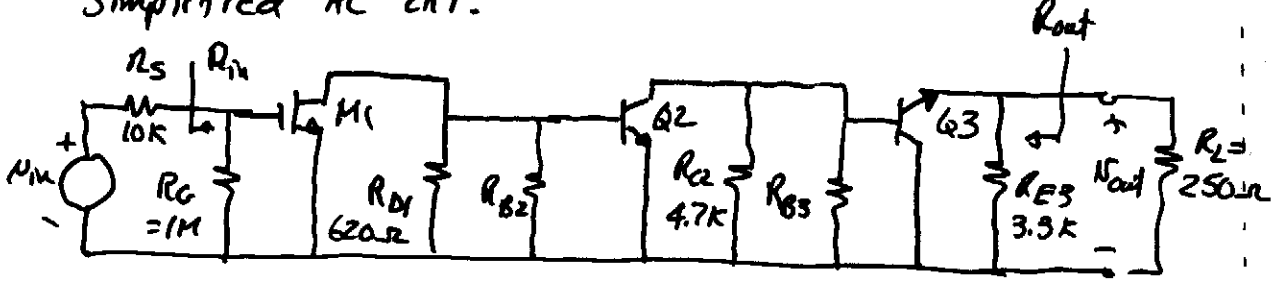
M1: $I_{DS1} = 5mA$, $V_{DS1} = 10.9V \rightarrow g_{m1} = 10mS$ & $r_{o1} = 12.2k\Omega$

Q2: $I_{C2} = 1.57mA$, $V_{CE2} = 5.09V \rightarrow g_{m2} = 62.8mS$, $r_{\pi 2} = 2.39k\Omega$, $r_{o2} = 54.2k\Omega$

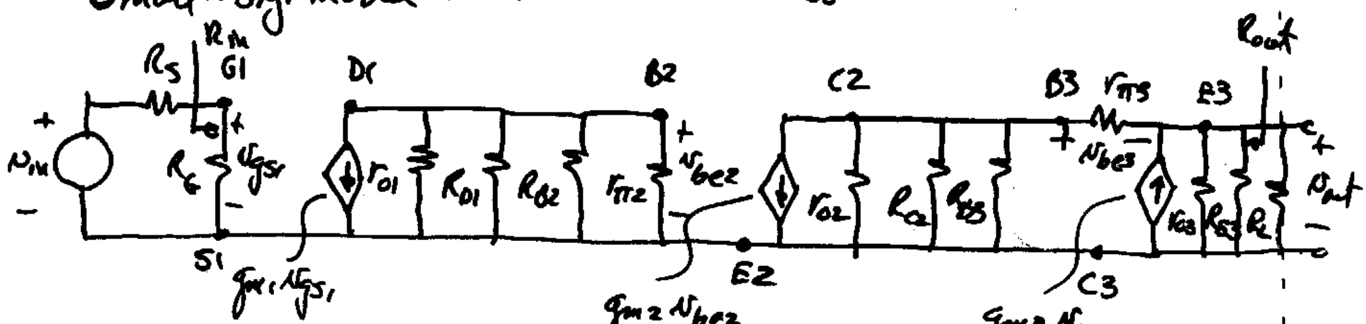
Q3: $I_{C3} = 1.99mA$, $V_{CE3} = 8.36V \rightarrow g_{m3} = 79.6mS$, $r_{\pi 3} = 1k$, $r_{o3} = 34.4k\Omega$

AC analysis –

Simplified AC ckt:



Small-sig. model – $R_{B2} = 17.1k$ $R_{B3} = 51.75k$



$\underline{R_{in} = R_G = 1M\Omega}$

$$R_{out} = R_{E3} \| r_{o3} \| \left(\frac{r_{\pi 3} + r_{o2} \| R_{C2} \| R_{B3}}{1 + \beta_3} \right) = 60.4\Omega$$