\[ V_o = 3 - V_t - (V_{GS} - V_t) = \frac{2V_t}{K^1 C_{ox}} \]
\[ V_{GS} - V_t = \sqrt{\frac{2(220)}{90(10)}} \approx 0.67V \rightarrow V_o = 3 - 0.7 - 0.67 = 1.63V \]
\[ \frac{V_o}{V_t} = \frac{g_{m} R_o}{1 + g_{m} R_o} \rightarrow R_0 = \infty \text{ because } v = 0 \rightarrow \frac{V_o}{V_t} = 1 \]

\[ V_t = V_{to} + \alpha (2\Phi_F + V_{SB} - (2\Phi_F)) \]
\[ \alpha = \frac{2.86 \times 10^{-7}}{1.38 \times 10^{-7}} = 0.19 \text{ V} \]

\[ V_{SB} = V_o - \text{use answer from (a) to start} \]
\[ \Phi_F = \frac{V_t \ln \frac{N_A}{N_D}}{1.02 \times 10^{-5}} = 1.5V \]

\[ V_t = 0.7 + 0.19(0.84 - 0.67) = 0.84V \]
\[ V_o = 3 - 0.7 - 0.84 = 1.42 \text{ V} \]

Try Again
\[ V_t = 0.7 + 0.19(0.83 - 0.67) = 0.83 \text{ V} \]
\[ V_o = 3 - 0.7 - 0.83 = 1.42 \text{ V} \]
\[ \frac{V_o}{V_t} = 0.92 \approx 0.93 \]

So use \( V_o \) from (b) to start \( \Rightarrow I_d \approx 200 \mu A + \frac{1.5}{100} k = 215 \mu A \) \( \text{(about same as in (b) so don't bother to recalculate } V_t) \)

For \( CD \): 
\[ A_v = \frac{g_m}{g_m + g_{mb}} \approx 0.93 \text{ from (b)} \]
\[ R_o = \frac{1}{g_m + g_{mb}} = \frac{g_m}{g_m (1 + \alpha)} \]
\[ g_m = \frac{2I_o K^1 \Phi_F}{1.5k + 100k} \]
\[ \frac{V_D}{V_t} = 0.93 \cdot \frac{100k}{1.5k + 100k} = 0.92 \]

So model:

\[ \frac{V_o}{V_t} = 1 \]

\[ V_o = 3 - 0.83 - \frac{2(348)}{90.10} = 1.29V = 348 \mu A \]
\[ V_t = 0.7 + 0.19 \left( \sqrt{0.6+1.29} - \sqrt{0.6} \right) = 0.81 \text{ V} \]

So \[ I_p = 200 + \frac{1.29}{10k} = 329 \mu\text{A} \]

Accurate

\[ V_0 = 3 - 0.81 - \sqrt{\frac{2 \times 329}{90.1}} = 1.33 \text{ V} \]

55:

\[ A_v = \frac{I}{1+X} \quad X = 0.19/(2 \sqrt{0.6+1.33}) \approx 0.07 \]

\[ \approx \frac{1}{1+0.09} = 0.93 \]

\[ R_0 = \frac{g_m}{g_m(1+X)} = \frac{0.77}{0.77(1.07)} = 1.2k\Omega \]

From model in C:

\[ \frac{N_0}{N_i} = A_v \cdot \frac{R}{R+R_0} = \frac{0.93}{10k+1.2k} = 0.83 \]

(2) From SPICE op. st.

\[ V_0 = 1.32 \text{ V} \quad \frac{V_0}{V_i} = 0.835 \]

\[ R_2 = m \frac{M_2}{V_{BIAS}} \]

Ocv: \[ V_{oc} = -GmR_0 = 2.1 \text{ mV (3.7 mV)} \approx -7100 \]

\[ \text{For } R_2 \to \infty \]

\[ Gm = 0 \quad \text{mV R} \]

\[ R_0 = \frac{(Gm+Gm2)R2R1}{R2+R1} = \frac{g_{m1}}{250} = 40k\Omega \]

\[ R_0 = 21 \quad (1+0.1)(40k)^2 \approx 3.7 \text{ mV R/V} \]

\[ \text{Adm} = -GmR_0 \]

\[ Gm = \frac{9m}{1+9m R_E} \]

\[ \text{Adm} = - \frac{9m R_E}{1+9m R_E} \rightarrow \infty \]

Since the resistance connected to the source \( \to \infty \), Gm here = 0 and

\[ \text{Adm} = 0 \]
From (3.54) \(\rightarrow\) (without \(R_L\) and \(g_{mb}\)),

\[
R_i = \frac{r_o + R_D}{1 + g_m r_o}
\]

\[
r_o = \left(\frac{1}{\eta I_D}\right) = \frac{1}{(0.01)(100\,\mu A)} = 1\,\text{M} \Omega
\]

\[
g_m = \sqrt{2 \kappa \left(\frac{W}{L}\right) I_D} = \sqrt{2 \times (200)(100)} = 2000\,\mu A/V
\]

\[
g_m r_o = 2000
\]

\[
R_i = \frac{1\,\text{M} \Omega + 10\,\text{k} \Omega}{2001} = \frac{1\,\text{M} \Omega}{2000} = \frac{1}{g_m} = 500\,\text{\mu} \Omega
\]