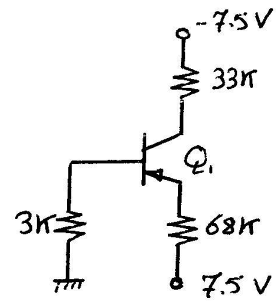
Homework from Chapter 13

13.16



KVL in BE loop

$$7.5 = (3k)\,I_B + (\beta_F+1)(68k)\,I_B + V_{BE_{ON}}$$

($V_{BE_{ON}} \to 0.7V$)

$$\Rightarrow I_B = 1.51\,\mu A\ , \quad I_C = 98.4\,\mu A$$

$$V_{EC} = 7.5 - (-7.5) - (68k)\,I_E - (33k)\,I_C = 4.96\,V$$

($I_E \to (\beta_F+1)\,I_B$, $I_C \to \beta_F I_B$)

$$\therefore Q_1\,(98.4\,\mu A,\ 4.96\ V)$$

13.4[illegible]

a. $$r_d = \frac{V_T}{I_S \exp(V_D/V_T)} = \frac{0.025}{10\times10^{-15}\,\exp(0.6/0.025)} = 94.4\ \Omega$$

b. $$r_d = \frac{0.025}{10\times10^{-15}} = 2.5\ T\Omega$$

c. $$\frac{0.025}{10\times10^{-15}\exp(V_D/0.025)} > 10^{15} \Rightarrow \exp(V_D/0.025) < 2.5\times10^{-3}$$

$$\therefore V_D < 0.025\,\ln(2.5\times10^{-3})$$

$$\Rightarrow V_D < -0.15\ V$$

13.66 (check example 13.3)

$$g_m = \frac{I_C}{V_T} = \frac{50\times10^{-6}}{25\times10^{-3}} = 2\ mS$$

$$r_\pi = \frac{\beta_o}{g_m} = \frac{100}{2\times10^{-3}} = 50\ k\Omega\ , \quad r_o = \frac{V_A + V_{CE}}{I_C} = \frac{75+10}{50\times10^{-6}} = 1.7\ M\Omega$$

$$R_{BB} = R_B \,//\, R_\pi = (100k)//(50k) = 33.3\ k$$

$$\therefore A_v = -g_m R_L \frac{R_{BB}}{R_S + R_{BB}}\ , \quad R_L = r_o \,//\, R_C \,//\, R_3 = 48.57\ k\Omega$$

$$\therefore A_v = -(2\times10^{-3})(48.57k)\,\frac{33.3k}{33.3k + 0.75k} = -95$$

13.101

$$V_G = 10V \frac{R_1}{R_1+R_2} = 4.343V$$

KVL in GDS loop $\quad V_G - V_{GS} - I_D R_4 = 0 \Rightarrow V_{GS} = 4.343 - 2\times10^4 I_D$

From the FET c/c's (assume saturation) $\quad I_D = \frac{K_n}{2}(V_{GS}-V_{TN})^2 = 2.5\times10^{-4}(V_{GS}-1)^2$

Solving both eq $\Rightarrow I_D = 131\mu A$ & $V_{GS} = 1.72V$

$V_{DS} = 10 - (43K + 20K) I_D = 1.75 > V_{GS} - V_{TN} \Rightarrow$ saturation assumption is c

Now $g_m \simeq \sqrt{2K_n I_D} = 362\mu S$ & $r_o = \frac{1/\lambda + V_{DS}}{I_D} = 586 k\Omega$

$$\therefore A_V = (-g_m R_L)\frac{R_G}{R_G+R_S}$$

$R_G = R_1 \| R_2 = 243k\Omega$, $R_L = r_o \| R_D \| R_3 = 28.6K$

$$\Rightarrow A_V = -(362\times10^{-6})(28.6\times10^3)\frac{243\times10^3}{243\times10^3+10^3} = -10.3$$

Comparing with fig. 13.3 we got more gain because g_m increased with decrease in I_D.

13.102

$$g_m = \sqrt{2K_n I_D(1+\lambda V_{DS})} = \sqrt{2(500\times10^{-6})(100\times10^{-6})(1+0.02\times5)} = 332\mu S$$

$$r_o = \frac{1/\lambda + V_{DS}}{I_D} = \frac{1/0.02+5}{100\times10^{-6}} = 550k\Omega$$

$$\therefore A_V = -g_m(R_D \| R_3 \| r_o)\frac{R_G}{R_G+R_1}$$

$$\Rightarrow A_V = -10.9$$