- IE: Tutorial 1

g1) { hole concentration
$p(x) = 10^{16}\,(1 + x/L)^2\ cm^{-3}$

$L = 12\,\mu m$ $\qquad -L \le x \le 0$

hole diffusion constant $D_p = 10\ cm^2/s$

p type → majority : holes

doping with GaAs

hole diffusion current density = ?

$$J_p = -qD_p \frac{dp(x)}{dx}$$

$$= -1.6\times10^{-19} \times 10 \times 2\times10^{16} \times \left(1+\frac{x}{L}\right)\times\frac{1}{L}$$

$L = 12\times10^{-6}$

$$= -1.6\times10^{-2} \times 2 \times \left(1+\frac{x\times10^6}{12}\right)\times\frac{10^6}{12}$$

$$= \left(\frac{-3.2\times10^4}{12}\right)\left(1+\frac{10^6\times x}{12}\right)$$

at $x=0 \rightarrow \quad \frac{-3.2\times10^4}{12} = -2.666\times10^3\ A/cm^3$

unit change: $-26.6\ A/cm^2$

g2) $A_{V_0} = 100\ V/V$ when? (unit less)

(a) $R_i = 10R_s$, $R_L = 10R_o$

$$V_i = \frac{R_i}{R_i+R_s} V_s = \frac{10}{11} V_s$$

$$V_o = \frac{R_L}{R_L+R_o} A_{V_o} V_i = \frac{10}{11} \times A_{V_o} \times \frac{10}{11} V_s$$

$$\frac{V_o}{V_s} = \frac{100}{121} A_{V_o} = 82.64$$

(b) $R_i = R_s$, $R_L = R_o$

$$V_o = \frac{R_L}{R_L+R_o} A_{V_o} \frac{R_i}{R_i+R_s} V_s$$

$$\frac{V_o}{V_s} = \frac{1}{2} A_{V_o} \cdot \frac{1}{2} = \frac{1}{4} A_{V_o} = 25$$

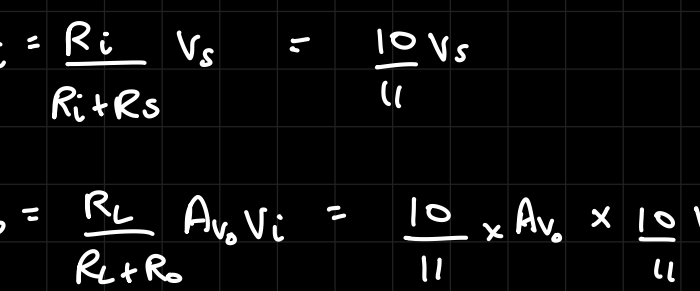
(c) $R_i = \frac{R_s}{10}$, $R_L = \frac{R_o}{10}$

$$V_o = \frac{R_L}{R_L+R_o} A_{V_o} \frac{R_i}{R_i+R_s} V_s$$

$$\frac{V_o}{V_s} = \frac{R_o(1/10)}{R_o(1/10)+R_o} A_{V_o} \times 11\ V_s$$

$$\frac{V_o}{V_s} = 11\times11\ A_{V_o} = 121\ A_{V_o} = 12100$$

g3)



voltage gain = $A_v = \frac{V_o}{V_i} = \frac{2.2}{0.2} = 11\ V/V$

$A_{v|dB} = 20\log_{10}|A| = 20.8\,dB$

power gain = $A_p = \frac{P_o}{P_i} = \frac{(2.2/\sqrt{2})^2/100}{\frac{0.2}{\sqrt{2}}\times\frac{1}{\sqrt{2}}\times10^{-3}} = 242$

for power and sinusoidal voltage src, we use the Rms value

$A_{p_{dB}} = 10\log_{10}242 = 23.8\,dB$

Power supply: $2\times3\times20\times10^{-3} = 120mW$ (2 = V, 20×10⁻³ = I)

because $-3 \rightarrow 3$, $2+3$

output power = $\frac{V_{Rms}^2}{R_L}$

efficiency = $\frac{V_{out}}{V_{in}} \times 100$