2.1 $0.99 > 1 - e^{-t/RC}$ with $t = 1\mu s$, $C = 1pF$ $\Rightarrow R = \dfrac{-t}{C \ln(0.01)} < 217k\Omega$

R of ohmic device $R = \dfrac{1}{k' \frac{W}{L}(V_{GS} - V_t)}$

consider $V_{in} = V_{Tp}$. P device off, N device on

$$R_N = \frac{1}{K_n' \frac{W_n}{L_n}(3V - V_{Tp} - V_{TN})} \Rightarrow \frac{W}{L} > \ldots \quad , \text{choose } \frac{W}{L} = 1,\ W = L = 0.5\mu m$$

Consider $V_{in} = V_{DD} - V_{Tn}$ N device off, P device on

$$R_p = \frac{1}{K_p' \frac{W_p}{L_p}(3V - V_{Tp} - V_{TN})} \Rightarrow \frac{W}{L} = \ldots \quad , \text{choose } \frac{W}{L} = 1.\ W = L = 0.5\mu m$$

2.2 a) for an accurate low gain choose 4 load with $\left(\frac{W}{L}\right)_{load} = \frac{1}{100}\left(\frac{W}{L}\right)_{in}$

b) $g_{m in} = \sqrt{2k\left(\frac{W}{L}\right)_{in} I_D}$, $g_{m load} = \frac{1}{10} g_{m in} = \sqrt{2k\left(\frac{W}{L}\right)_{load} I_D}$

$$\Rightarrow \left(\frac{W}{L}\right)_{in} = 100 \times \left(\frac{W}{L}\right)_{load}$$

Choose $I_D = 10\mu A$, $\left(\frac{W}{L}\right)_{in} = 10$, $\left(\frac{W}{L}\right)_{load} = \frac{1}{10}$ $\Rightarrow g_{m in} =$ $\qquad g_{m load} =$

c) $V_{in} = V_{TN} + \sqrt{\dfrac{I_D}{\frac{k'}{2}\left(\frac{W}{L}\right)_{in}}}$ $\qquad V_{out} = V_{DD} - V_{TN} - \sqrt{\dfrac{I_D}{\frac{k'}{2}\left(\frac{W}{L}\right)_{load}}}$

d) common source amplifier: output pole at $f_{3dB} = \dfrac{g_{m load}}{2\pi C_L} =$

c) input reffered noise density

$$V_n^2 = \frac{8}{3} kT \frac{1}{g_{m in}} df + \frac{8}{3} kT \frac{1}{g_{m load}} \left(\frac{g_{m load}}{g_{m in}}\right)^2$$

$$V_{noise} = \sqrt{\int_{20}^{20000} V_n^2 \, df} =$$

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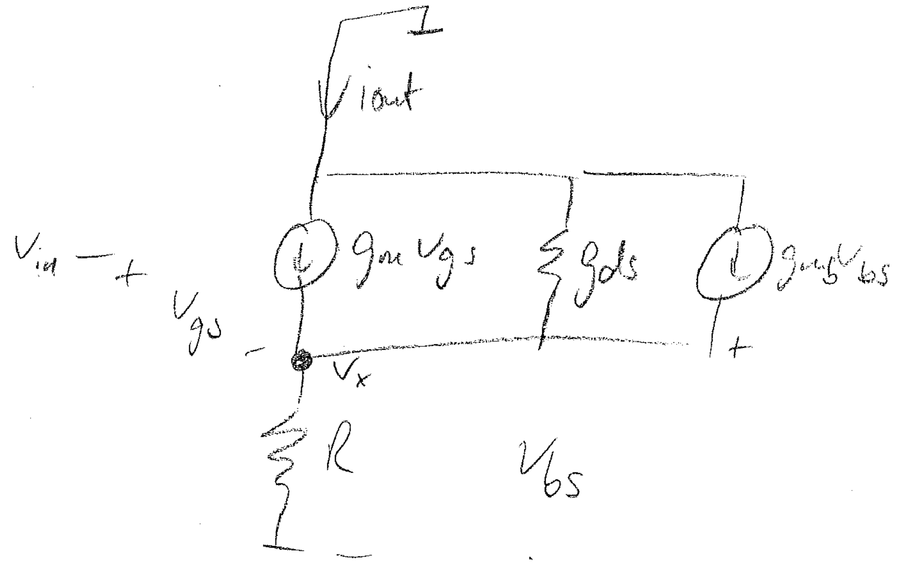

transconductance $G = \frac{i_{out}}{V_{in}}$

$V_x = R\, i_{out}$

$V_{gs} = V_{in} - V_x$

$V_{bs} = V_x$

$i_{out} = g_m v_{gs} + g_{mb} V_{bs} - V_x \cdot g_{ds}$

$i_{out} = g_m (V_{in} - R i_{out}) + g_{mb} R\, i_{out} - R i_{out}\, g_{ds}$

$i_{out}(1 + R g_m + R g_{ds} - g_{mb} R) = g_m v_{in}$

$$G = \frac{i_{out}}{v_{in}} = \frac{g_m}{(1 + R g_m + R g_{ds} - g_{mb} R)}$$

if R is large $G \simeq \frac{1}{R}$ (if $g_m >> g_{ds}, g_{mb}$)

if R is small $G \simeq g_m$