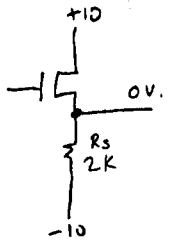
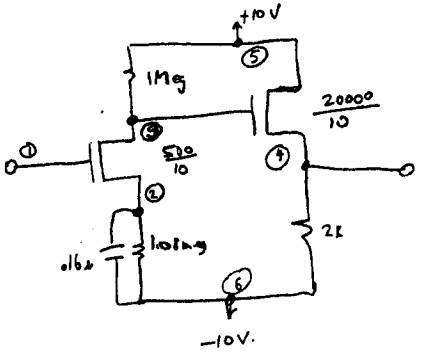
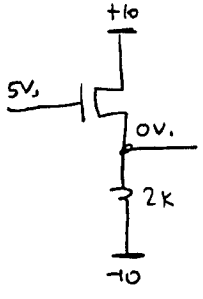
Last stage



$I_{DQ} = \frac{V}{R_s} = \frac{10}{2k} = 5ma$





TEST 1

$R_{out} = 50\Omega$

$= \frac{1}{g_m + \frac{1}{2k}}$

$g_m + \frac{1}{2K} = \frac{1}{50}$

$g_m = \frac{1}{50} - \frac{1}{2K} = \frac{1}{51.28} = .0195 \approx .02$

$g_m = \sqrt{2K_p \frac{W}{L} I_{DQ}}$

$.02 = \sqrt{(2)(20u)\frac{W}{L}(5ma)}$

$.02 = \sqrt{200 \times 10^{-9} \frac{W}{L}}$

$400 \times 10^{-6} = 200 \times 10^{-9} \frac{W}{L}$

$\frac{400 \times 10^{-6}}{200 \times 10^{-9}} = \boxed{\frac{W}{L} = 2000}$

$\boxed{L = 10u \quad W = 20{,}000u}$

$2K = K_p \frac{W}{L} = (20u)(2000)$

$= .04$

$K = .02$

$I_D = K(V_{GST})^2$

$.005 = .02\,(V_{GST})^2$

$\frac{.005}{.02} = (V_{GST})^2 = .25$

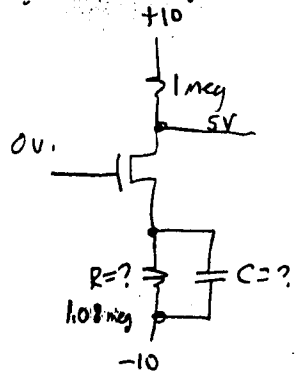
$\boxed{V_{GST} = .5}$

Choose FET:

$\boxed{V_{TH} = 4.5 \Rightarrow V_{GS} = 5.0}$

$V_{TH} = -2 \Rightarrow V_{GS} = -1.5$

First stage



Gain = 100 -- 40 dB.

$= -g_m R_L'$ $\quad R_L = 1meg.$

$g_m = \frac{100}{1e6} = 10^{-4}$

$= \sqrt{2K_p \frac{W}{L} I_{DQ}}$ $\quad I_{DQ} = \frac{5V}{1meg} = 5uA$

$10^{-4} = \sqrt{2(20 \times 10^{-6})\frac{W}{L}(5 \times 10^{-6})}$

$10^{-4} = \sqrt{12 \times 10^{-10} \frac{W}{L}}$

$10^{-8} = 12 \times 10^{-10} \frac{W}{L}$

$\frac{10^{-8}}{1.8 \times 10^{-10}} = \frac{W}{L} = 50$

$\boxed{L = 10u \quad W = 500u}$

$2K = K_p \frac{W}{L} = (20u)(50)$

$= .001$

$K = .0005$

$I_D = K(V_{GST})^2$

$5uA = 500\frac{uA}{V^2}(V_{GST})^2$

$\frac{5}{500} = V_{GST}^2$

$V_{GST} = .1$

Choose FET:

$\boxed{V_{TH} = 4.5 \Rightarrow V_{GS} = 4.6}$

$V_{TH} = -2 \Rightarrow V_{GS} = -1.9$

If $V_G = 0$, $V_{GS} = 4.6$

then $V_S = -4.6$

$V_{RS} = 10 - 4.6 = 5.4$

$I = 5uA$ (from I_D)

$R = \frac{V}{I} = \frac{5.4V}{5uA} = 1.08meg.$

C: $R_{s\,effective} = \frac{1meg}{100} = 10K$

$f = \frac{1}{2\pi RC} \Rightarrow C = \frac{1}{2\pi f R}$

$C = \frac{1}{2\pi(100)(10k)} = 1.59 \times 10^{-7}$

$\boxed{C = .16uf}$