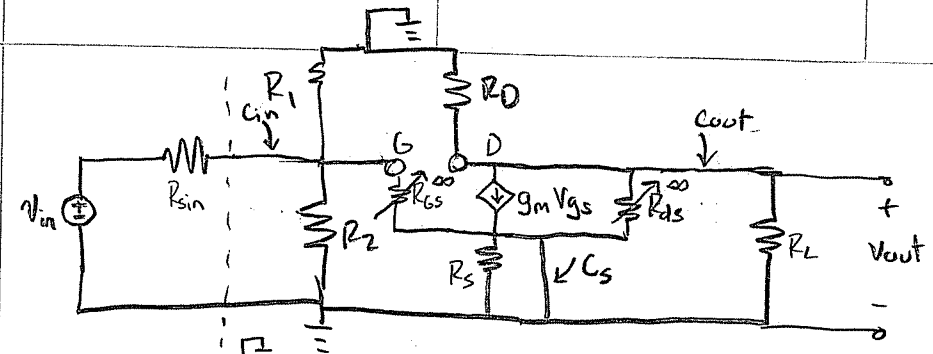
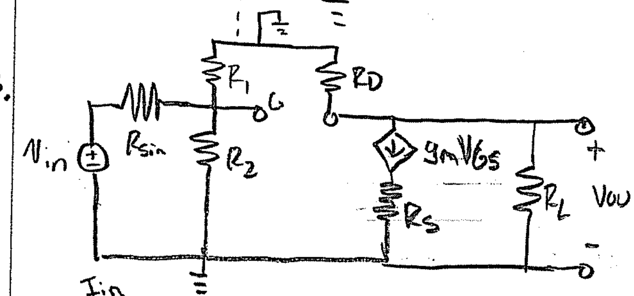
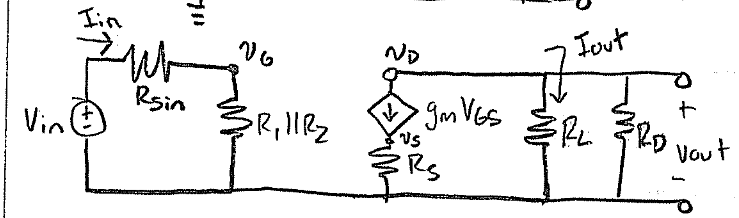
2.



3.





$$V_{out} = -g_m V_{GS}(R_L \| R_D) \qquad v_g = \frac{V_{in}(R_1 \| R_2)}{(R_1 \| R_2) + R_{sin}}$$

$$v_S = g_m v_{GS} R_S = g_m (v_G - V_S) R_S$$

$$v_S = g_m R_S V_G - g_m R_S V_S$$

$$v_S (1 + g_m R_S) = g_m R_S V_G$$

$$v_S = \frac{g_m R_S V_G}{1 + g_m R_S}$$

$$V_{GS} = V_G - V_S = V_G - V_G\left(\frac{g_m R_S}{1 + g_m R_S}\right)$$

$$= V_G\left(1 - \frac{g_m R_S}{1 + g_m R_S}\right)$$

$$V_{GS} = \frac{V_{in}(R_1 \| R_2)}{(R_1 \| R_2) + R_{sin}}\left(1 - \frac{g_m R_S}{1 + g_m R_S}\right)$$

$$\therefore \left[\frac{V_{out}}{V_{in}} = \frac{-g_m(R_L \| R_D)(R_1 \| R_2)}{(R_1 \| R_2) + R_{sin}}\left(1 - \frac{g_m R_S}{1 + g_m R_S}\right)\right]$$

$R_{sin} = 0$, $R_L = \infty$, ~~$R_D = 1k\Omega$, $R_S = 470\,\Omega$, $V_{GS} = 2V$~~, $k_p = .1233$, $R_1 = 200k\Omega$, $R_2 = 90k\Omega$

$$\frac{V_{out}}{V_{in}} = \frac{-g_m R_D \cancel{(R_1 \| R_2)}}{\cancel{(R_1 \| R_2)}}\left(1 - \frac{g_m R_S}{1 + g_m R_S}\right) = -g_m R_D + \frac{g_m^2 R_D R_S}{1 + g_m R_S}$$

$$g_m = \left.\frac{\partial I_D}{\partial V_{gs}}\right|_{V_{GS} = V_{GSQ}} = k_p(V_{GS} - V_{TR}) \approx .02466$$

$$\left.\frac{V_{out}}{V_{in}}\right|_{\substack{R_{sin}=0 \\ R_L=\infty}} \approx -2$$

$$\left.\frac{V_{out}}{V_{in}}\right|_{\substack{R_{sin}=50\,\Omega \\ R_L=1k\Omega}} = \frac{-g_m(500\,\Omega)(62069)}{(62069) + 50}\left(1 - \frac{g_m(470)}{1 + g_m(470)}\right) \approx -1$$

Source and load resistance reduce gain.

$$\left.\frac{I_{out}}{I_{in}}\right|_{R_L=\infty} = 0$$

$$\left.I_{out}\right|_{R_{sin}=50\Omega,\ R_L=1k\Omega} = \frac{V_{out}}{R_L} = \frac{-1\ V_{in}}{R_L} = -.001\ V_{in}$$

$$I_{in} = \frac{V_{in}}{R_{sin}+(R_1 \| R_2)}$$

$$\left.\frac{I_{out}}{I_{in}}\right|_{R_{sin}=50\Omega,\ R_L=1k\Omega} \approx -62.119$$

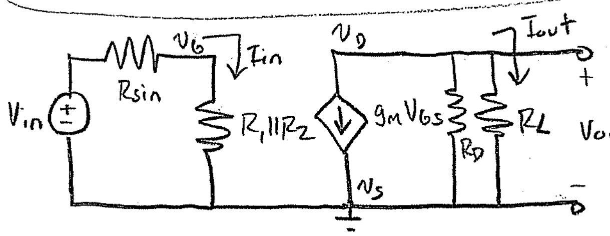
4.

$$\frac{1}{2\pi f R_{sin}} \lll C$$

$$1.5915 \times 10^{-6} \lll C$$

$16\mu F$ to $160\mu F$ will work.

5.



$$V_{out} = -g_m V_{GS} (R_L \| R_D) \qquad \frac{V_{in}(R_1 \| R_2)}{(R_1 \| R_2) + R_{sin}} = V_G \qquad V_S = 0$$

$$\boxed{\frac{V_{out}}{V_{in}} = \frac{-g_m (R_L \| R_D)(R_1 \| R_2)}{(R_1 \| R_2) + R_{sin}}} \quad \therefore V_{GS} = V_G$$

$$\left.\frac{V_{out}}{V_{in}}\right|_{R_L=\infty,\ R_{sin}=0} = -g_m R_D \approx -25$$

$$\left.\frac{V_{out}}{V_{in}}\right|_{R_{sin}=50\Omega,\ R_L=1k\Omega} \approx -12.3$$

$$\left.\frac{I_{out}}{I_{in}}\right|_{R_L=\infty} = 0 \quad \text{(no Load = No output current)}$$

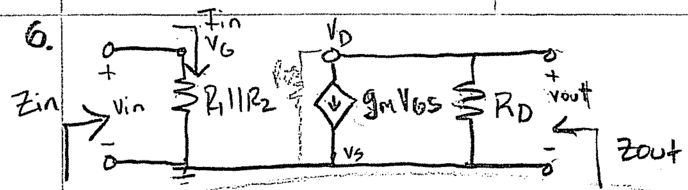
$$\left.I_{out}\right|_{R_{sin}=50\Omega,\ R_L=1k\Omega} = \frac{V_{out}}{R_L} = \frac{-12.3\ V_{in}}{R_L} = -.0123\ V_{in}$$

$$I_{in} = \frac{V_{in}}{R_{sin}+(R_1 \| R_2)} = 1.609 \times 10^{-5}\ V_{in}$$

$$\left.\frac{I_{out}}{I_{in}}\right|_{R_{sin}=50\Omega,\ R_L=1k\Omega} \approx -764.$$

– R_S greatly reduces current and voltage gain!

6.

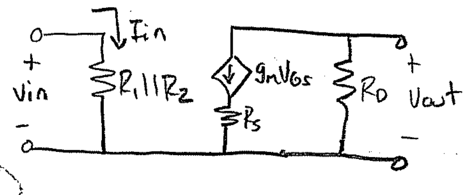


$$Z_{in} = \frac{V_{in}}{I_{in}} = \frac{V_{in}}{\frac{V_{in}}{R_1 \| R_2}} = R_1 \| R_2 \approx 62069\,\Omega$$

$$Z_{out} = \frac{V_{open}}{I_{short}} = \frac{-g_M V_{GS} R_D}{-g_m V_{GS}} = R_D = 1\,k\Omega$$

7. $Z_{in} = R_1 \| R_2 = 62069\,\Omega$

$$Z_{out} = \frac{V_{open}}{I_{short}} = \frac{-g_m V_{GS} R_D}{-g_m V_{GS}} = R_D = 1\,k\Omega$$



$V_{out} = -g_m V_{GS} R_D$

R_s does not effect output or input impedances (in the small signal model with these assumptions)