$k'_n = 800 \mu A/V^2$ $V_t = 1V$ $\lambda = .03V^{-1}$ $\frac{W}{L} = 10$

$I_{DQ} = .4mA$ $R_D = 4k\Omega$

V_{sig} in series with $R_{sig} = 500k\Omega$

a) $V_{GSQ} \rightarrow I_{DQ} = \frac{1}{2} k'_n \frac{W}{L} (V_{GSQ} - V_t)^2$

$.4mA = \frac{1}{2}(.8)(10)(V_{GSQ} - 1)^2$

$.0001 = (V_{GSQ} - 1)^2$

$.01 = V_{GSQ} - 1$

$V_{GSQ} = 1.32V$

$V_{GSQ} = \sqrt{\frac{2I_{DQ}}{W/L \, k'_n}}$

$g_m = (.8)(10)(1.32 - 1)$

$g_m = .0056 A/V$

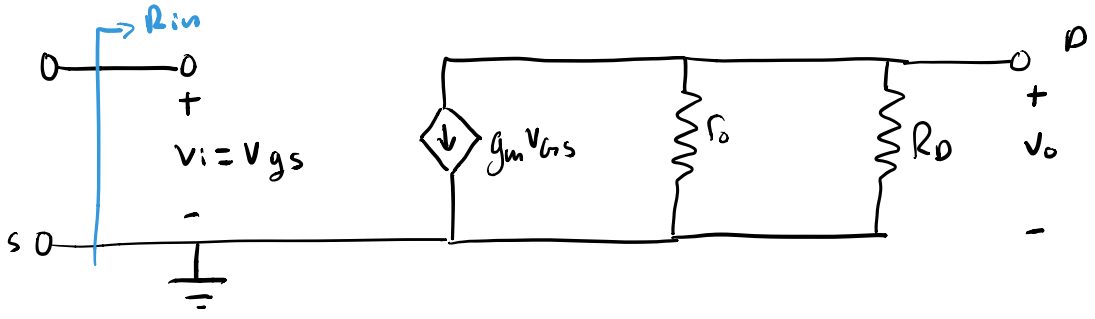
$g_m = \frac{i_d}{v_{gs}} = k'_n \left(\frac{W}{L}\right)(V_{GSQ} - V_t)$

$r_o = \frac{1}{(.03)(.0004)} = 83.33 k\Omega$

reminder: $r_o = \frac{1}{\lambda I_{DQ}} = \frac{V_A}{I_{DQ}}$

$r_o = 83.33 k\Omega$

b)



$R_{in} = \infty$

R_o: $R_D \,||\, r_o = 12 \,||\, 83.33 \Rightarrow \frac{12 \cdot 83.33}{12 + 83.33} = 10.49\ k\Omega$

$A_{VO} = -g_m (r_o \,||\, R_D) \Rightarrow -.00256\ (10.49)$

$A_{VO} = -26.85\ V/V$

C) $R_L = ?$ if $G_V = -5\ V/V$

$-5 = -2.53\,E{-3}(R_o \,||\, R_L)$

$1976.28 = \frac{R_o \times R_L}{R_o + R_L}$

$1976.28 R_o + 1976.28 R_L = R_o R_L$

$1976.28 R_o = R_o R_L - 1976.28 R_L$

$k'_n = .5\ mA/V^2 \quad \frac{W}{L} = 10 \quad \lambda = 0 \quad V_t = 1.1V$

$V_{GSQ} = 2.2V \quad R_D = 5.1k\Omega \quad R_L = 8k\Omega \quad R_{sig} = 280\Omega$

$R_{in} = 1/5.5 = .181 m\Omega$

$G_v = -g_m \left(\frac{R_D \| R_L}{R_{sig} + 1/g_m} \right) \quad \frac{1}{5.1} + \frac{1}{8}$

$R_D = 5.1k\Omega$

$g_m = k'_n \left(\frac{W}{L}\right)(V_{GSQ} - V_t) = 5.5$

$G_v = 6.74\ V/V$

$R_{in} = 1/g_m$

$R_o = R_D$

$v_{gs} = -v_i$

$v_o = -g_m(R_D)(-v_i) = g_m R_D v_i$

$A_{vo} = g_m R_D$

$A_v = g_m (R_D \| R_L)$

$G_v = \frac{R_D \| R_L}{R_{sig} + 1/g_m}$

or

$G_v = \frac{R_D \| R_L}{R_{sig} + R_{in}}$

$g_m = \frac{i_d}{v_{gs}} = k'_n \left(\frac{W}{L}\right)(V_{GSQ} - V_t)$

("Source Grounded")

so $v_i = v_{sig}$

$R_{in} = \infty \quad i_i = 0$

$R_o = R_D \| r_o$

$A_{vo} = -g_m (r_o \| R_D)$

$A_v = -g_m (r_o \| R_D \| R_L)$

$G_v = -g_m (r_o \| R_D \| R_L)$

$v_o = -g_m (v_i)(r_o \| R_D)$