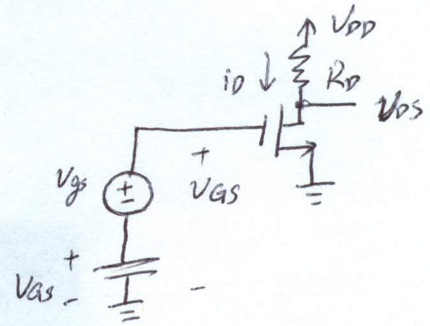
HW10 EE20242

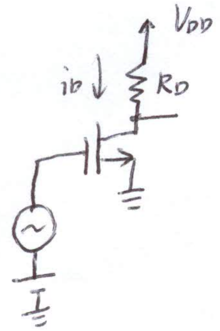


5.63 $A_v = -k_n V_{ov} R_D = \dfrac{-I_D R_D}{\frac{1}{2} V_{ov}}$

$A_v = \dfrac{-(V_{DD} - V_{ov})}{\frac{1}{2} V_{ov}}$ for $V_{DS} = V_{ov}$

The maximum of this expression is reached at $V_{GS} = V_t$ or $V_{ov} \to 0$. The allowable signal swing becomes zero as $V_{ov} \to 0$. The condition is not a practically useful one.

5.71



(a) $I_D = \frac{1}{2} k_n V_{ov}^2 = 125 \mu A$

$V_D = V_{DD} - I_D R_D = 0.8 V$

(b) $g_m = k_n V_{ov} = 1 mS$

(c) $A_v = -g_m R_D = -8.0$

(d) for $\lambda = 0.1 V^{-1}$ $r_o \cong \frac{1}{\lambda I_D} = 80k$ $A_v = -g_m (r_o \| R_D) = -7.3$

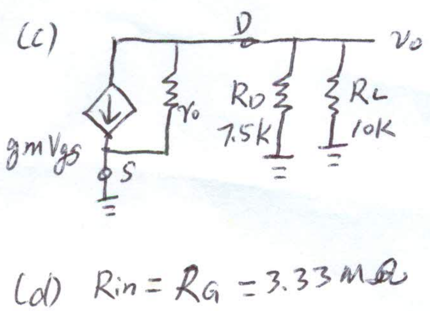
5.79 (a) $V_G = \frac{5}{15} 15 V = 5V$, Assume $I_D = 1 mA$

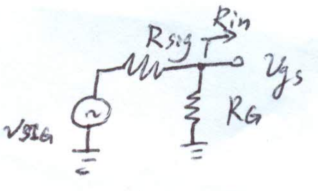
$V_S = 3V$, $V_{GS} = 2V$, $V_{ov} = 1V$, $I_D = \frac{1}{2} k' V_{ov}^2 = 1 mA$

$V_D = V_{DD} - I_D R_D = 7.5V$.

(b) $r_o = \dfrac{V_A}{I_D} = \dfrac{100V}{1mA} = 100 k\Omega$. $g_m = \sqrt{2 k_n I_D} = 2mS$

(c)



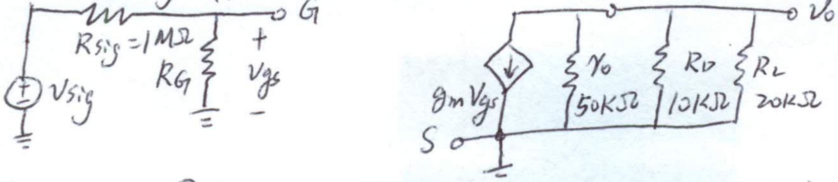


(d) $R_{in} = R_G = 3.33 M\Omega$

$\dfrac{v_{gs}}{v_{sig}} = \dfrac{R_{in}}{R_{sig} + R_{in}} = 0.97$ $\dfrac{v_o}{v_{gs}} = -g_m (r_o \| R_D \| R_L) = -8.2$ $\dfrac{v_o}{v_{sig}} = -8.0$

5.85 $$G_v = -\left(\frac{R_G}{R_G + R_{sig}}\right) g_m (r_o \| R_D \| R_L)$$

small signal:



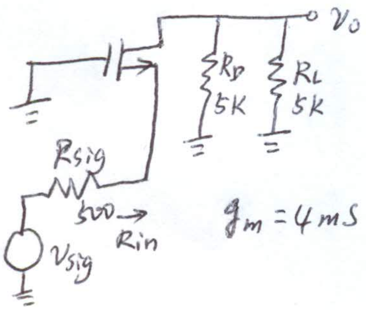
$$G_v = -\frac{R_G}{R_G + 1M\Omega}(2mA/V)(50k\Omega \| 10k\Omega \| 20k\Omega) = -\frac{R_G}{R_G + 1M\Omega}\, 11.76\ V/V$$

If $R_G \gg 1M\Omega$, $G_v = -11.76$. otherwise, the gain is smaller.

5.93 $$R_{in} = \frac{1}{g_m} = 250\Omega$$

$$G_v = \frac{v_o}{v_{sig}} = \frac{R_{in}}{R_{sig} + R_{in}}\, g_m (R_D \| R_L) = 3.3\ V/V$$

$g_m = \sqrt{2 k_n I_D}$, so for $\frac{1}{g_m} = R_{sig}$, g_m must decrease to $1/2$ and I_D decrease to $1/4$.



$g_m = 4mS$