1.

HW4

(a) $\frac{V_{DD} - V_{DS}}{R_D} = \frac{1}{2} k_n V_{ov}^2$

$\Rightarrow \frac{5-1}{R_D} = \frac{1}{2} \times 10^{-2} \times 0.2^2$

$\Rightarrow R_D = \underline{20k\Omega}$ #

(b) $\frac{1}{2} k_n \cdot (V_{GS} - V_t)^2 = \frac{V_{DD} - (V_{GS} - V_t)}{R_D}$

$\Rightarrow \frac{1}{2} \times 10^{-2} \times (V_{GS} - V_t)^2 = \frac{5 - (V_{GS} - V_t)}{20 \times 10^3}$

$\Rightarrow V_{GS} - V_t = 0.219 = V_{DS}$

$\Rightarrow V_{GS} = 0.719$

$\Rightarrow \underline{B(0.719, 0.219)}$ #

(c) $I_D = \frac{5-1}{20k} = 200\,\mu A$

$g_m = \frac{2I_D}{V_{ov}} = \frac{400\mu}{0.2} = 2\,mS$

$A_v = -g_m R_D = \underline{-40\ V/V}$ #

(d) $V_{DS,B} = 0.219\ V$

$V_{DS,Q} = 1\ V$

$\Rightarrow$ negative signal swing: $1 - 0.219 = \underline{0.781\ V}$ #

$\Rightarrow$ peak input signal $= \frac{V_o}{A_v} = \underline{19.525\ mV}$ #

2.

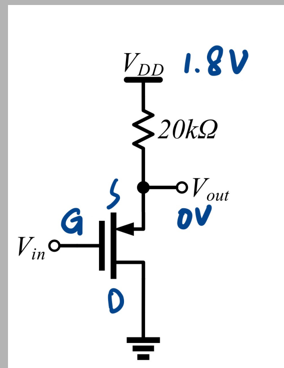
(a) $V_{DS} + 0.5 \le V_{DD}$, $V_{DS} - 0.5 \ge V_{ov}$

$\Rightarrow V_{DS} \le 4.5V$ $\Rightarrow V_{DS} \ge 0.7V$

choose $\underline{V_{DS} = 0.7\,V}$ #

(b) $A_v = -g_m R_D = -\frac{2 I_D R_D}{V_{ov}} = \frac{-2(V_{DD}-V_{DS})}{V_{ov}} = \frac{-2(5-0.7)}{0.2} = \underline{-43\ V/V}$ #

$43 = \frac{0.5}{V_{gs}} \Rightarrow V_{gs} = \underline{11.628\ mV}$ #



(b)

Fig. 3

(c) $V_{DD} - I_D R_D = 0.7\,V$

$\Rightarrow R_D = \underline{43\ k\Omega}$ #

(d) $I_D = \frac{1}{2} k_n' \frac{W}{L} V_{ov}^2 \Rightarrow \underline{\frac{W}{L} = 25}$ #

or

$-43 = -k_n' \frac{W}{L} V_{ov} \cdot R_D \Rightarrow \underline{\frac{W}{L} = 25}$ #

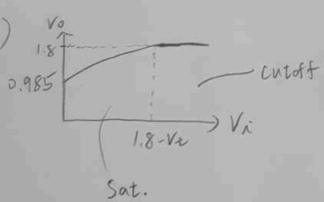
3.

(a)

$\frac{1}{2}\mu_n C_{ox}\left(\frac{W}{L}\right)(V_i - V_{out} - 0.7)^2 = \frac{V_{out}}{20}$

when $V_i = 1.8 \Rightarrow V_{out} = 0.815\,V$

(b)



PMOS

$V_{SD} - V_{ov}$

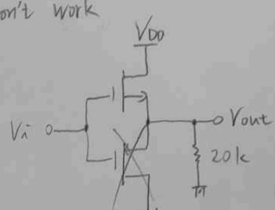
$= V_{out} - V_{in} - 0.7$

$\frac{1}{2}\mu_n C_{ox}\left(\frac{W}{L}\right)(V_i - V_{out} - 0.7)^2 = \frac{1.8 - V_{out}}{20}$

when $V_i = 0 \Rightarrow V_{out} = 0.985\,V$

(c) Same as (a)

pmos don't work



4. $V_{th} = \ldots\ldots$

↳ similar to 3.

5.

HW4

(a) $I_D = \frac{1}{2} k_n (V_{gs} - V_{tn})^2 = 7.5 \times 10^{-3} (0.6 - 0.4)^2 = \underline{0.1\ mA}$ #

$V_{DS} = V_{DD} - I_D R_D = \underline{0.8\ V}$ #

(b) $g_m = \frac{2I_D}{V_{ov}} = \underline{1\ mS}$ #

(c) $A_v = -g_m R_D = \underline{-10\ V/V}$ #

(d) $r_o = \frac{1}{\lambda I_D} = 100k$

$A_v = -g_m (R_D // r_o) = \underline{-9.09\ V/V}$ #

6.

(a) $A_v = -g_m R_D = -10$

$\Rightarrow g_m = \underline{0.5\ mS}$ #

(b) $I_D = \frac{V_{DD} - V_{peak}}{R_D} = \frac{1.8 - 0.2}{20k} = 80\mu A$

$g_m = \frac{2I_D}{V_{ov}} \Rightarrow \underline{V_{ov} = 0.32\ V}$ #

(c) $I_D = \frac{1}{2} \mu_n C_{ox} \frac{W}{L} V_{ov}^2$

$\Rightarrow \frac{W}{L} = \underline{7.81}$ #

(d) $V_{ov} = 0.32 = V_{gs} - V_{th}$

$\Rightarrow V_{gs} = \underline{0.72\ V}$ #