7.1 111511096 陳彥宇

$V_{DD} = 3V$

$C_{ox} = 3.9 \frac{\varepsilon_0}{t_{ox}} = 3.83673 \times 10^{-7}\ F/cm^2 = 3.83673 \times 10^{-15}\ F/\mu m^2$

$\mu_n = 350\ cm^2/V/s$ $\quad V_{t_n} = 0.7$

$\mu_p = 100\ cm^2/V/s$ $\quad V_{t_p} = -0.8$

$k'_n = 0.13428\ mA/V^2$ $\quad k'_p = 0.038367\ mA/V^2$

$\lambda_n = 0.1$

$\lambda_p = 0.2$

(a) $\because V_{out,max} = V_{DD} - V_{ov6}$

$V_{out,min} = V_{ov5}$

Output Swing $= V_{DD} - V_{ov6} - V_{ov5}$

$= 2.4$

The problem requires $V_{ov6} = V_{ov5}$

$\therefore V_{ov6} = V_{ov5} = 0.3V$

$I_m = \frac{1}{2} \cdot 0.13428m \left(\frac{W}{L}\right)_5 \cdot 0.3^2$

$\left(\frac{W}{L}\right)_5 = 165.492$ #

$I_m = \frac{1}{2} \cdot 0.038367m \left(\frac{W}{L}\right)_6 \cdot 0.3^2$

$\left(\frac{W}{L}\right)_6 = 579.221$ #

(b)

$g_{m5} = \sqrt{2 \cdot 0.13428m \times 165.492 \times I_m} = 6.66667mA/V$

$r_{o5} = \frac{1}{0.1 \cdot I_m} = 10k$ $\quad r_{o6} = \frac{1}{0.2 \cdot 0.1m} = 5k$

$A_v = -g_{m5}(r_{o5} \parallel r_{o6})$

$= -6.66667m \times 3.3333k$

$= -22.222\ V/V$ #

(c)

$0.5m = \frac{1}{2} \cdot 0.13428m \left(\frac{W}{L}\right)_{3,4} \cdot 0.3^2$

$\left(\frac{W}{L}\right)_{3,4} = 82.796$ #

(d) Overall Gain $= -g_{m1}(r_{o4} \parallel r_{o2}) \cdot (-22.222)$

$r_{o4} = \frac{1}{0.1 \cdot 0.5m} = 20k$

$r_{o2} = \frac{1}{0.2 \cdot 0.5m} = 10k$

$(r_{o4} \parallel r_{o2}) = 6.6667k$

$g_{m1} = 2.7m$

$= \sqrt{2 \cdot 0.038367m \cdot \left(\frac{W}{L}\right)_{1,2} \cdot 0.5m}$

$\left(\frac{W}{L}\right)_{1,2} = 190.013$ #

7.2

$V_{DD} = 3V$

$C_{ox} = 3.9 \frac{\epsilon_0}{t_{ox}} = 3.83673 \times 10^{-7} F/cm^2 = 3.83673 \times 10^{-15} F/\mu m^2$

$\mu_n = 350 cm^2/V/s$ $V_{t_n} = 0.7$

$\mu_p = 100 cm^2/V/s$ $V_{t_p} = -0.8$

$k_n' = 0.13428 mA/V^2$ $k_p' = 0.03837 mA/V^2$

$\lambda_n = 0.1$

$\lambda_p = 0.2$

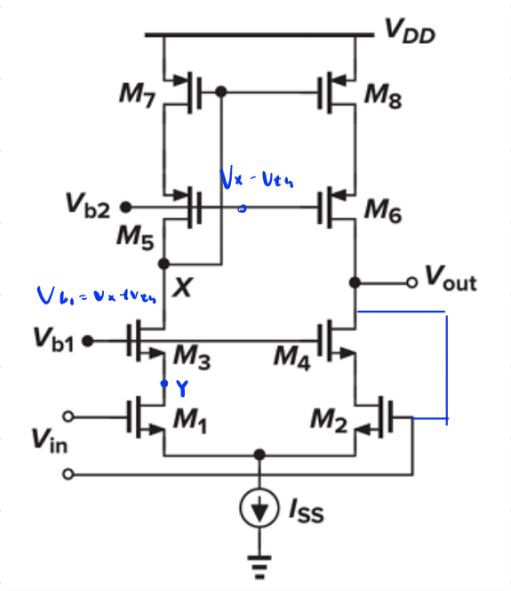
(a) $k_n = 32.2272 mA/V^2$ $k_p = 9.2078 mA/V^2$

$I_0 = 0.5 mA$

$\Rightarrow V_{ov\,5,6,7,8} = 0.32955 V$

$V_{ov\,1,2,3,4} = 0.17615 V$

$V_{gs1,2} = 0.87615 V$



$V_{in,cm\,max} = V_Y + |V_{th1}|$

$V_Y = 1.7 - 0.87615 V$

$V_{in,cm\,max} = 1.7 - 0.87615 + 0.7$

$= 1.52385 V$

$\doteq 1.524 V$ #

(b) $V_X = V_{DD} - V_{sg7}$

$= 3 - (0.32955 + 0.8)$

$= 1.87045 V$

$\doteq 1.870 V$ #

(c)

$V_{out,max} = V_{Iss} + V_{gs2}$

$V_{out,min} = V_{Iss} + V_{ov1,2} + V_{ov3,4}$

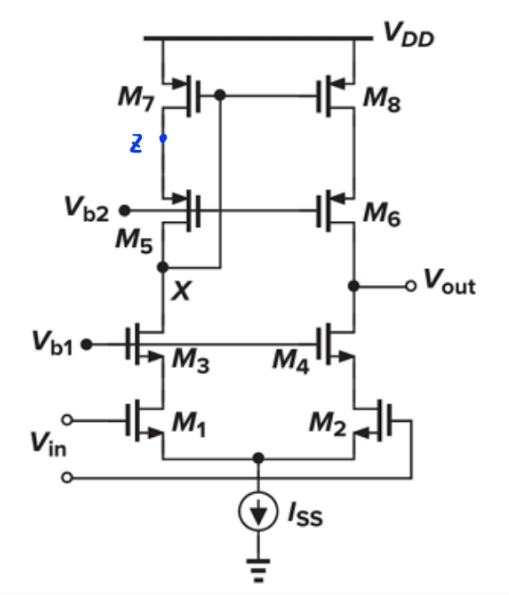
$V_{out,max} - V_{out,min} = V_{gs2} - V_{ov1,2} - V_{ov3,4}$

$= (0.17615 + 0.7) - 0.17615 - 0.17615$

$= 0.52385 V$

$\doteq 0.524 V$ #

(d)



$V_Z = V_X + |V_{th,p}| = 1.87095 + 0.8$

$V_{b2,max} = V_Z - V_{sg,5}$

$= 2.67045 - (0.32955 + 0.8)$

$= 1.5909\ V$

$V_{b2,min} = V_X - |V_{th,p}|$

$= 1.87045 - 0.8$

$= 1.07045$

$1.070\ V < V_{b2} < 1.591\ V$ #