Homework 9

5.2

a) $NM_H = V_{OH} - V_{IH} = 1.7V - 1.6V = 0.1V$

b) $NM_L = V_{IL} - V_{OL} = 0.3V - 0.2V = 0.1V$

c) Circuit fidelity is not compromised because $1.7V - 0.05V > 1.6V$

d) Circuit fidelity is compromised because $1.7V - 0.15V < 1.6V$

5.4

$NM_L = 0.9V * 0.2 = 0.18V$

$NM_H = 0.18V$ $\qquad V_{IH} = V_{OH} - NM_H = 0.8 - 0.18 = 0.62V$

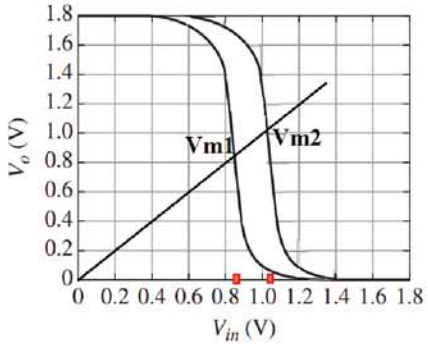
$V_{IH} = NM_L + V_{OL} = 0.18 + 0.1 = 0.28V$

5.5

$V_{M1} \simeq 0.86V$

$V_{M2} \simeq 1.02V$

$V_{M2} - V_{M1} = 1.02 - 0.86 = 0.16V$

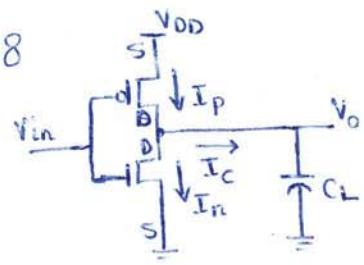


5.6

a) $\frac{W_p}{W_n} = \frac{\mu_n}{\mu_p} \frac{\left(\frac{V_{DD}}{2} - V_{th,n}\right)^2}{\left(\frac{V_{DD}}{2} - |V_{th,p}|\right)^2} = \frac{\left(1400 \frac{cm^2}{V.s}\right)(0.65V - 0.35V)^2}{\left(500 \frac{cm^2}{V.s}\right)(0.65 - |-0.35V|)^2} = 2.8$

b) $\frac{W_p}{W_n} = \frac{\left(1400 \frac{cm^2}{V.s}\right)(0.65V - 0.35V)^2}{(500\ cm^2/V.s)(0.65V - 0.45V)^2} = 6.3$

5.8



$$K_n * (V_{GSn} - V_{tn})^2 = K_p * (V_{GSp} - V_{tp})^2$$

$K_p = 3K_n$

$V_{GSn} = V_i$

$V_{GSp} = V_i - V_{DD}$

$V_i = V_o + V_{tn}$

$$\Rightarrow (V_i - V_{tn})^2 = 3(V_i - V_{DD} - V_{tp})^2$$

$$(V_o + V_{tn} - V_{tn})^2 = 3(V_o + V_{tn} - V_{DD} - V_{tp})^2$$

$$V_o = 0.665\,V$$

$$\frac{V_{DD} - V_o}{V_{DD}} = \frac{2.5\,V - 0.665\,V}{2.5\,V} = 0.734 = 73.4\%$$

5.9

$I_{DD} = 5\mu A$

For PMOS: $5\mu A = \frac{25\,\mu A/V^2}{2}(4)(|V_i - 2.1 - 1 - 0.61)^2 \Rightarrow V_i = 1.084\,V$

NMOS: $5\mu A = 50\mu A/V^2\,(2)\left[(1.084 - 0.5)V_{out} - \frac{V_{out}^2}{2}\right] \Rightarrow V_{out} = 0.4255$