HOMEWORK-9

52

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

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

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

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

54) $N_{ML} = 0.9 \times 0.2 = 0.18V$

$N_{MH} = 0.18V$

$V_{IH} = V_{OH} - N_{MH} = 0.8 - 0.18 = 0.62V$

$V_{IL} = N_{M_L} + V_{OL} = 0.18 + 0.1 = 0.28V$

55) From the graph we have

$V_{M1} = 0.86V$

$V_{M2} = 1.02V$

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

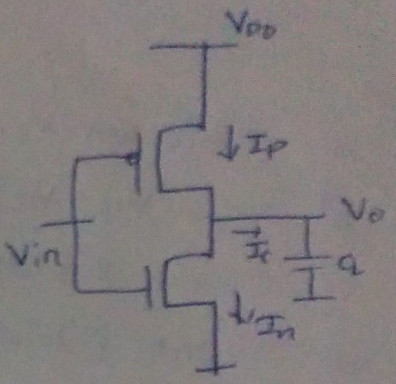
5.6) a) $\frac{W_p}{W_n} = \frac{\mu_n}{\mu_p} \frac{\left(\frac{V_{DD}}{2} - V_{tn}\right)^2}{\left(\frac{V_{DD}}{2} - V_{tp}\right)^2} = \frac{1400}{500} \frac{(0.65 - 0.35)^2}{(0.65 - 0.35)^2} = 2.8$

b) $\frac{W_p}{W_n} = \frac{1400\,(0.65 - 0.35)^2}{500\,(0.65 - 0.45)^2} = 6.3$

5.8) Given $K_n\left(\frac{W}{L}\right)_n = 100\ \mu A/V^2$

$K_p\left(\frac{W}{L}\right)_p = 300\ \mu A/V^2 \Rightarrow K_p = 3K_n$

$V_{tn} = 0.7V,\ V_{tp} = -0.75,\ V_{DD} = 2.5V$



Equating the drain currents we have

$I_n = I_p$

$K_n\left(\frac{W}{L}\right)_n (V_{gsn} - V_{tn})^2 = K_p\left(\frac{W}{L}\right)_n (V_{gsp} - V_{tp})^2$

$K_n (V_{gsn} - V_{tn})^2 = 3K_n (V_{gsp} - V_{tp})^2$ — ①

$V_{gsn} = V_i \quad V_{gsp} = V_i - V_{DD} \quad V_i = V_o + V_{tn}$

Substituting the above values in ①

we have $V_o = 0.665$

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

5.9) ~~Inverter~~ $K_n = 50\ K_p = 25\ V_{tn} = 0.5\ V_{tp} = -0.6$

$(W/L)_n = 2,\ (W/L)_p = 4.\ I_{DD} = 11\mu A,\ V_{DD} = 2V$

For PMOS $11\mu A = \frac{25\mu A}{2}(4)(V_i - 2 + 0.6)^2$

Solving $V_i = 0.94$

For NMOS $11\mu A = \frac{50\mu A}{2}(2)\left[(0.94 - 0.5)V_{out} - \frac{V_{out}^2}{2}\right]$

$-V_{out}^2 + 0.88 V_{out} - 0.44 = 0$

$V_{out} = -0.35$ or 1.235