Prelab 5

Tuesday, April 7, 2020 7:45 PM

1) i.

$k_n = k_p \qquad \left(\frac{W_n}{L_n}\right) k_n' = \left(\frac{W_p}{L_p}\right) k_p'$

$\text{Inverter}: W_N = 2\mu_m \left(\frac{2}{0.1}\right).432 = \left(\frac{W_p}{0.1}\right)108$

$W_p = 8\mu m$ for invert

$W_{eff} = \frac{W_n}{2} = 2\mu m \qquad \left(\frac{4}{0.1}\right)432 = \left(\frac{W_p}{0.1}\right)108$

$W_n = 4\mu m$

$W_p = 16\mu m$

ii) $V_{DD} = 1.2_v$

$V_{90\%} = 1.08_v \quad V_{10\%} = 0.12 \quad V_{SDSAT} = 1.2 - 0.4 = 0.8_v$

$t_{fall} = \frac{C(V_{90} - V_{10})}{I_{DAvg}} = \frac{60\times10^{-9}(1.08 - 0.12)}{1.7635} = 32.6_{\mu s}$

At $V_{90\%}$, N_{mos} is saturation

$I_{D90\%} = \frac{432}{2} \cdot \left(\frac{2}{0.1}\right) \cdot (1.2 - 0.4)^2 = 2.76_{mA}$

$I_{Davg} = 1.7635_{mA}$

At $V_{10\%}$, N_{mos} is triode

$I_{10\%} = 432\left(\frac{2}{0.1}\right)\left[(1.2 - 0.4)\cdot 0.12 - \frac{0.12^2}{2}\right] = 0.767_{mA}$

$W_{peff} = 8\mu m$

ii) $V_{DD} = 1.2 \quad V_{90\%} = 1.08_v \quad V_{10\%} = 0.12_v$

$t_{rise} = \frac{60\times10^{-9}(1.08 - 0.12)}{1.7635_{mA}} = 32.6_{ns}$

At $V_{90\%}$, P_{mos} is triode

$I_D = 108\times10^{-6} \cdot \left(\frac{8}{0.1}\right)\left[(1.2 - 0.4)\cdot 0.12 - \frac{0.12^2}{2}\right] = 0.767$

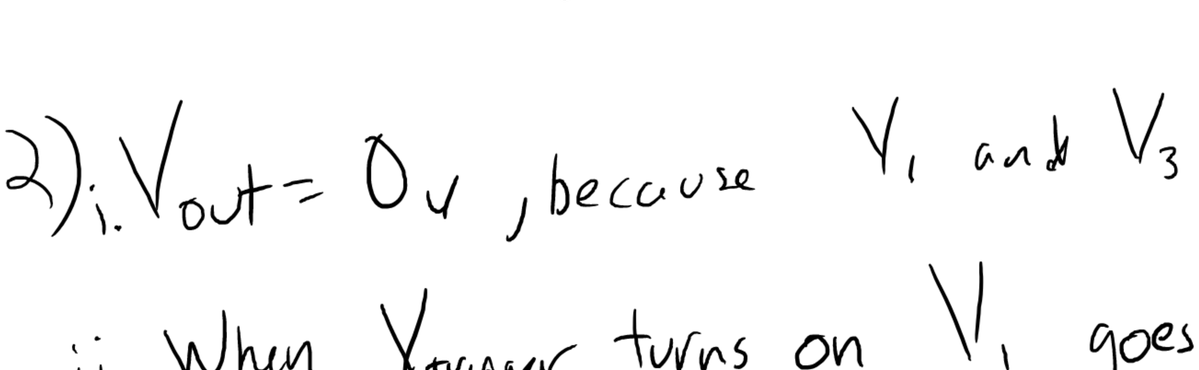
$I_{DAVG} = 1.7635$

At $V_{10\%}$, P_{mos} is saturation

$I_D = \frac{108\times10^{-6}}{2}\left(\frac{8}{0.1}\right)(1.2 - 0.4)^2 = 2.76_{mA}$

2) i. $V_{out} = 0_v$, because V_1 and V_3 are high

ii. When $V_{trigger}$ turns on V_1 goes low because both inputs to NAND#1 are high which makes V_2 go high and then V_3 go high. V_c has a capacitor before it so it decreases



iii. $V_{th} = V_{DD}\left(1 - e^{\frac{-t}{RC}}\right) \Rightarrow V_{th} = V_{DD} - V_{DD}e^{-\frac{t}{RC}}$

$V_{DD} - V_{th} = V_{DD}e^{-\frac{t}{RC}}$

$\frac{V_{DD} - V_{th}}{V_{DD}} = e^{-t/RC}$

$\ln\left(\frac{V_{DD} - V_{th}}{V_{DD}}\right) = -\frac{t}{RC} \Rightarrow RC\ln\left(\frac{V_{DD} - V_{th}}{V_{DD}}\right) = -t$

$t_{pw} = RC\ln\left(\frac{V_{DD}}{V_{DD} - V_{th}}\right)$

$t_{pw} = RC\ln\left(\frac{V_{DD}}{V_{DD} - V_{th}}\right) = 15{,}000 \cdot 22\cdot10^{-9}\ln\left(\frac{5}{5 - 1.75}\right) = 142_{\mu s}$