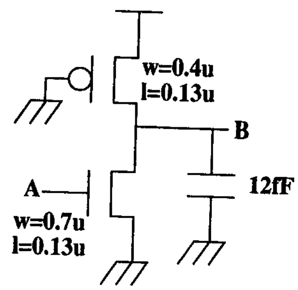
ECE124d/ECE256c

Name: Key

Quiz 4



$V_t = 0.3V = -0.3V(p)$
$k_n = 180uA/V^2$
$k_p = 78uA/V^2$
$Vsat(n) = 0.4V$
$Vsat(p) = 0.6V$
$Vdd = 1.3V$

a. Find the output low (Vol) voltage for the gate above.

Assume < 0.4 V; $V_{SAT}(p)$

$A \leftarrow 1.3V \quad I_{dN} = \frac{k_N \cdot 0.7}{.13}((1.3-.3)\cdot V_{ds} - V_{ds}^2/2) = I_{dp} = \frac{k_p \cdot 0.4}{0.13}((1.3-.3)0.6 - \frac{0.6^2}{2})$

$I_{dp} = 101\mu A \quad \sim 1/1000 \quad = ((1)\cdot V_{ds} - V_{ds}^2/2) = .104V \Rightarrow$ **$V_{ds} \sim .110\ V$**

b. Estimate the rising propagation delay for the inverter assuming the input transition is instantaneous and all output capacitances have been lumped into the linear load shown.

Rising Prop delay $\Rightarrow$ Two point. Init $I_{dp_1} = 101\mu A$

I_{dp_2} = B @ .65 V $\Rightarrow$ same current.

$I_{avg} = 101\mu A \quad \tau = \frac{C \cdot \Delta V}{I_{av}} = \frac{12fF \cdot 0.65V}{101\mu A}$

$\cong 77pS$

c. Estimate the falling propagation delay. Hint -- Do not ignore the pull-up device!

Falling Prop delay:

$I_{dN_1} = \frac{K_n \cdot 0.7}{.13}((1).4V - \frac{.4^2}{2}) = 310\mu A$

$I_{dN_2} = I_{dN_1} - I_{dp_1} = 310 - 101 = 209\mu A$

$\cong 35pS$