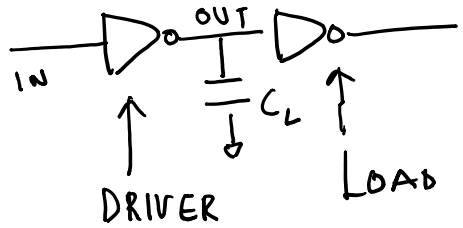
Optimal choice of NFET/PFET ratio (slides 38 - 40)

Saturday, September 26, 2015 8:44 PM



ASSUME :- Load size = Driver size

That is, $(W/L)_{LOAD} = (W/L)_{DRIVER}$ for both PFET/NFET.

Lets say $(W_p/W_n) = \alpha$ for both LOAD & DRIVER.

Ques :- What should 'α' be for minimum delay?

$$C_L = (1+\alpha)\, C_{FET-n} + C_w + (1+\alpha)\, C_{gn}$$

Parasitic → gate capacitance

$$t_d = 0.5\, \frac{C_L V_{DD}}{(V_{DD}-V_T)^2} \left(\frac{1}{\beta_n} + \frac{1}{\beta_p}\right) \qquad V_{Tn} = |V_{Tp}| = V_T$$

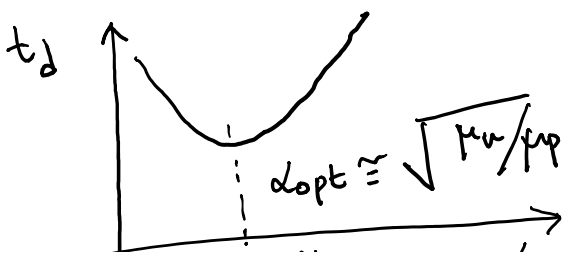
For $C_L = (1+\alpha)\, C_{FET-n} + C_w + (1+\alpha)\, C_{gn}$

we see that t_d is a non-monotonic function of 'α'.

∴ For minimum delay, one must solve

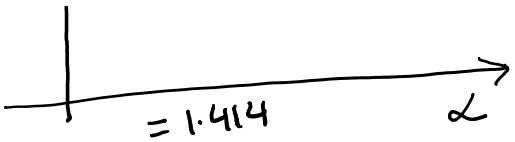
$$\frac{\partial t_d}{\partial \alpha} = 0 \Rightarrow \boxed{\alpha_{opt} = \sqrt{\frac{\mu_n}{\mu_p}} \sqrt{1 + \frac{C_w}{C_{FETn} + C_{gn}}}}$$

Final Answer



$\mu_n > \mu_p$

Typically $\mu_n = 2\mu_p$



For $\frac{\mu_n}{\mu_p} = 2.0$

Typically $\mu_n = 2\mu_p$

So $\alpha_{opt} \approx 1.414$