Quiz #3 **EEC116** **Fall 2011**

Name: Solutions Lab Section:________

Problem 1 (3 points) Suppose a 1μm wide wire in Metal 1 (M1) has resistance per unit length r = 100mΩ/mm and capacitance per unit length c = 100pF/mm while a 1μm wide wire in Metal 2 (M2) has resistance per unit length r = 80mΩ/mm and capacitance per unit length c = 120pF/mm. Using the Elmore delay approximation, what is the delay for the fastest of the two wires assuming length L=1.3mm?

$\tau_D = \frac{rcL^2}{2}$ (1pt.)

$rc\,(M1) = 10{,}000\ m\Omega\cdot pF/mm^2$

$rc\,(M2) = 9600\ m\Omega\cdot pF/mm^2$

M2 fastest (1pt.)

$\tau_D(M2) = \frac{9.6\times10^3\,(1.3)^2}{2} = \boxed{8.112\,ps}$ (1pt.)

Problem 2 (2 points) Using the Elmore delay approximation, what is the maximum length of a 1μm wide wire in Metal 1 (M1) such that its delay is less than 25ps?

$\frac{rcL^2}{2} \le 25ps \Rightarrow L \le \sqrt{\frac{2(25ps)}{(100m\Omega/mm)(100pF/mm)}} = \boxed{2.24\,mm}$

(1pt.) (1pt.)

Problem 3 (5 points) For the inverter buffer chain below, assume the optimal fanout factor is f = 4.4 and a minimum size inverter has W_n = 0.45μm and W_p = 1.35μm. How many stages N are required for a minimum delay through the chain and what are the transistor widths for the final inverter in the chain?

N = $\boxed{5 \text{ or } 6}$

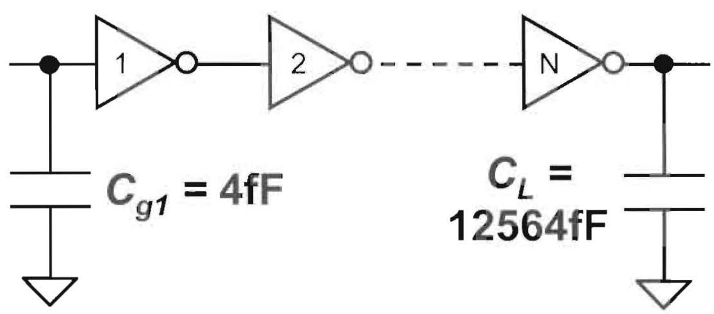
W_n (Nth inverter) = $\boxed{168.7 \text{ or } 742\ \mu m}$

W_p (Nth inverter) = $\boxed{506\ \mu m \text{ or } 2226\ \mu m}$

$F = \frac{C_L}{C_{g1}} = 3141,\quad f^N = F$ (2pt.)

$N = \frac{\ln(F)}{\ln(f)} = \frac{\ln(3141)}{\ln(4.4)}$ (1pt.)

$= 5.43$



for N=5: $W_n = (0.45\mu m)(4.4)^{(5-1)} = 168.7\mu m$

$W_p = (1.35\mu m)(4.4)^{(5-1)} = 506\ \mu m$ (1pt.)

for N=6: $W_n = (0.45\mu m)(4.4)^{(6-1)} = 742\mu m$

$W_p = (1.35\mu m)(4.4)^{(6-1)} = 2226\mu m$ (1pt.)