

University of New Mexico

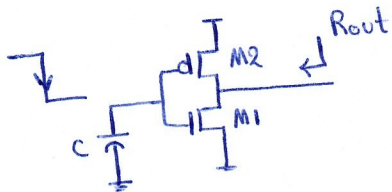
Department of Electrical and Computer Engineering

ECE321-Electronics I (Fall 2012)

Homework Solution # 10

Based on hint:

1. Connecting a load of 100pf to the gate



$$I_{av} = \frac{1}{2} [I_{ds}(V_{out}=0) + I_{ds}(V_{out} = \frac{V_{dd}}{2})]$$

2. Calculating the LH propagation delay

$$V_{out}=0 \quad I_{ds} = \frac{k'_p}{2} \left(\frac{W}{L} \right)_p [V_{gs} - |V_{tp}|^2] (1 + \lambda V_{ds}) = 802 \mu A \quad \Rightarrow I_{av} = 678.5 \mu A$$

$$V_{out} = \frac{V_{dd}}{2} \quad I_{ds} = \frac{k'_p}{2} \left(\frac{W}{L} \right)_p \left[2(V_{gs} - |V_{tp}|) \frac{V_{dd}}{2} - \frac{V_{dd}^2}{4} \right] = 555 \mu A$$

$$t_{pd} = \frac{C_L \frac{V_{dd}}{2}}{I_{av}} = \frac{(100 \text{ pF}) \left(\frac{1.5}{2} \text{ V} \right)}{678.5 \mu A} = 11.05 \text{ ns}$$

3. Equating propagation delay to a simple RC network

$$t_{pLH} = 0.7 R_{OH} C_L \rightarrow R_{OH} = \frac{t_{pLH}}{0.7 C_L} = \frac{11.05 \text{ ns}}{0.7 (100 \text{ pF})} \rightarrow R_{OH} = 1571 \Omega$$

Based on Elmore technique:

$$\begin{aligned} \tau &= (1.579 \text{ k}\Omega + 120 \Omega) 75 \text{ fF} \\ &+ (1.579 \text{ k}\Omega + 120 \Omega) (15 \text{ fF} + 45 \text{ fF} + 50 \text{ fF}) \\ &+ (1.579 \text{ k}\Omega + 120 \Omega + 165 \Omega) 100 \text{ fF} \\ &+ (1.579 \text{ k}\Omega + 120 \Omega + 165 \Omega) 95 \text{ fF} \\ &+ (1.579 \text{ k}\Omega + 120 \Omega + 165 \Omega + 105 \Omega) 65 \text{ fF} \\ &+ (1.579 \text{ k}\Omega + 120 \Omega + 165 \Omega + 105 \Omega + 220 \Omega) 200 \text{ fF} \end{aligned}$$

$$\begin{aligned} \tau &= 1.24 \text{ ns} \\ t_{pLH} &= 0.7 \tau = 0.7 * 1.24 \text{ ns} = 871 \text{ ps} \end{aligned}$$