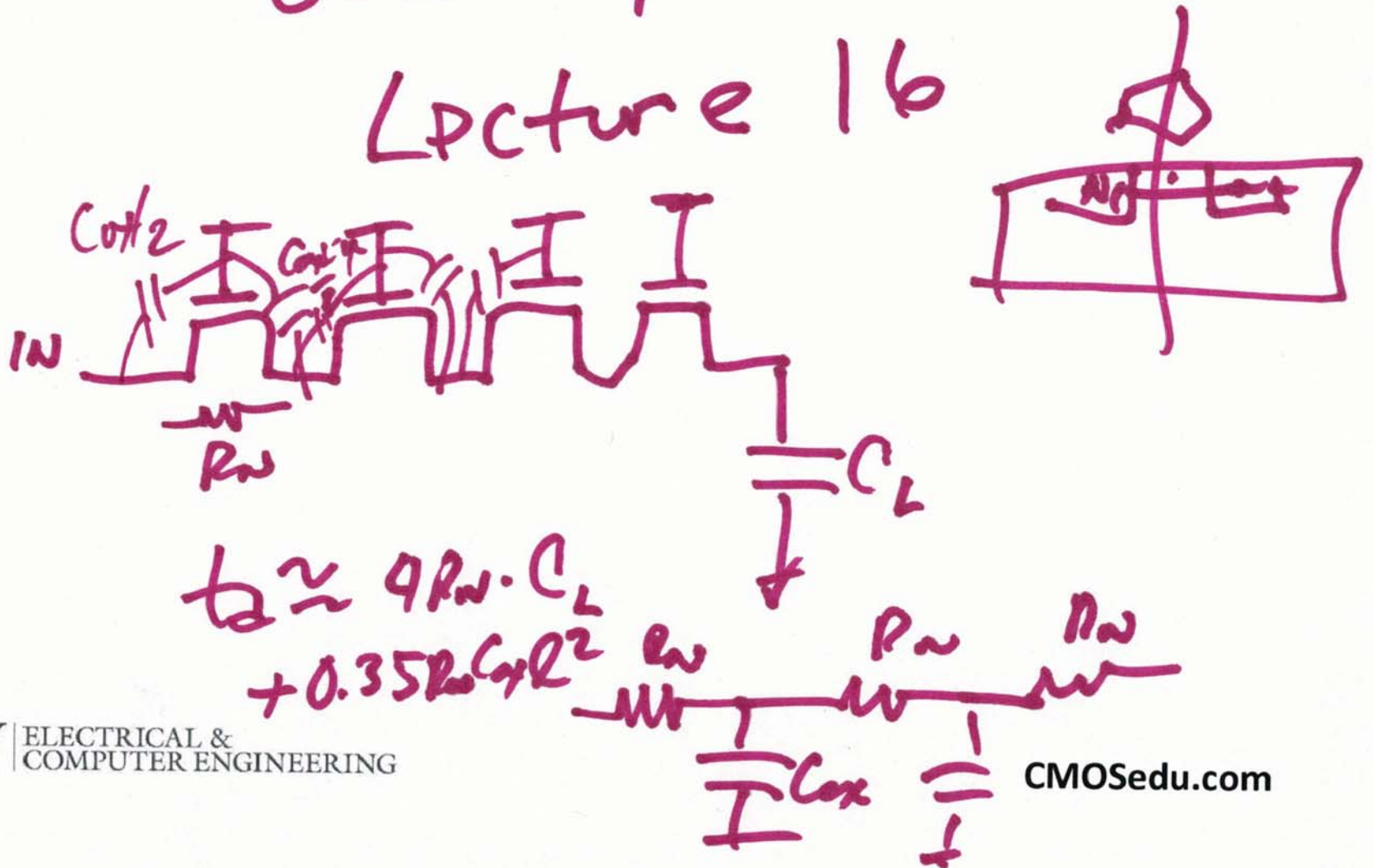


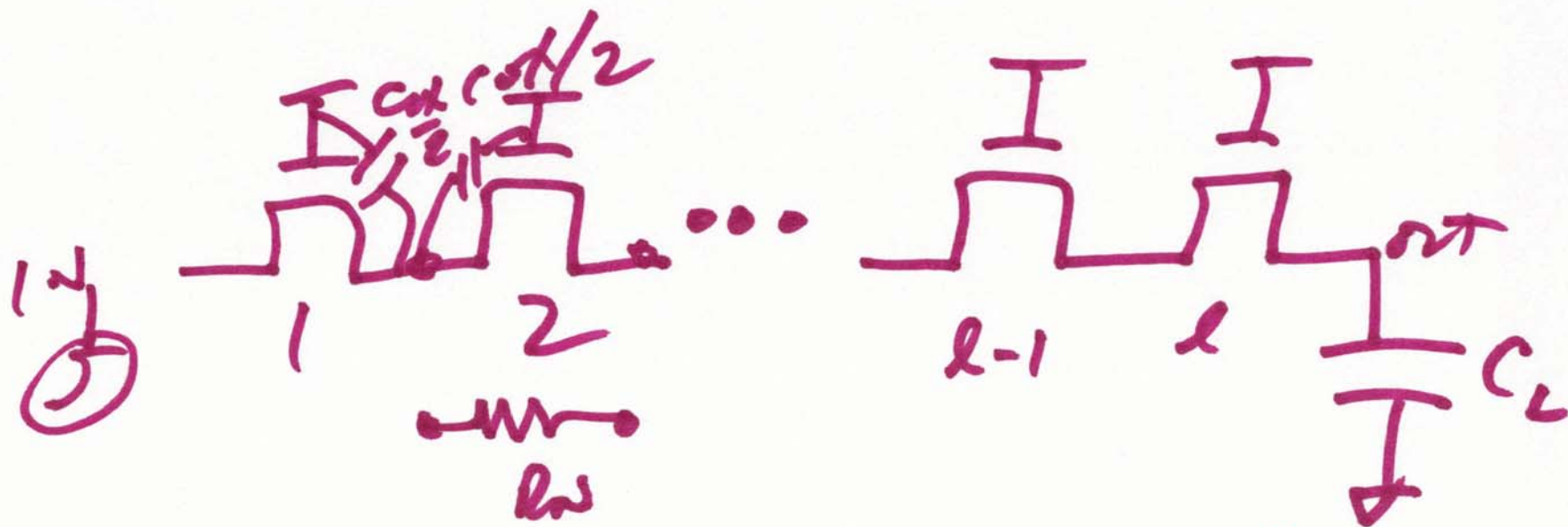
EE 421 / ECG 621

Digital IC Design

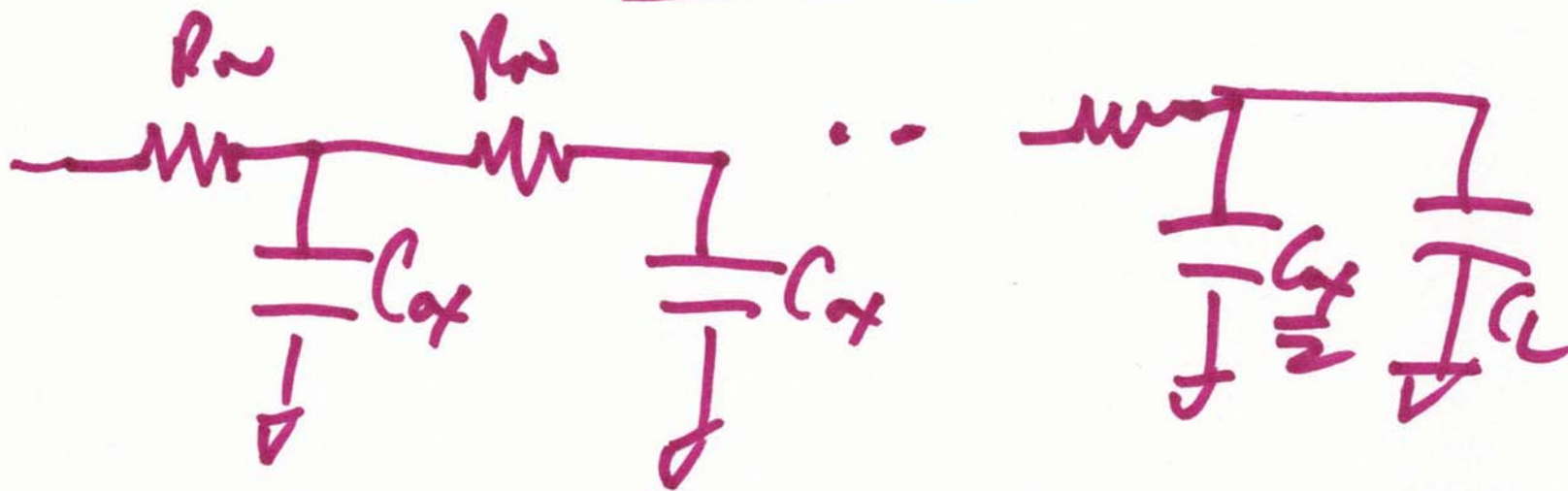
OCT. 21, 2015

Lecture 16

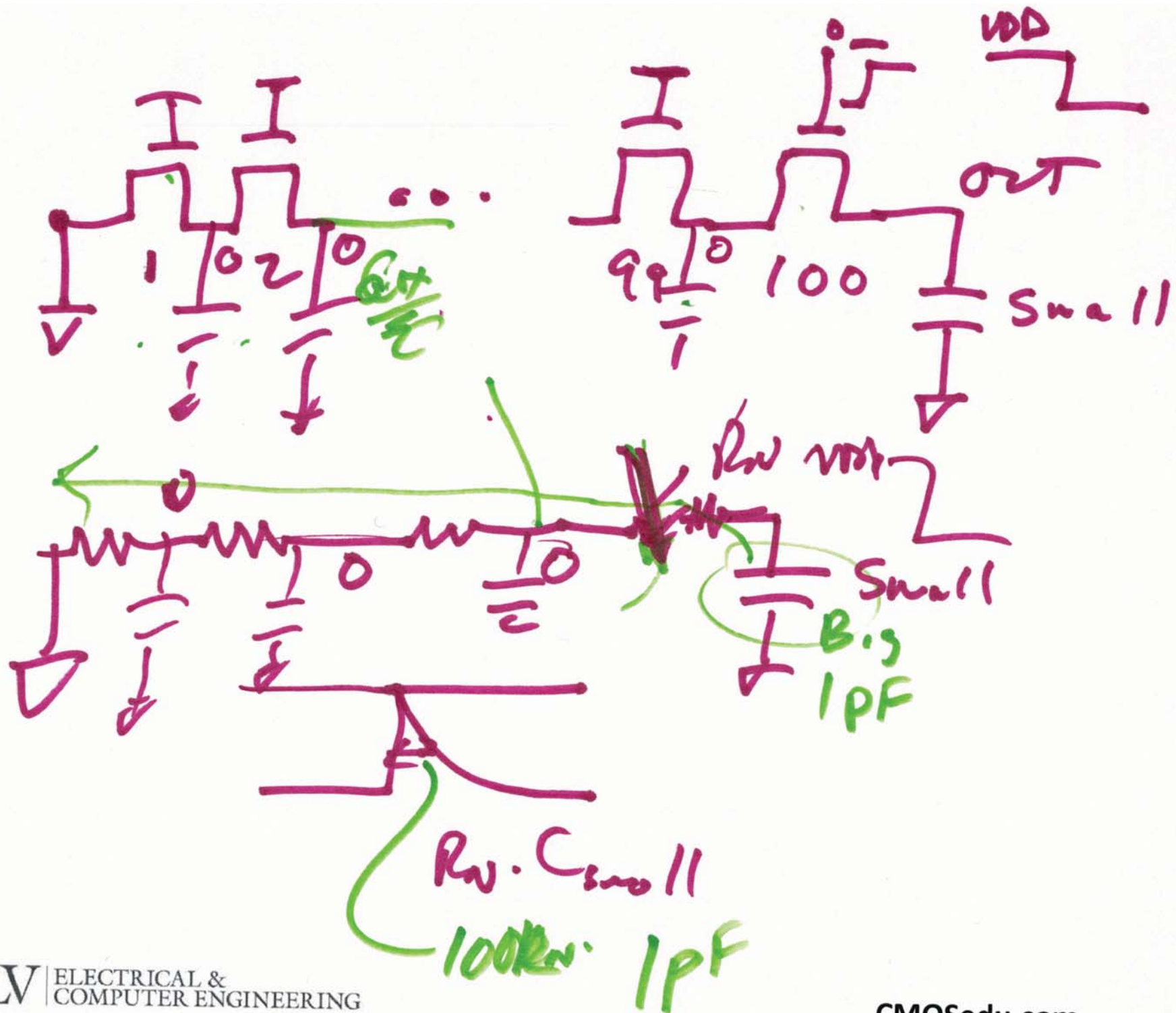




→  $t_d = l \cdot R_w \cdot C_L + \underbrace{0.35 \cdot R_w C_{ox}}_{\text{}} l^2$

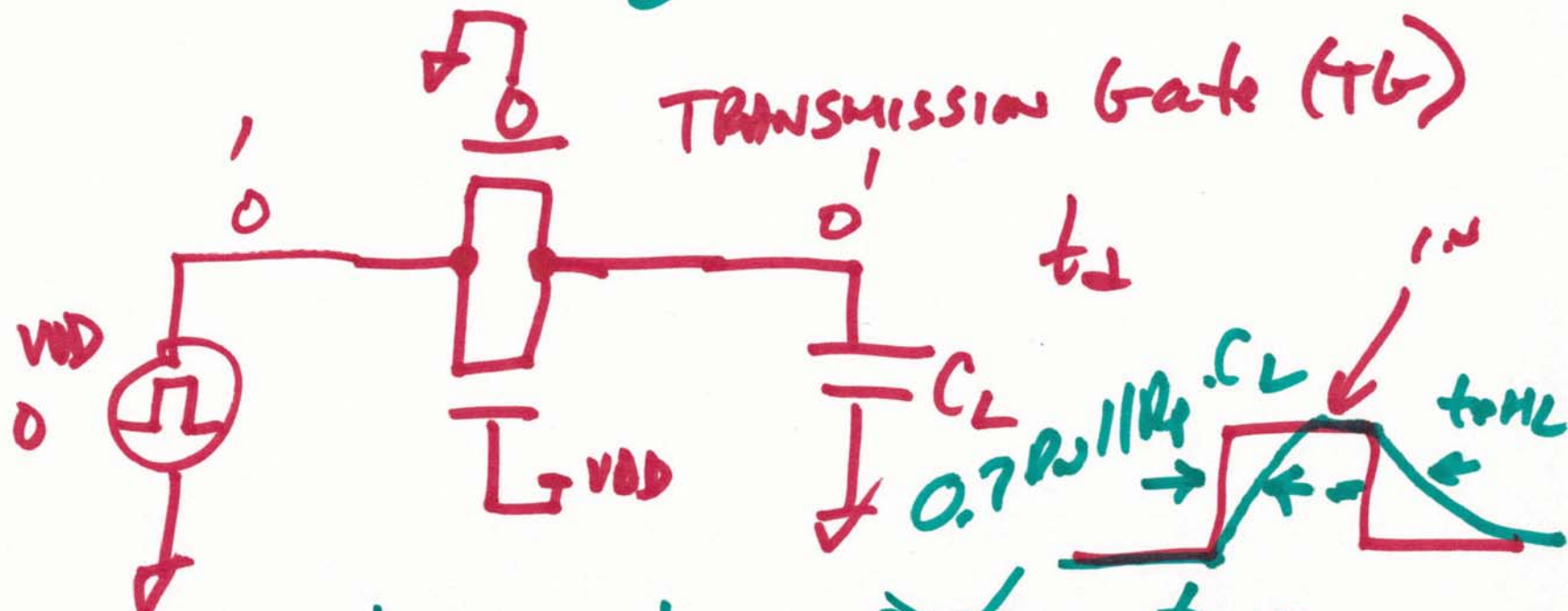
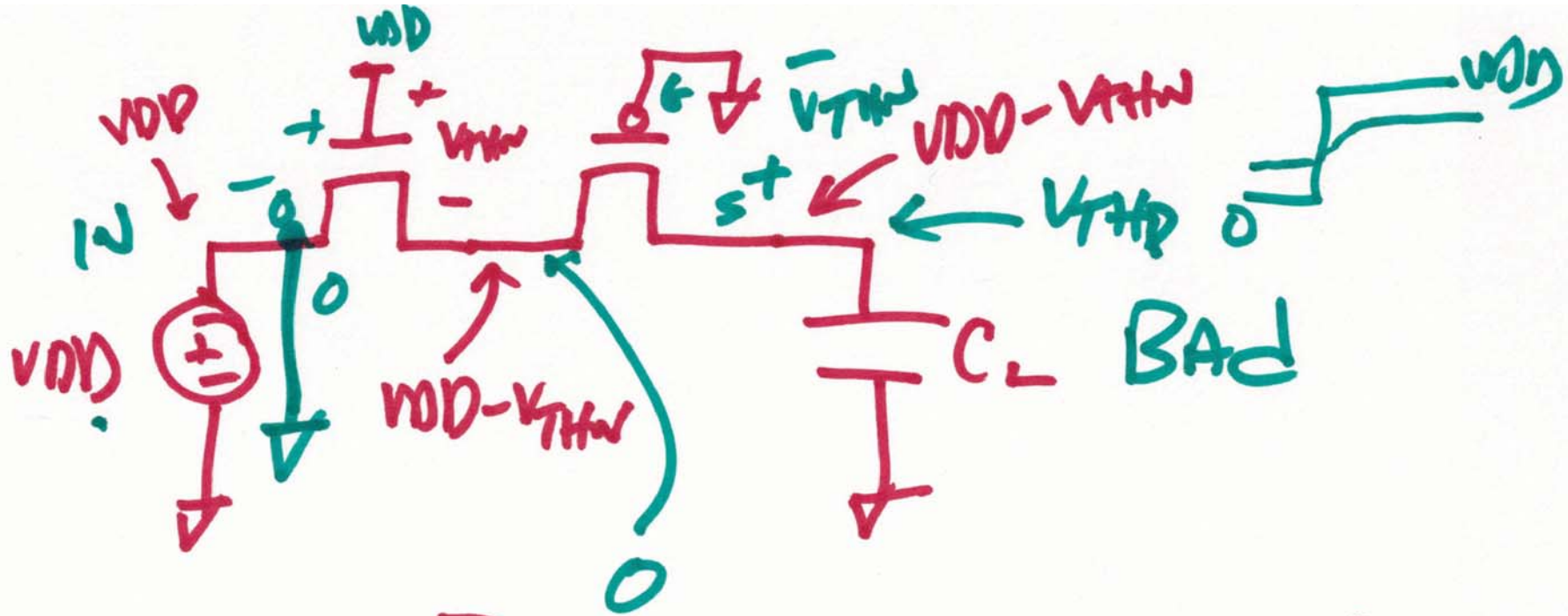


2)



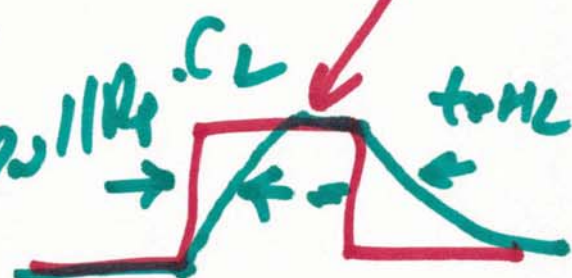
3)



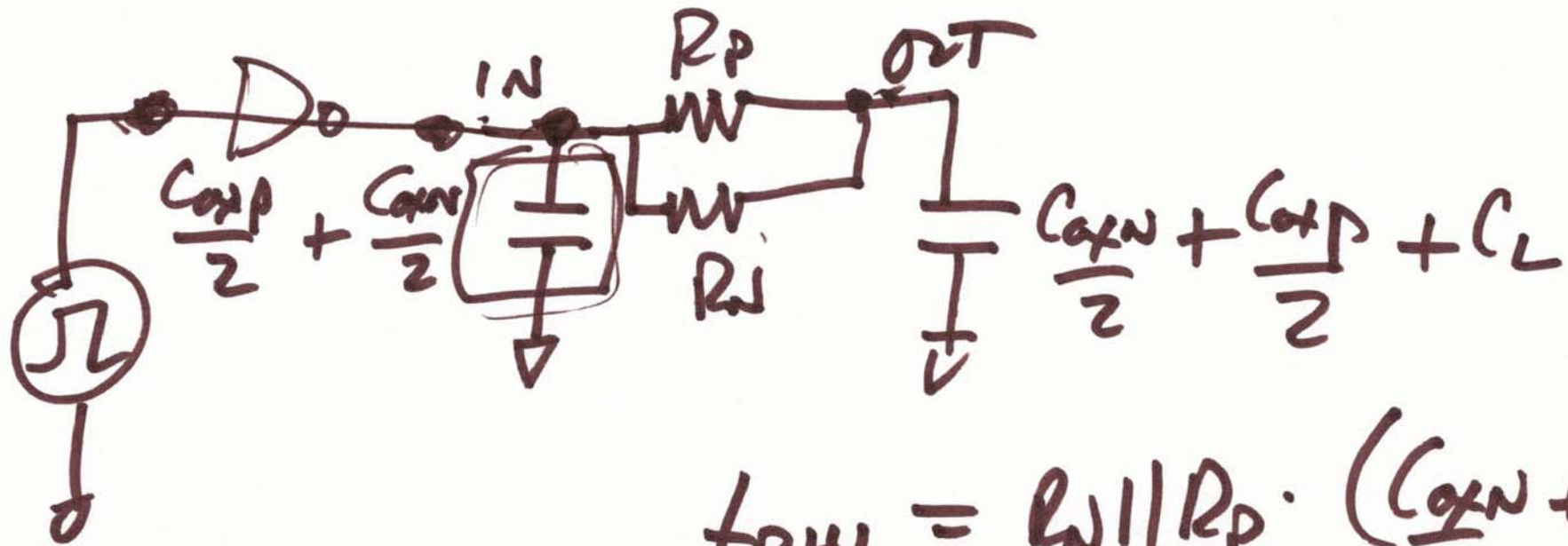
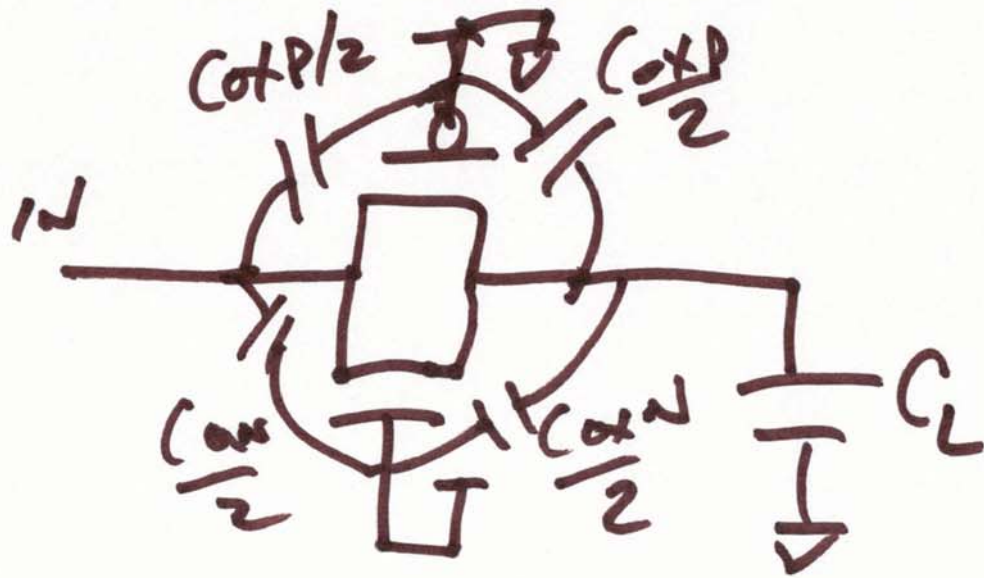


$$t_{pHL} = t_{pLH} = \frac{R_{eq} \cdot C_L}{2}$$

$$C_L \gg C_x$$



4)



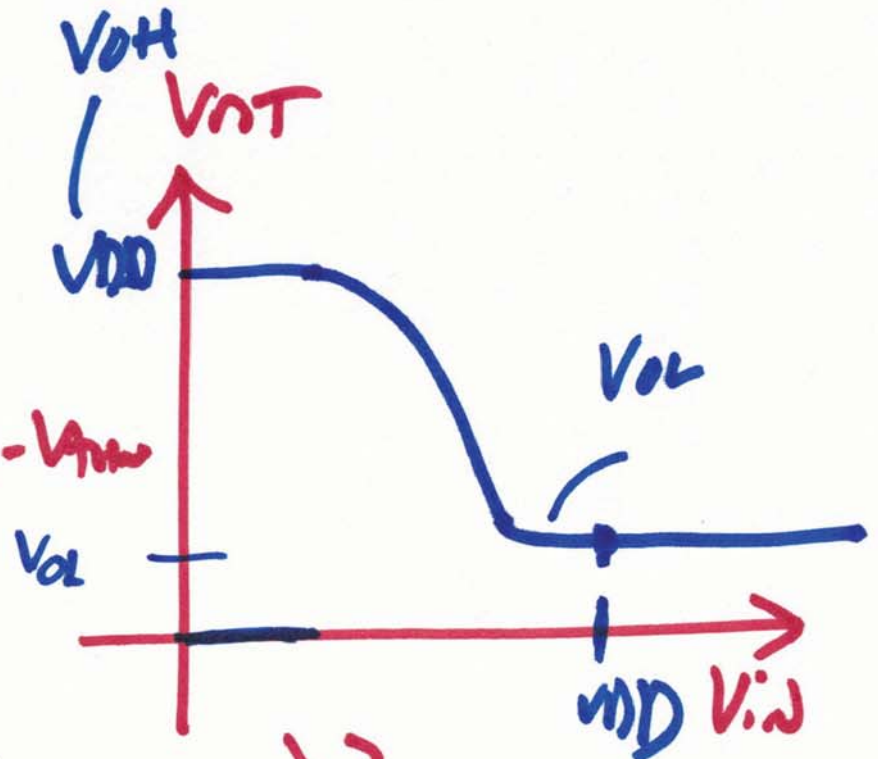
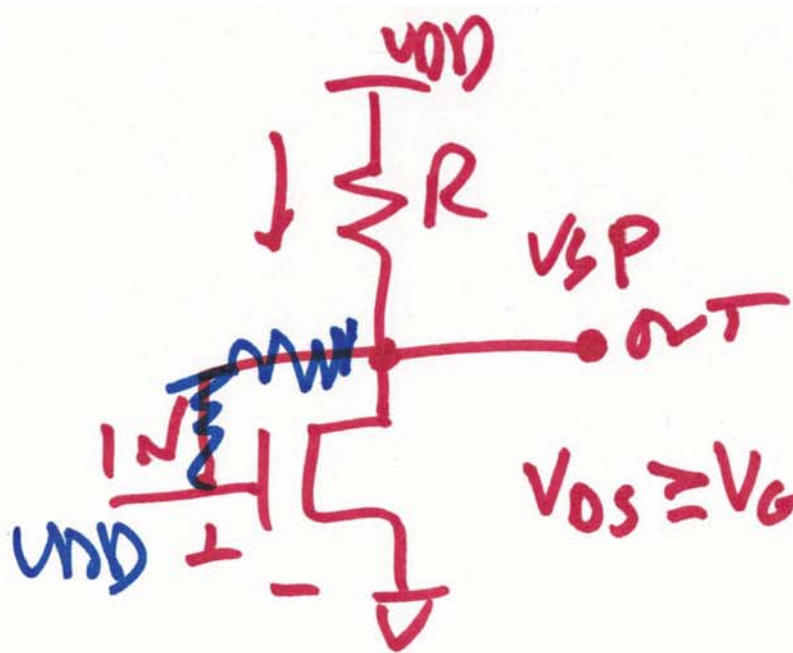
$$t_{PHL} = R_{N||P} \cdot \left( \frac{C_{oxN}}{2} + \frac{C_{oxP}}{2} + C_L \right)$$

PLH

5)

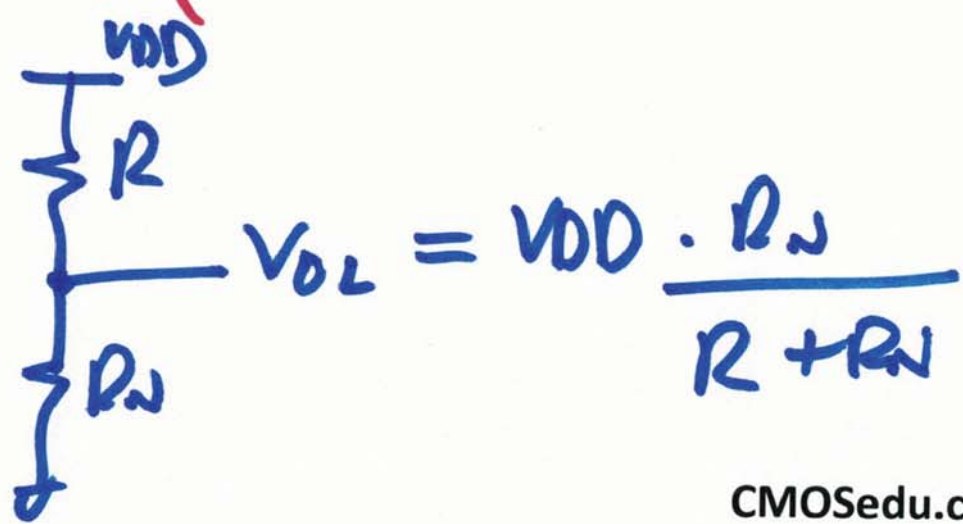






$$V_{DS} \geq V_{GS} - V_{THN}$$

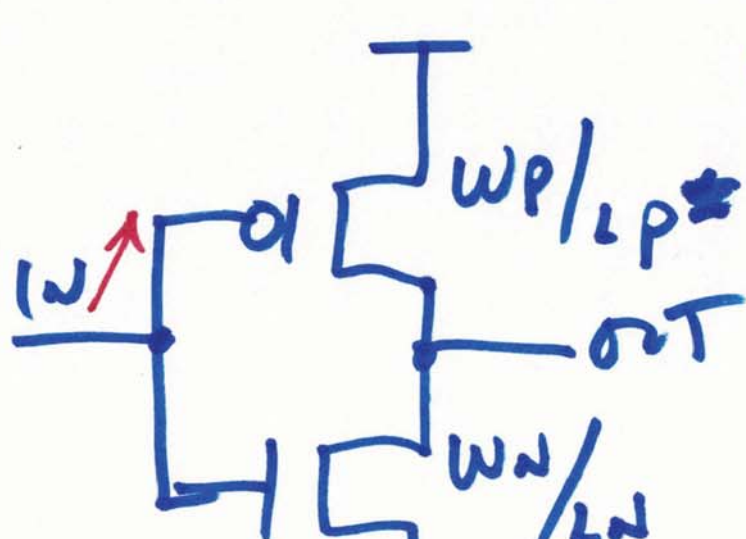
$$\frac{V_{DD} - V_{SP}}{R} = \frac{\mu_n \cdot C_{ox}}{2} \cdot \frac{W}{L} (V_{SP} - V_{THN})^2$$



$$V_{OL} = V_{DD} \cdot \frac{R_N}{R + R_N}$$

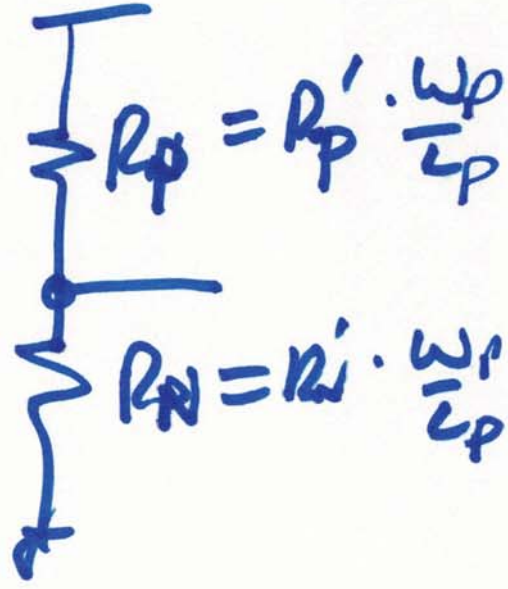
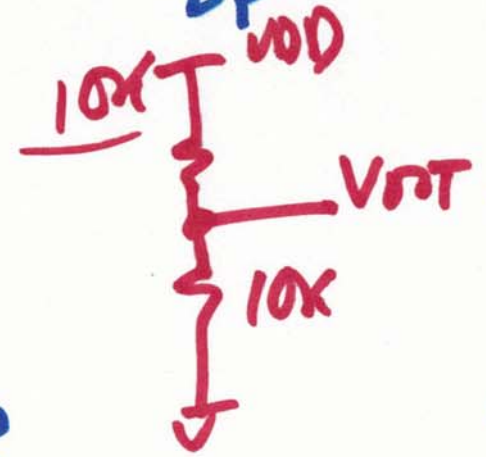
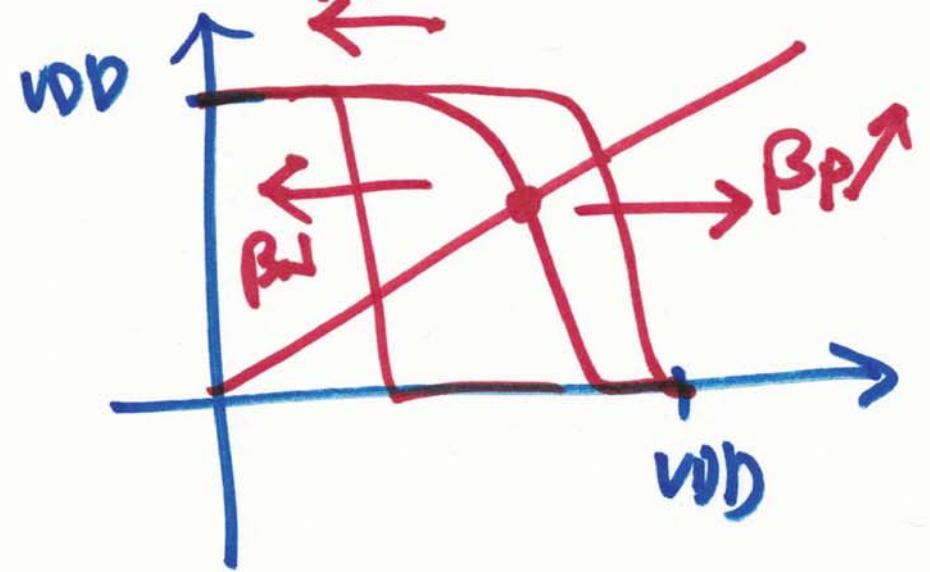






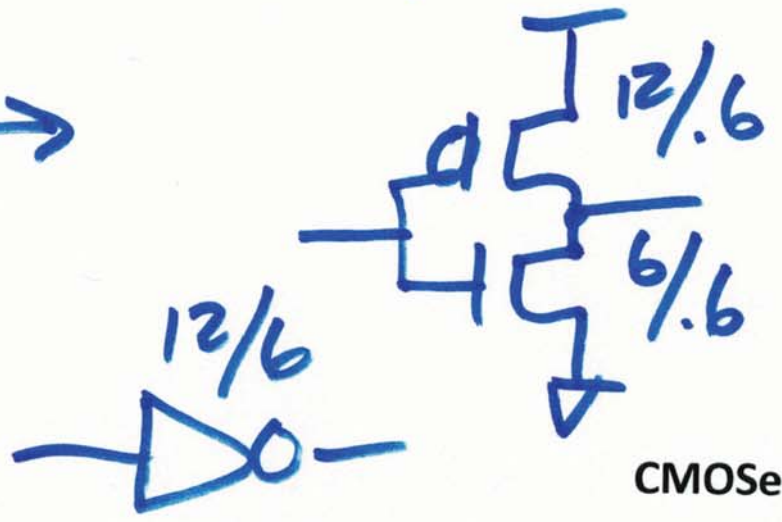
$$\beta_P = K_{PP} \cdot \frac{W_P}{L_P}$$

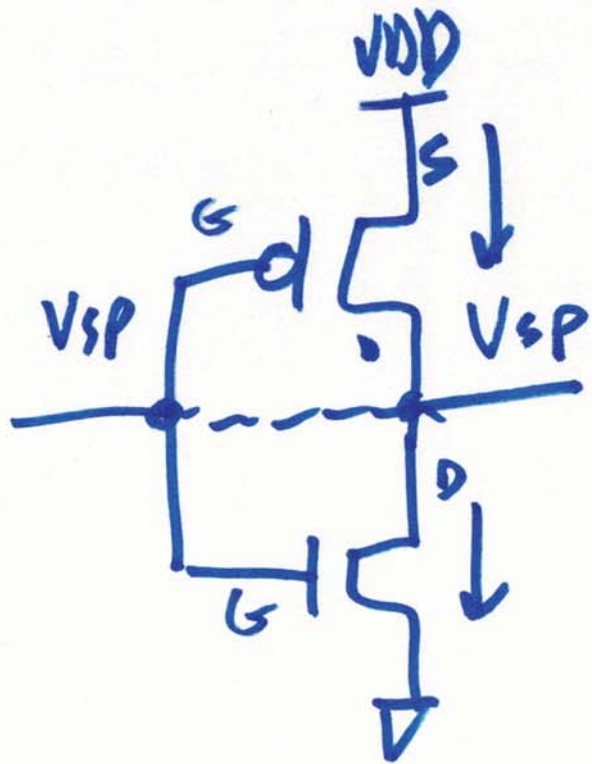
$$\beta_N = K_{PN} \cdot \frac{W_N}{L_N}$$



$$R'_N = 20k$$

$$R'_P = 40k$$





$$V_{SP} = ?$$

$$\frac{\beta_N}{2} (V_{SP} - V_{THN})^2 =$$

$$\frac{\beta_P}{2} (V_{DD} - V_{SP} - V_{THP})^2$$

$$\sqrt{\frac{\beta_N}{\beta_P}} \cdot V_{SP} - \sqrt{\frac{\beta_N}{\beta_P}} \cdot V_{THN} = V_{DD} - V_{SP} - V_{THP}$$

$$V_{SP} \left( 1 + \sqrt{\frac{\beta_N}{\beta_P}} \right) = V_{DD} - V_{THP} + \sqrt{\frac{\beta_N}{\beta_P}} \cdot V_{THN}$$

$$V_{SP} = \frac{V_{DD} - V_{THP} + \sqrt{\frac{\beta_N}{\beta_P}} \cdot V_{THN}}{1 + \sqrt{\frac{\beta_N}{\beta_P}}}$$

$$\beta_N = \beta_P \quad V_{THN} = V_{THP} \quad V_{SP} = \frac{V_{DD}}{2}$$

$$2 \frac{W_N}{L_N} = \frac{W_P}{L_P}$$

$$2 \cdot \frac{6\mu}{.6\mu} = \frac{12\mu}{.6\mu}$$

