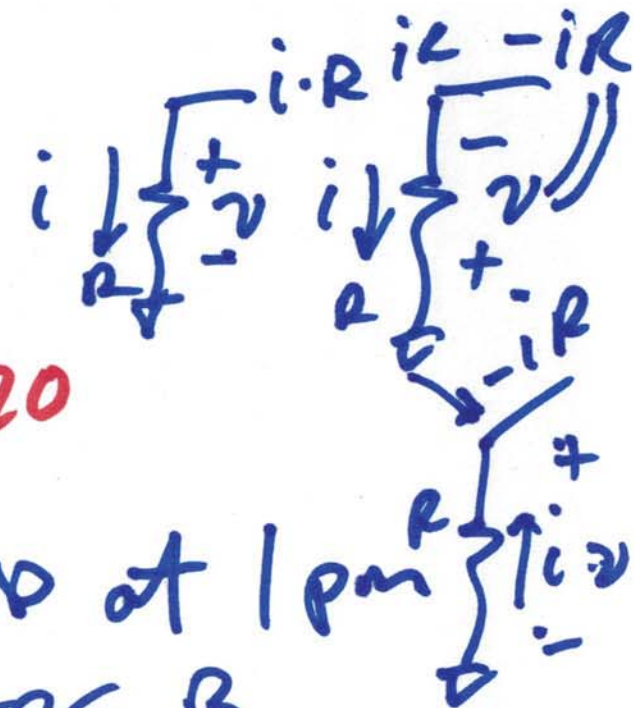
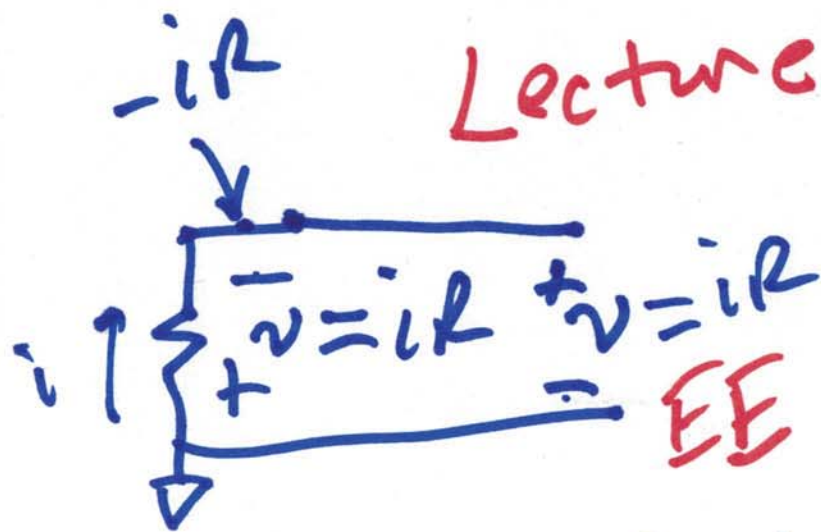


# Lecture 8

2/11/2016

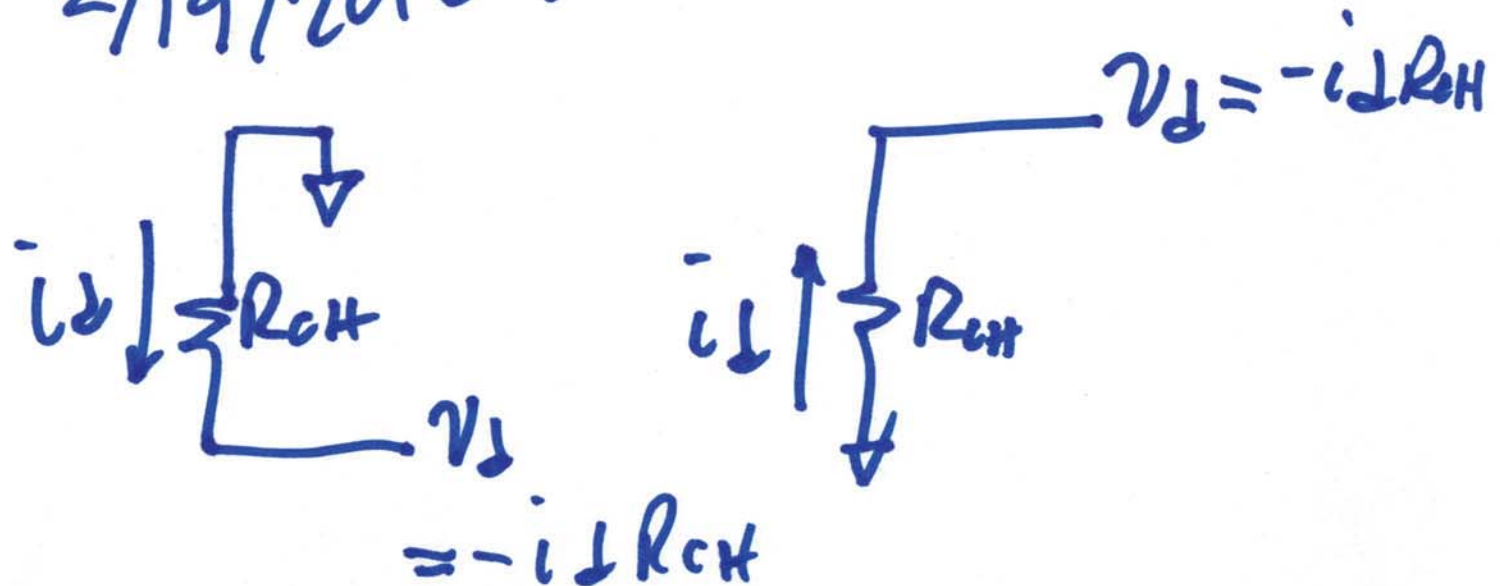
EE 420/ELG-620

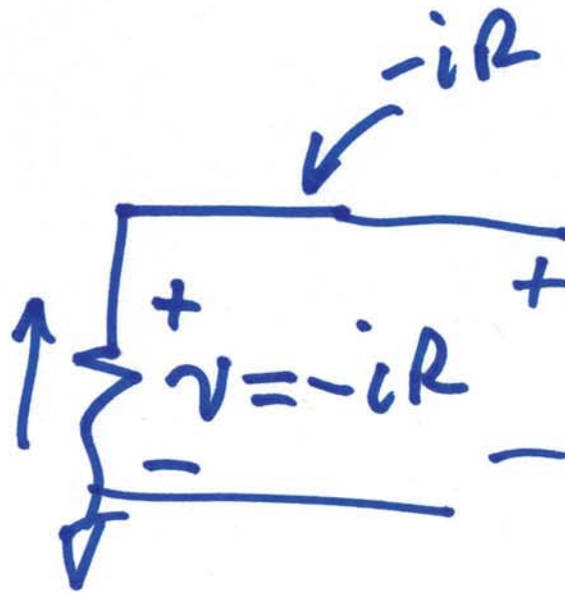
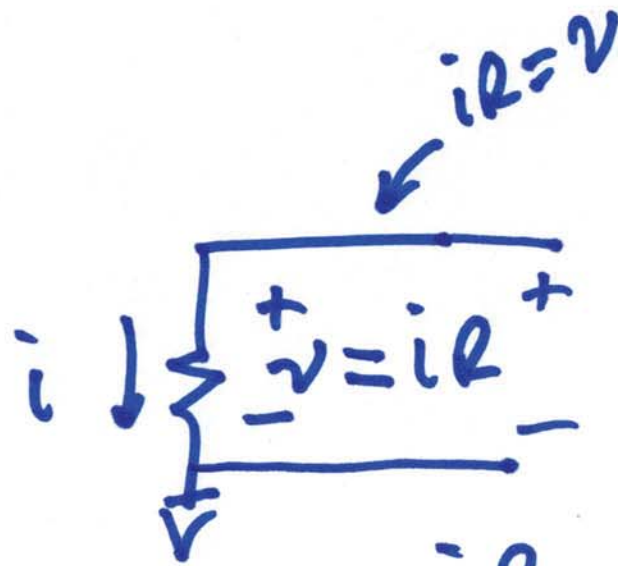


2/12/2016 - make  $v_D$  at 1 pm

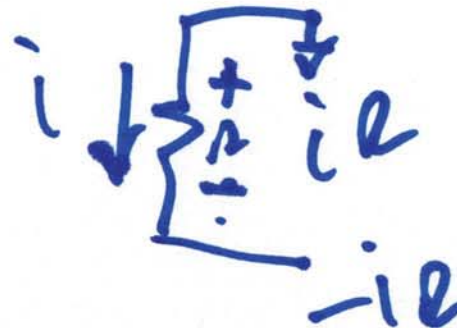
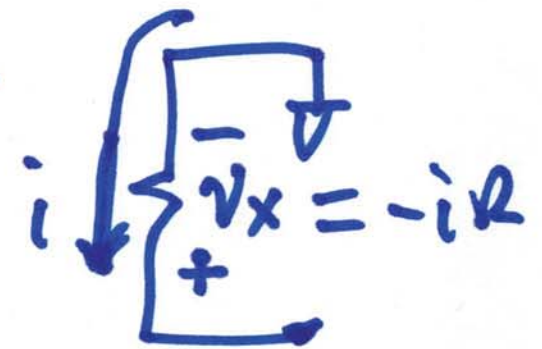
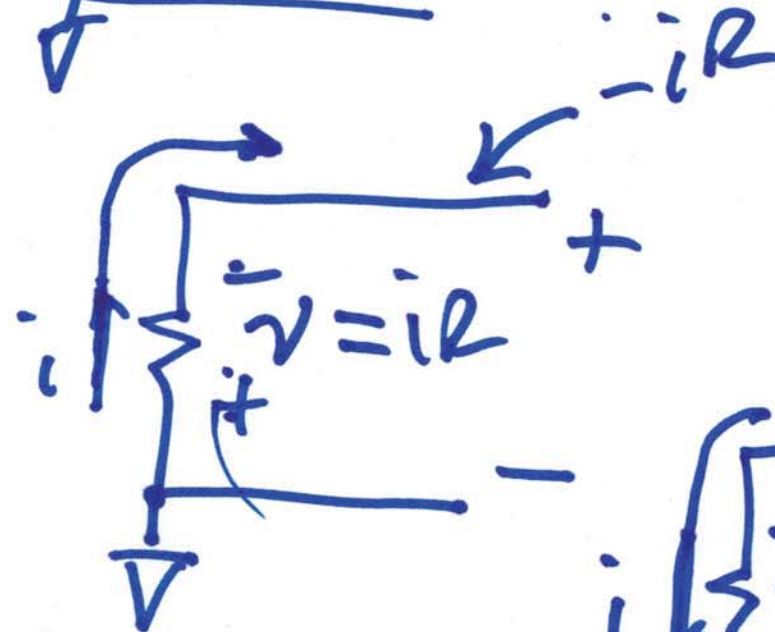
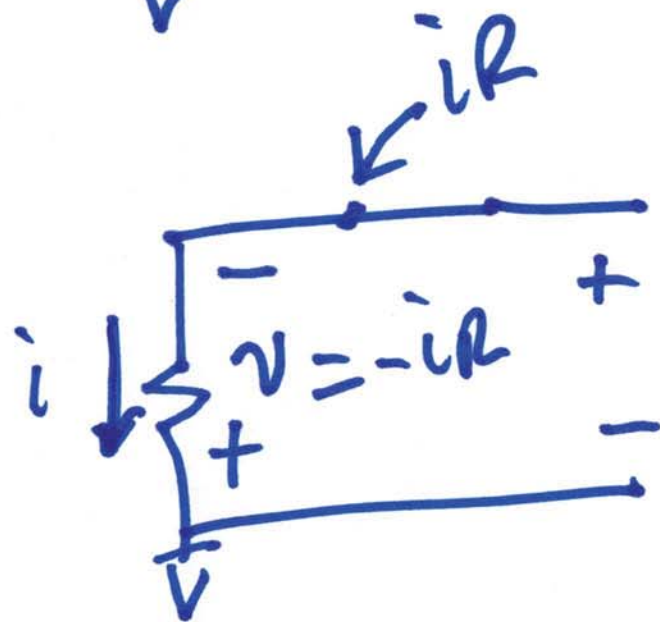
2/19/2016 →

TBE B





$$1 = \frac{1}{1} = \frac{xy}{xy} = \frac{-1}{-1}$$



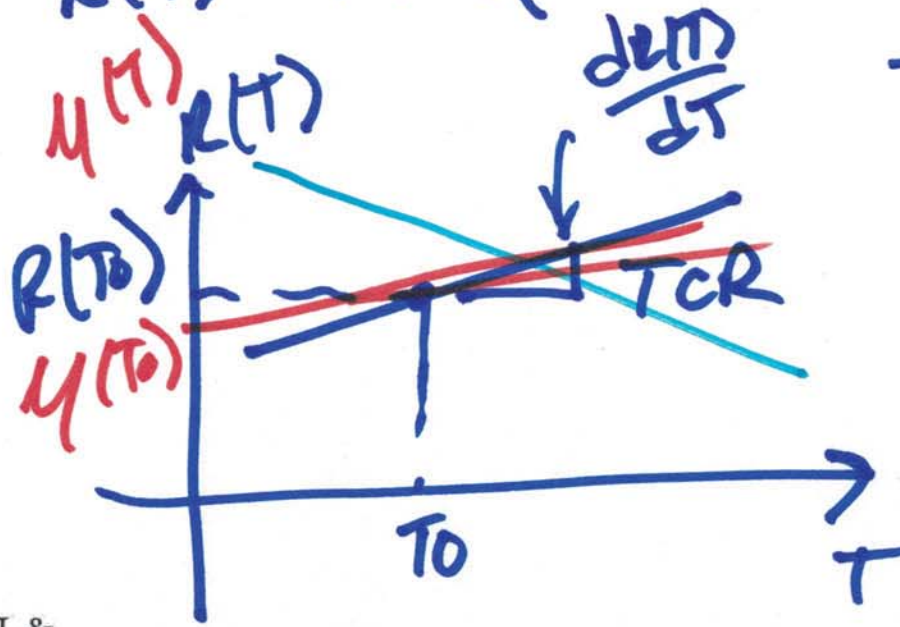
$$K_P(T) = K_P(T_0) \left( \frac{T_0}{T} \right)^{1.5}$$



$$\mu_n(T) = \mu_n(T_0) \left( \frac{T}{T_0} \right)^{-1.5} \quad K_{Pn} = \mu_n \cdot C_{ox}$$

$$K_{Pn} = \mu_n \cdot C_{ox}$$

$$R(T) = R(T_0) (1 + TCR(T - T_0))$$

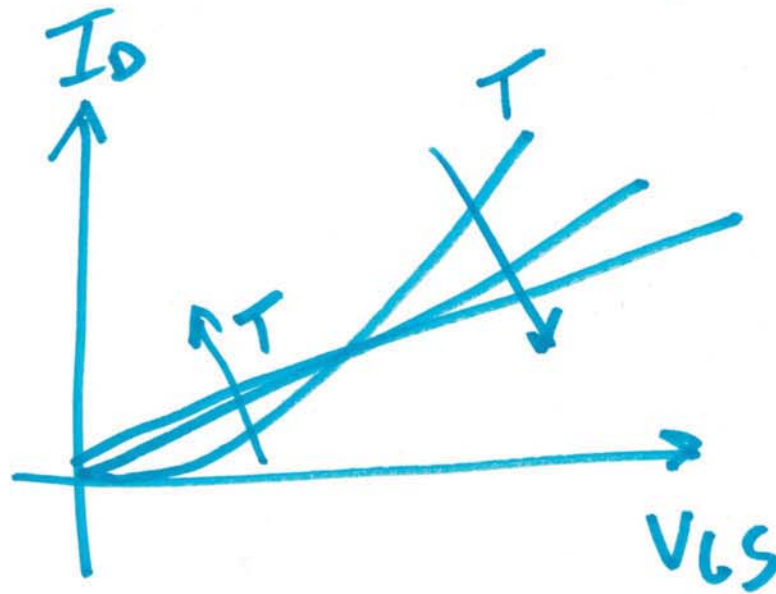


$$TCR = \frac{1}{R(T_0)} \frac{\delta R(T)}{\delta T}$$

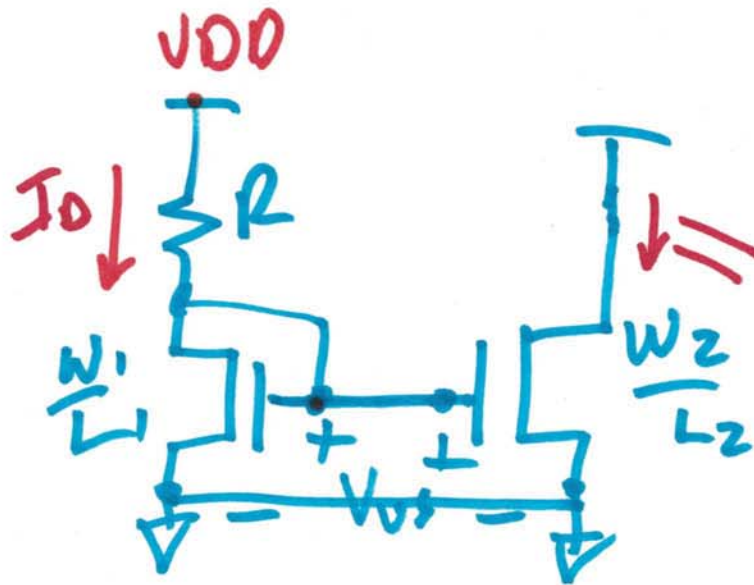
$$TC_{K_P} = \frac{1}{K_P(T_0)} \frac{\delta K}{\delta T}$$



$$I_D = \frac{K_P}{2} \cdot \frac{W}{L} \left( \underbrace{V_{GS}}_{2V} - \underbrace{V_{THN}}_{T \uparrow V_{THN} \downarrow} \right)^2$$



# CURRENT MIRROR



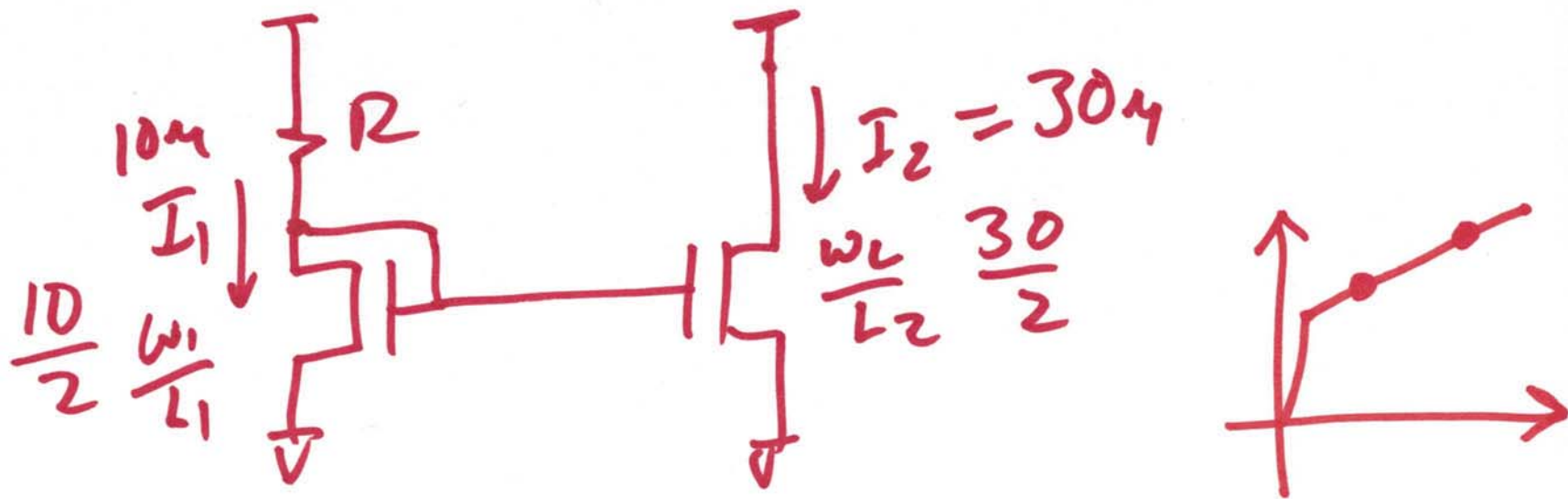
$$\frac{VDD - V_{gs}}{R} = \frac{KP W_1}{2 L_1} (V_{gs} - V_{THN})^2$$

$$\frac{KP W_2}{2 L_2} (V_{gs} - V_{THN})^2 = \frac{VDD - V_{gs}}{R}$$

$$\frac{VDD - V_{gs}}{R} = \frac{KP W_1}{2 L_1} (V_{gs}^2 - 2V_{gs}V_{THN} + V_{THN}^2)$$

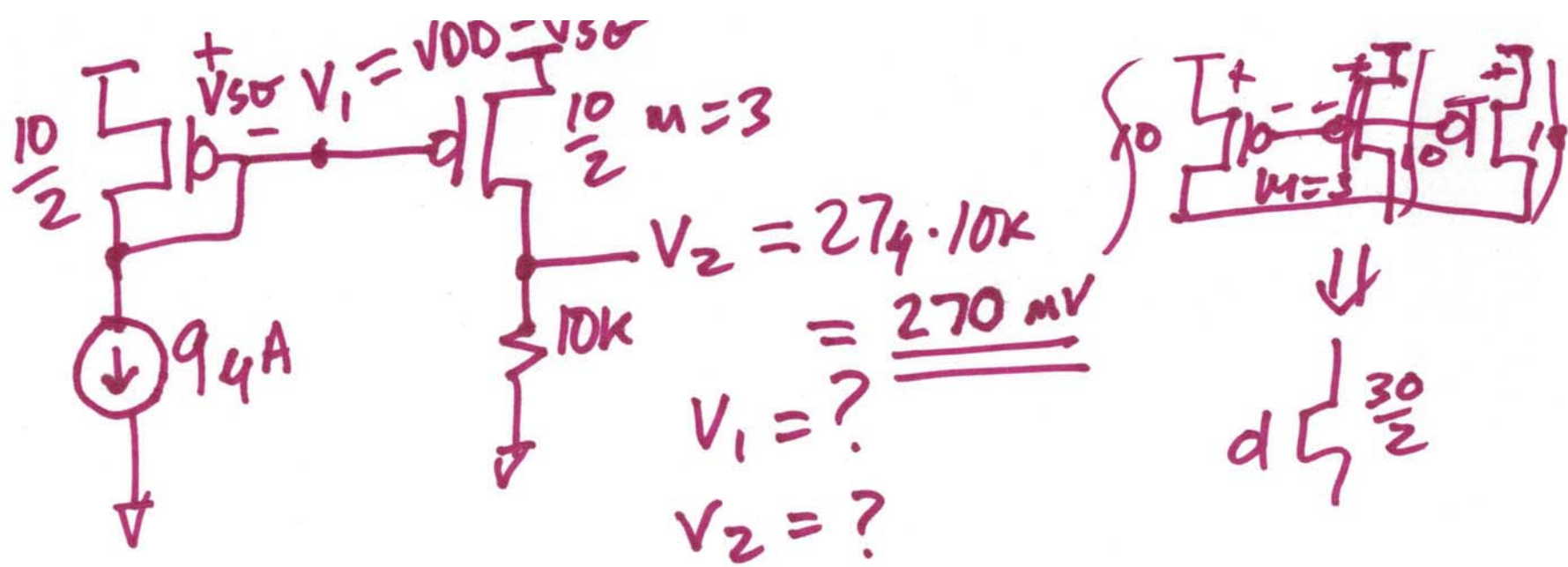
$$\sqrt{\left( \frac{VDD - V_{gs}}{R} \right) \left( \frac{2 L_1}{KP W_1} \right)} = V_{gs} - V_{THN}$$

bad!



$$\frac{I_1}{I_2} = \frac{\frac{K_P}{2} \frac{W_1}{L_1} (V_{GS} - V_{THN})^2}{\frac{K_P}{2} \frac{W_2}{L_2} (V_{GS} - V_{THN})^2} = \frac{W_1 \cdot L_2}{L_1 \cdot W_2}$$

if  $L_1 = L_2$   
 $= \frac{W_1}{W_2}$



$$94A = \frac{40 \mu A/V^2}{2} \cdot \frac{10}{2} (V_{SG} - 0.9)^2$$

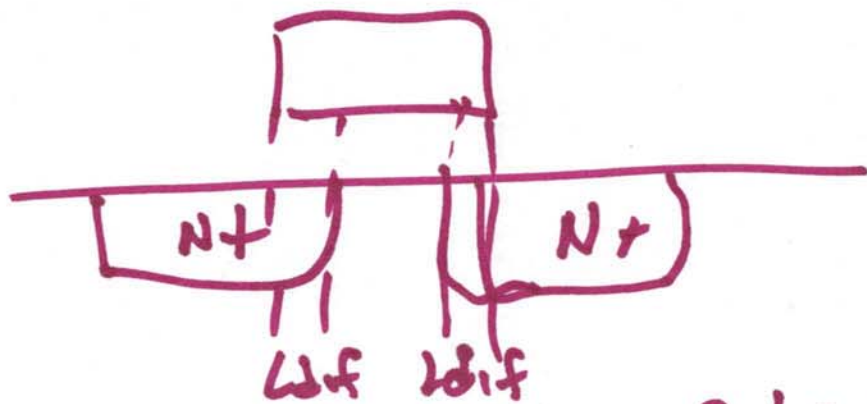
$$0.09 = (V_{SG} - 0.9)^2$$

$$\boxed{V_1 = 3.8V}$$

$$0.3 = V_{SG} - 0.9$$

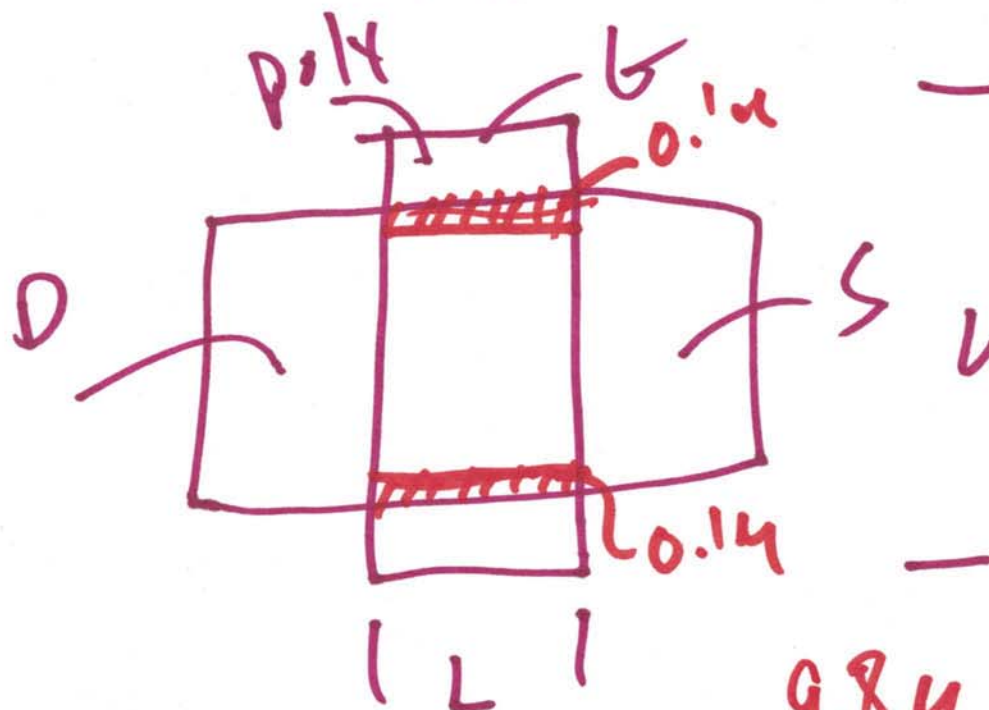
$$\boxed{V_{SG} = 1.2V}$$





$L_{eff}$   $L_{d.f}$

$$L_{eff} = L - 2L_{d.f}$$



9.84

USE SAME Length

$$9.84 \cdot 3$$

$$\frac{10}{2} m = 3$$

↓

$$\frac{30}{2}$$

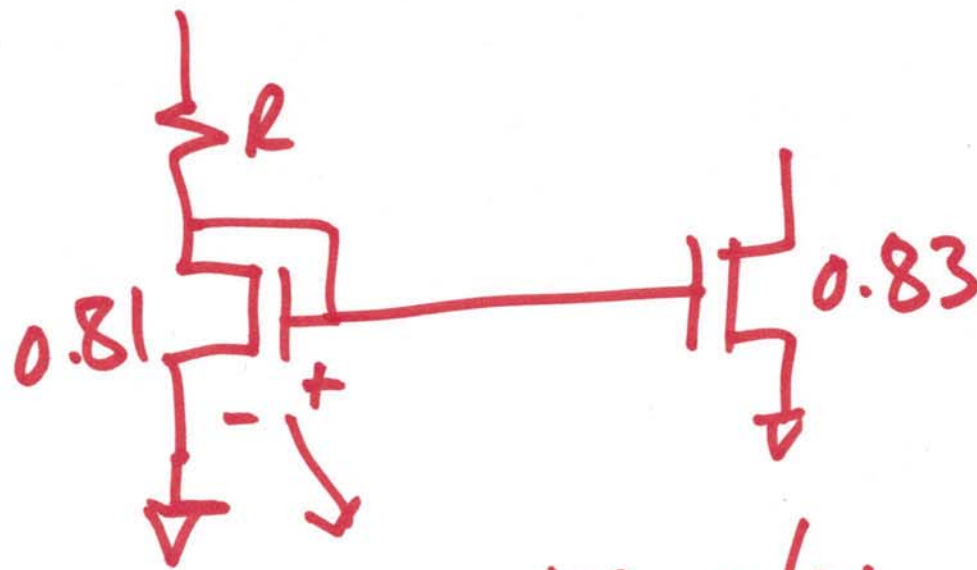
$$29.8n$$

$$V_{GS} - V_{THW} = V_{OV}$$

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8)

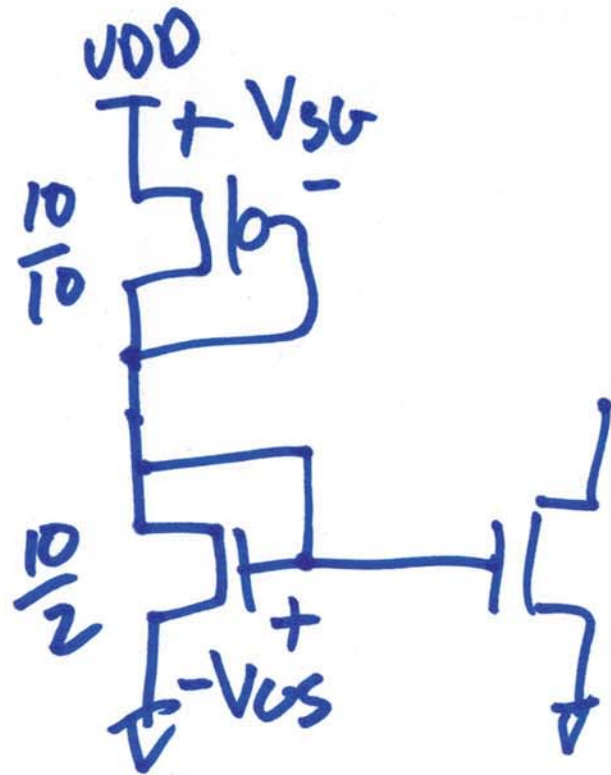




$V_{OV} \uparrow$  so  
mismatch  
due  
to  
 $V_{TH}$  is  
small!

$$I_0 = \frac{K_P}{2} \cdot \frac{W}{L} (V_{GS} - V_{TH})^2$$

$V_{GS}$   $\rightarrow$  big to minimize  
effects of threshold  
voltage variations.



$$I_D = \frac{K_P W}{2 L} (V_{GS} - V_{THN})^2$$

$$V_{GS} = \sqrt{\frac{2 I_D \cdot L}{K_P \cdot W}} + V_{THN}$$

$$V_{DD} = V_{SG} + V_{GS}$$

$$V_{DD} = \sqrt{\frac{2 I_D L_N}{K_{PN} W_N}} + V_{THN} +$$

$$\sqrt{\frac{2 I_D L_P}{K_{PP} \cdot W_P}} + V_{THP}$$