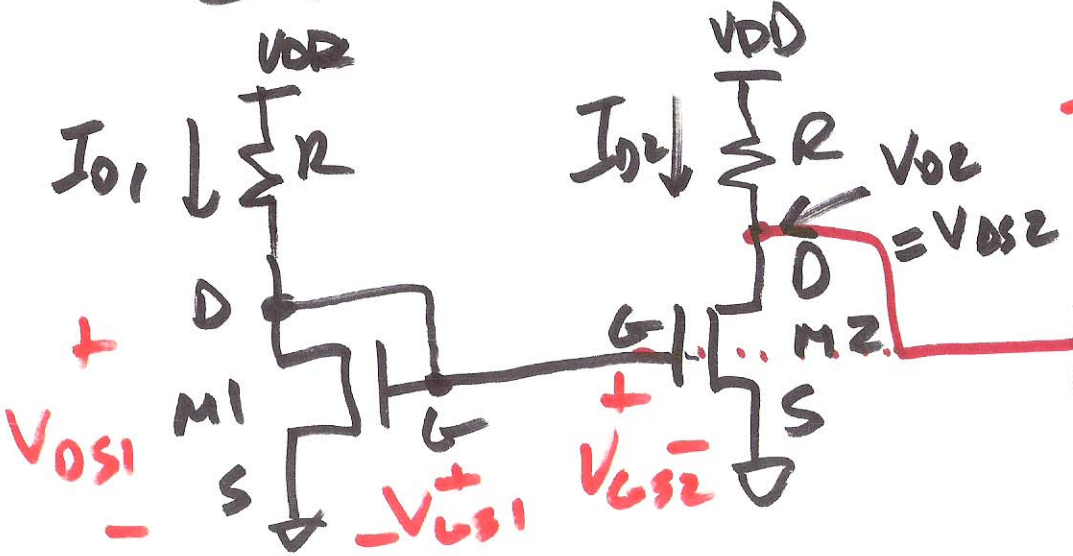
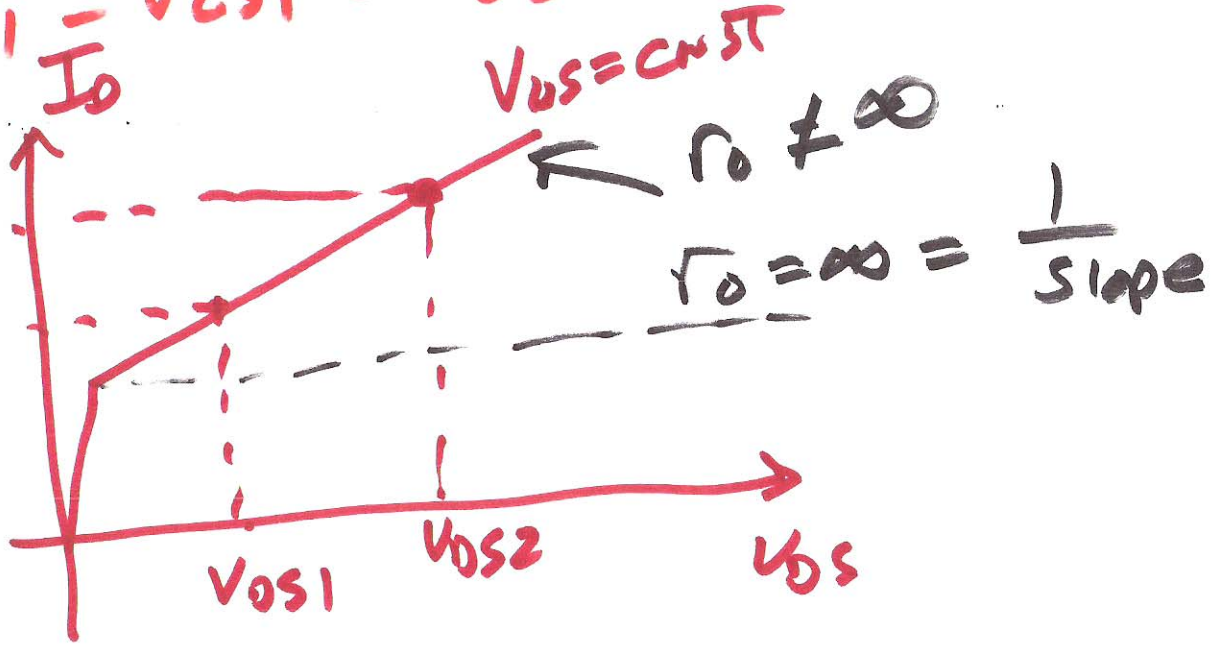
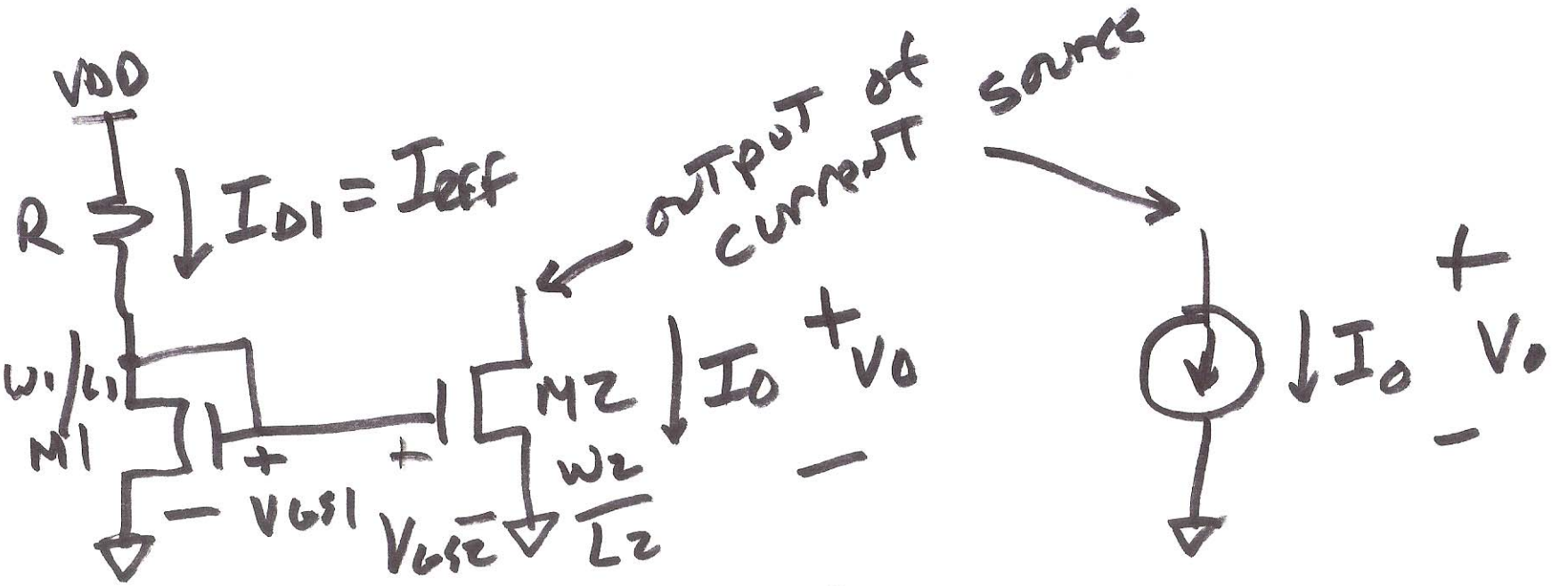
Ch. 20 CURRENT MIRRORS

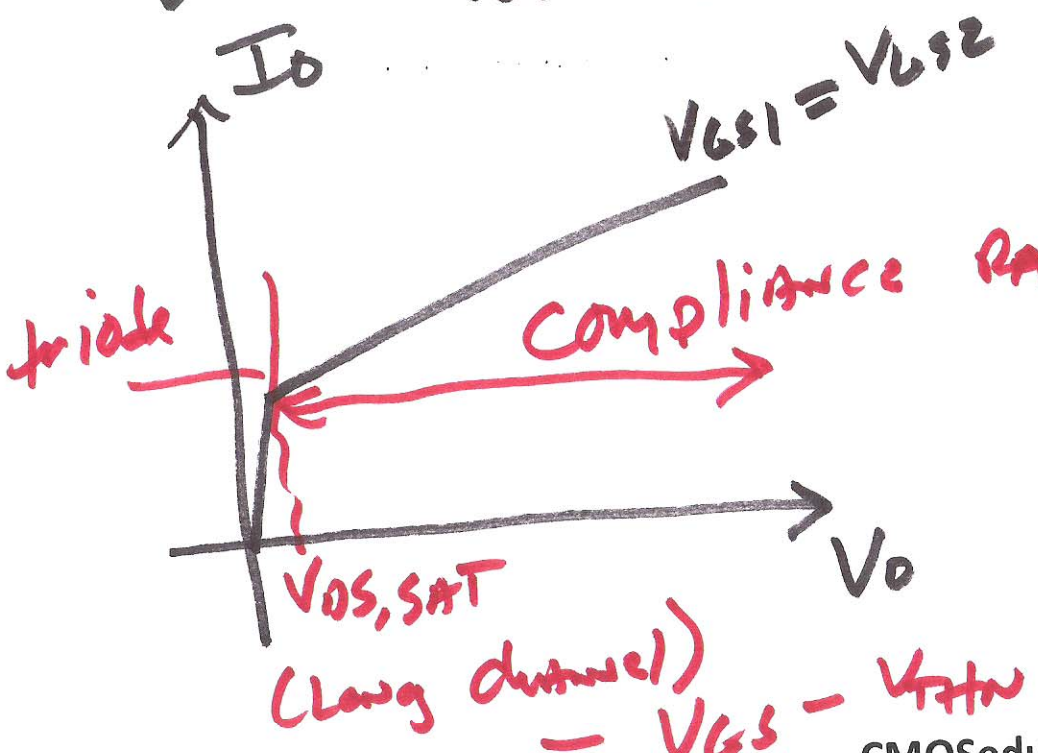


$$I_O = \frac{\beta_n}{2}\left(V_{GS} - V_{TH}\right)^2$$

$$V_{OS1} = V_{GS1} = V_{GS2} = V_{OS2}$$







$I_{REF} =$

$I_{D1} =$

$$\frac{KP_N}{2} \cdot \frac{W_1}{L_1} \left(V_{GS} - V_{THN}\right)^2 \cdot \left(1 + \lambda\left(V_{DS} - V_{DS,SAT}\right)\right)$$

I_{D2}

$$\frac{I_O}{I_{REF}} = \frac{\frac{KP_N}{2}\frac{W_2}{L_2}(V_{GS1}-V_{THN})^2 \cdot (1+\lambda(V_O - V_{DS1,SAT}))}{\frac{KP_N}{2}\frac{W_1}{L_1}(V_{GS1}-V_{THN})^2 \cdot (1+\lambda(V_{GS1}-V_{DS1,SAT}))}$$

I_{D1}

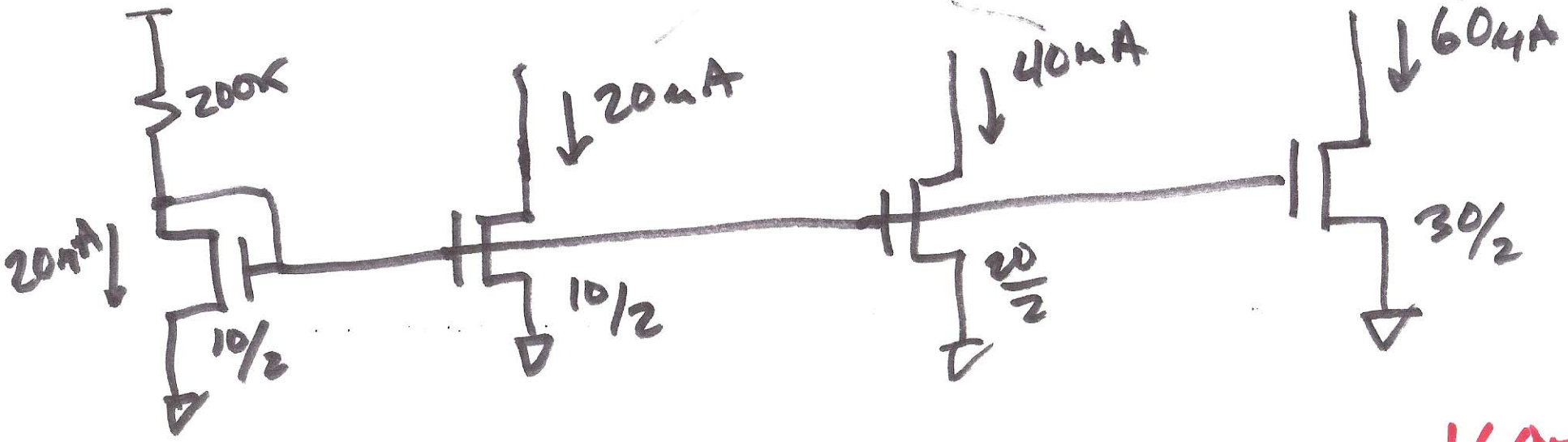
Generally you set $L_1 = L_2$

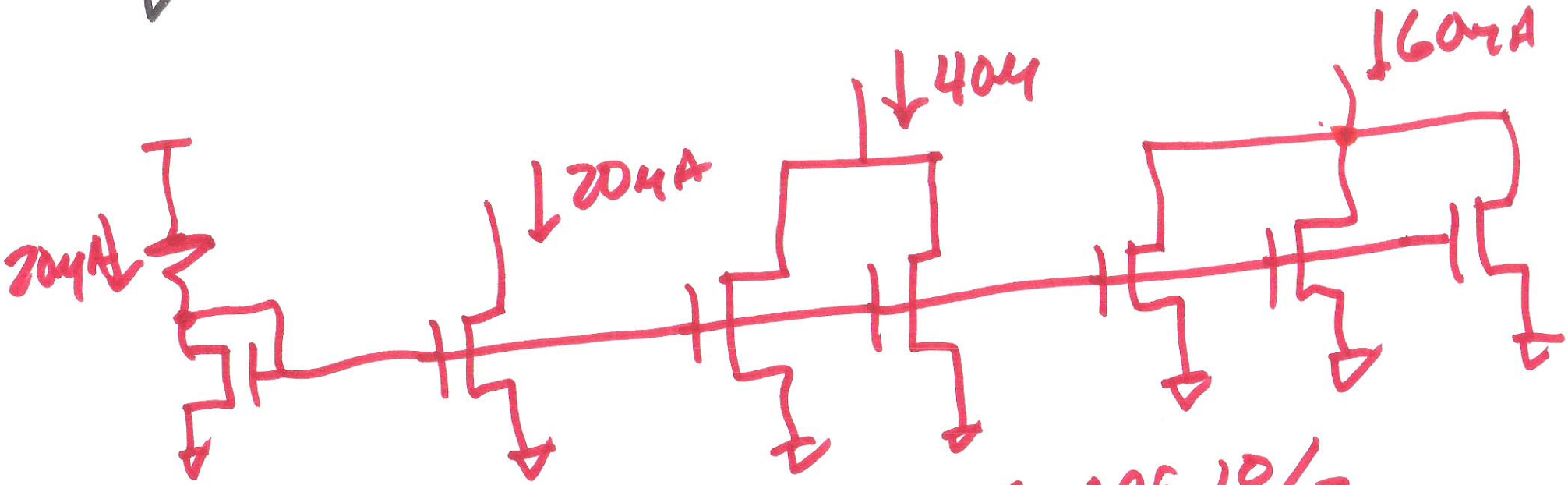
$$\frac{I_O}{I_{REF}} = \frac{W_2}{W_1} \cdot \frac{1+\lambda(V_O - V_{DS1,SAT})}{1+\lambda(V_{GS1}-V_{DS1,SAT})}$$

Approximate

$$\frac{I_O}{I_{REF}} \cong \frac{W_2}{W_1}$$

operating in saturation





All MOS are 10/2

M = # devices in parallel

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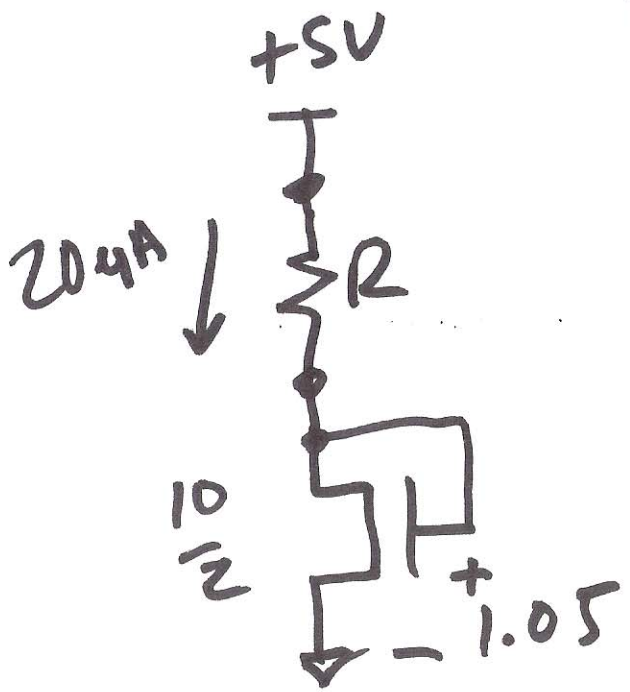
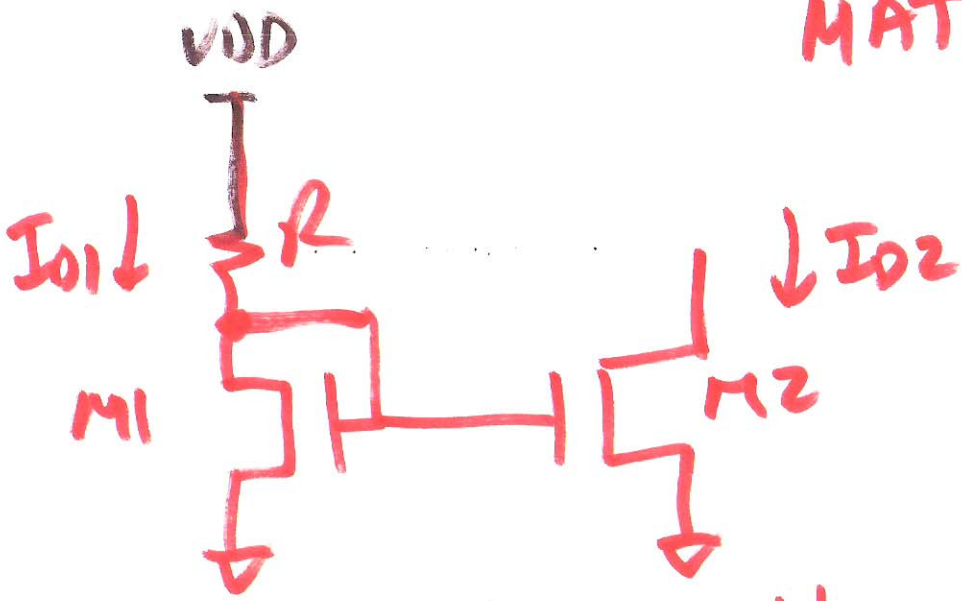
EX. 20.1



$$20mA = \frac{5 - 1.05}{R} \qquad R = 200K$$

MATCHING



perfect matching

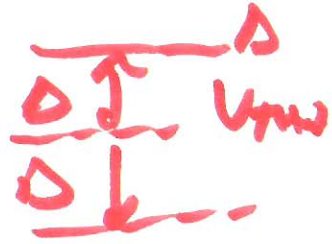
then $I_{D1} = I_{D2}$

Threshold Voltage matching

$V_{THN1} \neq V_{THN2}$

$$V_{THN1} = V_{THN} - \frac{\Delta V_{THN}}{2}$$

$$V_{THN2} = V_{THN} + \frac{\Delta V_{THN}}{2}$$



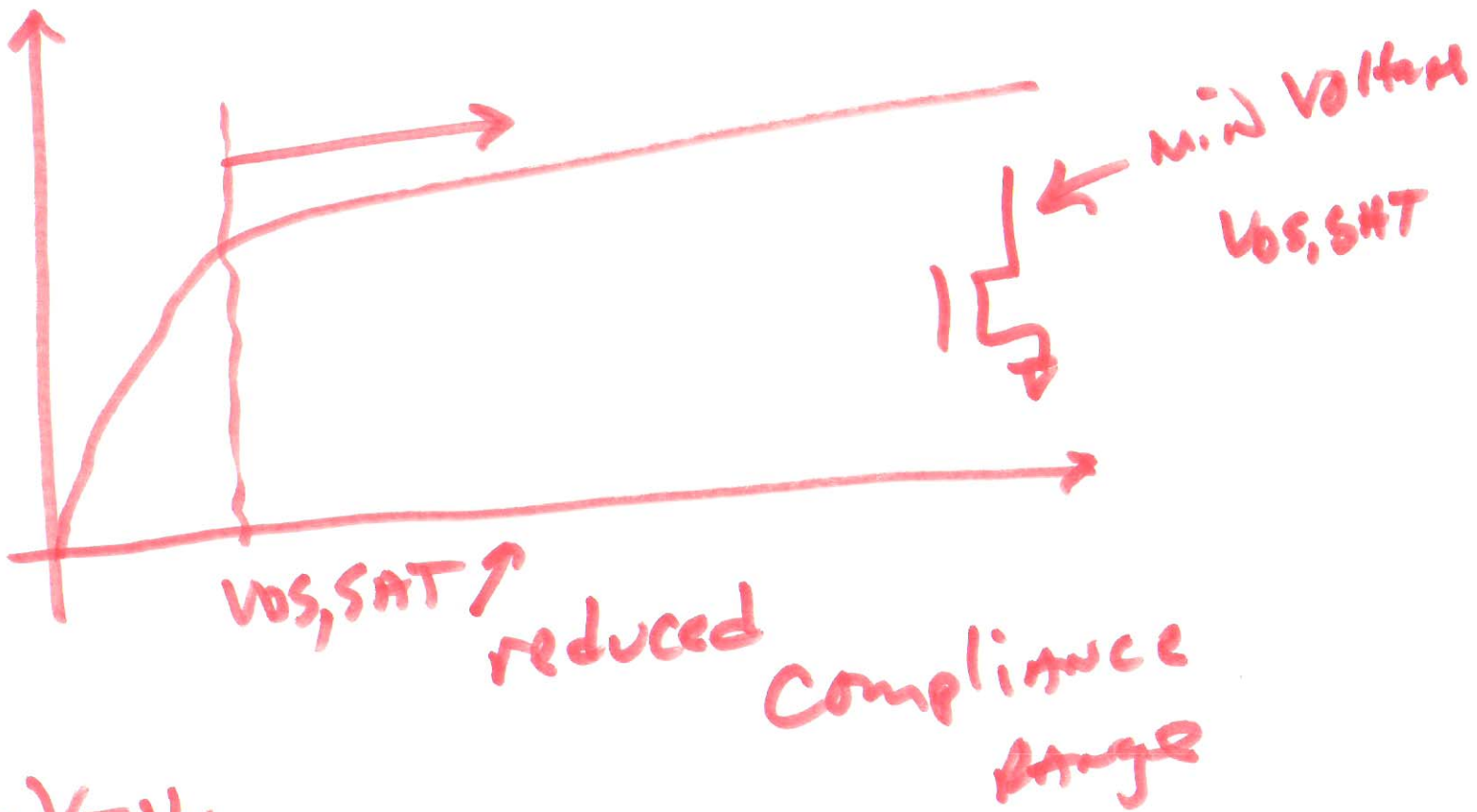
$$\frac{I_O}{I_{REF}} = \frac{\frac{K_{PN}}{2}\frac{W}{L}\left(V_{GS}-V_{THN}-\frac{\Delta V_{THN}}{2}\right)^2}{\frac{K_{PN}}{2}\frac{W}{L}\left(V_{GS}-V_{THN}+\frac{\Delta V_{THN}}{2}\right)^2}$$

$$= \frac{\left(1-\frac{\Delta V_{THN}}{2(V_{GS}-V_{THN})}\right)^2}{\left(1+\frac{\Delta V_{THN}}{2(V_{GS}-V_{THN})}\right)^2}$$

$$\frac{I_O}{I_{REF}} \simeq 1-\frac{2\Delta V_{THN}}{V_{GS}-V_{THN}} = 1-\frac{2\Delta V_{THN}}{V_{DS,SAT}}$$

reduce the effects of threshold voltage mismatch use large $V_{GS} \geq V_{DS,SAT}$!

$f_T \nearrow$ with $V_{OS} \nearrow$ & $V_{DS,SAT} \nearrow$



for C_{ox} or μ mismatch

i.e. KP

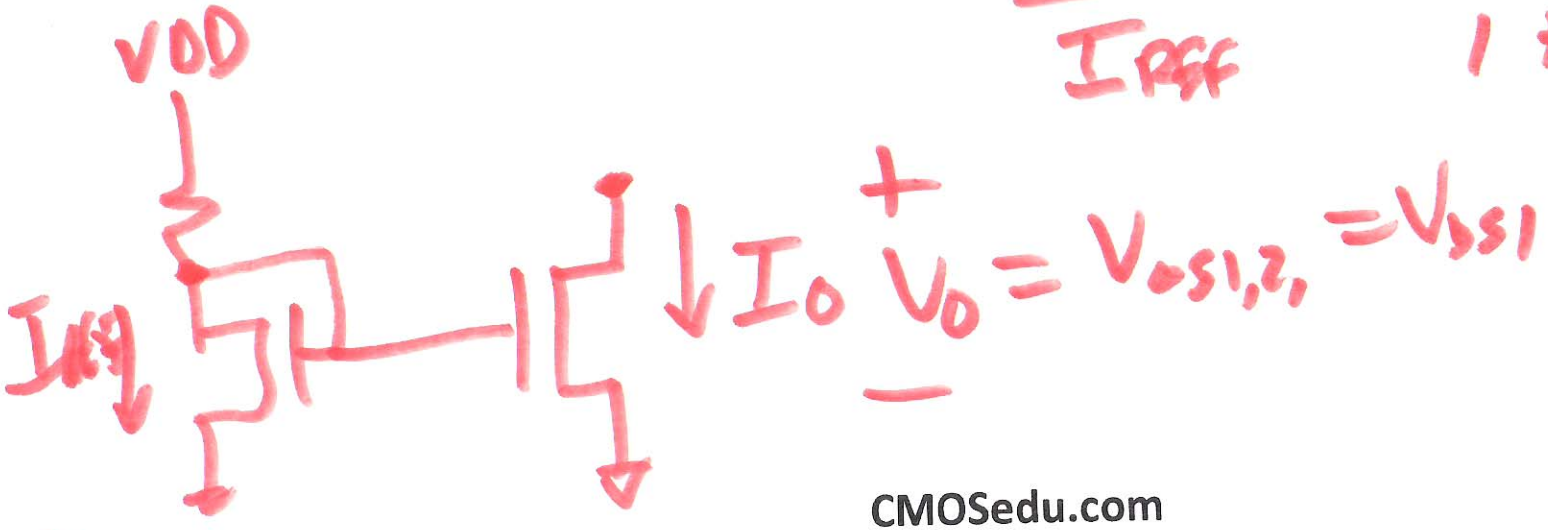
$$\frac{I_O}{I_{REF}} \simeq 1 + \frac{\Delta KP_N}{KP_N}$$

↖ depends process

MOST important for good matching

V_{OS}

$$\frac{I_O}{I_{REF}} \simeq \frac{1 + \lambda_2 \cdot V_O}{1 + \lambda_1 \cdot V_{DS1}}$$



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