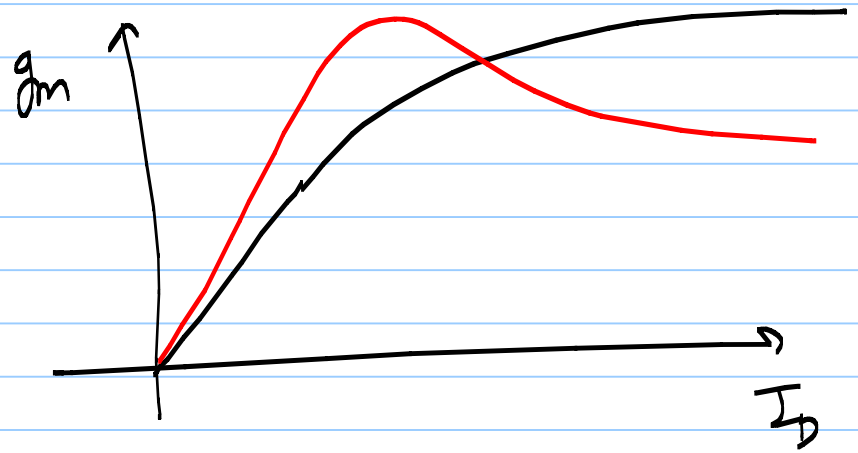
ECE 511 – Lecture 6.

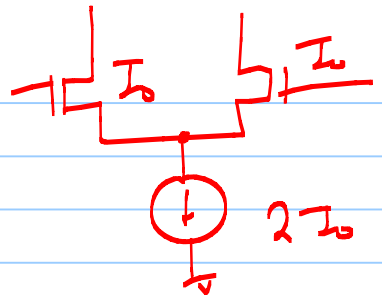
Note Title 2/7/2011

$$g_m = \frac{I_D}{nV_T}$$

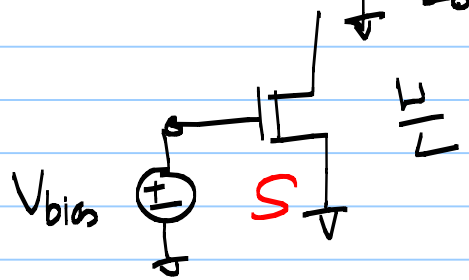
$$g_m = \sqrt{2\beta I_D}$$

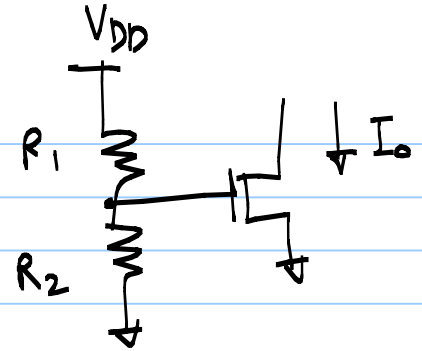


Current Mirrors



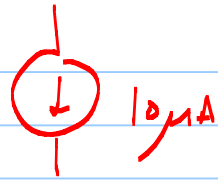
$$I_o = \frac{\beta_n}{2}(V_{bias} - V_{THN})^2$$





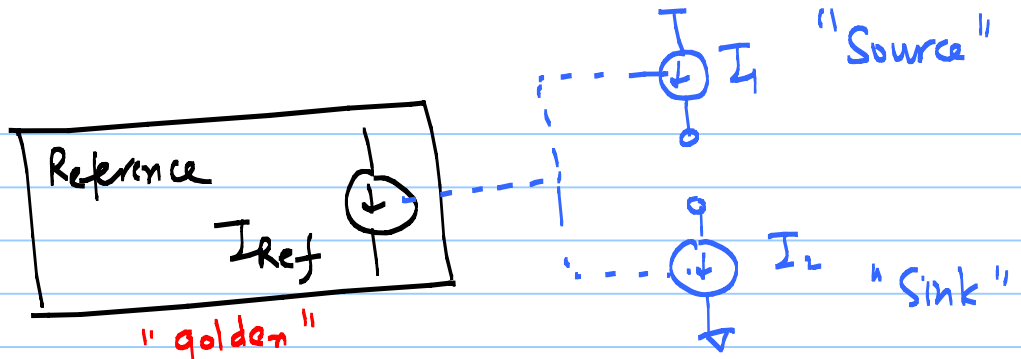
$$I_o = \frac{\beta_n}{2}\left(\frac{R_2}{R_1+R_2}V_{DD} - V_{THN}\right)^2$$

V_{ov}



Not a stable / precise current sink.

I_o is poorly defined!



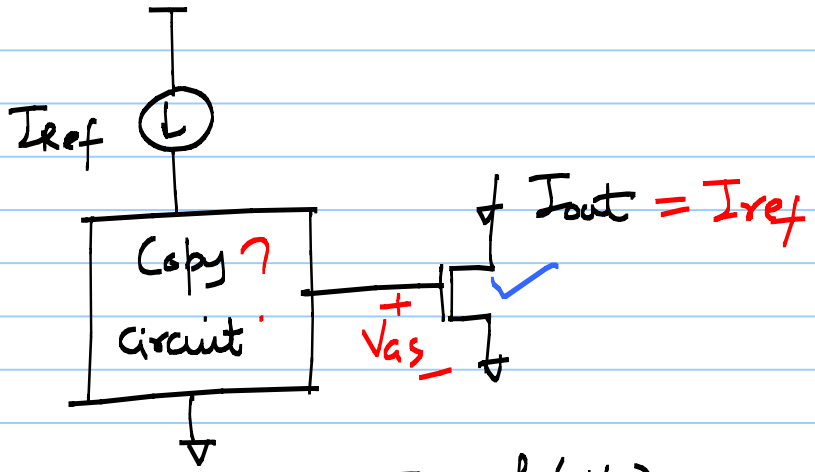
"golden" reference

highly precise & stable

V_{DD}, T, process

Copy the current reference

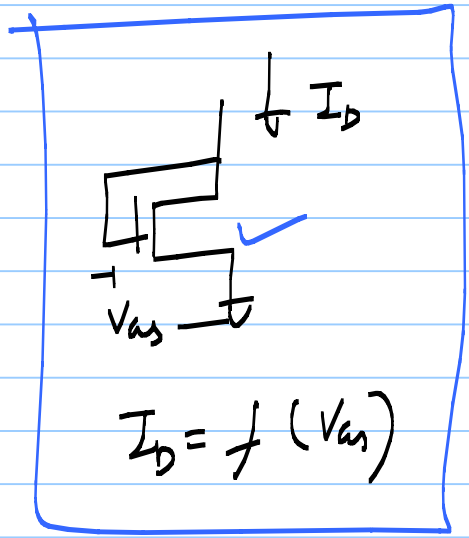
* How to generate copies of a reference current?



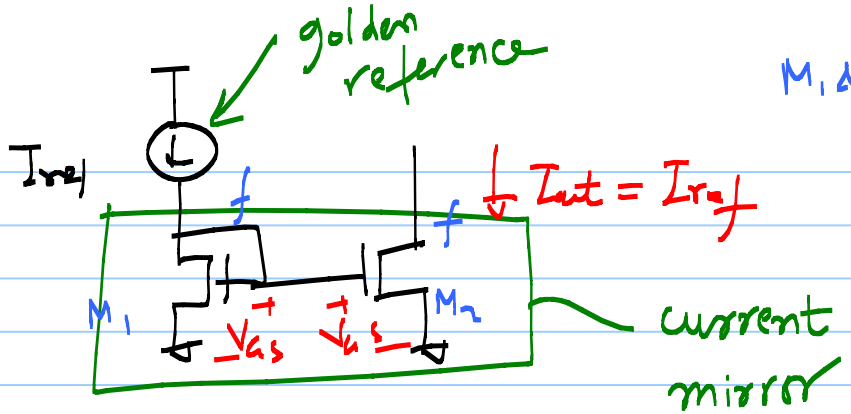
$I_D = f(V_{GS})$

$V_{GS} = f^{-1}(I_D)$

Assume "$\lambda = 0$"



$I_{out} = f(V_{GS}) = f(f^{-1}(I_{REF})) = I_{REF}$



M_1 & M_2 are "matched"
↳ identical

"$\lambda = 0$"

$$I_{ref} = \frac{1}{2} k_n \left(\frac{W}{L}\right)_1 (V_{GS} - V_{THN})^2$$

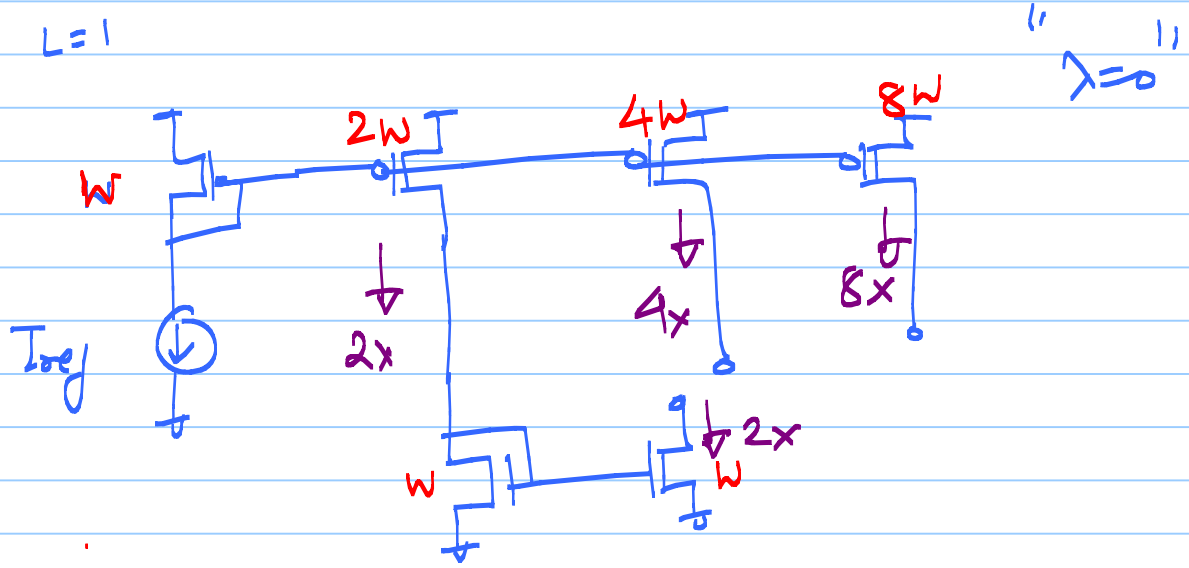
$$I_{out} = \frac{1}{2} k_n \left(\frac{W}{L}\right)_2 (V_{GS} - V_{THN})^2$$

$$\frac{I_{out}}{I_{ref}} = \frac{(W/L)_2}{(W/L)_1}$$

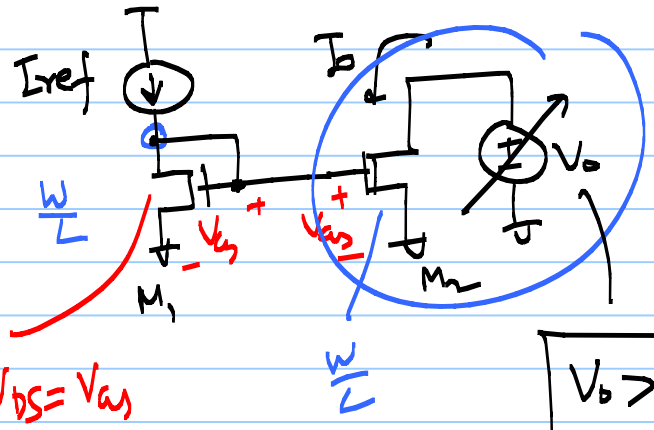
for the same "L"

$$\boxed{I_{out} = I_{ref} \cdot \left(\frac{W_2}{W_1}\right)}$$

$\Rightarrow$ precisely copying and scaling currents just by controlling the W/L ratios.



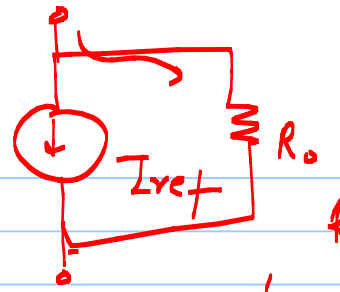
* what happens when $\lambda > 0$.



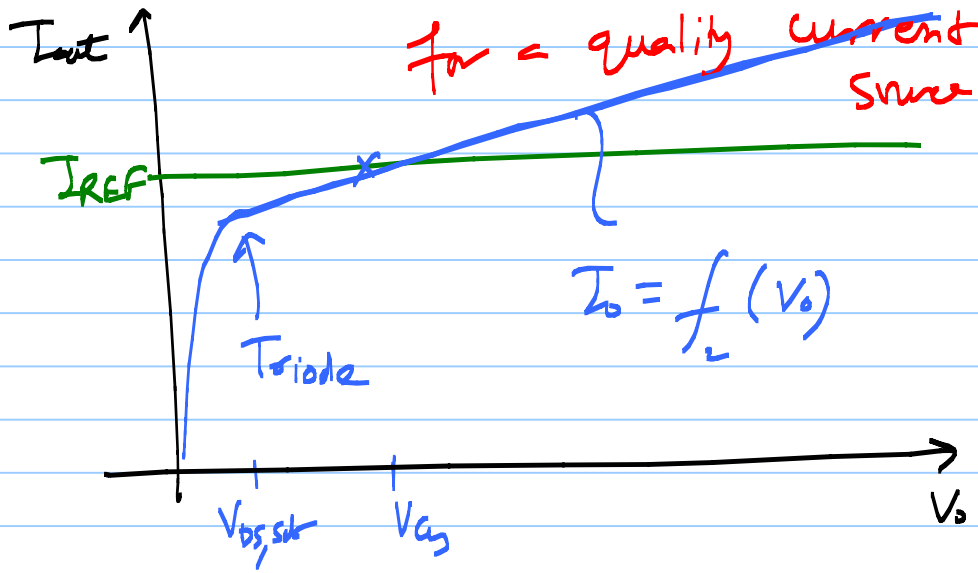
If $I_{out} = I_{ref}$

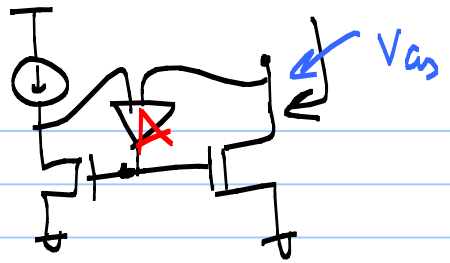
$V_{DS_2} = V_{GS}$

$V_o > V_{DS,sat}$



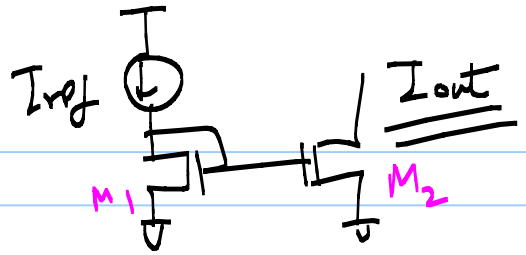
R_o should be very large for a quality current source.





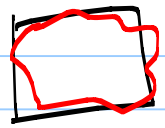
Can use −ve feedback to hold V_{DS_2} tighter.

↳ R_o ↑



$\sigma \cdot \Delta V_{THN} \longrightarrow$ tox N_D, ...

$\sigma \cdot \Delta\left(\frac{W}{L}\right) \longrightarrow$



L_{diff}

W_{enc}

"V_{DS}"