# ECE 511 – Lecture 12

Note Title 2/27/2014

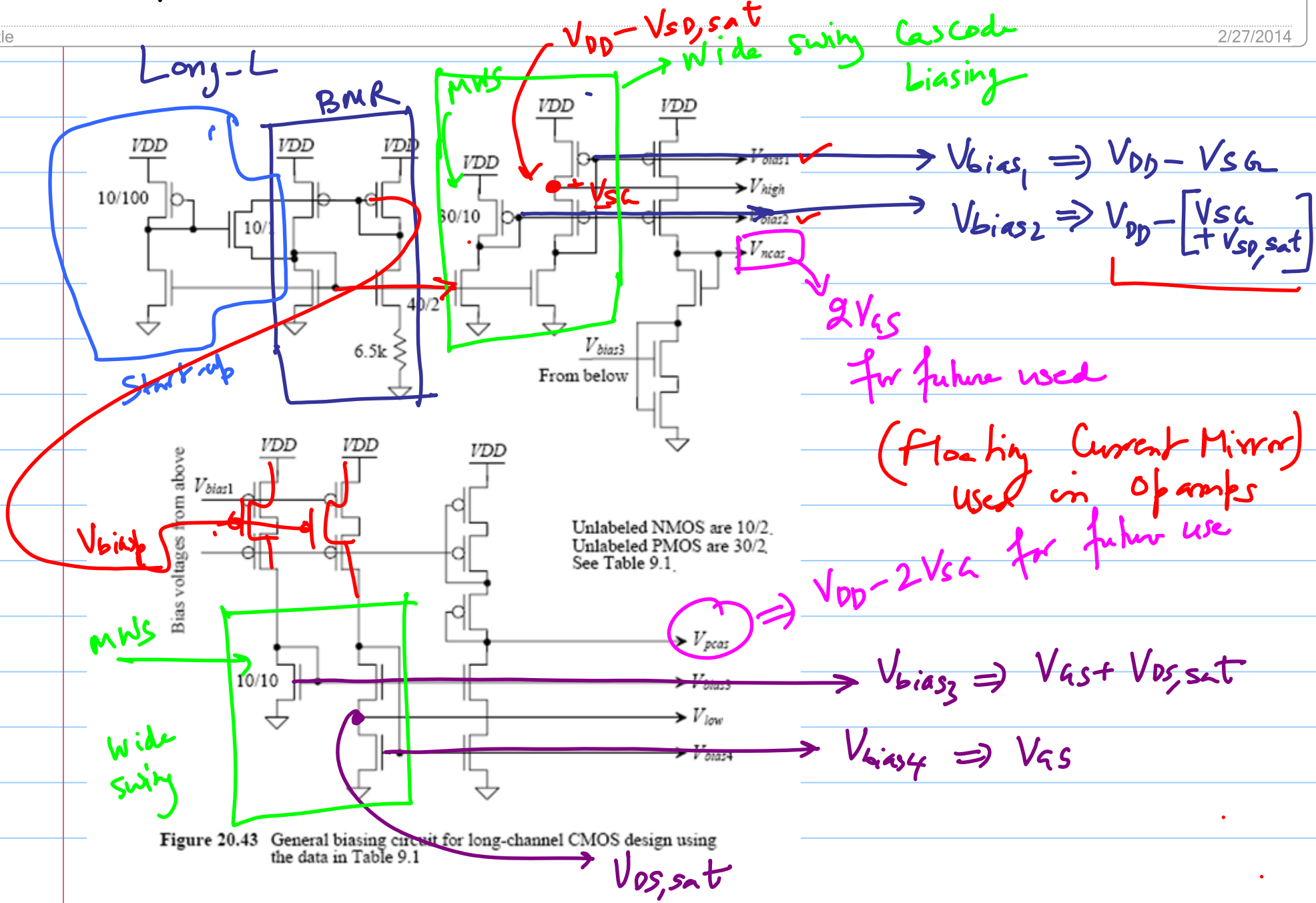
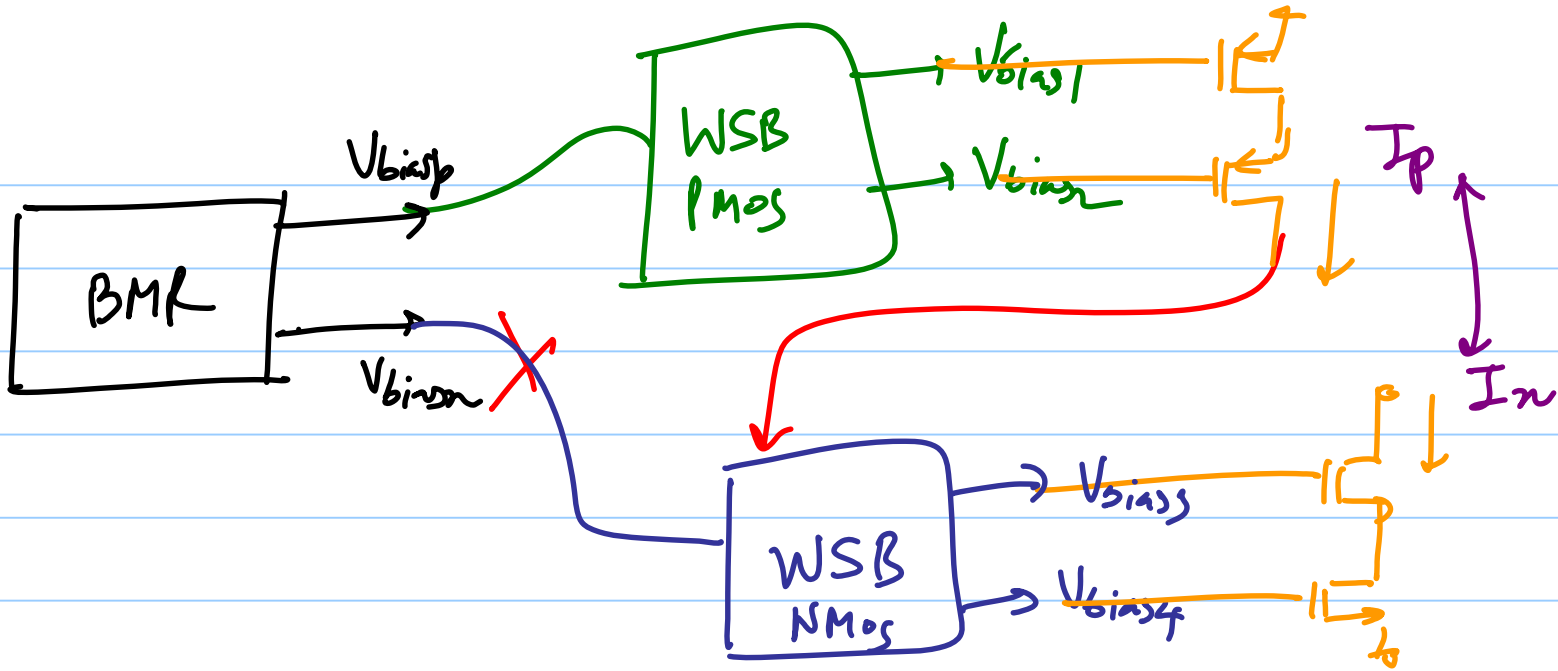
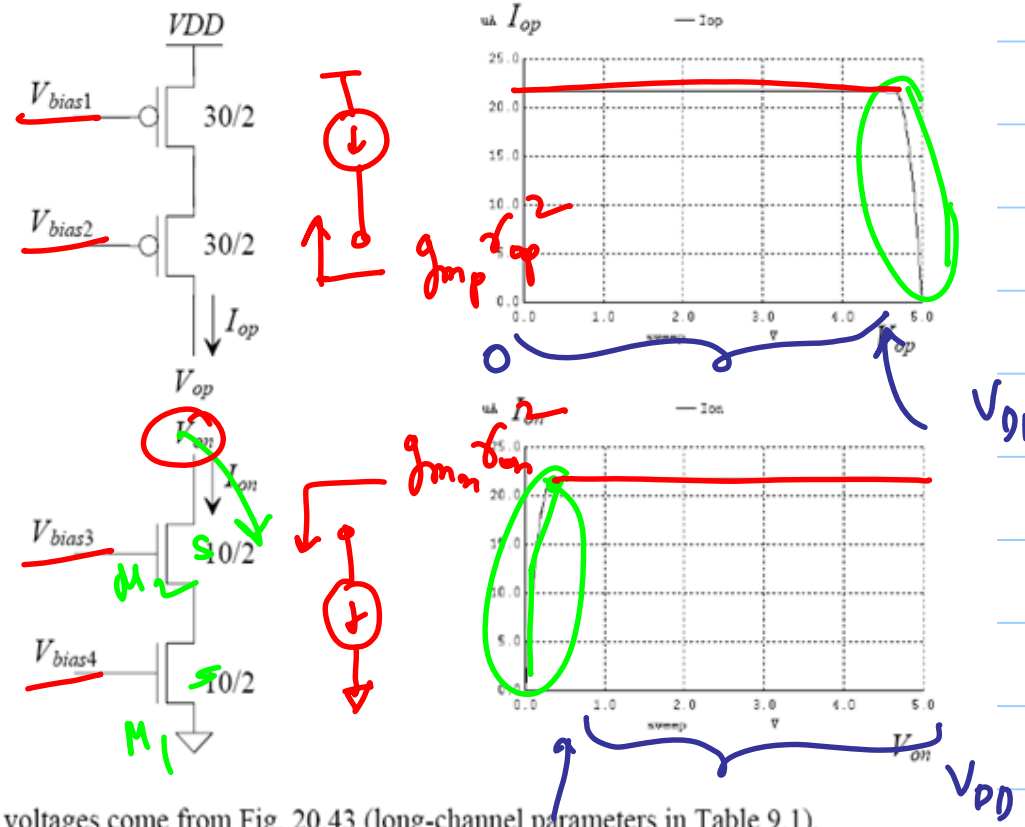



**Figure 20.43** General biasing circuit for long-channel CMOS design using the data in Table 9.1



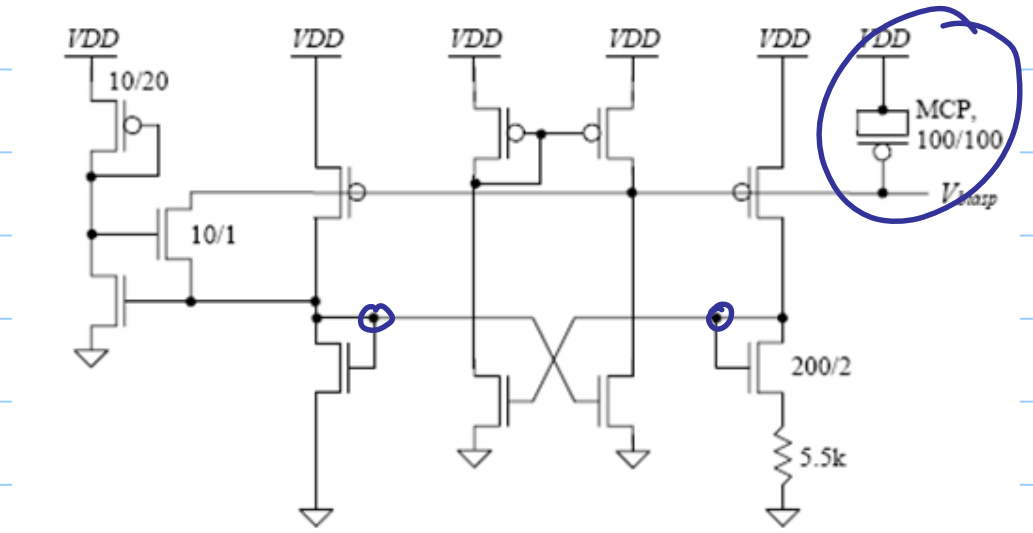

Minimizes systematic offset between the currents $I_p$ & $I_n$




Bias voltages come from Fig. 20.43 (long-channel parameters in Table 9.1).

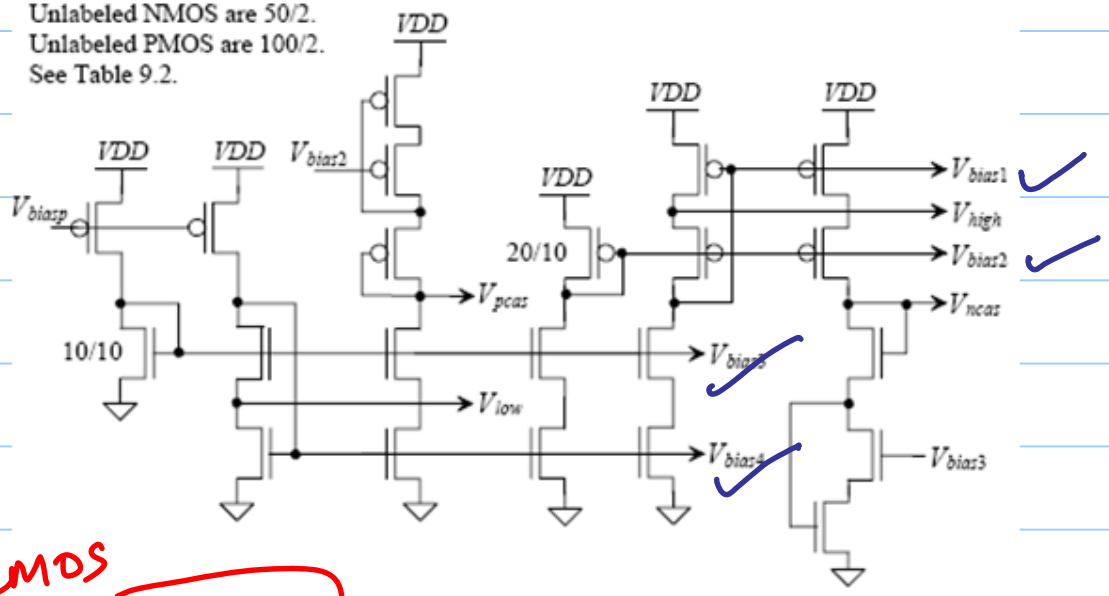
**Figure 20.44** How cascode currents are biased and how they operate.

# short-L biasing




compensation for stability

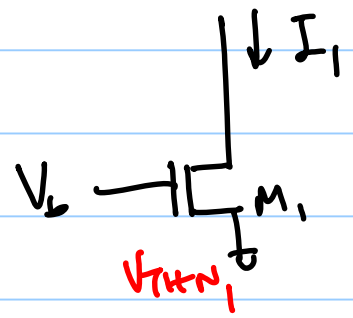
Unlabeled NMOS are 50/2.
Unlabeled PMOS are 100/2.
See Table 9.2.

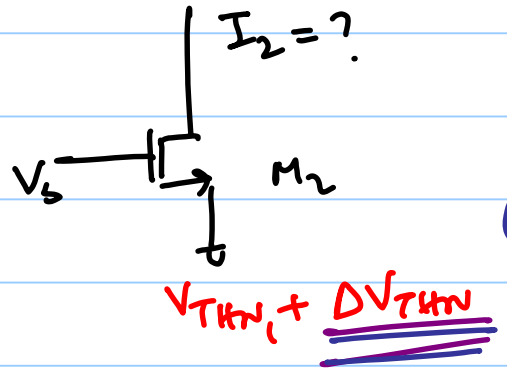



CMOS Book

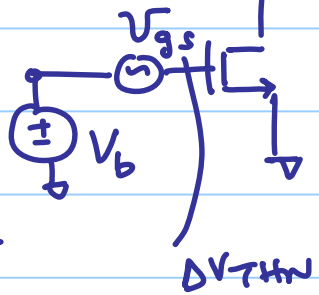
**Figure 20.47** General biasing circuit for short-channel design using the data in Table 9.2.

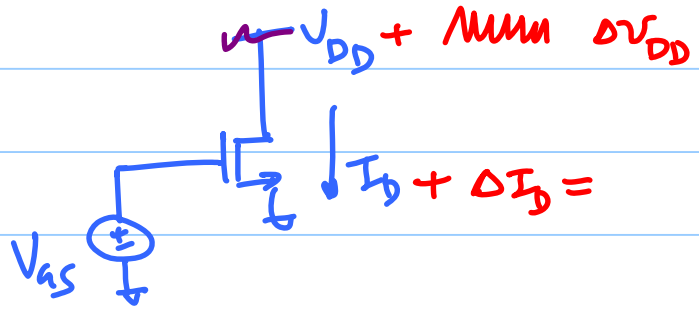
$$I_2 = I_1 - g_m|\Delta V_{THN}|$$

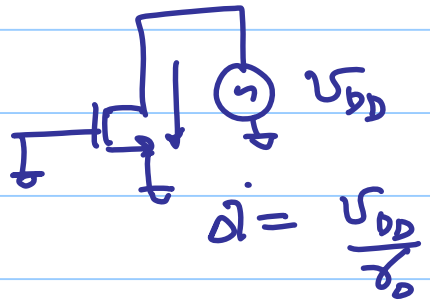



$\Delta i = g_m \Delta V_{THN}$



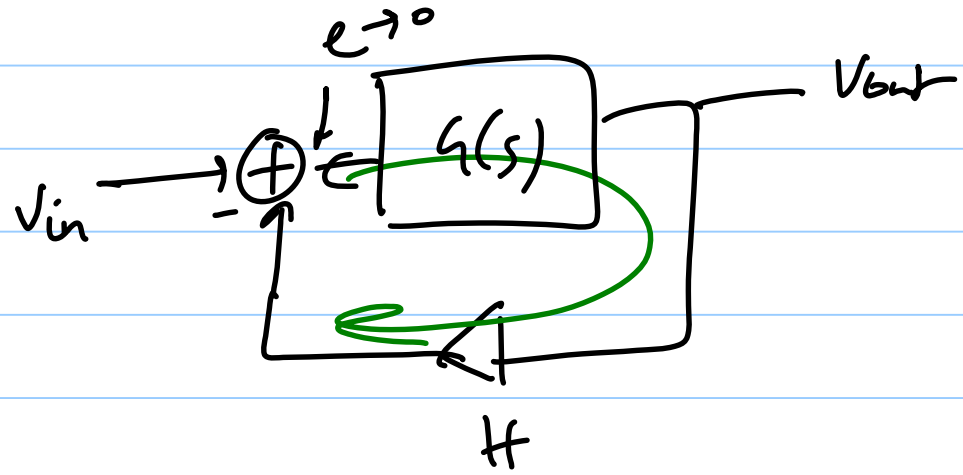



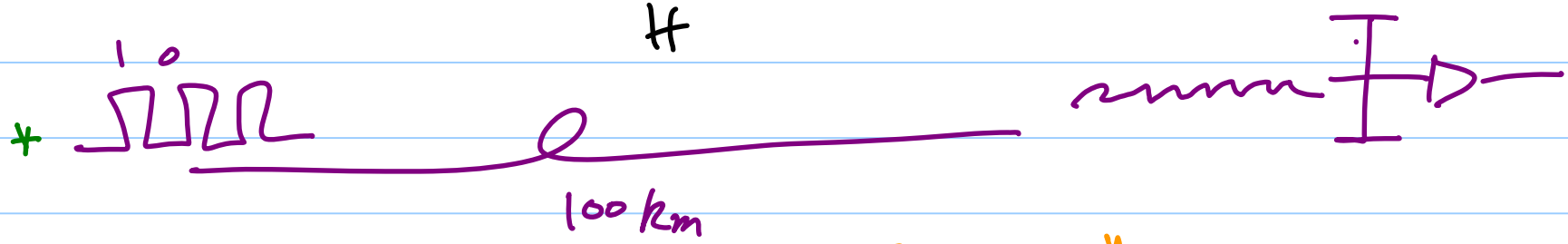



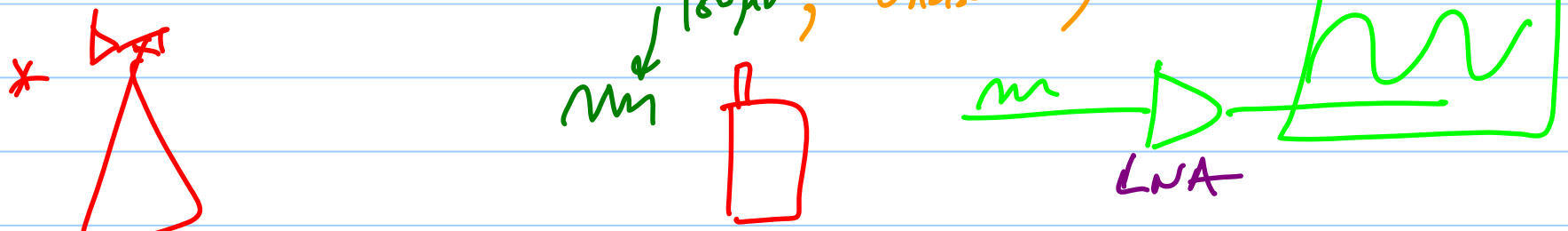

$$\Delta i = \frac{v_{DD}}{r_o}$$

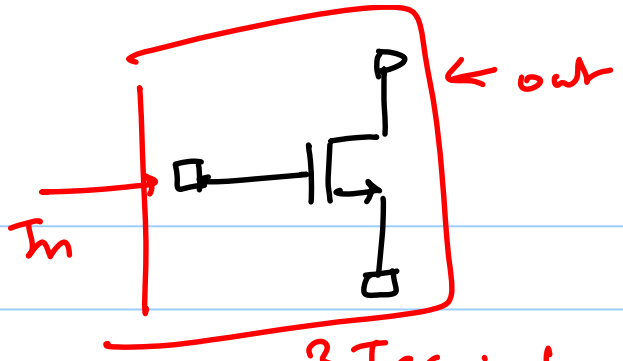
# Single Stage Amplifiers

* Signal processing → fundamental building (Opamp)



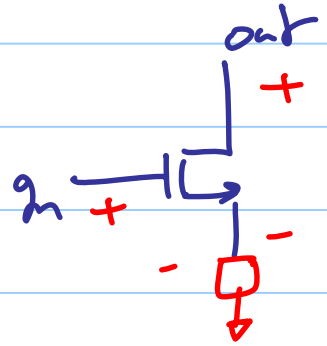





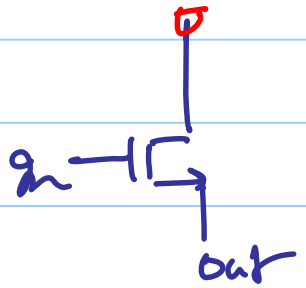

3 Terminals
2-port

Controlled source
↳ signal gain

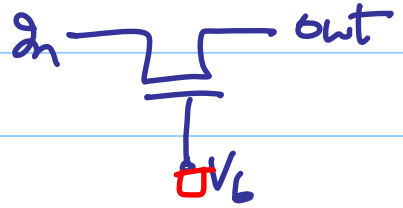
$$3G_2 = \frac{3.2}{1.2} = 3$$




CS

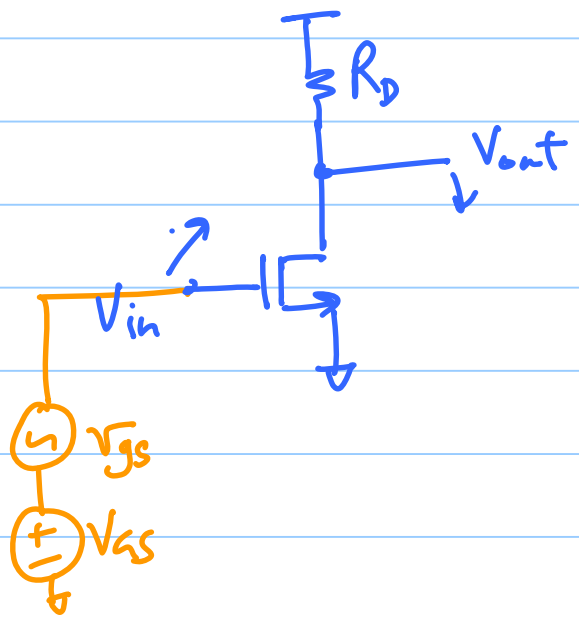



CD

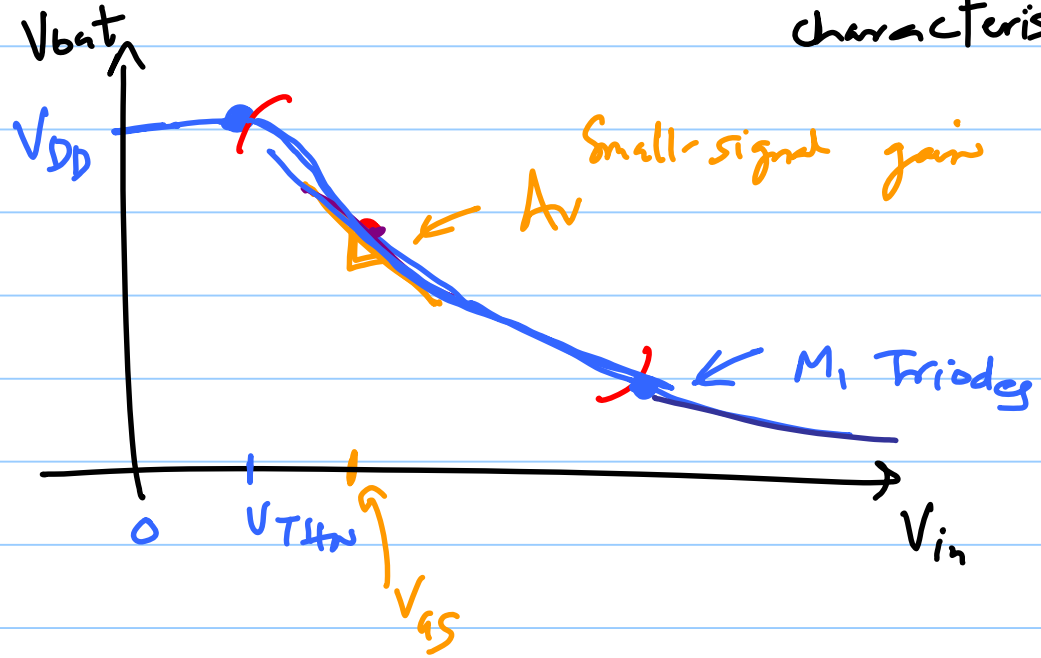



CG

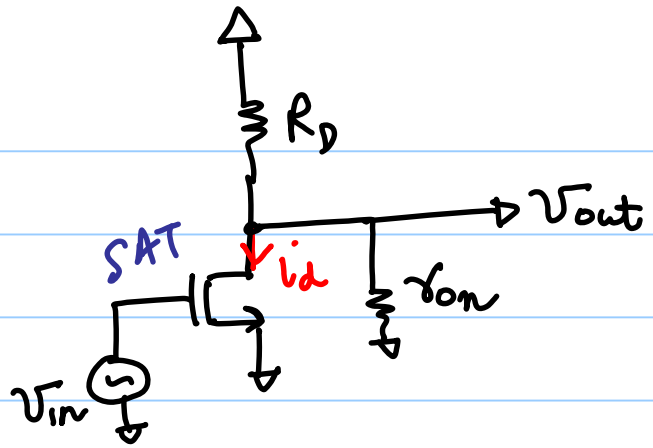
# Common Source Stage




Large signal characteristics



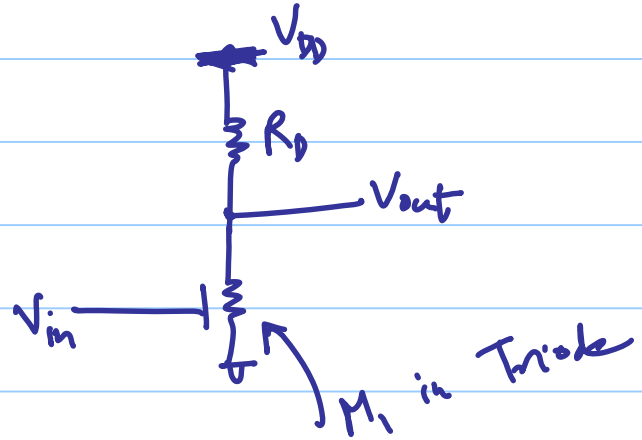
Ac

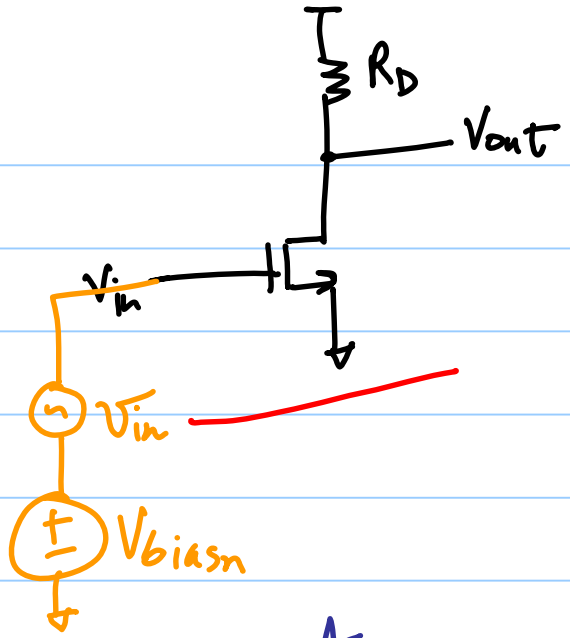


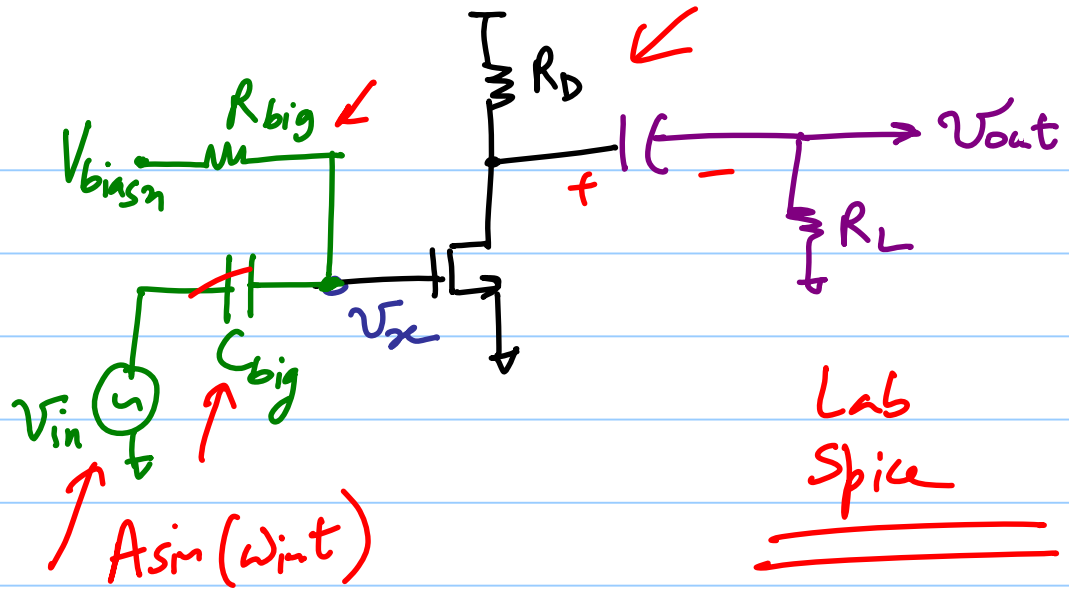

$$V_{out} = -i_d (R_D \| r_{on}$$
$$= -g_m v_{in} (R_D \| r_{on})$$

$$A_v = \frac{V_{out}}{V_{in}} = -g_m (R_D \| r_{on})$$
$$\simeq -g_m R_D \quad \text{for } r_{on} \gg R_D$$

$g_m$ depends on $V_{ov}$

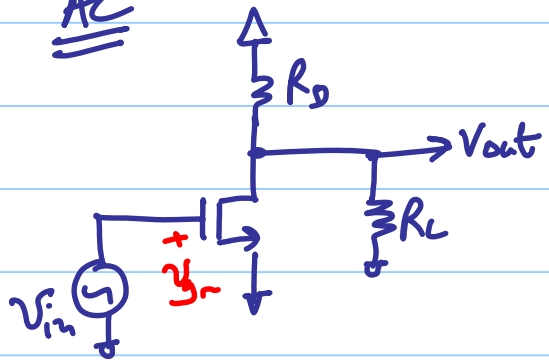




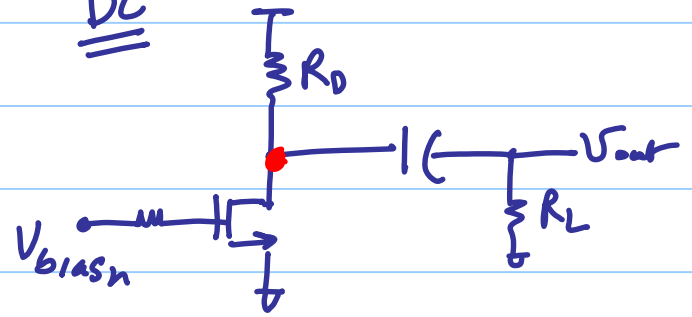



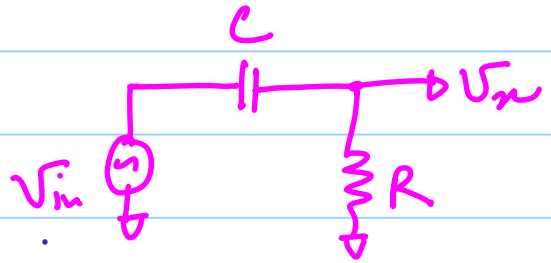

Lab
Spice

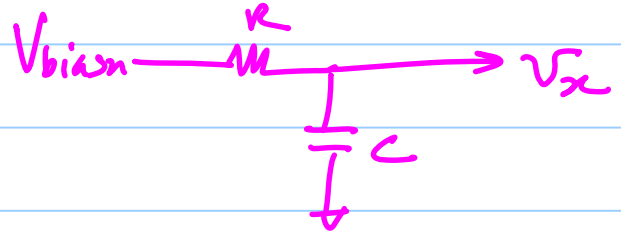
AC

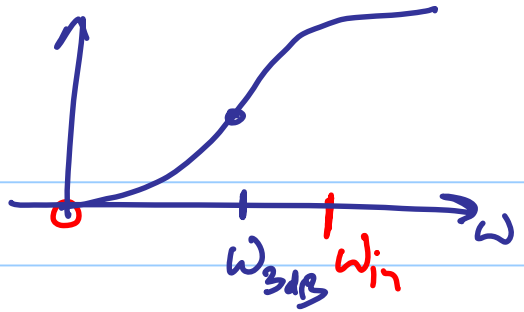


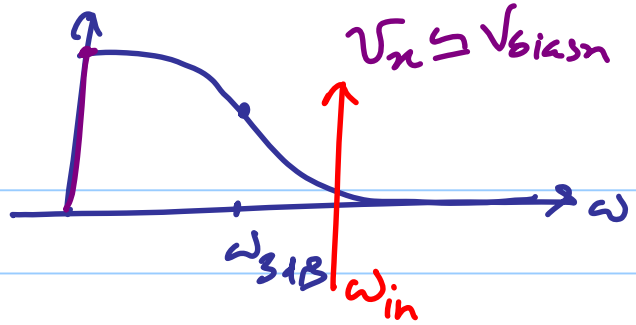

DC



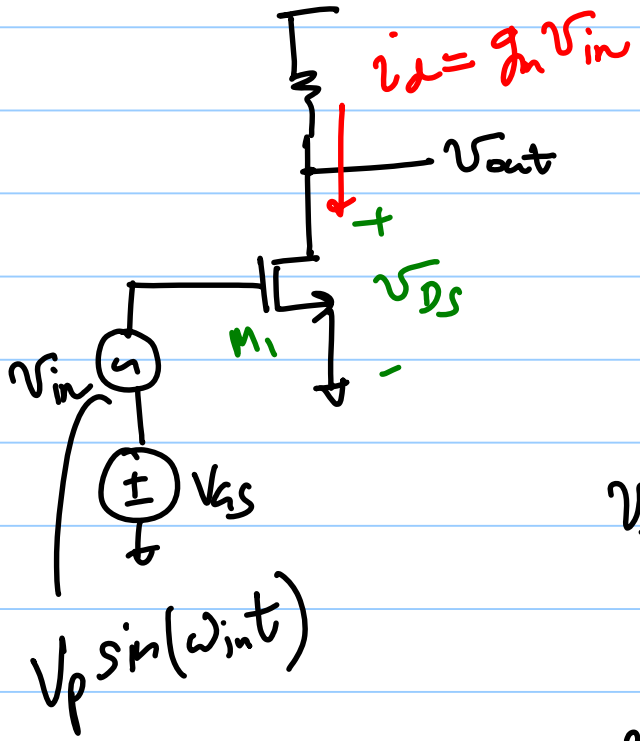



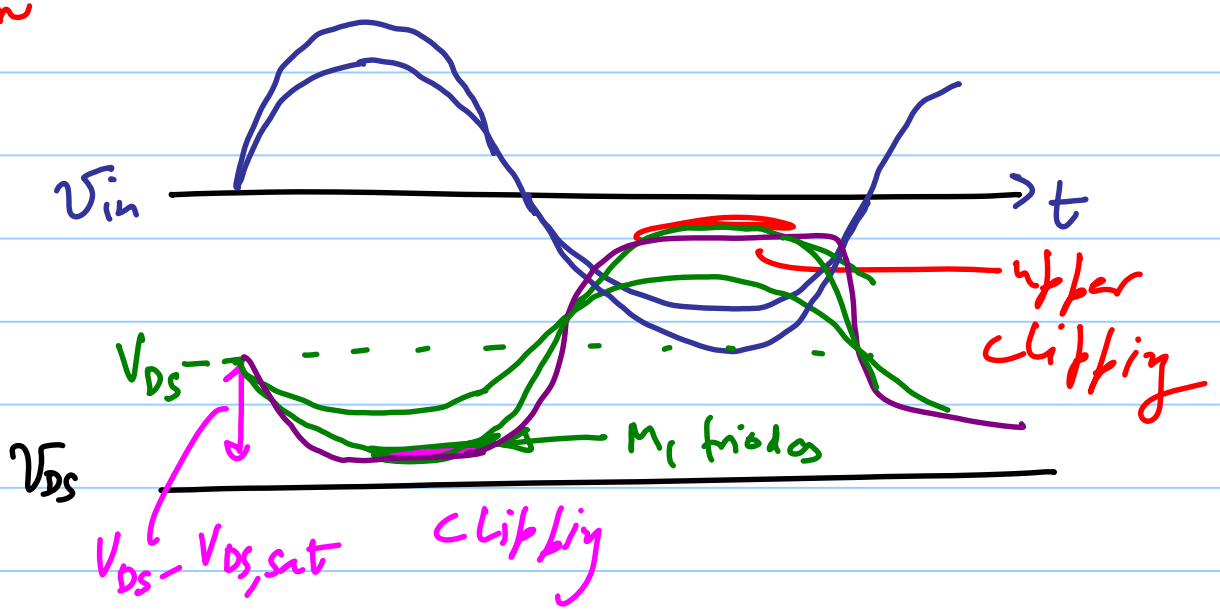


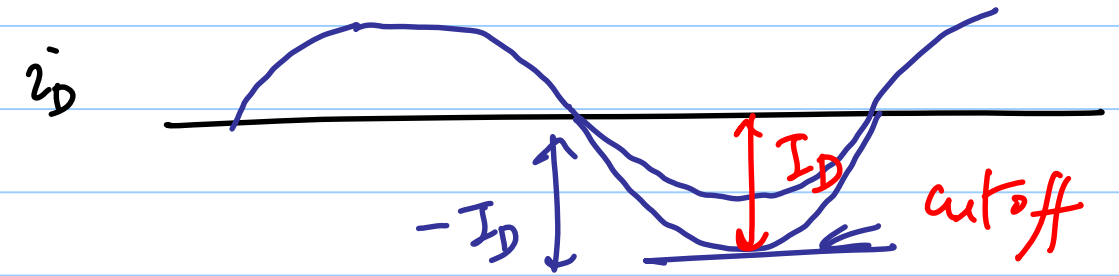




$$\omega_{3dB} \ll \omega_{in}$$

$$\Rightarrow \boxed{\frac{1}{R_{bij} C_{bij}} \leq \frac{\omega_{in}}{10}}$$




tve input cycle

$$V_{p,max_1} = \frac{(V_{DS} - V_{DS,sat})}{A_V}$$

} Assuming Linear device

$i_L = -I_D \Rightarrow i_D = 0$

-ve input cycle

$$V_{p,max_2} = \frac{I_D}{g_m}$$

max input amplitude without clipping $\min \left\{ V_{pmax_1}, V_{pmax_2} \right\}$

"Swing Limit"