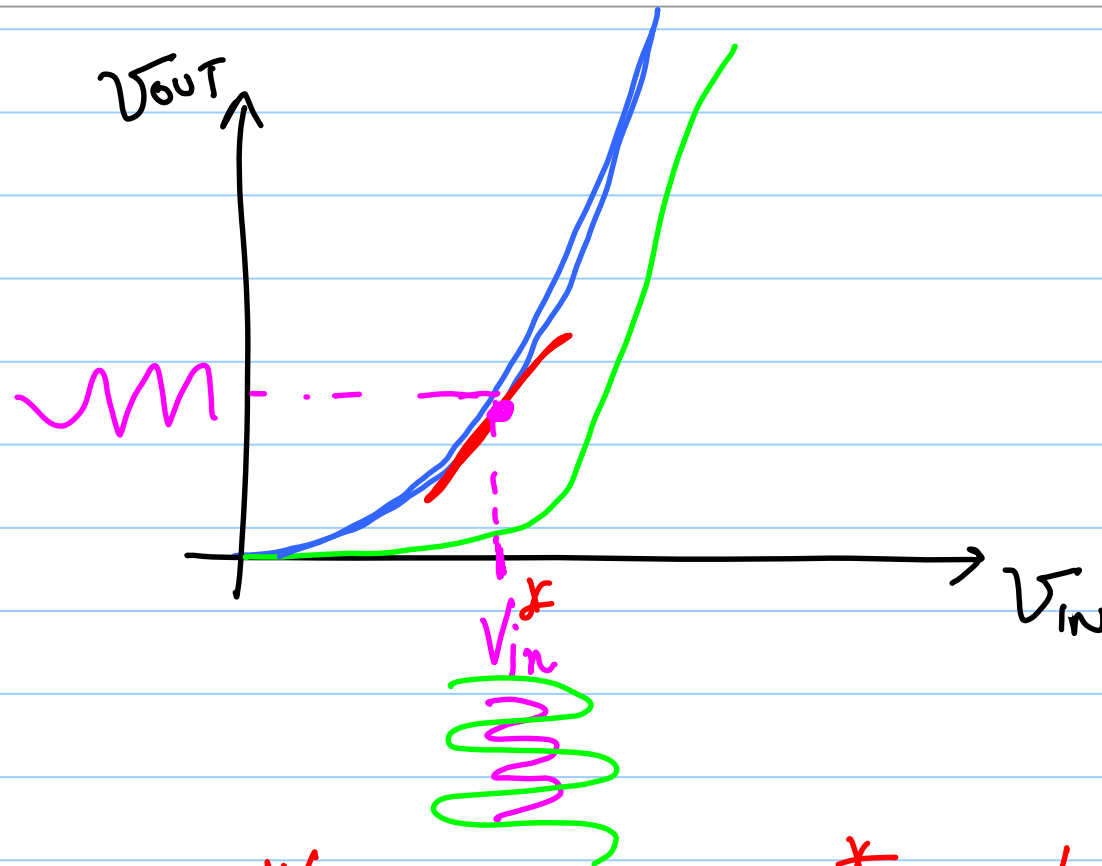


ECE 511 - Lecture 8

Note Title

2/10/2015



$$\frac{V_{in}^2}{V_A}$$

$$V_A e^{\frac{V_{in}}{V_A}}$$

$$\frac{dV_{out}}{dV_{in}} = 1 \Rightarrow V_{in}^* \propto V_A$$

$$V_{out} = f(V_{in})$$

small-signal
gain

$$= \underbrace{f(V_{in}^*)}_{Dc} + \underbrace{f'(V_{in}^*)}_{\text{small-signal gain}} v_{in} + \cancel{\frac{f''(V_{in}^*)}{2} v_{in}^2}$$

Small-signal

$$f'(V_{in}^*) v_{in} \gg f''(V_{in}^*) v_{in}^2$$

$$> 10 \cdot \boxed{f''(V_{in}^*)} v_{in}^2$$

$$\cancel{f'(V_{in}^*)} v_{in} = 10 \cancel{f''(V_{in}^*)} v_{in}^2$$

$$v_{in} = \frac{f'}{10 \cdot f''} \bigg|_{V_{in}^*}$$

this depends upon the
nature of non linearity
in $f(\cdot)$

$$\frac{V_{in}^2}{V_A}$$

$$V_A e^{V_{in}/V_A}$$

$$f_w$$

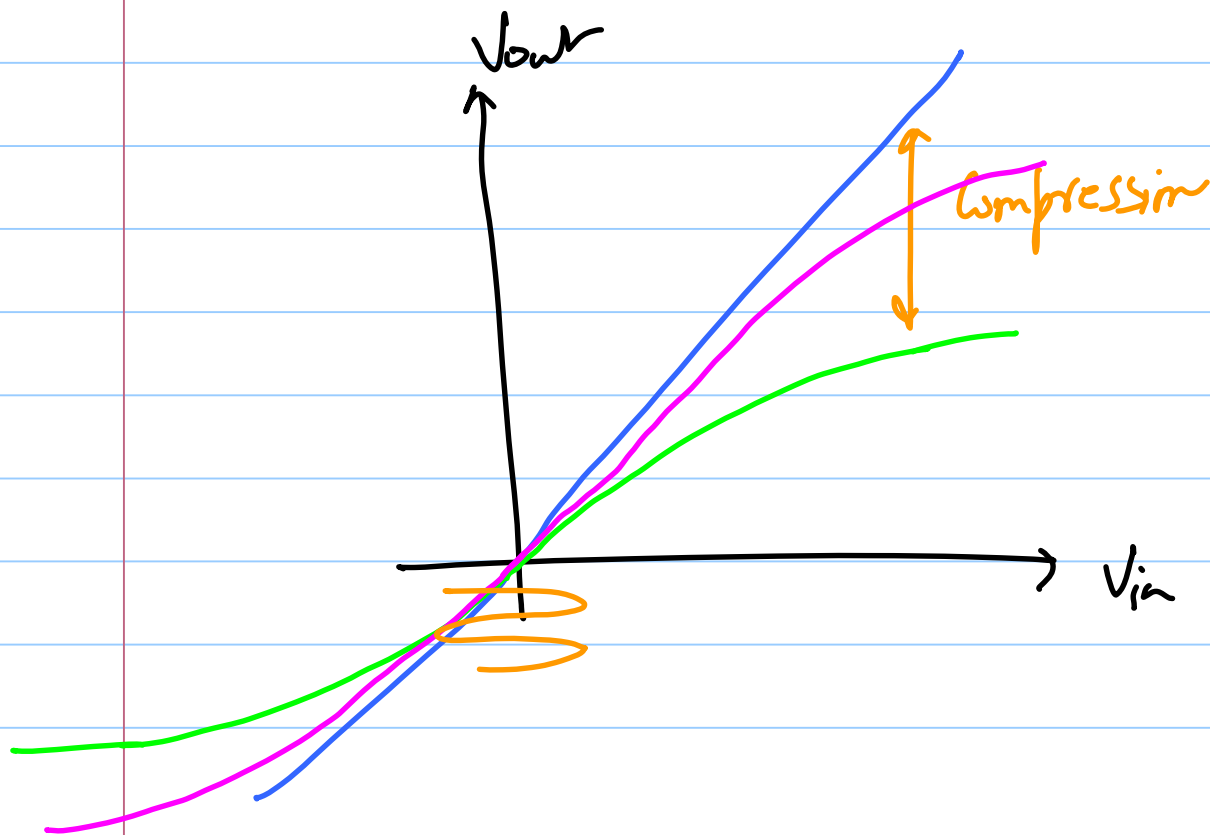
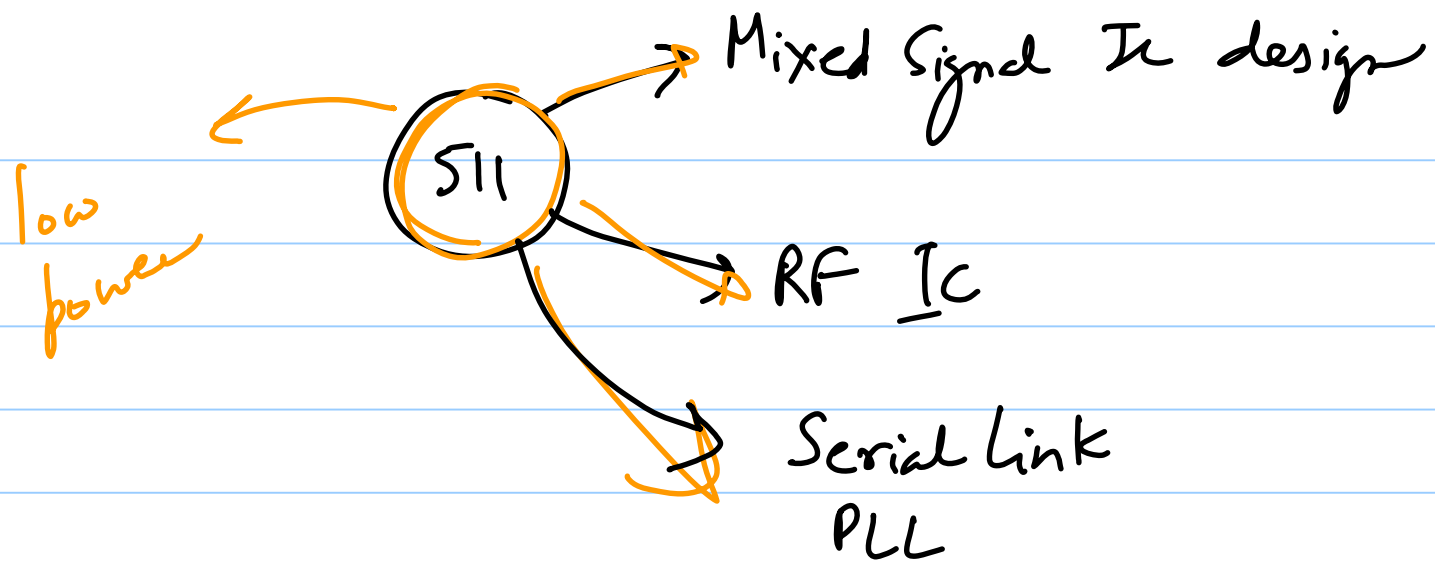
$$f'(V_{in}^*) = 10$$

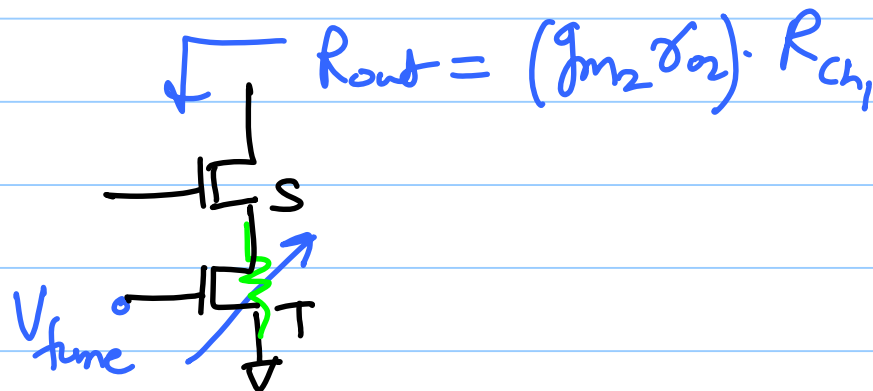
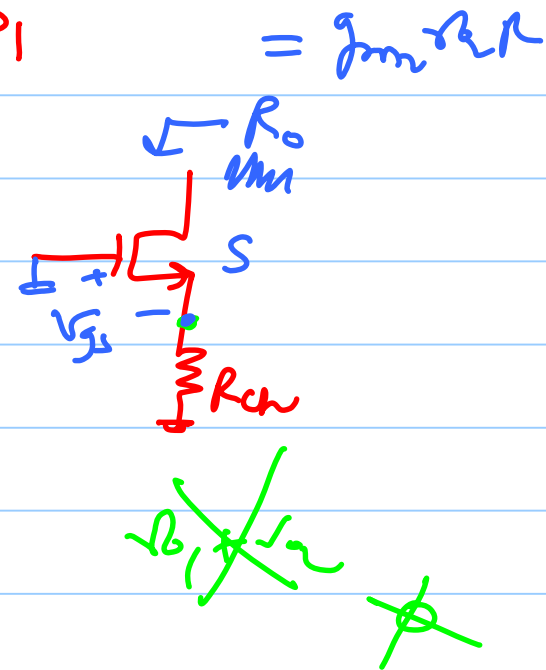
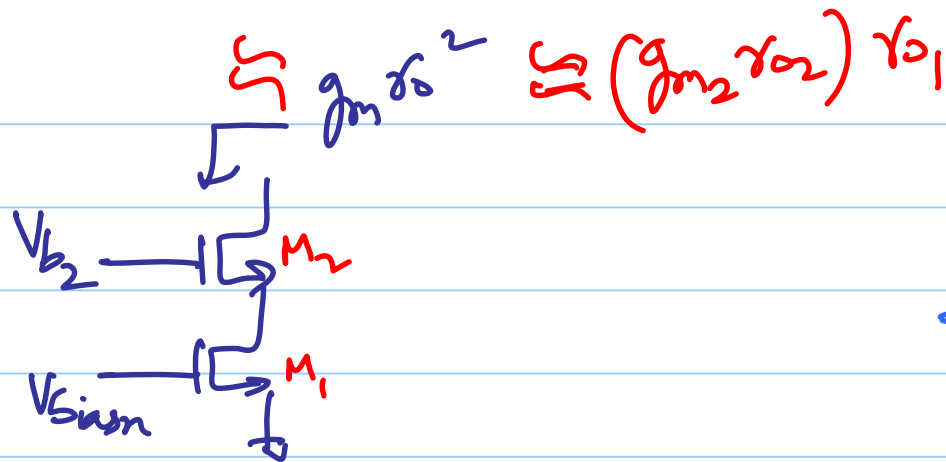
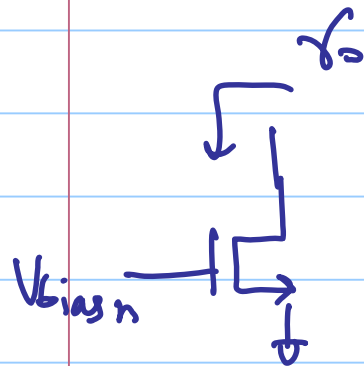
$$V_{in}^*$$

$$5V_A$$

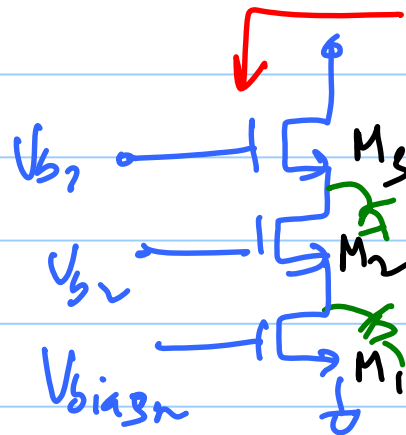
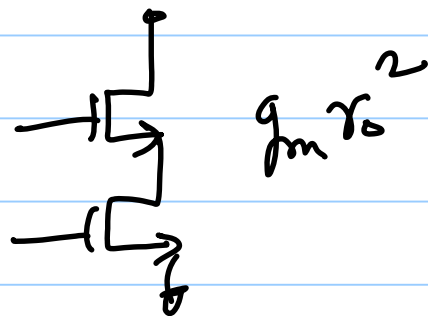
$$V_A \ln 10$$

$$\frac{f''(V_{in}^*)}{2}$$





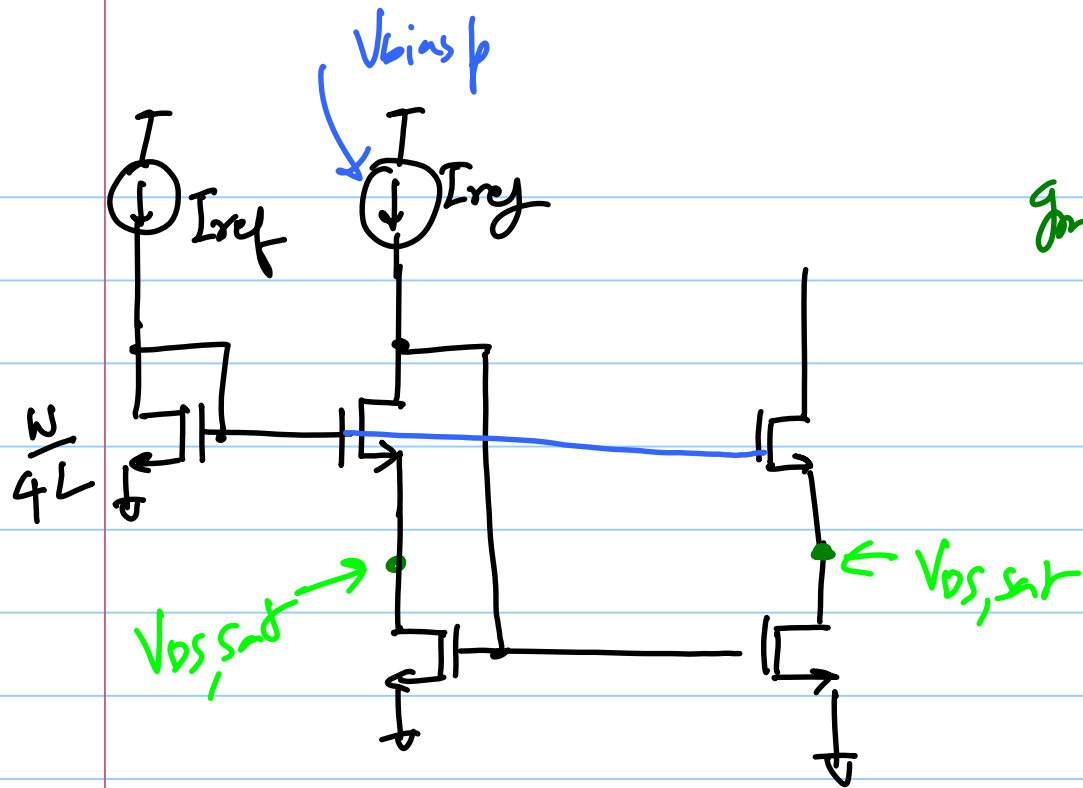
Triple Cascoding



$$g_{m3} r_{o3} (g_{m2} r_{o2} \cdot r_{o1}) \\ \approx g_m^2 r_o^3$$

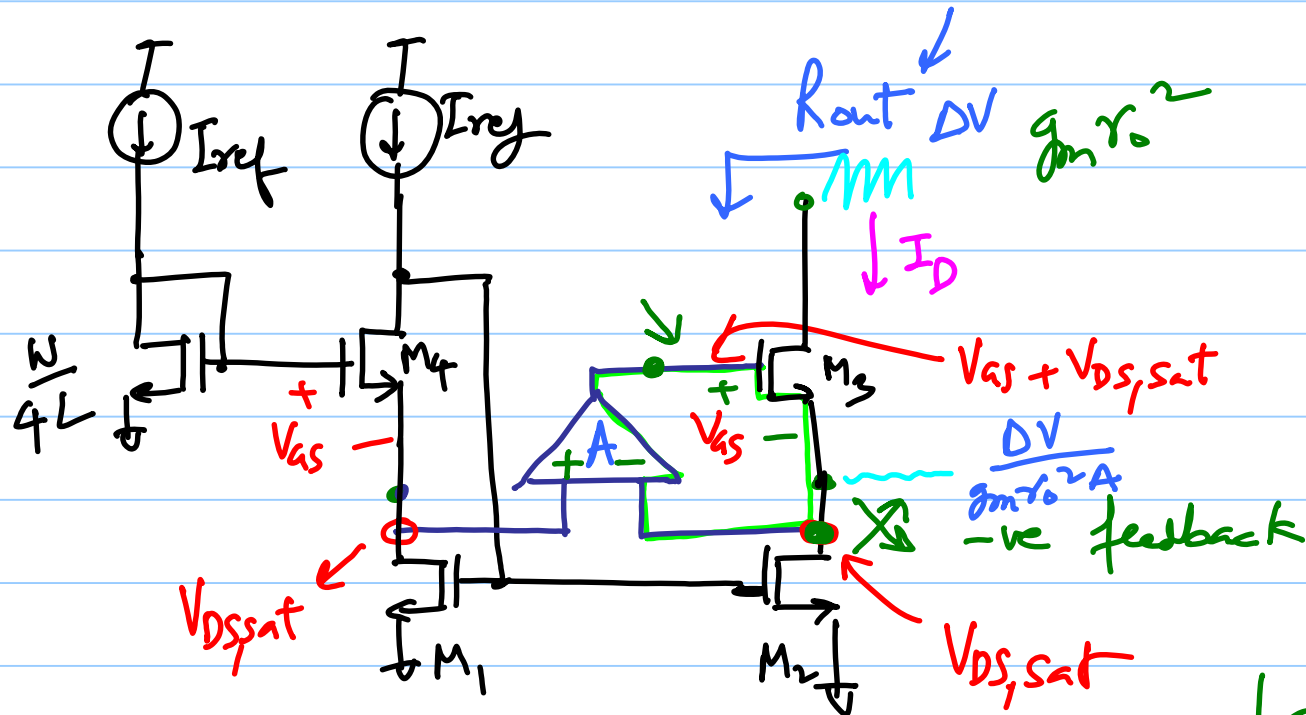
WSCascode

$g_m r_o^2$



$\frac{W}{4L}$

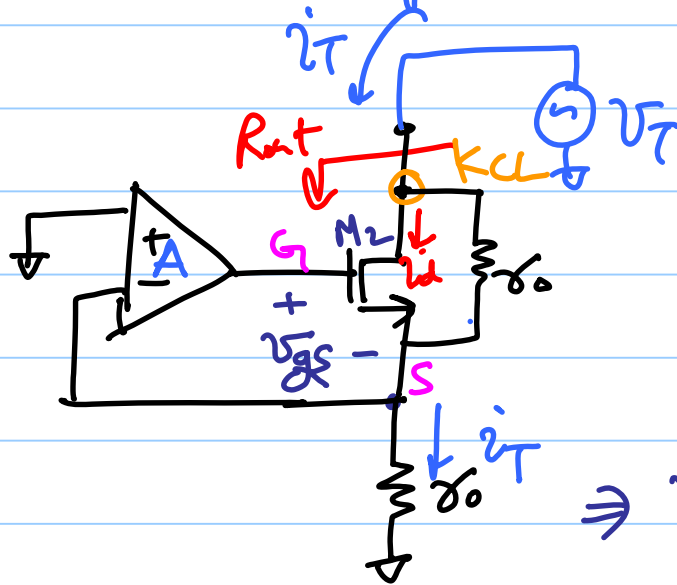
Regulated Drain Current Mirror



Later

↳ Stability & loop compensation

Small-signal analysis



$$v_{gs} = v_g - v_s$$

$$= A(0 - i_T r_o) - i_T r_o$$

$$\Rightarrow v_{gs} = -(A+1)i_T r_o \longrightarrow \textcircled{1}$$

$$i_T - \overbrace{g_m}^{i_d} v_{gs} - \frac{(v_T - i_T r_o)}{r_o} = 0$$

$$\Rightarrow i_T + g_m(A+1)r_o i_T - \frac{v_T}{r_o} + i_T = 0$$

$$\Rightarrow \frac{v_T}{r_o} = i_T [g_m(A+1)r_o + 2]$$

⇒

$$\frac{v_T}{2T} = g_m (A+1) \tau_o^2 + 2\tau_o$$

$$A \gg 1$$

$$R_{out} = g_m (A+1) \tau_o^2 + 2\tau_o$$

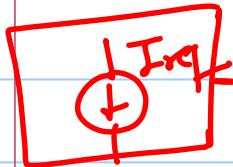
↳ $\underbrace{g_m \tau_o^2}_A$

$R_{out} \uparrow$ by a factor
of A

Let's say

$$A \triangleq g_m \tau_o$$

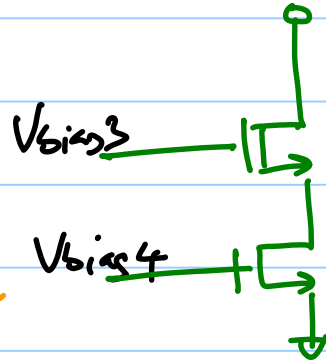
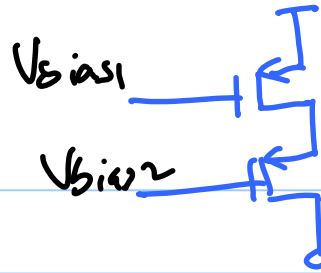
$$R_{out} \triangleq g_m^2 \tau_o^3$$

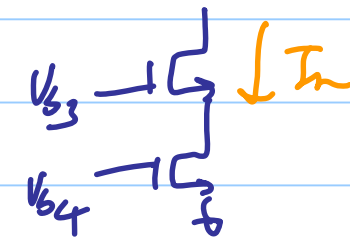
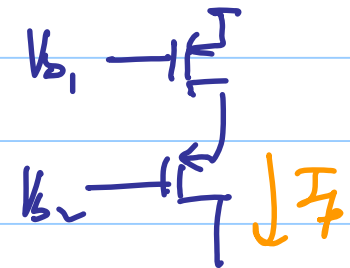
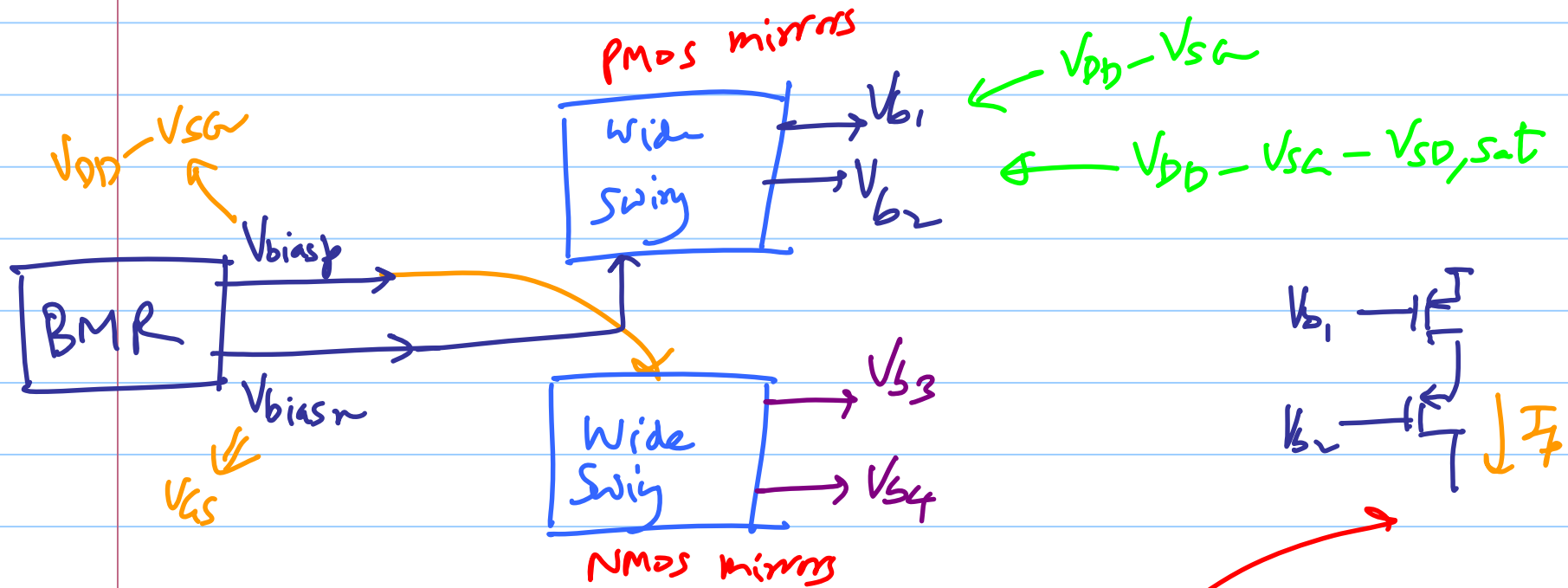


References

BMR $\Leftarrow$ PV indep.

BGR $\Leftarrow$ PVT indep

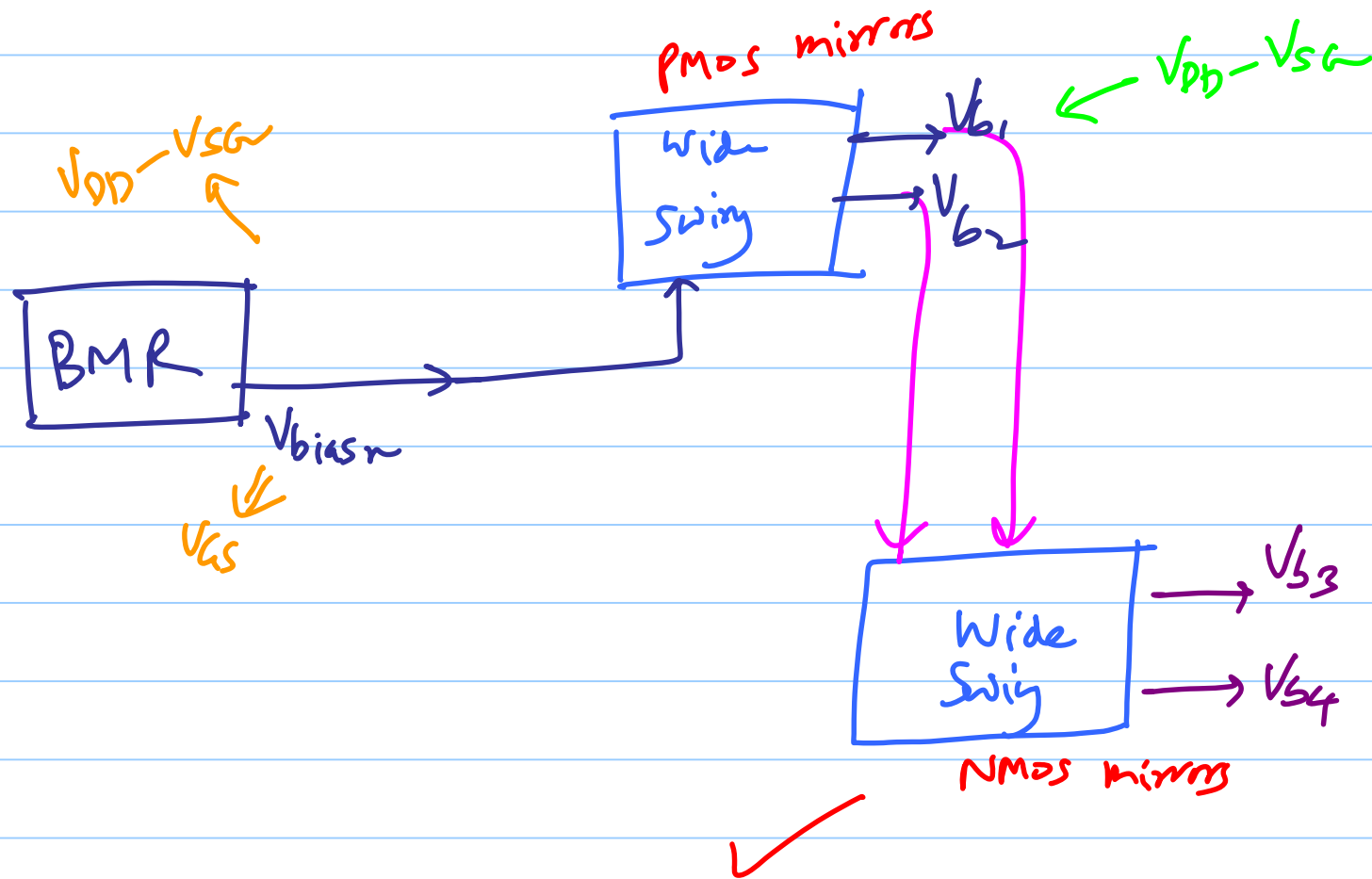




X

more
systematic
mismatch

Chap 20 in CMOS Book



$$V_{S1}: V_{DD} - V_{SA}$$

$$V_{S2} = V_{DD} - (V_{SA} + V_{SD,sat})$$

