

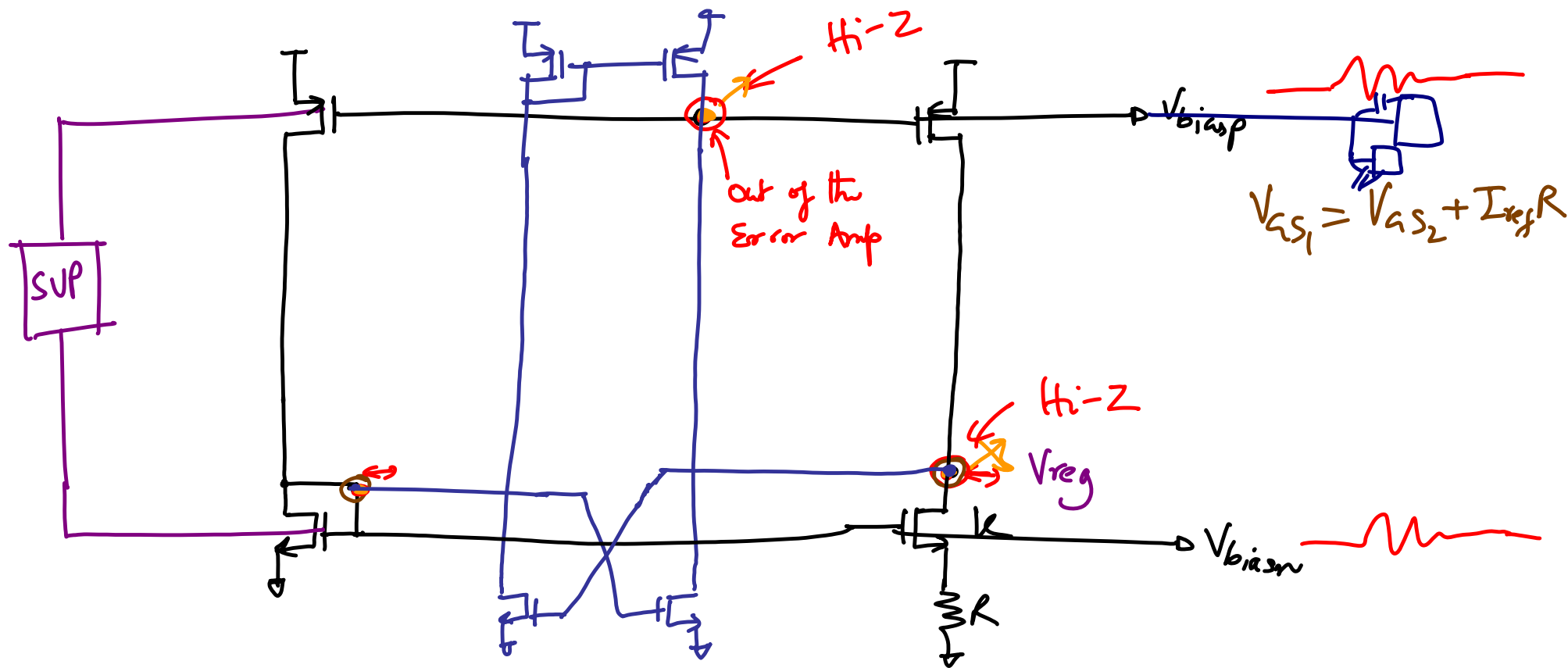
ECE 511- Lecture 9

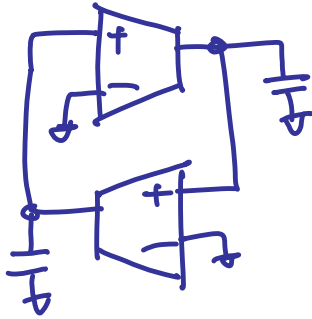
Note Title

2/18/2014

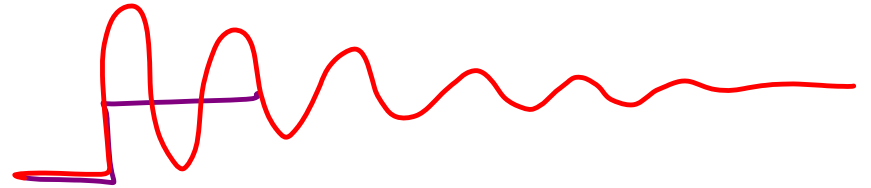
HW#4 due next
Tuesday.

Next Tuesday, Watch
Recorded Lecture
Video.

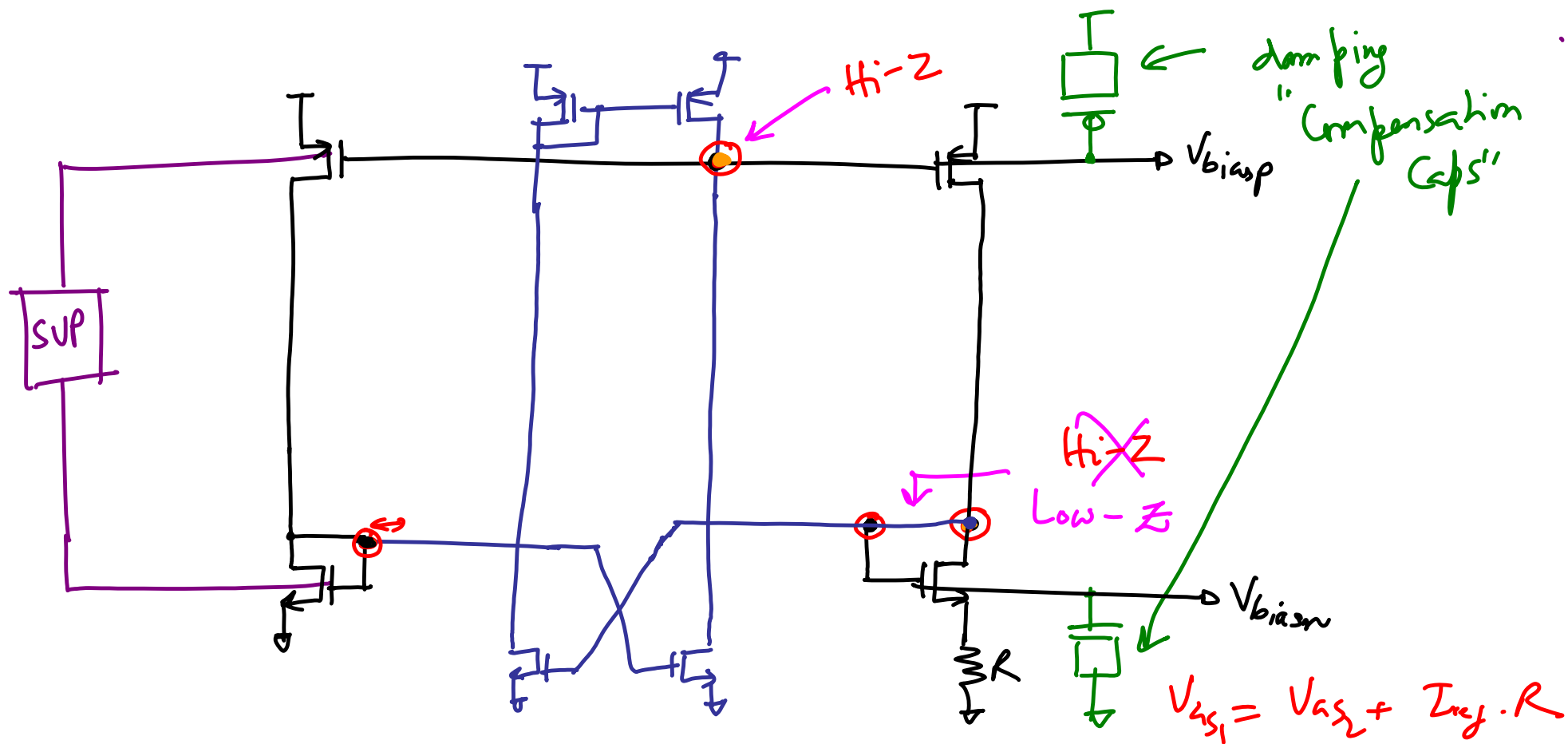




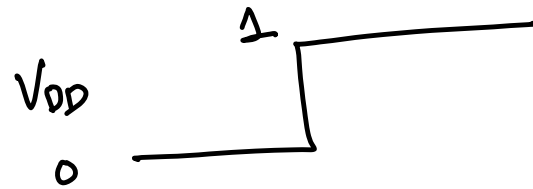
open loop response =
$$\frac{A}{\left(1 + \frac{s}{p_1}\right)\left(1 + \frac{s}{p_2}\right)}$$



* get rid of one hi-z node

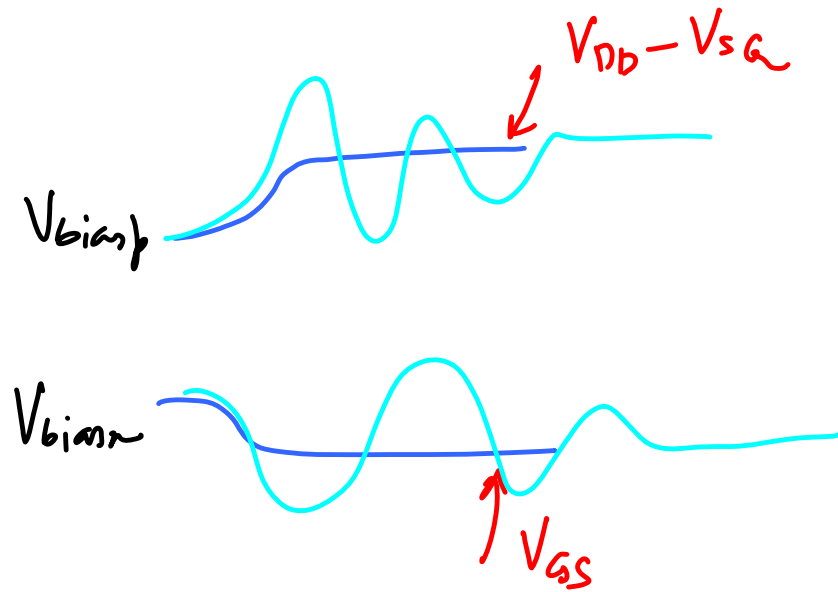


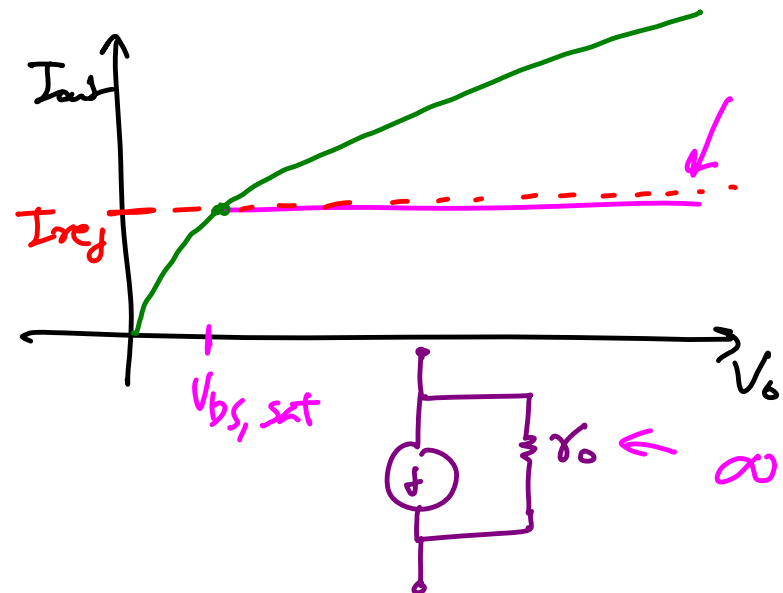
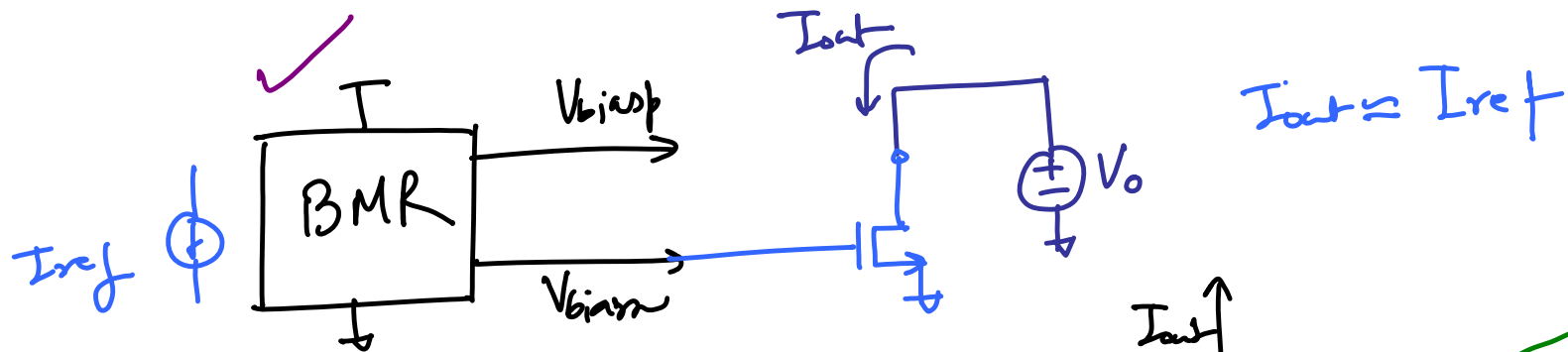
CMOS Fig 20.23

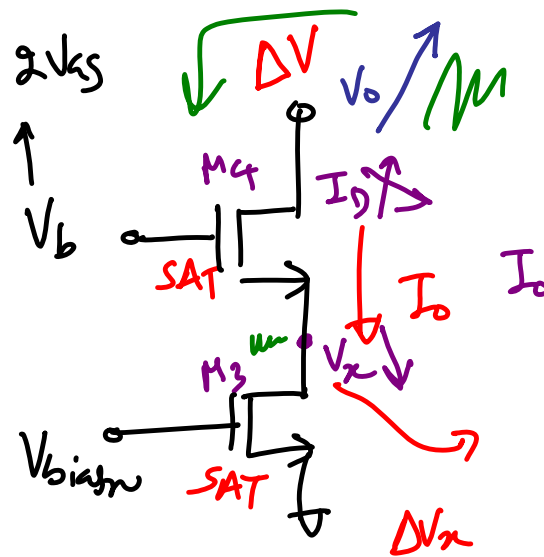
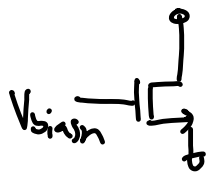


Remove the MosCaps

* Repeat Book Simulations

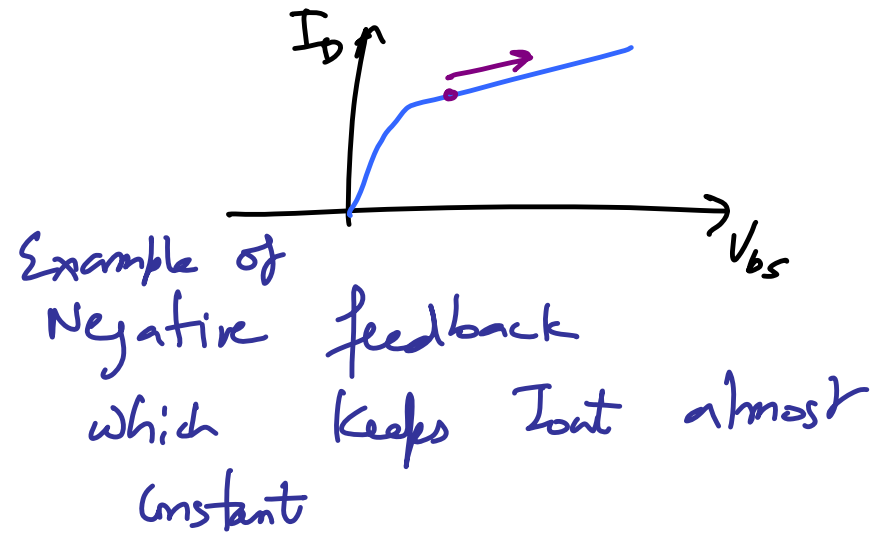




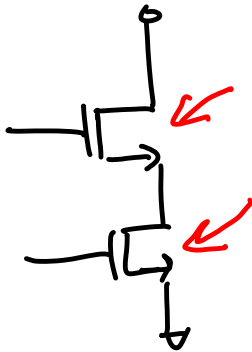


$$\approx \frac{\Delta V}{g_{m4} r_{o4} + 1}$$

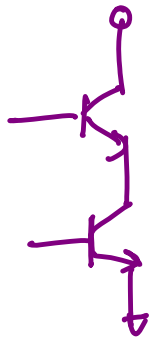
* Rout is increased by $(g_{m4} r_{o4} + 1)$ roughly



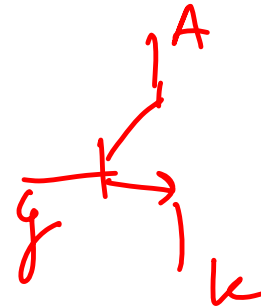
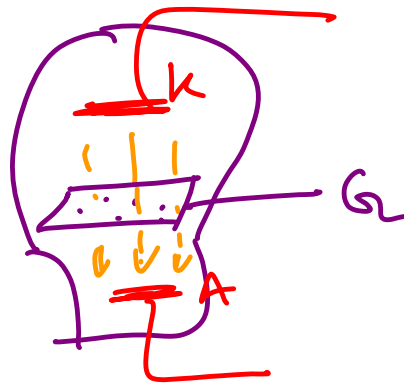
Cascode Current Mirror



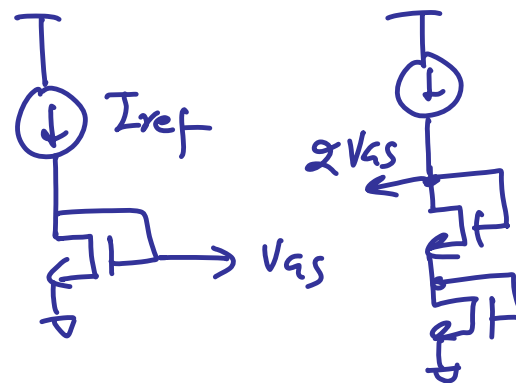
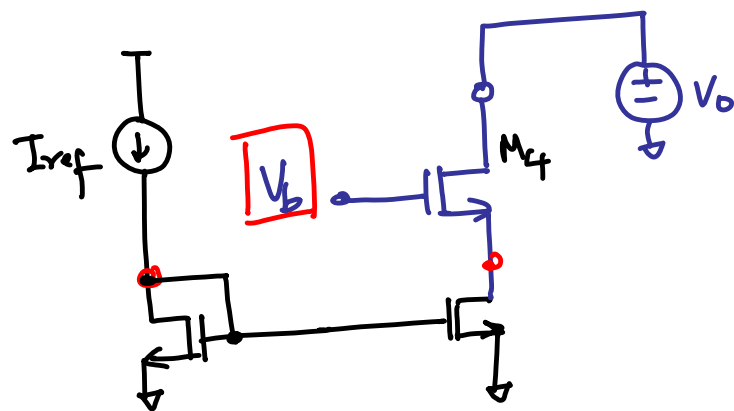
CASCODE $\Rightarrow$ Cascade of Common Cathode and Common Grid Amplifier

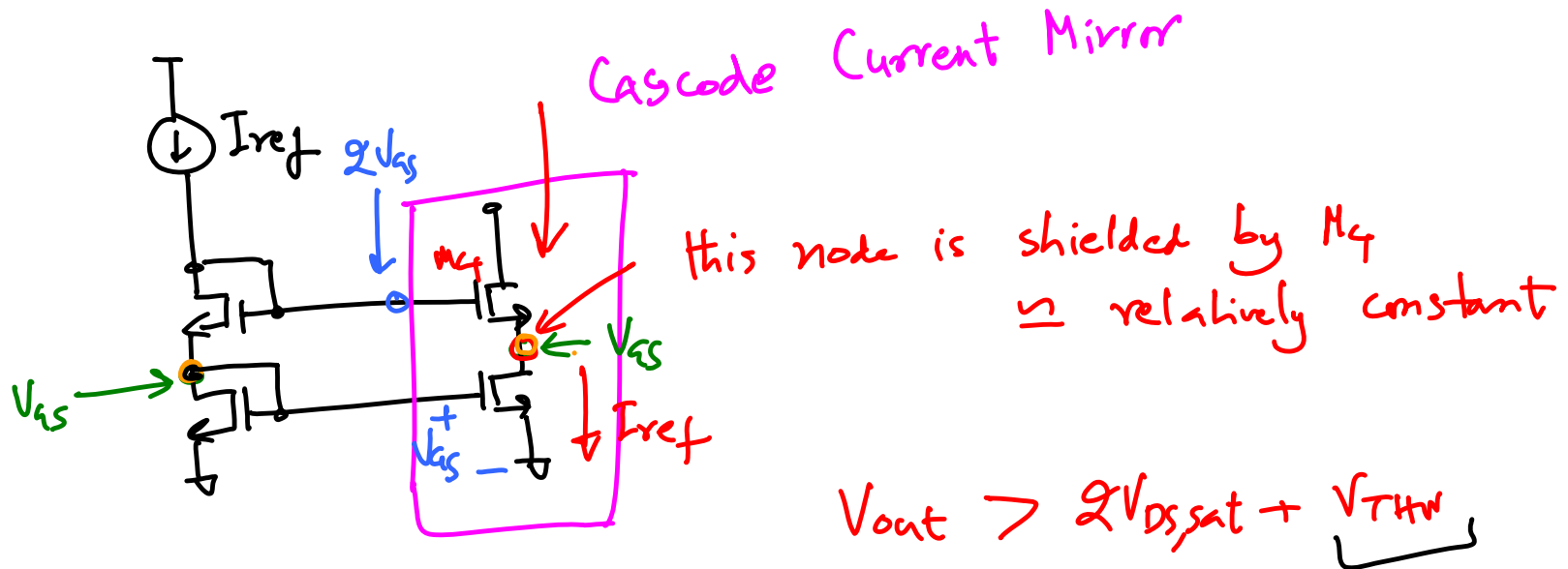


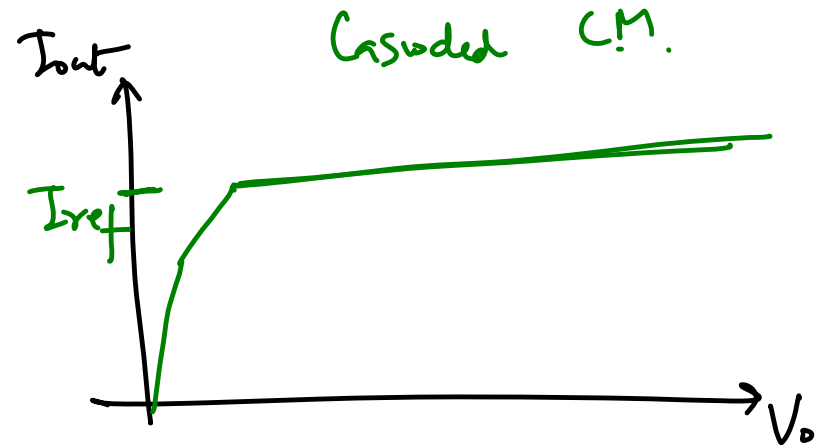
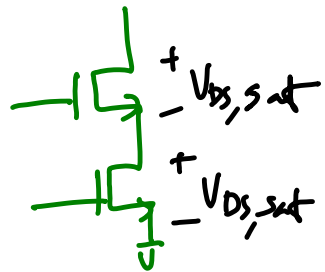
Triode



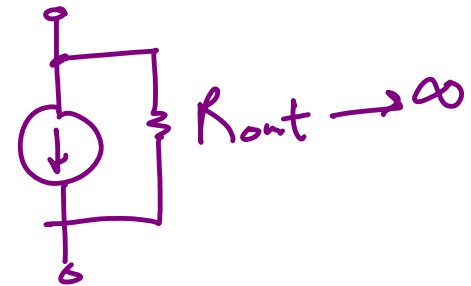
How to generate
 $V_b = 2V_{GS}$?



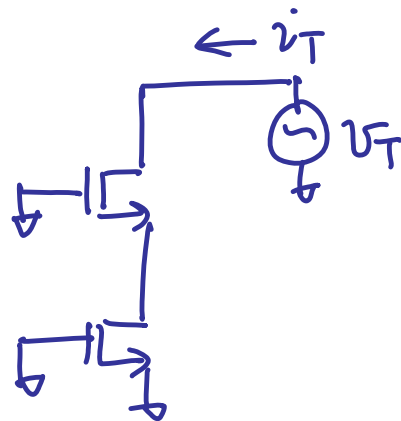
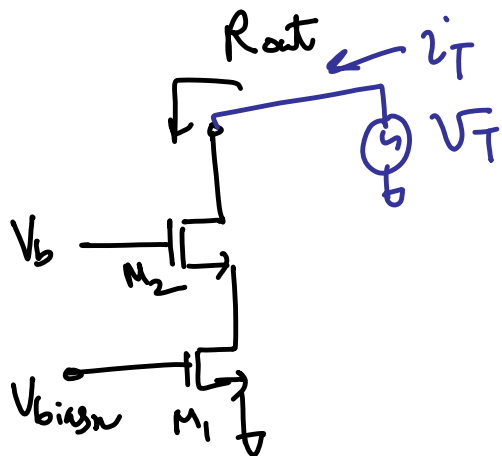


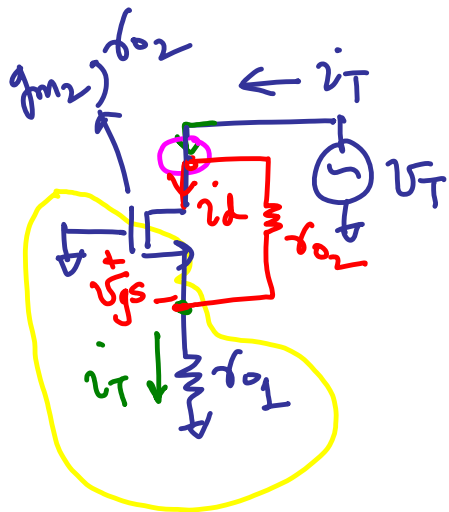


* Very high output
Impedance
 $R_{out} \rightarrow \infty$

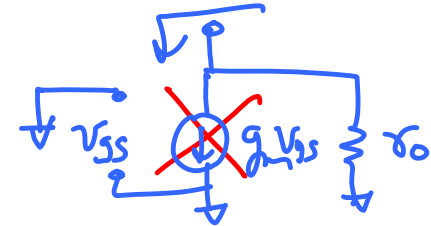


Small-Signal Output Resistance





$$i_d = g_{m2} V_{gs}$$



KVL:

$$V_{gs} + i_T r_{o1} = 0 \Rightarrow \boxed{V_{gs} = -i_T r_o} \longrightarrow \textcircled{1}$$

KCL:

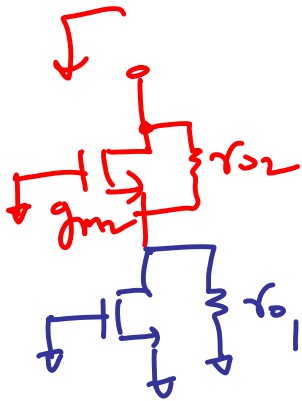
$$i_T - \overbrace{g_{m2} V_{gs}}^{i_d} - \underbrace{\frac{V_T - (-V_{gs})}{r_{o2}}}_{i_{r_{o2}}} = 0 \longrightarrow \textcircled{2}$$

Eliminate v_{gs} :

$$i_T + g_{m2} r_{o2} i_T - \frac{v_T}{r_{o1}} + i_T = 0$$

$$\Rightarrow \frac{v_T}{r_{o1}} = i_T (g_{m2} r_{o2} + 2)$$

$$R_{out} = \frac{v_T}{i_T} = (g_{m2} r_{o2} + 2) r_{o1} \\ \hookrightarrow 2r_o + g_m r_o^2$$



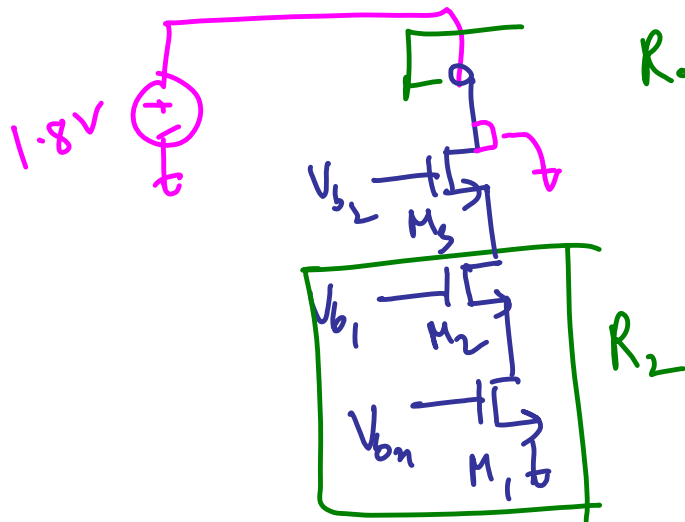
$$R_{out} = g_m r_o^2 + 2r_o \leftarrow$$

$$= (g_{m2} r_{o2}) r_{o1} + r_{o1} + r_{o2}$$

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

* R_{out} has gone up from r_o to $g_m r_o^2$
 $\downarrow$ $5M\Omega$ $750M\Omega$

Triple Cascode



$$\begin{aligned} R_{\text{out}} &= (g_{m3} \tau_{o3}) R_2 \\ &\cong (g_{m3} \tau_{o3}) (g_{m2} \tau_{o2}) \tau_{o1} \\ &\cong g_m^2 \tau_o^3 \end{aligned}$$