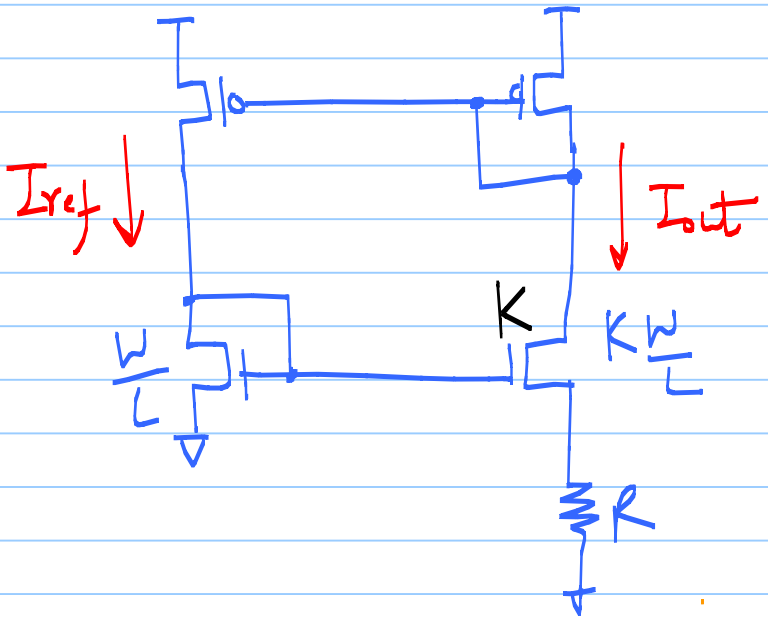
ECE 511 – Lecture 7

Note Title 2/8/2012

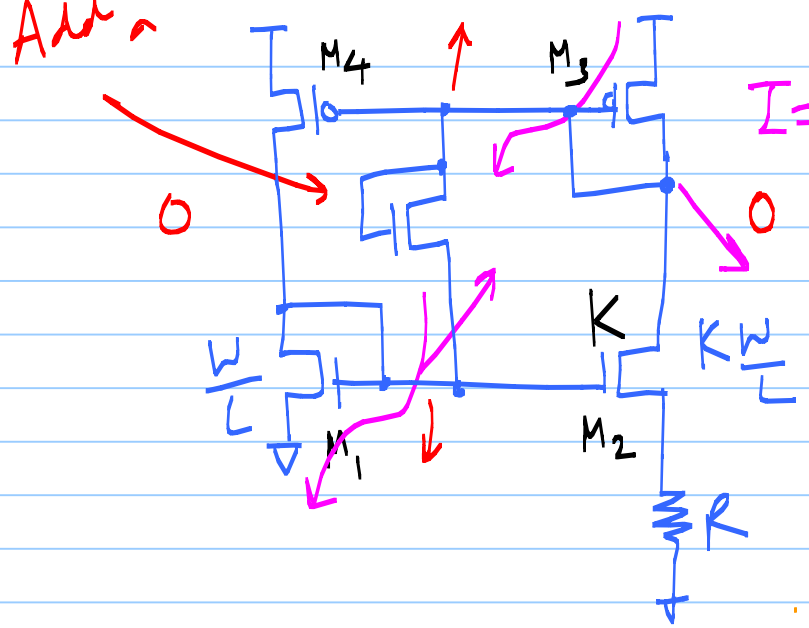
BMR

$$I_{out} = I_{ref} = \frac{2}{\beta R^2}\left(1 - \frac{1}{\sqrt{K}}\right)^2$$

$= 0$

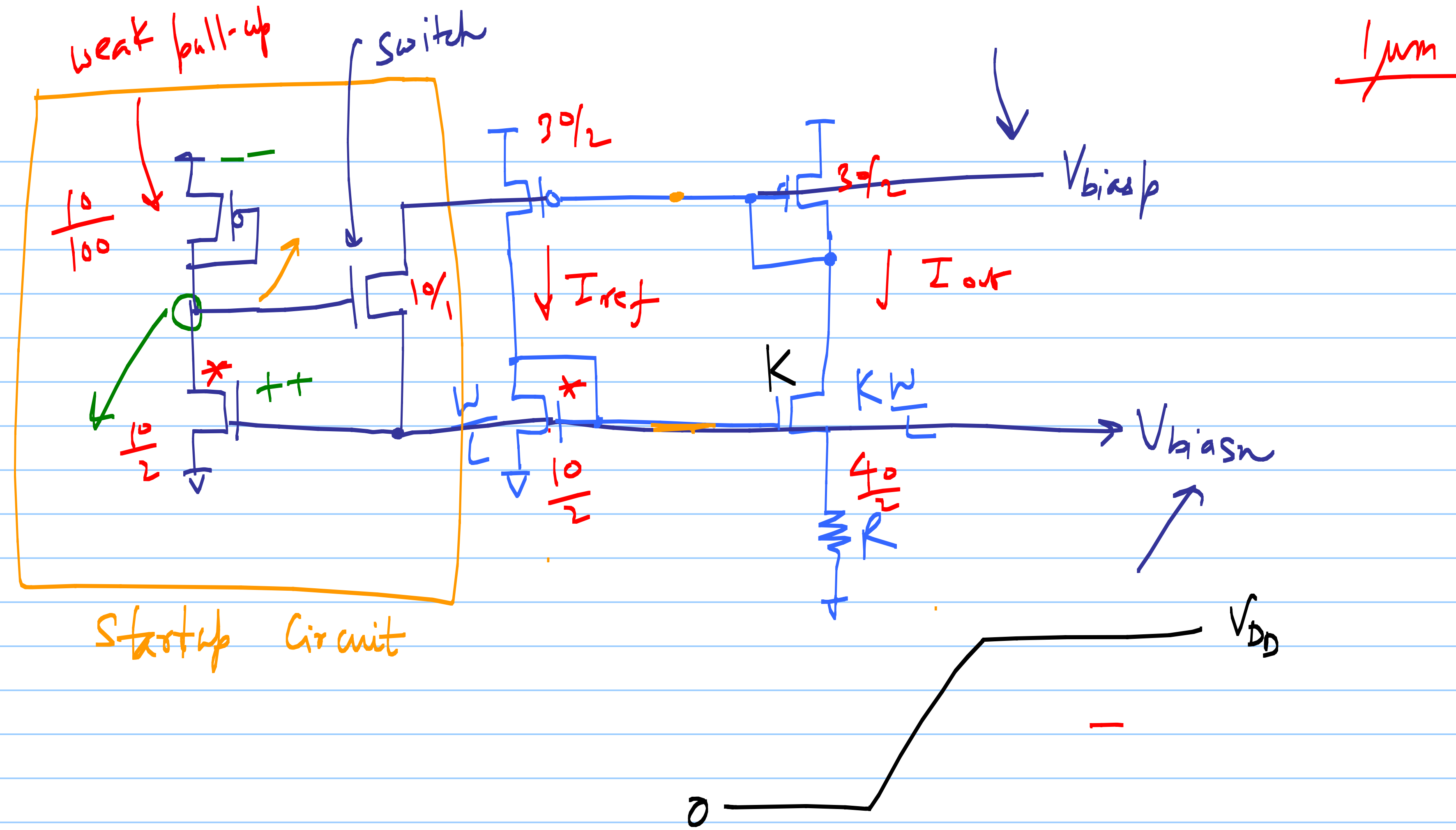


Add diode



$$I = \frac{2}{\beta R^2}\left(1 - \frac{1}{\sqrt{K}}\right)^2$$

Not a good start-up circuit


weak pull-up
Switch
10/100
10/1
10/2
30/2
Iref
Iout
K
KW/L
40/2
R
Vbiasp
Vbiasn
Startup Circuit
VDD
0
1μm

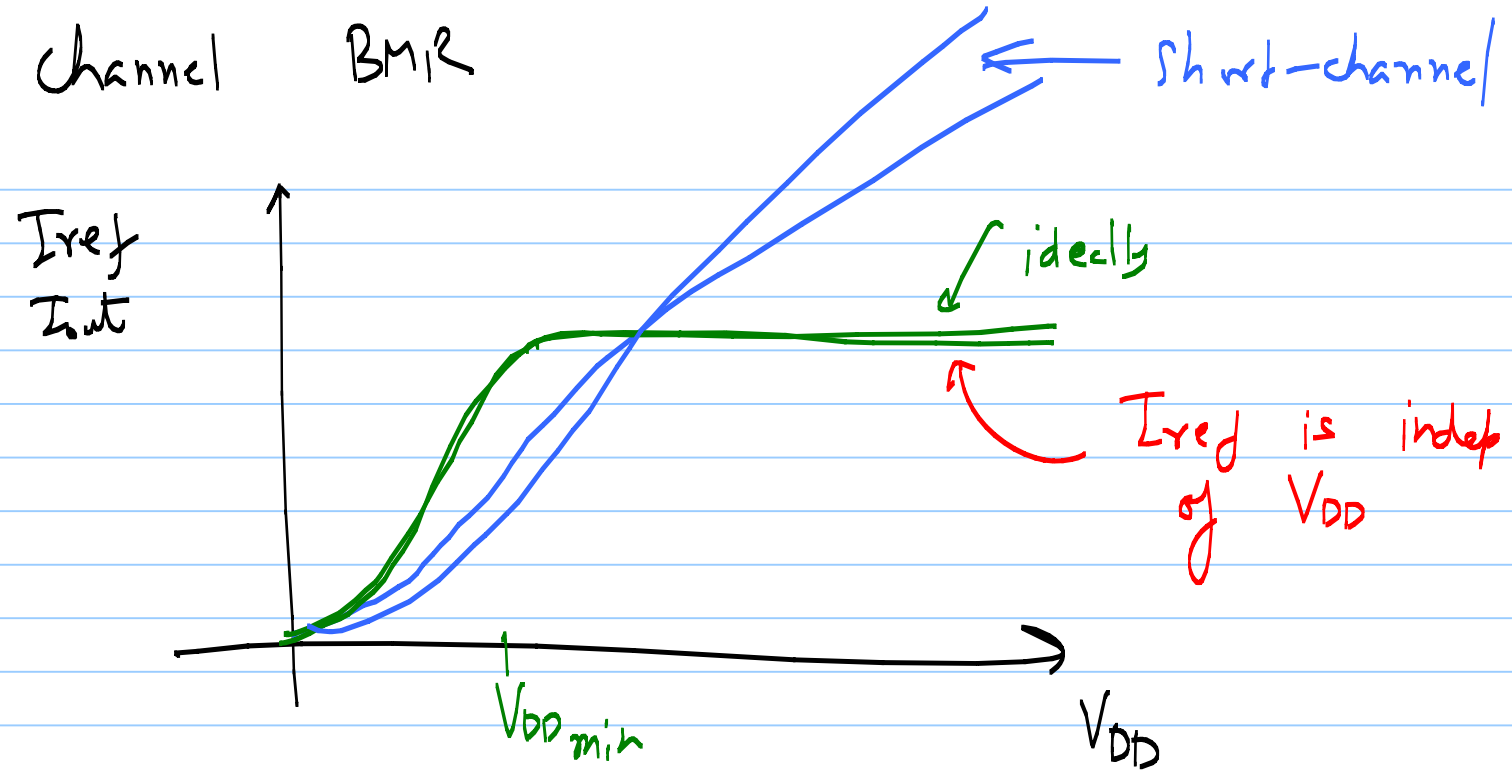
* BMR uses +ve feedback

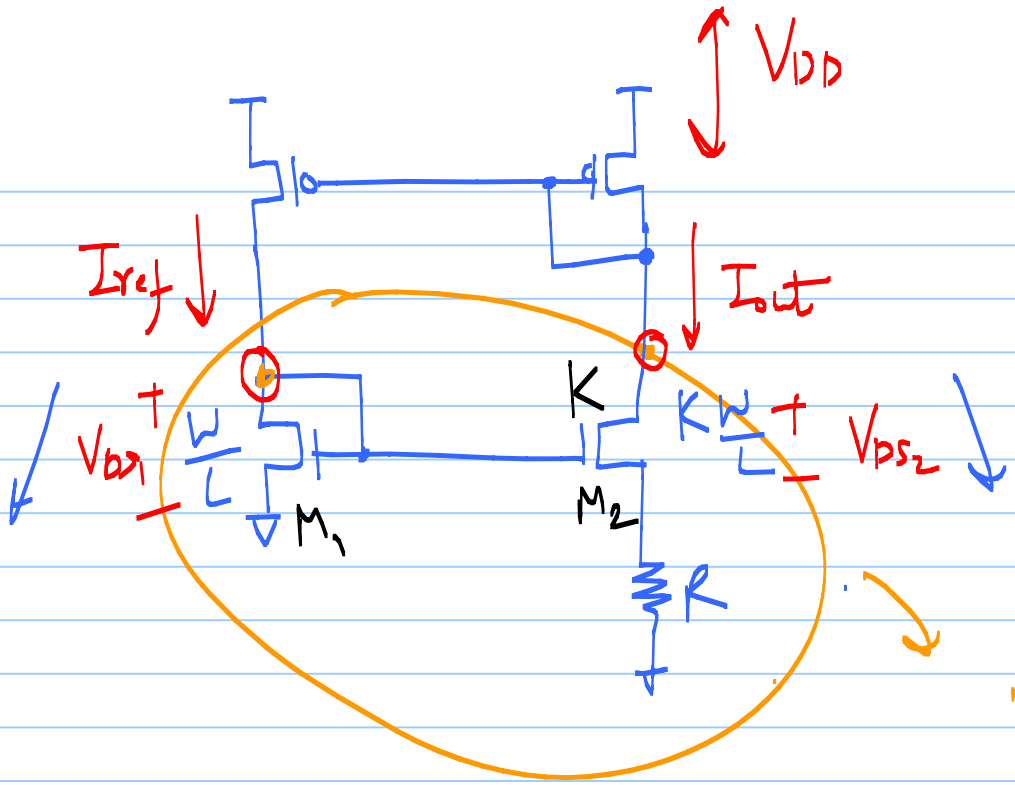
↳ loop gain < 1

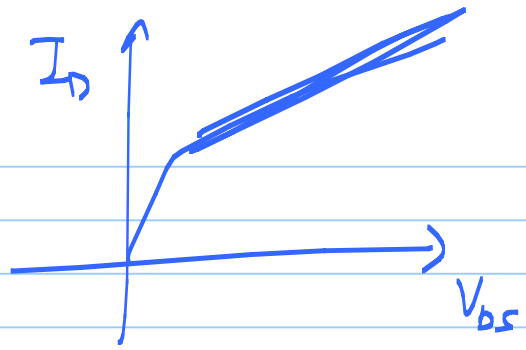
↳ fast action

↳ Analysis is skipped.

Short Channel BMR





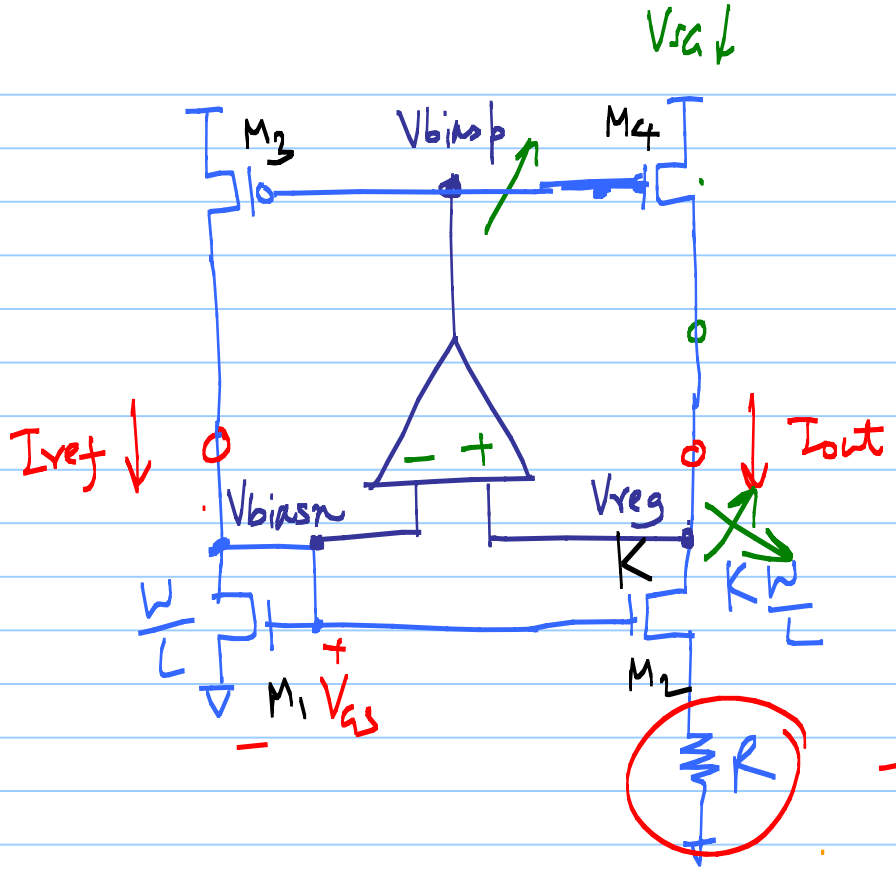


$\lambda \neq 0$

V_{DS} variation causes

↳ I_{ref} & I_{out} mismatch

↳ V_{DD} sensitivity



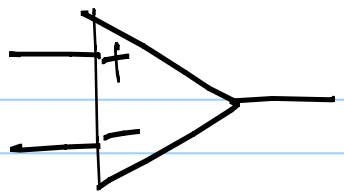
$V_{biasp} = V_{DD} - V_{SG}$

$V_{biasn} = V_{GS}$

ensure overall −ve feedback.

$V_{reg} \overset{D}{=} V_{biasn}$

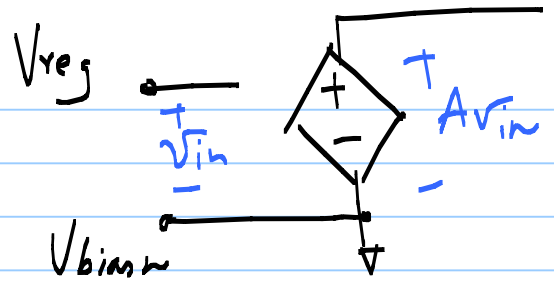
$I_{ref} \neq \frac{2}{\beta R^2}\left(1 - \frac{1}{\sqrt{K}}\right)^2$

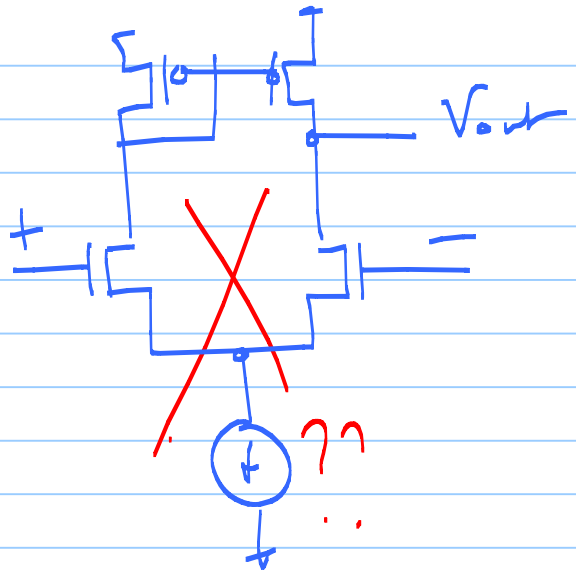


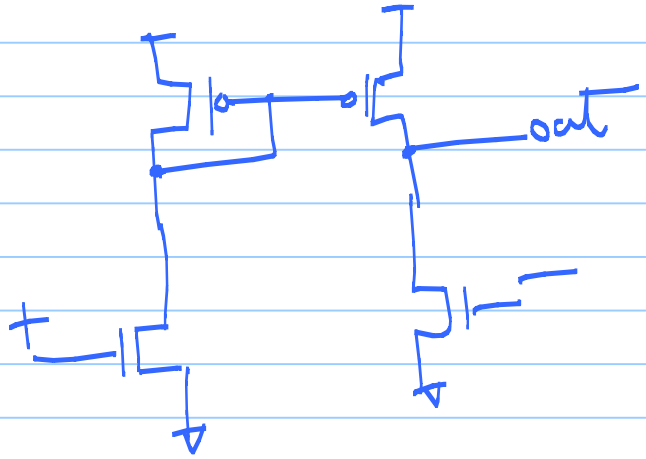
VCCS

gain $\Rightarrow$ A

$= 10$.

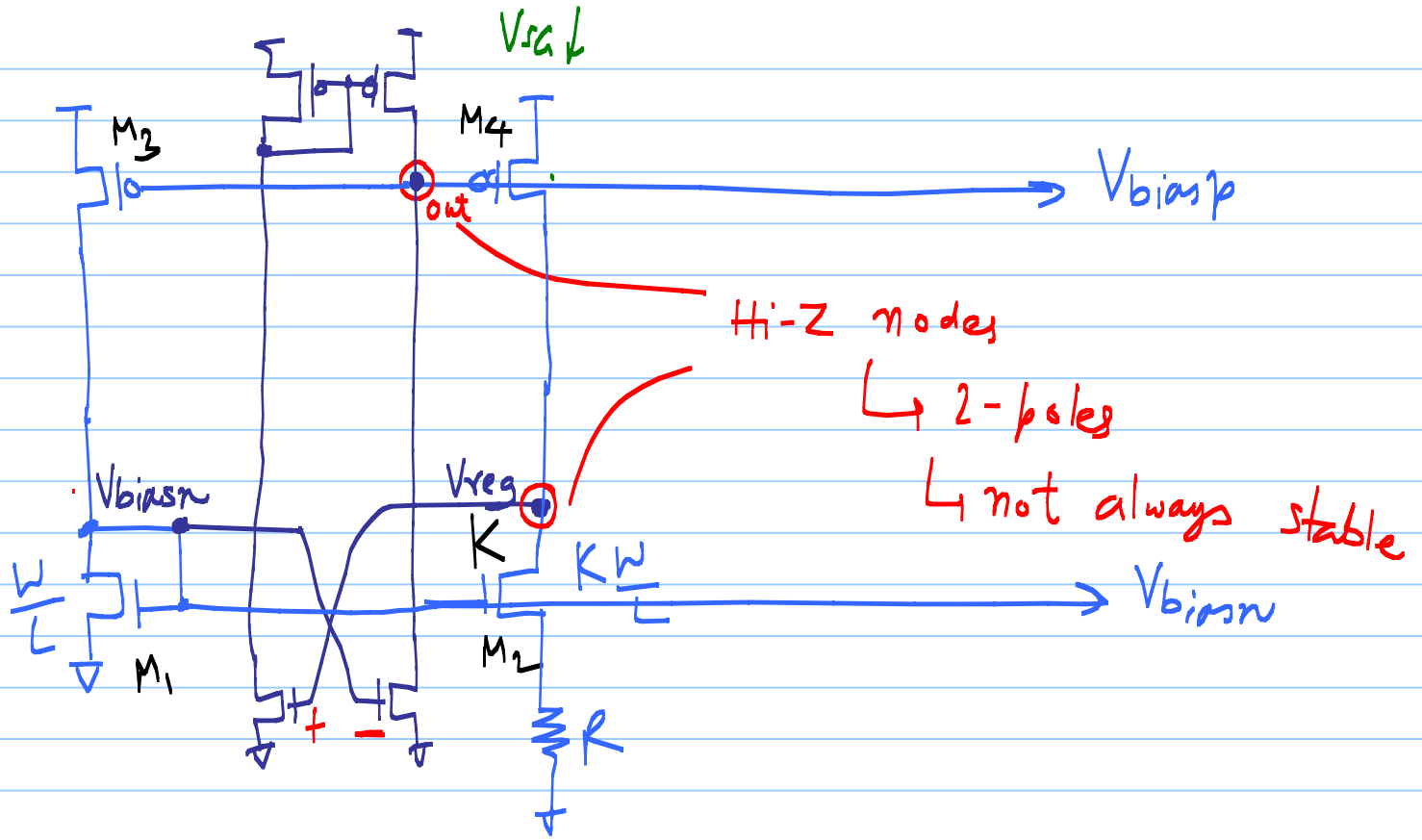


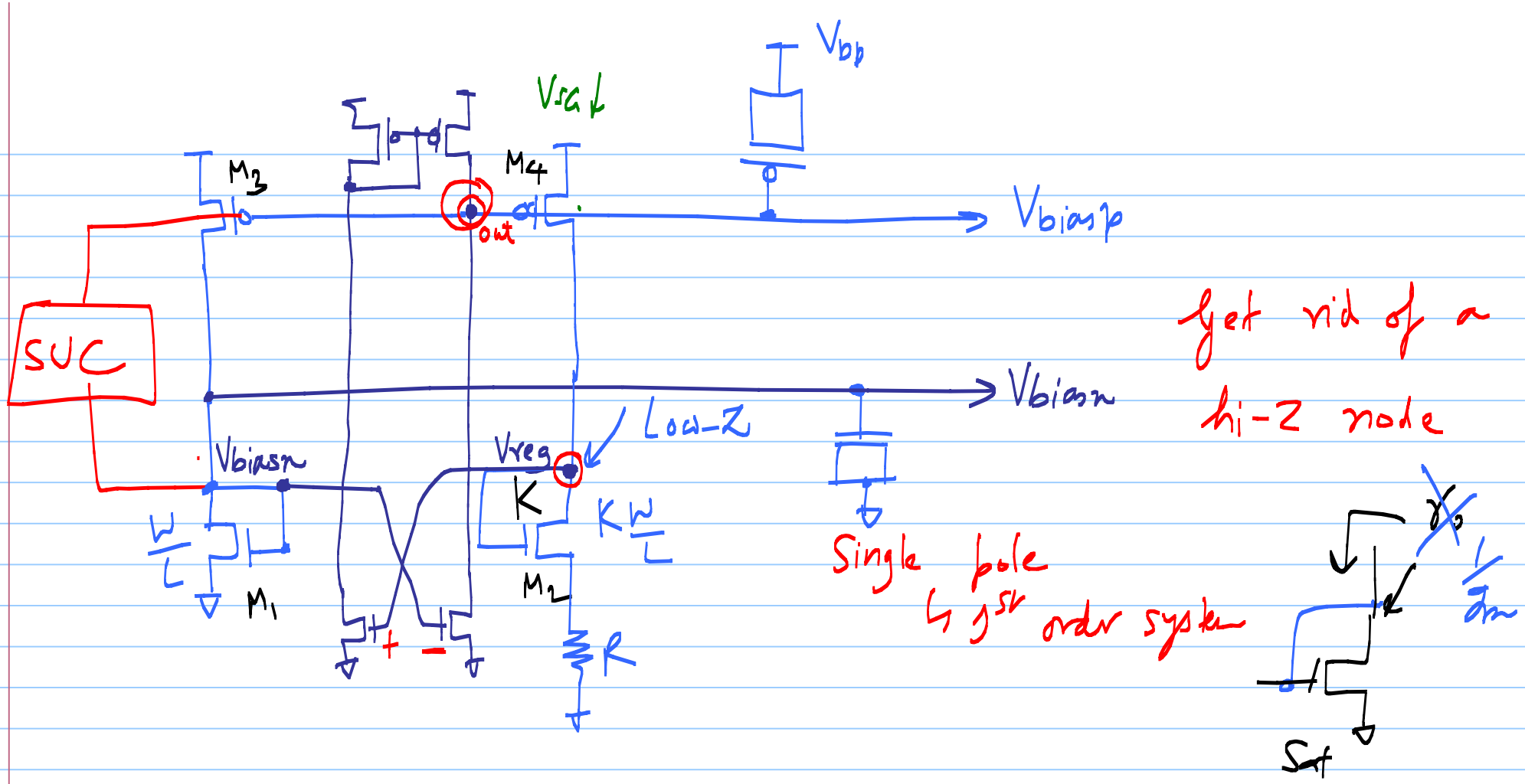




g_m

No precision bias needed.

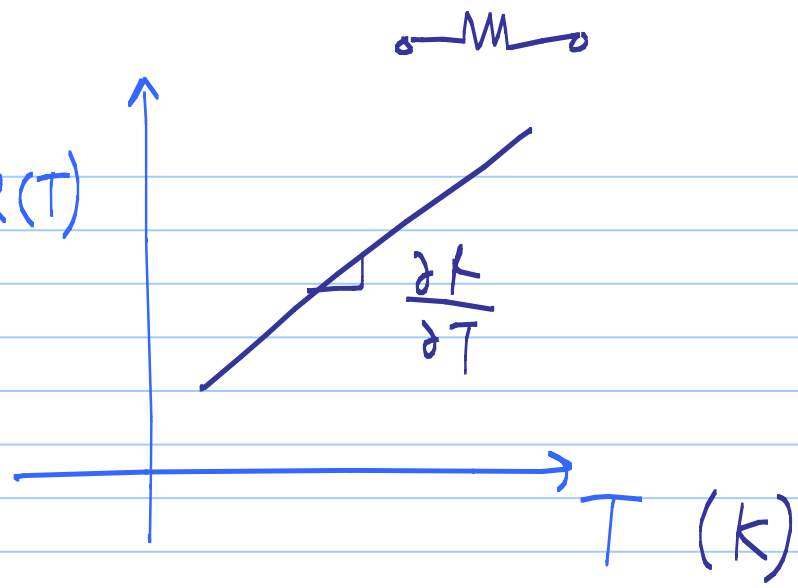

Vref
M3
M4
out
Vbiasp
Hi-Z node
↳ 2-poles
↳ not always stable
Vbiasn
Vreg
K
KW
W/L
M1
M2
+
−
R


Vbp
Vreg
M3
M4
out
Vbiasp
SUC
Vbiasn
Low-Z
Vreg
K
KW/L
W/L
M1
M2
R
+
−
Single pole
↳ 1st order system
get rid of a
hi-Z node
Sat

Temp. Coeff for a Resistor

$$TCR = \frac{1}{R}\cdot\left(\frac{\partial R}{\partial T}\right) \simeq 1000 \text{ ppm/}^{\circ}C$$

$$TC_{Kelvin} = \frac{-1.5}{T} = \frac{-1.5}{300} \text{ @ } 27^{\circ}C$$



BMR

$$I_{ref} = \frac{2}{K_{n}\frac{W}{L}R^2}\left(1-\frac{1}{\sqrt{K}}\right)^2$$

$$TC_{BMR} = \frac{\left(\frac{\partial I_{ref}}{\partial T}\right)}{I_{ref}} = -2\left(\frac{1}{R}\cdot\frac{\partial R}{\partial T}\right) - \frac{1}{K_n}\cdot\frac{\partial K_n}{\partial T}$$

$$= -2\cdot TCR - TC_{K_n}$$

$$= -0.002 + \frac{1.5}{300} \leq 1000\ ppm/^{\circ}C \neq 0$$

$TC_{Iref} \neq 0$

Not Temp independent

↳ Bandgap References (BGR) → Chap-25