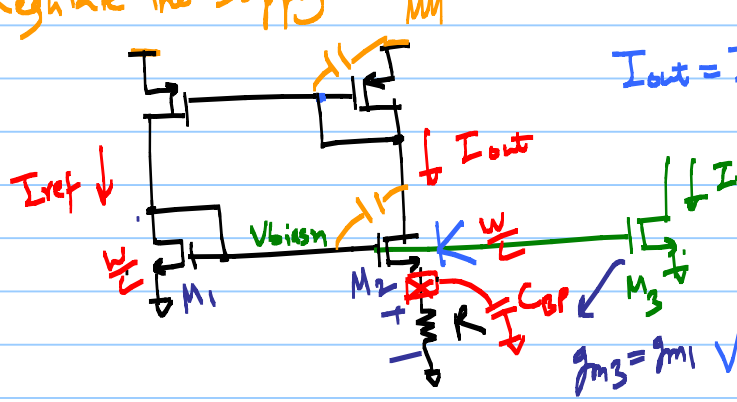
ECE 511 – Lecture 6

Note Title 2/7/2013

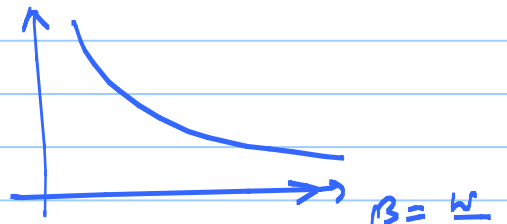
Regulate the supply



$$I_{out} = I_{ref} = \frac{2}{\beta R^2}\left(1-\frac{1}{\sqrt{K}}\right)^2 \neq 0$$

$g_{m3} = g_{m1}$ V_{ov}

$V_{GS_1} = V_{GS_2} + I_{out} \cdot R$



$\lambda > 0 \Rightarrow V_{DD}$ dependence

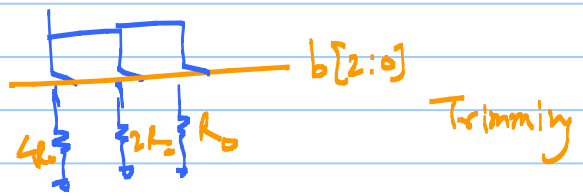
$$I_D = \frac{\beta}{2} V_{ov}^2$$

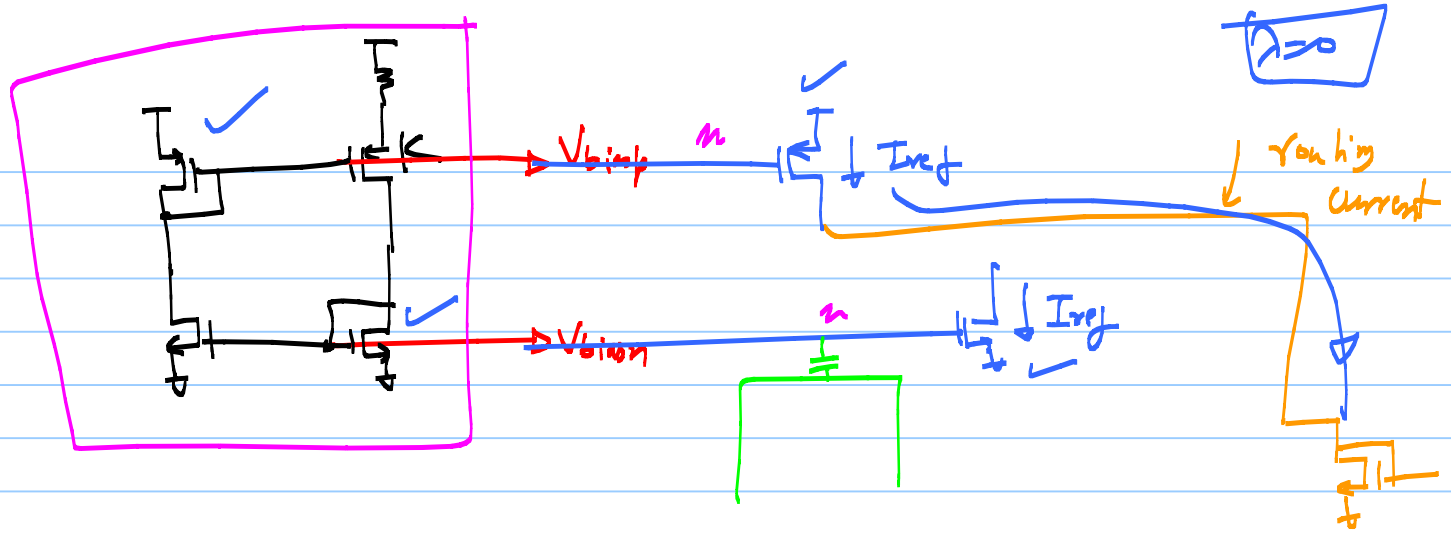
g_m of $M_1 \Rightarrow$ $g_{m_1} = \sqrt{2\beta \cdot I_{REF}}$

$\Rightarrow g_{m_1} = \frac{2}{\boxed{R}}\left(1 - \frac{1}{\sqrt{K}}\right)$ ← indep of V_{DD}

Constant g_m - biasing circuit

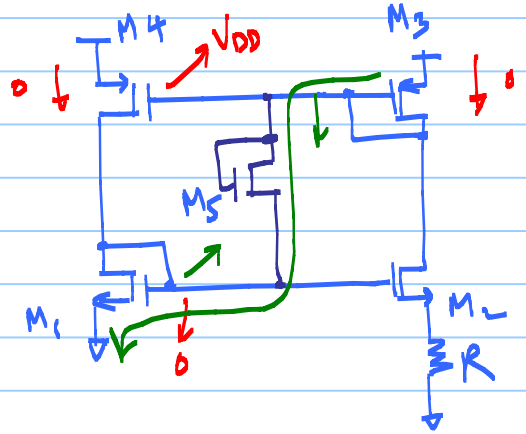
for $K = 4 \Rightarrow g_{m_1} = \frac{1}{R}$



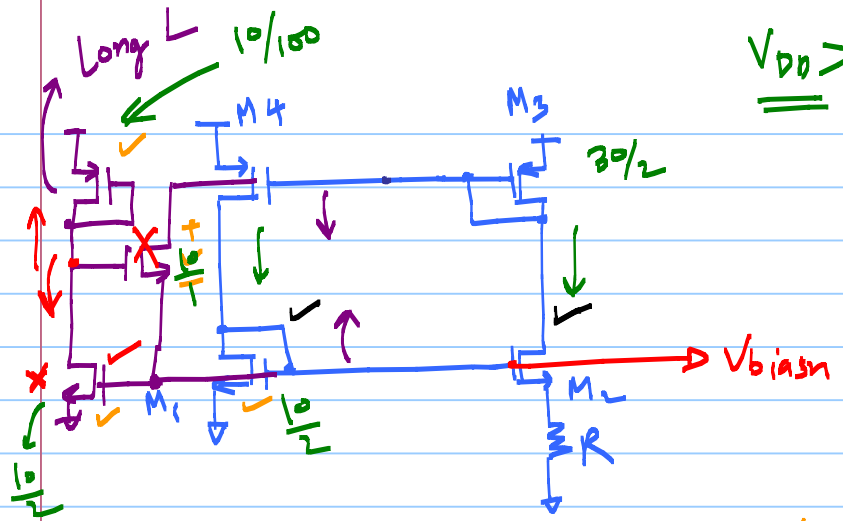


* routing current is better than routing voltages over large distance

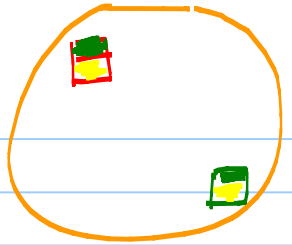
Start-up problem

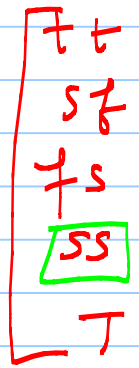


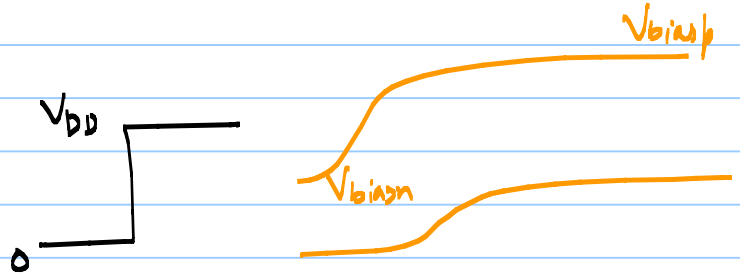
M_5 provides current path
↳ turns M_1 & M_3 ON
↳ M_2 & M_4 ON



$V_{DD} > V_{GS_1} + V_{SD_4}$



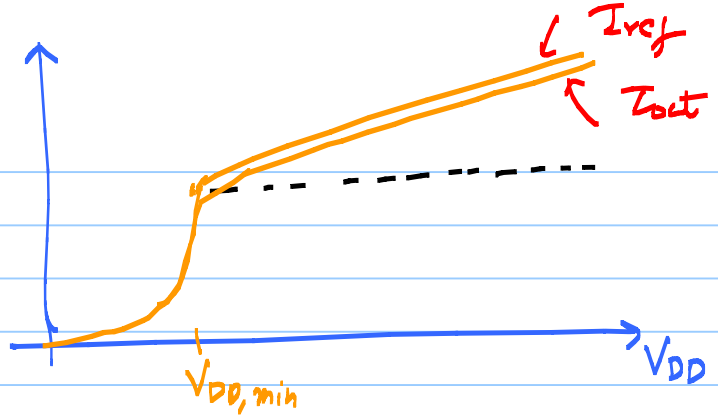




* in all process corners

fig 20.18

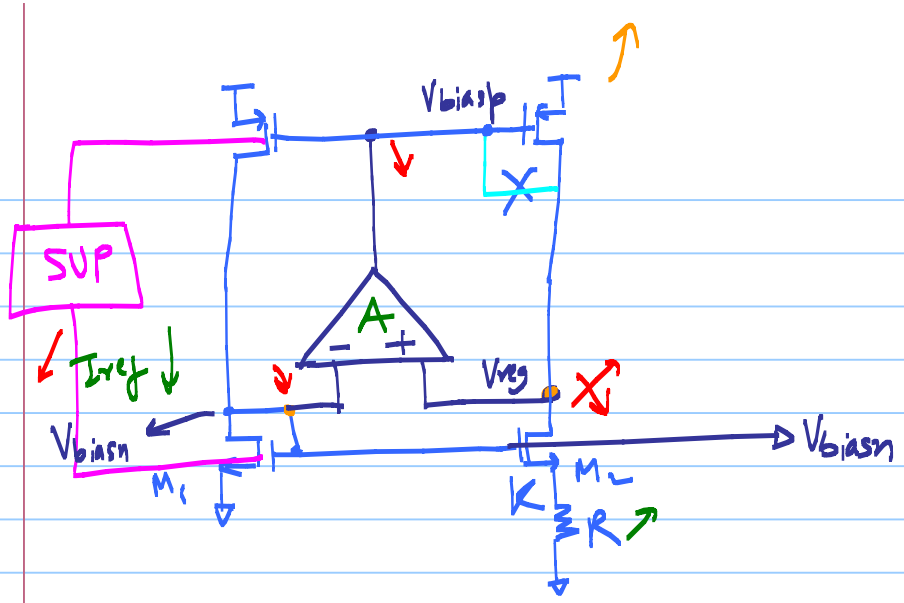
50nm CMOS



bad supply sensitivity

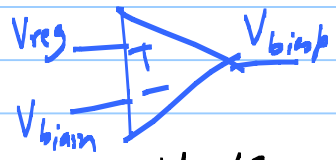
⇒ reduce V_{DD} sensitivity

⇒ reduce V_{DS} variation

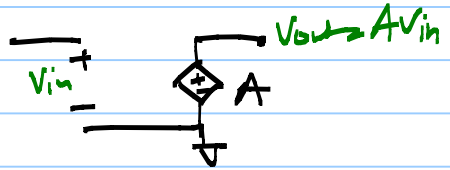


$I_{out} \neq I_{ref}$

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

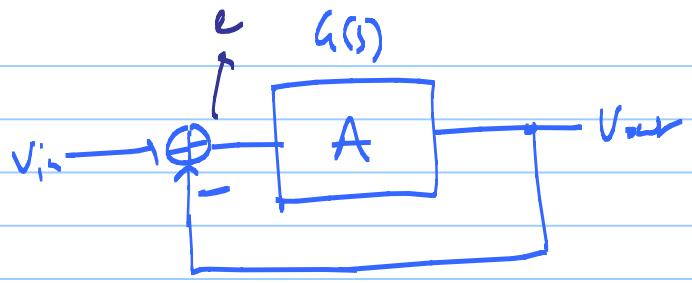


VCVS



low-frequency model

$H(s) = 1$

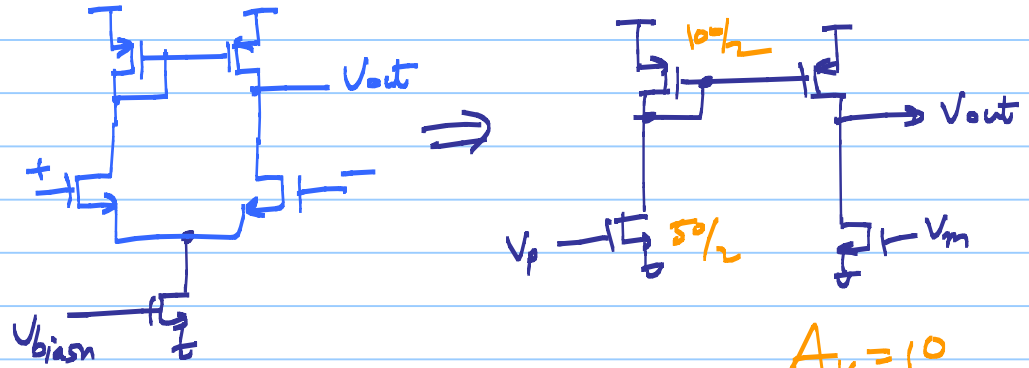


$e \to 0$

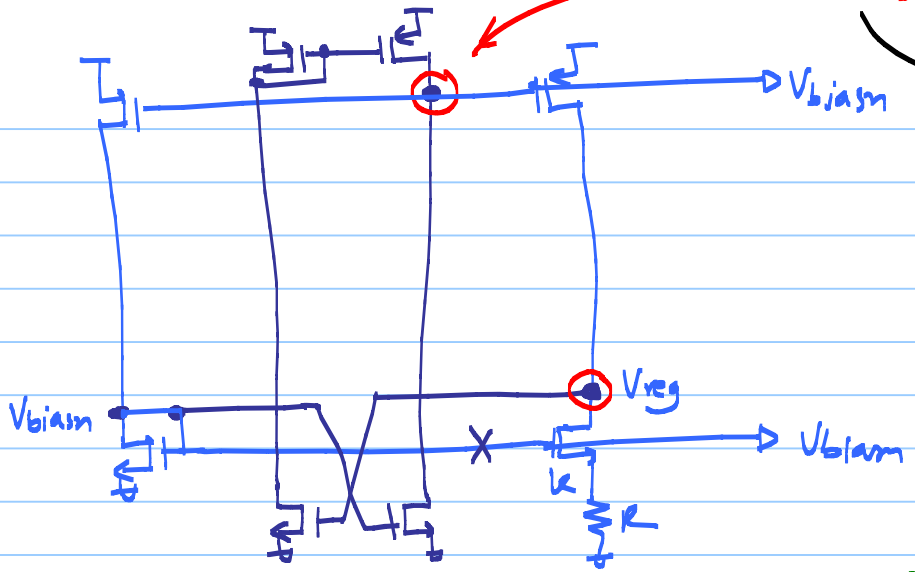
if $A \to \infty$

$\epsilon \to \frac{1}{A}$

CRUDE



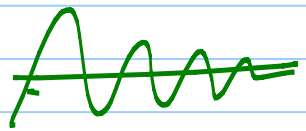
$A_V = 10$



low-f poles

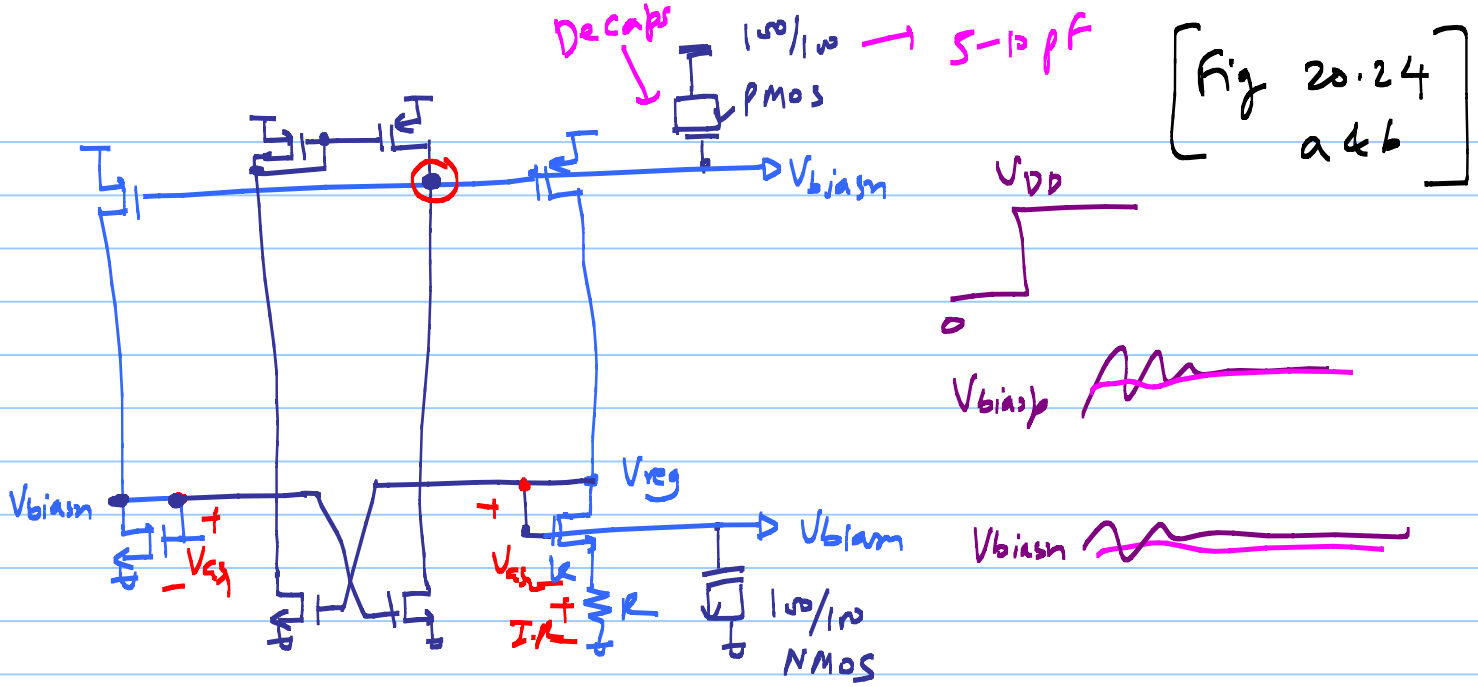
$$\frac{1}{s-\omega_1}$$

2-pole system



* two dominant poles
  - needs compensation

Modify → remove one of the Hi-Z nodes


Decaps
W/L
PMOS
5-10 pF
Vbiasn
Vreg
Vbiasn
Vreg
Vbiasn
R
W/L
NMOS

[Fig 20.24 a & b]

VDD
0
Vbiasp
Vbiasn