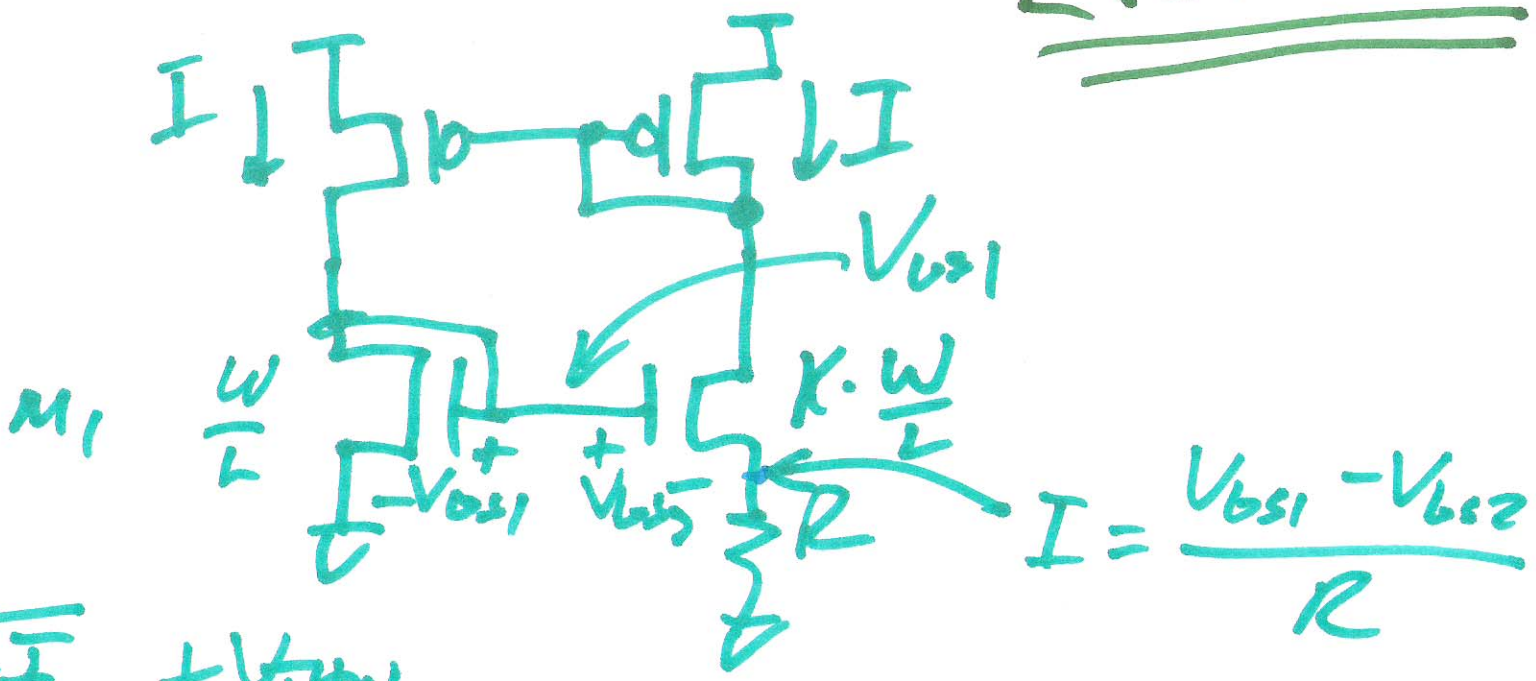
EE 420 / ECG 620

Analog IC Design

$I = \frac{\beta}{2}(V_{GS} - V_{THN})^2$ Feb. 18, 2015

Lecture 10



$$V_{GS1} = \sqrt{\frac{2I}{\beta}} + V_{THN}$$

$$V_{GS2} = \sqrt{\frac{2I}{K \cdot \beta}} + V_{THN}$$

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

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

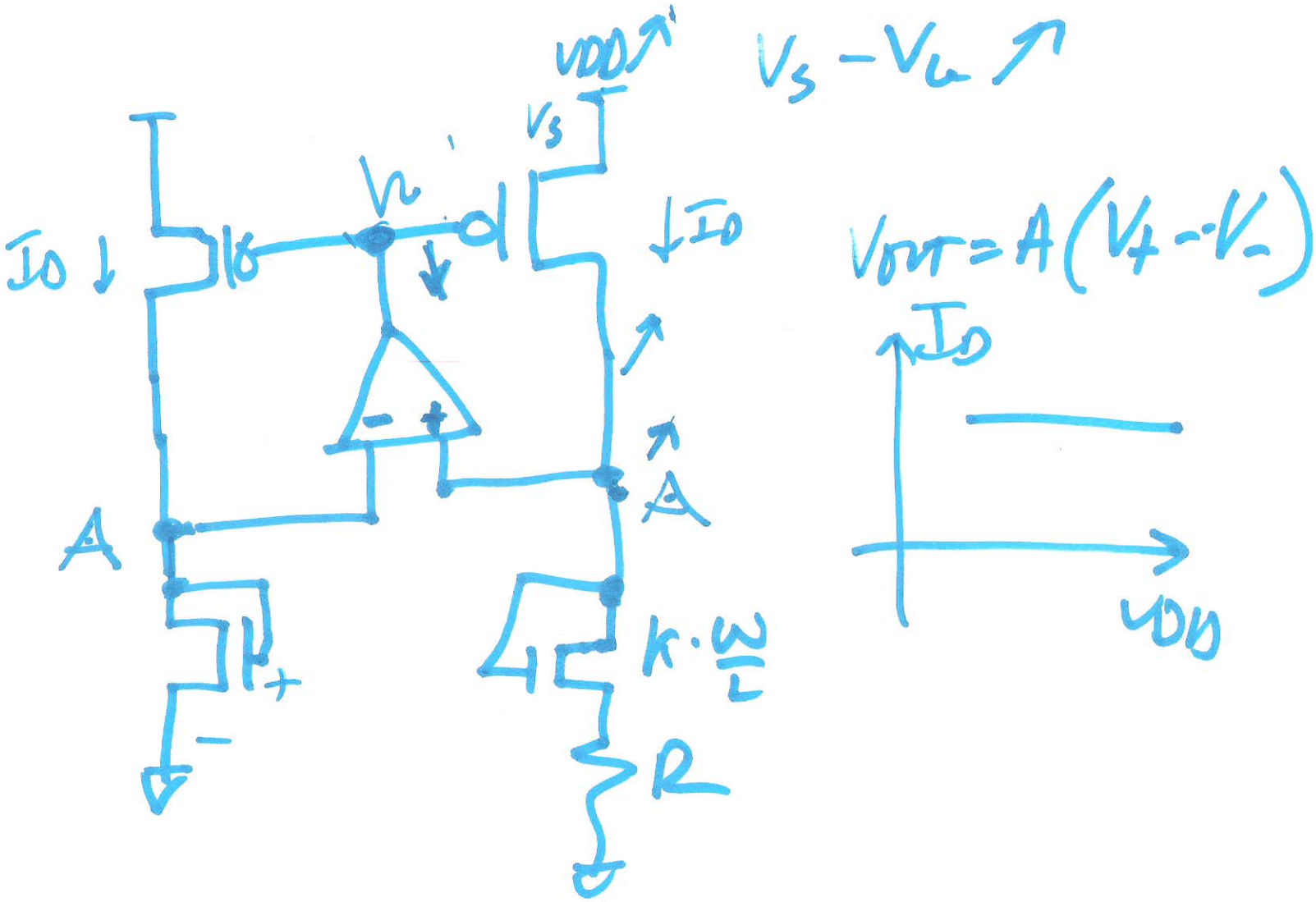
$$K = 4$$

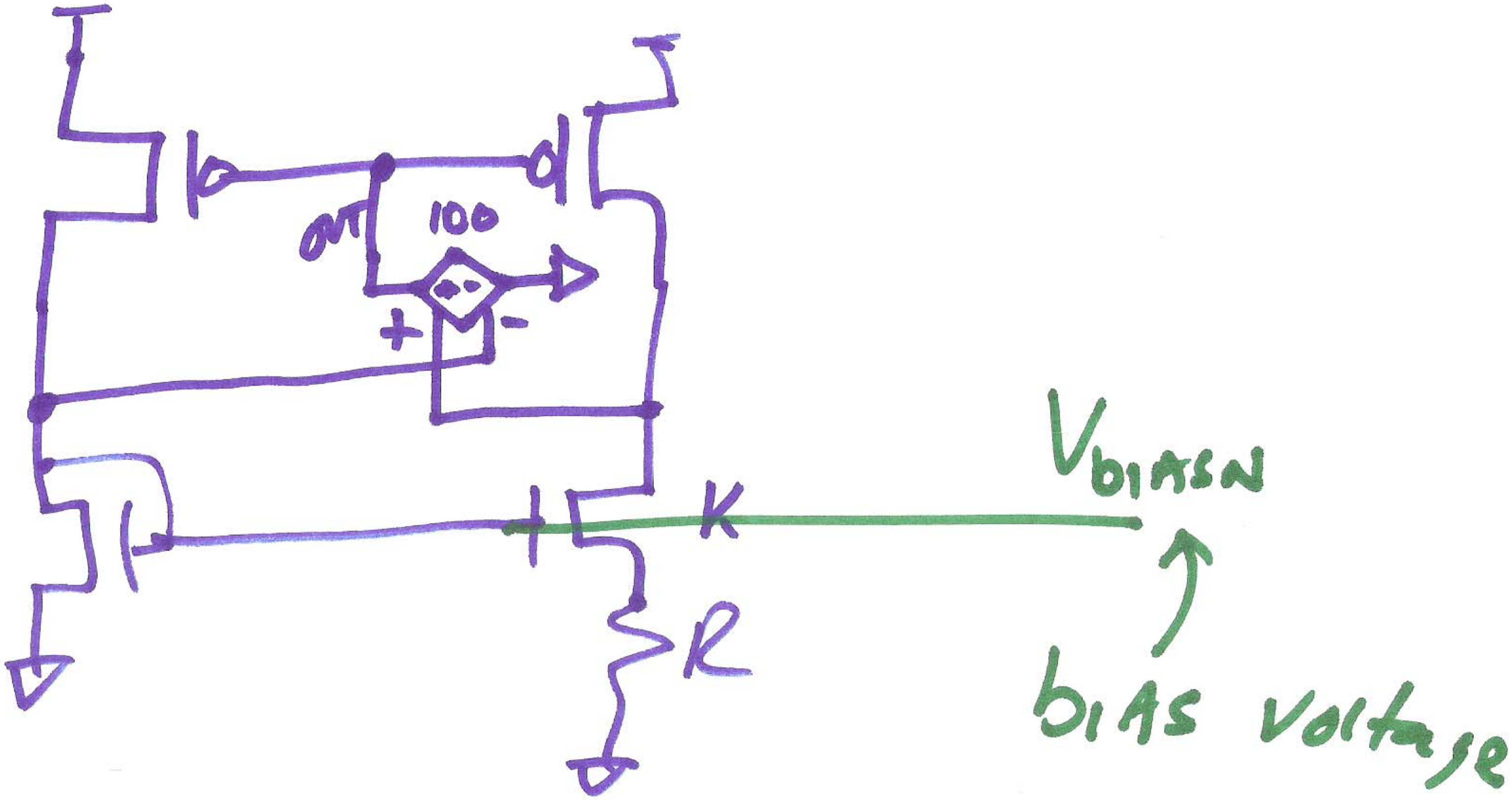
$$I = \frac{1}{2R^2\beta}, \quad \frac{1}{R} = \sqrt{2I \cdot KP \cdot \frac{W}{L}}$$

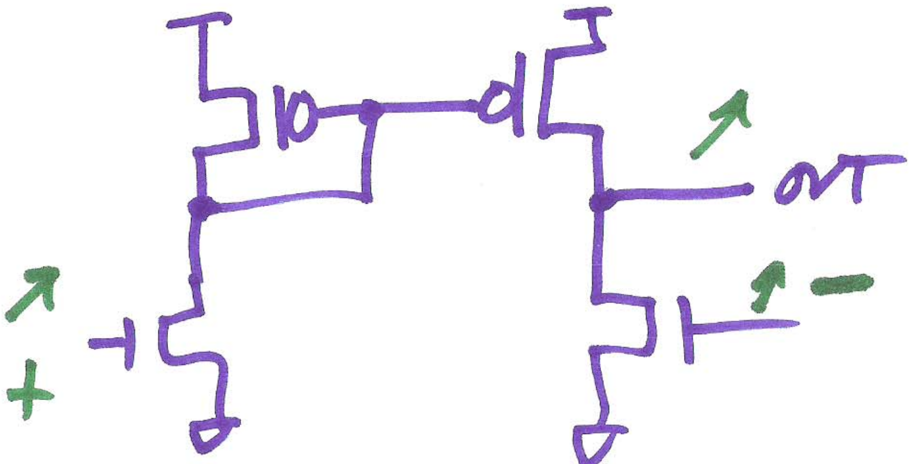
$$= g_m = K \cdot \frac{W}{L}\left(V_{GS} - V_{THN}\right)$$

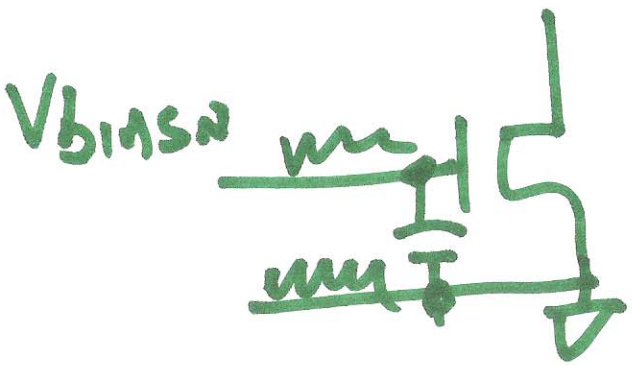
$$= \beta V_{OVN}$$

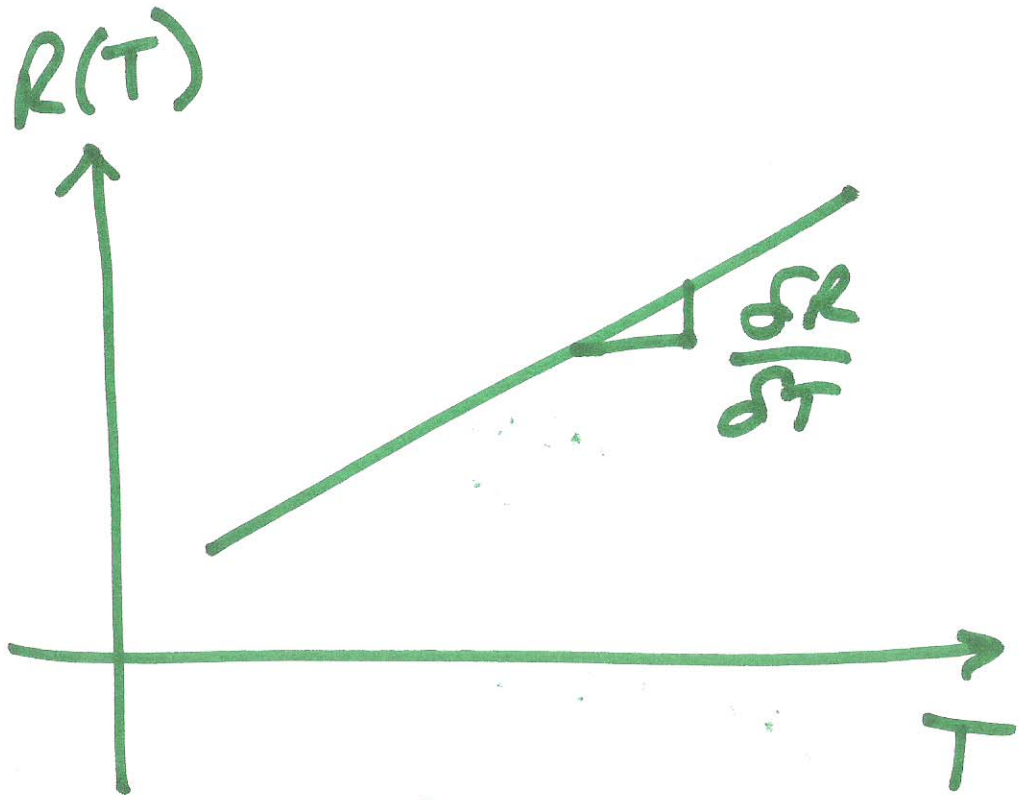
2)


VDD
$V_S - V_G$
V_S
V_2
I_D
I_D
$V_{OUT} = A(V_+ - V_-)$
A
A
$k \cdot \frac{W}{L}$
R
I_D
VDD


OUT
100
+
-
K
R
VBIASN
bias voltage


10
OUT
+
-



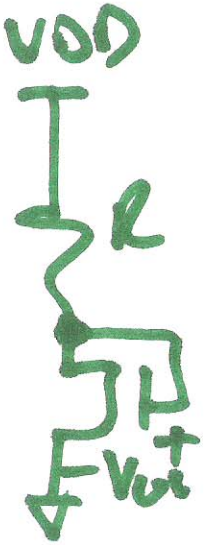


$$R(T) = R(T_0)\left(1 + TCR \cdot (T - T_0)\right)$$

$$\frac{\delta R}{\delta T} = R(T_0) \cdot TCR$$

$$0.002 = TCR = \frac{1}{R(T_0)} \frac{\delta R}{\delta T} = 2{,}000 \frac{ppm}{C^\circ}$$

5)



$$I_{REF} = \frac{VDD - V_{GS}}{R} = (VDD - V_{GS})R^{-1}$$

$$\frac{\delta I_{REF}}{\delta T} = R^{-1}\left(-\frac{\delta V_{GS}}{\delta T}\right) + (VDD - V_{GS})(-1)R^{-2}\frac{\delta R}{\delta T}$$

$$TCR = \frac{1}{R}\frac{\delta R}{\delta T} = 0.002$$

$$= -I_{REF}\cdot\left(\frac{1}{R}\frac{\delta R}{\delta T}\right) - \frac{1}{R}\frac{\delta V_{GS}}{\delta T}$$

$$I_{REF}(T) = I_{REF}(T_0)(1 + TC_{IREF}(T - T_0))$$

$$TC_{IREF} = \frac{1}{I_{REF}}\cdot\frac{\delta I_{REF}}{\delta T}$$