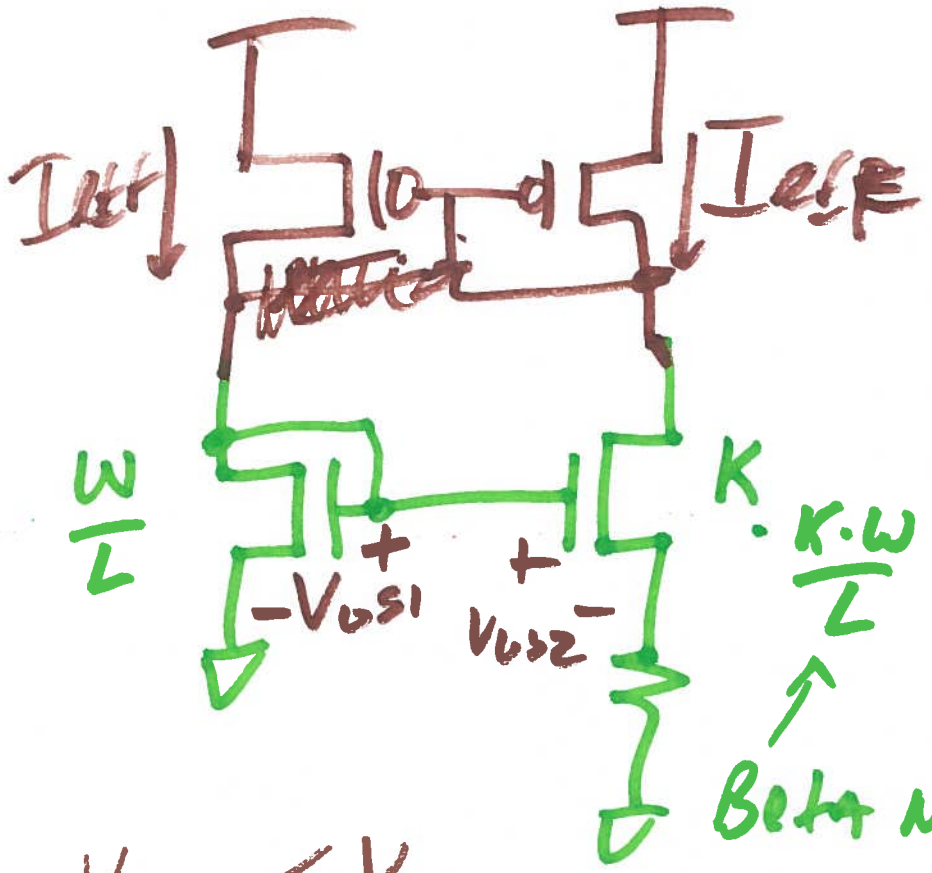
EE 420/ECG 620

Analog IC Design

Lecture 8

Feb. 20, 2019

$$\frac{VDD - V_{BIASN}}{R} = \frac{KP}{2}\frac{W}{L}(V_{BIASN} - V_{TN})^2$$



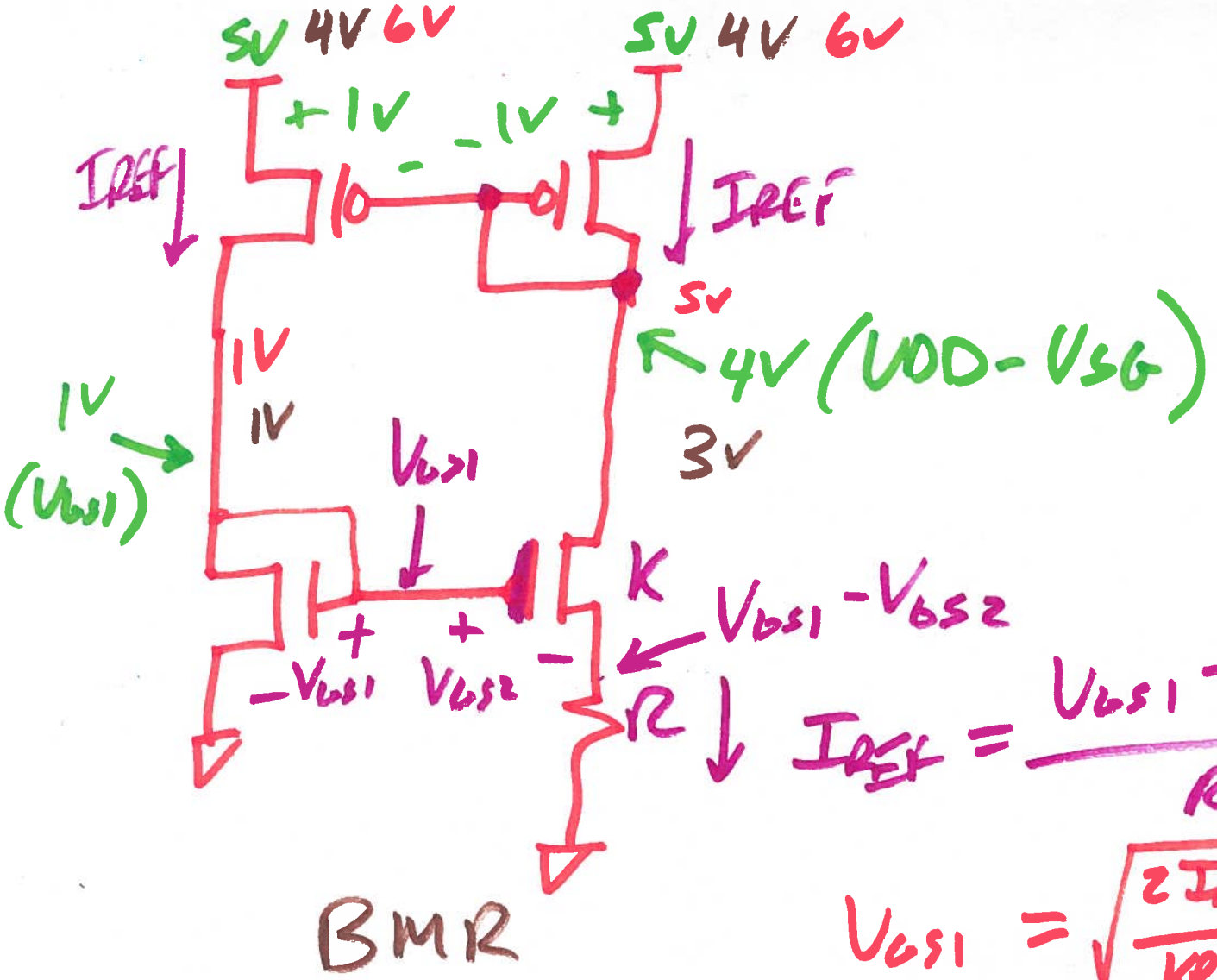
$$I_{REF} = \frac{KP}{2} \cdot \frac{K \cdot W}{L} \left(V_{GS2} - V_{THN} \right)^2$$

$$= \frac{KP}{2} \cdot \frac{W}{L} \left(V_{GS1} - V_{THN} \right)^2$$

$V_{GS2} < V_{GS1}$

Beta multiplier Reference

BMR



$$I_{REF} = \frac{V_{GS1} - V_{GS2}}{R}$$

$$V_{GS1} = \sqrt{\frac{2 I_{REF}}{KP \cdot \frac{W}{L}}} + V_{THN}$$

$$V_{GS2} = \sqrt{\frac{2 I_{REF}}{K \cdot KP \cdot \frac{W}{L}}} + V_{THN}$$

$$I_{REF} = \frac{1}{R}\left(1 - \frac{1}{\sqrt{K}}\right)\sqrt{\frac{2I_{REF}}{\frac{W}{L}.KP}}$$

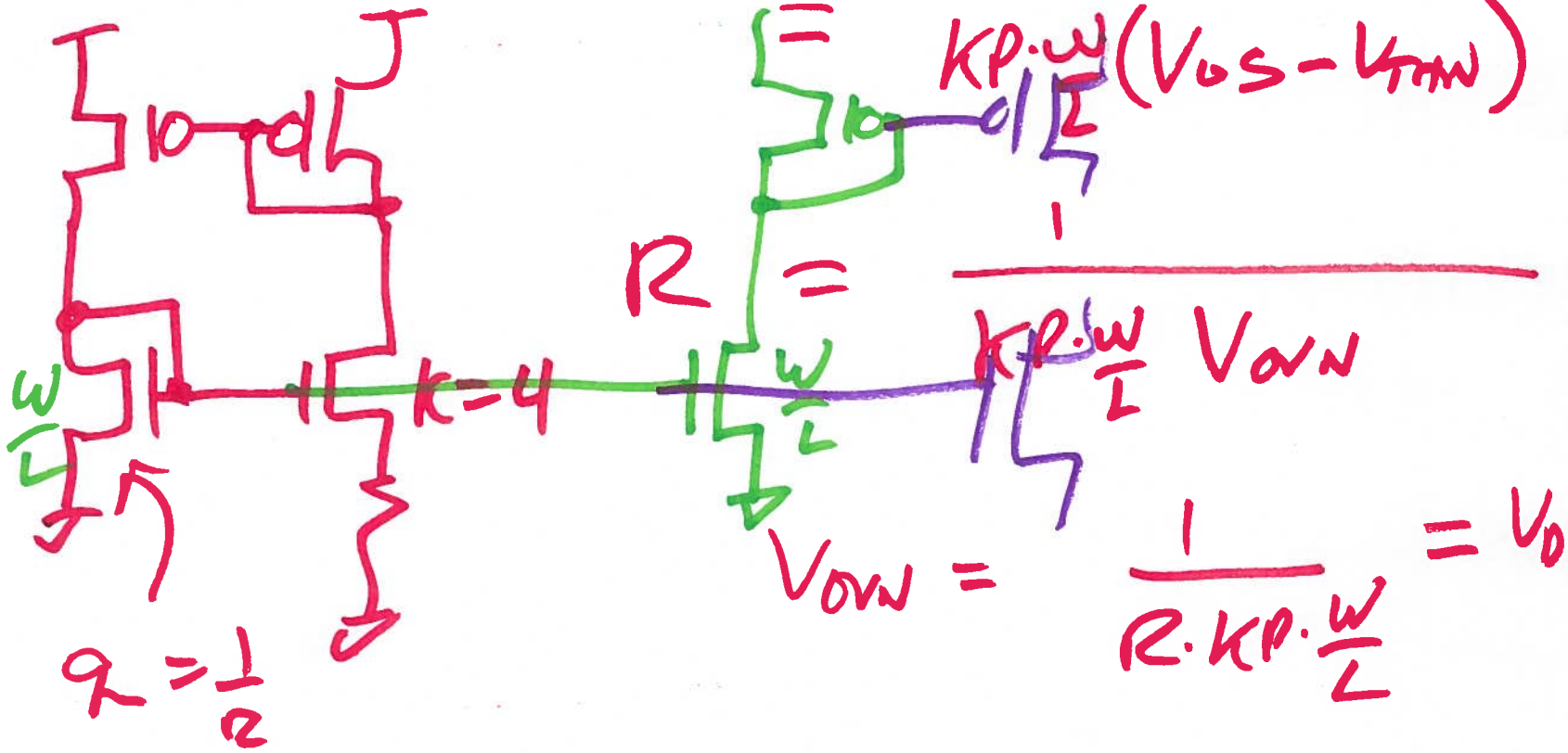
$$I_{REF}^2 = \frac{1}{R^2} \cdot \frac{2I_{REF}}{\frac{W}{L}.KP} \cdot \left(1 - \frac{1}{\sqrt{K}}\right)^2$$

$$\boxed{I_{REF} = \frac{2}{R^2.\frac{W}{L}.KP}\left(1 - \frac{1}{\sqrt{K}}\right)^2}$$

Assume $K = 4$

$$I_{REF} = \frac{1}{2R^2.\frac{W}{L}.KP}$$

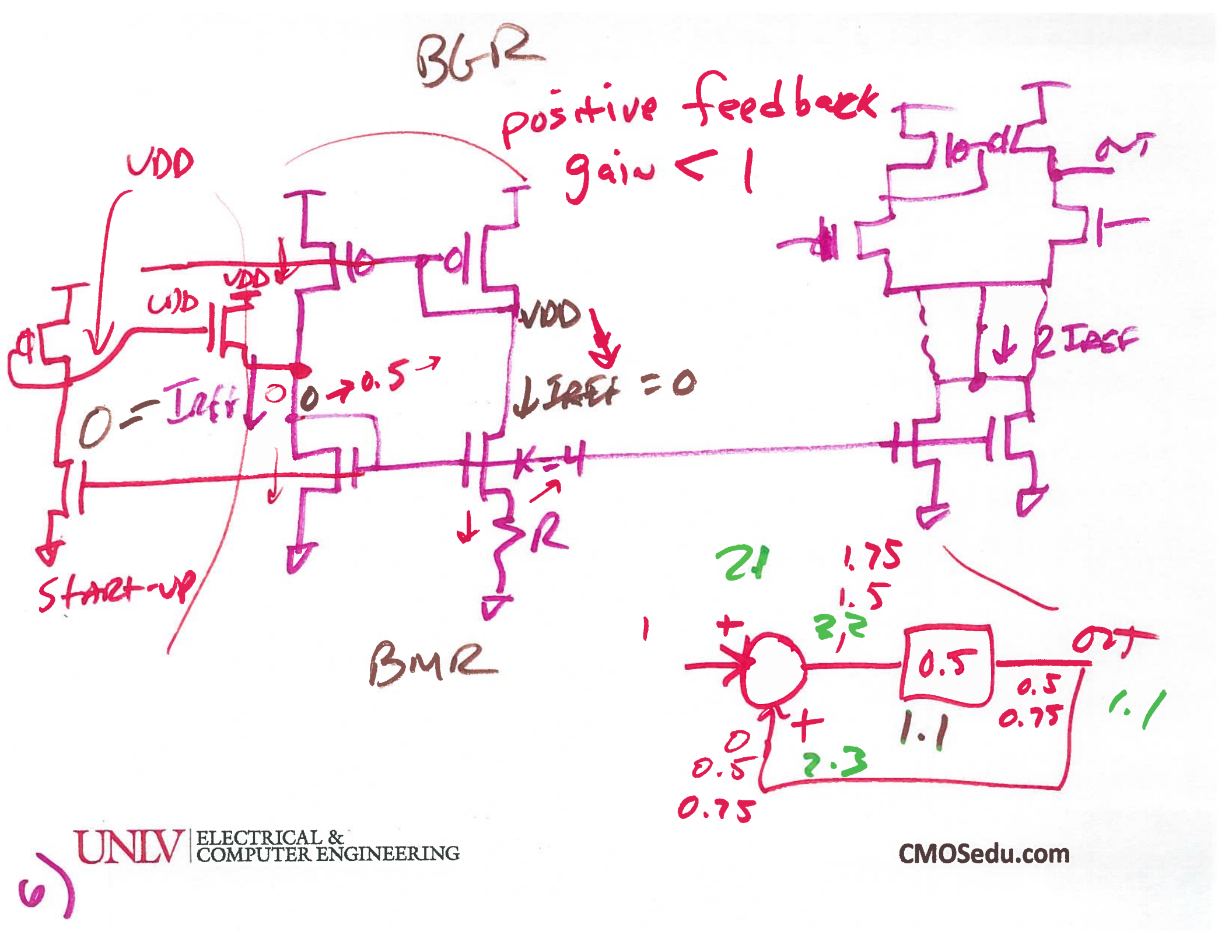
$$R = \frac{1}{\sqrt{2 I_{REF} \cdot \frac{W}{L} KP}} = \frac{1}{g_m}$$

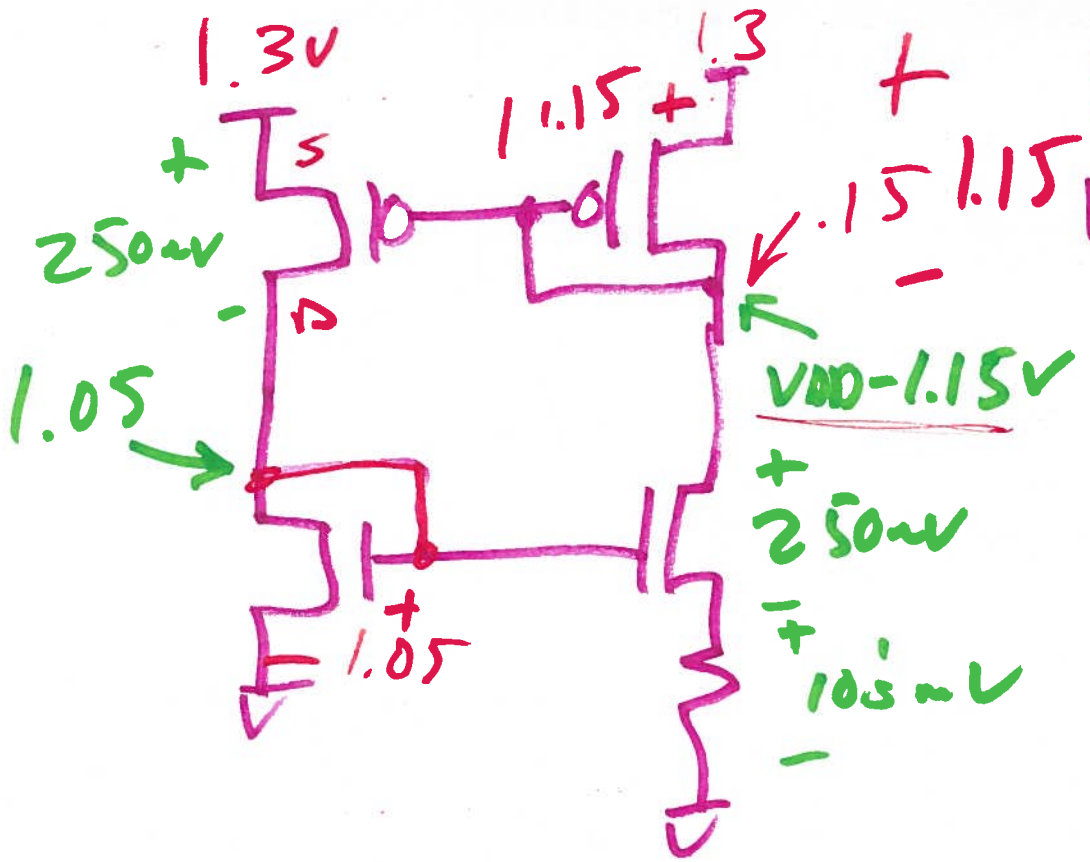


$$R = \frac{1}{KP \cdot \frac{W}{L}(V_{GS} - V_{THN})}$$

$$R = \frac{1}{KP \cdot \frac{W}{L} V_{OVN}}$$

$$V_{OVN} = \frac{1}{R \cdot KP \cdot \frac{W}{L}} = V_{DS,SAT} - V_{THN}$$


BGR
positive feedback
gain < 1
VDD
VDD
VDD
VDD
0 = Iaux
0 → 0.5
IREF = 0
K = 4
R
Start-up
BMR
2 IREF
21
1.75
1.5
3.2
1
+
0.5
1.1
0.5
0.75
1.1
+
2.3
0
0.5
0.75



$V_{GS} = 1.05V$

$V_{SG} = 1.15V$

$V_{DS,SAT} =$

$V_{SD,SAT} = 250mV$

$$I_{DS} = \frac{k'}{2}\frac{W}{L}\left(V_{GS} - V_{TH}\right)^2$$

1.4 $\quad 1.15 + .25 \simeq 1.4V$