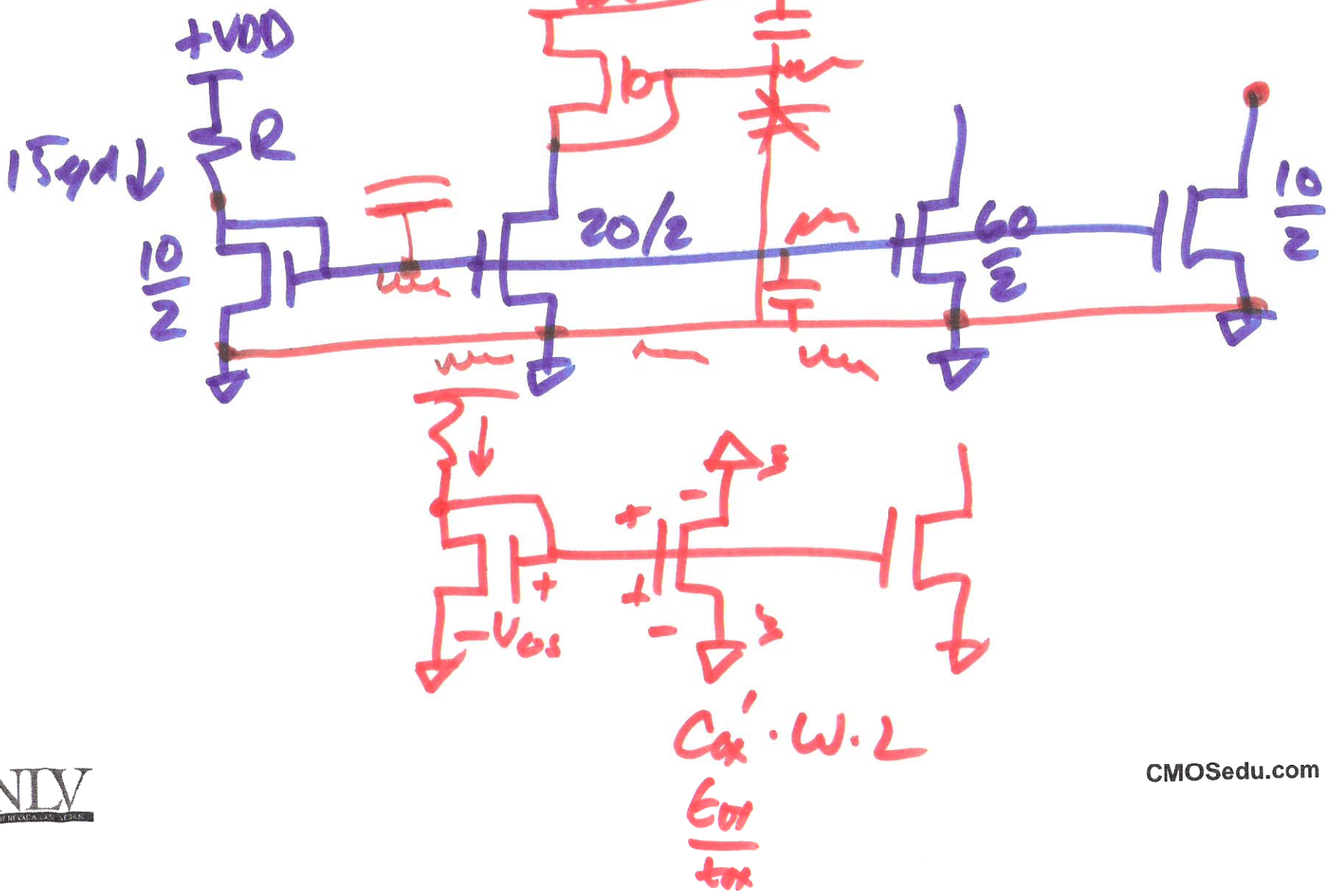
EE 422 / ECG 622

Analog IC Design

Lecture 10 2/25/13



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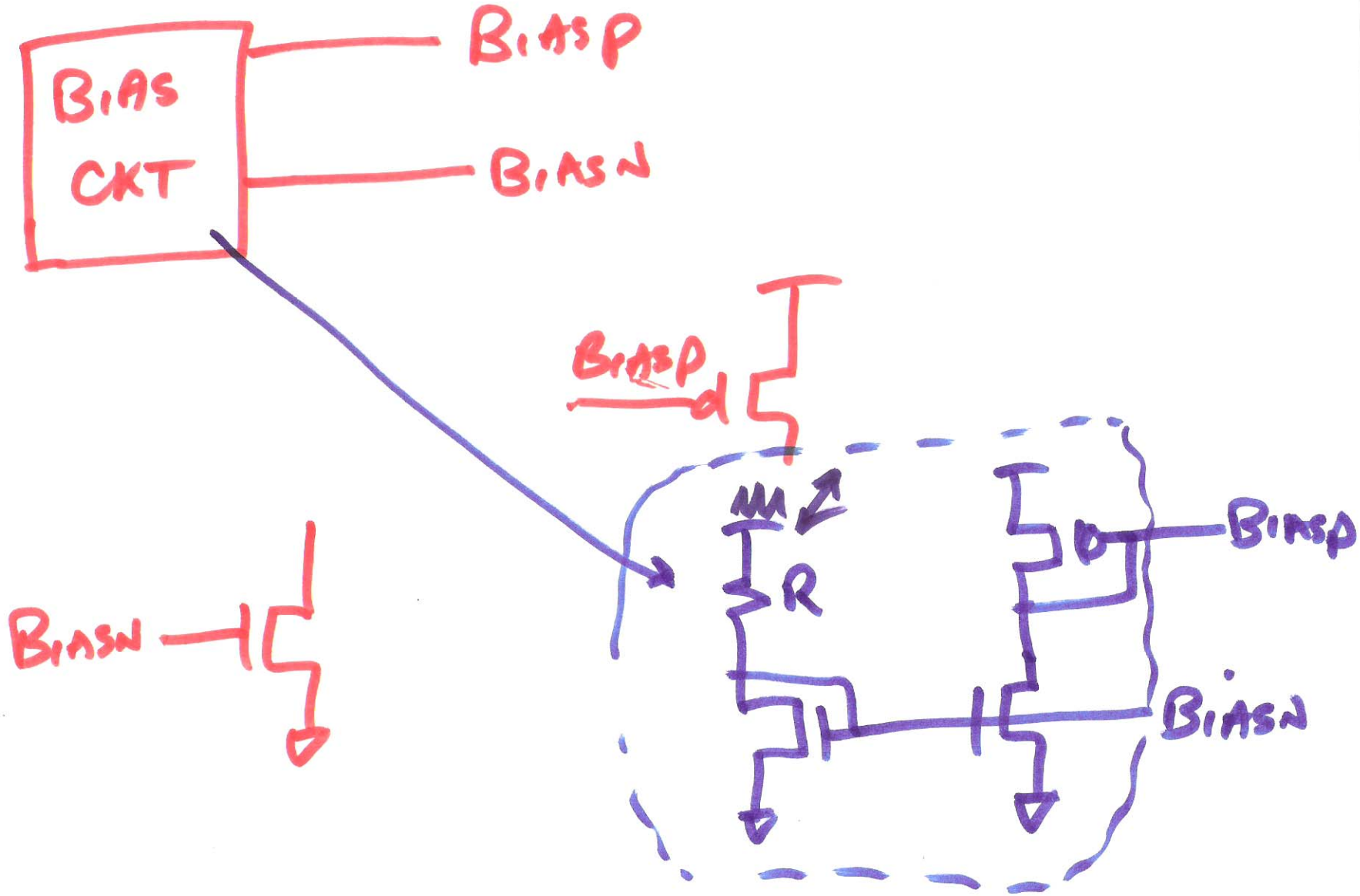
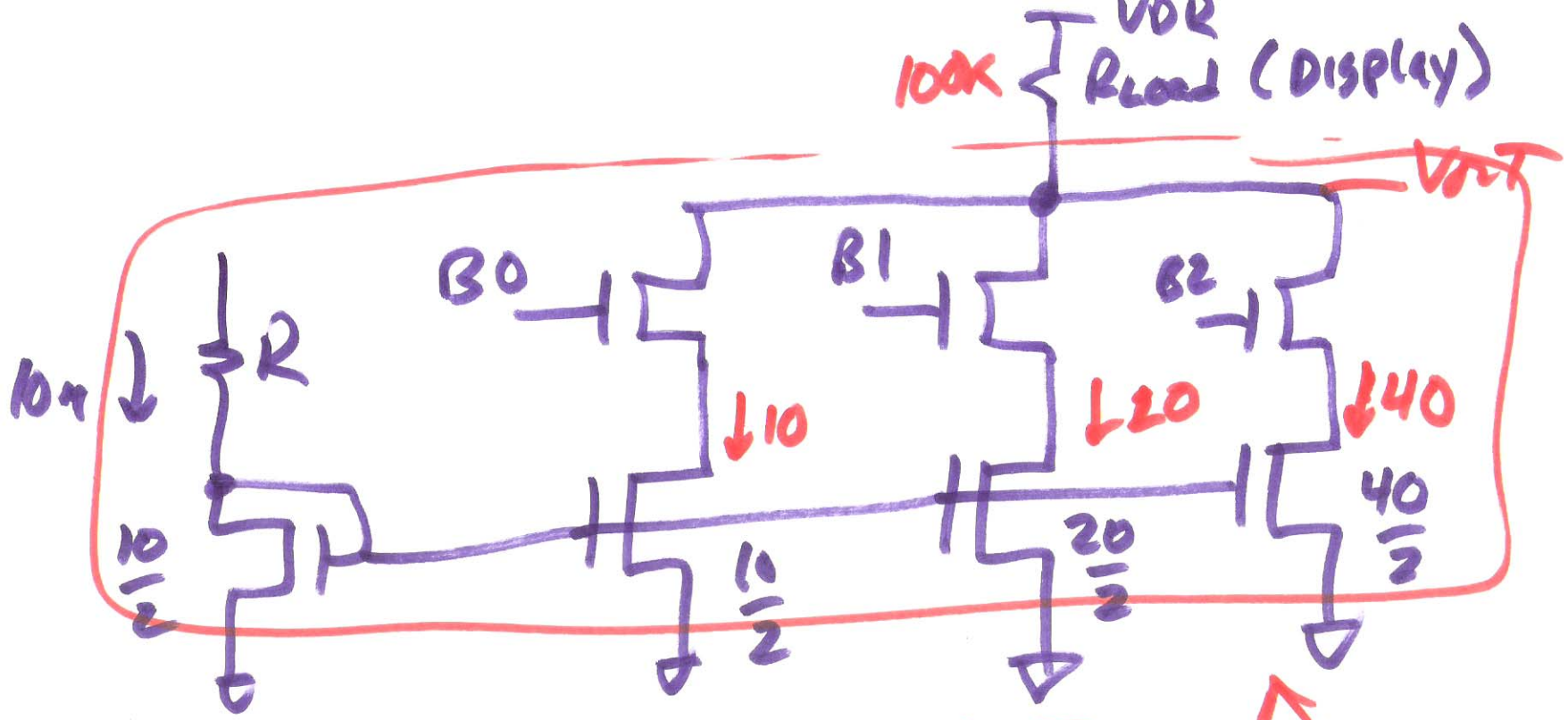
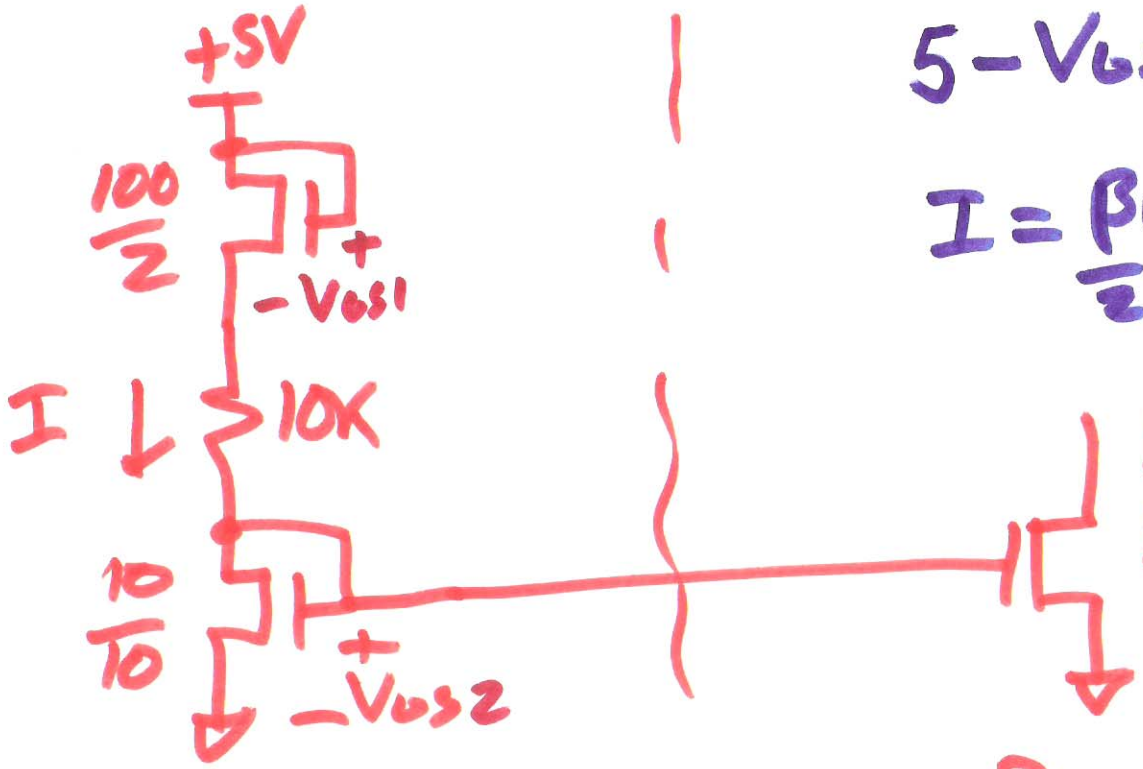




B0	B1	B2	VOUT	I
0	0	0	5V	0
1	0	0	4V	10μ
0	1	0	3V	20μ

Digital to Analog Converter (DAC)



$$5 - V_{GS1} - I \cdot 10K - V_{GS2} = 0$$

$$I = \frac{\beta_1}{2}(V_{GS1} - V_{TN})^2 =$$

$$\frac{\beta_2}{2}(V_{GS2} - V_{TN})^2$$

$$V_{GS} = \sqrt{\frac{2I}{\beta_1}} + V_{TN}$$

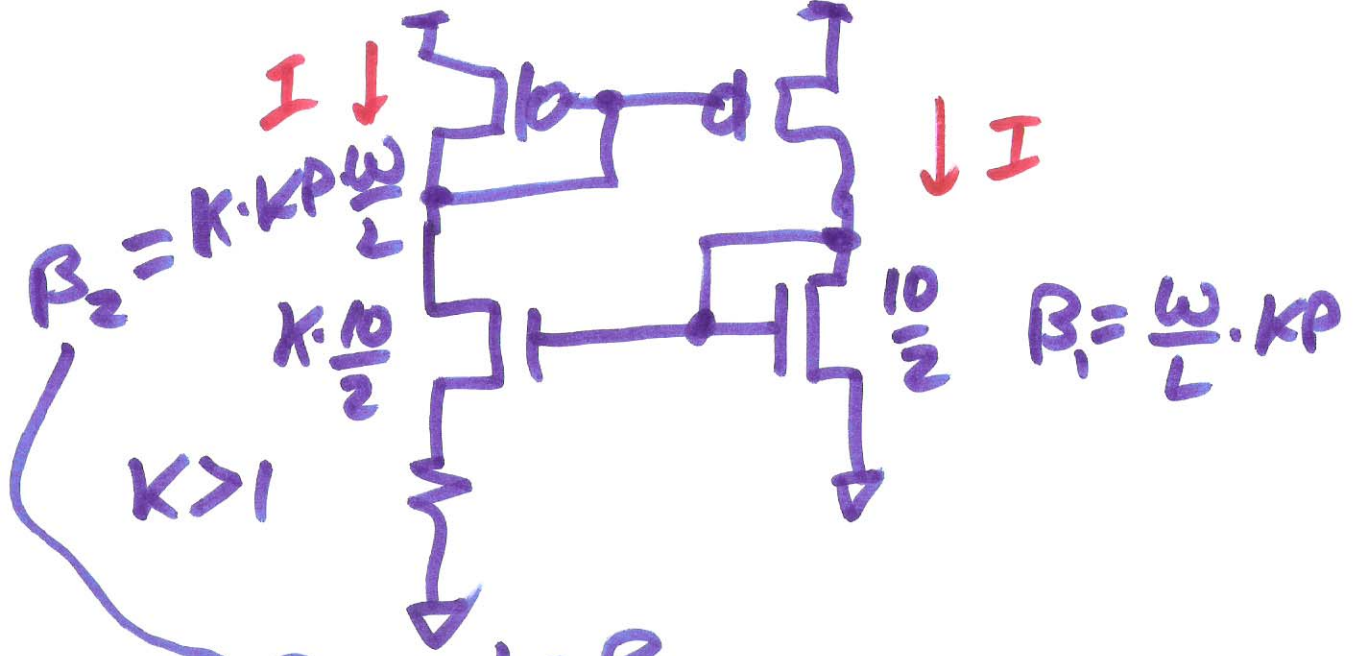
$I = ?$ $V_{GS2} = ?$

$$5 - \sqrt{\frac{2I}{K_{PN} \cdot \frac{100}{2}}} - V_{TN} - I \cdot 10K - \sqrt{\frac{2I}{K_{PN} \cdot \frac{10}{10}}} - V_{TN} = 0$$

$$(a + b\sqrt{x} + cx)^2$$

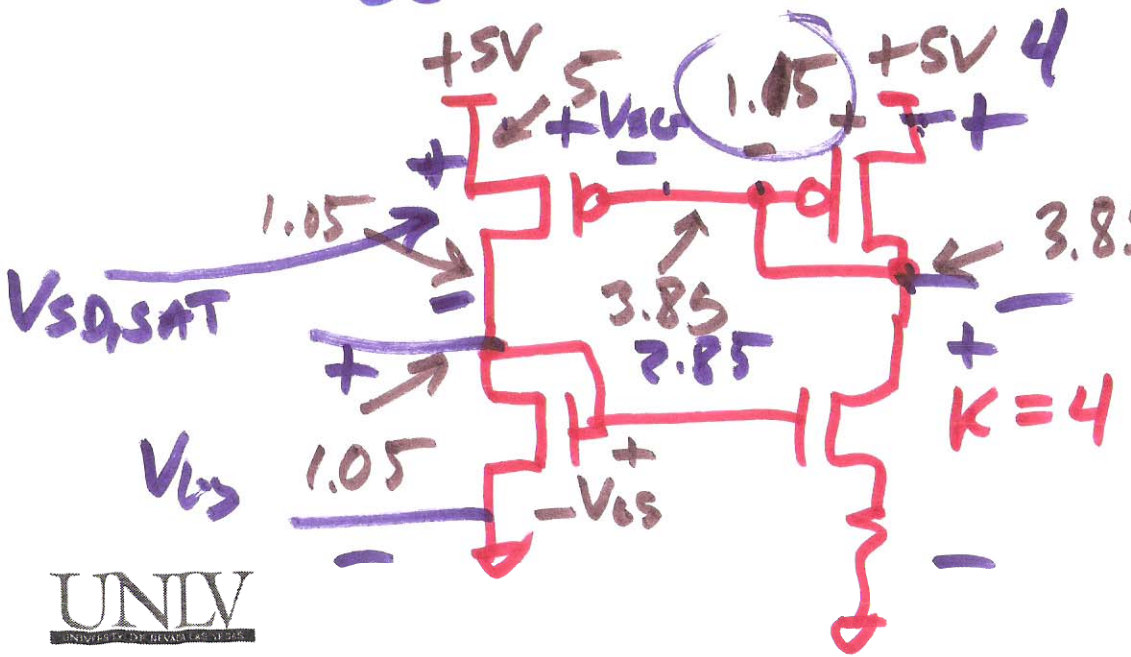
$$3.4 - \sqrt{\frac{2I}{K_{PN}}}\left(\sqrt{\frac{2}{100}} + \sqrt{\frac{10}{10}}\right) - I \cdot 10K = 0$$

let $x = \sqrt{I}$



$\beta_2 = K \beta_1$

↑ Beta is multiplied up!



$V_{DD,MIN} = ?$

$\geq V_{DD,SAT} + V_{GS}$

$V_{DD,MIN} \geq$

$\rightarrow V_{SG} + V_{DS,SAT}$

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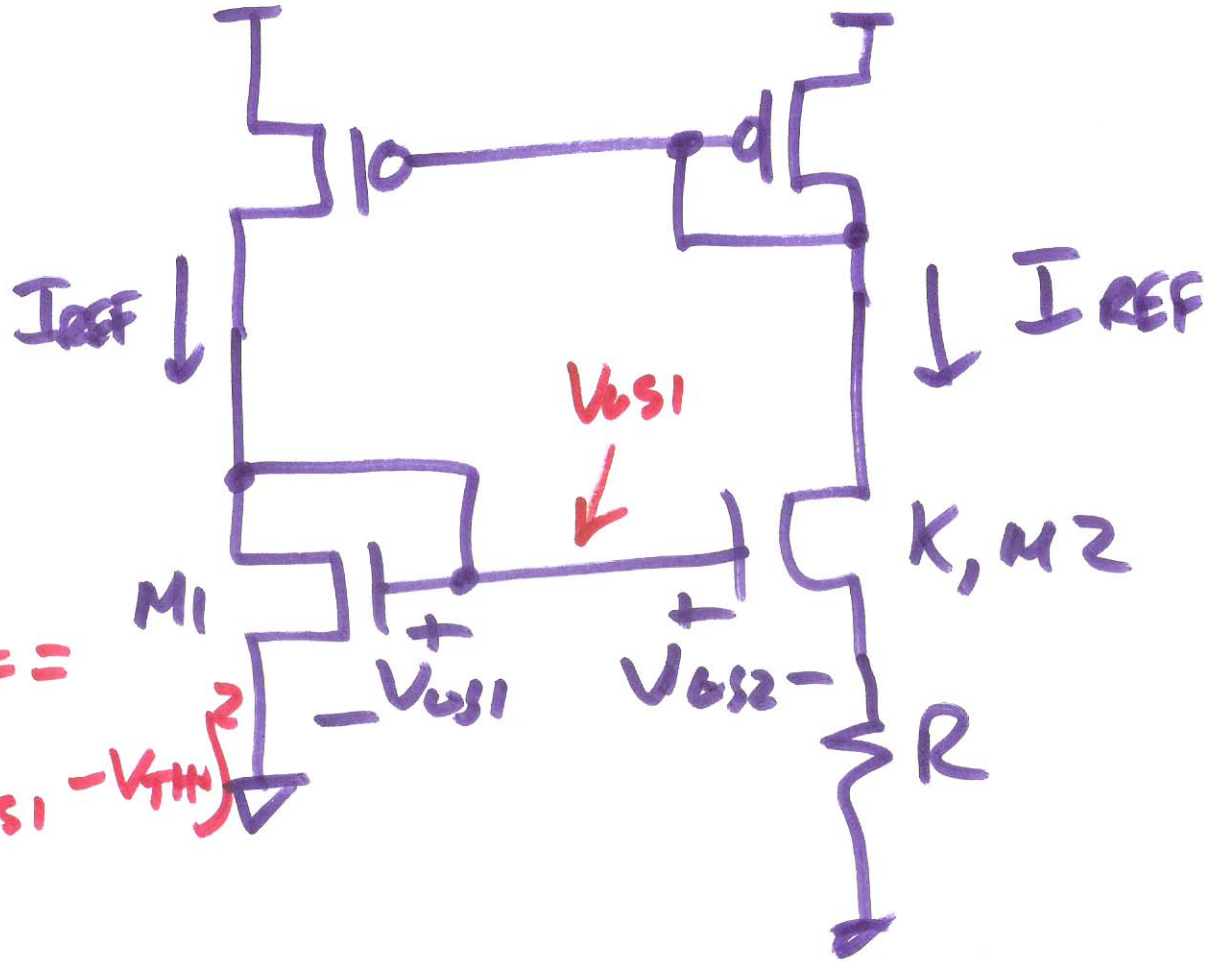

$$V_{GS1} = V_{GS2} + I_{REF} \cdot R$$

$$\sqrt{\frac{2I_{REF}}{\beta_1}} + V_{THN} = \sqrt{\frac{2I_{REF}}{K \cdot \beta_1}} + V_{THN} + I_{REF} R$$

$$-I_{REF} \cdot R + \sqrt{\frac{2I_{REF}}{\beta_1}}\left(1 - \frac{1}{\sqrt{K}}\right) = 0$$

$$\sqrt{I_{REF}} \cdot R = \sqrt{\frac{2}{\beta_1}}\left(\frac{-1}{\sqrt{K}} + 1\right)$$

$$I_{REF} = \frac{2}{\beta_1 \cdot R^2}\left(1 - \frac{1}{\sqrt{K}}\right)^2$$

$$\frac{1}{g_m} = \frac{1}{150\mu A} = R$$

$$\boxed{R = 6.5k}$$

$K = 4$

$K = 4$

$$I_{REF} = \frac{1}{2\beta_1 \cdot R^2}$$

$$R = \frac{1}{g_m}$$

$$\frac{1}{R} = \sqrt{2\beta_1 I_{REF}} = g_m$$