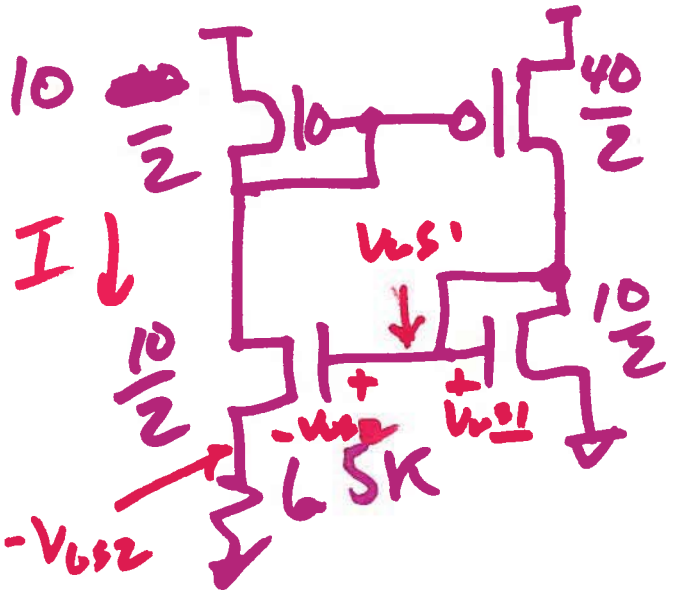
EE 420/ECE 620

Analog IC Design

Lecture 9

2/15/2017



$$V_{GS1} = \sqrt{\frac{2\cdot 4I}{KP_N \cdot \frac{10}{2}}} + V_{THN}$$

$$V_{GS2} = \sqrt{\frac{2I}{KP_N \cdot \frac{10}{2}}} + V_{THN}$$

$$I = \frac{V_{GS1} - V_{GS2}}{6.5K} = \sqrt{\frac{2\cdot I}{R^2 KP_N \cdot \frac{10}{2}}}\left(\sqrt{4}-1\right)$$

(R)

$$I = \frac{1}{R}\left(\sqrt{\frac{2.4I}{K_n \cdot \frac{10}{2}}} - \sqrt{\frac{2I}{K_n \cdot \frac{10}{2}}}\right)$$

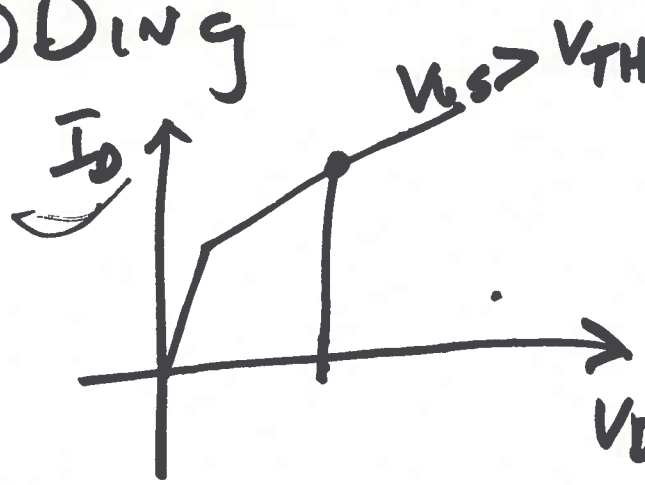
$$= \sqrt{\frac{2I}{R^2 K_n \cdot \frac{10}{2}}}\left(\sqrt{4} - 1\right) \rightarrow 1$$

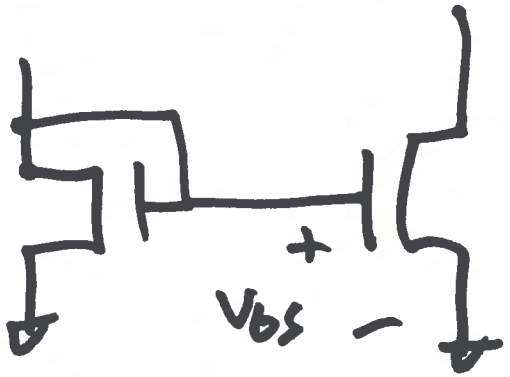
$$I = \sqrt{\frac{2I}{R^2 \cdot K_n \cdot \frac{10}{2}}}$$

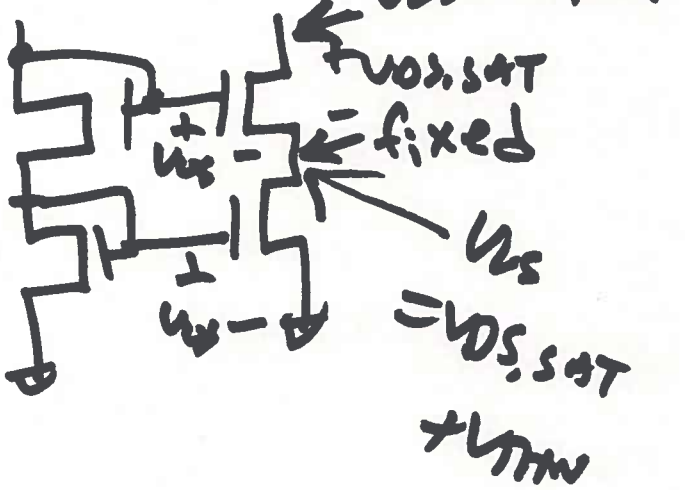
$$I = \frac{2}{R^2 \cdot K_n \cdot \frac{10}{2}} = \frac{2}{(6.5k)^2 \cdot 5 \cdot 120\mu}$$

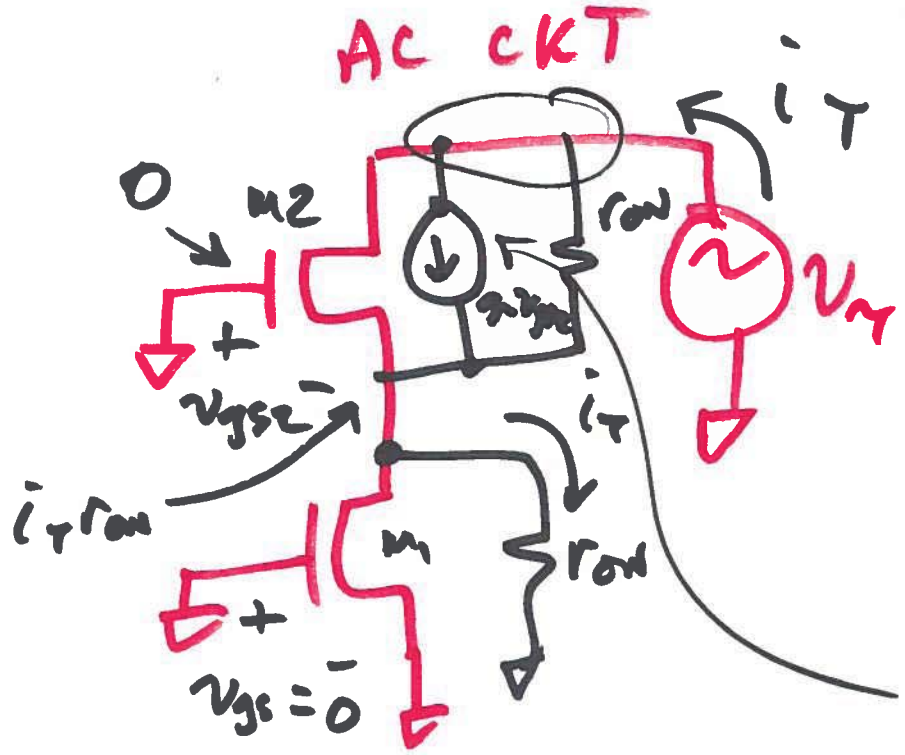
$$= 78\mu$$

CASCODing


I_D
$V_{GS} > V_{THN}$
V_{DS}


+
V_{DS} −


$2V_{OV,SAT} + V_{THN}$
$V_{GS} + V_{OV,SAT}$
$V_{OV,SAT}$
fixed
V_{GS}
$= V_{OV,SAT} + V_{THN}$



$$v_{gs2} = -i_T r_{ON}$$

$130\mu \cdot (2\,M\Omega)^2$

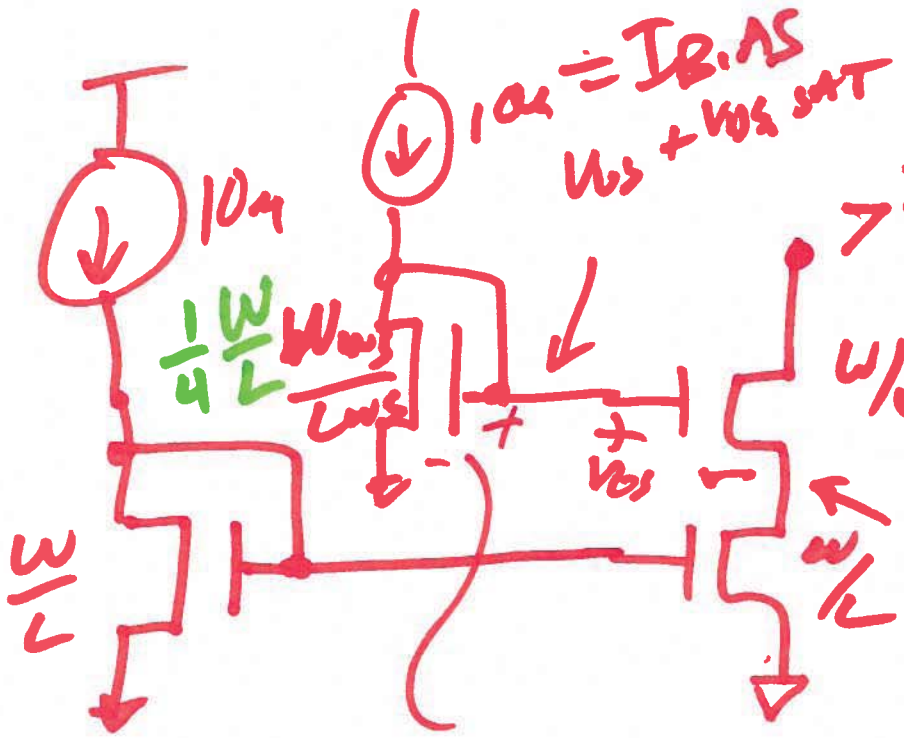
$130 \cdot 2 \cdot 2\ M\Omega$

$520\ m\Omega$

$$i_T = -g_{mN} i_T \cdot r_{ON} + \frac{v_T - (+i_T r_{ON})}{r_{ON}}$$

$$i_T (1 + g_{mN} \cdot r_{ON} + 1) = \frac{v_T}{r_{ON}}$$

$$R_{OUT,SW} = \frac{v_T}{i_T} = 2r_{ON} + g_{mN} r_{ON}^2 \simeq g_{mN} r_{ON}^2$$



$$I_{BIAS} \stackrel{?}{=} \frac{KP_n}{2}\frac{W}{L}(V_{GS} - V_{THN})^2$$

$$I_{BIAS} = \frac{KP_n}{2}\cdot\frac{W}{L}(V_{GS} - V_{THN})^2$$

$$V_{GS} + V_{DS,SAT} = 2V_{DS,SAT} + V_{THN}$$

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

$$\frac{K_{PN}}{2}\frac{W_{WS}}{L_{WS}}\left(V_{GS}-V_{THN}+V_{OS,SAT}\right)^2 = \frac{K_{PN}}{2}\frac{W_{WS}}{L_{WS}}\left(2V_{OS,SAT}\right)^2$$

$$= \frac{K_{PN}}{2}\frac{W}{L}\left(V_{GS}-V_{THN}\right)^2 = \frac{K_{PN}}{2}\cdot\frac{W}{L}V_{DS,SAT}^2$$

$V_{OS,SAT}$

$W = W_{WS}$

$L_{WS} = 4L$