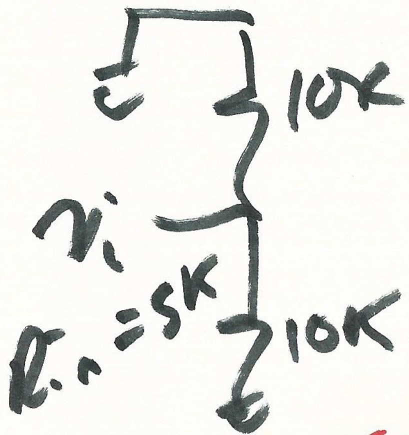
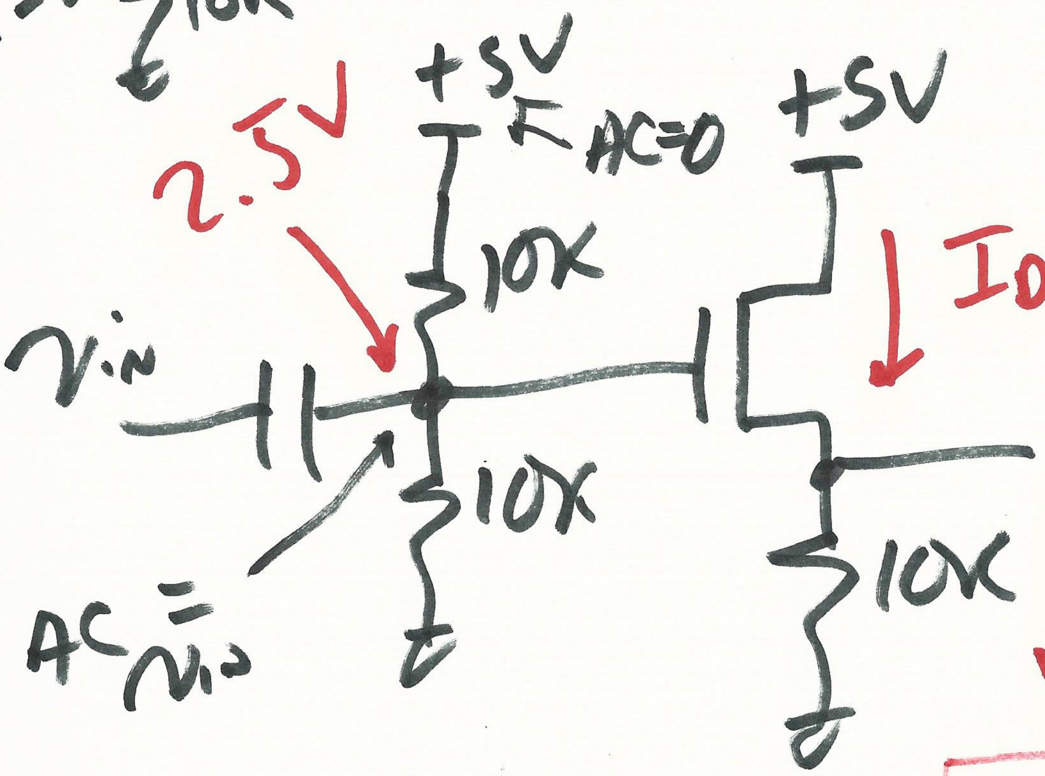
Lecture 23

April 23, 2014

EE 320





$$I_D = \frac{120\mu}{2}\cdot\frac{100}{1}\left(2.5 - I_D\cdot 10k - .8\right)^2$$

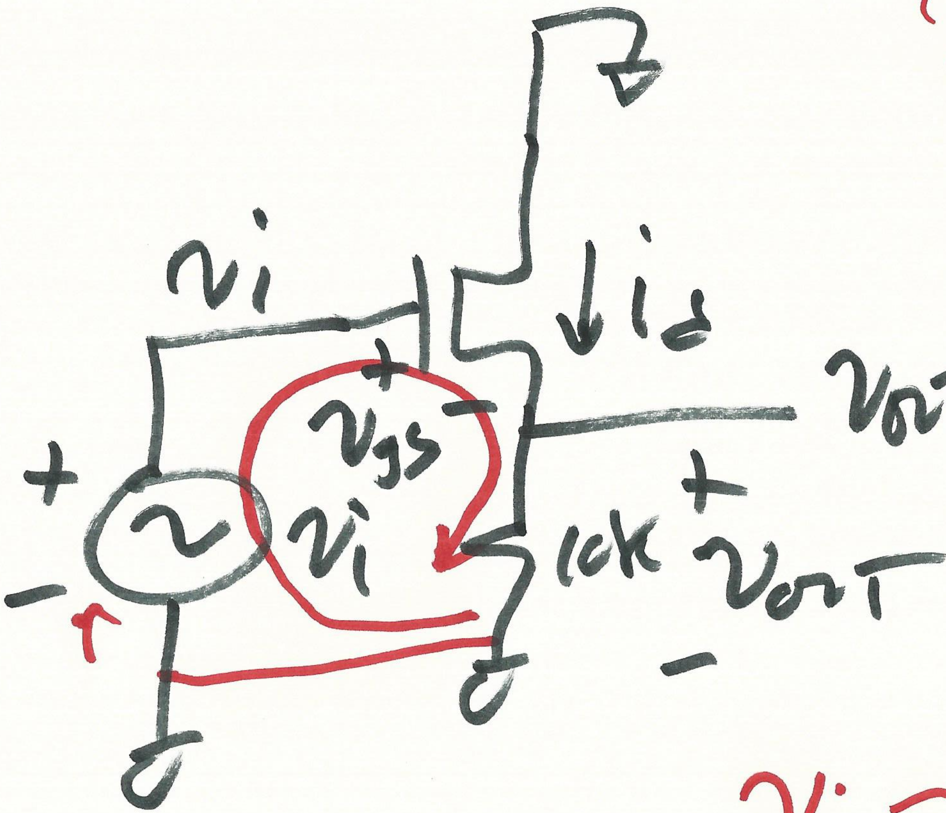
$$v_{OUT} = V_S = I_D\cdot 10k$$

$$I_D = 154\mu A$$

$$V_S = \underline{\underline{1.54V}}$$

$$g_m = \sqrt{2\cdot 120\mu\cdot\frac{100}{1}\cdot 154\mu}$$

$$g_m = 1.922\,mA/V$$



$$\frac{v_{OUT}}{v_i} = \frac{10k}{10k + \frac{1}{1.922m℧}}$$

$\frac{1}{1.922m℧} \rightarrow 500$

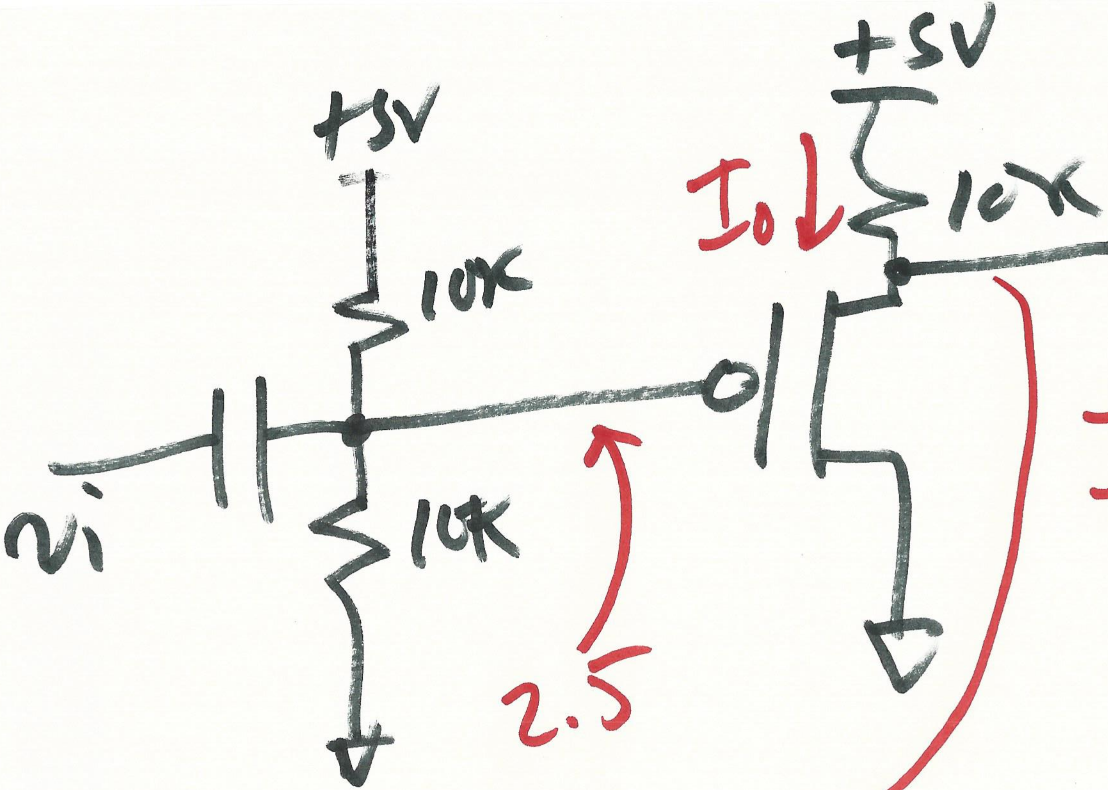
$$\approx .985$$

$$v_{OUT} = i_d \cdot 10k$$

$$v_i - v_{gs} - v_{OUT} = 0$$

$$v_i = i_d\left(10k + \frac{1}{g_m}\right)$$

$$\frac{v_{OUT}}{v_i} = \frac{\cancel{i_d} \cdot 10k}{\cancel{i_d} \cdot \left(10k + \frac{1}{g_m}\right)}$$



$\underline{\underline{3.61V}}$

$v_{OUT} = 5 - 10k \cdot I_D$

$$I_D = \frac{40\mu}{2} \cdot \frac{100}{1}\left(5 - 10k \cdot I_D - 2.5 - .9\right)^2$$

$$\boxed{I_D = 139\mu A}$$

$180\mu A$

$$g_m = \sqrt{2 \cdot 40\mu \cdot \frac{100}{1} \cdot 139\mu}$$

$5 - 10k \cdot 139\mu$

$= 3.61V$

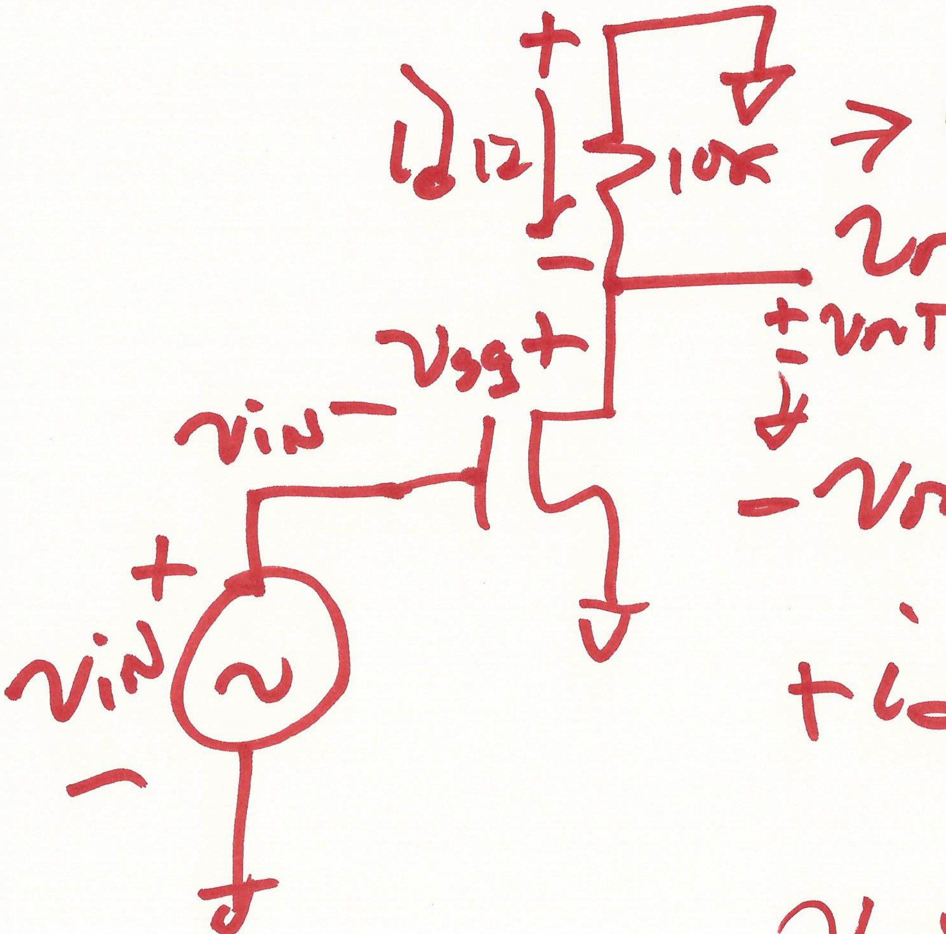
$g_m = 1.036 mA/V$

$5 - 10k \cdot 180\mu$

$= 3.2V$

$\frac{1}{g_m} \approx \underline{\underline{1K}}$

$V_S - V_G = 3.2 - 2.5 = .7 < .9$



$\rightarrow i_d \cdot 10k$

$v_{out} = -i_d \cdot 10k$

$-v_{out} + v_{sg} + v_{in} = 0$

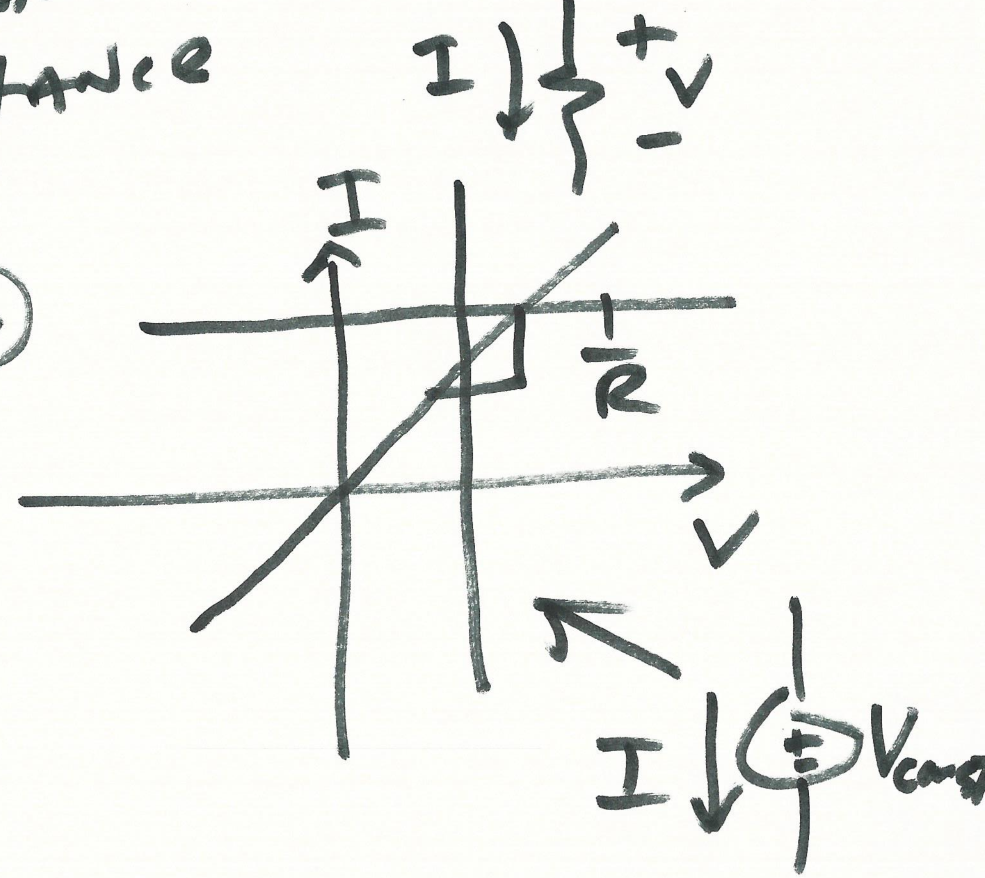
$+i_d \cdot 10k + \frac{i_d}{g_{mp}} + v_{in} = 0$

$v_{in} = -i_d\left(10k + \frac{1}{g_{mp}}\right)$

$$\frac{v_{out}}{v_{in}} = \frac{-i_d \cdot 10k}{-i_d \cdot \left(10k + \frac{1}{g_{mp}}\right)} = \frac{10k}{11k} = .91$$

S.F.

High input Resistance
Low output Resistance
No voltage gain
good current gain



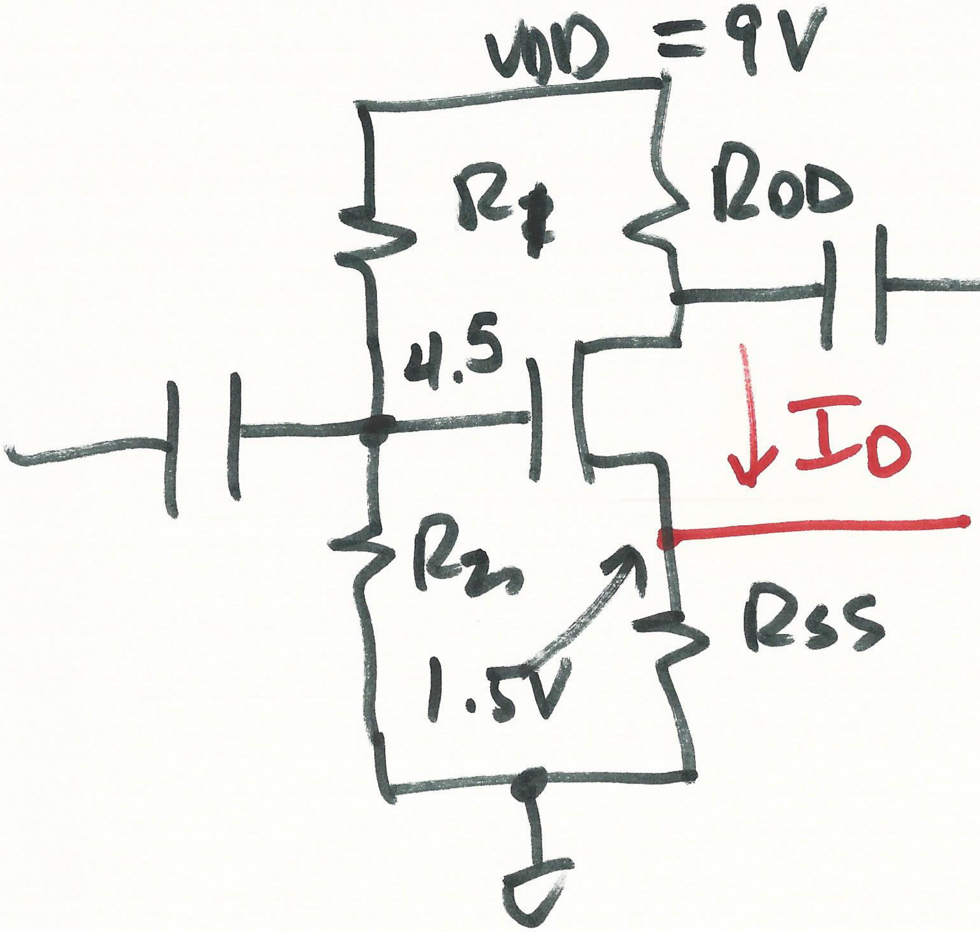
C. S.

High DC input resistance

High input C

High voltage gain

High current gain



$V_S = I_D \cdot R_{SS}$

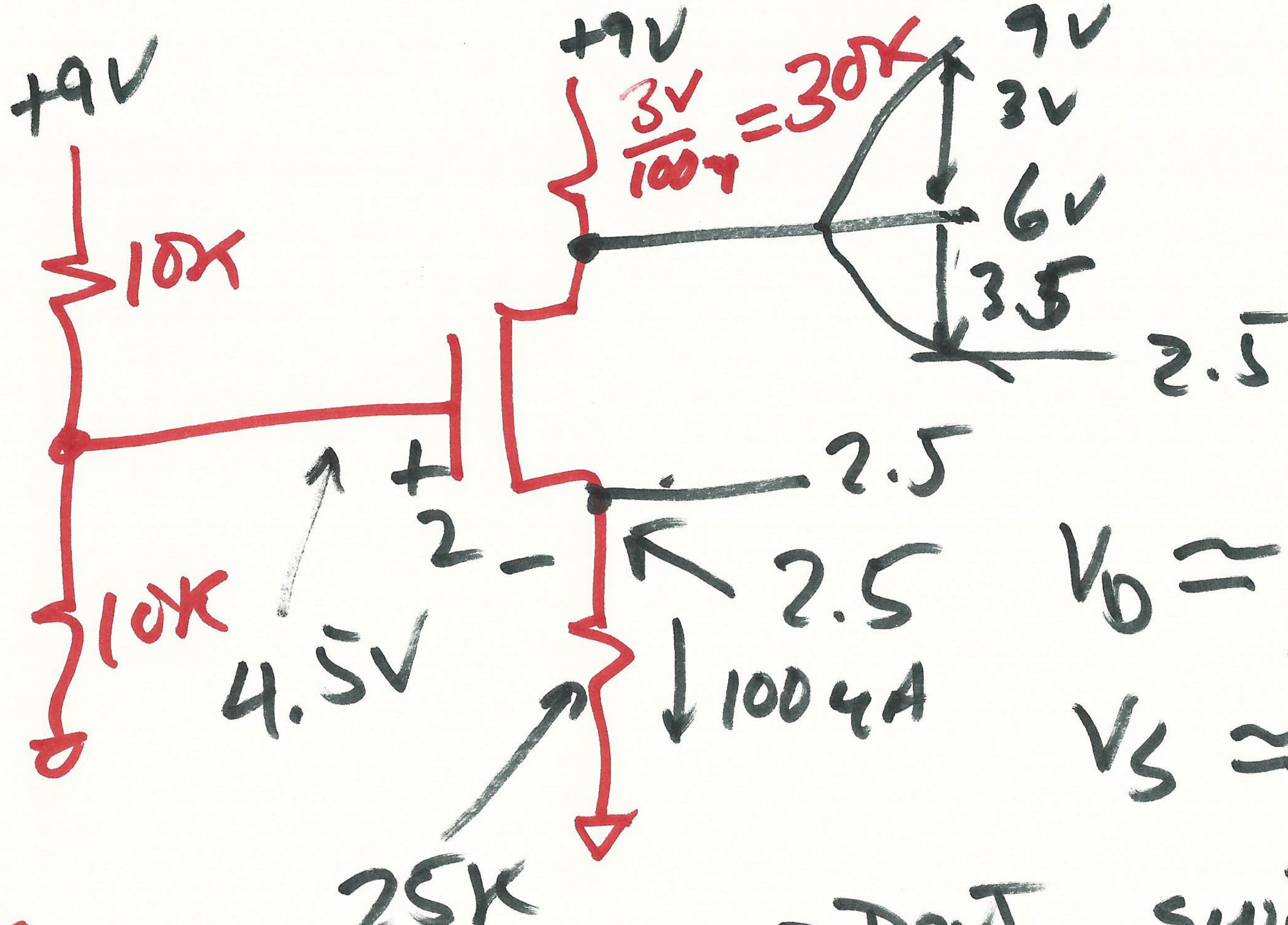
$I_D = \frac{V_S}{R_{SS}}$

$100\mu A = I_D$

$1.5 = V_S$

$R_{SS} = \frac{1.5}{100\mu} = \underline{15K}$

$I_D = \frac{V_S}{15K}$



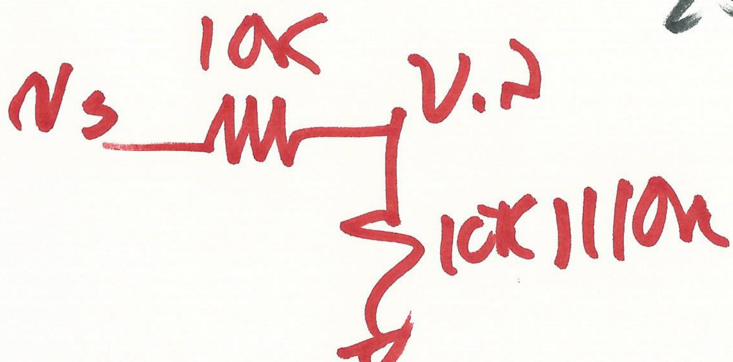
$V_D \simeq \frac{2}{3} VDD$

$V_S \simeq \frac{1}{3} VDD$

output swing

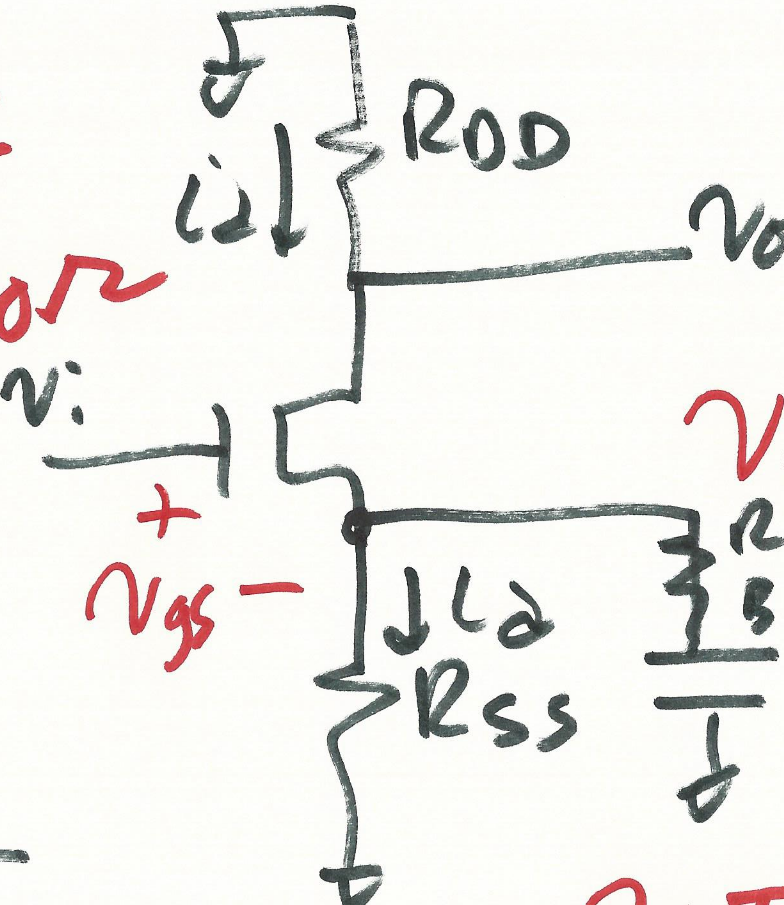
$VDD - \frac{1}{3} VDD$

swing $\simeq \frac{2}{3} VDD$



$g_m = 5\,\frac{mA}{V}$

$\frac{1}{g_m} \approx 200\Omega$



$v_{out} = -i_d R_{DD}$

$v_i = v_{gs} + i_d \cdot R_{SS}$

$= i_d\left(\frac{1}{g_m} + R_{SS}\right)$

$$\frac{-R_{DD}}{1/g_m + R_{SS} \| R_{SS2}}$$

$$\approx \frac{-R_{DD}}{1/g_m + R_{SS2}} \quad \Bigg| \quad R_{SS2} \ll R_{SS}$$

$$\frac{v_{out}}{v_i} = \frac{-R_{DD}}{1/g_m + \cancel{R_{SS}}} = -g_m R_{DD}$$

KNOW this!

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