$\frac{v_t}{i_t} = \frac{v_{gs}}{i_d} = 1/g_m$

AC = 1mV

EE 420/ECG 620 Analog IC Design

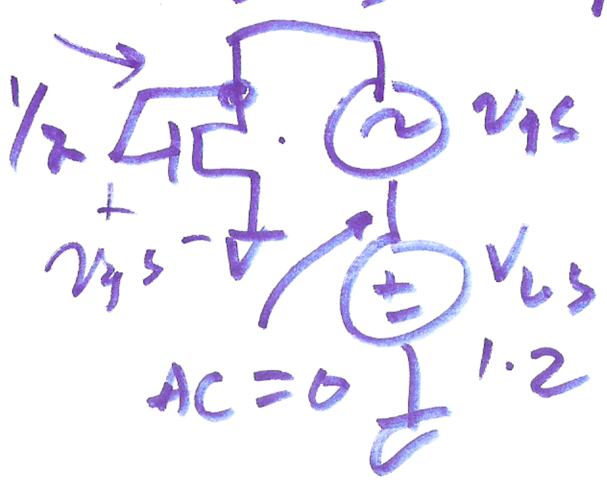
Lecture 13

March 2, 2015

$v_{gs} \cdot g_m = i_d$

$\sqrt{2KP \frac{W}{L} I_D}$

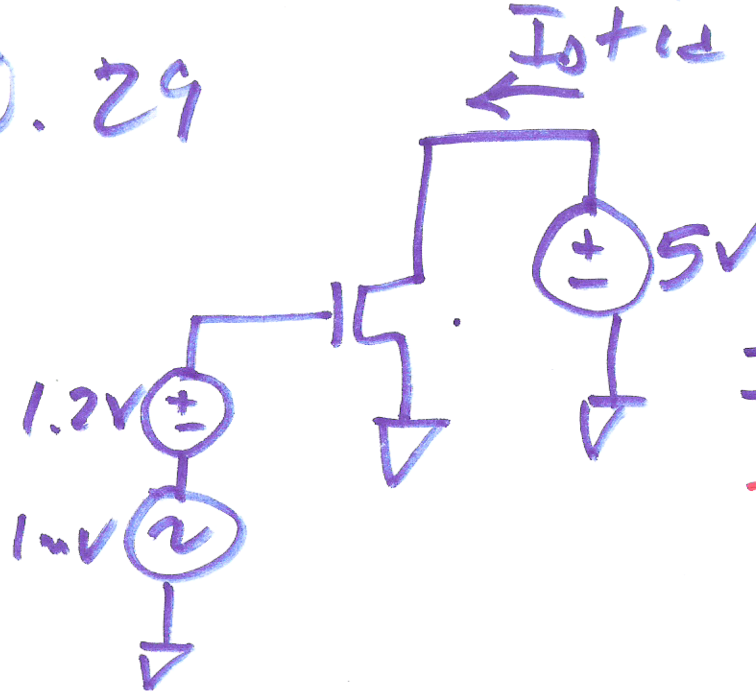
$KP \cdot \frac{W}{L}(V_{GS} - V_{THN})$



A20.29

$I_D = \frac{KP}{2} \cdot \frac{W}{L} (1.2 - V_{THN})^2$

$i_d = g_m v_{gs}$



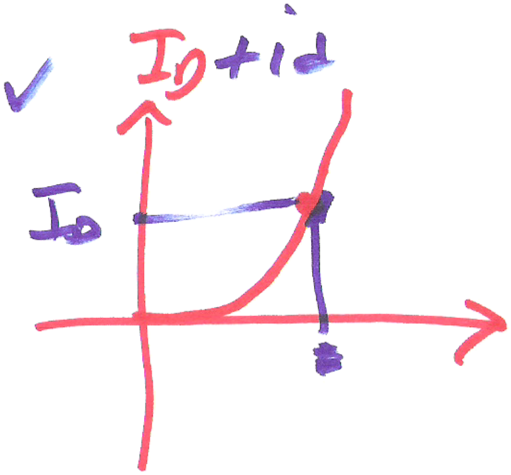
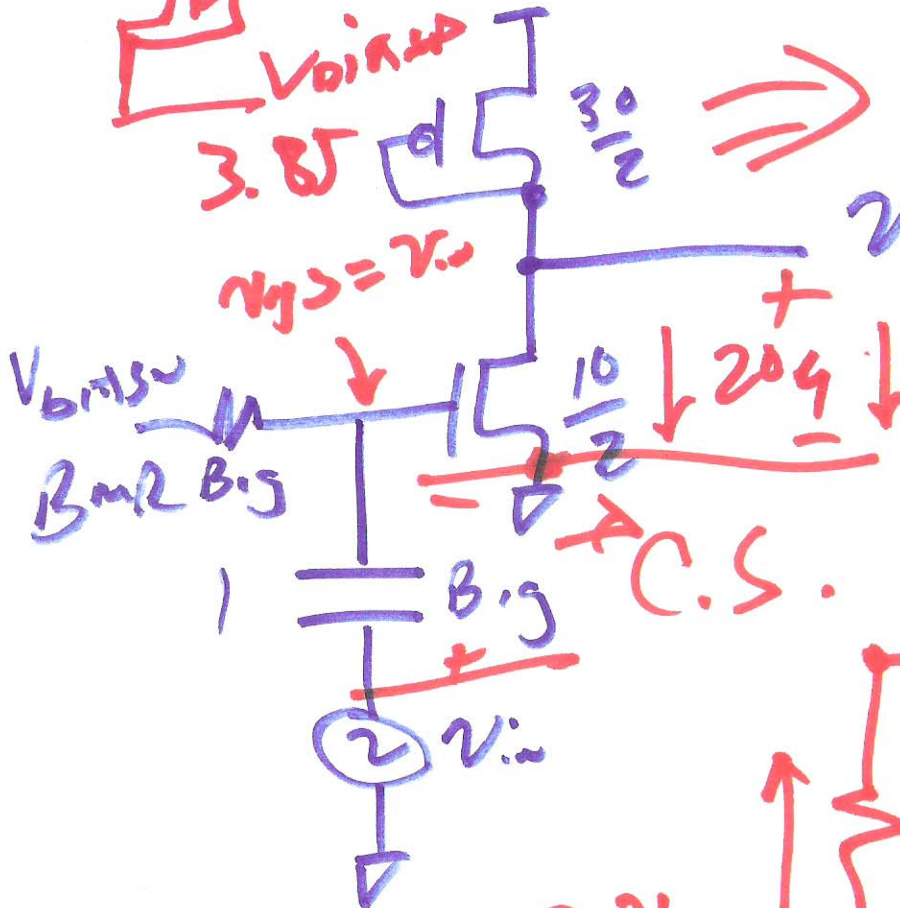
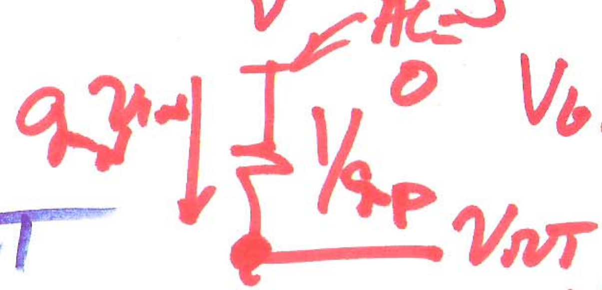


Fig 1.15 TABLE 9.1, $g_m = 150\frac{\mu A}{V}$, $\frac{1}{g_m} = 6.5k$



$\downarrow i_s = g_m v_{in}$

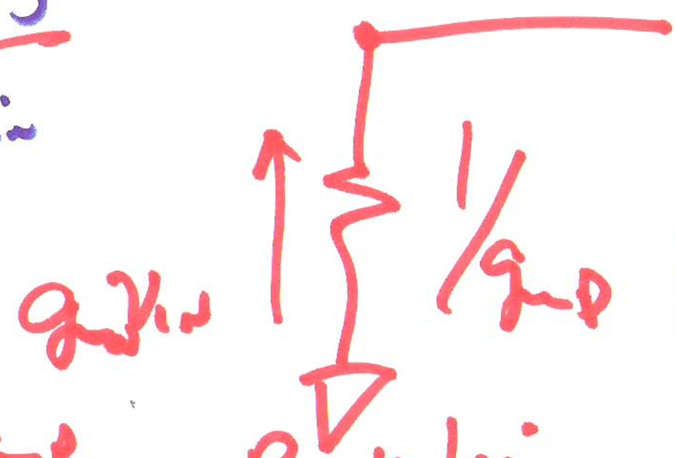
C.S.



$V_{GS} = V_{biasN}$
$= 1.05$

$V_{SG} = 1.15$

$V_{biasP} = 3.85$

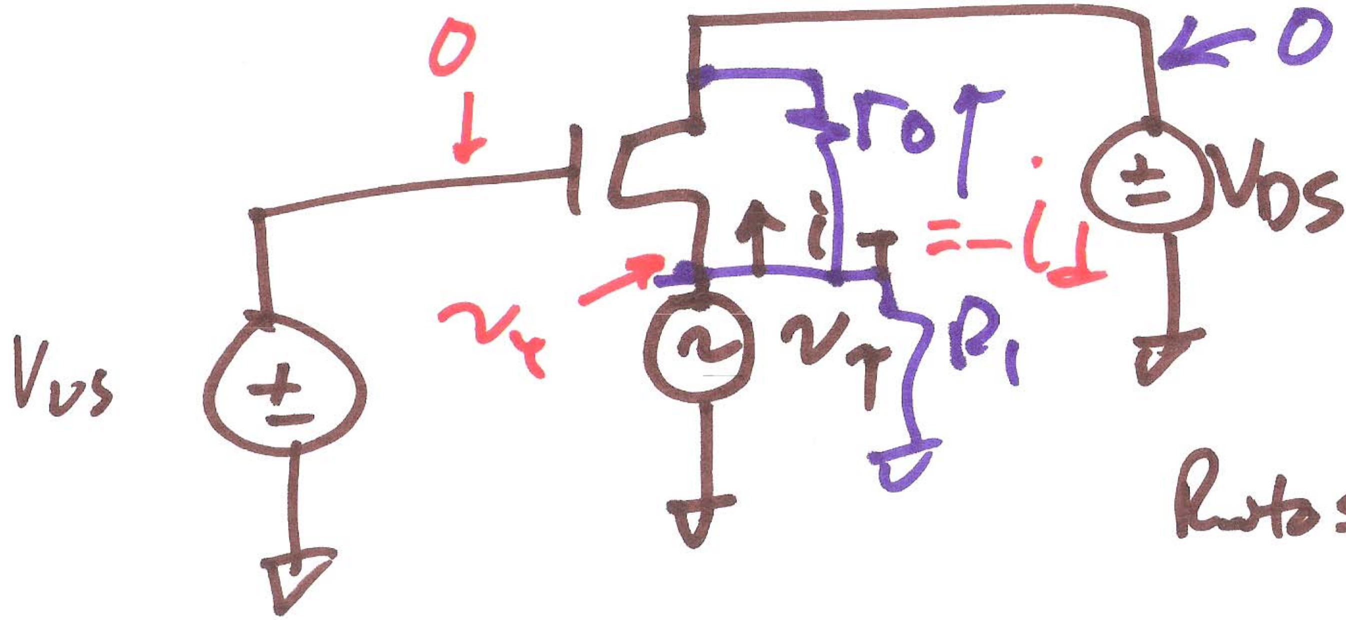


$$v_{out} = -g_m v_{in} \cdot \frac{1}{g_{mp}}$$

$$\boxed{\frac{v_{out}}{v_{in}} = -\frac{g_{mn}}{g_{mp}}}$$

$\simeq 1$

$$\text{GAin} = -\frac{1/g_{mp}}{1/g_{mn}} = \frac{R_{\text{into drain}}}{R_{\text{into source}}}$$



$$\frac{v_T}{r_o} = i_T$$

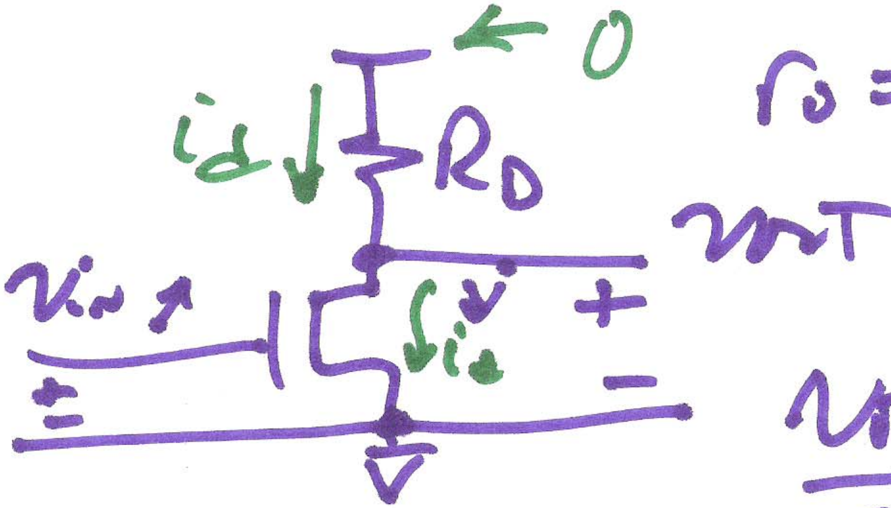
$$R_{to\,source} = \frac{v_T}{i_T}$$

$$v_{gs} = v_g - v_s = -v_T$$

$$i_d = v_{gs} \cdot g_m$$

$$-i_T = -v_T \cdot g_m \rightarrow \frac{v_T}{i_T} = \frac{1}{g_m}$$

$$\frac{v_T}{i_T} = \frac{1}{g_m} \| r_o$$



C.S.

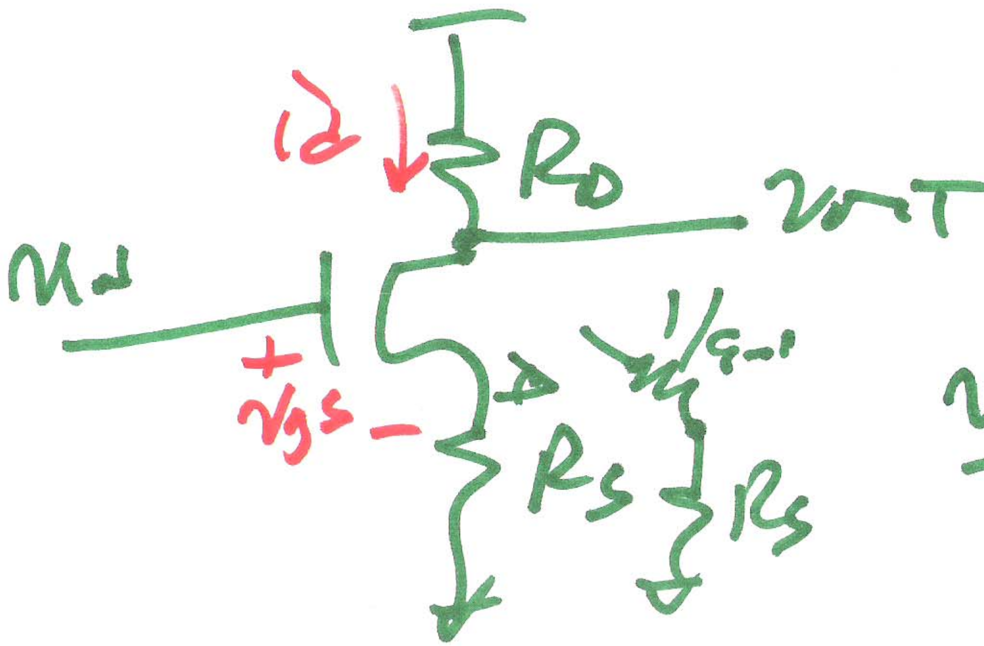
$r_o = \infty$

$$\frac{v_{out}}{v_{in}} = -\frac{R_D}{1/g_m}$$

$$\boxed{= -g_m R_D}$$

$$i_d = g_m v_{in}$$

$$v_{out} = -i_d \cdot R_D$$



$$\frac{v_{out}}{v_{in}} = -\frac{R_D}{1/g_m + R_S}$$

$$v_{out} = -i_d \cdot R_D$$

$$v_{in} = v_{gs} + i_d \cdot R_S$$

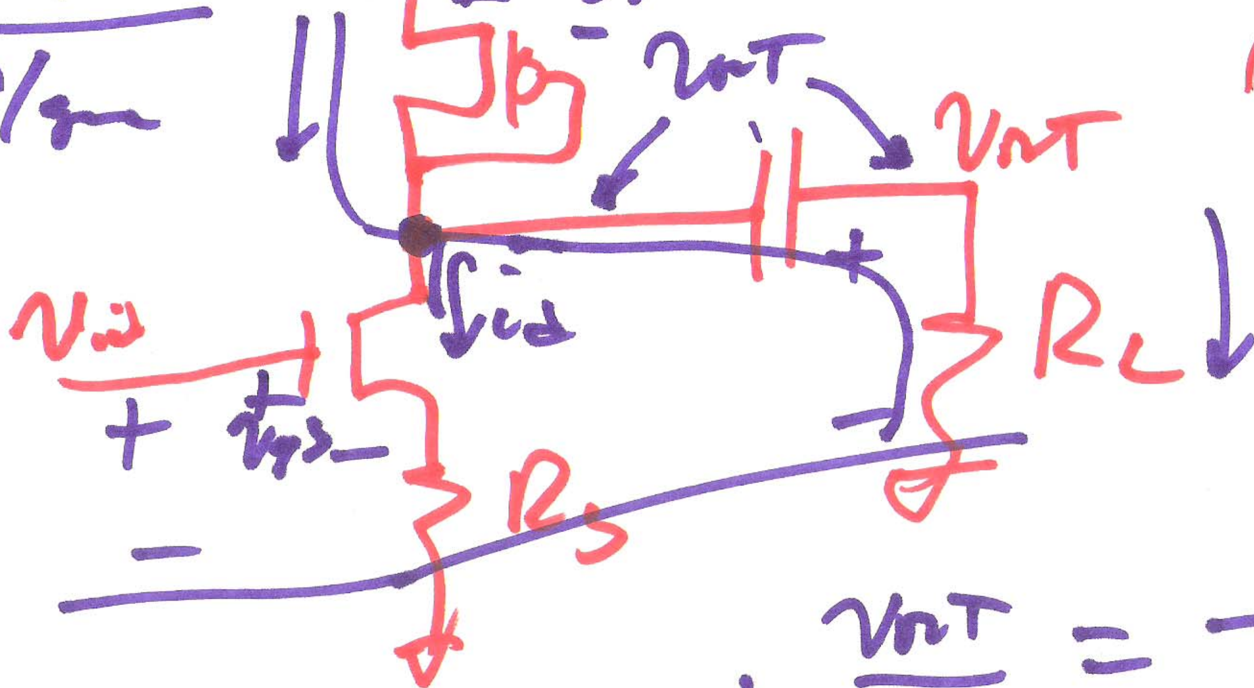
$$= \frac{i_d}{g_m} + i_d \cdot R_S$$

$$\frac{v_{out}}{v_{in}} = \frac{-R_D}{1/g_m + R_S}$$

$\frac{0 - v_{out}}{1/g_m}$

r_o is big

$R_1 \| R_2 = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2}}$



$\frac{v_{out}}{R_L}$

$$\frac{v_{out}}{v_{in}} = -\frac{1/g_{mp} \| R_L}{1/g_{mn} + R_S}$$

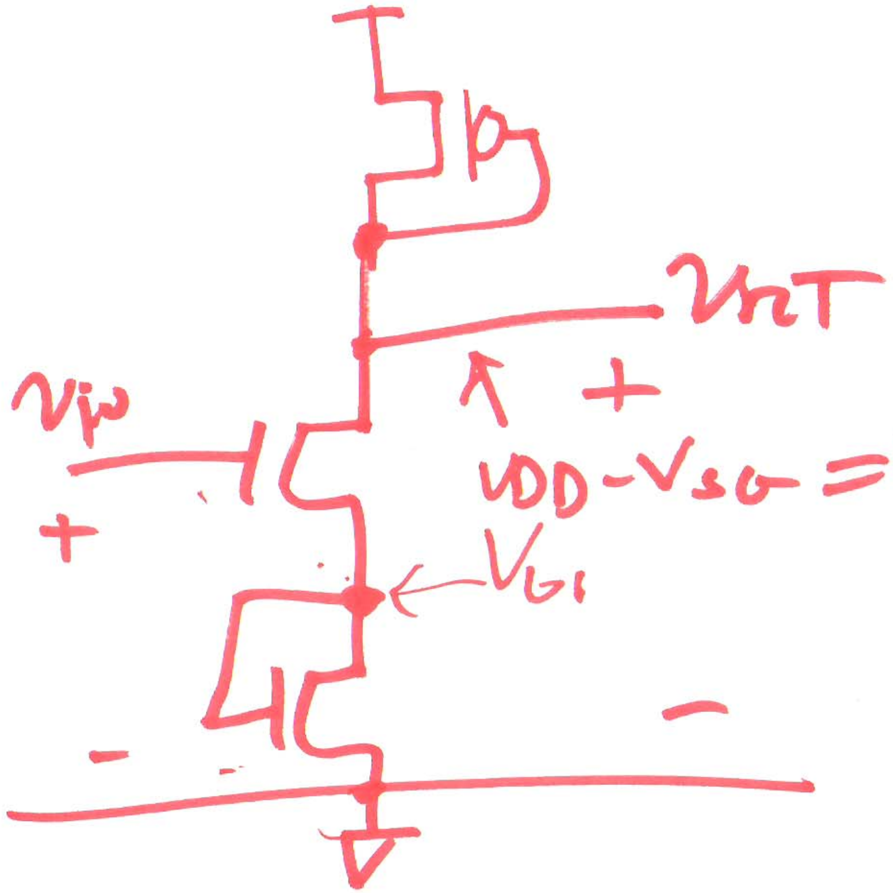
$$v_{in} = v_{gs} + R_S \cdot i_d$$
$$= i_d\left(\frac{1}{g_{mn}} + R_S\right)$$

$$i_d = -\frac{v_{out}}{1/g_{mp}} - \frac{v_{out}}{R_L}$$

$$\frac{v_{out}}{i_d} = -\frac{1}{\frac{1}{1/g_{mp}} + \frac{1}{R_L}} \quad \frac{v_{out}}{\ }$$

$$-i_d = v_{out}\left(\frac{1}{1/g_{mp}} + \frac{1}{R_L}\right)$$

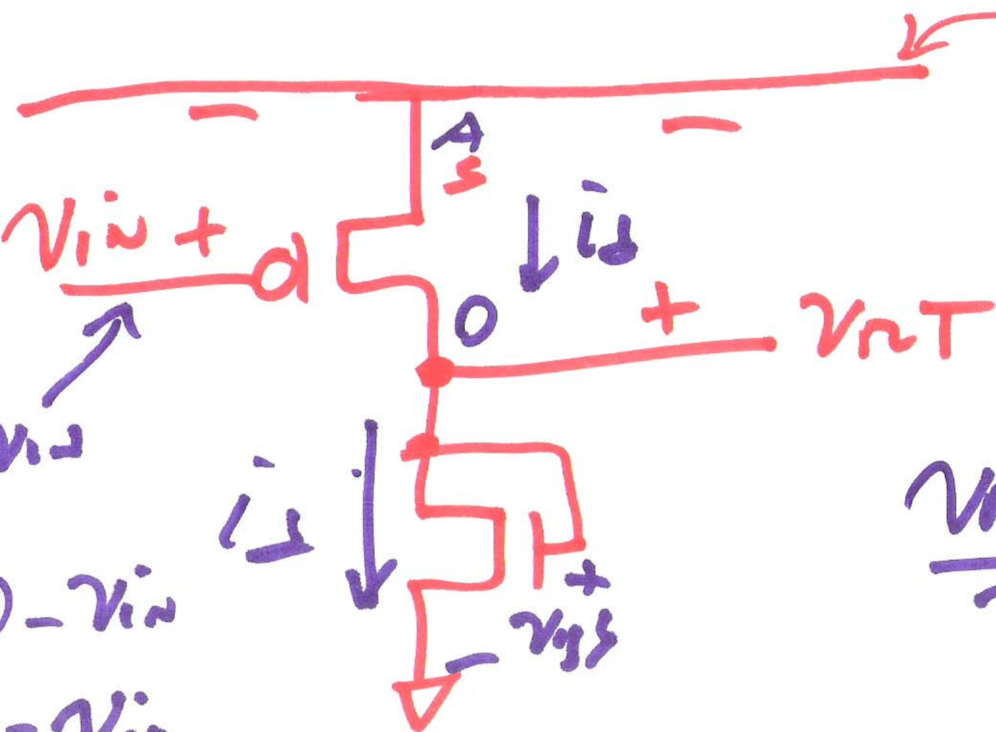
$$= R_L \| 1/g_{mp}$$



$$VDD - V_{SG} = VDD - V_{THP} - V_{SD,sat}$$

C.S.

$$\frac{v_{out}}{v_{in}} = \frac{-1/g_{mp}}{1/g_{mn} + \frac{1}{g_{mn}}}$$



$$g_m v_{gs} = i_d$$

$$\frac{v_{out}}{v_{in}} = -\frac{1/g_{mn}}{1/g_{mp}}$$

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

$$v_{sg} \cdot g_{mp} = i_d \qquad v_{out} = i_d \cdot 1/g_{mn} \qquad v_{gs} = \frac{i_d}{g_{mn}}$$

$$v_{in} = -\frac{i_d}{g_{mp}}$$

$$\frac{v_{out}}{v_{in}} = \frac{\cancel{i_d} \cdot 1/g_{mn}}{\cancel{i_d}\left(-1/g_{mp}\right)} = -\frac{g_{mp}}{g_{mn}}$$