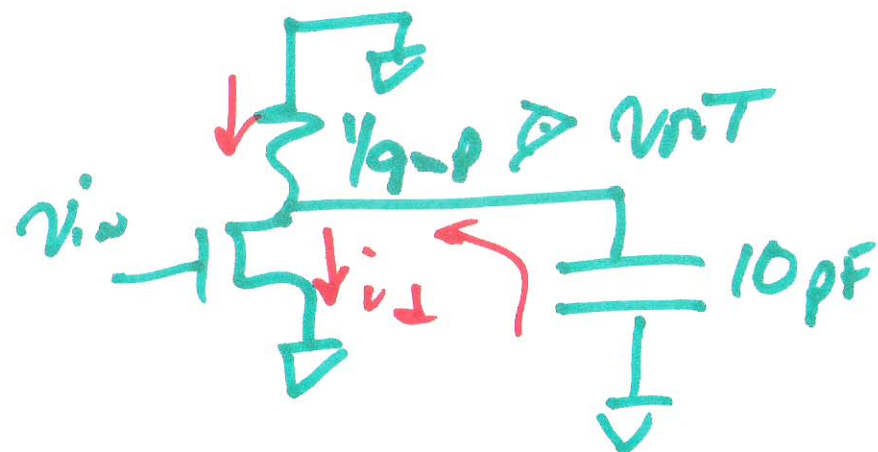


# EE 420 / ECG 620

## Lecture 14

MARCH 4, 2015

1K<sup>Ω</sup>



@ low freq.

$$\frac{v_{out}}{v_{in}} = - \frac{1/g_p}{1/g_n}$$

$$\frac{v_{out}}{v_{in}} = \frac{-g_n}{1 + j\omega \frac{1}{g_p} \cdot 10p}$$

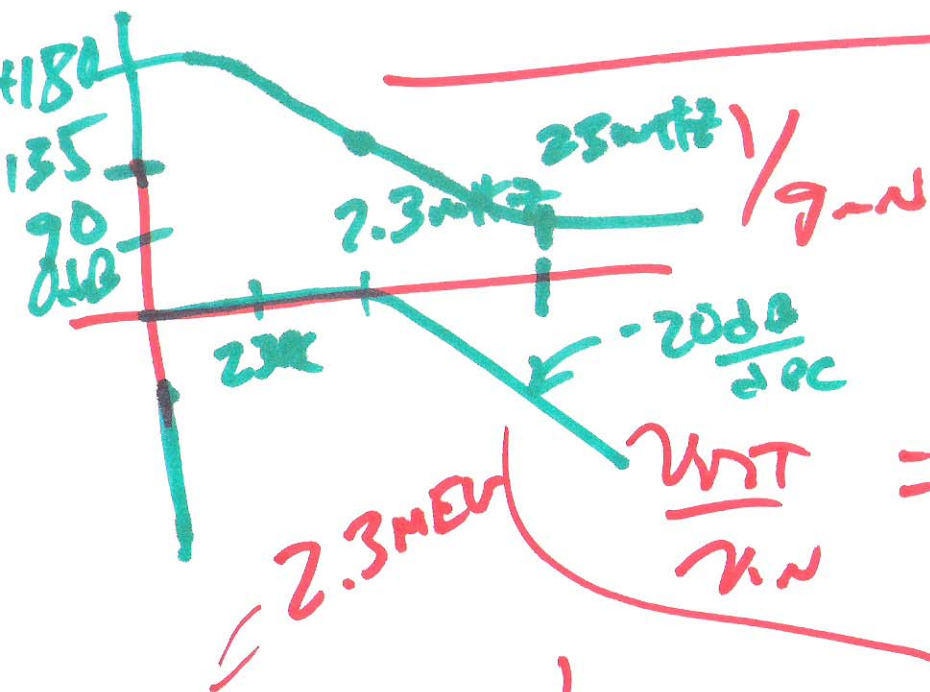
$$v_{out} = -i_d \cdot \frac{1}{g_p} \parallel \frac{1}{j\omega 10pF}$$

$$v_{in} = v_{gs} = \frac{i_d}{g_n}$$

$$-\frac{1}{g_{mP}} \cdot \frac{1}{j\omega_{OP}}$$

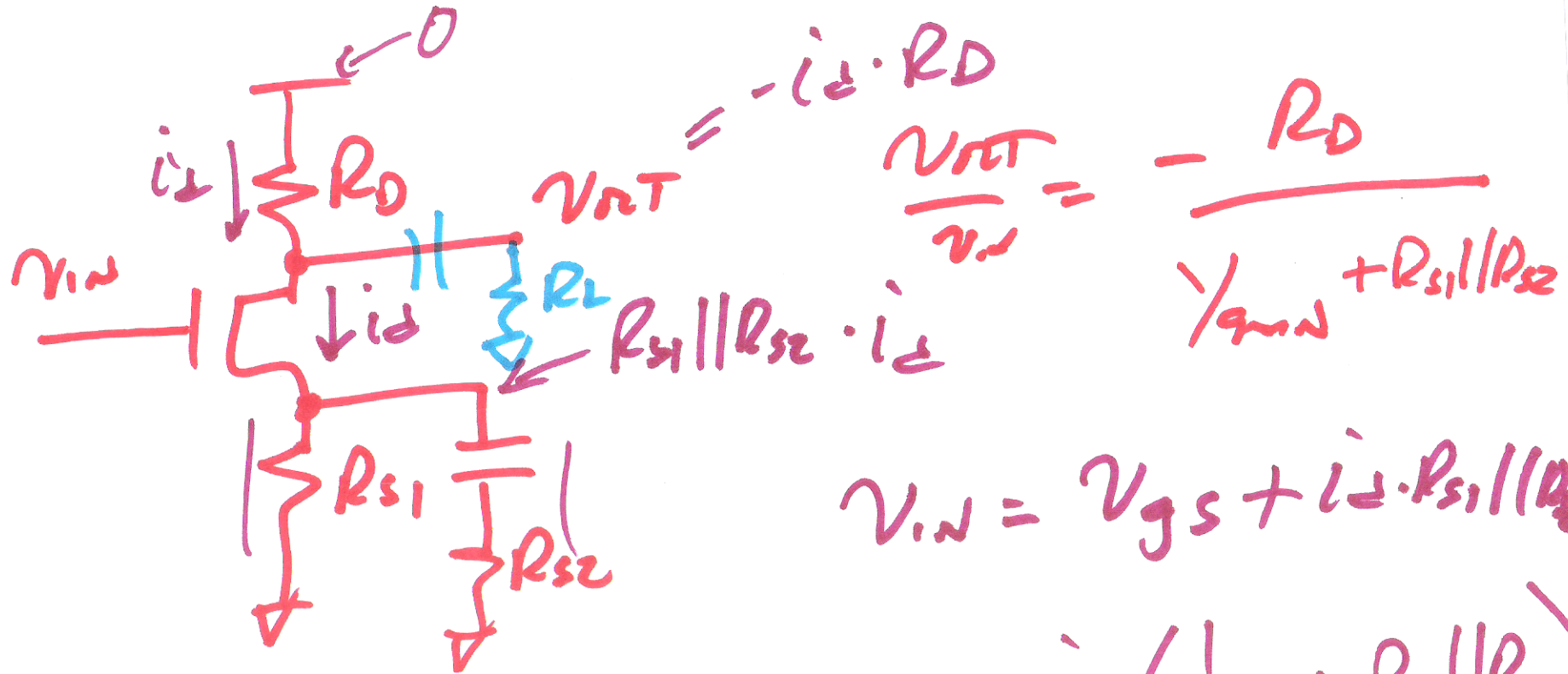
$$\frac{1}{g_{mP}} + \frac{1}{j\omega_{OP}C}$$

$$= -\frac{1}{g_{mP}} \cdot \frac{1}{\frac{1}{g_{mN}} + \frac{1}{j\omega_{OP}}}$$



$$-\frac{g_{mN}}{g_{mP}} \cdot \frac{1}{1 + j\omega_{OP} \cdot \frac{1}{g_{mP}}}$$

$$f_{3dB} = \frac{1}{2\pi \cdot 10p \cdot 6.5K} = -1 \cdot \frac{1}{1 + j \frac{f}{f_{3dB}}}$$



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

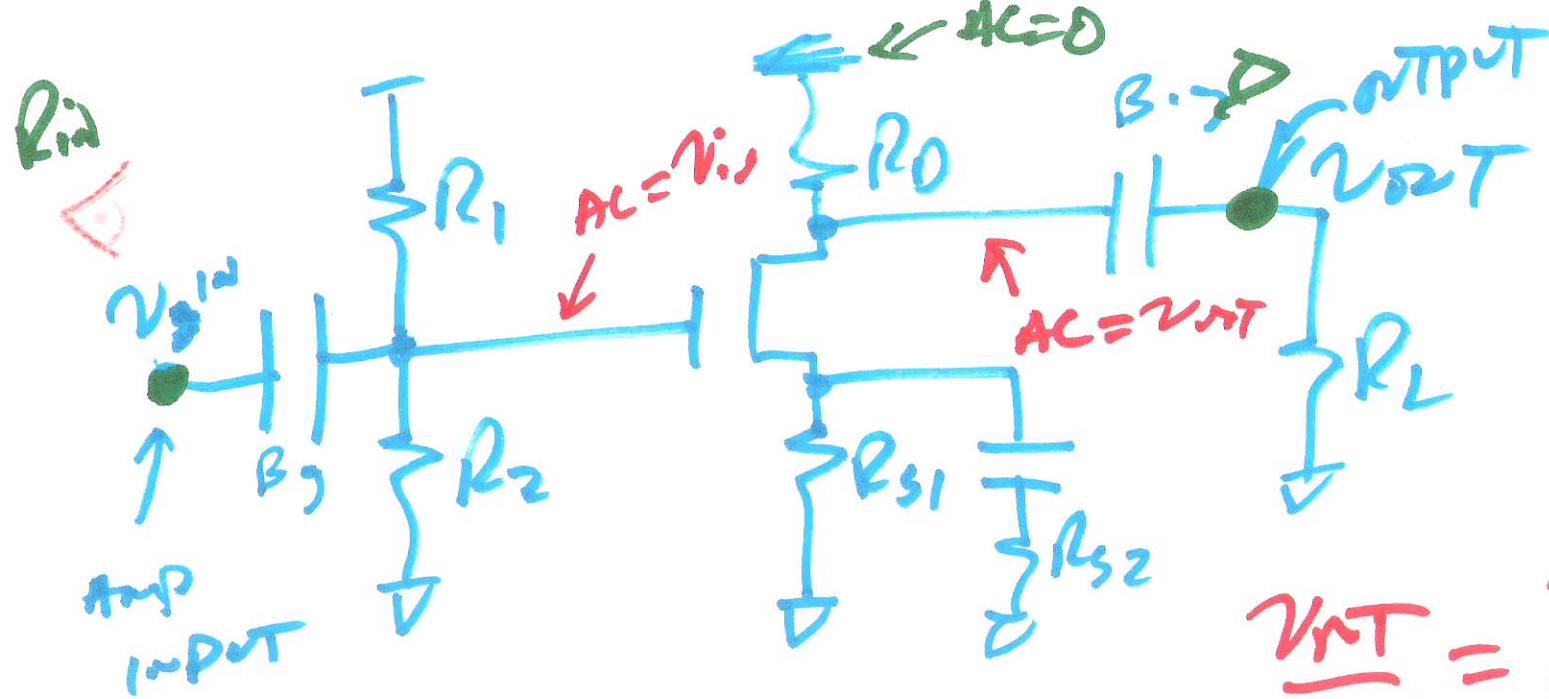
$$\frac{v_{out}}{v_{in}} = - \frac{R_D}{\frac{1}{g_m} + R_{S1} \parallel R_{S2}}$$

$$v_{in} = v_{gs} + i_d \cdot R_{S1} \parallel R_{S2}$$

$$= i_d \left( \frac{1}{g_m} + R_{S1} \parallel R_{S2} \right)$$

$$\frac{v_{out}}{v_{in}} = \frac{-R_L \parallel R_D}{\frac{1}{g_m} + R_{S1} \parallel R_{S2}}$$

3)

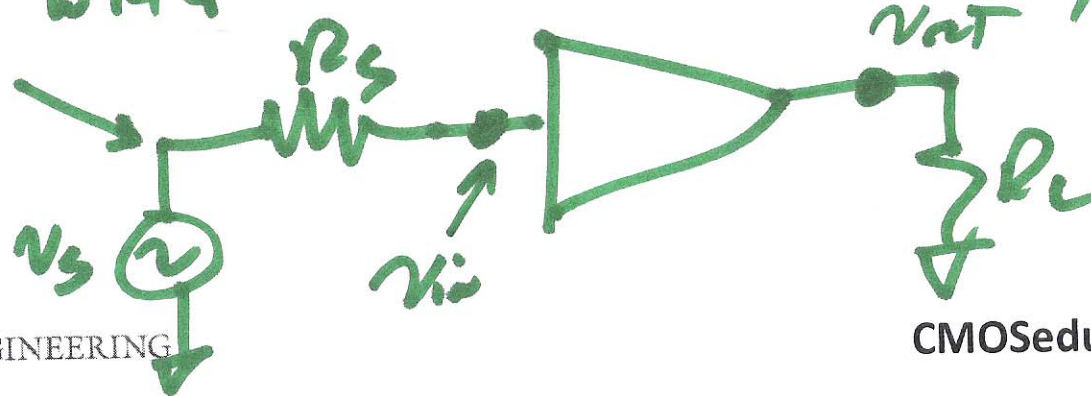


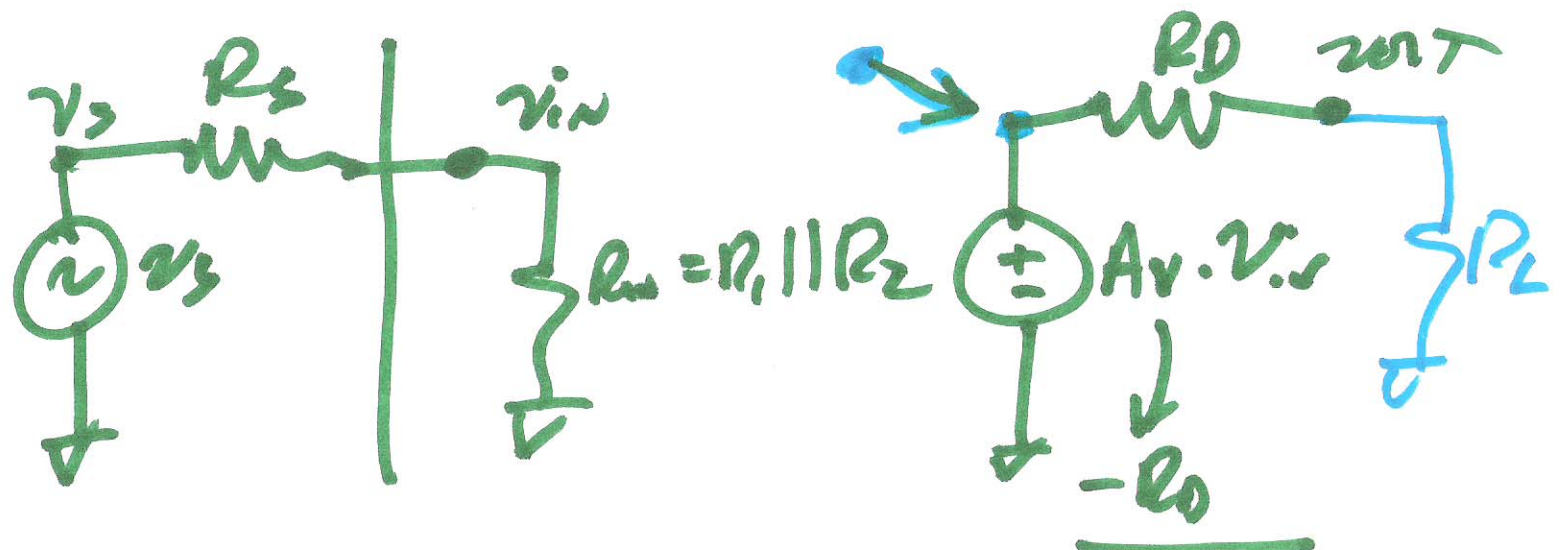
$$\frac{v_{out}}{v_{in}} = \frac{-R_0 \parallel R_L}{\frac{1}{g_{m1}} + R_{31} \parallel R_{32}}$$

$$R_{in} = R_1 \parallel R_2$$

$$R_{out} = R_0$$

$$G_{Ain} \text{ with no load} = \frac{v_{out}}{v_{in}} = \frac{A_v R_0}{\frac{1}{g_{m1}} + R_{31} \parallel R_{32}}$$





NO  $R_L$

$$v_{out} = v_{in} \cdot \left( \frac{-R_o}{\frac{1}{g_{m,n}} + R_{s1} || R_{s2}} \right)$$

with  $R_L$

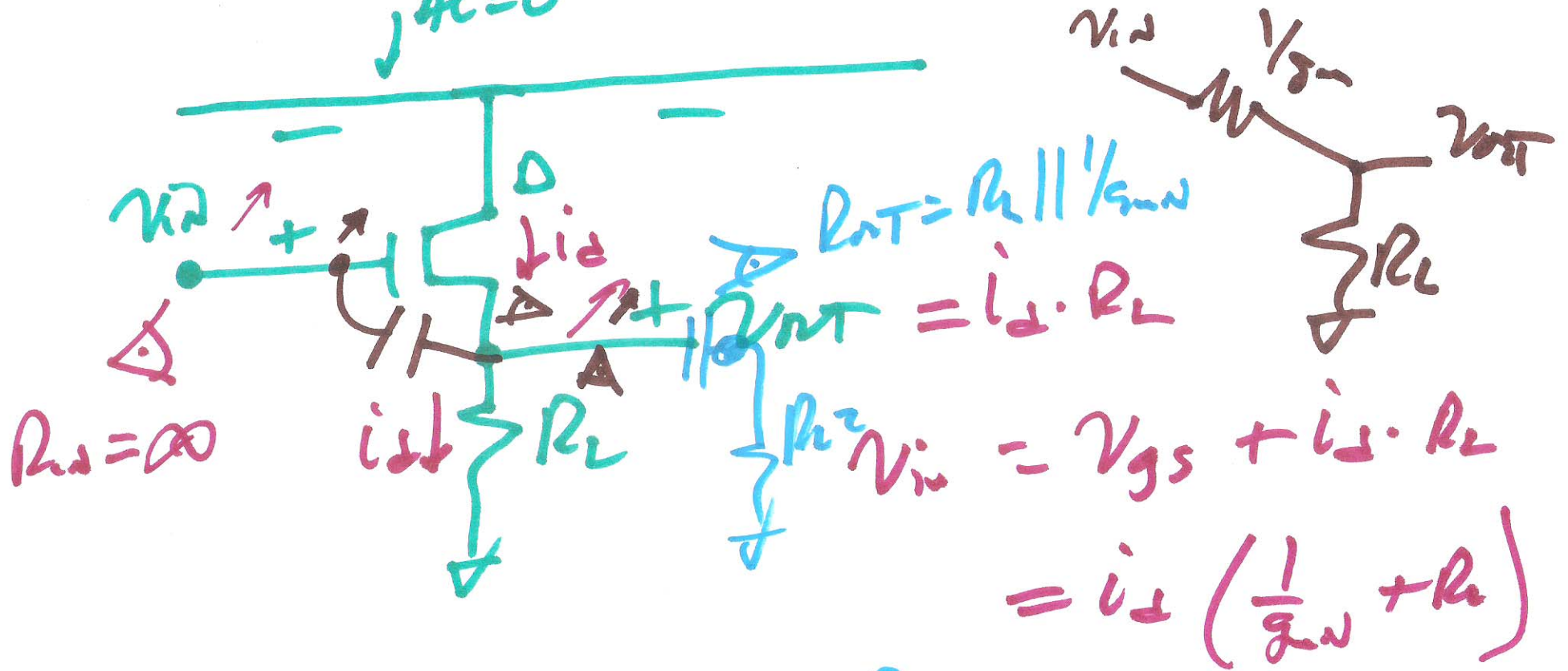
$$v_{in} = v_s \cdot \frac{R_{in}}{R_s + R_{in}}$$

$$v_{out} = v_{in} \left( \frac{-R_o}{\frac{1}{g_{m,n}} + R_{s1} || R_{s2}} \right) \cdot \frac{R_L}{R_L + R_o}$$

$$\frac{v_{out}}{v_{in}} = \frac{R_o || R_L}{\frac{1}{g_{m,n}} + R_{s1} || R_{s2}} \cdot \frac{R_L}{R_L + R_o} = \frac{v_{out}}{v_s}$$

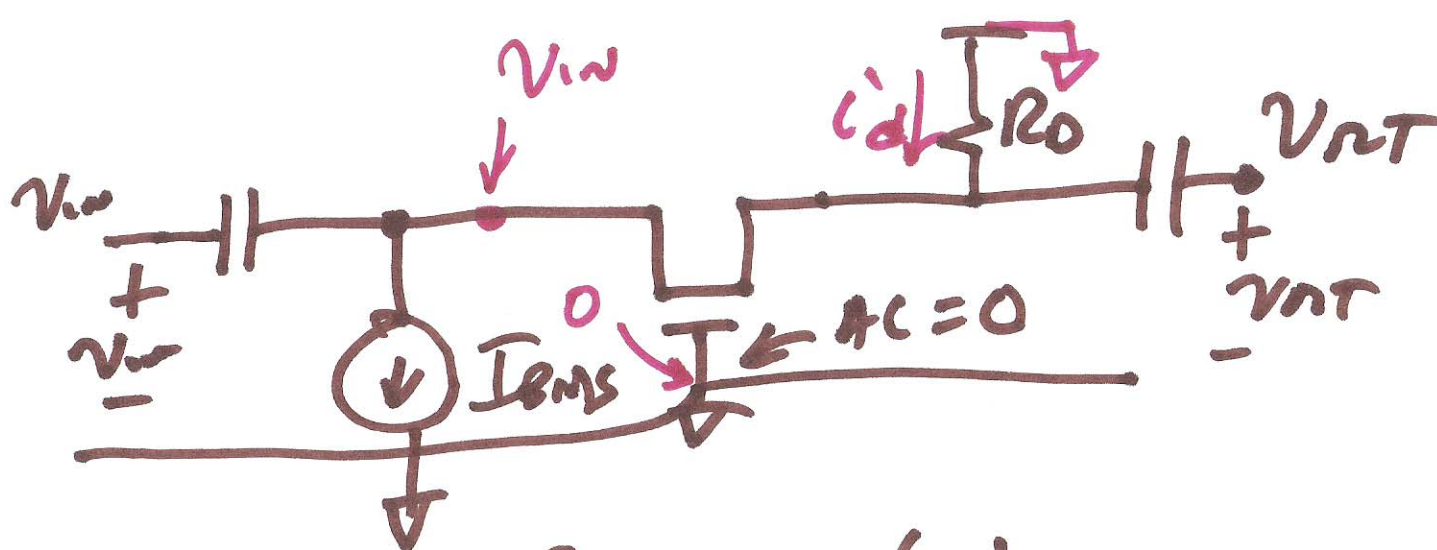
# Source follower Common - Drain

$\omega_{AC} = 0$



$$\frac{v_{out}}{v_{in}} = \frac{R_L \parallel R_{L2}}{1/g_{mN} + R_L \parallel R_{L2}}$$

6)

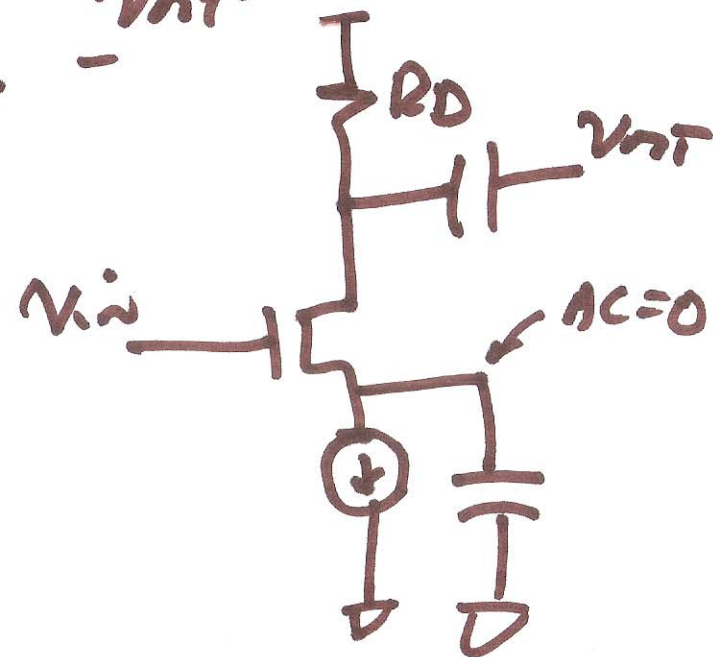


Common Gate  
C.G.

$$v_{gs} = (0 - v_{in}) = -\frac{i_d}{g_m}$$

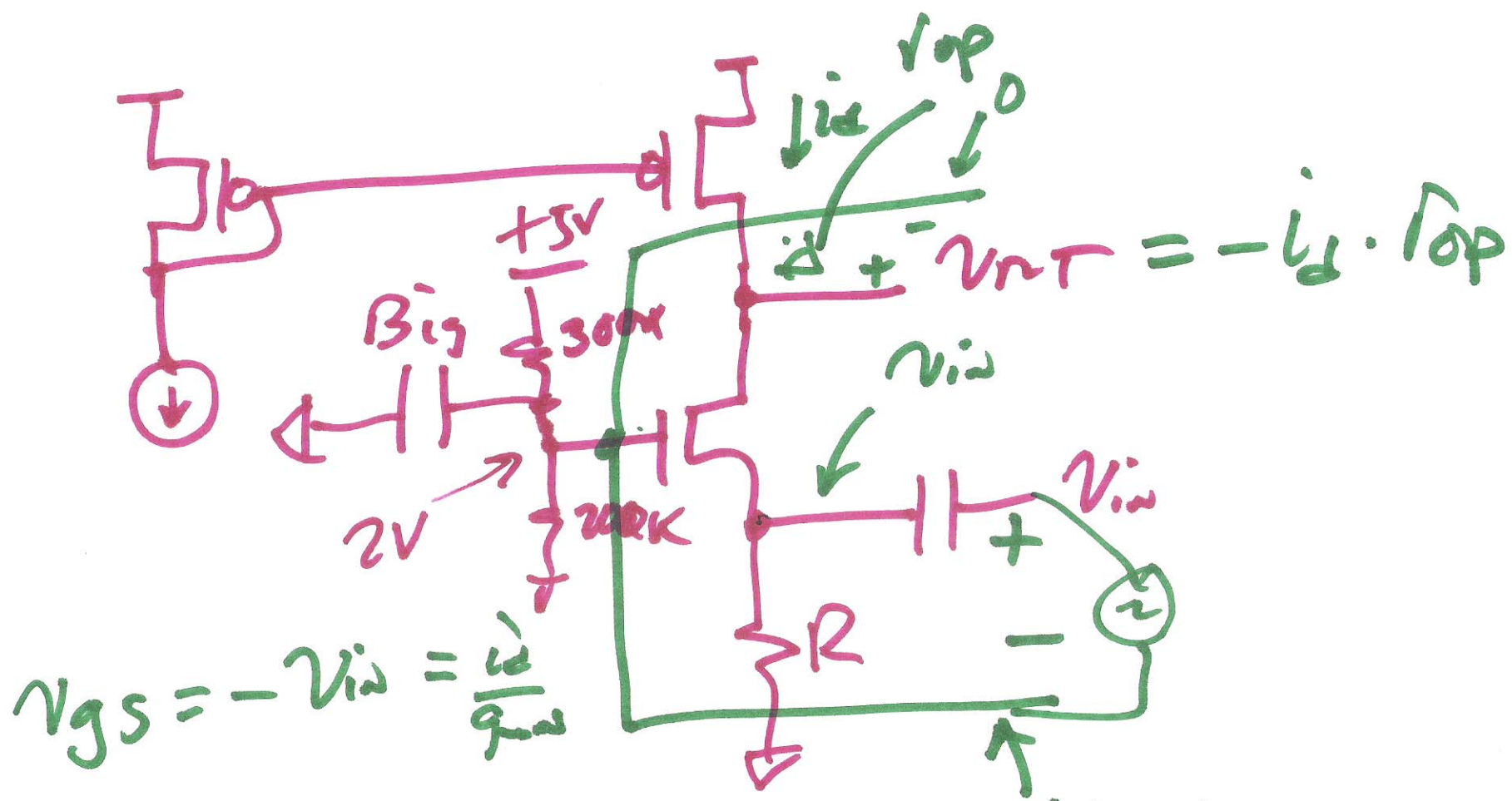
$$v_{out} = -i_d \cdot R_D$$

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

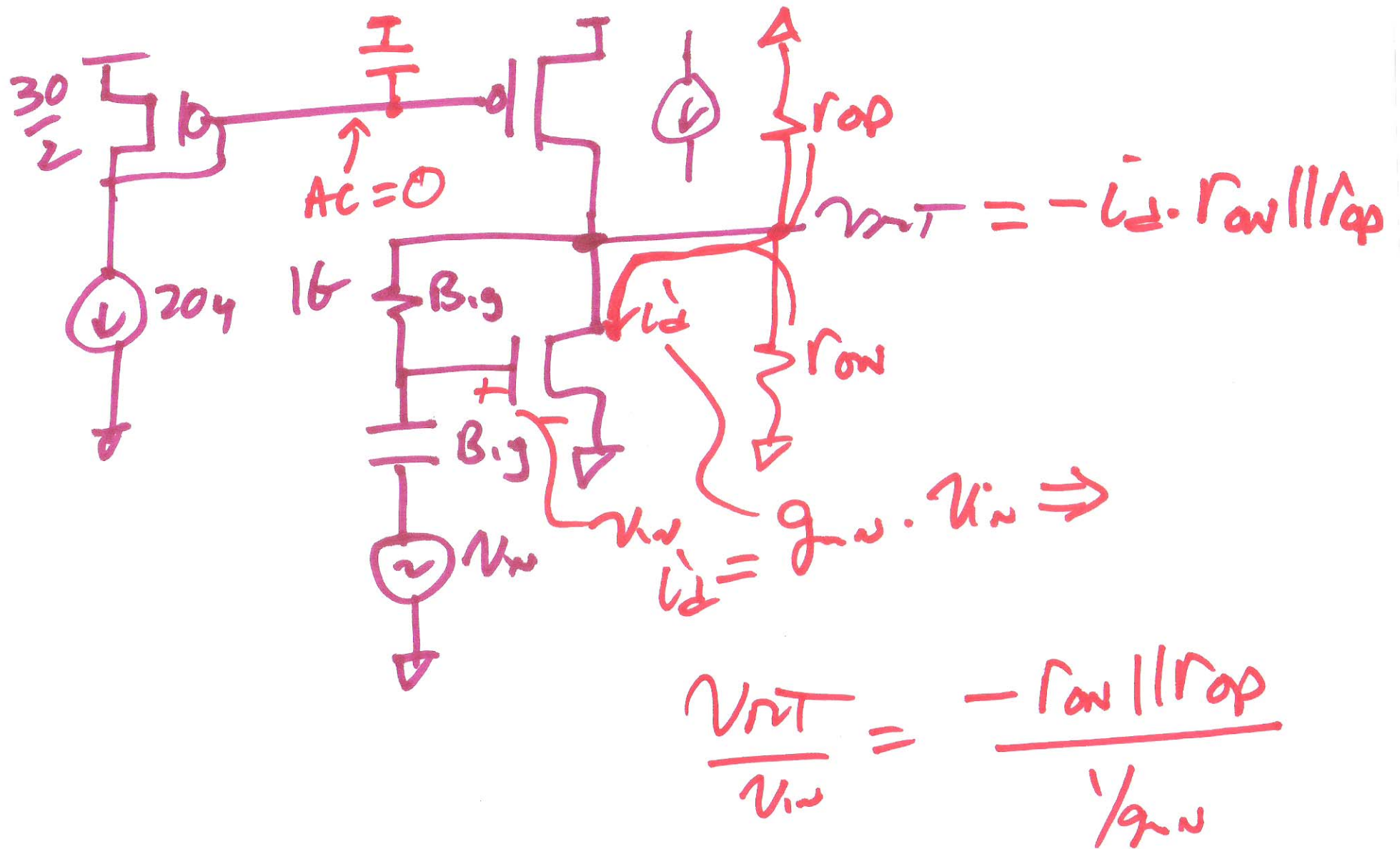


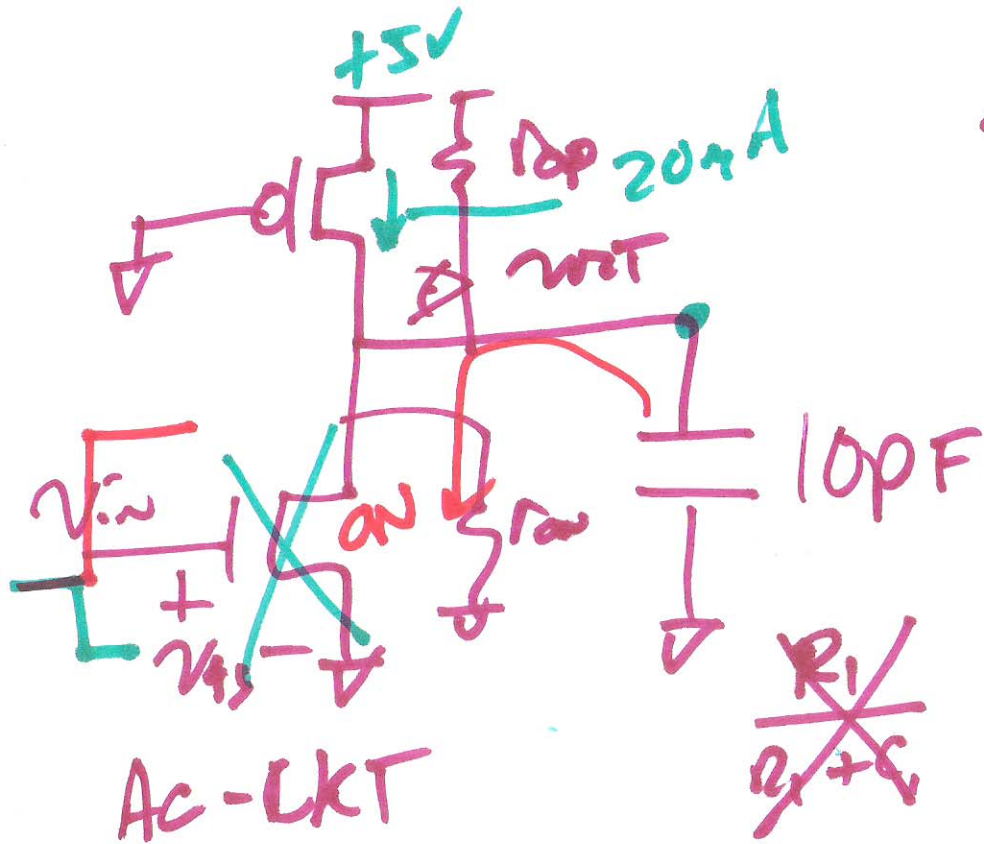
C.S.

$$\begin{aligned} \frac{v_{out}}{v_{in}} &= -\frac{R_D}{1/g_m} \\ &= -g_m \cdot R_D \end{aligned}$$



$$\frac{v_{NT}}{v_{in}} = \frac{-i_d \cdot r_{op}}{-i_d \cdot \frac{1}{g_{m1}}} = \frac{r_{op}}{\frac{1}{g_{m1}}} = g_{m1} r_{op}$$





$$\frac{v_{out}}{v_{in}} = \frac{-r_{on} || r_{op}}{1/g_{m,n}}$$

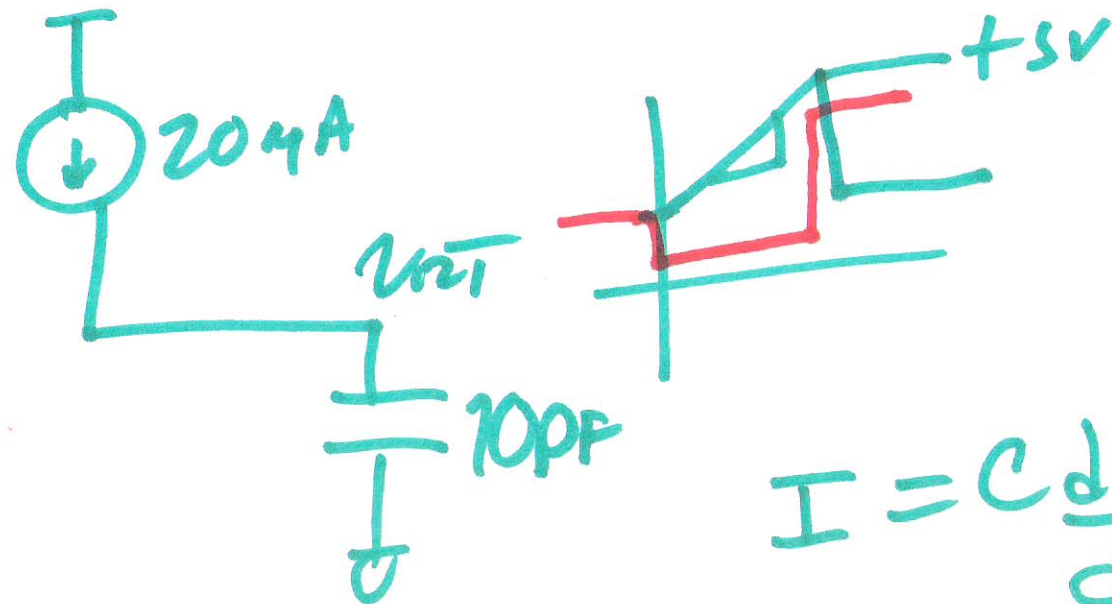
$$\frac{1}{1 + j\omega r_{on} || r_{op} \cdot 10 \text{ pF}}$$

$$\frac{R_1}{R_1 + R_2}$$

$$\frac{R_1 || R_2 || R_3}{\frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}}$$

$$\frac{v_{out}}{v_{in}} = \frac{-r_{on} || r_{op} || \frac{1}{j\omega 10 \text{ pF}}}{i_d / g_{m,n}}$$

$$R_1 || R_2 || R_3 = \frac{1}{\frac{1}{R_1 || R_2} + \frac{1}{R_3}}$$



$$I = C \frac{dV}{dt}$$

$$\frac{2\text{V}}{4\text{s}} = \frac{204\text{A}}{10\text{pF}} = \frac{I}{C} = \frac{\Delta V}{\Delta t}$$