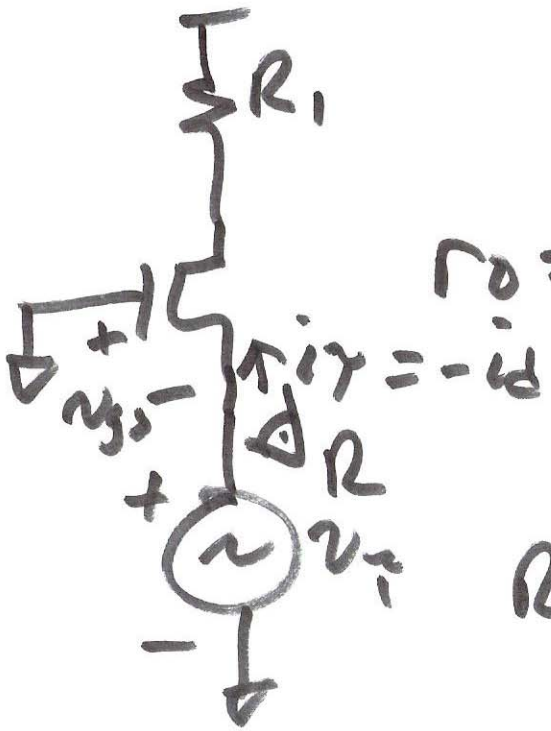
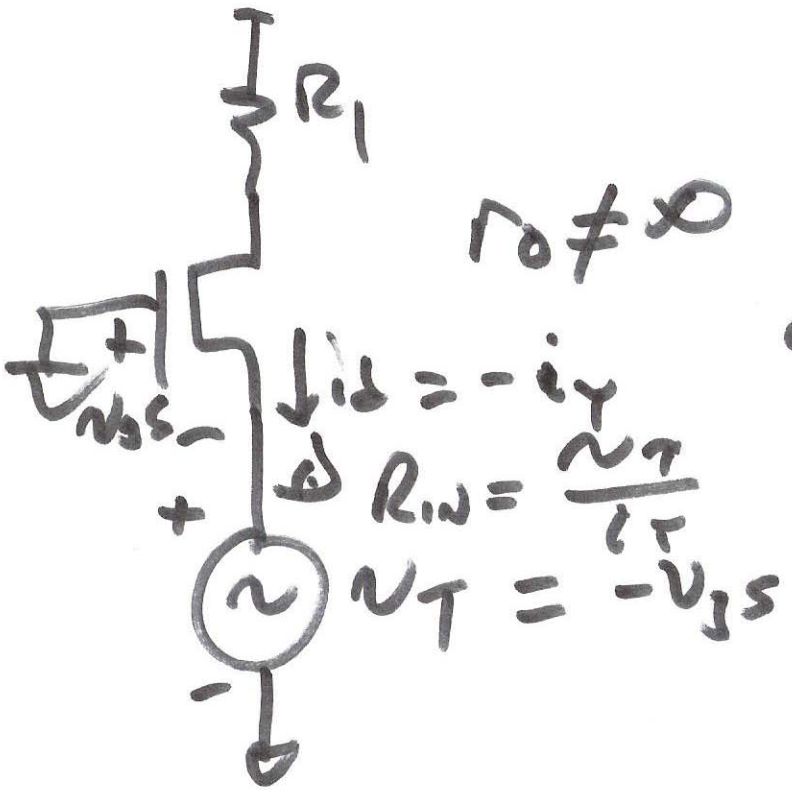
Sept. 2, 2011

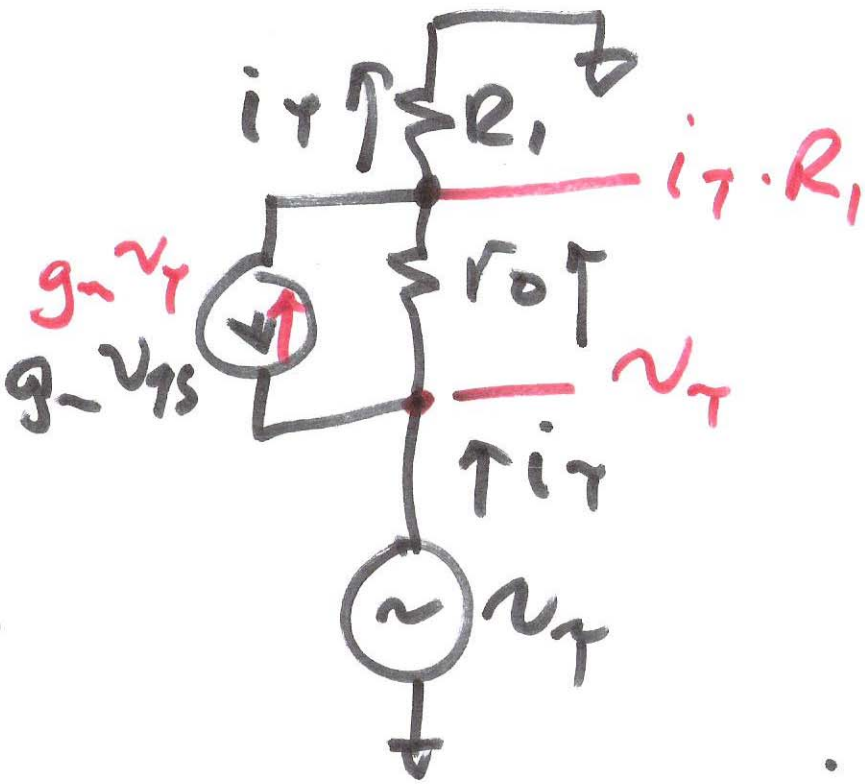
Shunt - shunt Amps



$$R = \frac{v_x}{i_x} = \frac{-v_{gs}}{-i_d} = \frac{1}{g_m}$$

1)



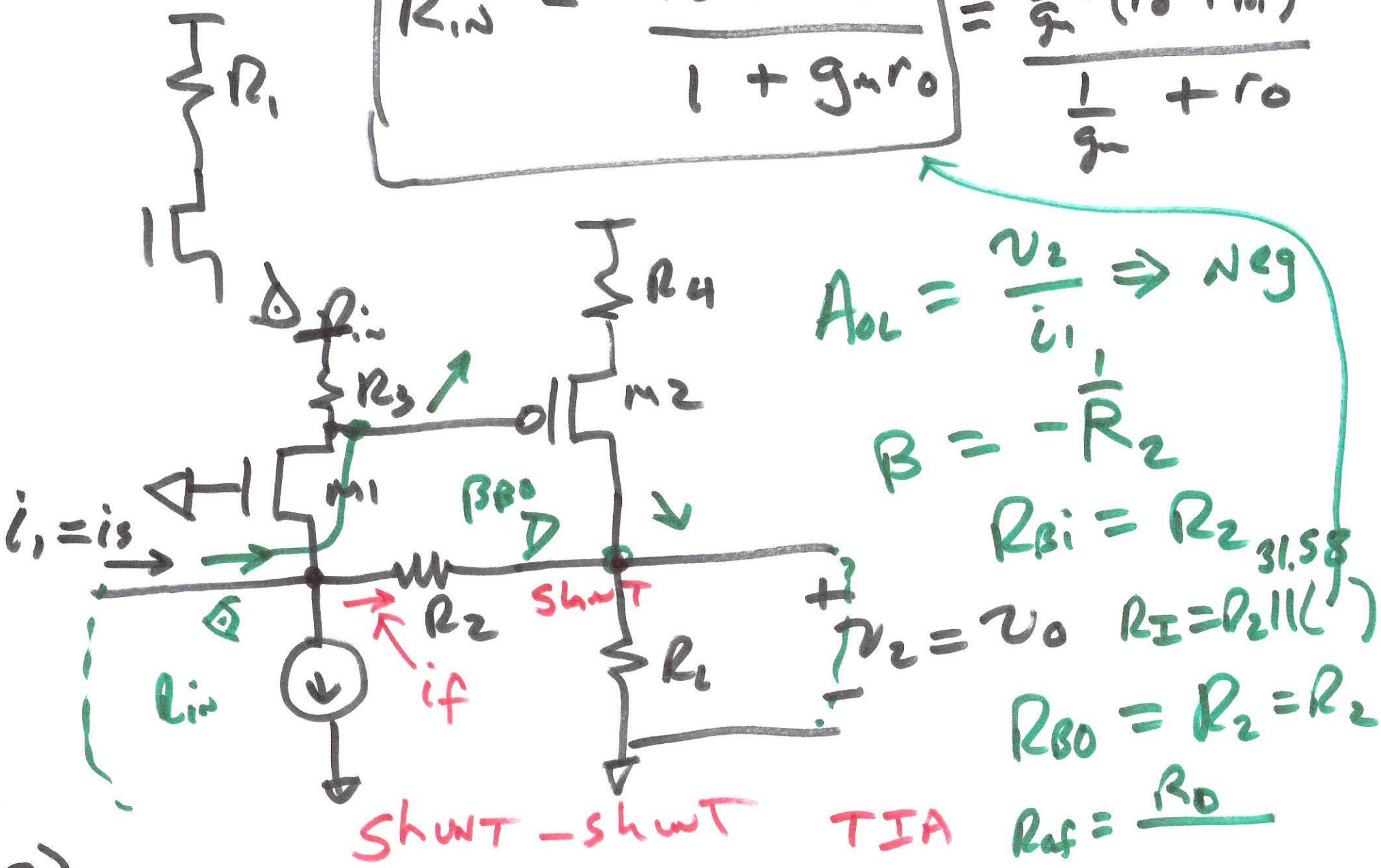


$$i_T = g_m v_T + \frac{v_T - i_T \cdot R_1}{r_o}$$

$$i_T\left(1 + \frac{R_1}{r_o}\right) = v_T\left(g_m + \frac{1}{r_o}\right)$$

$$\frac{1 + \frac{R_1}{r_o}}{g_m + \frac{1}{r_o}}$$

$$R_{in} = \frac{r_o + R_1}{1 + g_m r_o} = \frac{\frac{1}{g_m}\cdot(r_o + R_1)}{\frac{1}{g_m} + r_o}$$



$A_{OL} = \frac{v_2}{i_1} \Rightarrow$ Neg

$B = -\frac{1}{R_2}$

$R_{Bi} = R_2$ 31.5Ω

$R_I = R_2 \| (\quad)$

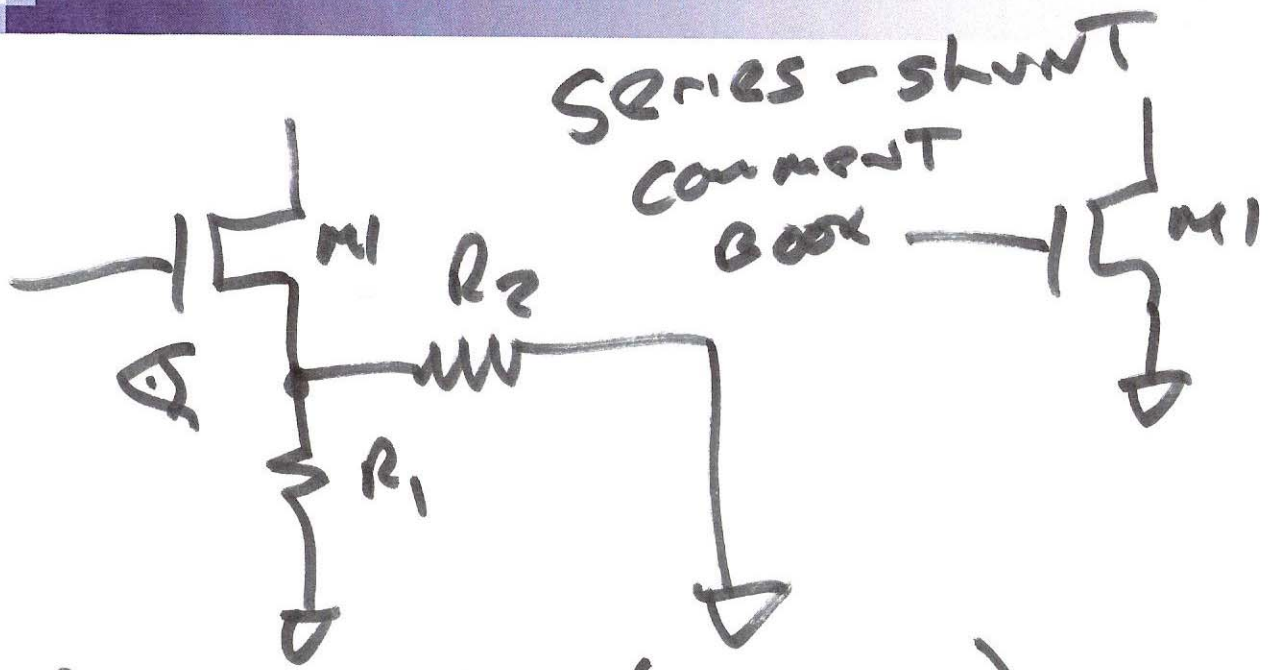
$R_{BO} = R_2 = R_2$

$R_{of} = \frac{R_O}{}$

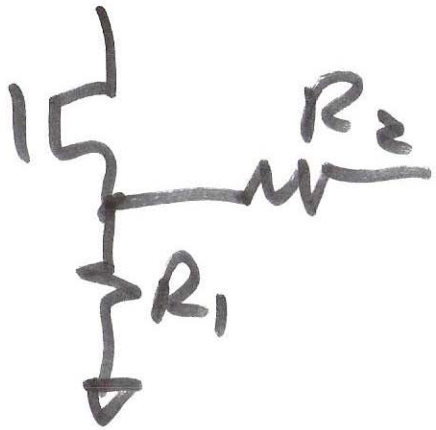
3)

Series-shunt

comment



$R_{Di} = R_1 \| R_2$ (Lecture)



$R_{Di} = R_2$

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4)

shunt-shunt

$A_{OL} \cdot B$ = pos.

A_{OL} is neg.

$B = -R_2$ B neg

Calculate A_{OL}

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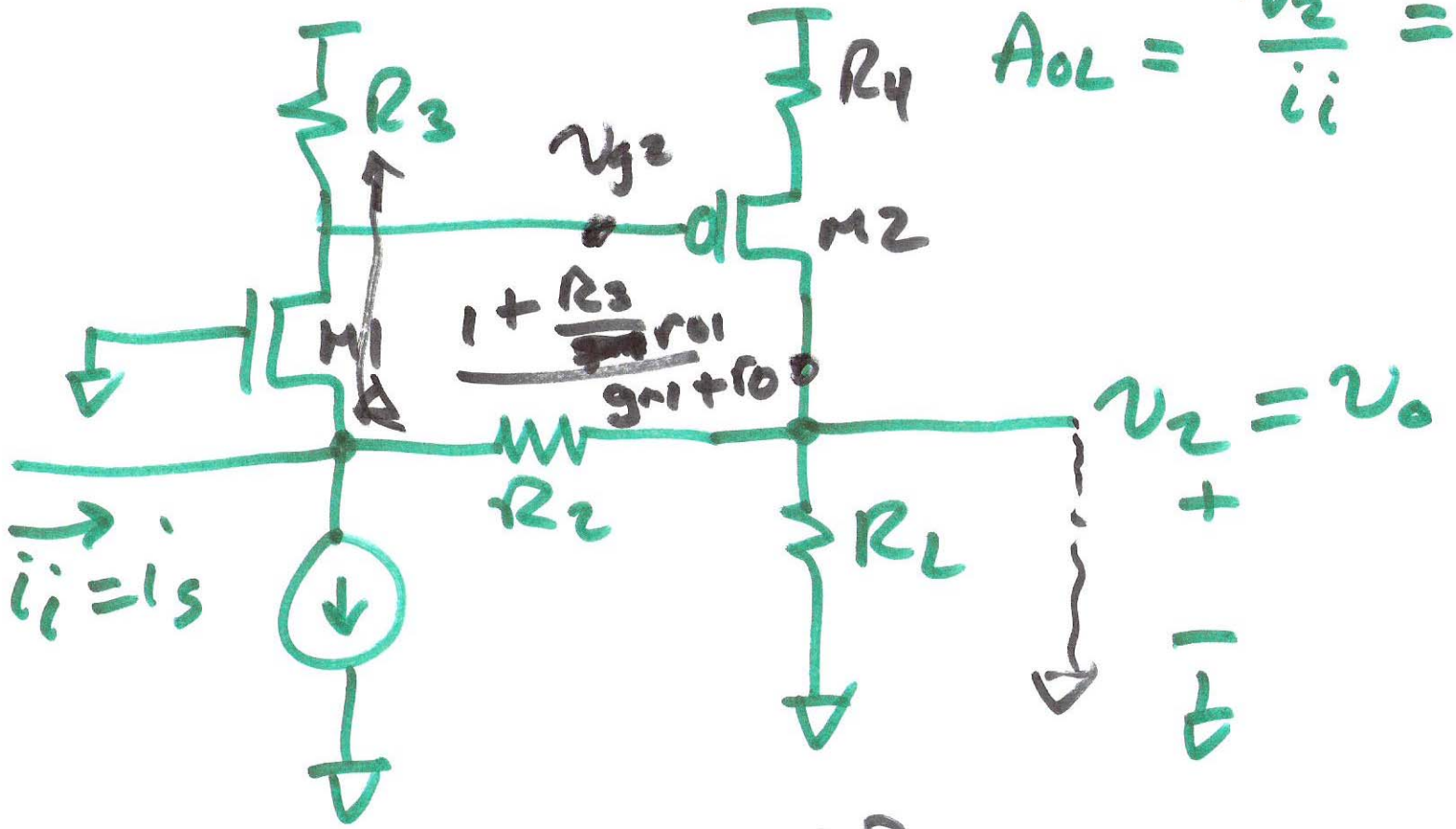
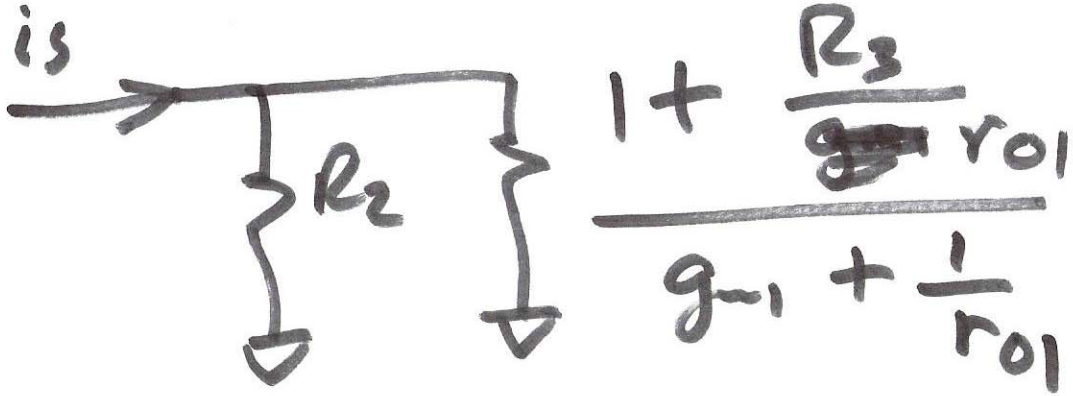
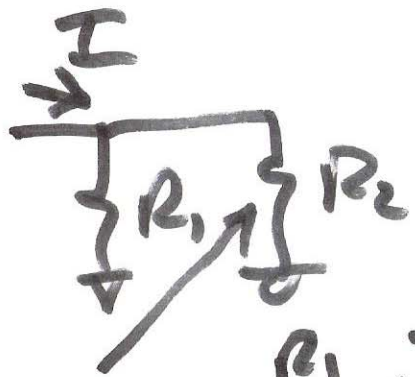
$$A_{OL} = \frac{v_2}{i_i} = \frac{v_o}{i_s}$$



$$\frac{v_2}{v_{g2}} = \frac{-R_L \| R_2}{R_4 + \frac{1}{g_{m2}}}$$

5)





$$(R_3 \cdot i_d) = v_{g2} = i_s \cdot \frac{R_2 \cdot R_3}{R_2 + \dfrac{1 + \dfrac{R_3}{r_{o1}}}{g_{m1} + \dfrac{1}{r_{o1}}}}$$

6)

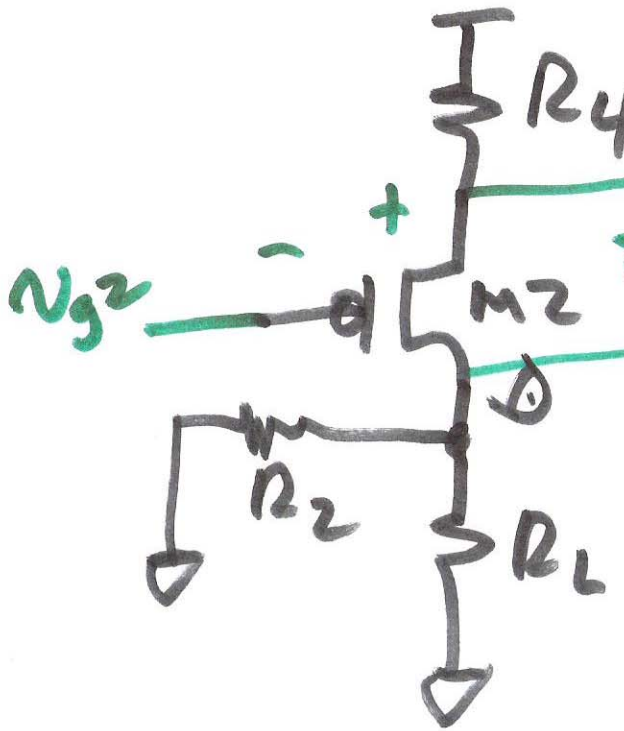
$$\frac{v_{g2}}{i_s} = \frac{R_2 \cdot R_3}{R_2 + \dfrac{1 + \frac{R_3}{r_{o1}}}{g_{m1} + \frac{1}{r_{o1}}}}$$

$$\frac{v_2}{v_{g2}} = \frac{-R_L \| R_2}{R_4 + 1/g_{m2}}$$

$$A_{vi} = \frac{v_2}{i_s} = \frac{v_o}{i_1} = \frac{-R_L \| R_2}{R_4 + 1/g_{m2}} \cdot \frac{R_2 R_3}{R_2 + \dfrac{1 + \frac{R_3}{r_{o1}}}{g_{m1} + \frac{1}{r_{o1}}}}$$

7)

$$A_{OL} = \frac{v_2}{v_{g2}} \cdot \frac{v_{g2}}{v_1} \cdot \frac{v_1}{i_s}$$

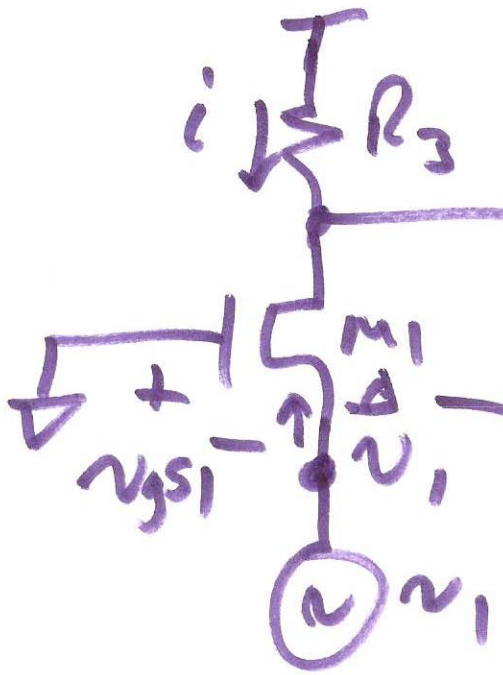


$$\frac{v_2}{v_{g2}} = \frac{-R_L \| R_2 \| \left[(1+g_{m2}R_4)\cdot r_{o2} + R_4\right]}{\frac{R_4}{g_{m2}r_{o2}} + \frac{1}{g_{m2}} + R_4}$$

$$(1+g_{m2}R_4)\cdot r_{o2} + R_4 \quad \text{EQ (20.53)}$$

$$\frac{v_{g2}}{v_1}$$

8)



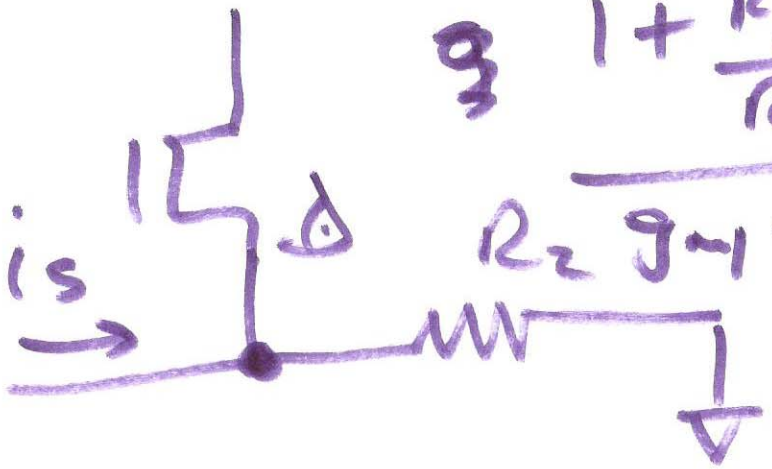
$$v_{g2} = -i \cdot R_3$$

$$\frac{-v_1}{\left(\frac{1 + \frac{R_3}{r_{o1}}}{g_1 + R_3 \frac{1}{r_o}}\right)} = i$$

$$\frac{v_{g2}}{v_1} = \left(\frac{g_1 + R_3 \frac{1}{r_o}}{1 + \frac{R_3}{r_{o1}}}\right) R_3$$

9)

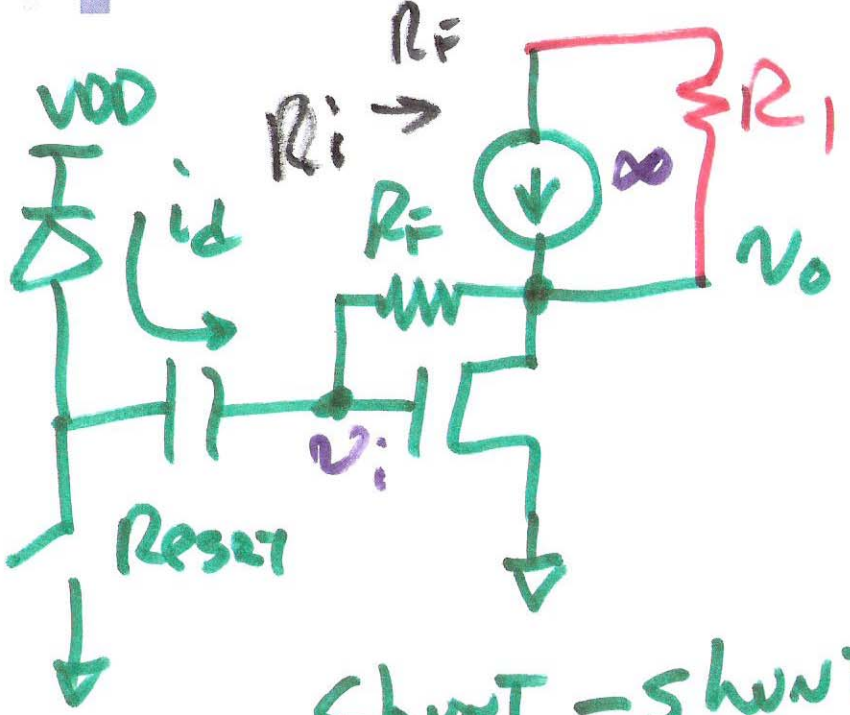
$$\frac{v_1}{i_s} \qquad g_3 \; 1 + \frac{R_3}{r_{o1}} \qquad R_2 \; g_{m1} + \frac{1}{r_{o1}}$$



$$\frac{v_1}{i_s} = R_2 \| \left(\frac{1 + \frac{R_3}{r_{o1}}}{g_{m1} + \frac{1}{r_{o1}}} \right)$$

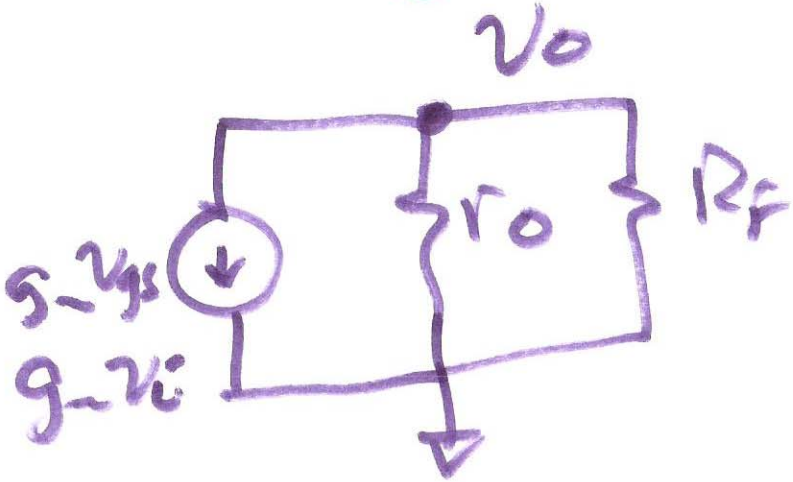
R_S $\qquad \beta = -\frac{1}{R_2}$

Shunt-shunt f.b.



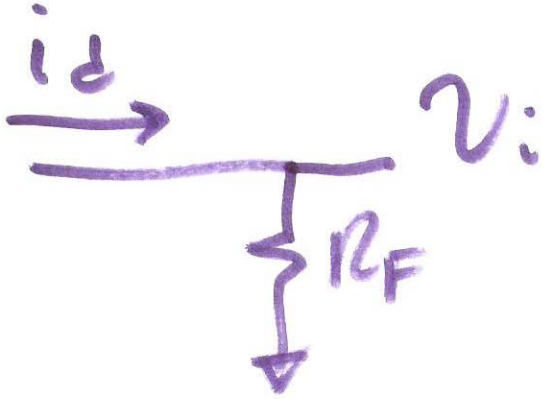
Shunt-shunt TiA

$A_{OL} = \frac{v_o}{i_d}$



$v_o = -g_m v_i \cdot r_o \| R_F$

$A_{OL} = -g_m R_F (r_o \| R_F \| R_i)$

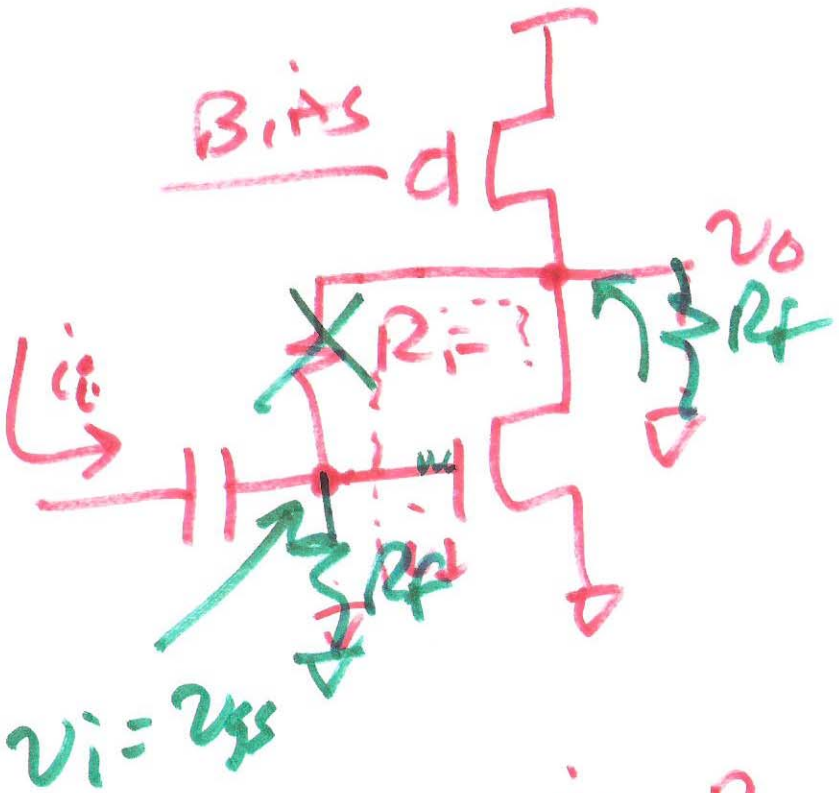


$v_i = i_d \cdot R_F$

$A_{OL} = \frac{v_o}{i_d} = -g_m R_F (r_o \| R_F)$

11)

$r_o = \infty$



$$A_{OL} = \frac{v_o}{i_i} = \frac{-i_d R_F}{i_s}$$

$$A_{OL} = \frac{v_o}{v_i} \cdot \frac{v_i}{i_i} =$$

$$\frac{-i_d \cdot R_F}{i_i \cdot R_F} = \frac{-g_m v_{gs} \cdot R_F}{v_i} \cdot \frac{R_F}{}$$

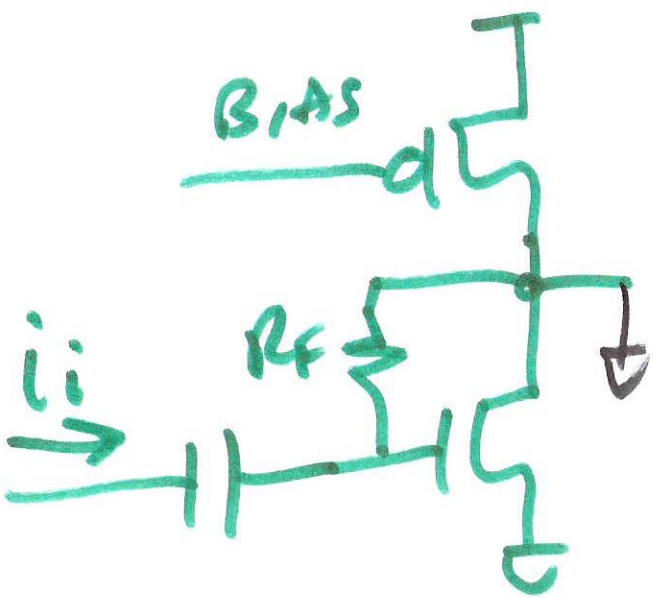
$$v_{gs} = i_i \cdot R_F$$

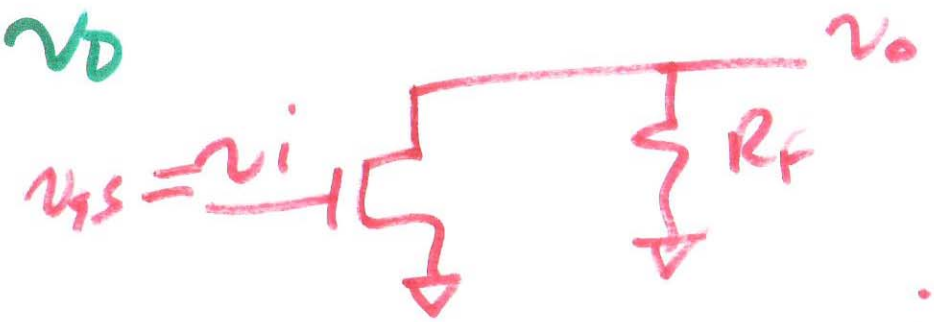
$$i_d = i_i$$

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

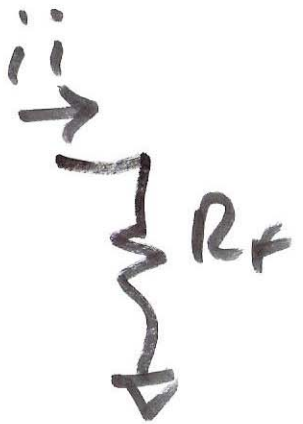
$$1 = g_m \cdot R_F$$

$R_o = \infty$ open loop





$$\frac{v_o}{v_i} = \frac{-i_d \cdot R_F}{v_i}$$



$$v_{gs} = i_i \cdot R_F = v_i$$

$$\beta = -\frac{1}{R_F} = \frac{-g_m v_{gs} R_F}{v_{gs}}$$

$$\frac{v_i}{i_i} = R_F$$

$$\frac{v_o}{v_i} = -g_m R_F$$

$$A_{OL} = -g_m R_F^2 = \frac{v_o}{i_i}$$

13)

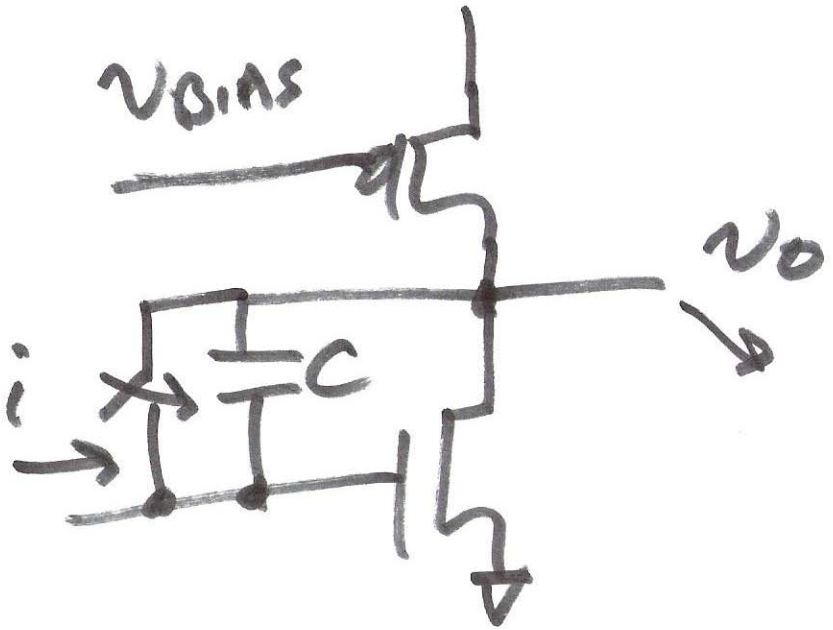
$$A_{CL} = \frac{A_{OL}}{1 + \beta A_{OL}}$$

$$= \frac{-g_m R_F^2}{1 + \left(\frac{-1}{R_F}\right)\left(-g_m R_F^2\right)}$$

$$A_{CL} \simeq \frac{1}{\beta} = \frac{-g_m R_F^2}{1 + g_m R_F}$$

$g_m R_F >> 1$

$$\boxed{A_{CL} \simeq -R_F}$$



$C \downarrow$ $A_{OL} \uparrow$

$A_{CL} \uparrow$

$\beta = -j\omega C$

Series - series

→ Voltage - current ←