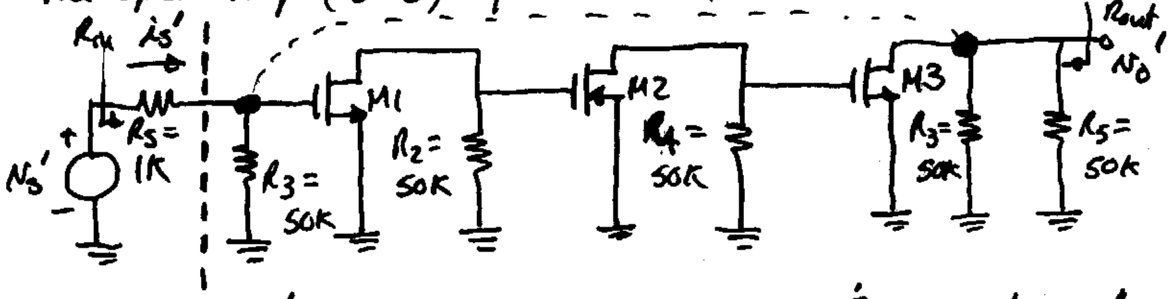
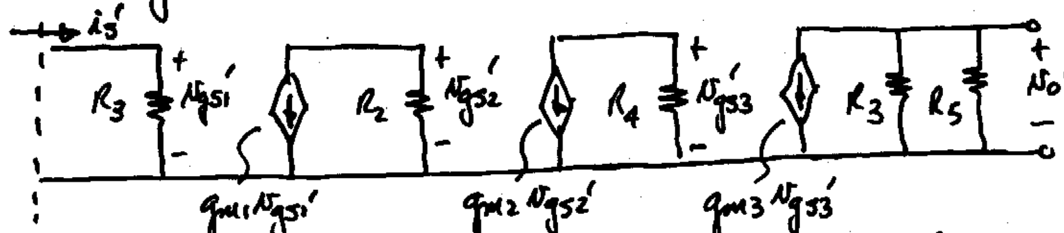
Shunt-Shunt Example - Cont'd

The open-loop ($B=0$) equivalent ckt. for calculation of A:



$A = R_T = \frac{v_o'}{i_s'} = ?$ Recall $B = y_{12} = \frac{i_1}{v_2}\Big|_{v_1=0} = \frac{-1}{R_3} = \frac{-1}{50K\Omega}$

Small-signal model



$$\frac{v_o'}{i_s'} = (-g_{m3} R_3 \| R_5)(-g_{m2}R_4)(-g_{m1}R_2)(R_3) = \left(\frac{v_o'}{v_{gs3}'}\right)\left(\frac{v_{gs3}'}{v_{gs2}'}\right)\left(\frac{v_{gs2}'}{v_{gs1}'}\right)\left(\frac{v_{gs1}'}{i_s'}\right)$$

$$R_T = \text{"}A\text{"} = (-0.2\times 25)(-0.2\times 50)(-0.2\times 50)(50K) = -25\times 10^6 \frac{V}{A} = -25M\Omega$$

5.) $$\frac{v_o}{i_s}\Big|_{B\neq 0} = \frac{A}{1+AB} = \frac{R_T}{1+BR_T} = \frac{-25\times 10^6}{1+(\frac{-1}{50K})(-25M)} = \frac{-25\times 10^6}{1+500} = -49.9K\Omega$$

$$\left(\frac{v_o}{i_s} \rightarrow \frac{1}{B} \text{ if } AB \gg 1\right)$$

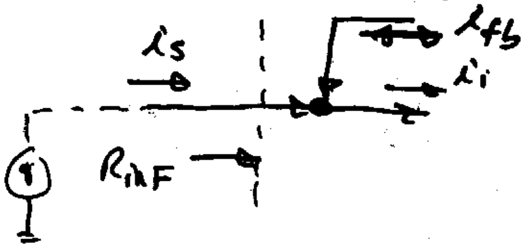
6.) $$R_{inF} = \frac{R_{in}}{1+AB} = \frac{R_3}{1+500} = \frac{50K}{501} = 99.8\Omega$$

$$\frac{v_s}{i_s} = R_s + R_{inF} = 1K + 99.8\Omega = \underline{\underline{1099.8\Omega}}$$

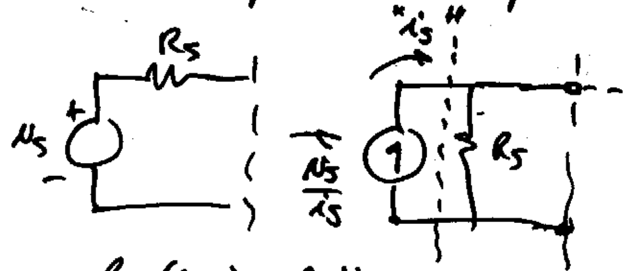
$$\frac{v_o}{v_s} = \frac{v_o}{i_s}\times\frac{i_s}{v_s} = (-49.9K\Omega)\left(\frac{1}{1099.8\Omega}\right) = \underline{\underline{-45.4\ V/V}}$$

7.) $$R_{out} = R_{outF} = \frac{R_{out}(B=0)}{1+AB} = \frac{25K}{501} = \underline{\underline{49.9\Omega}}$$

Pitfalls of shunt input –



For the previous example –



$R_{in}(B=0) = R_S \| \cdots$

$R_{in}(B\neq 0) = \frac{R_{in}(B=0)}{1+AB} = \frac{R_S\|\cdots}{1+AB}$

$R_{in}(B\neq 0) = \frac{1k\|\cdots}{501} \ll 1k$

3rd Type of Feedback

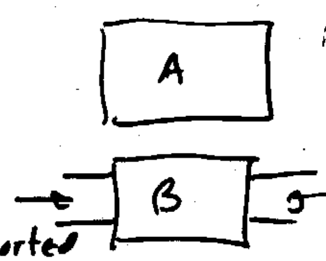
Current Amplifier – Shunt-Series Feedback

g-parameters

1.) $g_{11F} = \left.\frac{i_{1F}}{v_{1F}}\right|_{i_{2F}=0}$

2.) $g_{22F} = \left.\frac{v_{2F}}{i_{2F}}\right|_{v_{1F}=0}$

3.) $g_{12F} = \left.\frac{i_{1F}}{i_{2F}}\right)_{v_{1F}=0} = B$



R_{in} with output shorted if output is shunt and open if output is series

R_{out} (Beta) –

1.) If input is shunt, short input

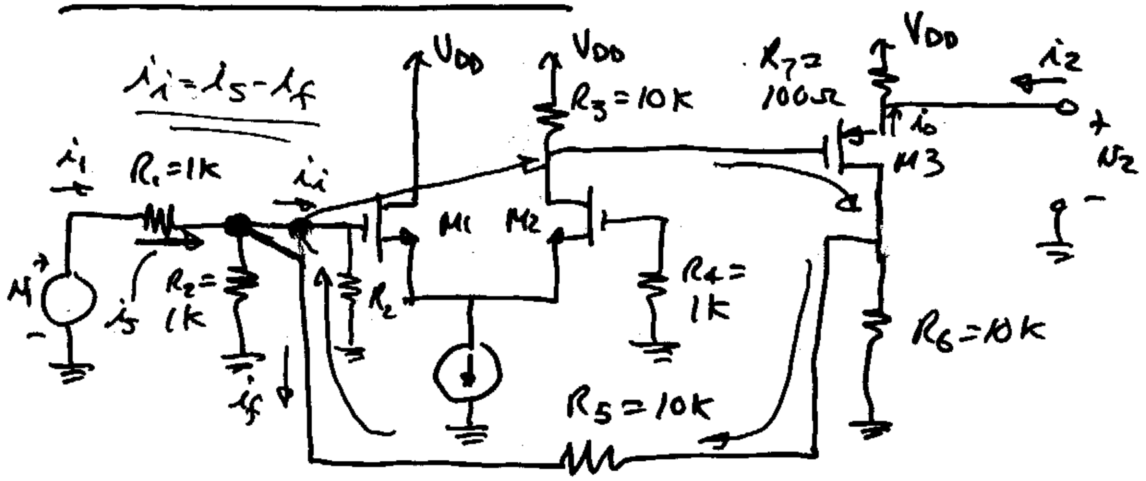
2.) If input is series, open the input

4.) $A = \frac{i_{out}}{i_{in}} = \frac{i_2}{i_1}$

5.) $R_{in}(B\neq 0) = \frac{R_{in}(B=0)}{1+AB}$

6.) $R_{out}(B\neq 0) = R_{out}(B=0)\,(1+AB)$ ← BE CAREFUL

Shunt-Series Example



If $g_m = 1mS$ for all MOSFETs and $r_{ds} = \infty$, find $\frac{v_2}{v_1}$, $\frac{v_1}{i_1}$, and $\frac{v_2}{i_2}$ using feedback analysis methods.