Quiz #10 - Series-shunt feedback

Quiz #11 - ? feedback

Quiz #12 - IEEE SSCS/CAS Chapter Seminar, 6:30pm, 11/22/04

Shunt-series feedback (Current Amplifier: $A \rightarrow \frac{Amps}{Amps}$)

Approach:

1.) Find $g_{11F} = \left.\frac{i_{1F}}{v_{1F}}\right|_{i_{2F}=0}$ (input conductance of the feedback ckt. with output a.c.)

2.) Find $g_{22F} = \left.\frac{v_{2F}}{i_{2F}}\right|_{v_{1F}=0}$ (output resistance of the F ckt. with input short-circuited)

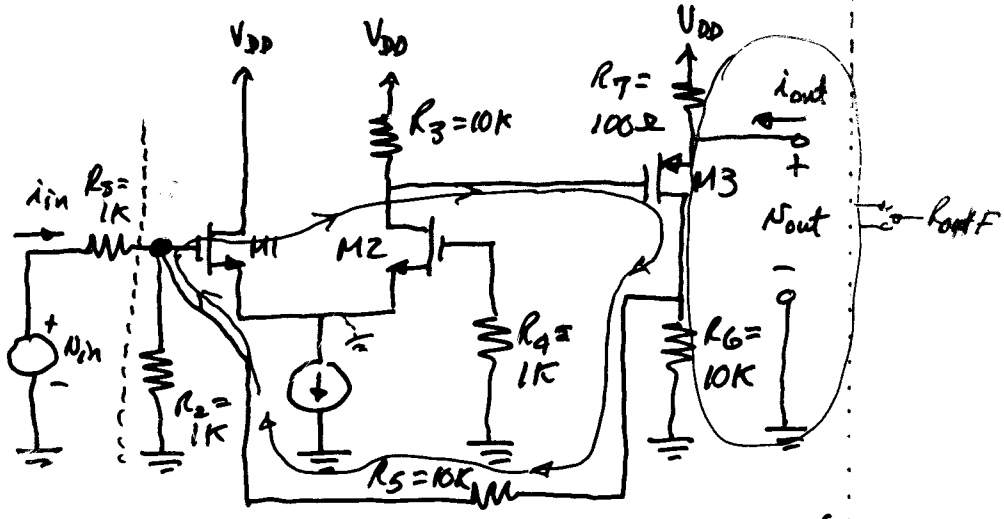
3.) Find $g_{12F} = \left.\frac{i_{1F}}{v_{2F}}\right|_{v_{1F}=0}$ (current gain from the output to the input of the F ckt. with the input short-circuited)

4.) Find A (units are A/A)

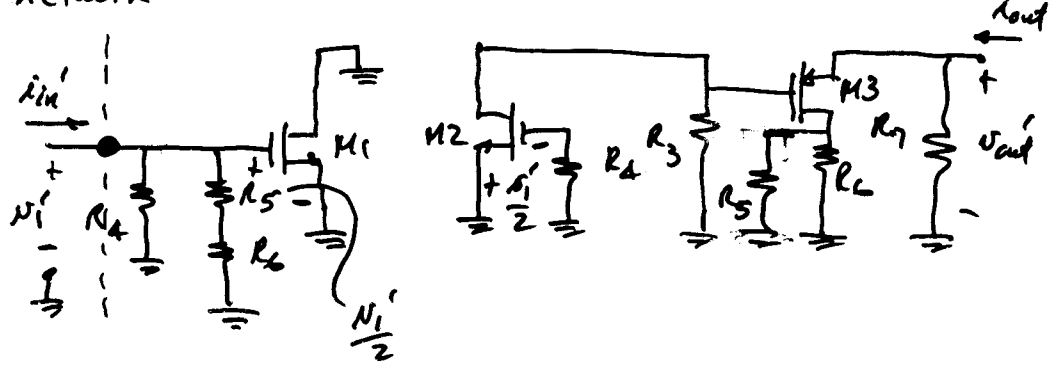
5.) Etc.

Example

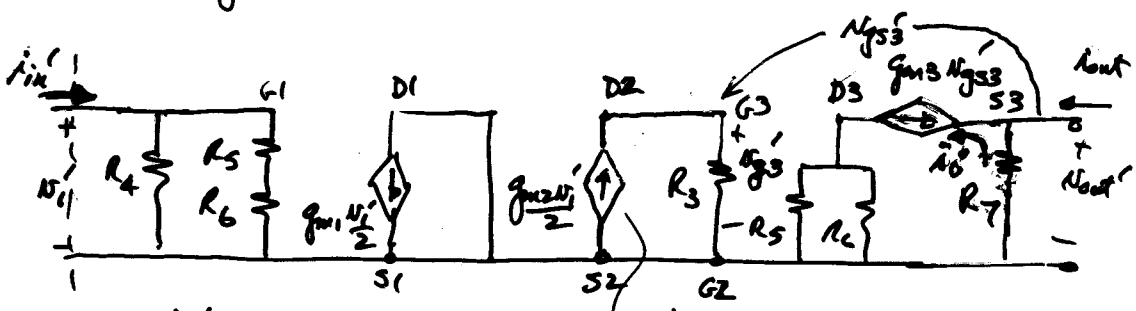
If $g_m = 1mS$ and $r_{ds} = \infty$ for MOSFETs, find $\frac{v_{out}}{v_{in}}$, $\frac{v_{in}}{i_{in}}$ & $\frac{v_{out}}{i_{out}}$.



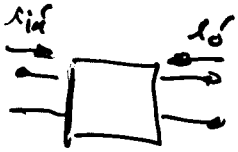
A network -

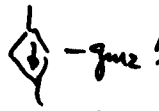


Small-signal A circuit (open loop)



$A = \frac{i_o'}{i_{in}'}$





$v_{gs3}' = v_{g3}' - v_{s3}'$

$$A = \frac{i_o'}{i_{in}'} = \left(\frac{i_o'}{v_{gs3}'}\right)\left(\frac{v_{gs3}'}{v_{g3}'}\right)\left(\frac{v_{g3}'}{v_1'}\right)\left(\frac{v_1'}{i_{in}'}\right)$$

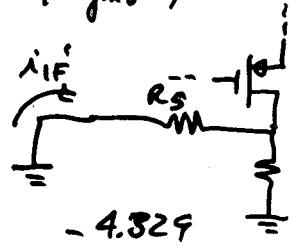
$$= (-g_{m3})\,(\quad)\left(\frac{g_{m2}R_3}{2}\right)\left[R_2 \| (R_5+R_6)\right] = -4.329\,\frac{A}{A}$$

$$v_{gs3}' = v_{g3}' - v_{s3}' = v_{g3}' - g_{m3}R_7 v_{gs3}'$$

$$v_{gs3}'(1 + g_{m3}R_7) = v_{g3}'$$

$$\frac{v_{gs3}'}{v_{g3}'} = \frac{1}{1+g_{m3}R_7}$$

$F = ?$



$\therefore F = \frac{i_{1F}'}{i_o'} = \frac{-R_6}{R_5+R_6} = -0.5$

$$A_F = \frac{i_o}{i_{in}} = \frac{A}{1+AF} = \frac{-4.329}{1+(-4.329)(-0.5)} = -1.368\,\frac{A}{A}$$

$$R_{inF} = \frac{R_{in}}{1+AF} = \frac{R_2 \| (R_5+R_6)}{1+2.164} = \frac{952\,\Omega}{3.164} = 301\,\Omega$$

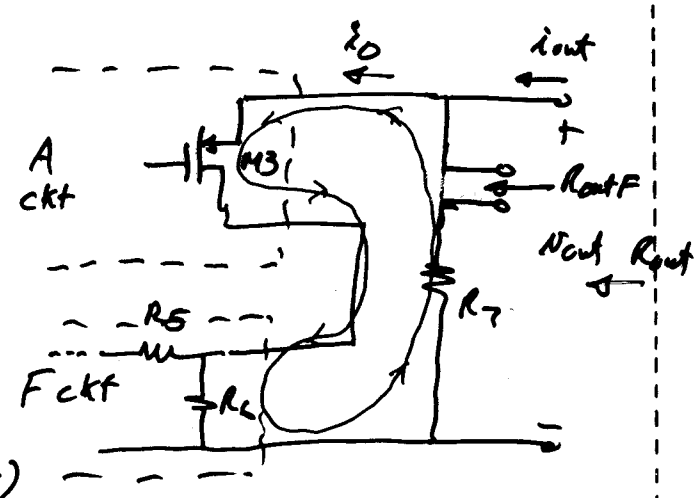
$$\frac{v_{in}}{i_{in}} = R_5 + R_{inF} = \underline{1.301\,k\Omega}$$

$$\frac{v_{out}}{v_{in}} = \frac{-i_o R_7}{i_{in}(R_5+R_{inF})} = -\left(\frac{i_o}{i_{in}}\right)\left(\frac{R_7}{R_5+R_{inF}}\right) = (1.368)\left(\frac{100}{1301}\right)$$

$$= \underline{0.105\ V/V}$$

Find R_{outF}

Consider the following -



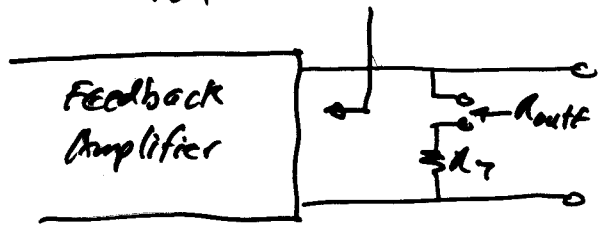
$R_{OUTF} = R_{out}(1+AF)$

$R_{out} = R_7 + \frac{1}{g_{m3}}$

$\therefore R_{OUTF} = (R_7 + \frac{1}{g_{m3}})(1+AF)$

$= (1700)(3.164) = 3.48\,K\Omega$

$R_{out} = \frac{N_{out}}{i_{out}} = ?$



$R_{out} = (R_{outF} - R_7) \| R_7$

$= 100 \| [3.48K - 100]$

$= 97.2\,\Omega$