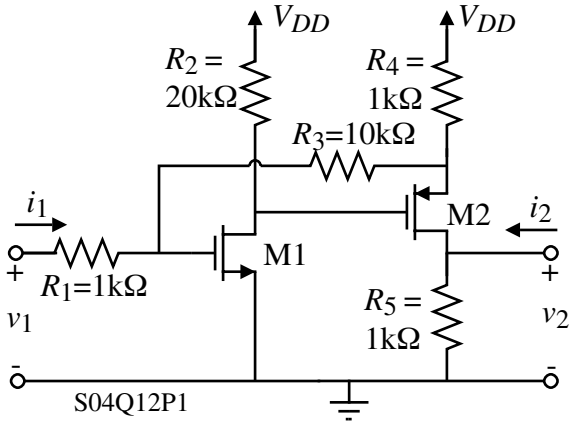
QUIZ NO. 12 - SOLUTION

(Average score = 6.0/10 of those taking the quiz)

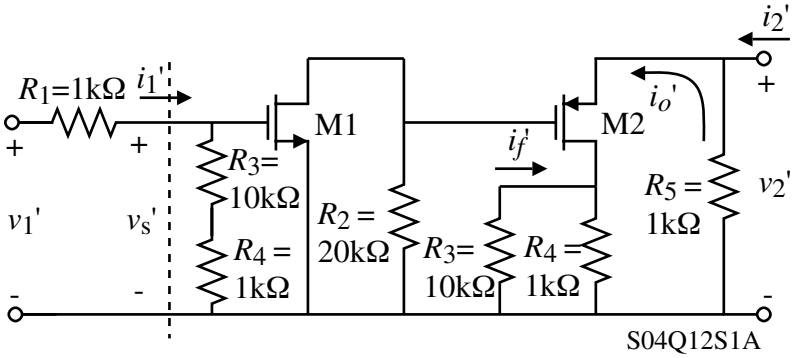
A feedback amplifier is shown. Use the methods of feedback analysis to find the numerical values of v_2/v_1, v_1/i_1, and v_2/i_2. Assume that all transistors are matched and that g_m= 1mS, and $r_{ds} = \infty$.



Solution

This feedback circuit is *shunt-series*. The units of *A* are A/A and the units of *F* are also A/A.

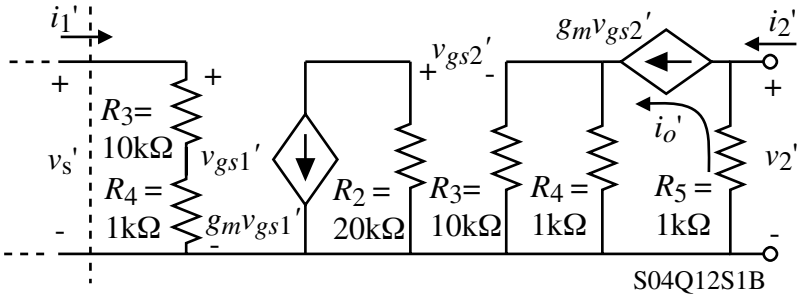
The open-loop circuit:



$$F = \frac{i_f'}{i_o'}\bigg|_{v_s'=0} = \frac{-R_4}{R_3+R_4}$$

$$F = -1/11$$

The open-loop small-signal model:



$$R_i = R_3+R_4 = 11\text{k}\Omega$$

$$R_o = \infty$$

$$A = \frac{i_o'}{i_1'} = \left(\frac{i_o'}{v_{gs2}'}\right)\left(\frac{v_{gs2}'}{v_{g2}'}\right)\left(\frac{v_{g2}'}{v_{gs1}'}\right)\left(\frac{v_{gs1}'}{i_1'}\right) = (g_m)\left(\frac{1}{1+g_m(R_3\|R_4)}\right)(-g_mR_2)(R_3+R_4)$$

$$= (1)\left(\frac{1}{1+0.909}\right)(-20)(11) = -115.24 \text{ A/A} \rightarrow A_f = \frac{i_o}{i_1} = \frac{A}{1+AF} = \frac{-115.24}{1+10.476} = -10.04 \text{ A/A}$$

$$R_{iF} = \frac{R_i}{(1+AF)} = \frac{11\text{k}\Omega}{(1+10.476)} = 959\Omega \quad \therefore \quad \frac{v_1}{i_1} = R_1 + R_{iF} = \underline{1959\Omega}$$

$$R_{oF} = R_o(1+AF) = \infty \qquad \therefore \qquad \frac{v_2}{i_2} = (R_{oF}-R_5)\|R_5 = R_5 = \underline{1\text{k}\Omega}$$

$$\frac{v_2}{v_1} = \left(\frac{v_2}{i_o}\right)\left(\frac{i_o}{i_1}\right)\left(\frac{i_1}{v_1}\right) = (-R_5)(A)\left(\frac{1}{R_1+R_{iF}}\right) = (-1)(-10.04)\left(\frac{1}{1.959}\right) = \underline{5.126 \text{ V/V}}$$