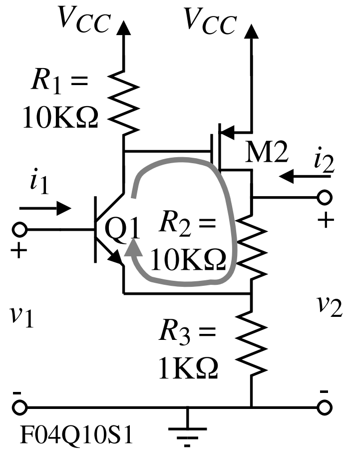
QUIZ NO. 10 - SOLUTION

(Average Score = 7.0/10 of those taking the quiz.)

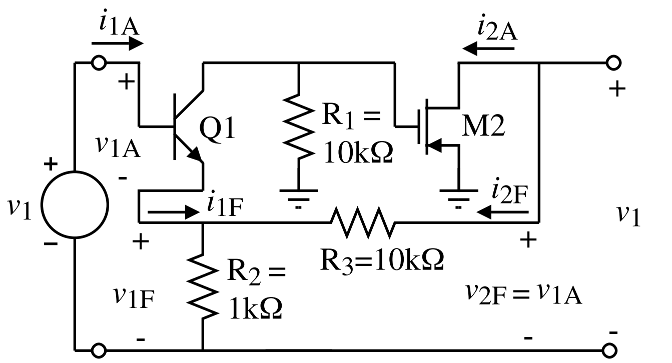
A series-shunt feedback amplifier is shown. Use the methods of feedback analysis to find the numerical values of v_2/v_1, v_1/i_1, and v_2/i_2. Assume that $\beta_1 = 100$, $r_{\pi 1} = 1\text{k}\Omega$, $r_{o1} = \infty$, $g_{m2} = 1\text{mS}$, and $r_{ds2} = \infty$.



F04Q10S1

Solution

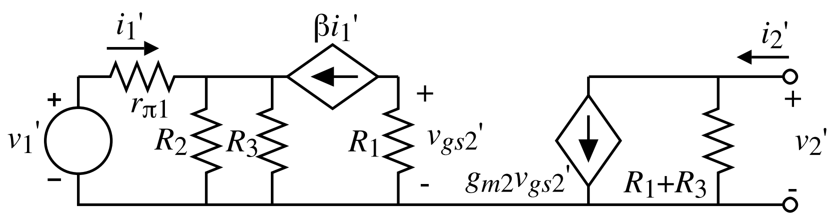
The feedback path is traced on the circuit. The circuit is redrawn to identify the A and the F circuit.



F04Q11S1A

$$F = h_{12F} = \frac{v_{1F}}{v_{2F}}\Big|_{i_{1F}=0} = 0.091\text{(V/V)}$$

We really don't need to calculate h_{11F} and h_{22F} if we correctly open the loop as illustrated below. The small-signal model for the open-loop calculation of A is,



F04Q10S1B

$$A = \frac{v_2'}{v_1'} = \left(\frac{v_2'}{v_{gs2}'}\right)\left(\frac{v_{gs2}'}{i_1'}\right)\left(\frac{i_1'}{v_1'}\right) = [-g_{m2}(R_2+R_3)]\,(-\beta R_1)\left(\frac{1}{r_{\pi 1}+(1+\beta)(R_2 \| R_3)}\right)$$

$$= (-11)(-1000\text{k}\Omega)\left(\frac{1}{1\text{k}\Omega+(101)(909)}\right) = 118.51\text{ V/V}$$

$$\therefore \quad A_F = \frac{v_2}{v_1} = \frac{A}{1+A\beta} = \frac{118.51}{1+118.51\ (0.0909)} = \frac{118.51}{11.773} = \underline{\underline{10.06\text{ V/V}}}$$

The open-loop input resistance is $R_i = r_{\pi 1}+(1+\beta)(R_1 \| R_3) = 92.82\text{k}\Omega$

$$\therefore \quad R_{in} = \frac{v_1}{i_1} = R_i(1+AF) = 92.82\text{k}\Omega(11.773) = \underline{\underline{1.093\text{M}\Omega}}$$

The open-loop output resistance is $R_o = R_1+R_3 = 11\text{k}\Omega$

$$\therefore \quad R_{out} = \frac{v_2}{i_2} = \frac{R_o}{1+AF} = \frac{11\text{k}\Omega}{11.773} = \underline{\underline{934\ \Omega}}$$