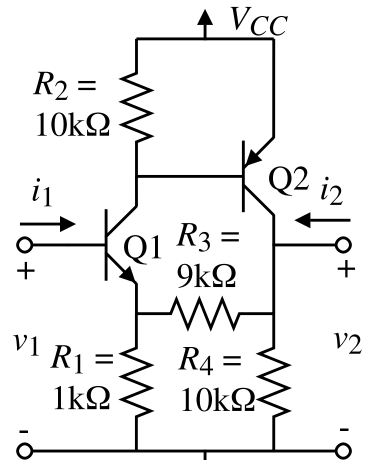
QUIZ NO. 11

(Average score = 8.1/10 of those taking the quiz)

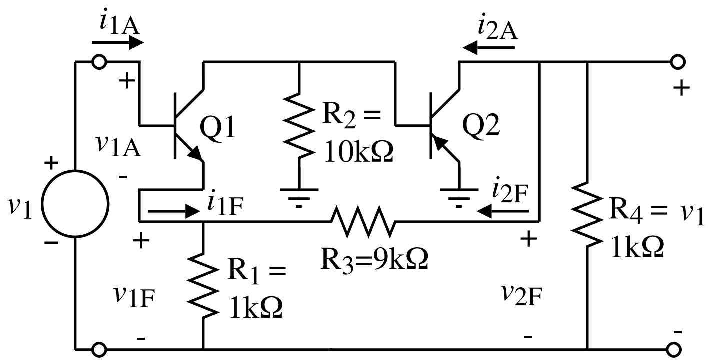
A series-shunt feedback amplifier is shown. Use the methods of feedback analysis to find the numerical values of v_2/v_1, v_1/i_1, and v_2/i_2. Assume that all transistors are matched and that $\beta = 100$, $r_\pi = 10\text{k}\Omega$ and $r_o = \infty$.



S04Q11P1

Solution

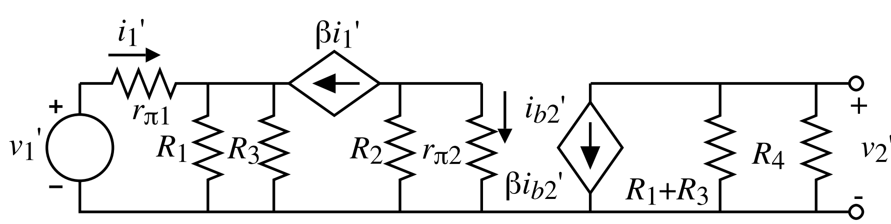
The circuit can redrawn as shown to identify more clearly the A circuit and the feedback circuit.



S04Q11S1A

$$F = h_{12F} = \frac{v_{1F}}{v_{2F}}\Big|_{i_{1F}=0} = 0.1\text{(V/V)}$$

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,



S04Q11S1B

$$A = \frac{v_2'}{v_1'} = \left(\frac{v_2'}{i_{b2}'}\right)\left(\frac{i_{b2}'}{i_1'}\right)\left(\frac{i_1'}{v_1'}\right) = [-\beta(R_4 \| R_1+R_3)]\left(\frac{-\beta R_2}{r_{\pi2}+R_2}\right)\left(\frac{1}{r_{\pi1}+(1+\beta)(R_1 \| R_3)}\right)$$

$$= (-500\text{k}\Omega)(-50)\left(\frac{1}{10\text{k}\Omega+(101)(909)}\right) = 245.53 \text{ V/V}$$

$$\therefore \quad A_F = \frac{v_2}{v_1} = \frac{A}{1+A\beta} = \frac{245.53}{1+245.53\ (0.1)} = \frac{245.53}{25.553} = \underline{\underline{9.61 \text{ V/V}}}$$

The open-loop input resistance is $R_i = r_{\pi1}+(1+\beta)(R_1 \| R_3) = 101.8\text{k}\Omega$

$$\therefore \quad R_{in} = \frac{v_1}{i_1} = R_i(1+AF) = 101.8\text{k}\Omega(25.553) = \underline{\underline{2.60\text{M}\Omega}}$$

The open-loop output resistance is $R_o = R_4 \| (R_1+R_3) = 5\text{k}\Omega$

$$\therefore \quad R_{out} = \frac{v_2}{i_2} = \frac{R_o}{1+AF} = \frac{5\text{k}\Omega}{25.553} = \underline{\underline{196\ \Omega}}$$