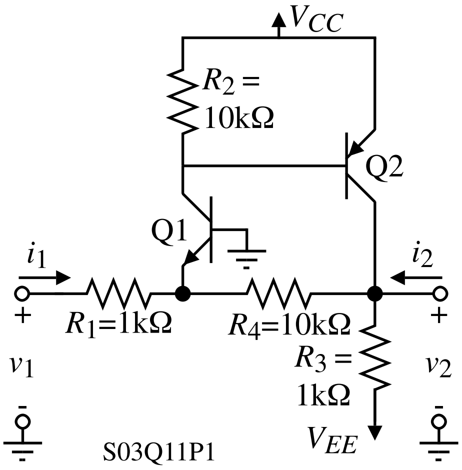
QUIZ NO. 11 - SOLUTION

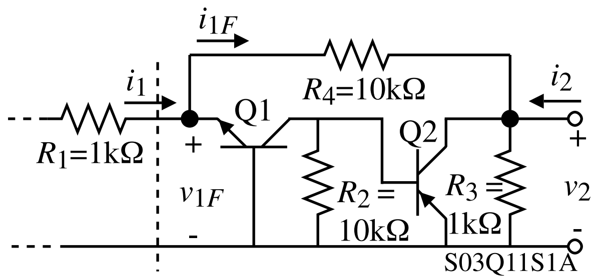
(Average score = 6.3/10 of those taking the quiz.)

A shunt-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 V_t= 25mV, β (of the BJT) = 100, $I_{C1} = I_{C2}$ = 100µA, and $r_o = \infty$.



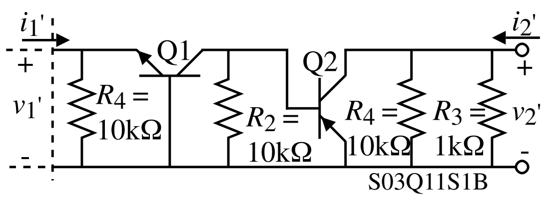
Solution

A simplified ac schematic for $\beta \neq 0$ is given as,

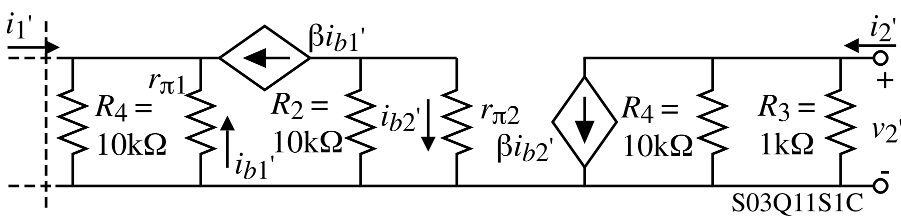


$$\beta = g_{12F} = \frac{i_{1F}}{v_2}\Big|_{v_{1F}=0} = \frac{-1}{R_4} = \frac{-1}{10\text{k}\Omega}$$

The open-loop (β =0) simplified ac schematic is given as,



The small-signal model for (β = 0) is,



$$\frac{v_2'}{i_1'} = \left(\frac{v_2'}{i_{b2}'}\right)\left(\frac{i_{b2}'}{i_{b1}'}\right)\left(\frac{i_{b1}'}{i_1'}\right) = [-\beta(R_3||R_4)]\left(\frac{-\beta R_2}{r_{\pi 2}+R_2}\right)\left(\frac{-R_4}{R_4 + 1/g_{m1}}\frac{1}{1+\beta}\right)$$

$$= (-100\cdot 1\text{K}||10\text{K})\left(\frac{-100\cdot 10\text{K}}{35\text{K}}\right)\left(\frac{-10\text{K}}{10\text{K}+0.25\text{K}}\frac{1}{101}\right) = (-90.9)(-28.571)(-0.00966)$$

$$R_T = \frac{v_2'}{i_1'} = -25.087\text{k}\Omega \qquad \Rightarrow \qquad \frac{v_2}{i_1} = \frac{R_T}{1+\beta R_T} = \frac{-25.087\text{K}\Omega}{1+2.5087} = -7.15\text{k}\Omega$$

$$R_{in} = R_4||(1/g_{m1}) = 1000||250 = 200\Omega,\ R_{inF} = \frac{R_{in}}{1+\beta R_T} = \frac{200\Omega}{3.509} = 57\Omega$$

$$\therefore \frac{v_1}{i_1} = R_1 + R_{inF} = 1000 + 57 = \underline{\underline{1057\Omega}} \qquad \frac{v_2}{v_1} = \frac{v_2}{i_1}\frac{i_1}{v_1} = \frac{-7.51\text{K}}{1057} = \underline{\underline{-6.764\text{V/V}}}$$

$$R_{out} = R_3||R_4 = 909\Omega \qquad \rightarrow \qquad \frac{v_2}{i_2} = \frac{R_{out}}{1+\beta R_T} = \frac{909\Omega}{3.509} = \underline{\underline{259\Omega}}$$