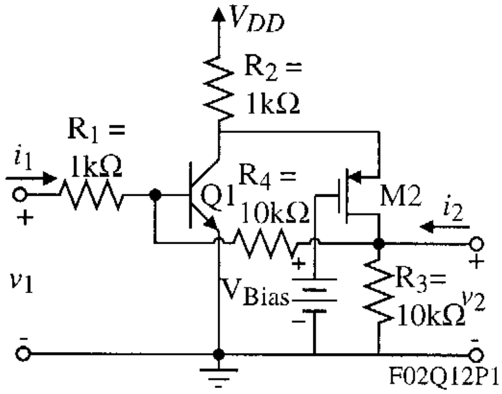
QUIZ NO. 12 - SOLUTION

(Average score = 6.2/10 of those taking the quiz)

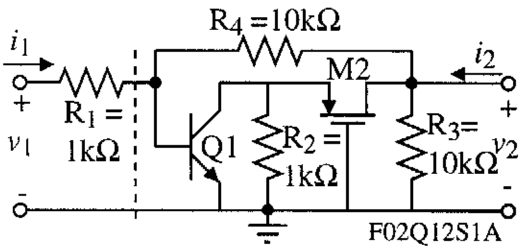
A shunt-shunt feedback amplifier is shown. Use the methods of feedback analysis to find the numerical values of v_2/v_1, v_1/i_1, and v_2/i_2. For Q1, assume that h_{fe} = 100, g_m = 50mS and $r_o = \infty$. For M2, assume that g_m = 1mS and $r_{ds} = \infty$.



F02Q12P1

Solution

Quasi-ac model of this circuit.



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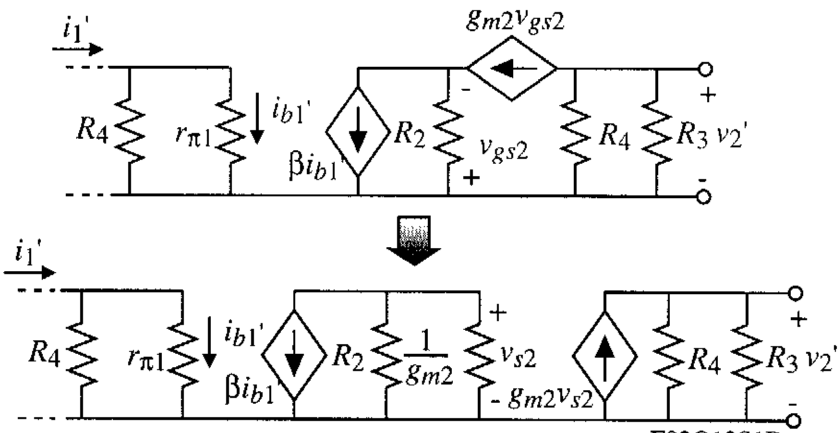
The feedback β is given as

$$\beta = g_{12F} = \frac{i_{1F}}{v_{2F}}\bigg|_{v_{2F}=0} = \frac{-1}{R_4} = \frac{-1}{10K}$$

The open-loop circuit to calculate A is given as,



F02Q12S1B

$$A = \frac{v_{2'}}{i_{1'}} = \left(\frac{v_{2'}}{v_{s2'}}\right)\left(\frac{v_{s2'}}{i_{b1'}}\right)\left(\frac{i_{b1'}}{i_{1'}}\right) = (g_{m2}\cdot R_3||R_4)[-\beta_1\cdot R_2||(1/g_{m2})]\left(\frac{R_4}{R_4 + r_{\pi 1}}\right)$$

$$= (5)(-50K)(10/12) = -208.33\text{k}\Omega \qquad \left(r_{\pi 1} = \frac{100}{50\text{mS}} = 2\text{k}\Omega\right)$$

$$A_F = \frac{v_2}{i_1} = \frac{A}{1+A\beta} = \frac{-208.33K}{1+(-208.33K/-10K)} = \frac{-208.33K}{1+20.833} = \frac{-208.33K}{21.833} = -9.542\text{k}\Omega$$

$$R_{in} = R_4||r_{\pi 1} = 2k||10K = 1.67K \qquad \rightarrow R_{inF} = \frac{1.67k}{21.833} = 76.34\Omega$$

$$\therefore \frac{v_1}{i_1} = 1\text{k}\Omega + 76.34\Omega = \underline{1.076\text{k}\Omega} \qquad \frac{v_2}{v_1} = \left(\frac{v_2}{i_1}\right)\left(\frac{i_1}{v_1}\right) = \frac{-9.542\text{k}\Omega}{1.076\text{k}\Omega} = \underline{-8.652\text{ V/V}}$$

$$R_{out} = R_3||R_4 = 5\text{k}\Omega \quad \rightarrow \quad \frac{v_2}{i_2} = \frac{5\text{k}\Omega}{21.833} = \underline{229\Omega}$$