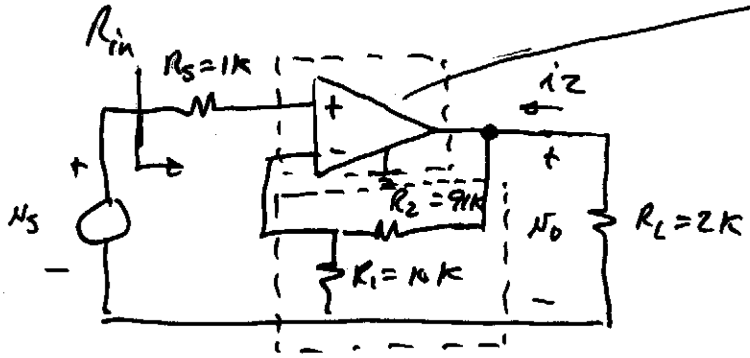
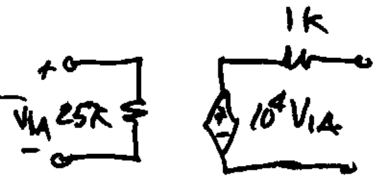
Example of Series-Shunt





$$\frac{v_o}{v_s} = \frac{A}{1+AB} \approx \frac{1}{B} \quad \text{if } AB \gg 1$$

$$A = 4730\,\tfrac{V}{V} \qquad B = 0.099$$

Input Resistance for a series-shunt feedback network

$$v_1 = h_{11T}\, i_1 + h_{21T}\, v_2$$
$$i_2 = h_{12T}\, i_1 + h_{22T}\, v_2$$

$$v_S = i_1 R_S + v_1$$
$$v_2 = -i_2 R_L$$

$$v_S = (R_S + h_{11T})\, i_1 + h_{12F}\, v_2 \qquad h_{12T} = \cancel{h_{12A}}^{\,0} + h_{12F} \approx h_{12F}$$

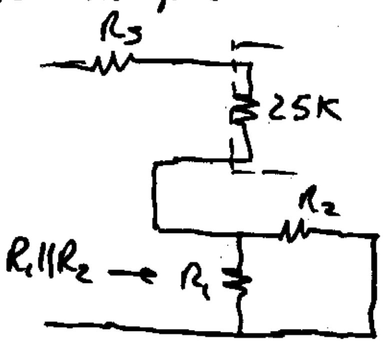
$$0 = h_{21A}\, i_1 + (h_{22T} + G_L)\, v_2$$

$$R_{inF} = \frac{v_S}{i_1} = (R_S + h_{11T}) + \frac{-h_{21A}\, h_{12F}}{(h_{22T} + G_L)}$$

$$= (R_S + h_{11T})\left[1 + \frac{-h_{21A}\, h_{12F}}{(R_S + h_{11T})(h_{22T} + G_L)}\right] = (R_S + h_{11T})(1 + AB)$$

$$B = h_{12F} \qquad A = \frac{-h_{21A}}{(R_S + h_{11T})(h_{22T} + G_L)}$$

Back to Example-

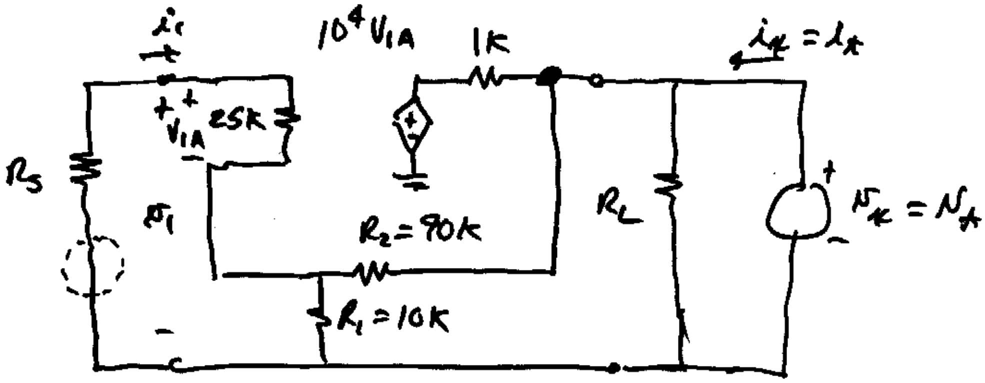


$$h_{11F} = \left.\frac{v_{1F}}{i_{1F}}\right|_{v_{2F}=0}$$

$$h_{11T} = 25K + R_1 \| R_2 = 25K + 9.01K$$

$$R_{in}(fb) = (35.01K)(1 + 4730 \times 0.099) = \underline{16.47\,M\Omega}$$

Output Resistance for Series-Shunt Feedback



$$R_{out}(fb) = \frac{v_x}{i_x}$$

$$0 = (R_S + h_{11T})\, i_1 + h_{12F}\, v_x$$

$$i_x = h_{12A}\, i_1 + (h_{22T} + G_L)\, v_x$$

$$R_{out}(fb.) = \frac{1}{(h_{22T}+G_L)\left[1 + \dfrac{-h_{21A}\, h_{12F}}{(R_S + h_{11T})(h_{22T}+G_L)}\right]} = \frac{1}{(h_{22T}+G_L)[1+AB]}$$

$$R_{out}(fb.) = \frac{\left(\dfrac{1}{h_{22T}+G_L}\right)}{1+AB}$$

Back to Example –

$$h_{22} = \left.\frac{i_2}{v_2}\right|_{i_1=0} \rightarrow h_{22A} = \frac{1}{1K} \;\&\; h_{22F} = \frac{1}{R_1+R_2} = \frac{1}{100K}$$

$$h_{22T} = h_{22A} + h_{22F} = \frac{1}{1K} + \frac{1}{100K} = \frac{1}{1K \| 100K}$$

$$R_{out}(fb.) = \frac{1}{\left(\frac{1}{1K}+\frac{1}{100K}+\frac{1}{2K}\right)(1+4730 \times 0.099)} \cong \frac{662\Omega}{474} = \underline{\underline{1.41\Omega}}$$

Summary

The general approach to analyzing neg. fb. ckts is:

1.) Find h_{11F} (input resistance of the fb. ntwk with output S.C.)

2.) Find h_{22F} (output conductance of the fb. ntwk with input O.C.)

3.) Find $h_{12F} = B$ (voltage gain from output to input with the input O.C.)

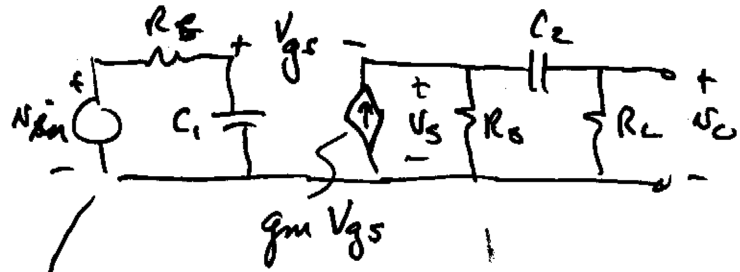
4.) Use the A circuit (including h_{11F} and h_{22F}) to find $A = \frac{v_o'}{v_s'}$

5.) $A(fb.) = \frac{A}{1+AB}$

6.) $R_{in}(fb.) = (R_S + h_{11T})(1+AB)$

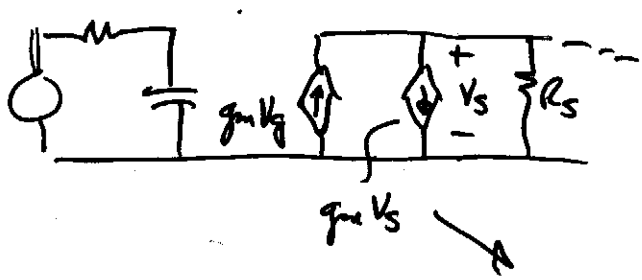
7.) $R_{out}(fb.) = \frac{1}{(h_{22T}+G_L)(1+AB)}$

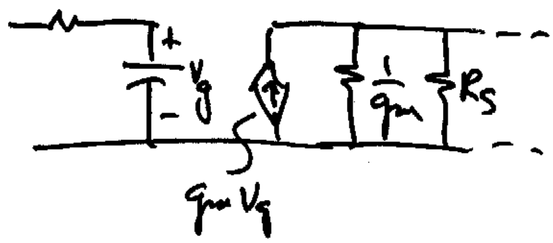
Comment on Quiz 9



$$\frac{V_o}{V_{in}} = \left(\frac{V_o}{V_{gs}}\right)\left(\frac{V_{gs}}{V_g}\right)\left(\frac{V_g}{V_{in}}\right)$$

$V_{gs} = V_g - V_S$ $\qquad g_m V_{gs} Z$





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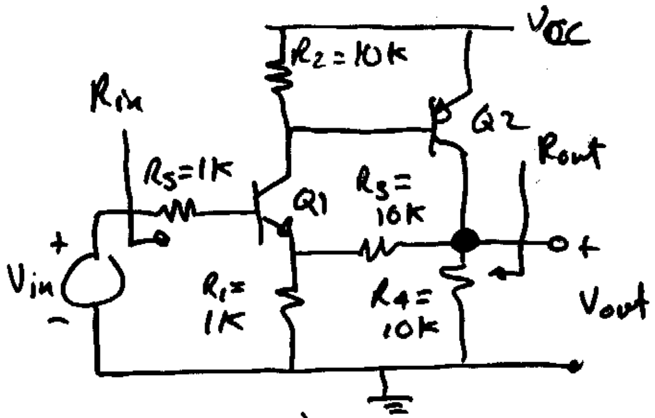

If $Q1 = Q2$, $h_{fe} = 100$
$r_c = \infty$, and $r_\pi = 10K$

use feedback analysis methods to find $\frac{V_{out}}{V_{in}}$, R_{in}, and R_{out}.