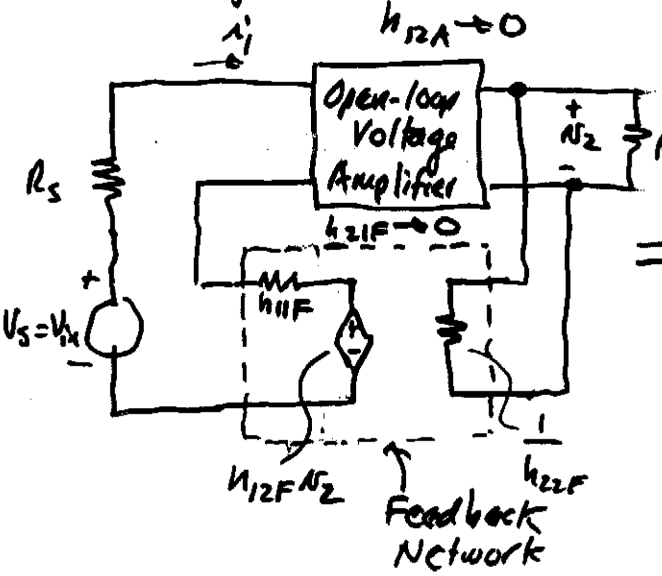
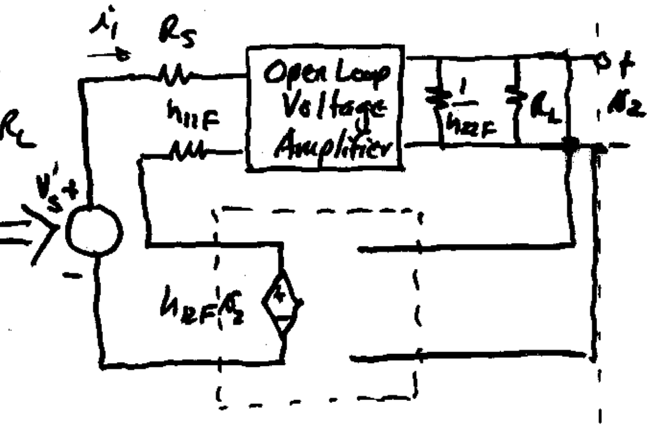
No office hours today.

Voltage Feedback Amplifier (Series-shunt fb.) - Cont'd

$$\frac{V_{out}}{V_{in}} = \frac{A}{1+AB} = A_F \quad A = \frac{-h_{21A}}{(R_S + h_{11T})(G_L + h_{22T})} \quad \& \quad B = h_{12F}$$

Looking at the two-port representation -

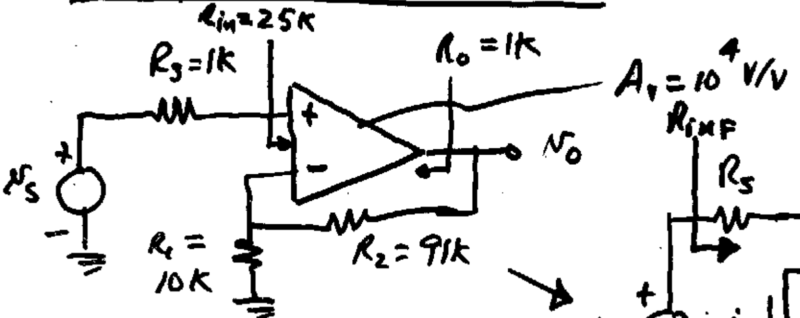




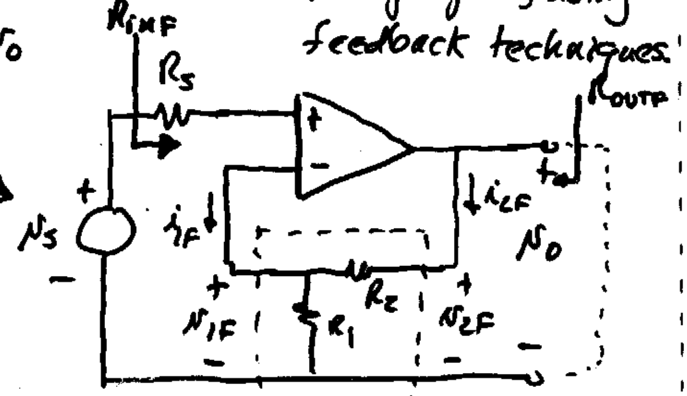
$$h_{11F} = \frac{v_{1F}}{i_{1F}}\Big|_{v_{2F}=0} \qquad h_{22F} = \frac{i_{2F}}{v_{2F}}\Big|_{i_{1F}=0}$$

$$h_{12F} = \frac{v_{1F}}{v_{2F}}\Big|_{i_{1F}=0}$$

Example of Series-Shunt



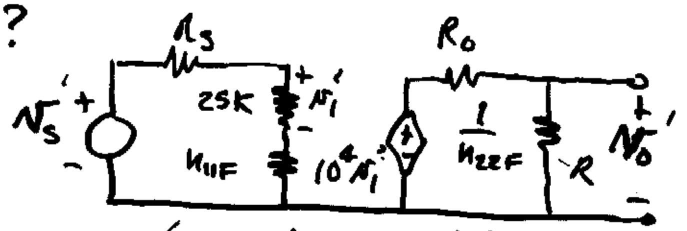
Find the closed loop voltage gain, using feedback techniques.



$$h_{11F} = \frac{v_{1F}}{i_{1F}}\Big|_{v_{2}=0} = R_1 \| R_2 = 9.01K \quad , \quad h_{22F} = \frac{i_{2F}}{v_{2F}}\Big|_{i_{1F}=0} = \frac{1}{R_1+R_2} = \frac{1}{101K}$$

$$h_{12F} = \frac{v_{1F}}{v_{2F}}\Big|_{i_{1F}=0} = \frac{R_1}{R_1+R_2} = 0.099 = B$$

$A = ?$



$$\frac{R}{R_o+R} = \frac{\frac{1}{h_{22F}}}{R_o+\frac{1}{h_{22F}}}$$

(open loop amplifier eq.)
$B = 0 = h_{12F}$

$$\frac{v_o}{v_S} = 10^4\left(\frac{101K}{102K}\right)\left(\frac{25K}{1K+25K+9.01K}\right) = 4730 \text{ V/V}$$

{ Open Loop Voltage Gain, $B = 0$, $h_{12} = 0$

$$\therefore A_F = \frac{v_{out}}{v_{in}} = \frac{v_o}{v_S} = \frac{A}{1+AB} = \frac{4730}{1+4730(0.099)}$$

$$\underline{A_F = 10.06 \text{ V/V}}$$

Closed Loop input resistance, R_{INF}

$$v_S \cong (R_S + h_{11T})\, i_1 + h_{12F} v_2$$
$$0 \cong h_{21A} i_1 + (h_{22T}+G_T) v_2$$
$h_{12A} \to 0$ & $h_{21F} \to 0$

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

$$R_{INF} \equiv \frac{v_S}{i_1} = (R_S+h_{11T})\left[1 + \frac{-h_{21A} h_{12F}}{(R_S+h_{11T})(h_{22}+G_L)}\right] = R_{IN}(1+AB)$$

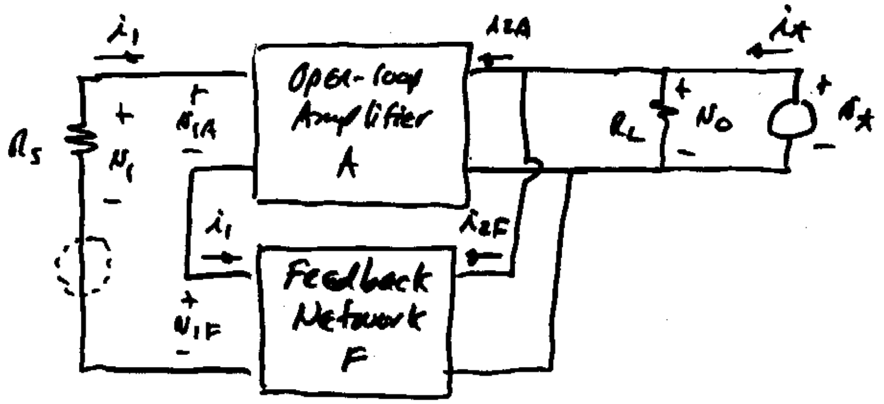
$R_{in} \equiv R_{INF}\,(B \to 0)$ $\boxed{R_{INF} = R_{IN}(1+AB)}$

Back to example:

$$R_{in} = R_S + h_{11T} = 35.1K$$

$$R_{INF}\Big|_{B\neq 0} = R_{IN}(1+AB) = 35.1K(1+4730\times 0.099)$$
$$= 35.1K\,(469.3) = \underline{16.47M\Omega}$$

Closed Loop Output Resistance, R_{OUTF}



$$R_{OUTF} = \frac{v_x}{i_x}$$

$$\left.\begin{aligned} 0 &\cong (R_S + h_{11T}) i_1 + h_{12F} v_x \\ i_x &\cong h_{21A} i_1 + (h_{22T} + G_L) v_x \end{aligned}\right\} \frac{v_x}{i_x} = \frac{1}{(h_{22T} + G_L) + \dfrac{-h_{21A} h_{12F}}{R_S + h_{11T}}}$$

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

$$\boxed{R_{OUTF} = \frac{R_{OUT}}{1 + AB}}$$

Back to example:

$$R_{OUT} = 1k || 101k = 662\,\Omega$$

$$R_{OUTF} = \frac{662\,\Omega}{1 + (4730)(0.099)} = \frac{662\,\Omega}{469.3} = \underline{\underline{1.41\,\Omega}}$$

Generalize the approach and work examples.