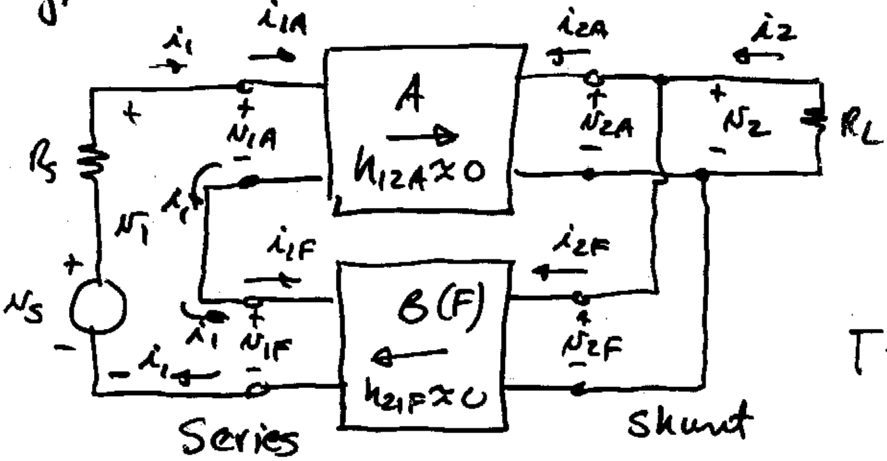
$$\frac{dA_f}{dA} = ? \qquad A_f = \frac{A}{1+AB} \qquad A_{ideal} = 200 = \frac{1}{B}$$

Voltage Amplifiers – Series-Shunt Feedback

Topology



$v_2 = -i_2 R_L$

$T = \frac{\text{Response}}{\text{Excitation}}$

Choose h-parameters

$$\begin{bmatrix} v_{1A} = h_{11A} i_{1A} + h_{12A} v_{2A} \\ i_{2A} = h_{21A} i_1 + h_{22A} v_2 \end{bmatrix} + \begin{bmatrix} v_{1F} = h_{11F} i_1 + h_{12F} v_2 \\ i_{2F} = h_{21F} i_1 + h_{22F} v_2 \end{bmatrix} =$$

$$\begin{bmatrix} v_1 = h_{11T} i_1 + \overset{h_{12F}}{h_{12T}} v_2 \\ i_2 = \underset{h_{21A}}{h_{21T}} i_1 + h_{22T} v_2 \end{bmatrix} \qquad h_{11T} = h_{11A} + h_{11F} \quad \vdots$$

$$h_{11T} = \left.\frac{v_1}{i_1}\right|_{v_2=0} \qquad h_{12T} = \left.\frac{v_1}{v_2}\right|_{i_1=0} \qquad h_{21T} = \left.\frac{i_2}{i_1}\right|_{v_2=0}$$

$$h_{22} = \left.\frac{i_2}{v_2}\right|_{i_1=0}$$

Include R_L and R_S –

$$v_1 = h_{11T} i_1 + h_{12F} v_2$$
$$i_2 = h_{21A} i_1 + h_{22T} v_2$$

$$v_S = i_1 R_S + v_1 \longrightarrow \underline{v_S = i_1 (R_S + h_{11T}) + h_{12F} v_2}$$

$$-\frac{v_2}{R_L} = i_2 = h_{21A} i_1 + h_{22T} v_2 \longrightarrow \underline{0 = h_{21A} i_1 + (G_L + h_{22T}) v_2}$$

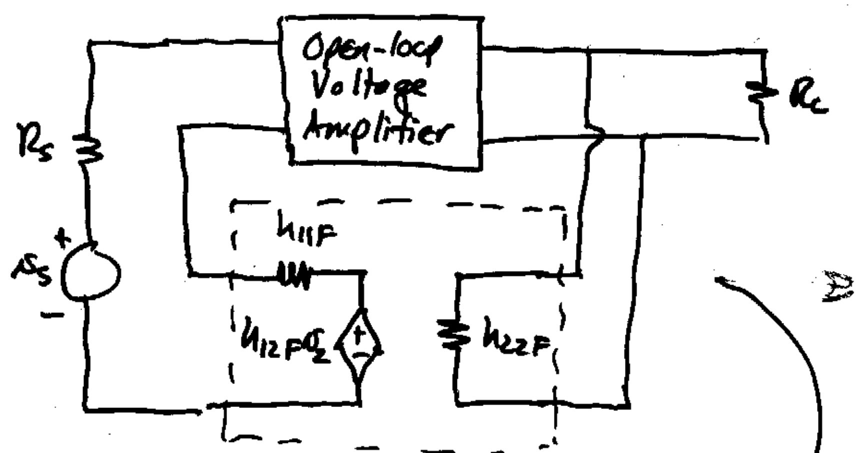
$\therefore$ Solving for $\frac{v_2}{v_S}$, gives

$$\frac{v_2}{v_S} = \frac{\mp h_{21A}}{\mp(R_S+h_{11T})(G_L+h_{22T}) \mp h_{12F}h_{21A}} = \frac{\frac{-h_{21A}}{(R_S+h_{11T})(G_L+h_{22T})}}{1+\frac{-h_{21A}}{(R_S+h_{11T})(G_L+h_{22T})}(h_{12F})}$$

$$= \frac{A}{1+AB}$$

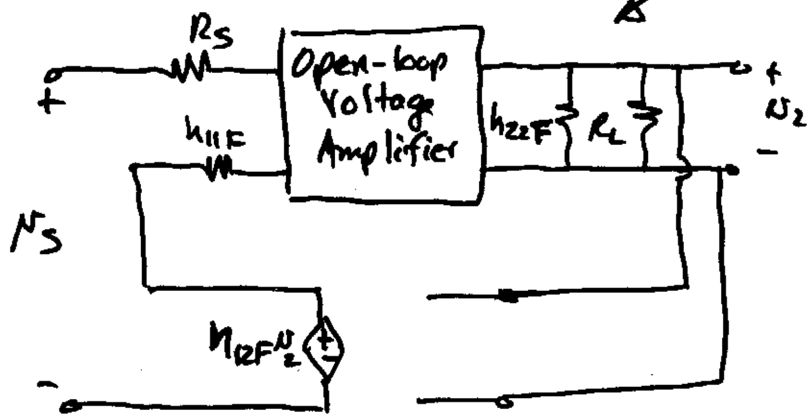
$$\therefore \boxed{A = \frac{-h_{21A}}{(R_S+h_{11T})(G_L+h_{22T})}} \quad \& \quad \boxed{B = h_{12F}}$$

To illustrate -



Closed loop

Closed-loop to open loop



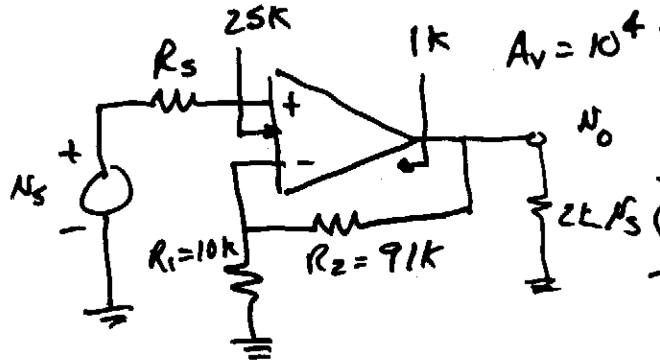
If $v_2 = 0 \to$ Loop is open

$$h_{11F} = \left.\frac{v_{1F}}{i_1}\right|_{v_2=0}$$

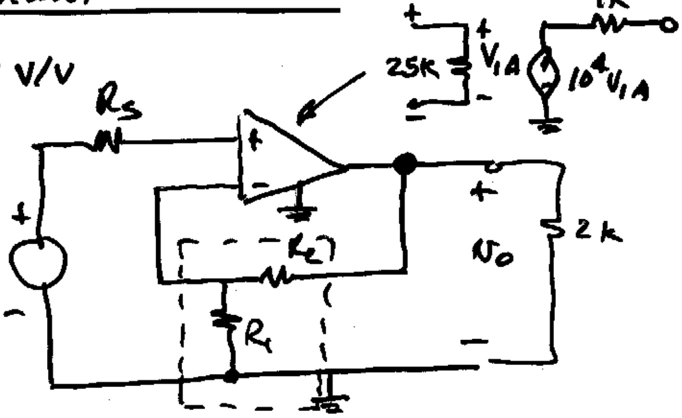
$$h_{22F} = \left.\frac{i_{2F}}{v_{2F}}\right|_{i_1=0}$$

$$h_{12F} = \left.\frac{v_{1F}}{v_2}\right|_{i_1=0}$$

Example of Series-Shunt Feedback



$A_v = 10^4$ V/V



Find $\frac{v_o}{v_s}$ using fb. concepts

How do we approach this problem?

1.) Find h_{11F}, h_{22F} and $h_{12F} = B$

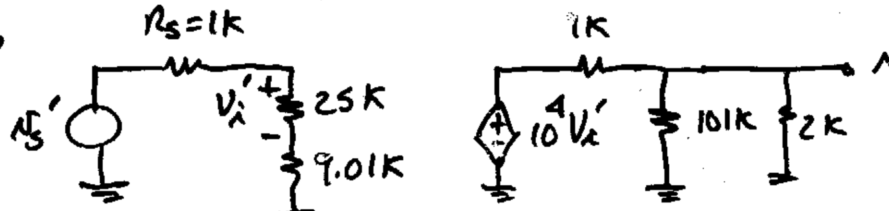
2.) Go for A

3.) $\frac{v_o}{v_s} = \frac{A}{1+AB}$

$h_{11F} = \left.\frac{v_{1F}}{i_{1F}}\right|_{v_2=0} = R_1 \| R_2 = 9.01K$ $h_{22F} = \left.\frac{i_{2F}}{v_{2F}}\right|_{i_1=0} = \frac{1}{R_1+R_2} = \frac{1}{101K}$

$h_{12F} = B = \left.\frac{v_{1F}}{v_2}\right|_{i_1=0} = \frac{R_1}{R_1+R_2} = \frac{10}{101} = 0.099$ (Ans. $\approx \frac{101}{10} = 10.$

A=?



$$A = \frac{v_o'}{v_s'} = \left(\frac{v_o'}{v_i'}\right)\left(\frac{v_i'}{v_s'}\right) = \left(10^4 \frac{2K \| 101K}{1K + 2K \| 101K}\right)\left(\frac{25K}{1K + 25K + 9.01K}\right)$$

$= 4730 \frac{V}{V}$

$$A_f = \frac{A}{1+AB} = \frac{4730}{1 + 4730\left(\frac{1}{10.1}\right)} = \underline{10.08\ V/V}$$