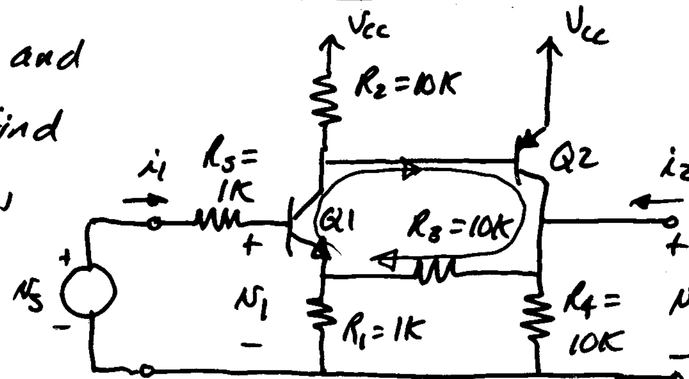
- Units of A? Should be V/V.

$$A = \frac{-h_{21A}}{(R_S + h_{11T})(G_L + h_{22T})} \quad \frac{(A/A)}{(\Omega)(1/\Omega)} \rightarrow \frac{A\cdot\Omega}{A\cdot\Omega} = \frac{V}{V}$$

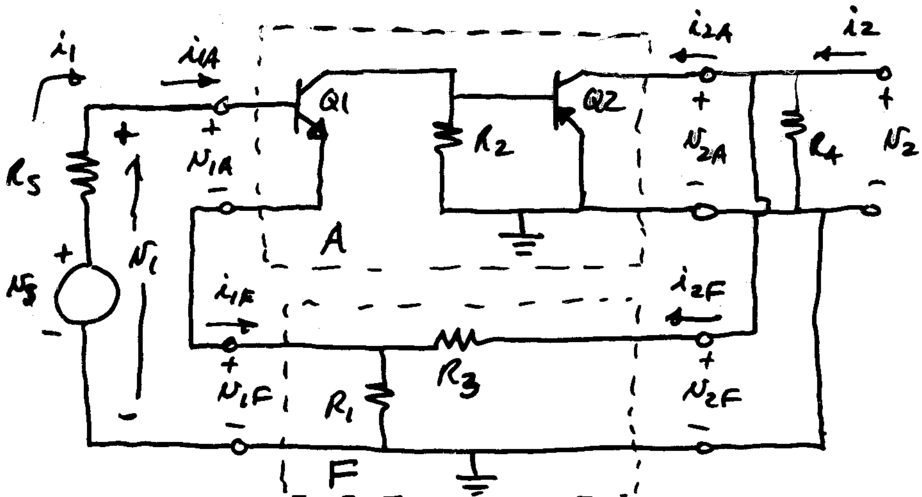
- Quiz 9 - High Frequency Response (Quiz? 11/22 at 7pm)

Series-Shunt Feedback Example

If $\beta_1 = \beta_2 = 100$ and $r_{\pi 1} = r_{\pi 2} = 10k\Omega$, find the value of $\frac{v_2}{v_S}$, $\frac{v_S}{i_1}$, and $\frac{v_2}{i_2}$.



Redraw to help identify the A & F circuits:



Note: $i_1 = i_{1A} \approx i_{1F}$ and $v_2 = v_{2A} = v_{2F}$

$v_1 = v_{1A} + v_{1F}$ $\qquad$ $i_2 = i_{2A} + i_{2F}$

1.) $h_{11F} = \left.\frac{v_{1F}}{i_{1F}}\right|_{v_{2F}=0} = R_1 \| R_3 = 0.91K$

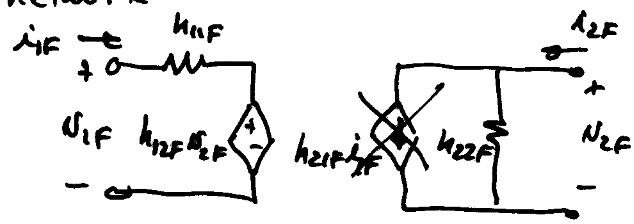
2.) $h_{22F} = \left.\frac{i_{2F}}{v_{2F}}\right|_{i_{1F}=0} = \frac{1}{R_1 + R_3} = \frac{1}{11K}$

3.) $h_{12F} = \left.\frac{v_{1F}}{v_{2F}}\right|_{i_{1F}=0} = \frac{R_1}{R_1 + R_3} = \frac{1}{11}$

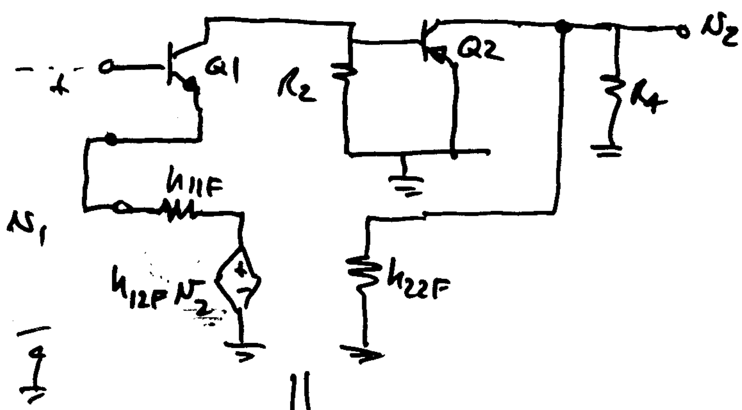
(If $AF \gg 1$, then $A_F \approx \frac{1}{h_{12F}} = 11$ V/V ??)

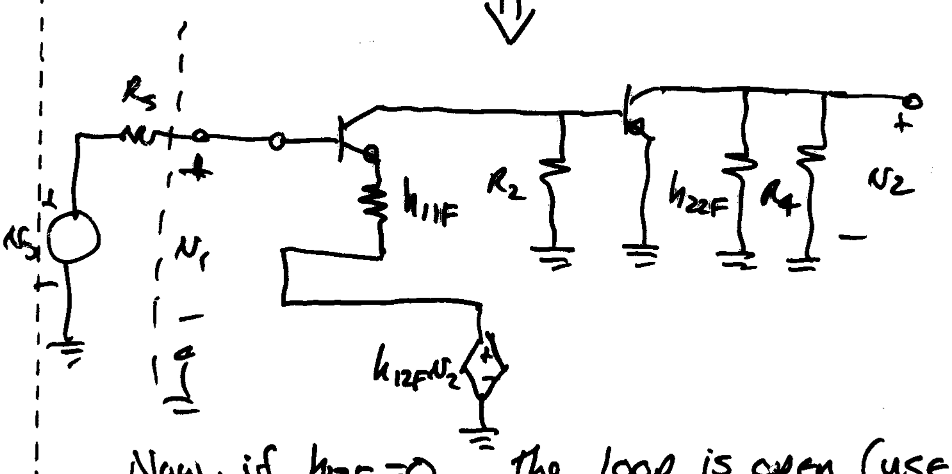
Time Out:

F network -



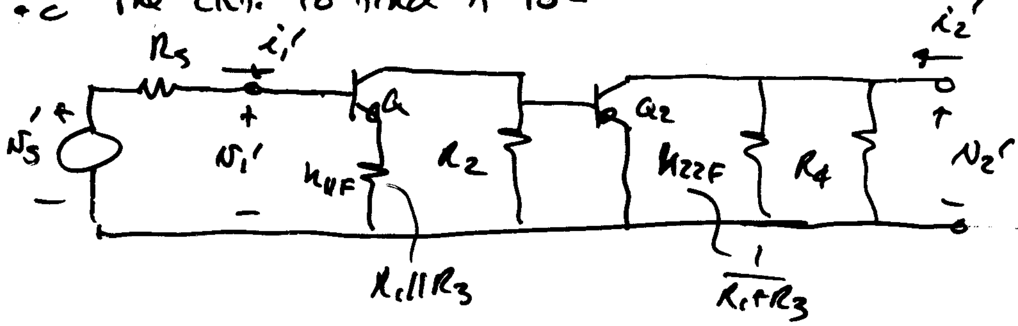
4.) Redrawing the previous ckt. -



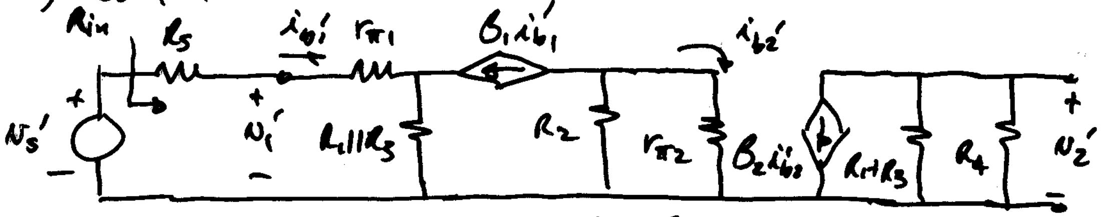


Now, if $h_{12F} = 0$, the loop is open (use primed variables)

∴ The ckt. to find A is -



4.) Cont'd



$$A = \frac{v_2'}{v_s'} = \left[-\beta_2 R_4 \| (R_1 + R_3)\right]\left[\frac{-\beta_1 R_2}{r_{\pi 2} + R_2}\right]\left[\frac{1}{R_S + r_{\pi 1} + (1+\beta_1) R_1 \| R_3}\right]$$

$(A = 255\ \tfrac{V}{V})$ $\qquad (F = \tfrac{1}{11})$

For neg. fb. $AF > 0$ $\qquad AF = \frac{255}{11} = 23.17$

$R_{in} = R_S + r_{\pi 1} + (1+\beta_1) R_1 \| R_3 = 102.8\text{K}\Omega$

$R_{out} = (R_1 + R_3) \| R_4 = 5.23\text{K}\Omega$

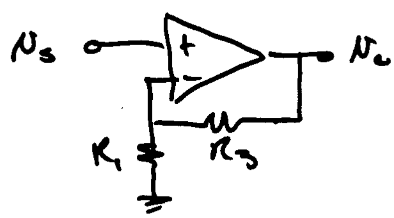
5.) Go back to closed loop –

$$A_F = \frac{A}{1+AF} = \frac{255}{1+23.17} = \underline{\underline{10.54\ v/v}} = \frac{v_o}{v_s} \approx \frac{1}{h_{12F}}$$

$$\frac{v_s}{i_1} = R_{inF} = R_{in}(1+AF) = 102.8\text{K}(24.17) = \underline{\underline{2.485\text{M}\Omega}}$$

$$R_{OUT} = \frac{v_2}{i_2} = \frac{R_{out}}{1+AF} = \frac{5230\Omega}{24.17} = \underline{\underline{216\Omega}}$$

Recall op amp ckts.



$\rightarrow \dfrac{v_o}{v_s} = \dfrac{R_1 + R_3}{R_1} = \underline{\underline{\dfrac{1}{h_{12F}}}}$

General Approach

Let $\psi = g, h, y$ or z

1.) Find ψ_{11F}
2.) Find ψ_{22F}
3.) Find ψ_{12F}

} assume $\psi_{21F} \approx 0$ $(\psi_{21F} \ll \psi_{21A})$

4.) Find A (the open loop amplifier gain) incorporating ψ_{11F} & ψ_{22F} and the correct ψ_{21} variable

5.) $A_F = \dfrac{A}{1+AF}$

6.) $$R_{inF} = \begin{cases} (R_S + \psi_{11F})(1+AF) & \text{if series at input} \\ \dfrac{1}{(G_S + \psi_{11F})(1+AF)} & \text{if shunt at input} \end{cases}$$

$$R_{inF} = R_{in}(1+AF) \text{ or } \frac{R_{in}}{1+AF}$$

$$R_{outF} = \begin{cases} \dfrac{1}{(G_L + \psi_{22F})(1+AF)} & \text{shunt at output} \\ (R_L + \psi_{22F})(1+AF) & \text{series " "} \end{cases}$$

Feedback Topology	Two-Port Parameter
Shunt-shunt (Transresistance Amplifier)	$i_1 = y_{11} v_1 + y_{12} v_2$ $i_2 = y_{21} v_1 + y_{22} v_2$
Shunt-series (Current Amplifier)	$i_1 = g_{11} v_1 + g_{12} i_2$ $v_2 = g_{21} v_1 + g_{22} i_2$
Series-series (Transconductance Amplifier)	$v_1 = z_{11} i_1 + z_{12} i_2$ $v_2 = z_{21} i_1 + z_{22} i_2$
Series-Shunt (Voltage amplifier)	$v_1 = h_{11} i_1 + h_{12} v_2$ $i_2 = h_{21} i_1 + h_{22} v_2$