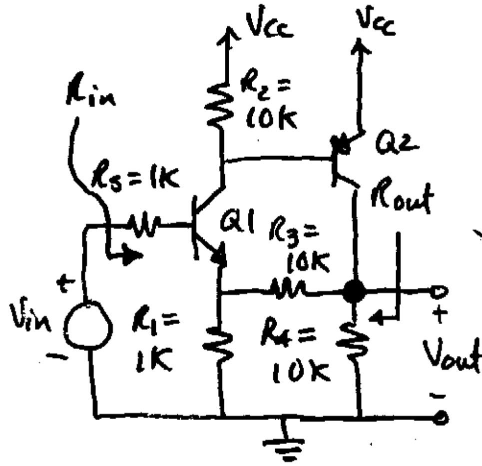
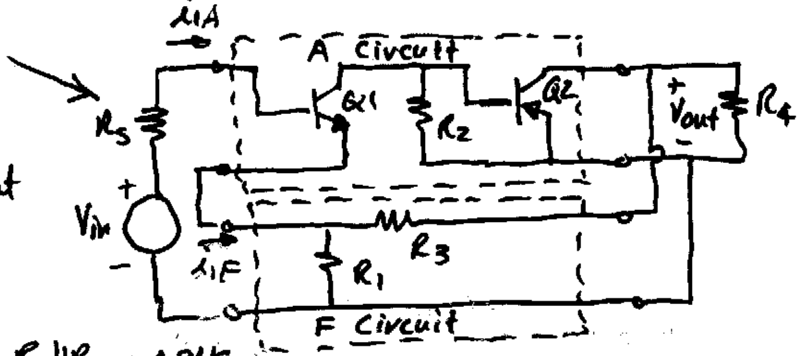
Series-Shunt Example



If $Q1 = Q2$, $h_{fe} = 100$, $r_\pi = 10K$ and $r_o = \infty$, use feedback analysis methods to find $\frac{V_{out}}{V_{in}}$, R_{in} & R_{out}.

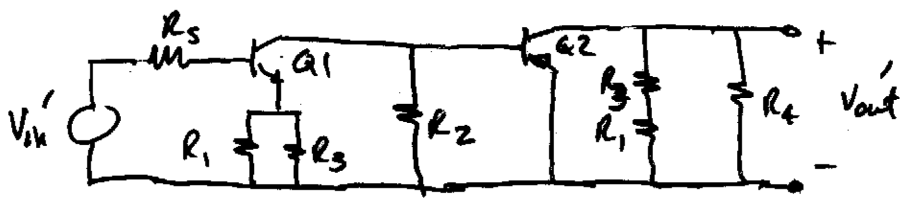


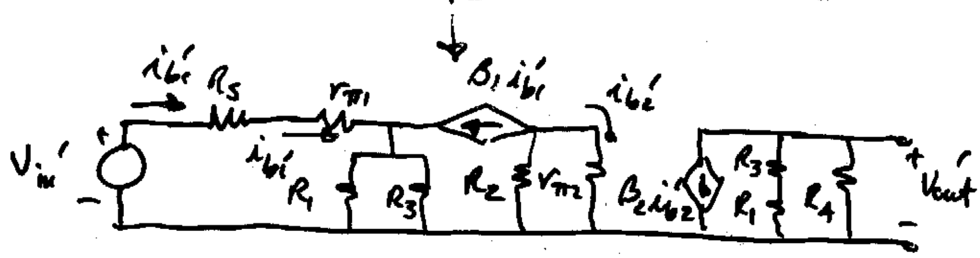
1.) $h_{11F} = \frac{v_{1F}}{i_{1F}}\Big|_{v_{2F}=v_O=0} = R_1 \| R_3 = 0.91K$

2.) $h_{22F} = \frac{i_{2F}}{v_{2F}}\Big|_{i_{1F}=i_1=0} = \frac{1}{R_1+R_2} = \frac{1}{11K}$

3.) $h_{12F} = \frac{v_{1F}}{v_{2F}}\Big|_{i_{1F}=0} = \frac{1}{11} = \beta$

4.) A circuit:





$$A = \frac{V_{out}'}{V_{in}'} = \left(\frac{V_{out}'}{i_{b2}'}\right)\left(\frac{i_{b2}'}{i_{b1}'}\right)\left(\frac{i_{b1}'}{V_{in}'}\right) =$$

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

$$= \left[-100(5.24K)\right]\left(-\frac{100 \cdot 10K}{20K}\right)\left(\frac{1}{102.8K}\right) = +255\ V/V$$

5.) $A_F = \frac{v_{out}}{v_{in}} = \frac{A}{1+A\beta} = \frac{255}{1+255(\frac{1}{11})} = \frac{255}{1+23.17} = \underline{\underline{10.54\ V/V}} \approx \frac{1}{h_{12F}} = 11$

6.) $R_S + h_{11T} = R_S + \left[r_{\pi 1} + (1+\beta_1)R_1 \| R_3\right] = 1K + 101.8k = 102.8K$

$R_{in} = R_{inF} = (R_S + h_{11T})(1+AB) = 102.8K(24.17) = \underline{\underline{2.485M\Omega}}$

7.) $h_{22T} + G_L = \frac{1}{R_1+R_3} + \frac{1}{R_4} + \frac{1}{r_o} = \frac{1}{11K} + \frac{1}{10K} + \frac{1}{\infty} = \frac{1}{5.23K}$

$R_{OUT} = \frac{1}{(h_{22T}+G_L)(1+AB)} = \frac{5.23K}{1+AB} = \frac{5.23K}{24.17} = \underline{\underline{216\Omega}}$

Moving on to the other 3 topologies –

Let $x = h, g, y$ or z

1.) Find x_{11F}
2.) Find x_{22F}
3.) Find $x_{12F} = B$
4.) Find A incorporating x_{11F} and x_{22F} for loading and using the correct variables which are the x_{21} variables
5.) $A_F = \frac{A}{1+AB}$
6.) $R_{inF} = \begin{cases} (R_S + x_{11T})(1+AB) & \text{if the input is series} \\ \frac{1}{(G_S + x_{11T})(1+AB)} & \text{if the input is shunt} \end{cases}$

7.) $R_{OUTF} = \begin{cases} \frac{1}{(G_L + x_{22T})(1+AB)} & \text{if the output is shunt} \\ (R_L + x_{22T})(1+AB) & \text{if the output is series} \end{cases}$

	Series-Shunt	Shunt-Shunt	Series-Shunt (↔)	Series-Series
Two-Port Parameters	$v_1 = h_{11}i_1 + h_{21}v_2$ $i_2 = h_{12}i_1 + h_{22}v_2$	$i_1 = y_{11}v_1 + y_{21}v_2$ $i_2 = y_{12}v_1 + y_{22}v_2$	$i_1 = g_{11}v_1 + g_{12}i_2$ $v_2 = g_{12}v_1 + g_{22}i_2$	$v_1 = z_{11}i_1 + z_{21}i_2$ $v_2 = z_{12}i_1 + z_{22}i_2$
Type of Amplifier	Voltage	Transresistance	Current	Transconductance