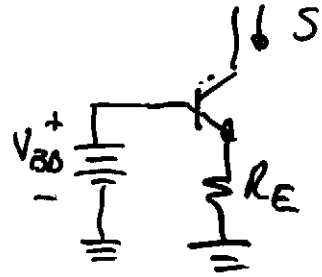
CHAPTER 18 - FEEDBACK

Feedback is a great conceptual tool, however it is a somewhat poor analytical tool.



1.) $I_c \uparrow \Rightarrow I_E \uparrow$

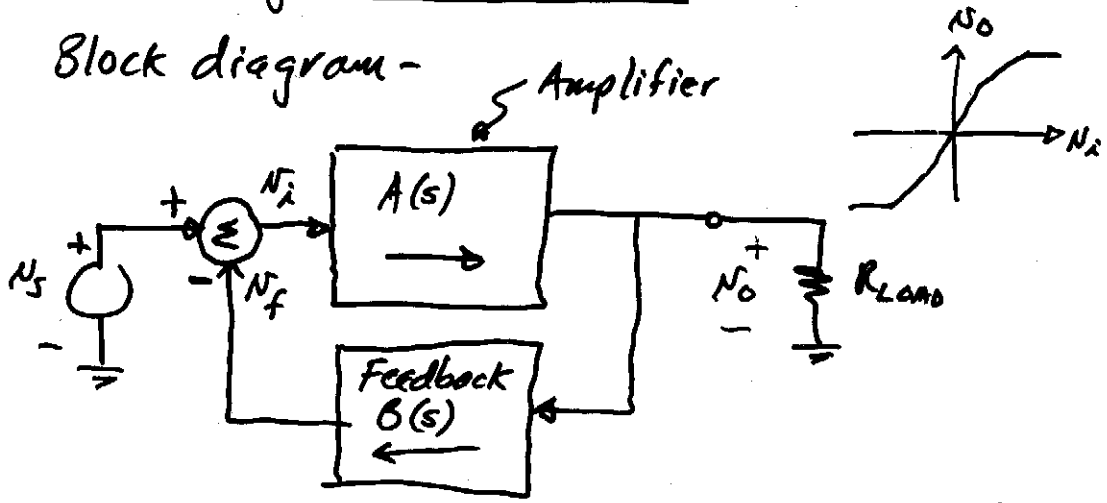
2.) $I_E \uparrow \Rightarrow V_E \uparrow$

3.) $V_E \uparrow \Rightarrow V_{BE} \downarrow$

4.) $V_{BE} \downarrow \Rightarrow I_c \downarrow$

Classic Single Loop Feedback

Block diagram -



$$N_o = A(s) N_i = A(s)\left[N_s - N_f\right] = A(s) N_s - A(s)\left[B(s) N_o\right]$$

$$N_o\left[1 + A(s)B(s)\right] = A(s) N_s$$

$$\therefore \text{ Closed loop voltage gain} = \boxed{\frac{N_o}{N_s} = \frac{A(s)}{1 + A(s)B(s)}}$$

$$\text{Loop gain} \equiv T(s) = A(s)B(s) \rightarrow \frac{N_o}{N_s} = \frac{A(s)}{1 + T(s)}$$

If $A(s)B(s) >> 1$, then $\frac{N_o}{N_s} \rightarrow \frac{1}{B(s)}$

Positive feedback: $T(s) < 0$

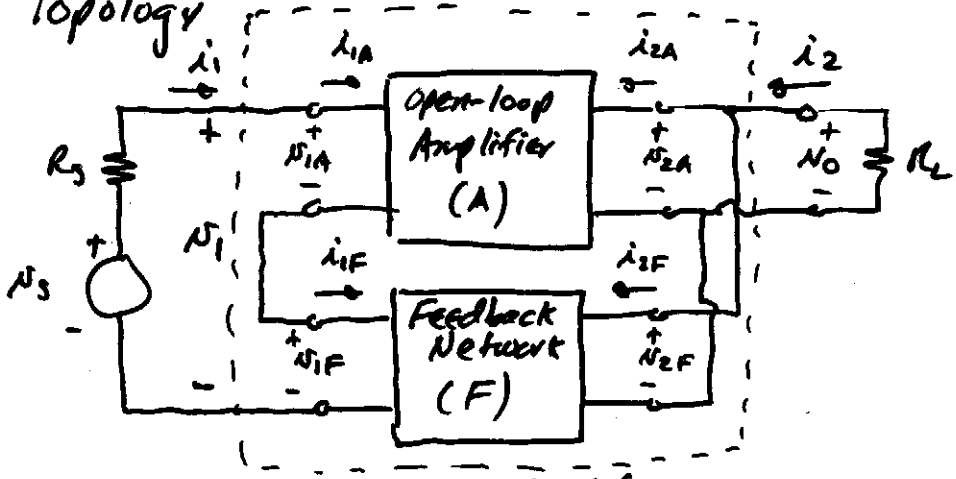
Negative feedback: $T(s) > 0$

Types of Amplifiers

Type	Input Variable	Output Variable
VCVS	Voltage (series)	Voltage (shunt)
CCVS	Current (shunt)	Voltage (shunt)
CCCS	Current (shunt)	Current (series)
VCCS	Voltage (series)	Current (series)

Voltage Amplifiers – Series-Shunt Feedback

Topology



h-parameters –

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

Feedback network:

$$v_{1F} = h_{11F} i_{1F} + h_{12F} v_{2F}$$
$$i_{2F} = h_{21F} i_{1F} + h_{22F} v_{2F}$$

Amplifier:

$$v_{1A} = h_{11A} i_{1A} + h_{12A} v_{2A}$$
$$i_{2A} = h_{21A} i_{1A} + h_{22A} v_{2A}$$

Total (dotted box):

$$v_1 = h_{11T} i_1 + h_{12T} v_o$$
$$i_2 = h_{21T} i_1 + h_{22T} v_o$$

$$\therefore \quad v_1 = (h_{11A} + h_{11F})\, i_1 + (h_{12A} + h_{12F})\, v_0$$

$$i_2 = (h_{21A} + h_{21F})\, i_1 + (h_{22A} + h_{22F})\, v_0$$

We observe that for a "good" amplifier $h_{12A} \to 0$ and for a "good" feedback network $h_{21F} \to 0$

As a consequence, we can write the total h-parameters as,

$$v_1 \cong h_{11T}\, i_1 + h_{12F}\, v_0$$

$$i_2 \cong h_{21A}\, i_1 + h_{22T}\, v_0$$

Recall that $v_1 = v_s + i_1 R_s$

or $v_s = v_1 + i_1 R_s$

and $v_0 = -i_2 R_L$

$$\therefore \quad v_s = h_{11T}\, i_1 + h_{12F}\, v_0 + i_1 R_s \longrightarrow \boxed{v_s = (h_{11T} + R_s)\, i_1 + h_{12F} v_0}$$

$$-\frac{v_0}{R_L} = h_{21A}\, i_1 + h_{22T}\, v_0 \longrightarrow \boxed{0 = h_{21A}\, i_1 + \left(h_{22T} + \frac{1}{R_L}\right) v_0}$$

Solve for $\dfrac{v_0}{v_s} = \dfrac{A}{1 + AF}$

$$i_1 = -\frac{(h_{22T} + G_L)}{h_{21A}}\, v_0$$

$$v_s = (h_{11T} + R_s)\, i_1 + h_{12F}\, v_0$$

$$\frac{v_0}{v_s} = \frac{+h_{21A}}{h_{12F} h_{21A} - (h_{11T} + R_s)(h_{22T} + G_L)}$$

$$\frac{v_0}{v_s} \cong \frac{\dfrac{-h_{21A}}{(R_s + h_{11T})(G_L + h_{22T})}}{1 + \dfrac{-h_{21A}}{(\quad X \quad)}\, h_{12F}} = \frac{A}{1 + AF}$$

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