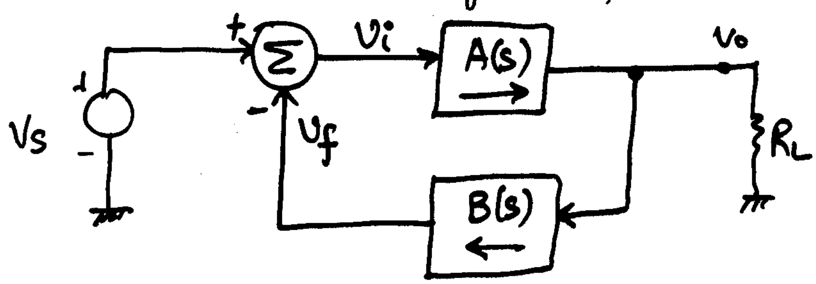
CHAPTER 18: FEEDBACK, STABILITY, AND OSCILLATORS

- → Introduction
- → series-shunt
- → shunt-shunt
- → shunt-series
- → series-series

What can feedback do??

- → Increase/decrease Rin/Rout
- → Increase accuracy
- → Remove non-linearity
- → Increase f_H and decrease f_L
- → Create oscillators

Classical single-loop Feedback



$$\frac{V_o}{V_s} = ??$$

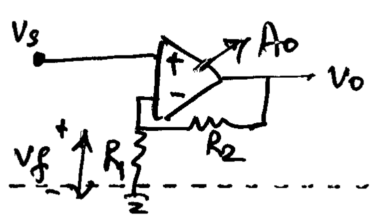
$$v_o = A(s)\, v_i = A(s)\cdot\{V_s - V_f\} = A(s)\{V_s - B(s)\cdot V_o\}$$

$$V_o = A(s)\cdot V_s - A(s)\cdot B(s)\, V_o$$

$$\frac{V_o}{V_s} = \frac{A(s)}{1 + A(s)B(s)} = \frac{A(s)}{1 + T(s)}$$

$$T(s) = A(s)B(s) = \text{Loop gain}$$

$$T(s) >> 1 \Rightarrow \frac{V_o}{V_s} \simeq \frac{A(s)}{T(s)} \simeq \frac{1}{B(s)}$$

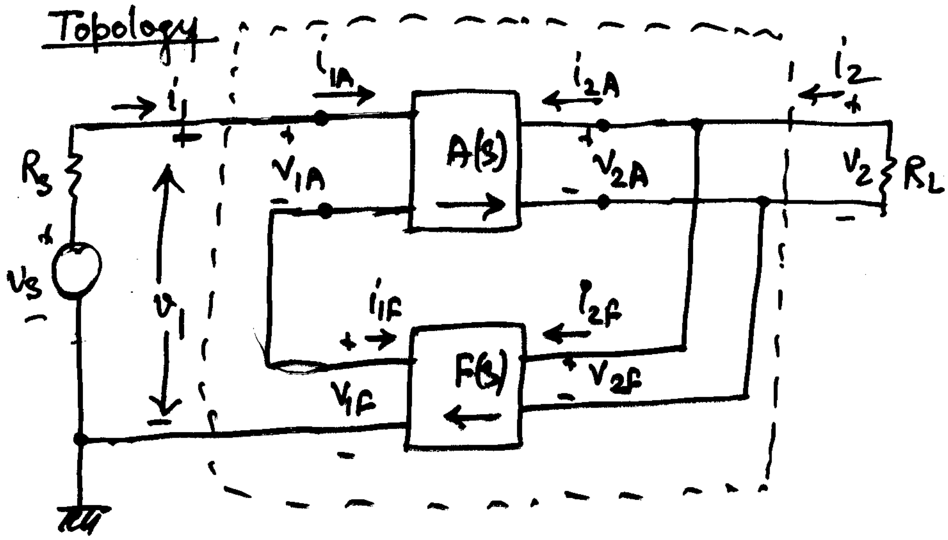


$$\Rightarrow \left.\begin{array}{l} A = A_o \\ B = \dfrac{R_1}{R_1+R_2} \end{array}\right\} \rightarrow \frac{V_o}{V_s} \simeq \frac{1}{B} = \frac{R_1+R_2}{R_1}$$

Voltage Amplifiers → Series - shunt Feedback

(Input) (output)

Topology



$$v_1 = V_{1A} + V_{1F} \quad ; \quad i_2 = i_{2A} + i_{2F}$$

A network F network

$$\begin{bmatrix} v_1 \\ i_2 \end{bmatrix} = \begin{bmatrix} V_{1A} = h_{11A} i_{1A} + h_{12A} \cdot V_{2A} \\ i_{2A} = h_{21A} i_{1A} + h_{22A} V_{2A} \end{bmatrix} + \begin{bmatrix} V_{1F} = h_{11F} i_{1F} + h_{12F} v_{2F} \\ i_{2F} = h_{21F} i_{1F} + h_{22F} V_{2F} \end{bmatrix}$$

$$v_1 = (h_{11A} + h_{11F}) i_1 + (h_{12A} + h_{12F}) v_2$$

$$i_2 = (h_{21A} + h_{21F}) i_1 + (h_{22A} + h_{22F}) v_2$$

$$\left.\begin{aligned} h_{11T} &= h_{11A} + h_{11F} \\ h_{12T} &= \cancel{h_{12A}} + h_{12F} \cong h_{12F} \\ h_{21T} &= h_{21A} + \cancel{h_{21F}} \cong h_{21A} \\ h_{22T} &= h_{22A} + h_{22F} \end{aligned}\right] \quad \begin{aligned} v_1 &= h_{11T} i_1 + h_{12T} v_2 \\ i_2 &= h_{21T} \cdot i_1 + h_{22T} \cdot v_2 \end{aligned}$$

$$\frac{V_o}{V_s} = ?? \quad \text{with } R_s \text{ and } R_L$$

$$v_s = i_1 R_s + v_1 = i_1 R_s + \{h_{11T} \cdot i_1 + h_{12F} v_2\} = \left. \begin{matrix} i_1 (R_s + h_{11T}) \\ + h_{12F} \cdot v_2 \end{matrix} \right\} \quad (1)$$

$$v_2 = -i_2 R_L \Rightarrow i_2 = -\frac{v_2}{R_L} \Rightarrow \left(h_{21A} \cdot i_1 + h_{22T} v_2\right) = -\frac{v_2}{R_L}$$

$$\downarrow$$

$$i_1 = -\frac{(h_{22T} + G_L)}{h_{21A}} \cdot v_2 \rightarrow (2)$$

$$v_s = -(R_s + h_{11T}) \underbrace{\left(\frac{h_{22T} + G_L}{h_{21A}}\right) v_2}_{i_1} + h_{12F} v_2$$

$$\left(\frac{v_2}{v_s}\right) = \text{Closed-loop T.F} = A_{vF}.$$

$$\left(\frac{V_2}{V_s}\right) = A_{vF} = \frac{\dfrac{-h_{21A}}{(R_s + h_{11T})(h_{22T} + G_L)}}{1 + \left\{\dfrac{-h_{21A}}{(R_s + h_{11T})(h_{22T} + G_L)}\right\}(h_{12F})}$$

$$= \frac{A}{1 + A \cdot F}$$

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