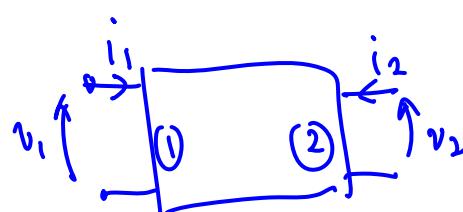
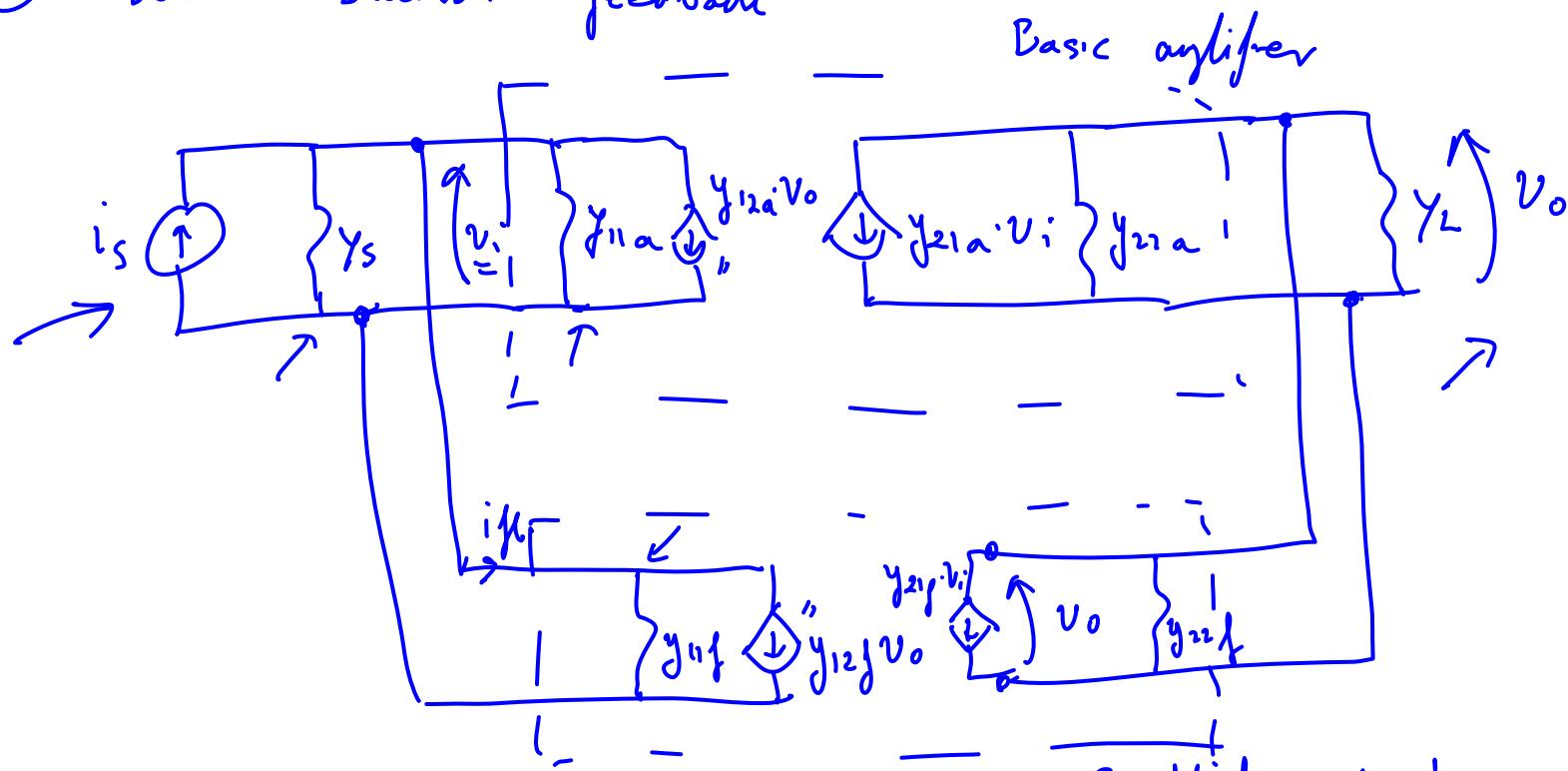


Two-port feedback representation - effects of loading

① Shunt - shunt feedback



$$\begin{aligned} i_1 &= y_{11} \cdot v_1 + y_{12} \cdot v_2 \\ i_2 &= y_{21} \cdot v_1 + y_{22} \cdot v_2 \end{aligned}$$

$$y_{11} = \frac{i_1}{v_1} \Big|_{v_2=0}$$

$$y_{12} = \frac{i_1}{v_2} \Big|_{v_1=0}$$

$$y_{21} = \frac{i_2}{v_1} \Big|_{v_2=0}$$

$$y_{22} = \frac{i_2}{v_2} \Big|_{v_1=0}$$

$$i_s = \underbrace{(y_s + y_{11}a + y_{11f})}_{y_i} \cdot v_i + (y_{12a} + y_{12f}) \cdot v_o$$

$$0 = (y_{21a} + y_{21f}) \cdot v_i + \underbrace{(y_L + y_{22a} + y_{22f})}_{y_o} \cdot v_o$$

$$\frac{v_o}{v_i} = -\frac{(y_{21a} + y_{21f})}{y_o}$$

$$A_{c,L} = \frac{v_o}{i_s} = -\frac{(y_{21a} + y_{21f})}{y_i \cdot y_o - (y_{21a} + y_{21f}) \cdot \underbrace{(y_{12a} + y_{12f})}_{y_o}} = -\frac{\frac{a}{(y_{21a} + y_{21f})}}{1 + \frac{-\frac{(y_{21a} + y_{21f})}{y_i \cdot y_o} \cdot (y_{12a} + y_{12f})}{(y_{21a} + y_{21f})}}$$

$$A_{c,L} = \frac{a}{1 + a \cdot f}$$

$$a = -\frac{(y_{21a} + y_{21f})}{y_i \cdot y_o}$$

$$f = y_{12a} + y_{12f}$$

\uparrow \uparrow
 x

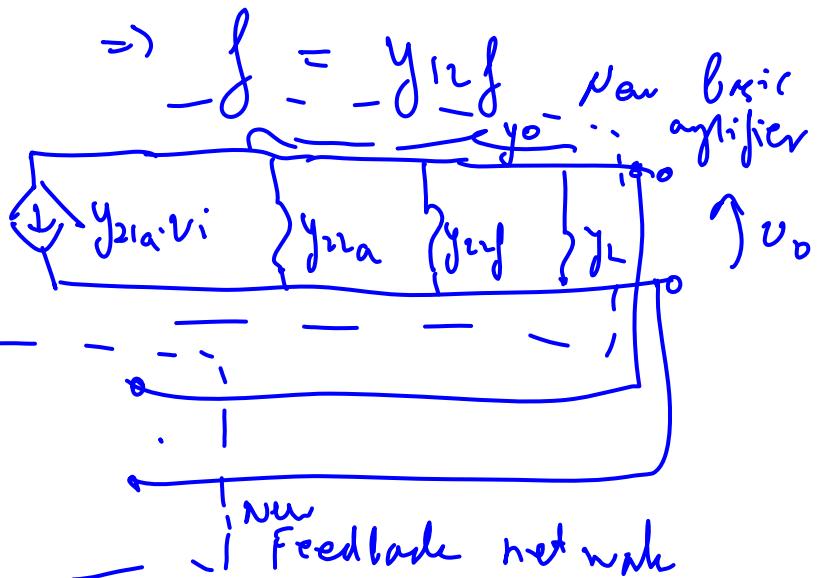
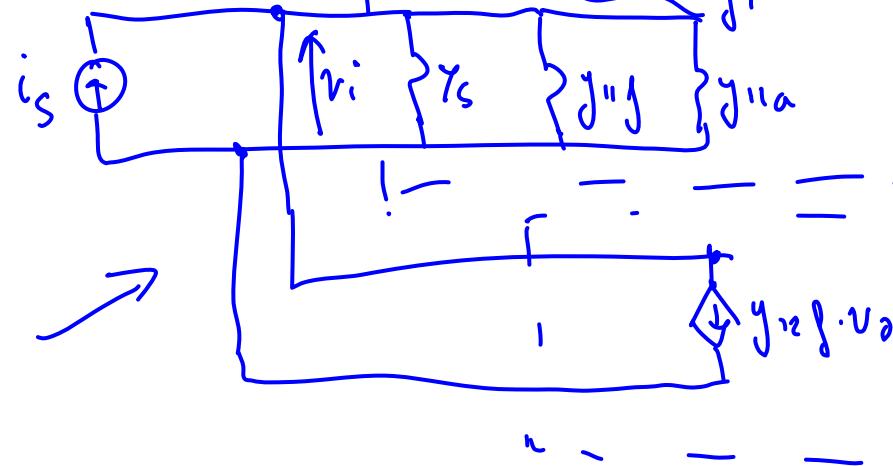
Approximations -

a) Signal through the amplifier much stronger than feed-forward signal through f_L -network

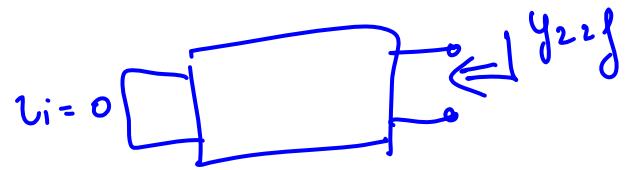
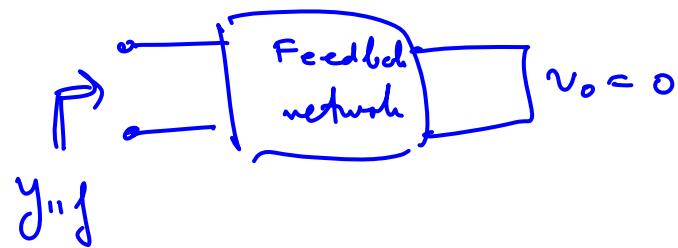
$$|y_{21a}| \gg |y_{12f}| \quad \Rightarrow \quad a = -\frac{y_{21a}}{y_i y_o}$$

b) Feedback signal through the amplifier much smaller than feedback signal through f_L -network

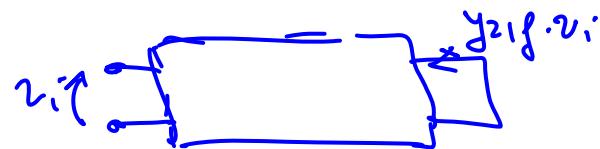
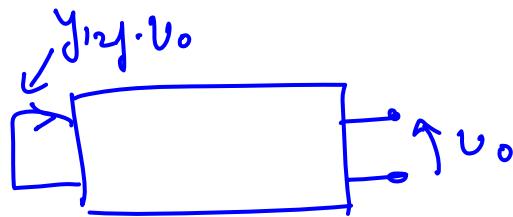
$$|y_{12a}| \ll |y_{12f}|$$

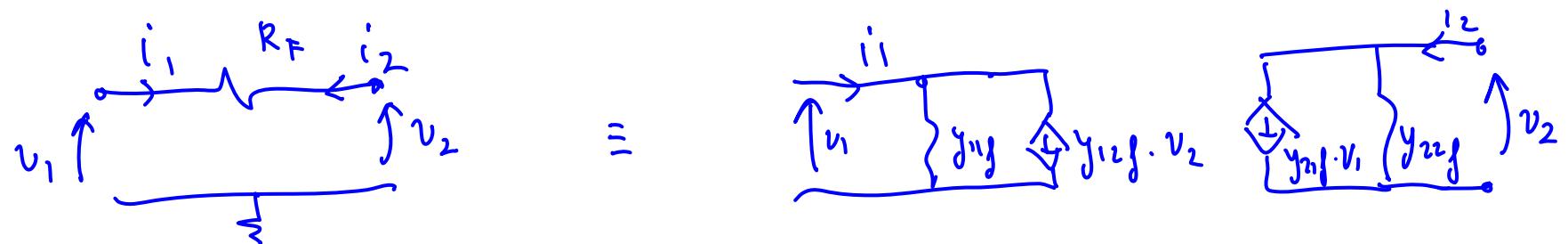
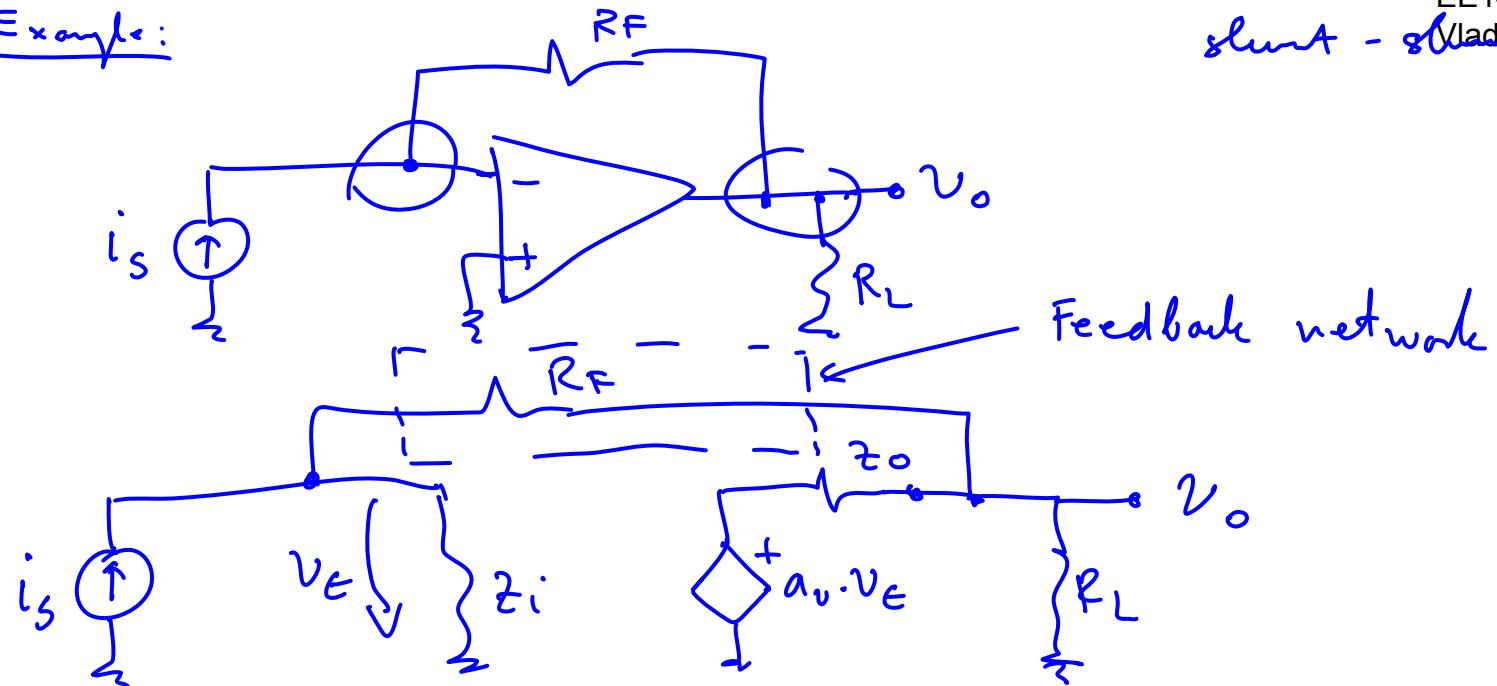


In practice: Isolate fl. network



Often by inspection



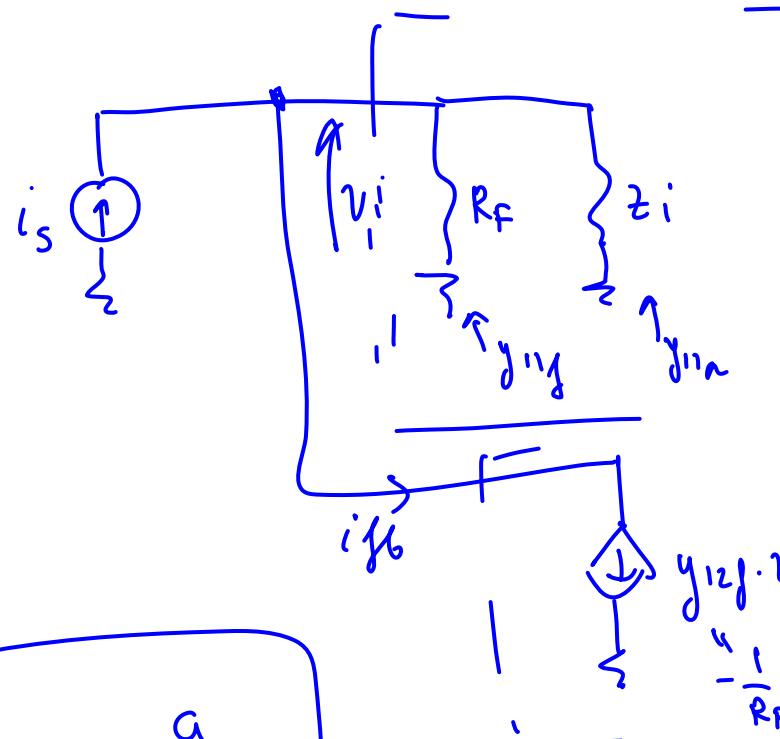
Example:

$$y_{11f} = \left. \frac{i_1}{v_1} \right|_{v_2=0} = \frac{1}{R_F}$$

$$y_{12f} = \left. \frac{i_1}{v_2} \right|_{v_1=0} = -\frac{1}{R_F}$$

$$y_{22f} = \left. \frac{i_2}{v_2} \right|_{v_1=0} = \frac{1}{R_F}$$

$$y_{21f} = \left. \frac{i_2}{v_1} \right|_{v_2=0} = -\frac{1}{R_F}$$



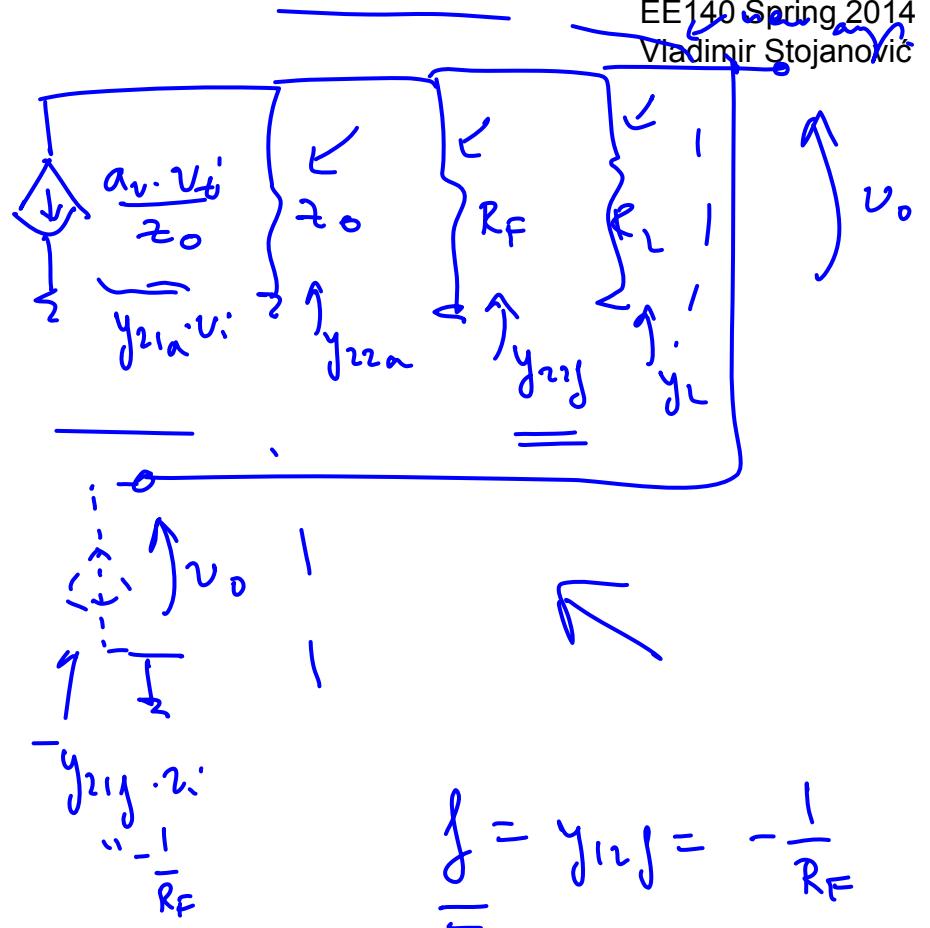
$$A_{v,L} = \frac{a}{1 + a \cdot f}$$

a: $i_{fb} = 0$

$$\frac{a_v \cdot v_i}{z_0} = \frac{v_o}{z_0 \parallel R_F \parallel R_L}$$

$$v_i = i_s (R_F \parallel z_i)$$

$$[a] \quad \frac{v_o}{i_s} \Big|_{i_{fb}=0} = - \frac{a_v \cdot (z_0 \parallel R_F \parallel R_L) \parallel (R_F \parallel z_i)}{z_0}$$



$$f = y_{12f} = -\frac{1}{R_F}$$

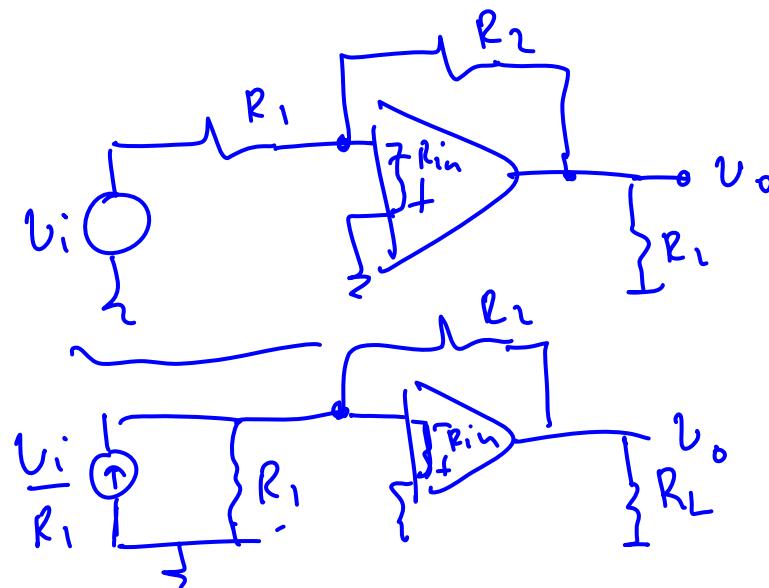
$$\frac{z_0 \cdot R_F \parallel R_L}{z_0 + R_F \parallel R_L}$$

$$Z_{ia} = R_F \parallel Z_i$$

$$T = a \cdot f$$

shunt

$$Z_i = \frac{Z_{ia}}{1+T}$$



$$Z_i = R_1 \parallel R_2$$

$$Z_{oa} = Z_o \parallel R_F \parallel R_L$$

shunt

$$Z_o = \frac{Z_{oa}}{1+T}$$

