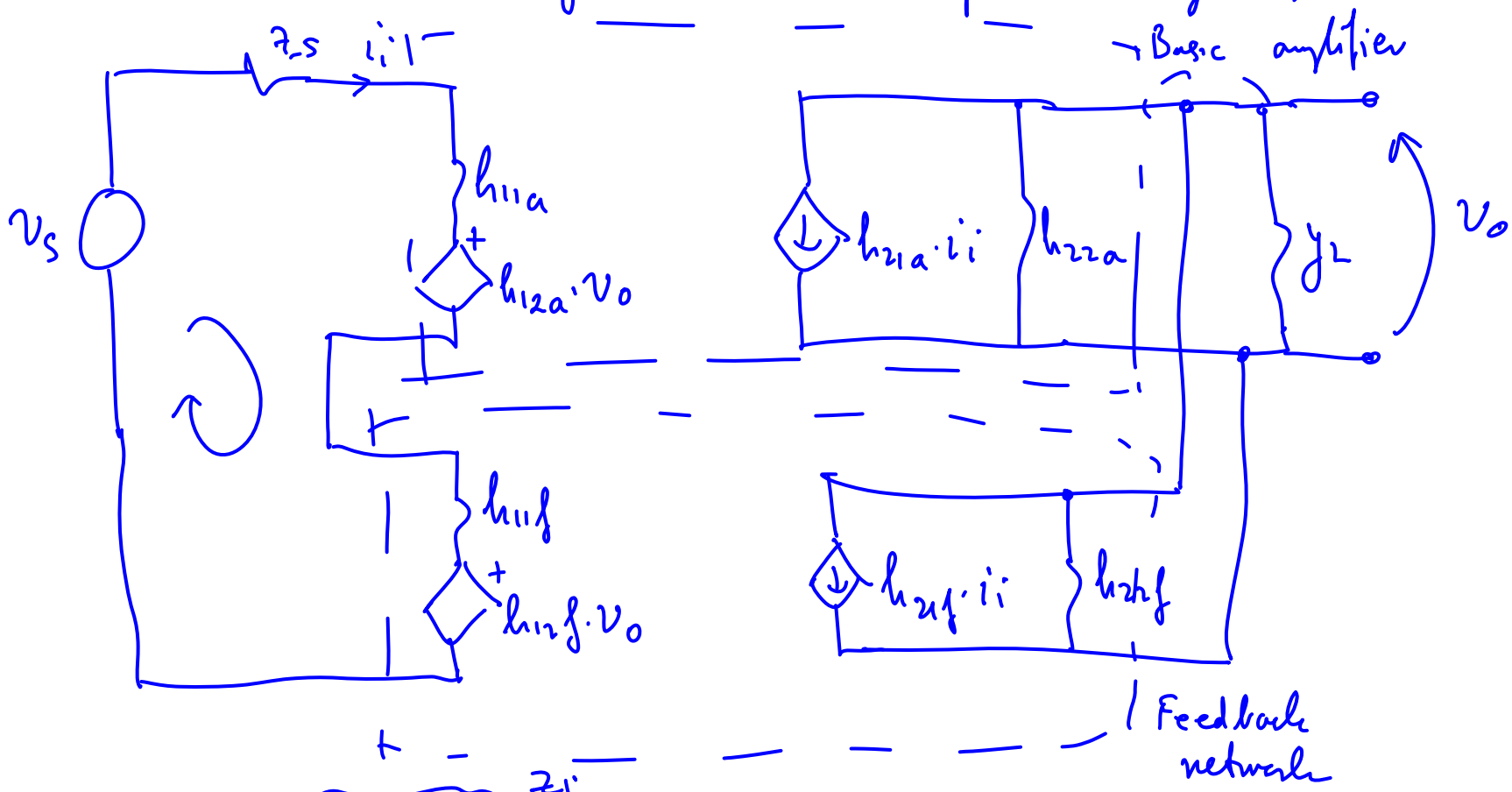
Series - shunt feedback (2-port analysis)



$$v_s = \overbrace{(R_s + h_{11a} + h_{11f})}^{z_i} \cdot i_i + (h_{12a} + h_{12f}) \cdot v_o$$

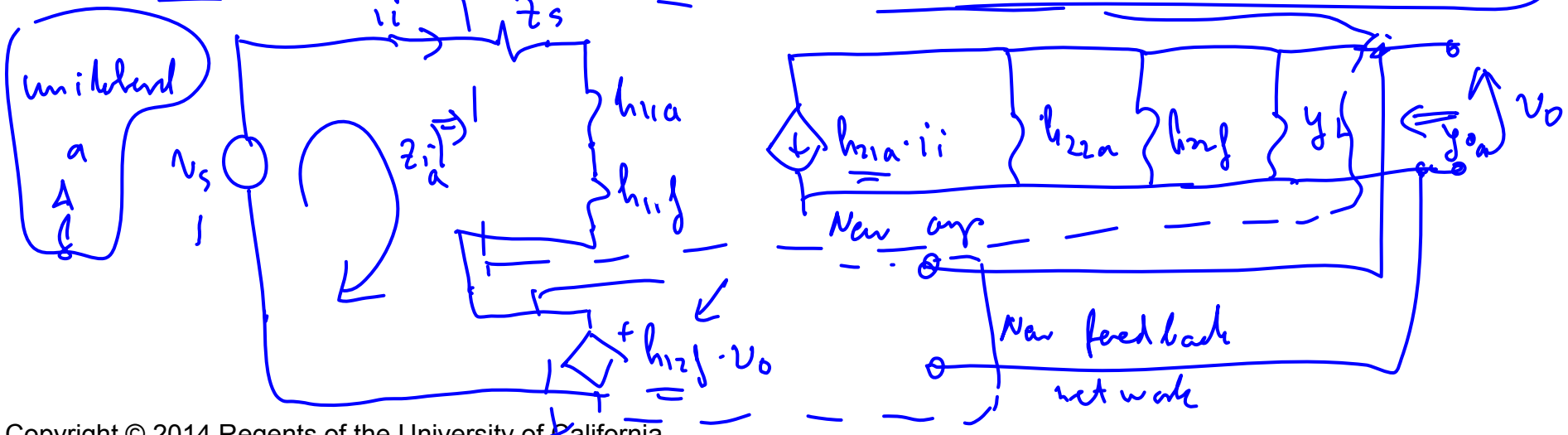
$$0 = (h_{21a} + h_{21f}) \cdot i_i + \underbrace{(y_L + h_{22a} + h_{22f})}_{y_o} \cdot v_o$$

$$i_i = \frac{-y_o}{h_{12a} + h_{12f}} \cdot v_o$$

$$\frac{v_o}{v_s} = A_{c.l} = \frac{-(h_{21a}+h_{21f})}{y_o z_i - (h_{21a}+h_{21f})(h_{12a}+h_{12f})}$$

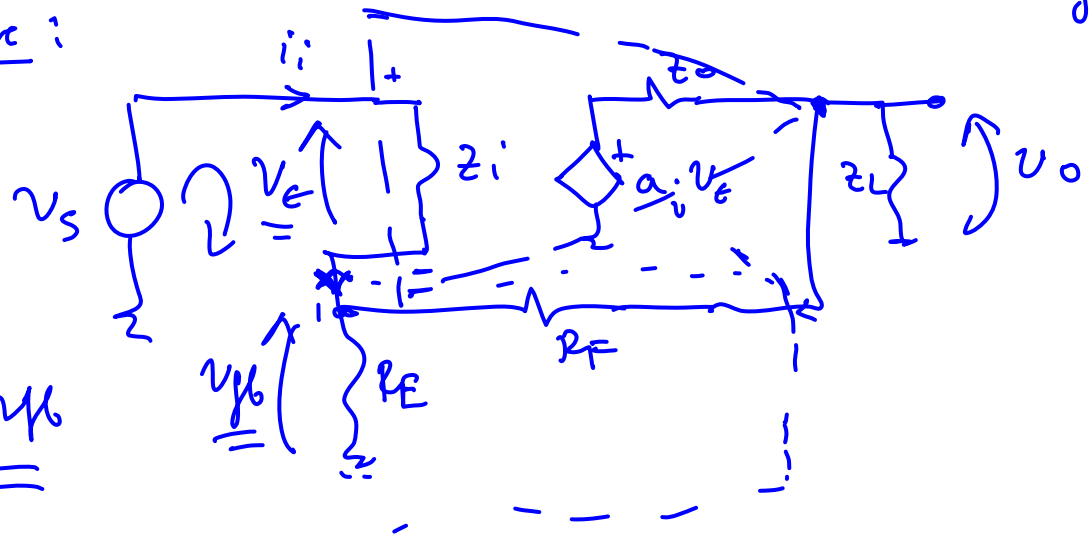
$$= \frac{\overbrace{\frac{-(h_{21a}+h_{21f})}{y_o z_i}}\, a}{1 + \underbrace{\frac{-(h_{21a}+h_{21f})}{y_o z_i}\cdot(h_{12a}+h_{12f})}}$$

$|h_{21a}| >> |h_{21f}|$ & $|h_{12a}| << |h_{12f}|$ unilateral flow assumption. $\Rightarrow$ $a = -\frac{h_{21a}}{y_o z_i}$, $f = h_{12f}$

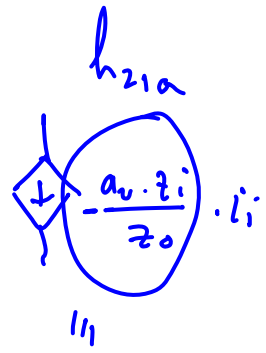


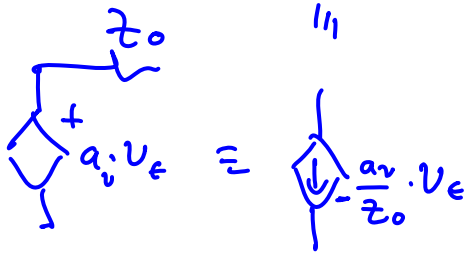
$$Z_i = r_{ia}\cdot(1+T) \qquad Z_o = \frac{r_{oa}}{1+T} = \frac{1}{g_{oa}(1+T)}$$

Example:

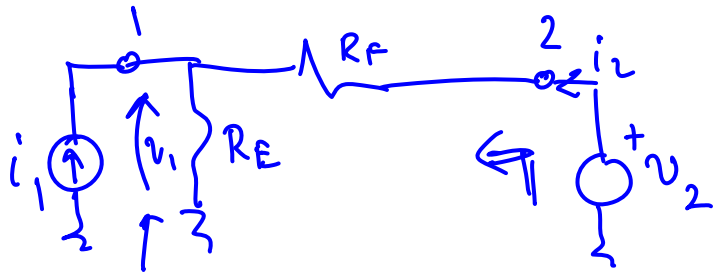


$$v_\epsilon = v_s - v_{fb}$$

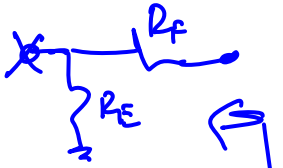




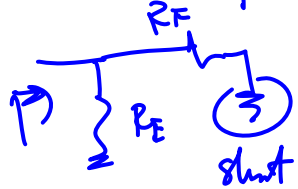
$$v_\epsilon = z_i \cdot i_i$$



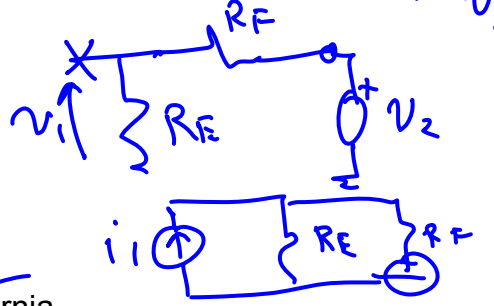
$$h_{22f} = \left.\frac{i_2}{v_2}\right|_{i_1=0} = \frac{1}{R_E+R_F}$$



$$h_{11f} = \left.\frac{v_1}{i_1}\right|_{v_2=0} = R_E \parallel R_F$$

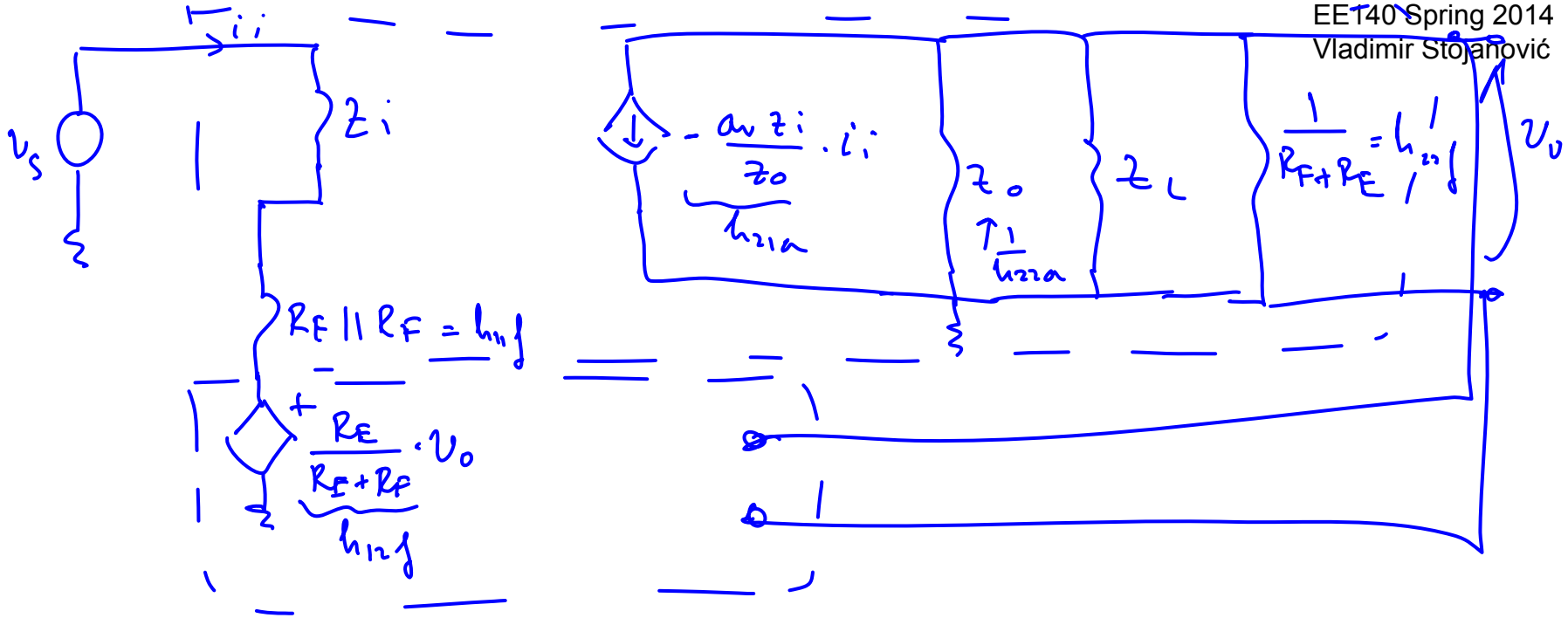


$$f = h_{12f} = \left.\frac{v_1}{v_2}\right|_{i_1=0} = \frac{R_E}{R_E+R_F}$$



$$h_{21f} = \left.\frac{i_2}{i_1}\right|_{v_2=0} = -\frac{R_E}{R_E+R_F}$$

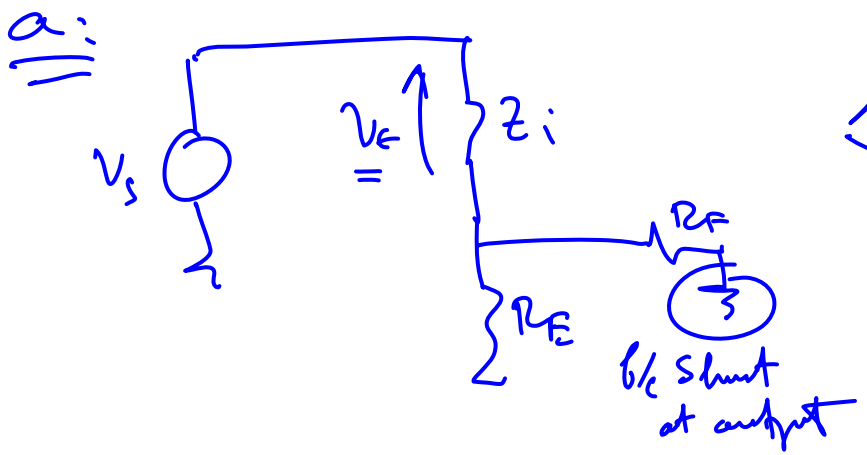
$$\boxed{|h_{21a}| >> |h_{21f}|}$$

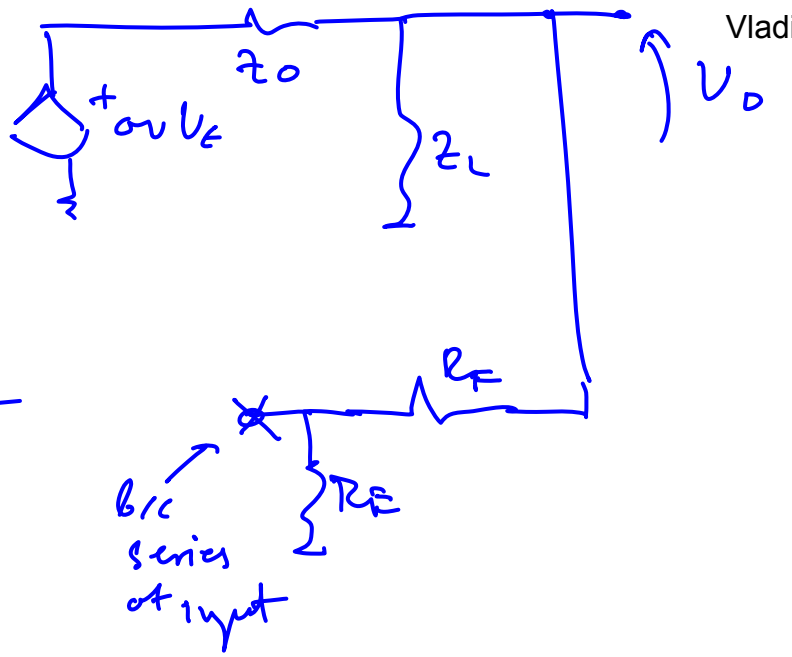


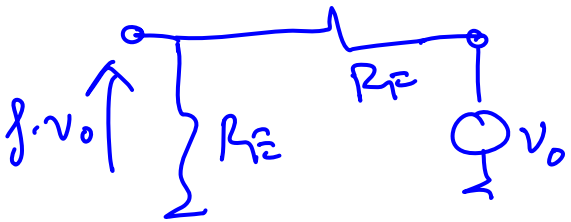
$$a = -\frac{h_{21a}}{y_{out} z_{in}} = -\frac{-\frac{a_v z_i}{z_o}}{\left(\frac{1}{z_o} + \frac{1}{z_L} + \frac{1}{R_F+R_E}\right)(z_i + R_E \| R_F)} =$$

$$= \frac{z_i}{z_i + R_E \| R_F} \cdot a_v \cdot \frac{z_L \| (R_E+R_F)}{z_o + z_L \| (R_E+R_F)}$$

In practice.







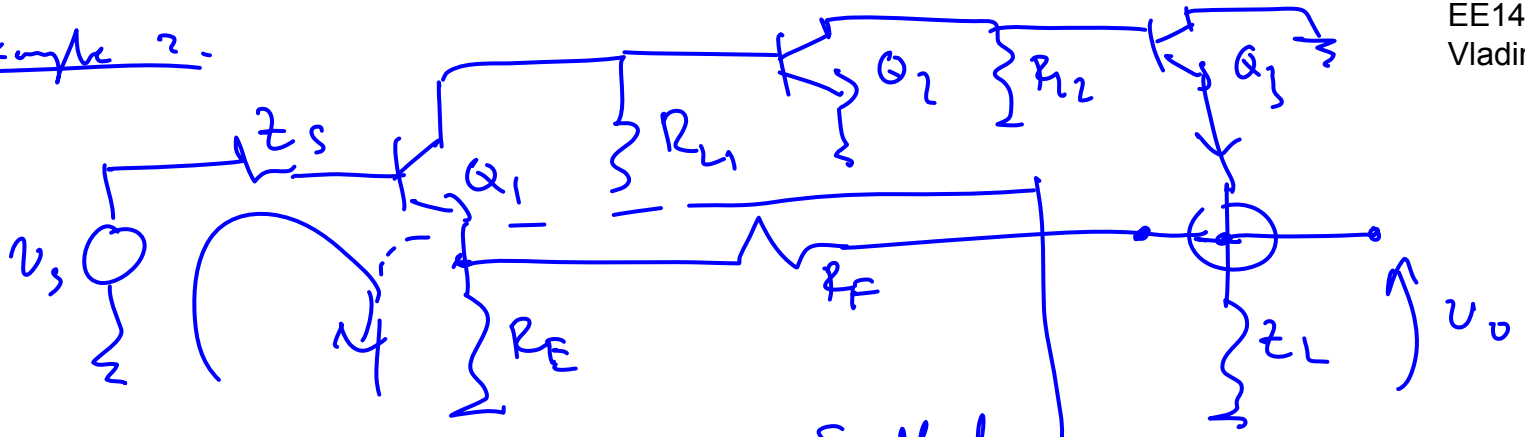
$$\underline{f} = h_{12} = \frac{R_E}{R_E + R_F}$$

$$\underline{a} = \frac{z_i}{z_i + R_E \| R_F} \cdot a_v \cdot \frac{z_L \| (R_E + R_F)}{z_o + z_L \| (R_E + R_F)}$$

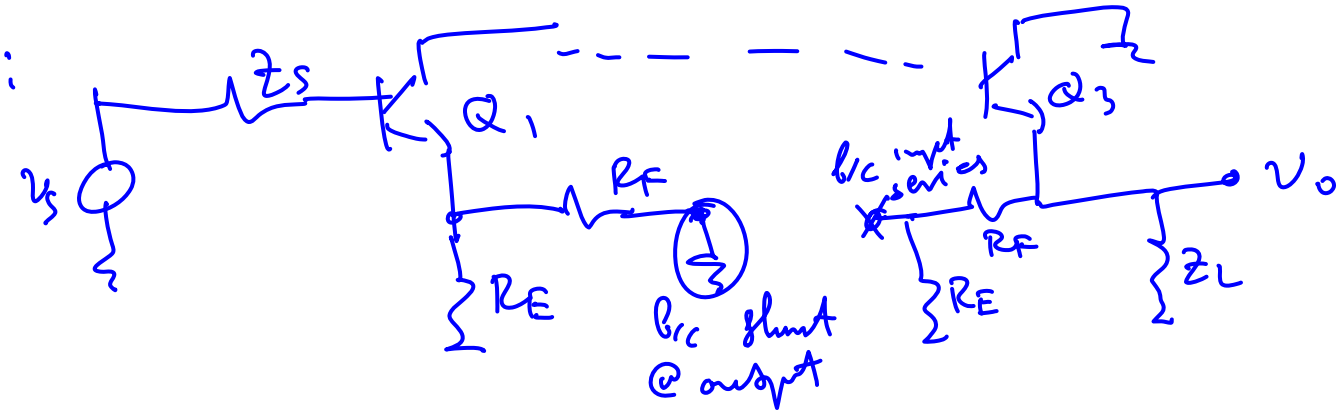
$$z_{in} = z_i + R_E \| R_F \quad , \quad z_{out} = z_o \| z_L \| (R_E + R_F)$$

$$z_i = z_{in}(1+T) \quad , \quad z_o = \frac{z_{out}}{1+T}$$

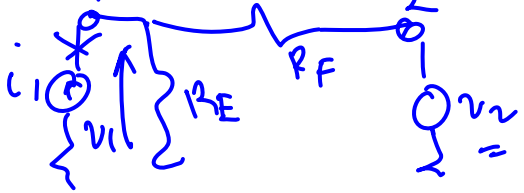
Example 2.



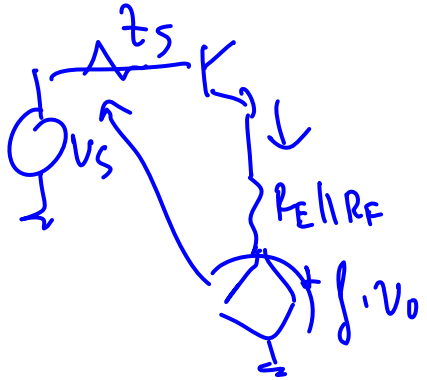
a:

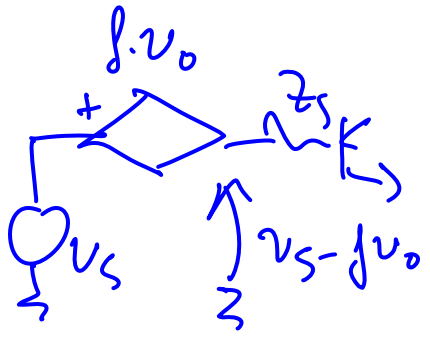


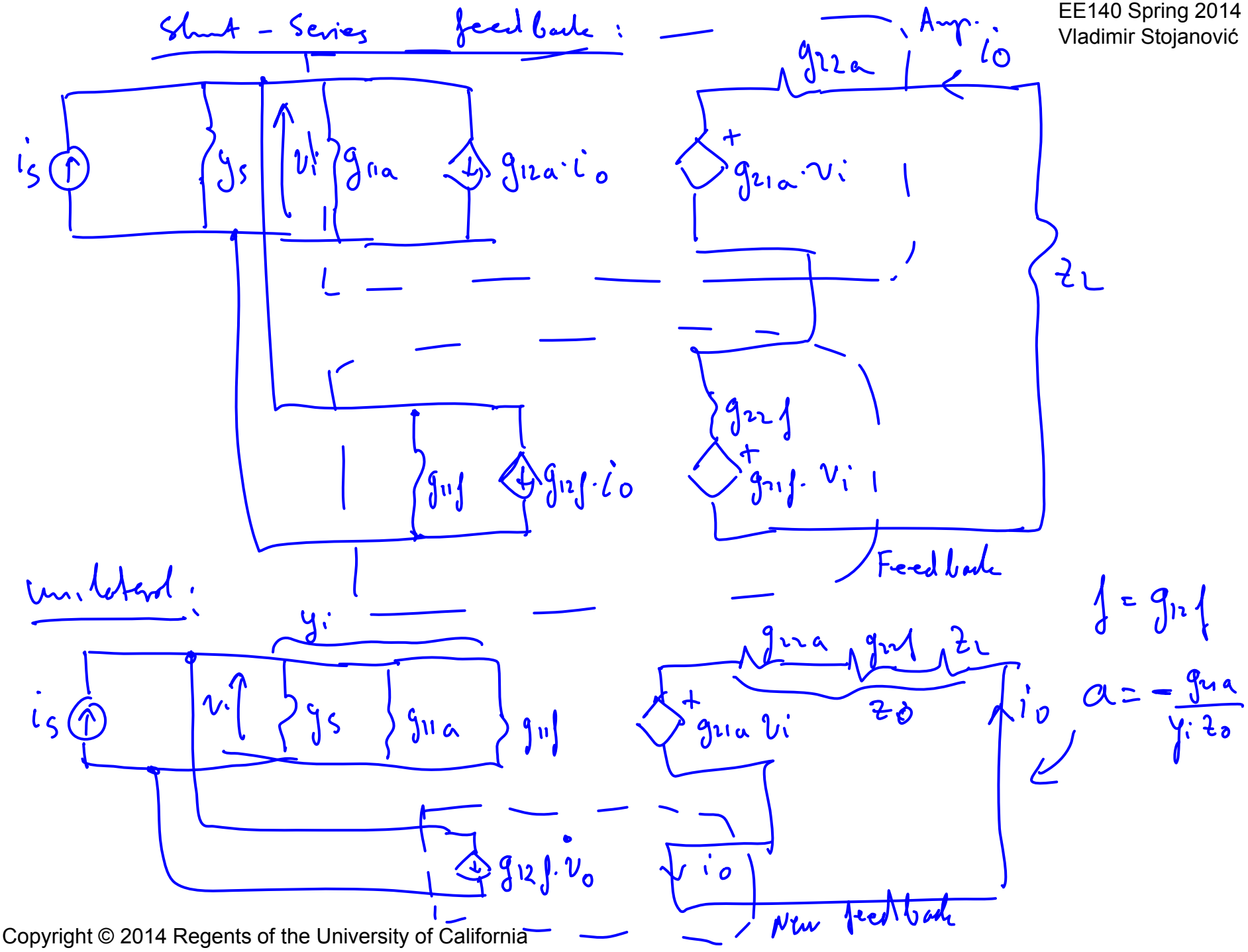
to calculate f:

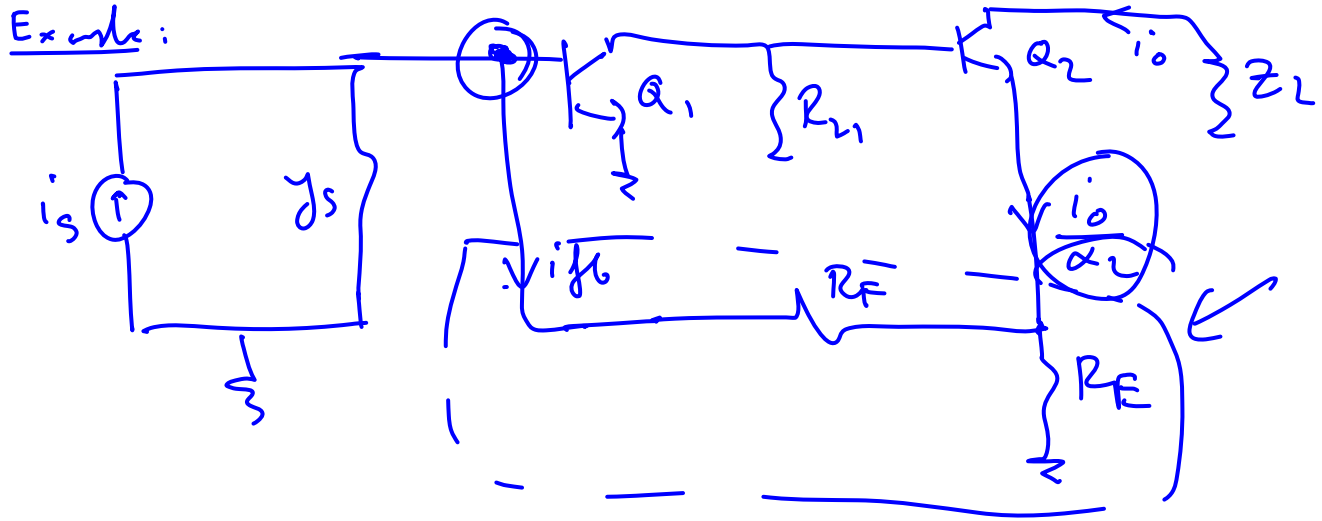


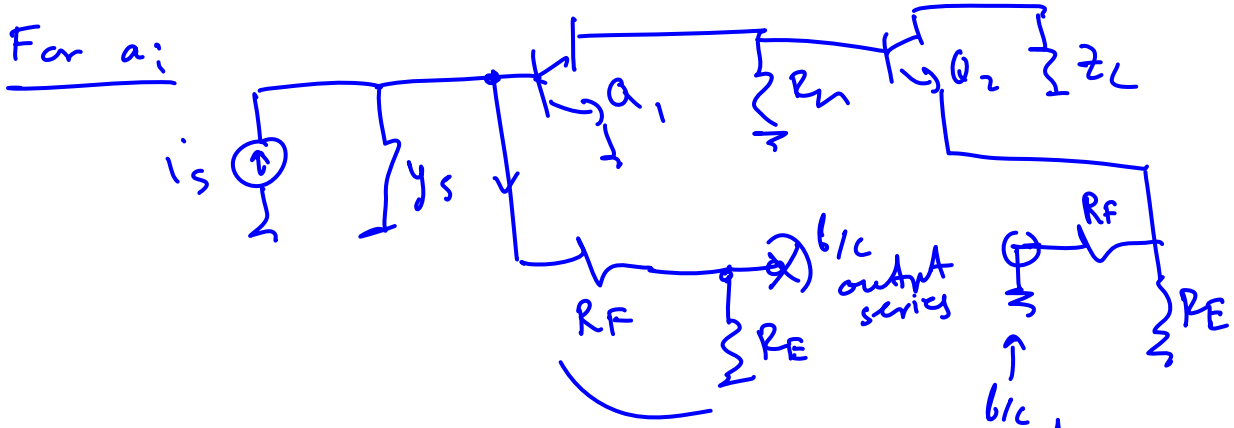
$$f = \frac{R_E}{R_E + R_F}$$





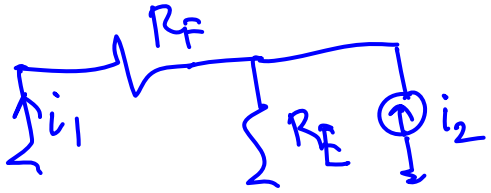






$\Rightarrow a$

g_{11f}, g_{22f}



$$g_{12f} = \frac{i_1}{i_2}\bigg|_{v_1=0} = -\frac{R_E}{R_E+R_F}$$

$$f = -\frac{R_E}{(R_F+R_E)\alpha_2}$$