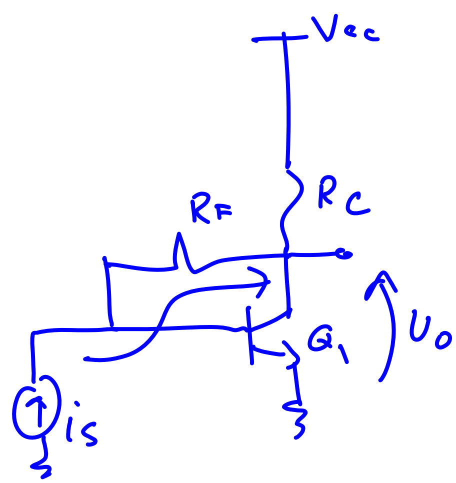

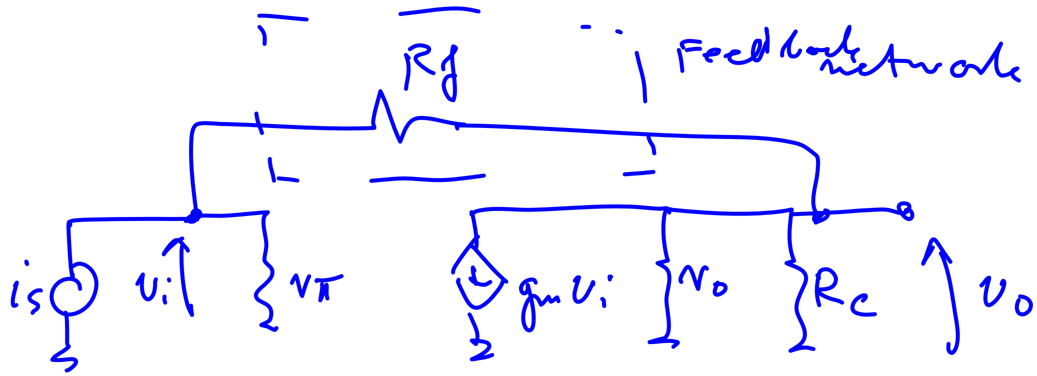

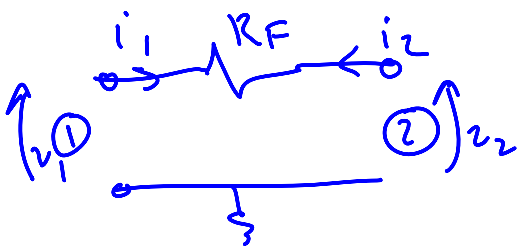

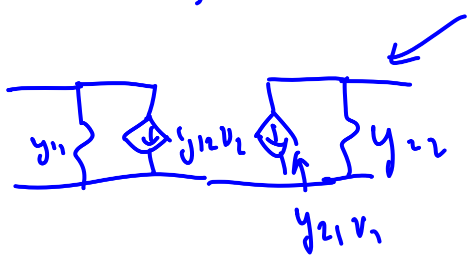

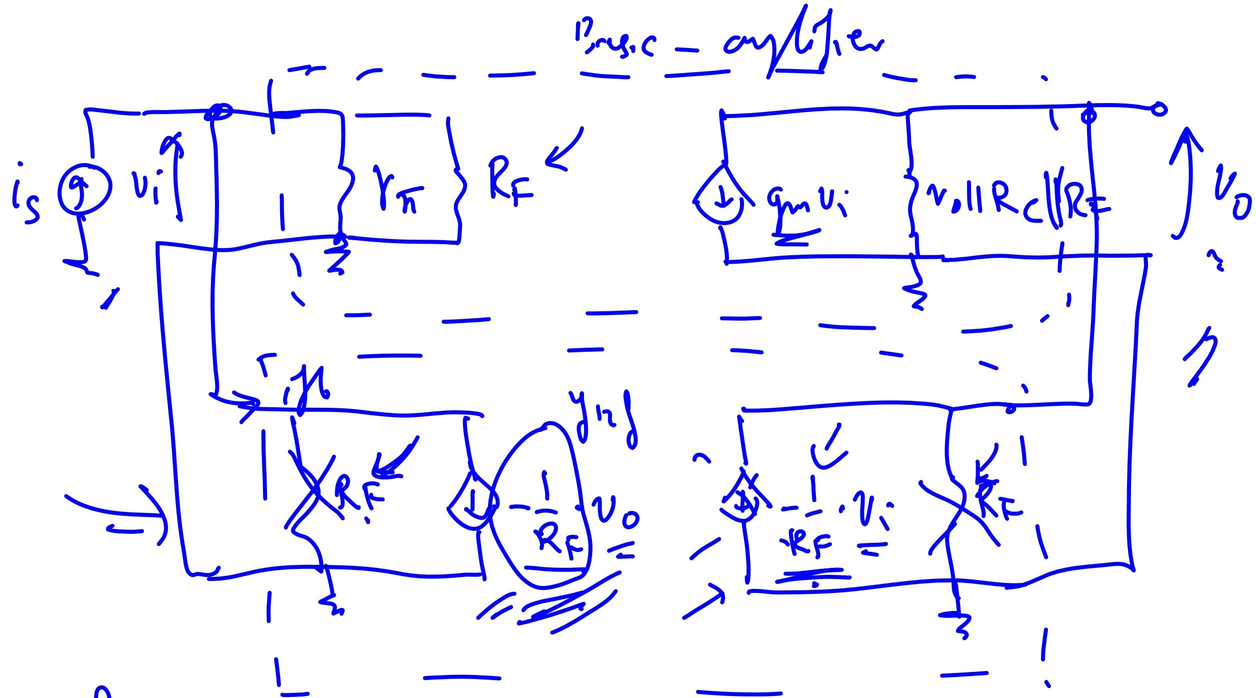

$$a = -\frac{(y_{21a} + y_{21f})}{y_i\, y_o} = -\frac{\left(g_m - \frac{1}{R_F}\right)}{\left(\frac{1}{r_\pi} + \frac{1}{R_F}\right)\left(\frac{1}{r_o} + \frac{1}{R_C} + \frac{1}{R_F}\right)} = -\underbrace{\left(g_m - \frac{1}{R_F}\right)}\cdot(r_\pi \| R_F)(r_o \| R_C \| R_F)$$

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

feedback block

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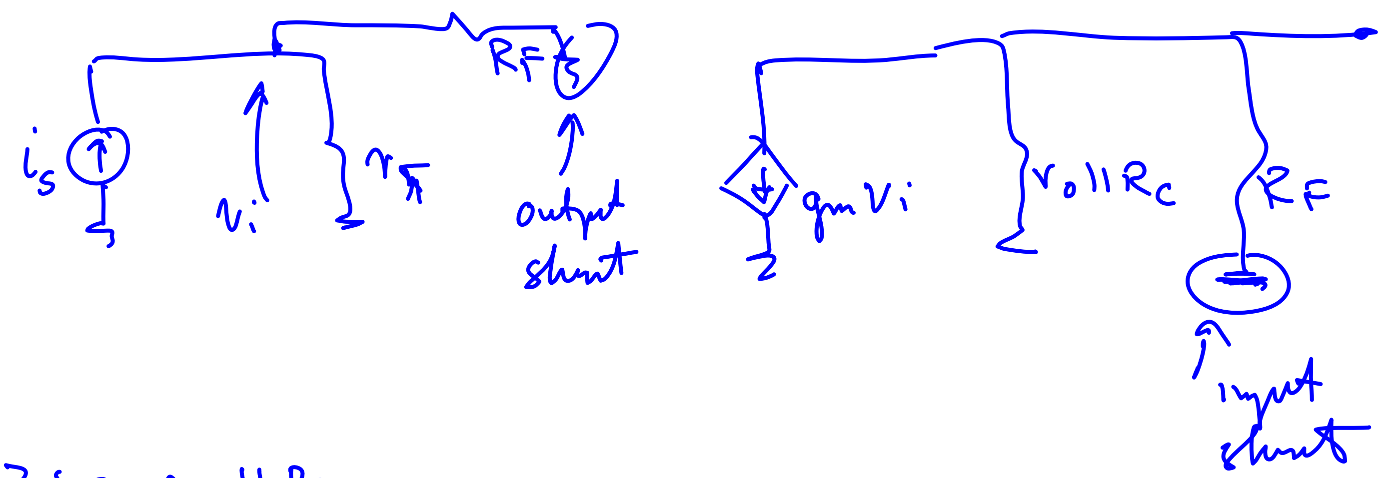

$$a = \frac{v_o}{i_s}$$

no feedbk

$$Z_{ia} = r_\pi \| R_F \qquad Z_{oa} = r_o \| R_C \| R_F$$

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

$$A_{c,2} = \frac{a}{1+\underbrace{a \cdot f}_{T}} = \frac{1}{f} \cdot \frac{1}{1+\frac{1}{T}} = \frac{1}{f} \cdot \frac{T}{1+T}$$

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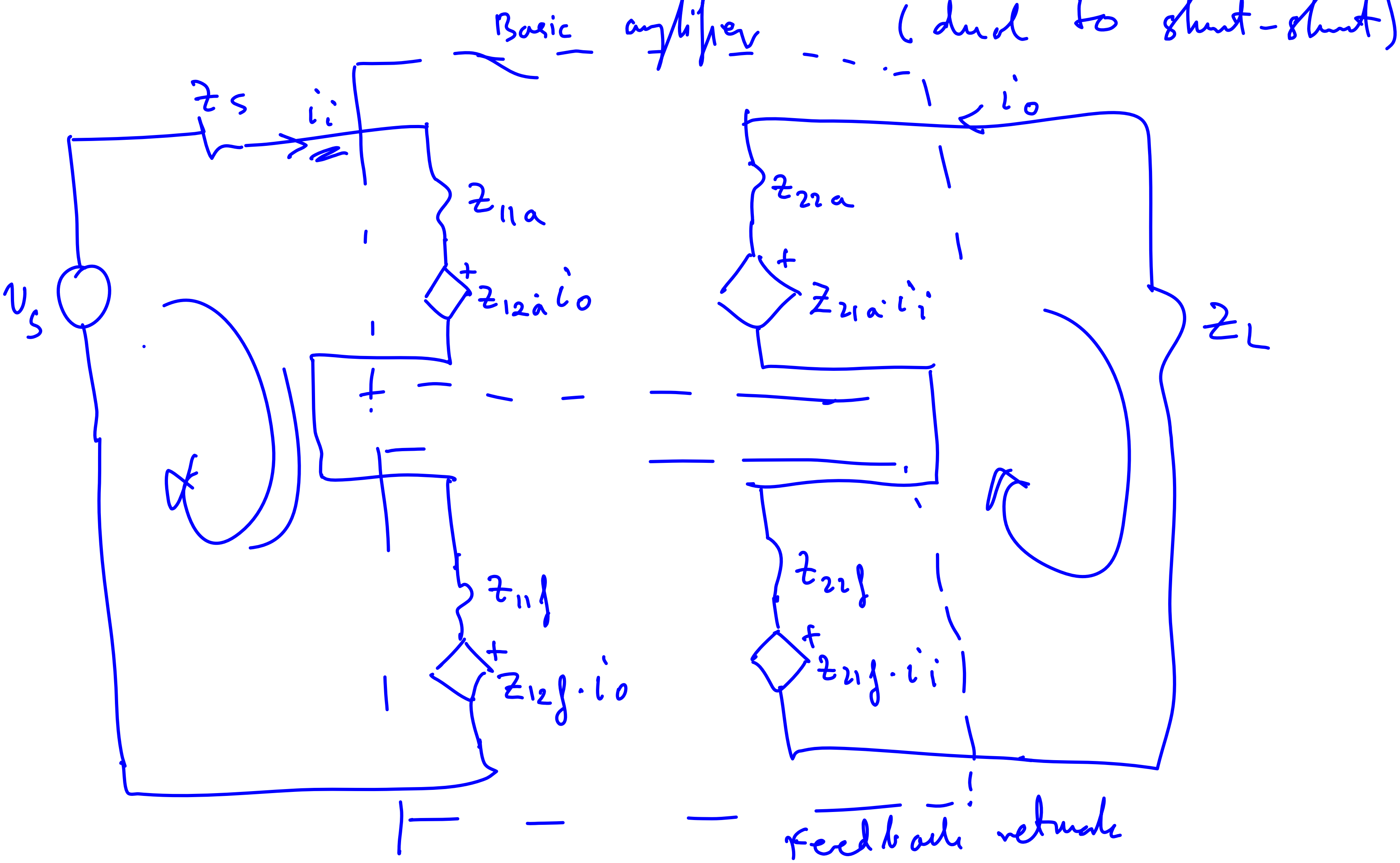
Series - series fb. with 2-port analysis



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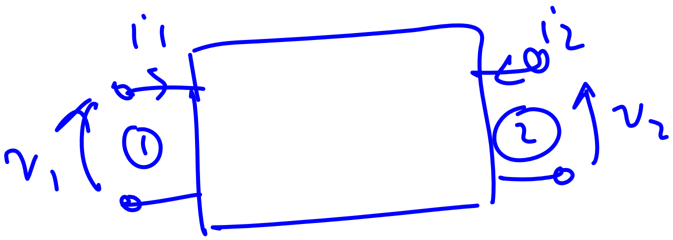

$$v_1 = z_{11} \cdot i_1 + z_{12} \cdot i_2$$

$$v_2 = z_{21}\, i_1 + z_{22} \cdot i_2$$

$$z_{11} = \frac{v_1}{i_1}\Big|_{i_2=0}$$

$$z_{12} = \frac{v_1}{i_2}\Big|_{i_1=0}$$

$$z_{21} = \frac{v_2}{i_1}\Big|_{v_2=0}$$

$$z_{22} = \frac{v_2}{i_2}\Big|_{i_1=0}$$

$$v_s = \big(\overbrace{z_s + z_{11a} + z_{11f}}^{z_i}\big)\cdot i_i + (z_{12a} + z_{12f})\cdot i_o$$

$$0 = (z_{21a} + z_{21f})\cdot i_i + \big(\underbrace{z_{22a} + z_{22f}}_{z_o}\big)\cdot i_o$$

$$i_i = -\frac{z_o}{z_{21a} + z_{21f}} \cdot i_o$$

$$\frac{v_s}{i_o} = -\frac{z_i\, z_o}{z_{21a} + z_{21f}} + (z_{12a} + z_{12f}) \quad ; \quad A_{CL} = \frac{i_o}{v_s}$$

$$A_{CL} = \frac{-(z_{21a} + z_{21f})}{z_i z_o - (z_{21a} + z_{21f})(z_{12a} + z_{12f})}$$

$$= \frac{\frac{-(z_{21a} + z_{21f})}{z_i z_o}}{1 + \frac{-(z_{21a} + z_{21f})}{z_i z_o}\cdot (z_{11a} + z_{12f})\, f} = \frac{a}{1 + af}$$

$$\frac{-(z_{21a} + z_{21f})}{z_i z_o} = a$$

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Often:

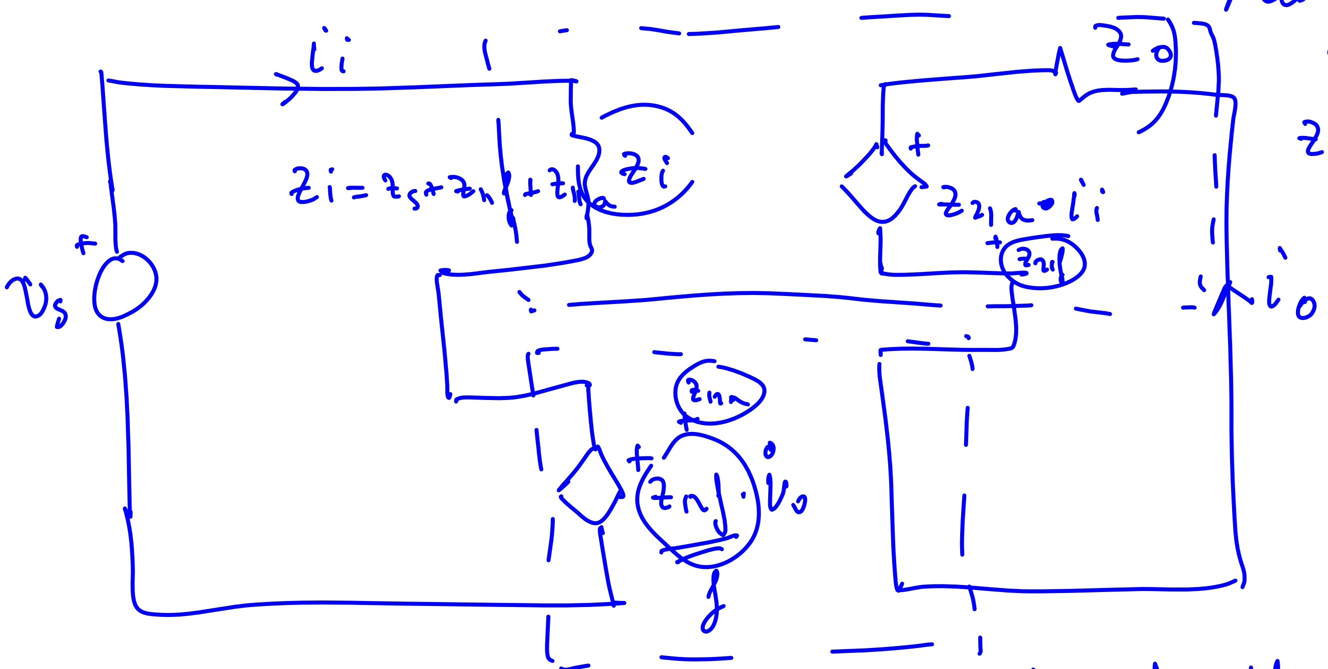
$$\left.\begin{aligned} &|z_{12a}| \ll |z_{12f}| \\ &\quad\& \\ &|z_{21f}| \ll |z_{21a}| \end{aligned}\right\}$$

unilateral amplifier & feedback assumptions

$$a = -\frac{z_{21a}}{z_i z_o} \quad ; \quad f = z_{12f}$$

New basic amplifier

$z_o = z_{22a} + z_{22f} + z_L$



New feedback

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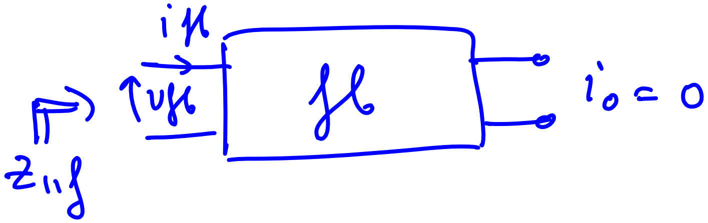
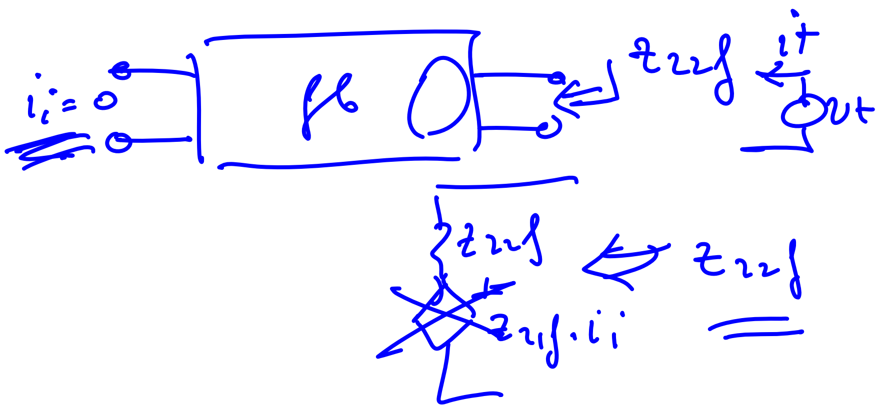
In practice :



$$z_{11f} = \frac{v_{fb}}{i_{fb}} = \frac{v_t}{i_t}\Big|_{i_o = 0}$$

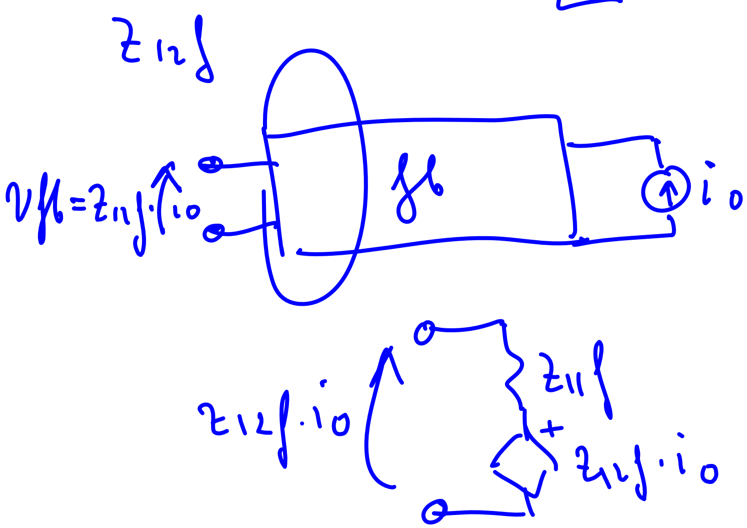


series

$$Z_i = z_i \cdot (1+T)$$

series

$$Z_o = z_o (1+T)$$



$$z_{12f} = \frac{v_{fb}}{i_o}\Big|_{i_i = 0} = f$$

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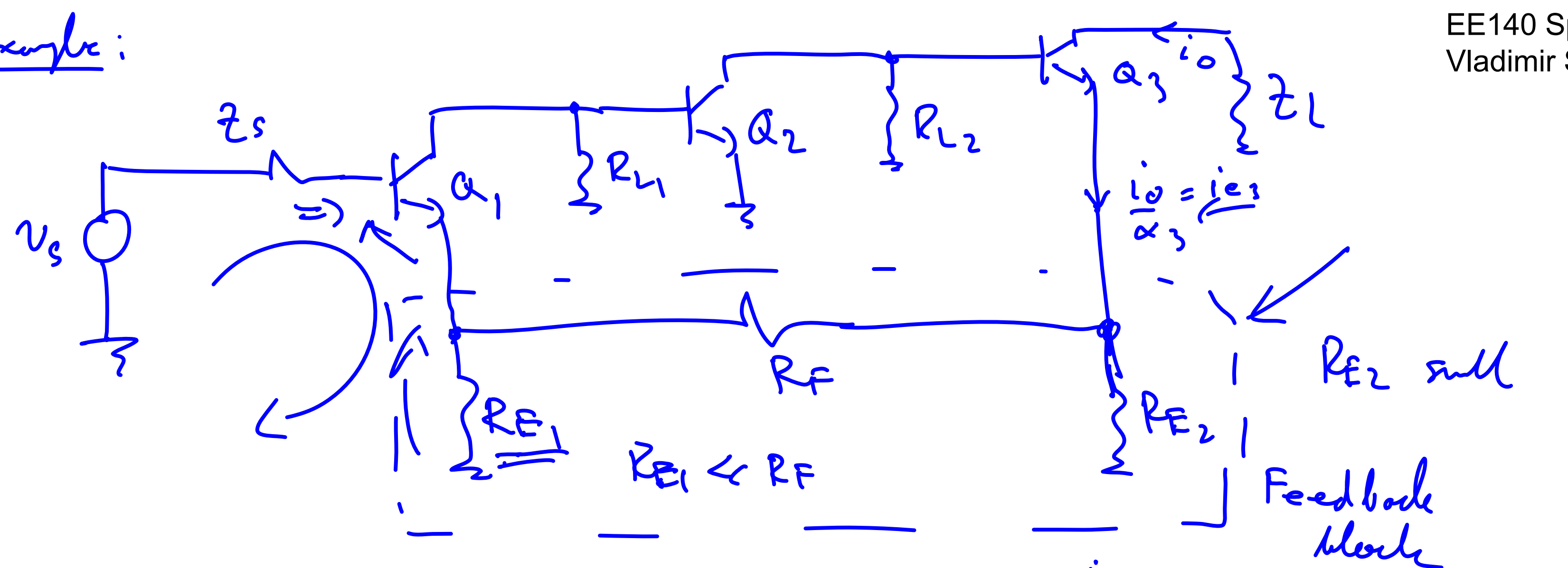
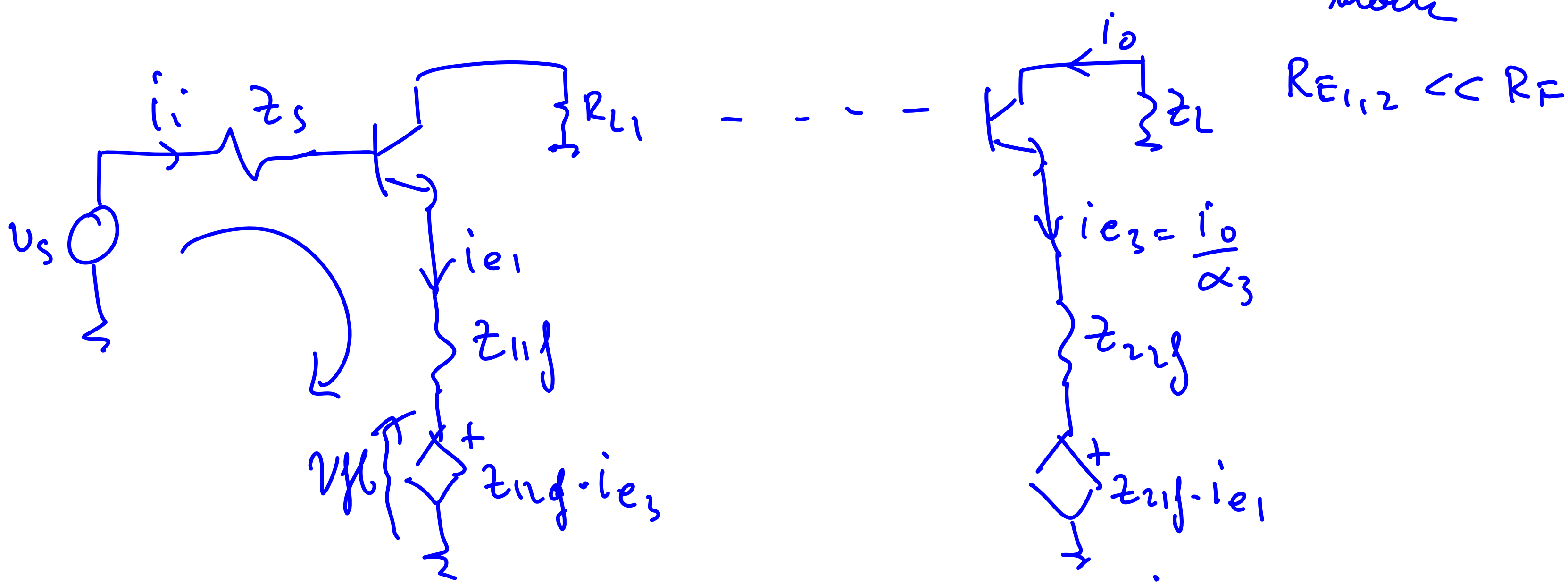
Example:





$$v_s = i_i \cdot z_s + v_{be} + i_{e1} \cdot z_{11f} + z_{12f} \cdot i_{e3}, \quad i_{e3} = \frac{i_o}{\alpha_3}$$

$$v_s - \frac{z_{12f}}{\alpha_3} \cdot i_o = i_i z_s + \underline{v_{be}} + i_{e1} \cdot z_{11f}$$

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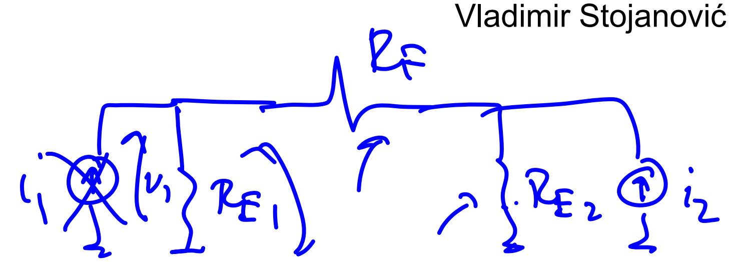
$$z_{12f} = \frac{v_1}{i_2}\Big|_{i_1=0} = \frac{R_{E2}}{R_{E1}+R_F+R_{E2}} \cdot R_{E1}$$

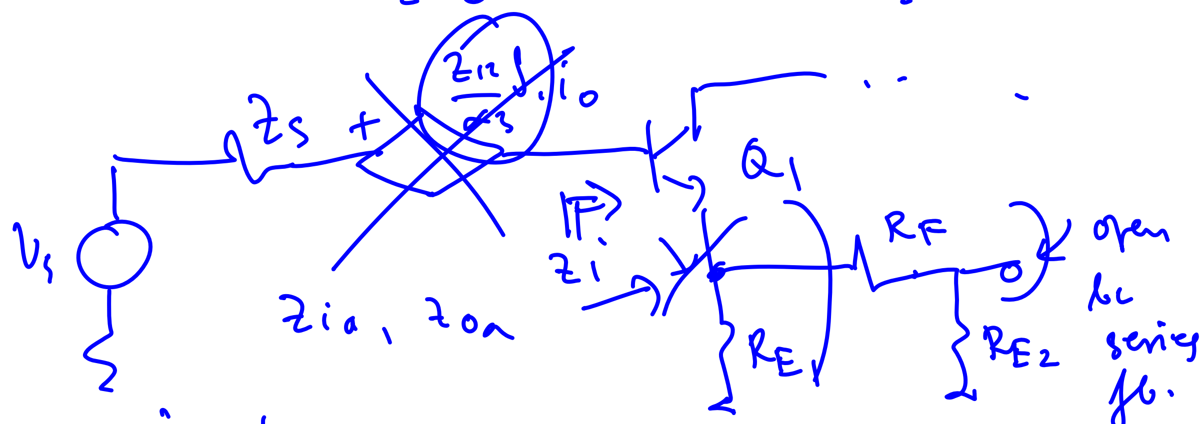


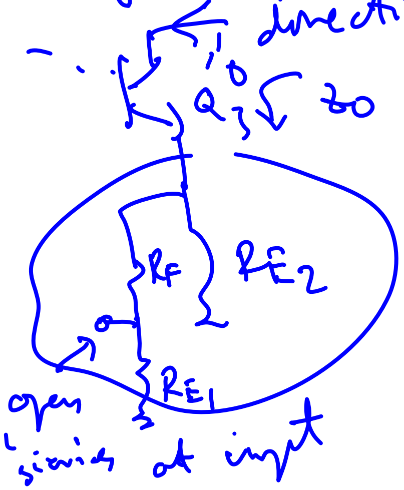
$$z_{22f} = \frac{v_2}{i_2}\Big|_{i_1=0} = R_{E2} \,\|\, (R_F + R_{E1})$$

$$z_{11f} = \frac{v_1}{i_1}\Big|_{i_2=0} = R_{E1} \,\|\, (R_F + R_{E2})$$

$$z_{21f} = \frac{v_2}{i_1}\Big|_{i_2=0} = \frac{R_{E1}}{R_{E1}+R_F+R_{E2}} \cdot R_{E2}$$

can still neglect in feed-forward direction





$$a = \frac{i_o}{v_s}\Big|_{\text{no feedback}}$$

$$f = \frac{z_{12f}}{\alpha_3}$$

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