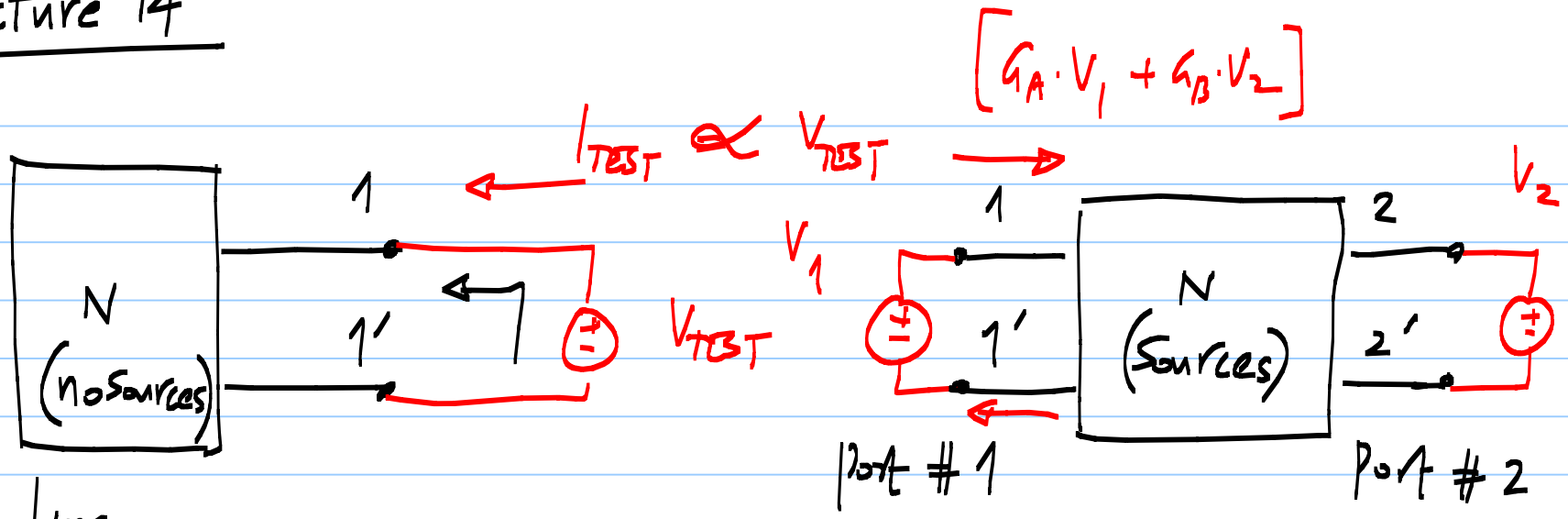
Lecture 14

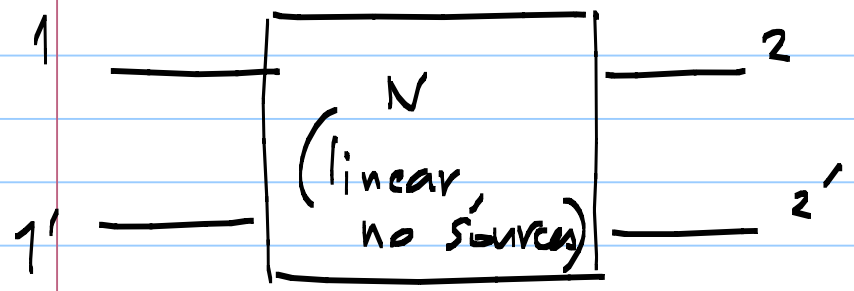


Linear network

1-port network

Two port network

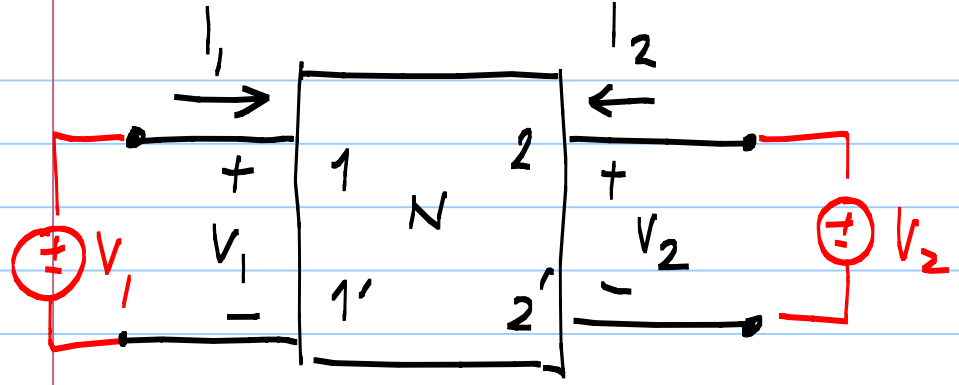
Two port:



Two port parameters

port #1	port #2	
V_1	V_2	y
I_1	I_2	Z
I_1	V_2	H
V_1	I_2	G

Y parameters: (Short circuit parameters)



$$\begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} y_{11} & y_{12} \\ y_{21} & y_{22} \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \end{bmatrix}$$

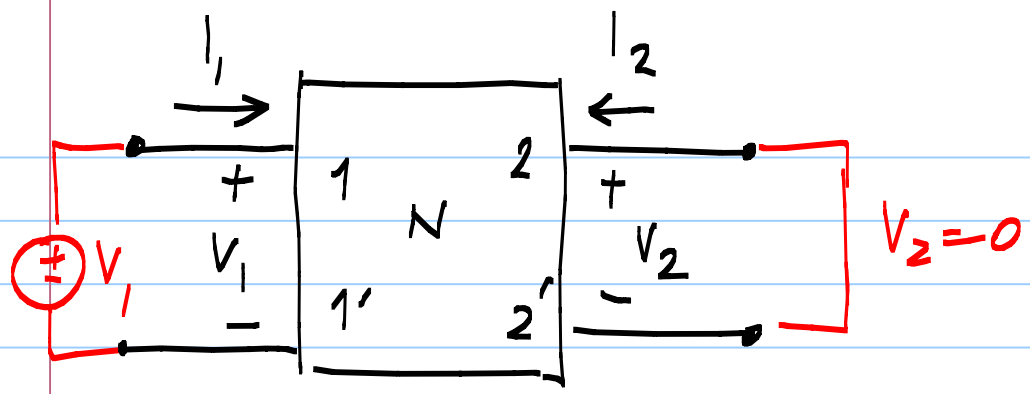
$$y_{11} = \left.\frac{I_1}{V_1}\right|_{V_2=0} \quad ; \quad y_{12} = \left.\frac{I_1}{V_2}\right|_{V_1=0}$$

$$I_1 = y_{11} \cdot V_1 + y_{12} \cdot V_2$$

$$y_{21} = \left.\frac{I_2}{V_1}\right|_{V_2=0} \quad ; \quad y_{22} = \left.\frac{I_2}{V_2}\right|_{V_1=0}$$

$$I_2 = y_{21} V_1 + y_{22} V_2$$

effect — cause

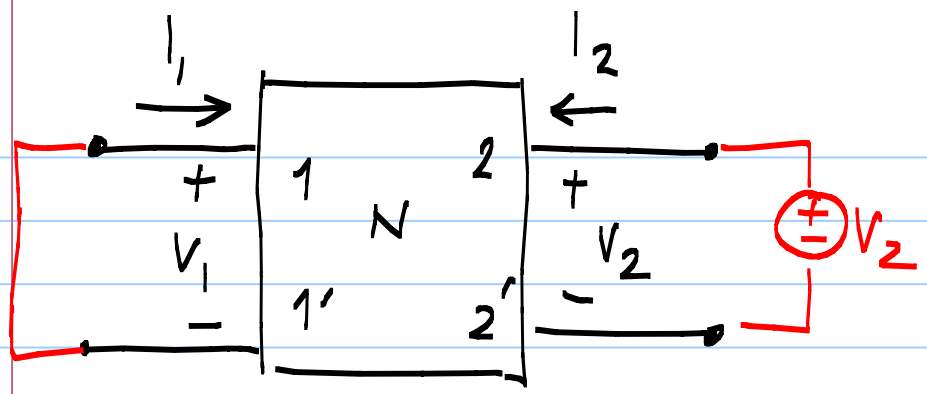


$$y_{11} = \left.\frac{I_1}{V_1}\right|_{V_2=0} ;$$

$$y_{21} = \left.\frac{I_2}{V_1}\right|_{V_2=0} ;$$

Port 2: terminated in a short circuit

Measure I_1 & I_2 to obtain y_{11} & y_{21}

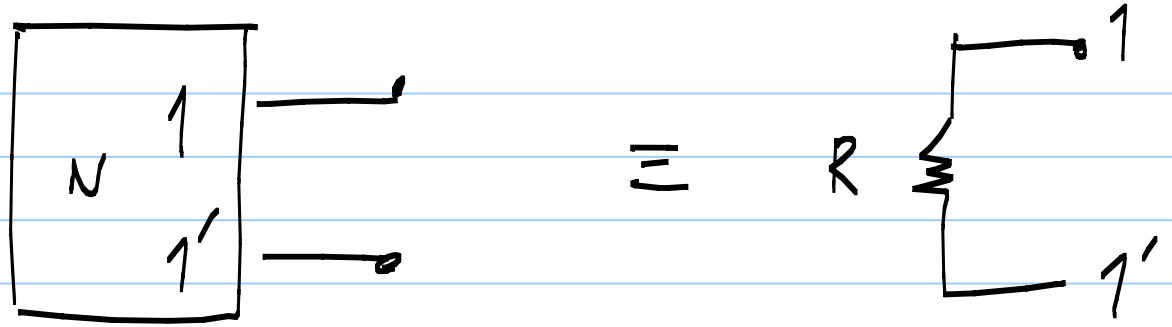


Port 1 : terminated in a short circuit

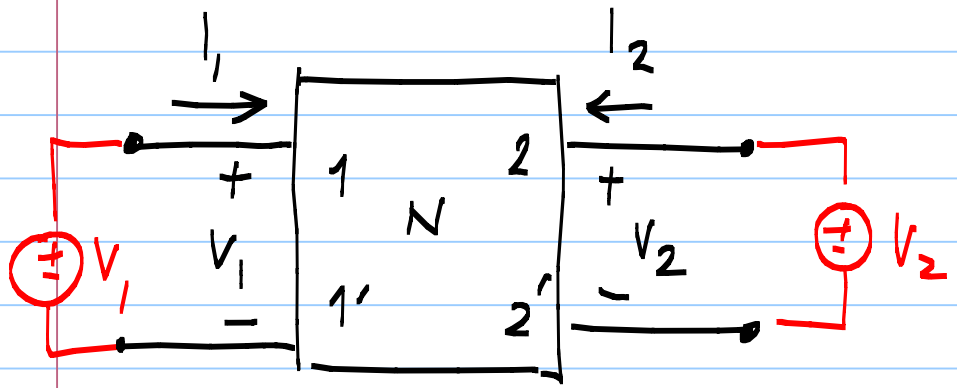
Measure I_1 & I_2 to obtain y_{12} & y_{22}

$$y_{12} = \left.\frac{I_1}{V_2}\right|_{V_1=0}$$

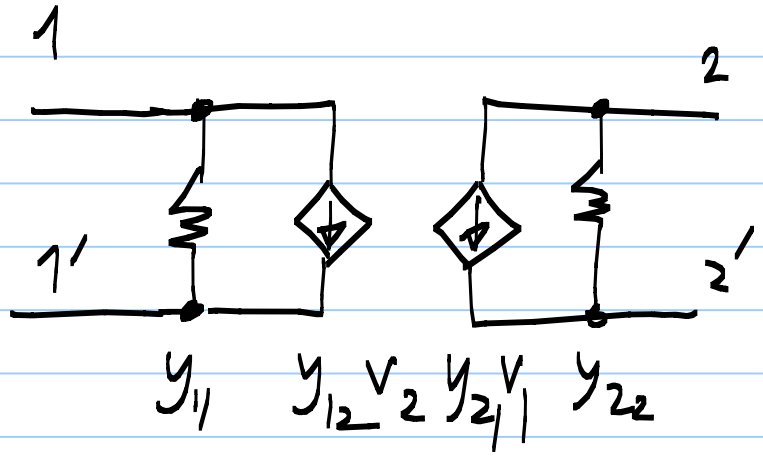
$$y_{22} = \left.\frac{I_2}{V_2}\right|_{V_1=0}$$

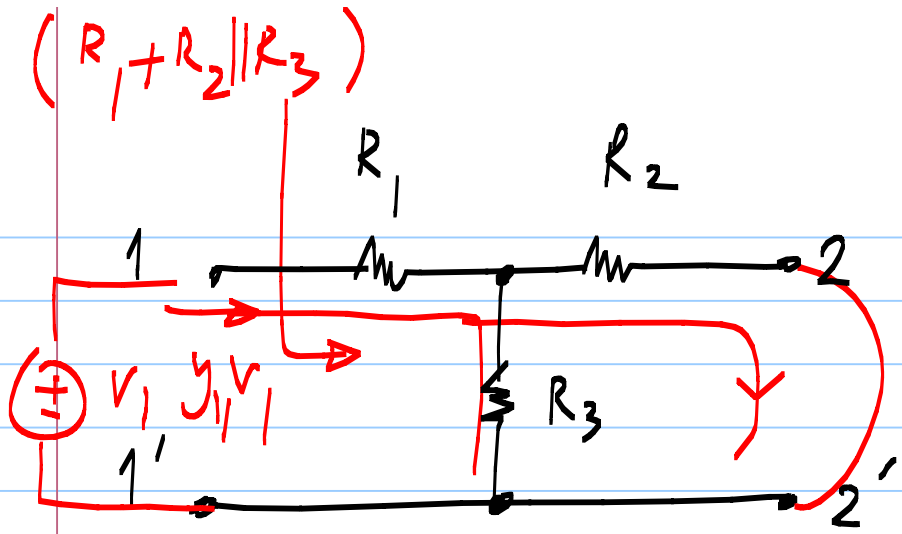


$$I_1 = y_{11} V_1 + y_{12} V_2$$



≡



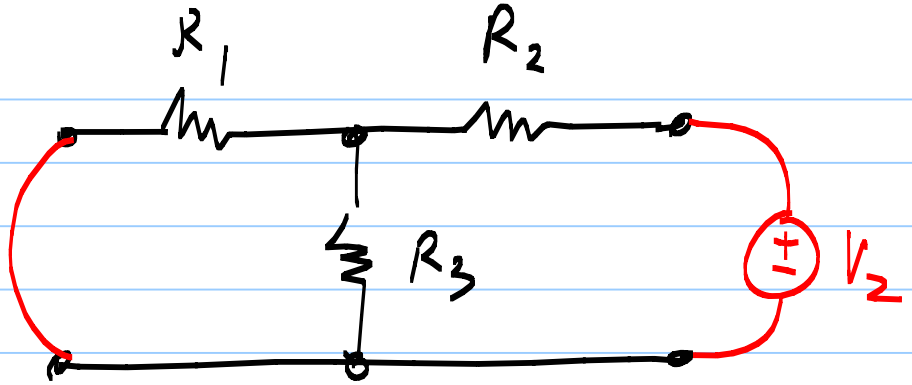


$$y_{11} = \frac{1}{R_1 + (R_2 \| R_3)}$$

$$= \frac{R_2 + R_3}{R_1 R_2 + R_2 R_3 + R_3 R_1}$$

$y_{11} V_1 \cdot \dfrac{R_3}{R_2 + R_3}$

$$y_{21} = -\, y_{11} \frac{R_3}{R_2 + R_3} = \frac{-R_3}{R_1 R_2 + R_2 R_3 + R_3 R_1}$$

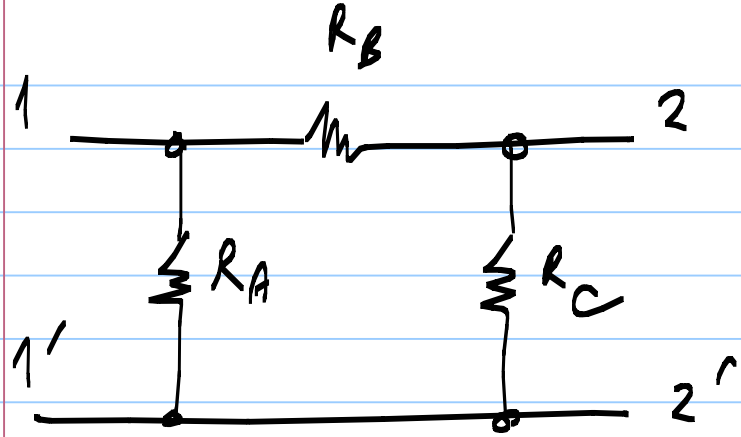


$$y_{22} = \frac{1}{R_2 + R_1 \| R_3}$$

$$= \frac{R_1 + R_3}{R_1 R_2 + R_2 R_3 + R_3 R_1}$$

$$y_{12} = -\frac{R_3}{R_1 R_2 + R_2 R_3 + R_3 R_1}$$

$$= y_{21}$$

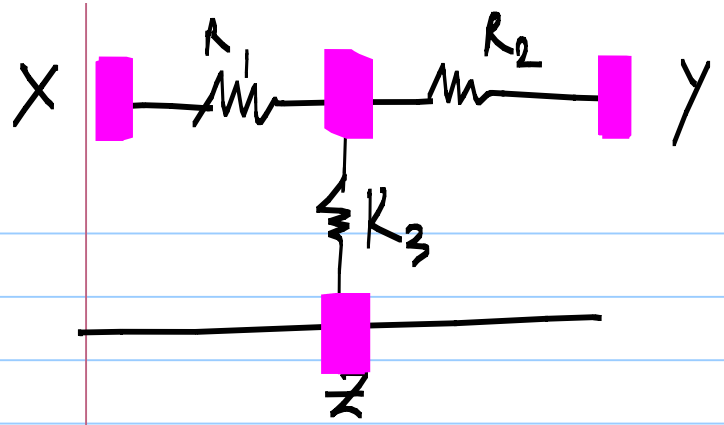


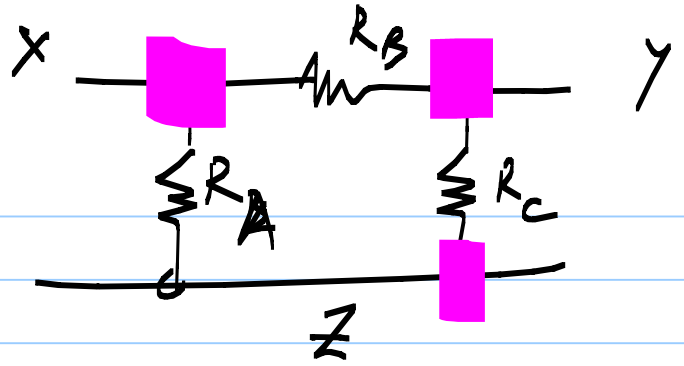
$$y_{11} = \frac{1}{R_A \| R_B} = \frac{R_A + R_B}{R_A R_B}$$

$$y_{21} = -\frac{1}{R_B}$$

$$y_{12} = -\frac{1}{R_B}$$

$$y_{22} = \frac{R_C + R_B}{R_C R_B}$$





$$y_{11} = \frac{R_2 + R_3}{\sum R_i \cdot R_j}$$

$$y_{11} = \frac{R_A + R_B}{R_A R_B}$$

$$y_{12} = y_{21} = \frac{-R_3}{\sum R_i \cdot R_j}$$

$$y_{12} = y_{21} = -\frac{1}{R_B}$$

$$y_{22} = \frac{R_1 + R_3}{\sum R_i \cdot R_j}$$

$$y_{22} = \frac{R_B + R_C}{R_B R_C}$$

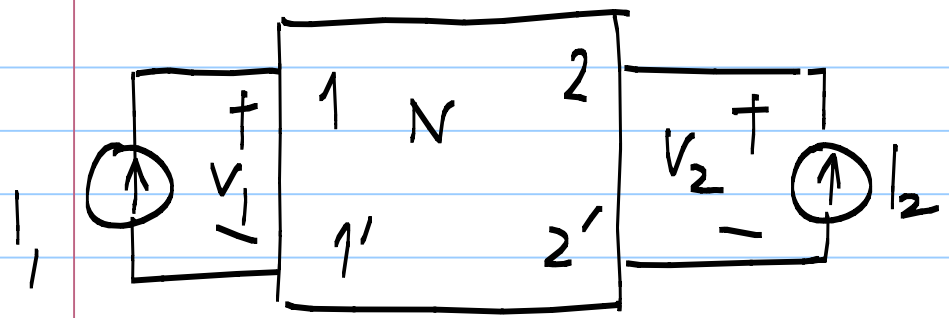
Δ Network

Y Network

$$R_B = \frac{R_1 R_2 + R_2 R_3 + R_3 R_1}{R_3}$$

$$R_C = \frac{\sum R_i \cdot R_j'}{R_1}$$

$$R_A = \frac{\sum R_i \cdot R_j'}{R_2}$$



$$\begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} z_{11} & z_{12} \\ z_{21} & z_{22} \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix}$$

$\mathbf{Z}$

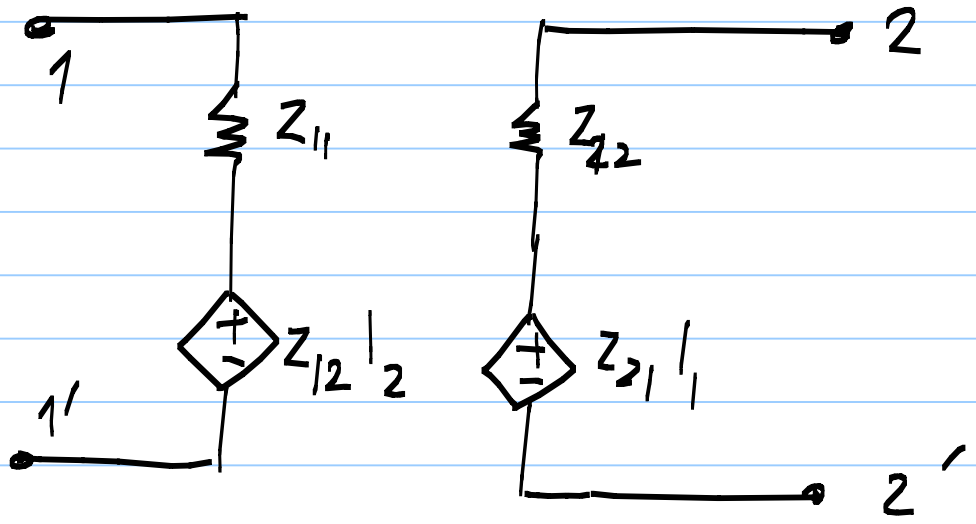
Z parameters

open-circuit parameters

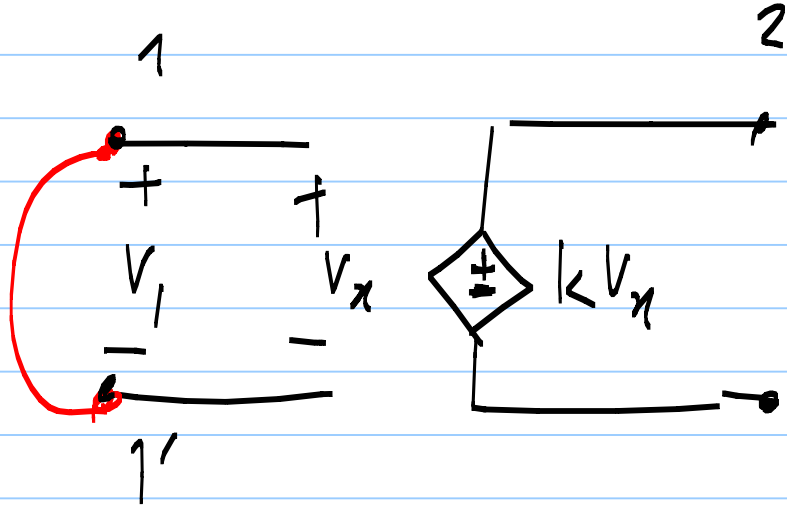
$$z_{11} = \left.\frac{V_1}{I_1}\right|_{I_2=0} \qquad z_{12} = \left.\frac{V_1}{I_2}\right|_{I_1=0}$$

$$z_{21} = \left.\frac{V_2}{I_1}\right|_{I_2=0} \qquad z_{22} = \left.\frac{V_2}{I_2}\right|_{I_1=0}$$

$$[\mathbf{Z}] = [\mathbf{Y}]^{-1}$$


1
1'
2
2'
Z_{11}
Z_{22}
$Z_{12} I_2$
$Z_{21} I_1$

VCVS



$$[Y] = \begin{bmatrix} 0 & 0 \\ \infty & \infty \end{bmatrix} \quad X$$

$$[Z] = \begin{bmatrix} \infty & \\ & \end{bmatrix} \quad X$$