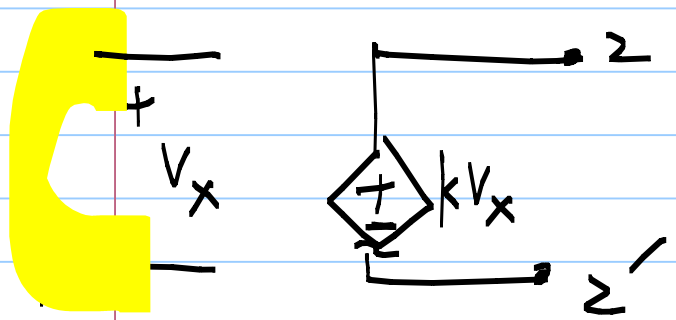
EE 2015 Two-port networks 8/9/2017

Controlled sources



$$g = \begin{bmatrix} 0 & 0 \\ k & 0 \end{bmatrix}$$

$V_2 = k \cdot V_1$

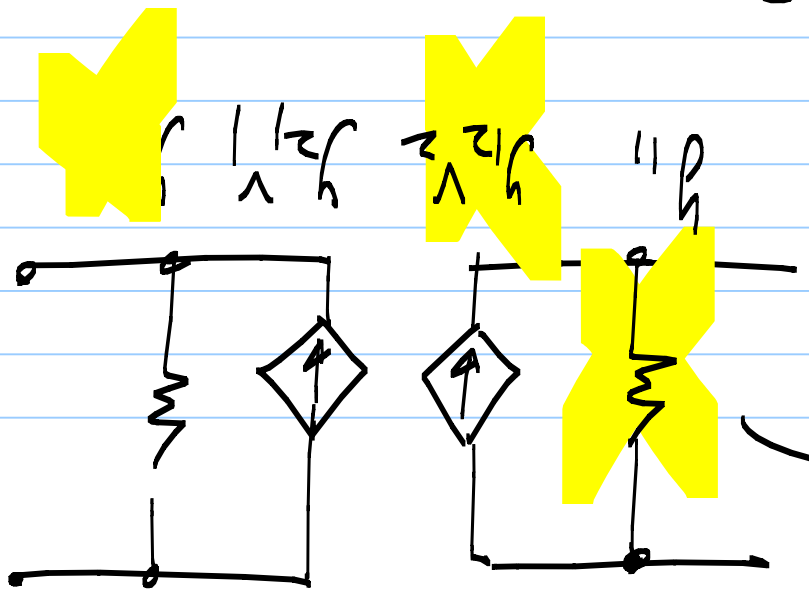
$\left.\frac{V_2}{V_1}\right|_{I_2=0}$

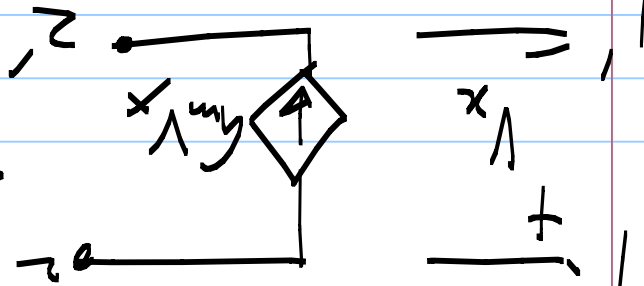
$$Z = \begin{bmatrix} \infty & \\ & \end{bmatrix}$$

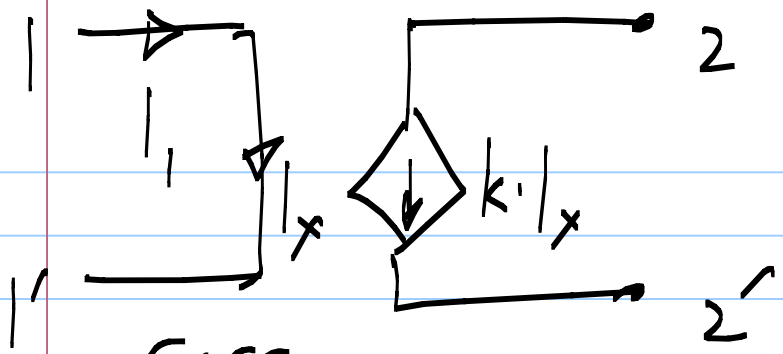
$$\begin{bmatrix} 0 & h_{rv} \\ 0 & 0 \end{bmatrix} = [h]$$

$$I_2 = h_{rv} V_1$$

$$V_{CCS}$$

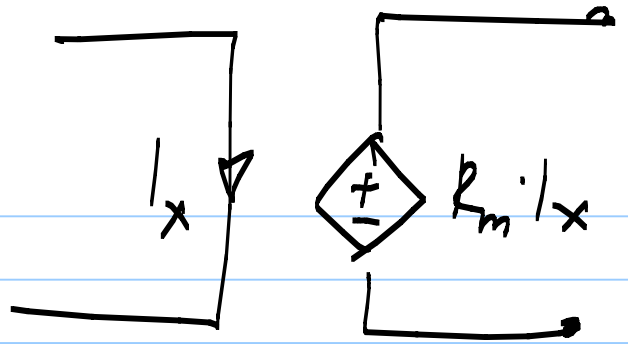






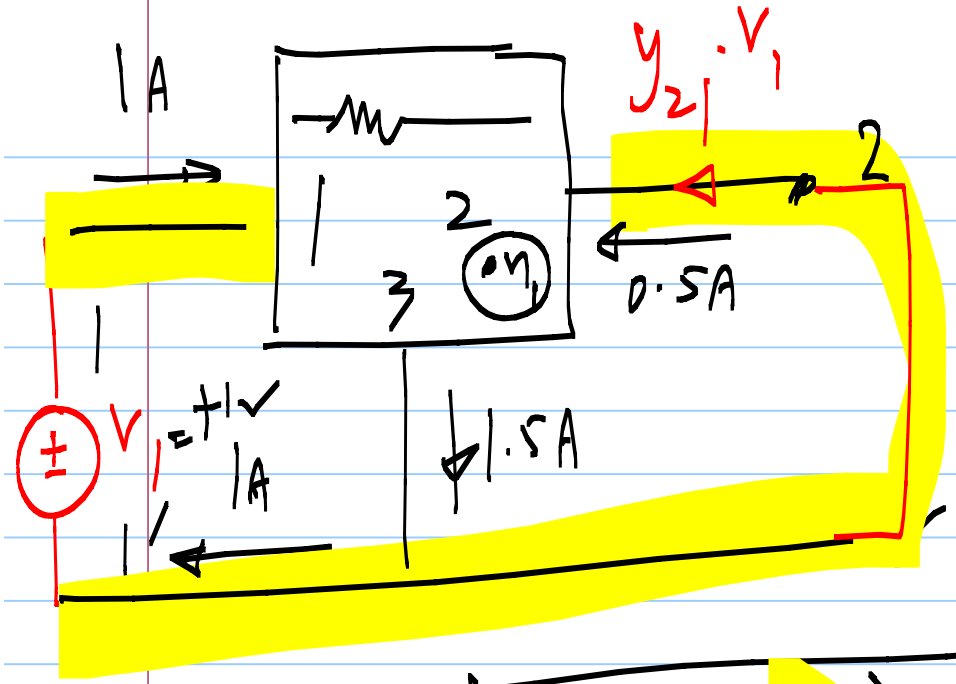
CCCS

$$h = \begin{bmatrix} 0 & 0 \\ k & 0 \end{bmatrix}$$



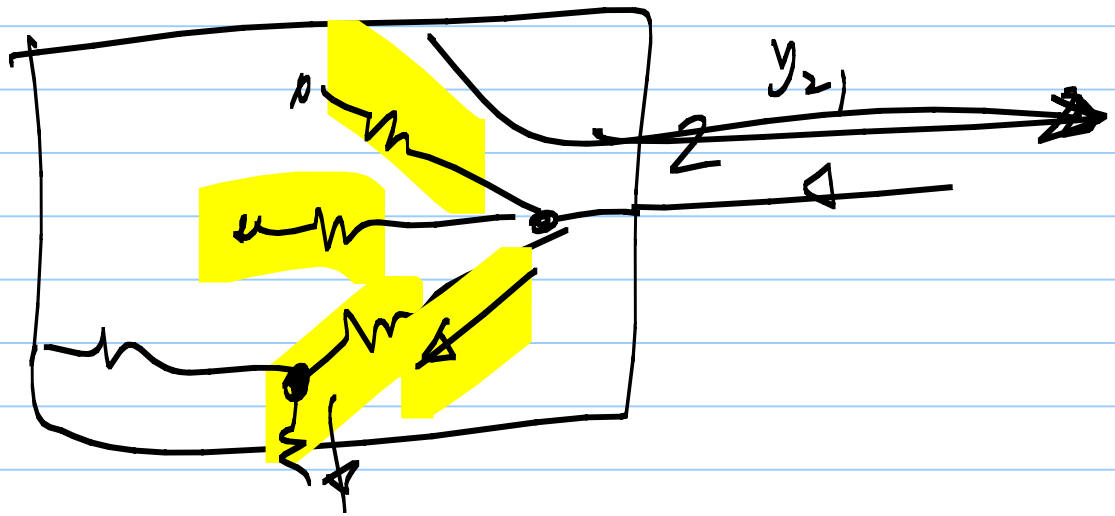
CCVS

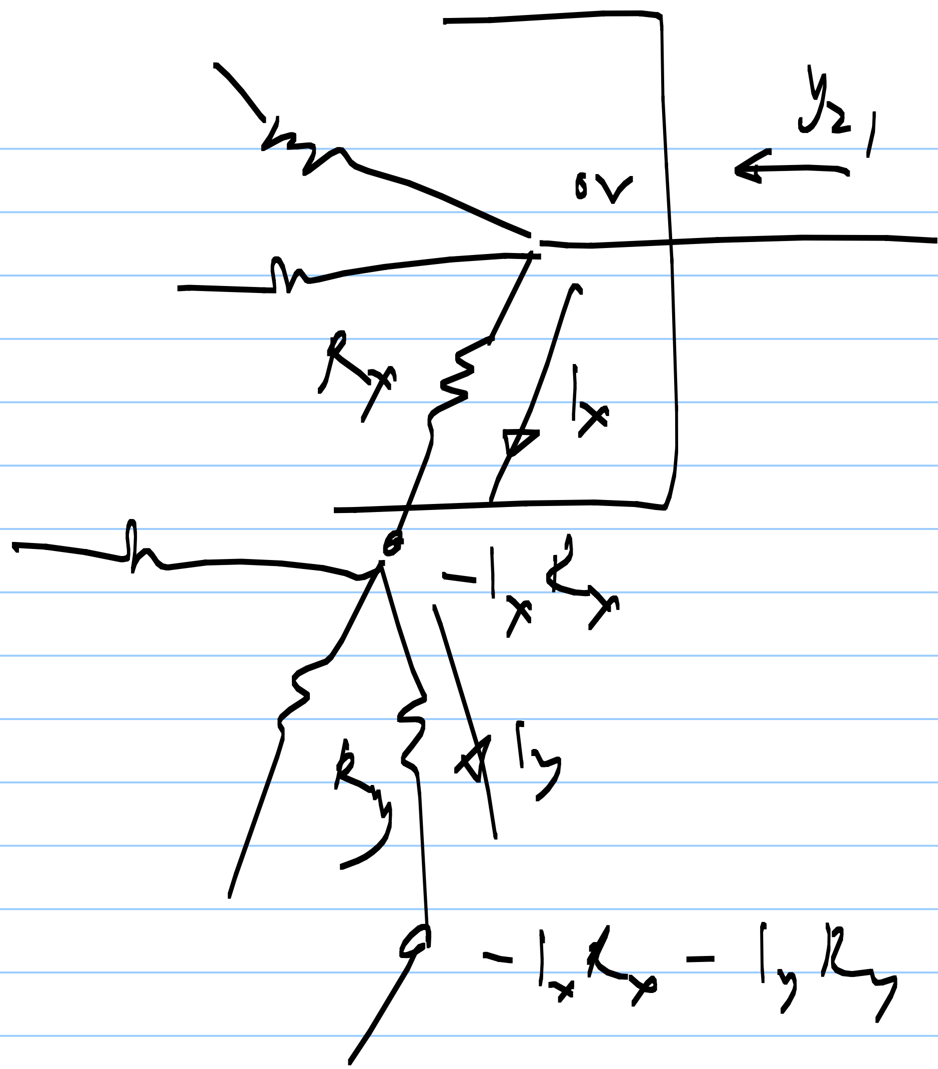
$$z = \begin{bmatrix} 0 & 0 \\ R_m & 0 \end{bmatrix}$$



$$y = \begin{bmatrix} & \\ & \end{bmatrix}$$

$y_{12}, y_{21} < 0$





y_{21}
0V
R_x
I_x
$-I_x R_x$
R_y
I_y
$-I_x R_x - I_y R_y$

Resistive

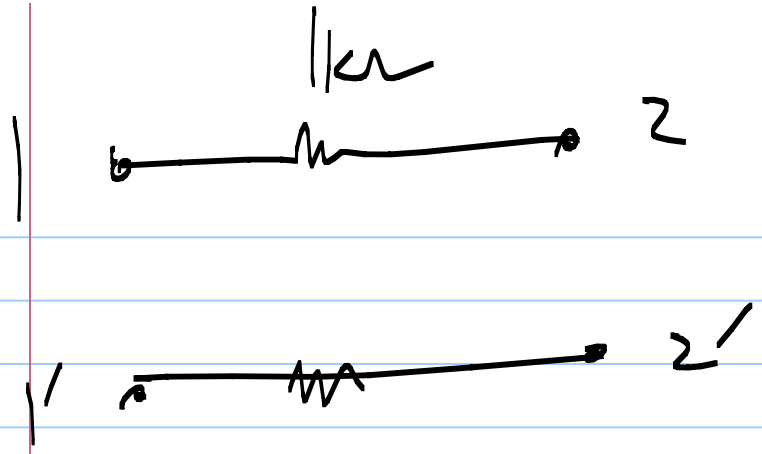
3-terminal 2 port

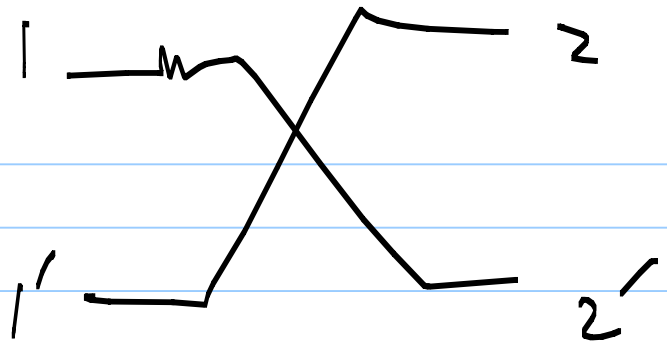
V_1 applied to port 1

or applied to port 2

all internal node voltages are $(0, V_1)$

$\Rightarrow$ $y_{12}, y_{21} < 0$



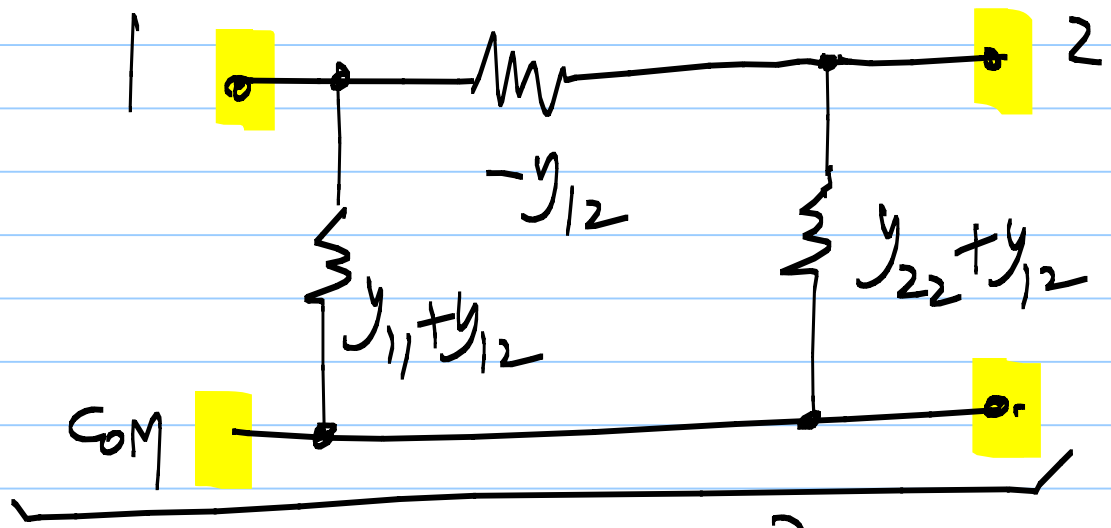


$$y = \begin{bmatrix} \ln s & -\ln s \\ -\ln s & \ln s \end{bmatrix}$$

Resistive 3-terminal 2 port

$y_{12} \leq 0$

π - network



$y_{12}, \not\leq 0$

$|y_{12}| \leq y_{11}, y_{22}$

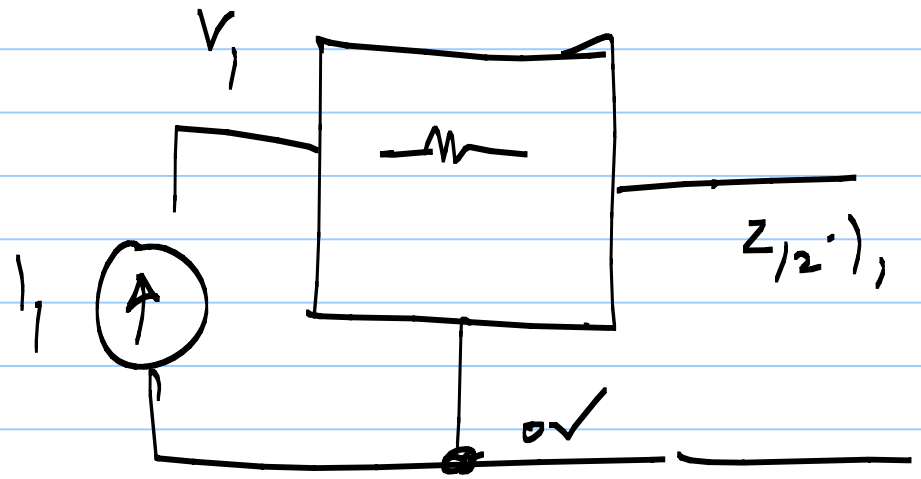
$$y = \begin{bmatrix} -y_{12} & y_{12} \\ y_{12} & -y_{12} \end{bmatrix}$$

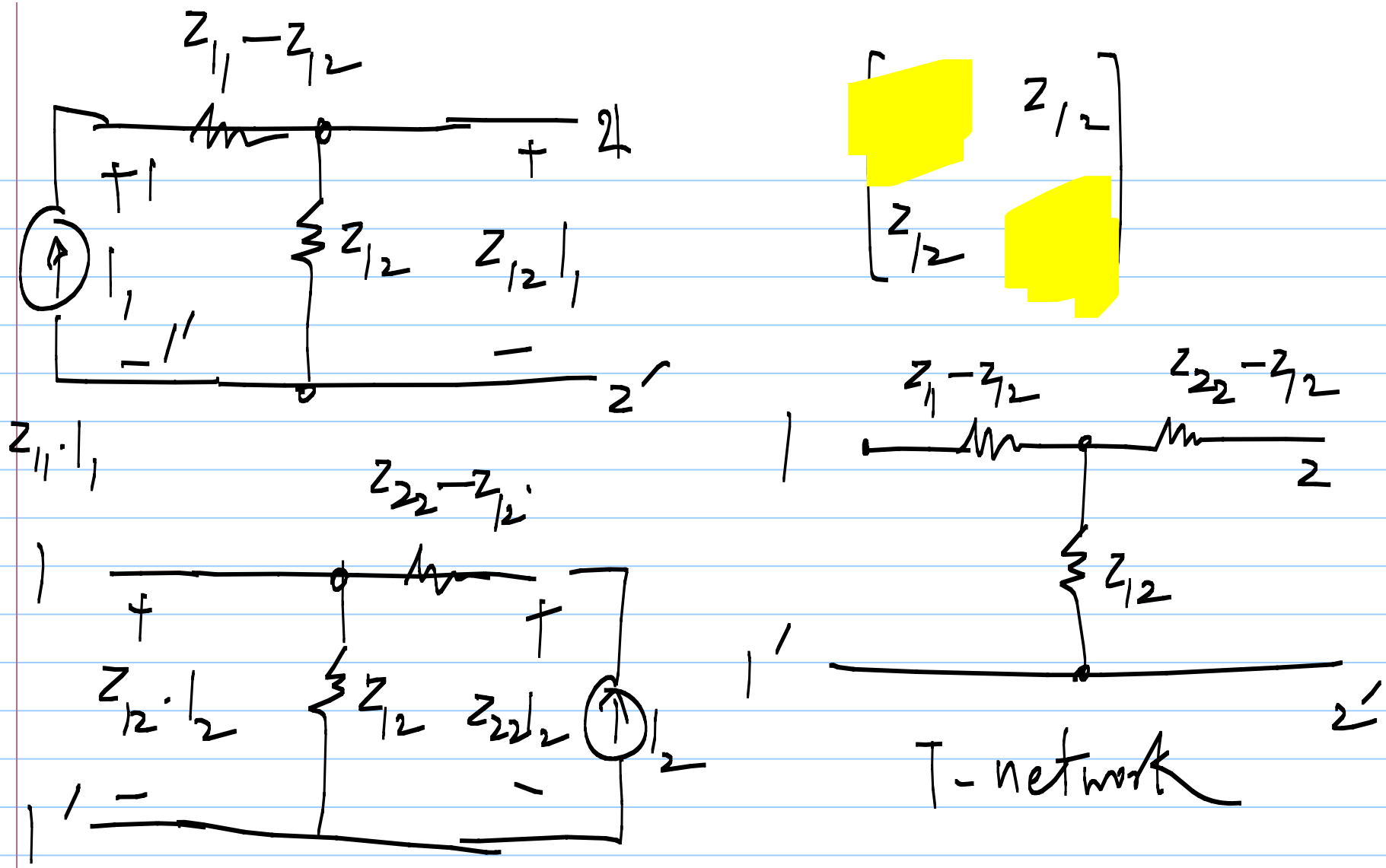
$$\begin{bmatrix} y_{11} & y_{12} \\ y_{12} & y_{22} \end{bmatrix}^{-1} = \frac{1}{y_{11}y_{22} - y_{11}^2} \begin{bmatrix} y_{22} & -y_{12} \\ -y_{12} & y_{11} \end{bmatrix}$$

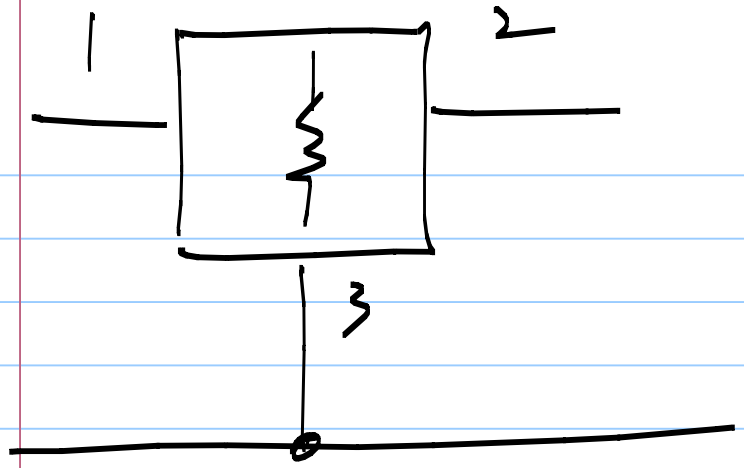
$z_{12} \geq 0$

$z_{22}, z_{11} \geq z_{12}$

Resistive 3-terminal 2-port




$Z_{11}-Z_{12}$
2
+
+
1
I_1
Z_{12}
$Z_{12}I_1$
1'
2'
$Z_{11}\cdot I_1$
$Z_{22}-Z_{12}$
+
+
$Z_{12}\cdot I_2$
Z_{12}
$Z_{22}I_2$
I_2
1'
Z_{12}
Z_{12}
$Z_{11}-Z_{12}$
$Z_{22}-Z_{12}$
1
2
Z_{12}
1'
2'
T-network



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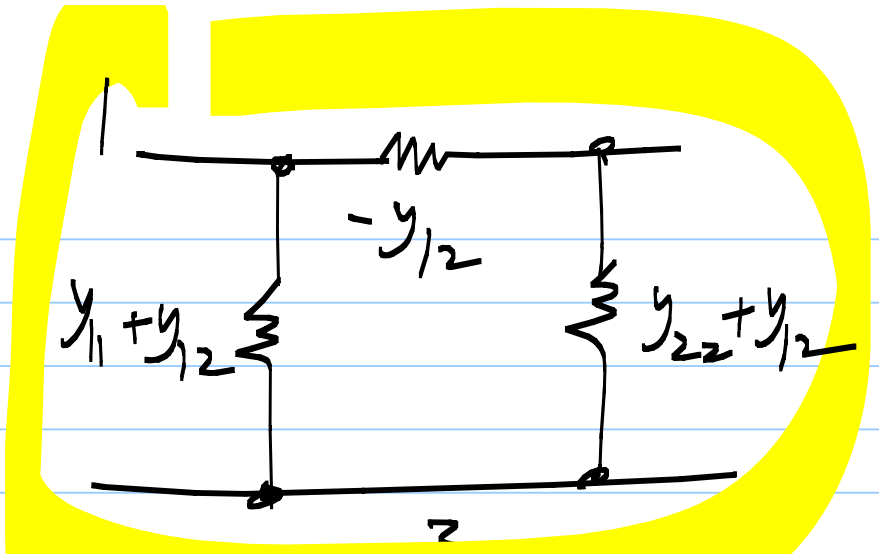
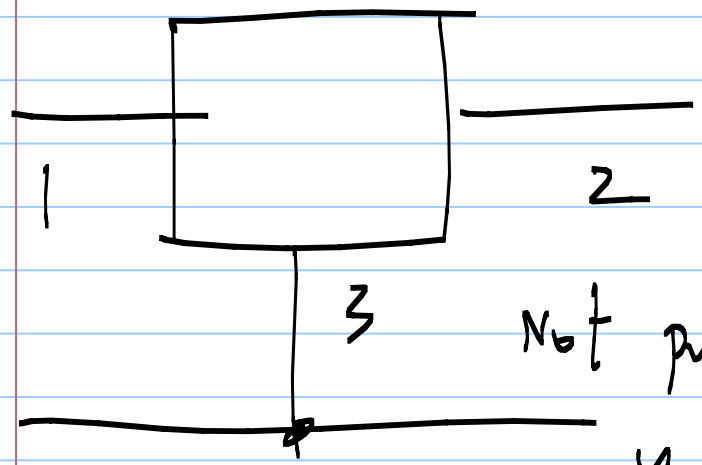


$$\begin{bmatrix} y_{11} & y_{12} \\ y_{21} & y_{22} \end{bmatrix}$$



Not purely resistive

$y_{12} \neq y_{21}$