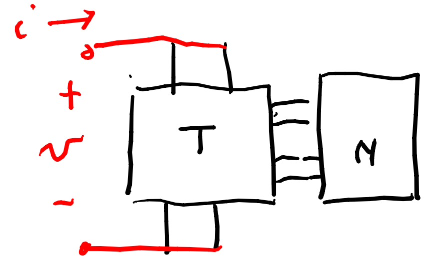
EE610

11/01/12

Note Title 11/1/2012



$v_1 \qquad v_2$

$i_1 \qquad i_2 = -i_N = -y_N v_N = -y_N v_2$

$\underbrace{\qquad}_{\text{transformer}}$

$v_2 = T^T v_1$

$i_1 = -T i_2$

$$i_1 = -T i_2 = -T(-y_N v_2) = T y_N T^T v_1$$

$$y_{in} = T y_N T^T$$

$i = y v;\quad i = i_{1,1} + i_{1,2}$ = sum 1st row + 2nd row of $T y_N T^T$

= (sum of all entries in $T y_N T^T$) $\cdot\, v$

$$T y_N T^T = \begin{bmatrix} t_{11} & t_{12} \\ t_{21} & t_{22} \end{bmatrix} \begin{bmatrix} y_{11} & y_{12} \\ y_{21} & y_{22} \end{bmatrix} \begin{bmatrix} t_{11} & t_{21} \\ t_{12} & t_{22} \end{bmatrix}$$

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

$$\Rightarrow \quad y_{11} = t_{11}^2 y_{11} + t_{11}t_{12}y_{21} + t_{11}t_{12}y_{12} + t_{12}^2 y_{22}$$

PR if N is passive

$$t_{11}t_{21}y_{11} + t_{12}t_{21}y_{21} + t_{11}t_{22}y_{12} + t_{12}t_{22}y_{22}$$

$$+ \ \ldots$$

but if there is a pole in y_{21} not in y_{11} & y_{22}

then this is dominated by the terms like $t_{11}t_{12}$

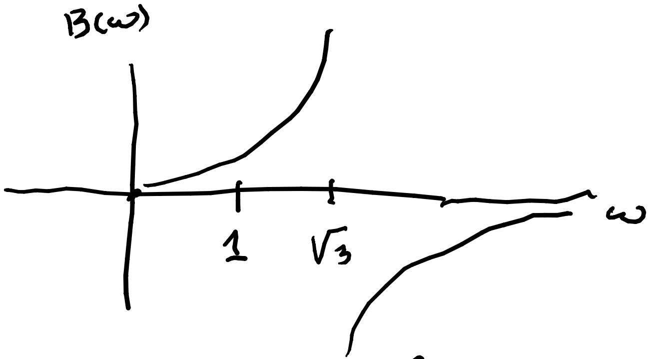
$\therefore$ we can choose this to have a negative residue

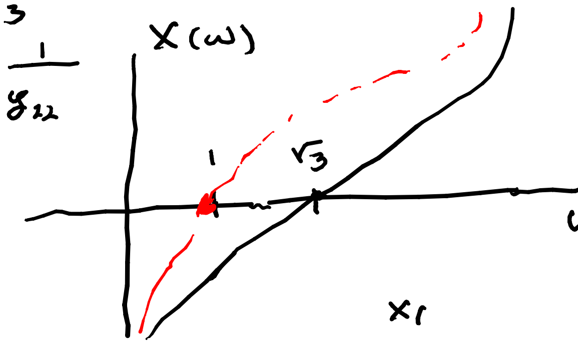
$\Rightarrow$ that y is not PR

Partial pole removal for zeros of $\frac{v_2}{v_1}$ not at 0 or ∞ but on $j\omega$ axis:

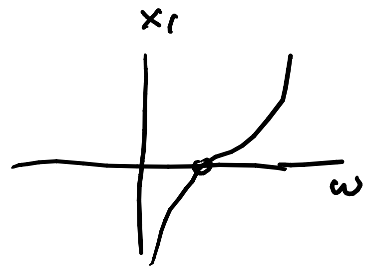
$$\frac{v_2}{v_1} = \frac{k(s^2+1)}{s^2+3s+3} = \frac{k\left(\frac{s^2+1}{s^2+3}\right)}{1+\frac{3s}{s^2+3}} = -\frac{y_{21}}{1+y_{22}}$$

$$\frac{s^2+3}{3s} = \frac{1}{y_{22}}$$



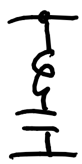


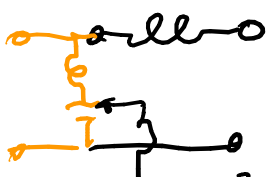
$$\frac{1}{y_{22}} = \frac{s^2+3}{3s} = \frac{s^2+1}{3s} + \frac{2}{3s} = \frac{1}{s} + \frac{1}{3}s$$



need a series arm

or a shunt arm





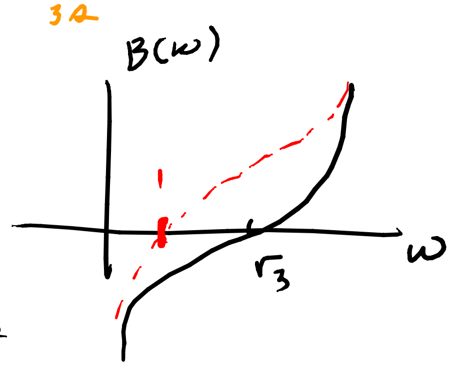
$$\leftarrow y_{22} = \frac{3s}{s^2+3}$$

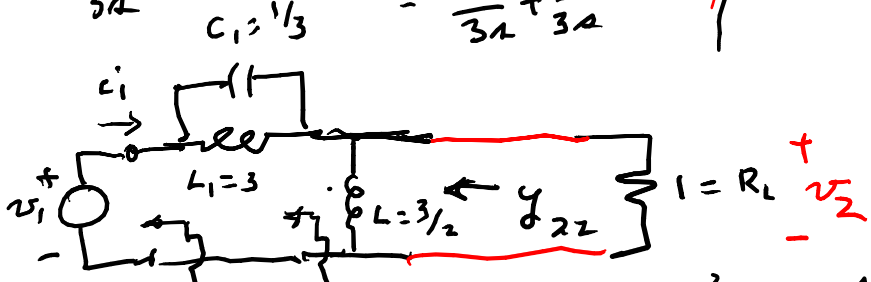
$$z_1 = \frac{s^2+1}{3s} = \frac{1}{3}s + \frac{1}{3s}$$

$\therefore$ need to write

$$\frac{v_2}{v_1} = \frac{k\left(\frac{s^2+1}{3s}\right)}{1+\frac{s^2+3}{3s}} \Rightarrow y_{22} = \frac{s^2+3}{3s}$$

$$= \frac{s^2+1}{3s} + \frac{2}{3s}$$





$$y_2 = 0 \quad z_1 = \frac{3s}{s^2+1} \Rightarrow y_1 = \frac{s^2+1}{3s} = \frac{s}{3} + \frac{1}{3s}$$

To find k:

$$v_2 = \left(\frac{1}{1+\frac{1}{3s/2}}\right) i_1 \; ; \quad i_1 = \left(\frac{1}{3}s + \frac{1}{3s}\right)(v_1 - v_2) = \frac{s^2+1}{3s}(v_1 - v_2)$$

$$v_2 = \left(\frac{3s/2}{1+\frac{3s}{2}}\right) \frac{s^2+1}{3s} (v_1 - v_2)$$

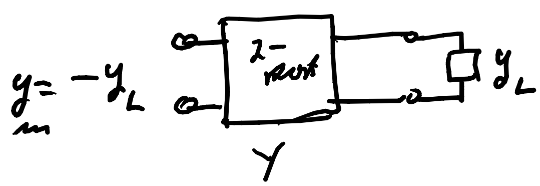
$$\left(1+\frac{3s/2}{(1+\frac{3}{2}s)}\cdot\frac{s^2+1}{3s}\right)v_2=\frac{3s/2}{(1+\frac{3s}{2})}\frac{(s^2+1}{3s}v_1$$

$$\frac{v_2}{v_1}=\frac{\frac{1}{2}(s^2+1)/(1+\frac{3}{2}s)}{1+\frac{\frac{1}{2}(s^2+1)}{(1+\frac{3}{2}s)}}=\frac{\frac{1}{2}(s^2+1)}{1+\frac{3}{2}s+\frac{1}{2}s^2+\frac{1}{2}}=\frac{s^2+1}{3+3s+s^2}$$

$\Rightarrow$ $k=1$ and synthesized the desired $\frac{v_2}{v_1}$

How to make a negative capacitor:

Use a negative impedance converter: NIC



$$y_{in}=y_{11}-\frac{y_{21}y_{12}}{y_{22}+y_L}=\frac{\Delta y+y_{11}y_L}{y_{22}+y_L}$$

can not get an NIC out of a 2-port with an admittance

Chain matrix, $\mathcal{Y}$

$$\begin{bmatrix}v_1\\i_1\end{bmatrix}=\mathcal{Y}\begin{bmatrix}v_2\\-i_2\end{bmatrix}=\begin{bmatrix}A&B\\C&D\end{bmatrix}\begin{bmatrix}v_2\\-i_2\end{bmatrix}$$

Several types of NIC $\qquad i_2=-y\,v_2$

a) $v_1=v_2$
$i_1=i_2$ $\quad\Rightarrow\quad i_1=-y\,v_1$

$$\mathcal{Y}=\begin{bmatrix}1&0\\0&-1\end{bmatrix}$$ current inverting

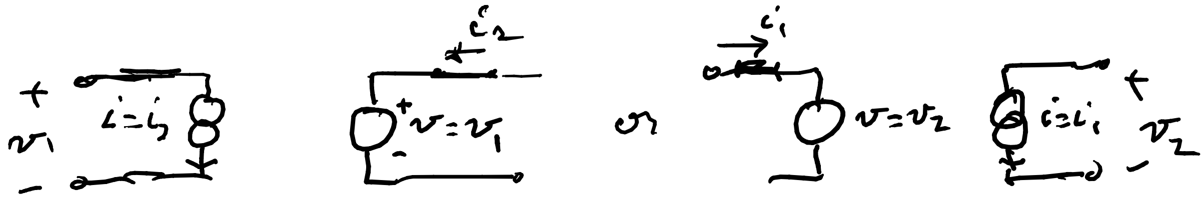
b) $v_1=-v_2$
$i_1=-i_2$

$$i_1=y_{in}v_1=-y_{in}v_2=-\frac{1}{y_L}y_{in}(-i_2)$$
$$v_2=-\frac{1}{y_L}i_2$$

$$\mathcal{Y}=\begin{bmatrix}-1&0\\0&1\end{bmatrix}$$ voltage inverting NIC

if $y_{in}=-y_L\Rightarrow i_1=-i_2$

for the I NIC can make in 2 ways



can use 2 forms for V NIC also