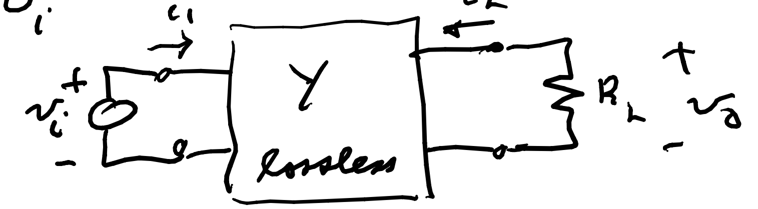
EE 610
10/22/13

Synthesis v_0/v_i



$-i_2 = G_L v_0$

$$\begin{bmatrix} i_1 \\ i_2 \end{bmatrix} = \begin{bmatrix} y_{11} & y_{12} \\ y_{21} & y_{22} \end{bmatrix} \begin{bmatrix} v_1 \\ v_2 \end{bmatrix}$$

$-G_L v_0 = i_2$, $v_1 = v_i$, $v_2 = v_0$

$$-(G_L + y_{22}) v_0 = y_{21} v_i \Rightarrow \frac{v_0}{v_i} = \frac{-y_{21}}{G_L + y_{22}} = \frac{-y_{21}/G_L}{1 + y_{22}/G_L}$$

if $\frac{v_0}{v_i}(s) = \frac{N(s)}{D(s)}$ & $D(s) =$ Hurwitz

$$= Ev\,D(s) + Od\,D(s) = Ev(D(s))\left[1 + \frac{Od\,D(s)}{Ev\,D(s)}\right]$$

$$= Od(D(s))\left[1 + \frac{Ev(D(s))}{Od\,D(s)}\right]$$

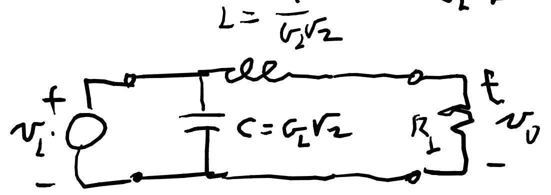
and ∴ choose $\frac{y_{22}}{G_L} = \frac{Od(D(s))}{Ev(D(s))}$ or $\frac{Ev(D(s))}{Od(D(s))}$ these are reactance functions

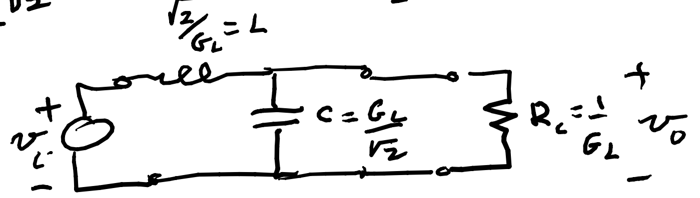
Ex: $T(s) = \frac{A_0}{s^2 + \sqrt{2}s + 1}$ $s^2+\sqrt{2}s+1 =$ Hurwitz } max flat low pass

$$= \frac{A_0/(s^2+1)}{1 + \frac{\sqrt{2}s}{s^2+1}} = \frac{A_0/\sqrt{2}s}{1 + \frac{s^2+1}{\sqrt{2}s}}$$

Choose $y_{22} = G_L \cdot \frac{\sqrt{2}s}{s^2+1}$ or $y_{22} = G_L\left(\frac{s^2+1}{\sqrt{2}s}\right)$

$$= \frac{1}{\frac{s}{G_L\sqrt{2}} + \frac{1}{sG_L\sqrt{2}}} \qquad = \frac{G_L}{\sqrt{2}}s + \frac{1}{\frac{\sqrt{2}}{G_L}s}$$





if $D(s) = s^n + \ldots$
$n =$ odd use this
(÷ by even)

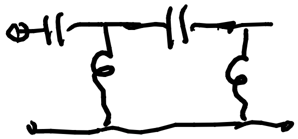
if $D(s) = s^n + \ldots$
n even
(use this one here, $n=2$)

for high pass use 2nd Cauer

c

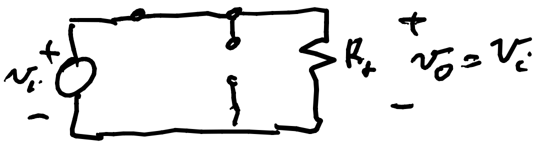
n=3 1st Cauer

$$\frac{\dots A_0}{s^3+\dots}$$



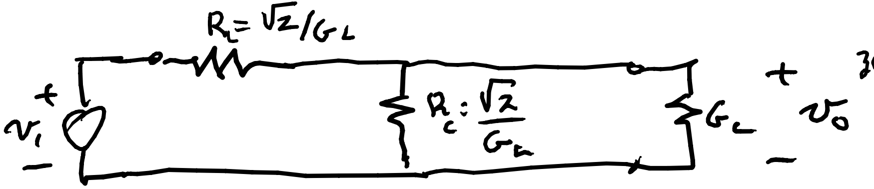
$$\frac{A_4 s^4}{s^4+\dots}$$

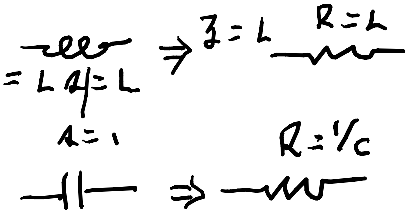
To find A_0, look at $s=0$



$$T(0)=\frac{A_0}{1}=\frac{v_o}{v_i}(0)=1 \Rightarrow A_0=1$$

as another check
can evaluate at $s=1$, a real number ⇒ resistive circuit





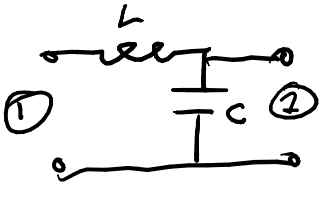
$Y(s)=Cs\Big|_{s=1}=C$

$$R=\underbrace{\frac{\sqrt{2}/G_L\cdot 1/G_L}{\sqrt{2}/G_L+\frac{1}{G_L}}}=\frac{\sqrt{2}/G_L}{1+\sqrt{2}}$$

$$\frac{v_o}{v_i}=\frac{\frac{\sqrt{2}/G_L}{1+\sqrt{2}}}{\sqrt{2}/G_L+\frac{\sqrt{2}/G_L}{1+\sqrt{2}}}=\frac{\frac{1}{1+\sqrt{2}}}{\frac{1+\sqrt{2}+1}{1+\sqrt{2}}}=\frac{1}{2+\sqrt{2}}=T(1)=\frac{A_0}{1+\sqrt{2}+1}=\frac{A_0}{2+\sqrt{2}}$$

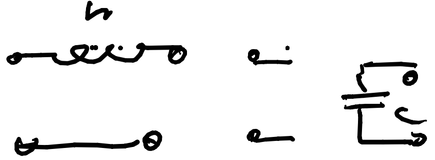
$$\Rightarrow A_0=1$$

2-port



⇒

is



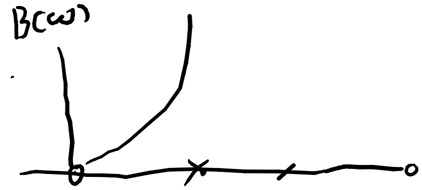
are in parallel

$$Y=\frac{1}{sL}\begin{bmatrix}1&-1\\-1&1\end{bmatrix}+\begin{bmatrix}0&0\\0&sC\end{bmatrix}=\begin{bmatrix}1/sL&-1/sL\\-1/sL&\frac{1}{sL}+sC\end{bmatrix}$$

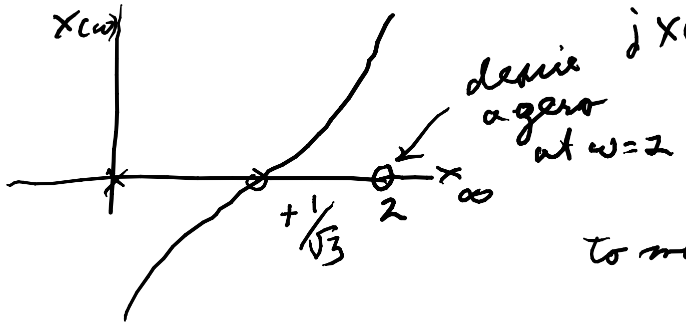
Ex: $$\frac{v_o}{v_i}=\frac{A_0(s^2+4)}{s^3+3s^2+2s+1}=\frac{A_0(s^2+4)/(3s^2+1)}{1+\frac{s^3+2s}{3s^2+1}}$$

$$y_{22} = \frac{s^3+2s}{3s^2+1} = \frac{1}{3}s + \frac{5/3\, s}{3s^2+1}$$

$$\begin{array}{r|l} & \frac{1}{3}s \\ 3s^2+1 & s^3+2s \\ & s^2+\frac{1}{3}s \\ \hline & \frac{5}{3}s \end{array}$$



$$jB(\omega) = \frac{j\,5/3\,\omega}{-3\omega^2+1}$$



$$jX(\omega) = \frac{-3\omega^2+1}{\frac{5}{3}\omega}$$

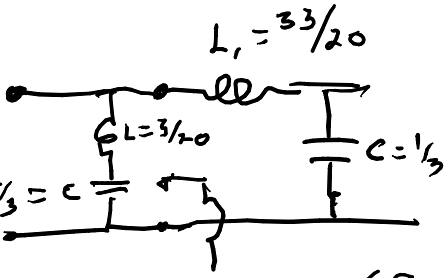
to move, take out part of pole at ∞ to move zero to 2

$$z_{rem} = \frac{3s^2+1}{\frac{5}{3}s} = \frac{9}{5}s + \frac{1}{\frac{5}{3}s}$$

$$z_{new} = \left(\frac{9}{5}-L_1\right)s + \frac{1}{5/3\,s} = \frac{\left(\frac{9}{5}-L_1\right)5/3\,s^2+1}{5/3\,s} \Rightarrow \left(3-\frac{5}{3}L\right)(-4)+1=0$$

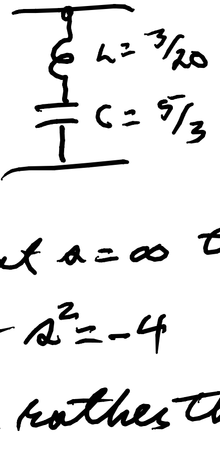
$$\Rightarrow \frac{20}{3}L = 11$$

$$\Rightarrow L = \frac{3\times 11}{20} = \frac{33}{20}$$



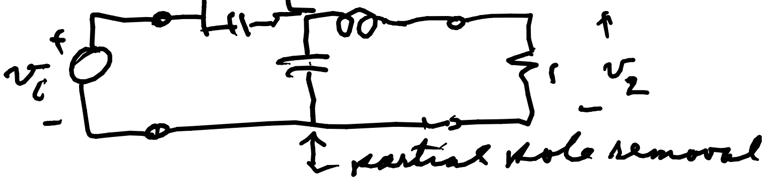
$$z_{new} = \left(\frac{9}{5}-\frac{33}{20}\right)s + \frac{1}{5/3\,s} = \frac{36-33}{20}s + \frac{1}{\frac{5}{3}s} = \frac{3}{20}s + \frac{1}{\frac{5}{3}s}$$

$$y = \frac{5/3\,s}{\frac{1}{4}s^2+1} \Rightarrow$$



has an extra element due to the partial pole removal at $s=\infty$ to create the zero of transmission at $s^2=-4$

if correctly divide by odd rather then even get correct circuit



has zero of $\frac{v_2}{v_1}$ @ $s^2=-4$