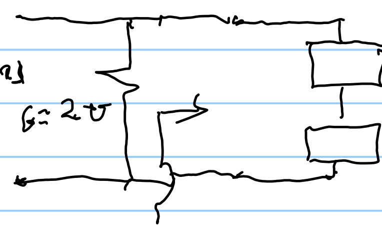
ENEE 610
11/01/18

Note Title 11/1/2018

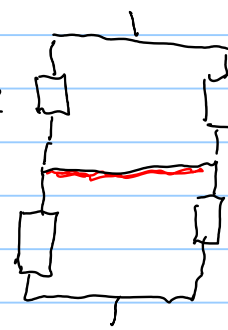
$$\frac{y_m(s)}{y_m(s)} = \frac{1}{\dfrac{1}{\frac{k}{s} + \hat{y}_n} + \dfrac{1}{\frac{1}{\hat{y}_n} + \frac{s}{k}}} \Rightarrow$$



$z_1 = \dfrac{1}{\frac{k}{s} + \hat{y}_n} \leftarrow \circ\ y_i$

$z_2 = \dfrac{1}{\frac{1}{\hat{y}_n} + \frac{s}{k}}$

$y_m \qquad \underbrace{\quad}_{a z}$



$y_1 = \frac{k}{s}$ $\quad y_2 = \hat{y}_n$

$y_4 = \frac{1}{\hat{y}_n}$ $\quad y_3 = s/k$

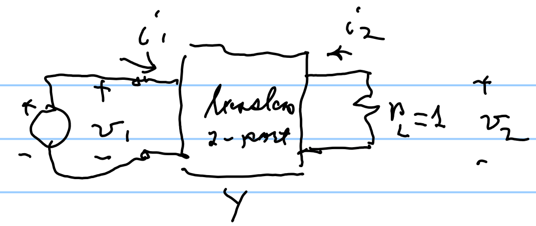
$y_1 y_3 = 1 = y_2 y_4$

$\Downarrow$

balanced bridge

can remove

$\frac{v_2}{v_1}$ synthesis



$$i_2 = -g_L v_2 = -v_2$$
$$= y_{21} v_1 + y_{22} v_2 \Rightarrow -(1 + y_{22}) v_2 = y_{21} v_1$$

$$\frac{v_2}{v_1} = \frac{-y_{21}}{1 + y_{22}} = \frac{-n_{21}/d_{21}}{1 + n_{22}/d_{22}} = \frac{-n_{21}\left(\frac{d_{22}}{d_{21}}\right)}{n_{22} + d_{22}}$$
$$= \frac{N(s)}{D(s)}$$

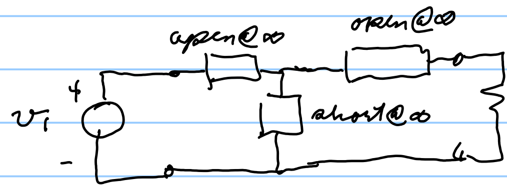
choose y_{22} as LPR if $D(s)$ is Hurwitz

Given $\frac{N}{D}$ form $D = (1 + n_{22}/d_{22})\, d_{22} \Rightarrow y_{22} = n_{22}/d_{22}$ synthesize as LPR to get zeroes of $N(s)$ by ladder circuits

Ex: $\dfrac{v_2}{v_1}(s) = \dfrac{k}{s^3+3s^2+3s+1} = \dfrac{k/(s^3+3s)}{1+\dfrac{3s^2+1}{s^3+3s}}$; $\dfrac{v_2}{v_1}$ has 3 zeroes of transmission @ ∞

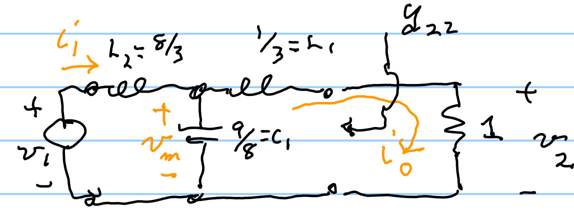
synthesize $y_{22}(s) = \dfrac{3s^2+1}{s^3+3s}$

$\dfrac{1}{y_{22}}$ has a pole @ ∞ $\Rightarrow$ 1st Cauer



$$\begin{array}{r|l}
 & \frac{1}{3}s \quad \leftarrow z \\
3s^2+1 & s^3+3s \\
 & s^3+\frac{1}{3}s \\
\hline
 & \frac{8}{3}s \quad \frac{9}{8}s \quad \leftarrow y \\
\frac{8}{3}s & 3s^2+1 \\
 & 3s^2 \\
\hline
 & 1 \quad \frac{8}{3}s
\end{array}$$

$y_{22}(s) = \dfrac{1}{\frac{1}{3}s + \dfrac{1}{\frac{9}{8}s + \dfrac{1}{\frac{8}{3}s}}}$



for $v_2 = 1$, $i_0' = R_{load} v_2 = 1 \cdot 1 = 1 \Rightarrow v_m = v_2 + sL_1 i_0' = 1 + sL_1 = 1 + \frac{1}{3}s$

$i_1 = i_{C_1} + i_1' = sC_1 v_m + 1 = sC_1\left(1+\frac{1}{3}s\right) + 1 = s \cdot \frac{9}{8}\left(1 + \frac{1}{3}s\right) + 1 = \frac{3}{8}s^2 + \frac{9}{8}s + 1$

$v_1 = sL_2 \cdot i_1 + v_m = sL_2\left(\frac{3}{8}s^2 + \frac{9}{8}s + 1\right) + \left(\frac{1}{3}s + 1\right) = s\cdot\frac{8}{3}\cdot\frac{3}{8}s^2 + \frac{8}{3}s\cdot\frac{9}{8}s + s\cdot\frac{8}{3} + \left(\frac{1}{3}s + 1\right)$

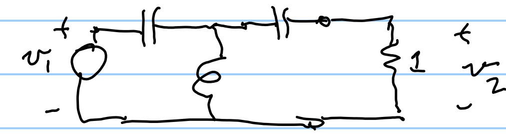
$= s^3 + 3s^2 + \frac{9s}{3} + 1 = (s^3 + 3s^2 + 3s + 1) \cdot v_2 = 1$

$\frac{v_2}{v_1} = \frac{1}{s^3 + 3s^2 + 3s + 1}$; $k = 1$

For $\frac{v_2}{v_1} = \frac{k s^3}{s^3 + 3s^2 + 3s + 1}$ use 2nd Cauer $\Rightarrow$ 3 zeros of transmission @ $s = 0$

(series arms open @ $s = 0$, shunt short @ $s = 0$)

$\Downarrow$



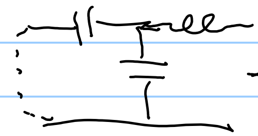
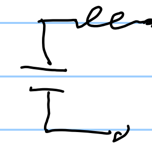
for $\frac{v_2}{v_1} = \frac{k s}{s^3 + 3s^2 + 3 + 1}$

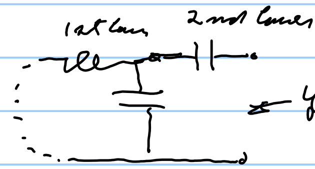
$\Downarrow$

one zero @ 0, two @ ∞.

$\Uparrow$ 2nd Cauer once

$\Uparrow$ 1st Cauer twice

 $\to y_{22} \Rightarrow$  $\Leftarrow$ degree 2 but $\frac{v_2}{v_1}$ is degree 3 $\quad s^3+3s^2+3s+1$

try 

$\leftarrow y_{22}$ of degree 3 need y_{22} as $\frac{\text{odd}}{\text{ev}}$ or $\frac{\text{ev}}{\text{odd}}$

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

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

$\Uparrow$ desire as $s=0$ is a zero of y_{21}

$$y_{22} = \frac{s^3+3s}{3s^2+1} = \frac{1}{\frac{1+3s^2}{\underbrace{3s+s^3}_{s(3+s^2)}}}$$

$$\Rightarrow 3s+s^3 \overline{\big)\,1+3s^2} \quad \frac{1}{3s}$$

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

$$\frac{8}{3}s^2$$

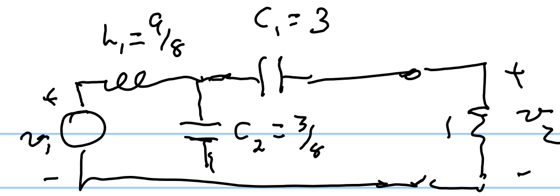
$$s^3+3s$$

$$\Rightarrow \frac{8}{3}s^2 \overline{\big)\,s^3+3s} \quad \frac{3}{8}s$$

$$s^3$$

$$3s \overline{\big)\,\frac{8}{3}s^2} \quad \frac{8}{9}s$$

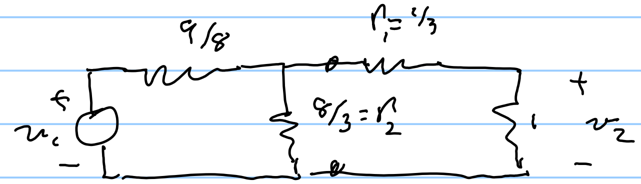
$$y_{22} = \cfrac{1}{\cfrac{1}{3s} + \cfrac{1}{\cfrac{3}{8}s + \cfrac{1}{\cfrac{9}{8}s}}}$$



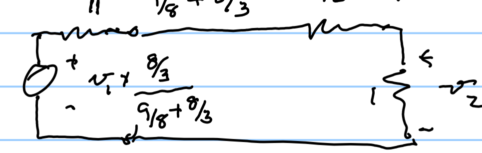
; k:

to find k: $\dfrac{v_2}{v_1} = \dfrac{ks}{s^3+3s^2+3s+1}$; let $s=1$; $\dfrac{v_2}{v_1}(1) = \dfrac{k}{1+3+3+1} = \dfrac{k}{8}$

$s=1$ in circuit



$r_{11} = \dfrac{9/8 \times 8/3}{9/8 + 8/3}$



$r_{11} = \dfrac{3}{\frac{27+64}{8\times 3}} = \dfrac{9\times 8}{91} = \dfrac{72}{91}$

$v_2 = \dfrac{1}{1 + 1/3 + \frac{72}{91}} \times \left[\dfrac{64}{91}\right] v_1 \Rightarrow \dfrac{v_2}{v_1} = \dfrac{k}{8} = \dfrac{64\times 3}{273+91+216} \Rightarrow k = 2.662$