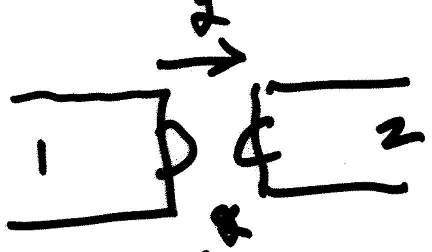
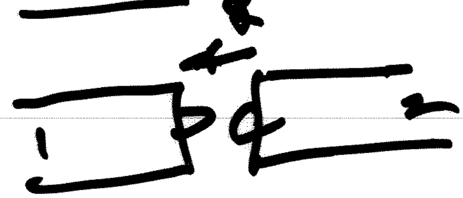
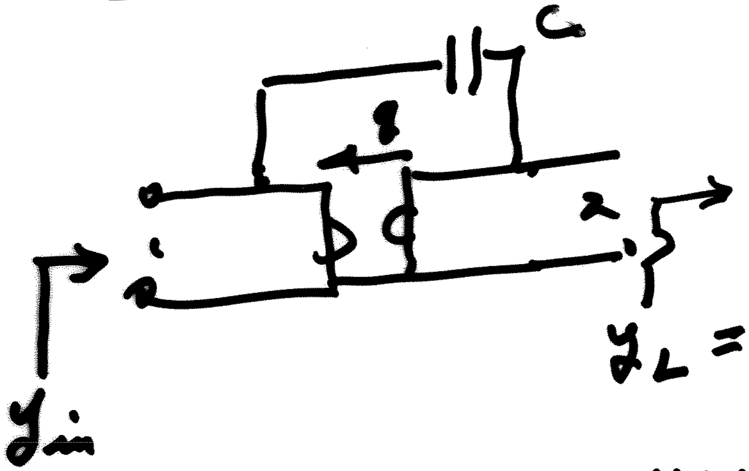
EE610 10/14/02 p. 1



$$Y = \begin{bmatrix} 0 & g \\ -g & 0 \end{bmatrix}$$



$$Y = \begin{bmatrix} 0 & -g \\ g & 0 \end{bmatrix}$$



$$y_L = \frac{g^2 - Cs \cdot y_{in}(s)}{y_{in}(s) - Cs}$$

$$y_R = \frac{k\, y(k) - s\, y(s)}{k\, y(s) - s\, y(k)}$$; y_R is PR if y is zero @ $s = k$ cancels

also a zero and a pole @ $s = -k$ if $y(k) = -y(-k)$ i.e. @ a zero of $Ev\, y(s) = [y(s) + y(-s)]/2$

$\delta[y_R] = \delta[y] - 1$ if k is a zero of $Ev\, y(s)$.

always true if $y(s)$ is lossless for any k

EE 610 10/14/02

$$y_L(\lambda) = \frac{y(\lambda_c)}{y(\lambda_c)} \cdot \frac{\dfrac{g^2}{c} - \alpha\, y_{in}^{1,2'}(\lambda)}{\dfrac{y_{in}(\lambda)}{c} - \alpha}$$

$$= y(\lambda_c)\, \frac{\left[\dfrac{g^2}{c\, y(\lambda_c)} - \alpha \dfrac{y_{in}(\lambda)}{y(\lambda_c)}\right]}{\dfrac{y(\lambda_c)}{c} \cdot \dfrac{y_{in}(\lambda)}{y(\lambda_c)} - \alpha}$$

$$\frac{y_R}{y(\lambda_c)} \Rightarrow \frac{k\, y(\lambda_c) - \alpha\, y(\lambda)}{k\, y(\lambda) - \alpha\, y(\lambda_c)}$$

$$= \frac{k - \alpha\, y(\lambda)/y(\lambda_c)}{k \dfrac{y(\lambda)}{y(\lambda_c)} - \alpha}$$

$$\frac{g^2}{c\, y(\lambda_c)} = k \quad , \quad \frac{y(\lambda_c)}{c} = k$$

$$\Rightarrow \frac{g^2}{c\, y(\lambda_c)} = \frac{y(\lambda_c)}{c} \Rightarrow g^2 = y(\lambda_c)^2$$

$$g = \pm\, y(\lambda_c)$$

$$\frac{y(k)}{C} = k \Rightarrow C = \frac{k}{y(k)} > 0$$

Philosophy: find a k such that $Ev\, y_{in}(s) = 0$

then

$$y_L = y_{in}(k) \cdot \frac{k\, y_{in}(k) - s\, y_{in}(s)}{k\, y_{in}(s) - s\, y_{in}(k)}$$

this is PR and has all zeros of $Ev(y_{in})$ the same as those for $y_{in}(s)$ except that at $s = k$

EE 610 10/14/02 p. 4

Ex: $$y_{in}(s) = \frac{s(s^2+3)}{3(s^2+1/3)}$$

$y_{in}(s) + y_{in}(-s) \equiv 0$ so any s is a zero of Ev y_{in}

choose k pos. & real
say $k = 2$ [then $(s+2)(s-2)$ should cancel in Y Richards]

$$y_{in}(s)\Big|_{s=2} = \frac{2(4+3)}{3(4+1/3)} = \frac{2\times 7}{13} = \frac{14}{13}$$

form

$$\frac{Y_R}{14/13} = \frac{k\,y(k) - s\,y(s)}{k\,y(s) - s\,y(k)} = \frac{2\cdot 14/13 - \dfrac{s^2(s^2+3)}{3(s^2+1/3)}}{\dfrac{2\cdot s(s^2+3)}{3(s^2+1/3)} - s\cdot\dfrac{14}{13}}$$

$$= \frac{6\times 14\left(a^2+\tfrac{1}{3}\right) - 13a^2\left(a^2+3\right)}{2\times 13\left(a\left(a^2+3\right)\right) - a\times 3\times 14\left(a^2+\tfrac{1}{3}\right)}$$

$$= \frac{-13a^4 + 3\left(\cancel{6}^{\,2}\times 14 - \cancel{3}\times 13\right)a^2 + \frac{\cancel{6}^{\,2}\times 14}{\cancel{3}}}{\underset{26}{2\times 13}\,a^3 - \underset{42}{3\times 14}\,a^3 + 2\times 13\times 3\,a - \frac{\cancel{3}\times 14}{\cancel{3}}\,a}$$

$$\begin{array}{r} 78 \\ -14 \\ \hline 64 \end{array}$$

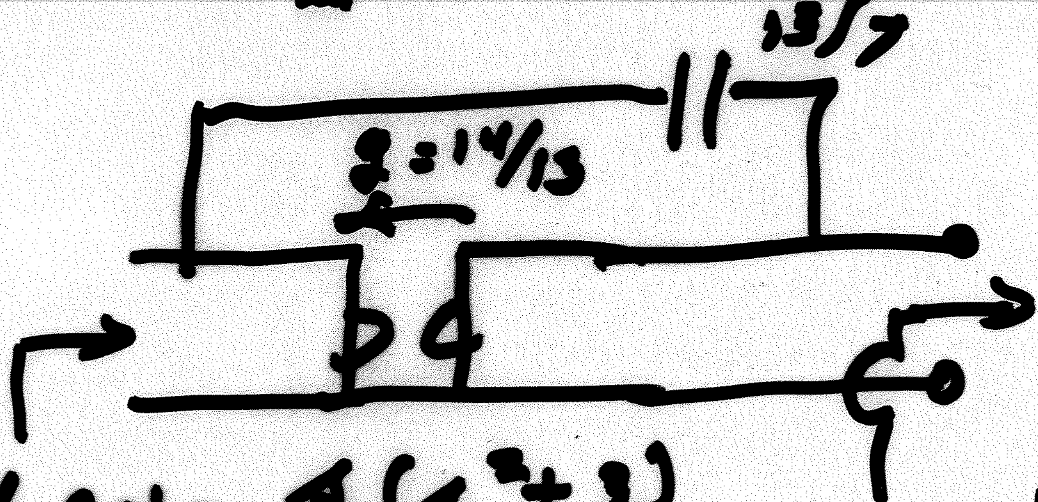
$$= \frac{-13a^4 + 45a^2 + 28}{\underbrace{-16a^3 + 64a}_{16a\left(-a^2+4\right)}}$$

$$\begin{array}{r|l} & -13a^2 - 7 \\ \hline a^2-4 & -13a^4 + 45a^2 + 28 \\ & -13a^4 + 52a^2 \\ \hline & 0 - 7a^2 \\ & -7a^2 + 28 \\ \hline & 0 \quad\; 0 \end{array}$$

$$y_L(a) = \frac{14}{13}\left(-\frac{13a^2+7}{16a}\right); \quad \delta[y_L] = \delta[y_{in}] - 1$$

$g = y_{in}(k) = 14/13$

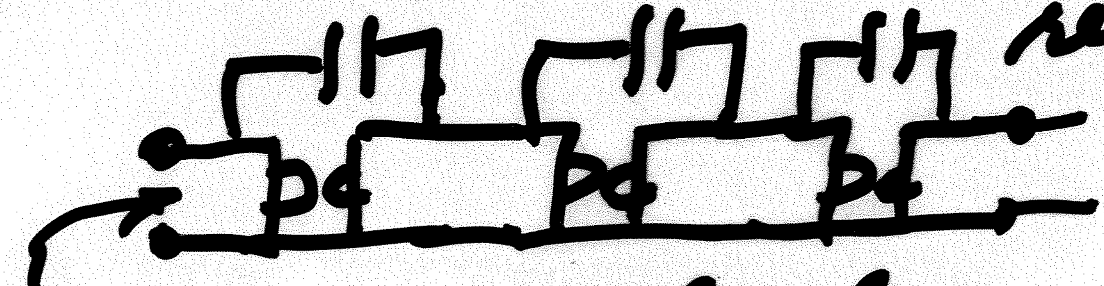
$C = \dfrac{k}{y_{in}(k)} = \dfrac{2}{14/13} = \dfrac{13}{7}$



$y_{in}(s) = \dfrac{s(s^2+3)}{3(s^2+1/3)}$

$y_L = \dfrac{14}{13}\left(\dfrac{13s^2+7}{16s}\right)$

repeat



$y_{in}(s)$

for lossless
minimum # of C's
(3 in our case as
$\delta[y_{in}] = 3$

EE610 10/14/02 p.7

Zeros of $Ev[y_R(s)]$

Richards

$$y_R = \frac{k y_k - s y}{k y - s y_k}$$

lower $*$: $s \to -s$

$$2\,Ev\, y_R = y_R + y_{R*}$$

$$= \frac{k y_k - s y}{k y - s y_k} + \frac{k y_k + s y_*}{k y_* + s y_k}$$

$$num = (k y_k - s y)(k y_* + s y_k) + (k y_k + s y_*)(k y - s y_k)$$

$$= k^2 y_k y_* + \cancel{k s y_k^2} - \cancel{s k y y_*} - s^2 y_k y + k^2 y_k y - \cancel{k s y_k^2} + \cancel{s k y y_*} - s^2 y_k y_*$$

$$= k^2 y_k [y_* + y] - s^2 y_k [y + y_*]$$

$$= (k^2 - s^2)\, y_k \cdot \underbrace{(y + y_*)}_{2\,Ev\,y}$$

RC functions:

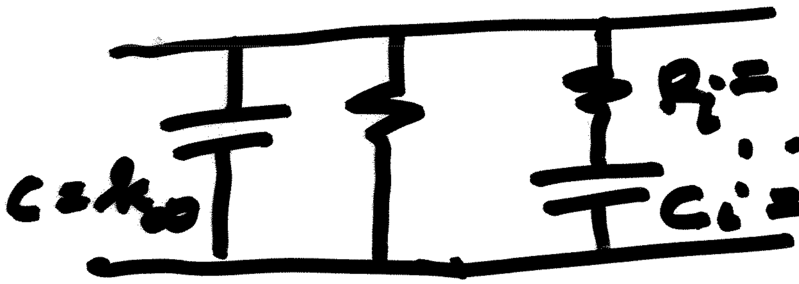
$$y_{LC}(s) = k_\infty s + \frac{k_0}{s} + \sum_{i=1}^{N} \frac{k_i s}{s^2+\omega_i^2}$$

LC

$$\frac{k_i s}{s^2+\omega_i^2} = y_i$$

$\Downarrow$ $C_i = \dfrac{k_i}{\omega_i^2}$ $\quad z_i = \dfrac{s}{k_i} + \dfrac{\omega_i^2}{k_i s}$

RC



$R = 1/k_0$

$$z_{i_{RC}} = \frac{1}{k_i} + \frac{\omega_i^2}{s k_i}$$

$$y_{RC}(s) = k_\infty s + k_0 + \sum_{i=1}^{N} \frac{s k_i}{s+\omega_i^2}$$

all poles on $-\sigma$ axis, possible pole at $s=\infty$, none @ $s=0$ but possibly ≥ 0 @ $s=0$