Revised Version

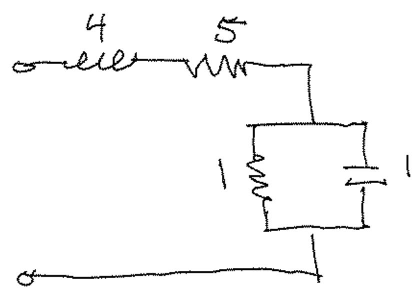
ENEE 610 9/26/07

CHAPTER 8

SYNTHESIS OF PASSIVE & ACTIVE NETWORKS

EX. $Z(s) = \dfrac{4s^2+9s+6}{s+1} = \dfrac{4s(s+1)+5(s+1)+1}{s+1}$

$4s + 5 + \dfrac{1}{s+1}$



$Z(s) = s-1$ ← NOT REAL

POSITIVE REAL FUNCTIONS

A RATIONAL FUNCTION $Z(s) = \dfrac{N(s)}{D(s)}$ A POSITIVE REAL

iff a) $Z(s)$ HAS NO POLES IN THE RHP OF THE COMPLEX PLANE

b) THE POLES OF $Z(s)$ ON $(j\omega)$ AXIS SHOULD BE SIMPLE WITH REAL & POSITIVE RESIDUES

MUST BE ORDER 5 OR LOWER

c) $\mathrm{Re}\{Z(j\omega)\} \geq 0$ FOR ALL ω $(0 \leq \omega \leq \infty)$

IF $Z(s) = \frac{N(s)}{D(s)}$ IS POSITIVE REAL THE THE FOLLOWING ARE TRUE :

1.) $N(s)$ & $D(s)$

2.) ALL THE ZEROS AND POLES OF $Z(s)$ ARE IN THE LHP S-PLANE

3) $Z(s)$ & $\frac{1}{Z(s)}$ ARE SIMPLE (ON $j\omega$) w/ R & P RESIDUES

4) $N(s)$ & $D(s)$ DIFFER ONLY 1 DEGREE

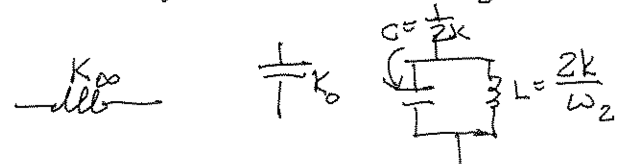
5) NO MULTIPLE POLES OR ZEROS AT THE ORIGIN

EX. $Z(s) = \frac{1}{s^2+1}$ ⇒ CONDITION 4 VIOLATED

- FOSTER METHOD → 1ST ~~ORDER~~ FORM, 2ND ~~ORDER~~ (IMPEDENCE) 1ST FORM
- CAUERS METHOD → 1ST ~~ORDER~~, 2ND ~~ORDER~~ (ADMITTANCE) 2ND FORM

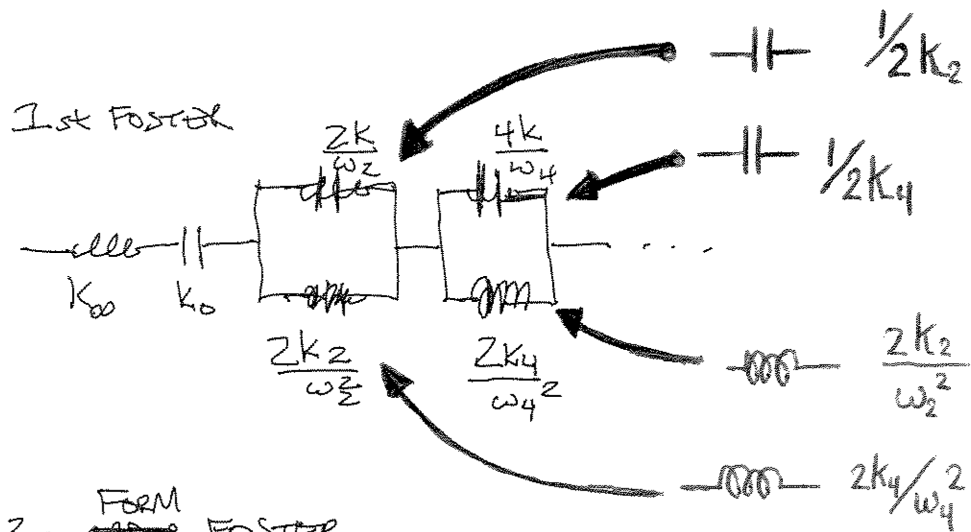
ONCE A FUNCTION IS PR & REACTANCE THEN :

$$Z(s) = K_\infty s + \frac{K_0}{s} + \frac{2K_2 s}{s^2+\omega_2^2} + \frac{2K_4 s}{s^2+\omega_4^2} + \dots + \frac{2K_m s}{s^2+\omega_m^2}$$



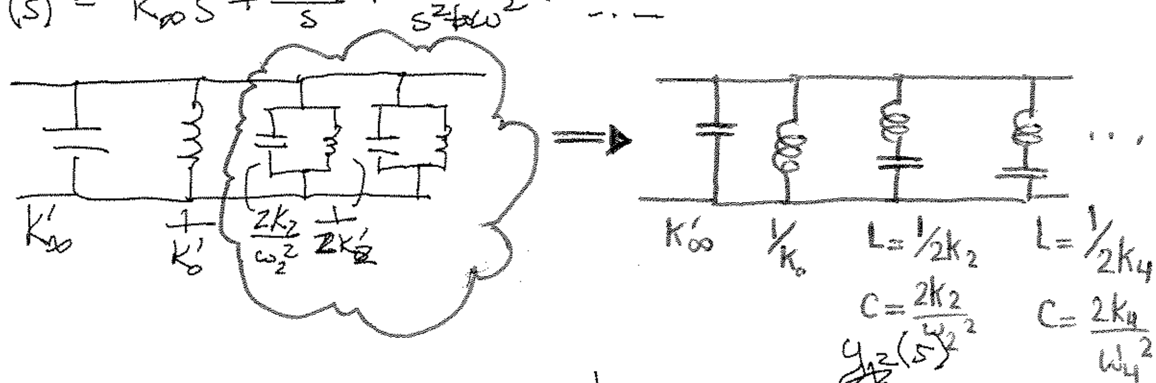
Note: Corrections Made Here

1st FOSTER



2ND FORM FOSTER

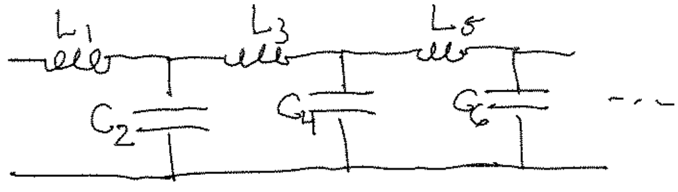
$$Y(s) = K_\infty s + \frac{K_0'}{s} + \frac{2k_2'}{s^2+\omega_2^2} + \dots$$



* in L-C tanks, L & C should be in series

$$Z(s) = L_1 s + Z_1(s) \qquad Y_1 = \frac{1}{Z_1} = C_2 s + y_2(s)$$

$$Z_2 = \frac{1}{y_2} = L_3 s + Z_3(s)$$



PROBLEM 8.4 IN TEXT BOOK

1ST FORM CAUER

$$\cancel{Z(s) = L_1 s}$$

$$Z_1(s) = L_1 s + \cfrac{1}{C_2 s + \cfrac{1}{L_3 s + \cfrac{1}{C_4 s + \ddots}}}$$

2ND FORM

$$Z(s) = \frac{1}{C_1 s} + \cfrac{1}{\frac{1}{L_2 s} + \cfrac{1}{\frac{1}{C_3 s} + \cfrac{1}{\frac{1}{L_4 s} + \ddots}}}$$

EXAMPLE FOR CAUER'S METHOD:

$$Z(s) = \frac{21(s^2+1)(s^2+5)}{5s(s^2+3)(s^2+7)} \Rightarrow L_1 = 0$$

$$y_1 = \frac{1}{Z_1(s)} = \frac{1}{Z(s)} = \frac{5}{21}s + \underbrace{\frac{5}{21}\left(\frac{4s^3+16s}{s^4+6s^2+5}\right)}_{y_2}$$

$$Z_2 = \frac{1}{y_2} = \frac{21}{5}\cdot\frac{1}{4}s + \underbrace{\frac{21}{5}\;\frac{2s^2+5}{4s^3+16s}}_{z_3(s)}$$

$$y_3 = \frac{1}{Z_3} = \frac{10}{21}s + \underbrace{\frac{5}{21}\;\frac{6s}{2s^2+5}}_{y_4}$$

$$L_5 = \frac{21}{15}$$

$$Z_3 = \frac{42s^2+105}{20s^3+80s} \rightarrow y_3 = \frac{1}{Z_3} = \frac{20s^3+80s}{42s^2+105}$$

2ND FORM

$C_1 = 1$

$$Z(s) = \frac{105+126s^2+21s^4}{105s+50s^3+5s^5} = \frac{1}{s} + \frac{76s^2+16s^2}{105s+50s^3+5s^5}$$

$$\frac{105s+50s^3+5s^5}{76s^2+16s^4} = \frac{1}{\left(\frac{76}{105}\right)s} + \frac{\left(\frac{530}{19}\right)s^3+5s^2}{76s^2+16s^4}$$

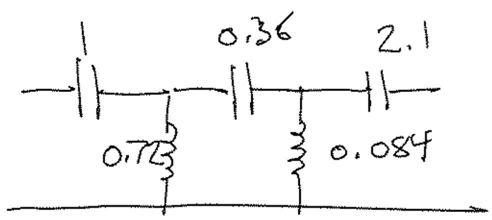
$$L_2 = \frac{76}{105}$$

$C_3 = 0.36$

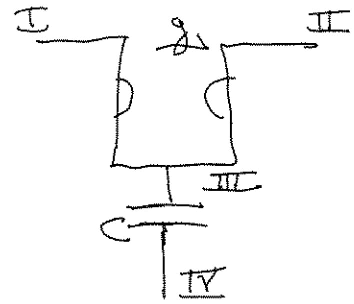
$L_4 = 0.084$

$C_5 = 2.1$

$Z(s) =$



RICHARDS' FUNCTION



$$Y_{2PORT} = \begin{bmatrix} \frac{g^2}{sC} & g - \frac{g^2}{sC} \\ -g - \frac{g^2}{sC} & \frac{g^2}{sC} \end{bmatrix}$$

$$Y_L(s) = \frac{y_{IN} \cdot y_{22} - \Delta y}{y_{11} - y_{IN}} = g^2 \frac{\left(\frac{1}{sC} y_{IN} - 1\right)}{\frac{g^2}{sC} - y_{IN}}$$

$$Z_L(s) = \frac{1}{Y_L(s)} = \frac{g^2 Z_{IN}(s) - sC}{g^2 - g^2 sC Z_{IN}(s)}$$

$$\frac{\frac{1}{C} Z_{IN}(s) - s\left(\frac{1}{g^2}\right)}{\frac{1}{C} - s Z_{IN}(s)}$$

$$R(s) = \frac{K Z(s) - s Z(K)}{K Z(K) - s Z(s)} \qquad K = \frac{1}{C} \qquad Z(K) = \frac{1}{g^2}$$