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ENEE 610 Outline of Lecture 1 of 08/29/01

1. Science => analysis;

   Engineering => design;

   synthesis => mathematical theory of design

2. Example of synthesis:

   admittance $y(s)=\dfrac{5s(s^2+3)}{(s^2+a)}$

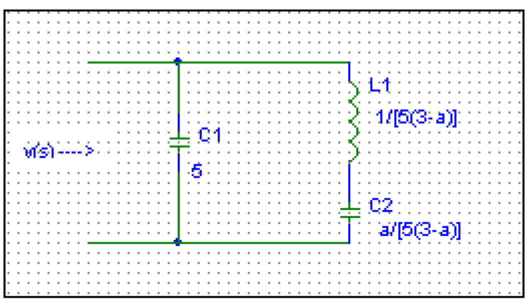
   partial fraction expansion

$$y(s)=\frac{5s(s^2+3)}{(s^2+a)}=5s+\frac{k(s+c)}{s^2+a}$$

$$: 15s=5as+ks+kc$$

$$kc=0 \text{ as } k\neq 0 \; c=0; k=5(3\text{-}a)$$

Circuit: $y(s)=5s+\dfrac{1}{\dfrac{s}{5(3-a)}+\dfrac{a}{5(3-a)}}$



Elements are positive if $3\geqslant a$, and $a\geqslant 0$; thus passive if $0\leqq a\leqq 3$ and active otherwise. If $0\leqq a\leqq 3$ then poles and zeros are simple, alternate on jω axis, with real and positive residues; in this case y(s) is positive real and lossless. In this lossless case y(s) is odd, that is the even part is zero where 2Ev[y(s)]=y(s)+y(-s), and the coefficients are real.

Definition of positive real: The (scalar) function y(s) is a positive-real function of the complex variable s=σ+jω if

1. y(σ) is real for σ > 0 (means real components)
2. y(s) is analytic in σ >0 (means some sort of stability)
3. 2Re[y(s)]=y(s)+y*(s)$\geqslant$0 in σ>0 (means a passive circuit; *=complex conjugate)

Passivity means no more energy can come out of the circuit than goes in.

Note: $y(s)=s^{1/2}$ is positive real as is y(s)=tanh(s). If y(s) is rational then coefficients are real, there are no poles in the RHP, only simple poles with real residues on the imaginary axis. An odd positive real function is lossless; examples: tanh(s) and the y(s) of above circuit.