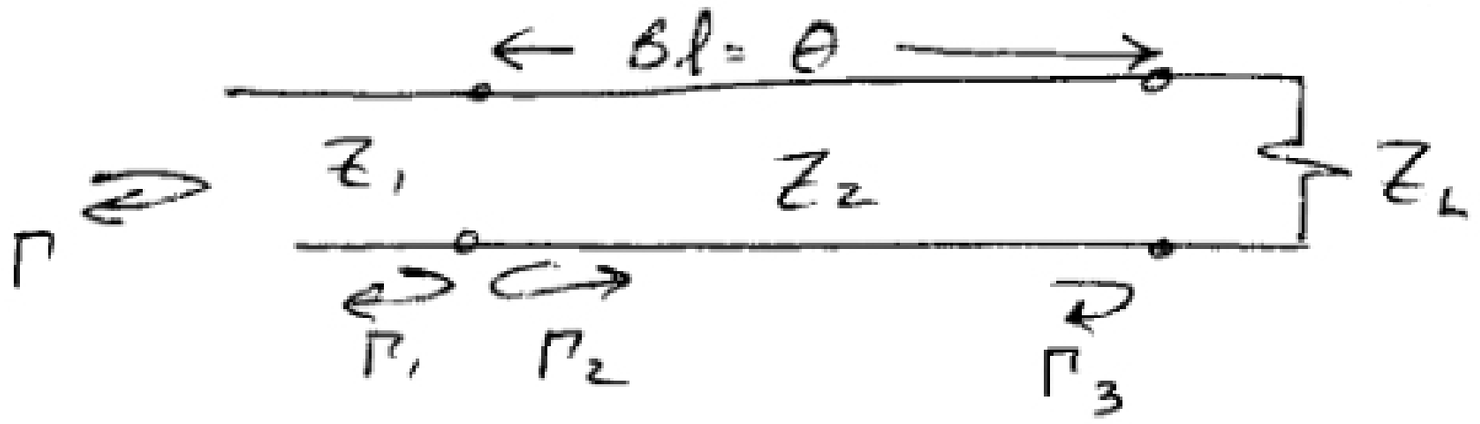
Broad Band Matching

Text Sections 5.5 + 5.6

How do you design a Broad Band match network?
Binomial, Chebyshev
Eq. 5.16, 20

General Theory:

Reconsider Single Section transformer:

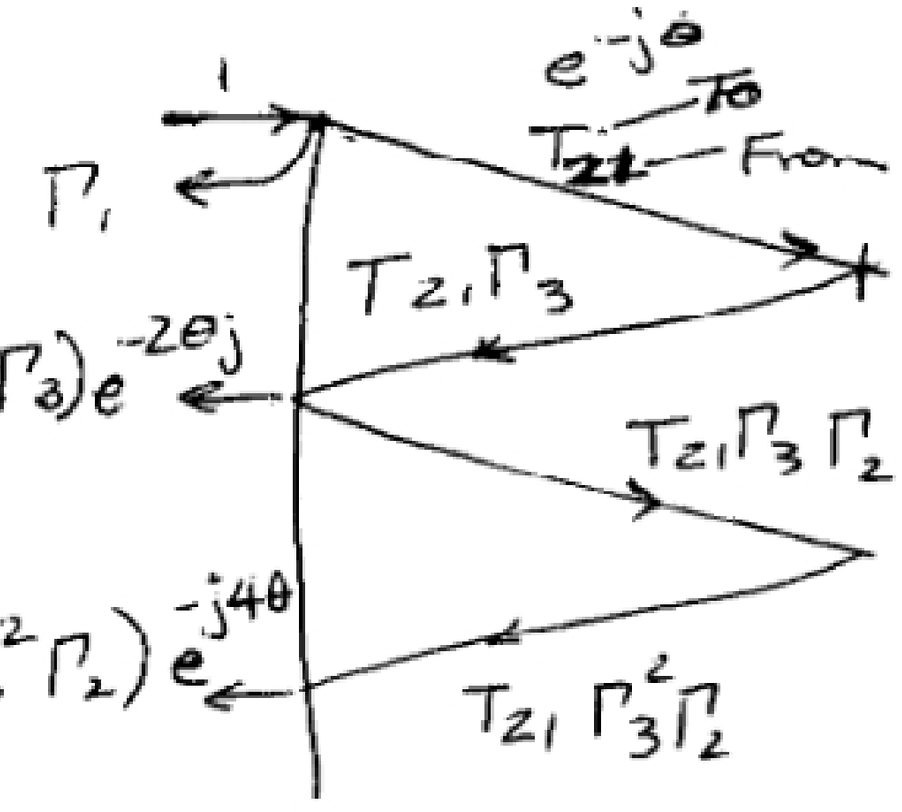


Find Γ:

$$\Gamma_1 = \frac{Z_2 - Z_1}{Z_2 + Z_1} \qquad \Gamma_2 = \frac{Z_1 - Z_2}{Z_2 + Z_1} = -\Gamma_1$$

$$\Gamma_3 = \frac{Z_L - Z_2}{Z_L + Z_2} \qquad T_{12} = 1 + \Gamma_2 \qquad T_{21} = 1 + \Gamma_1$$

$\Gamma = \Gamma_1 +$



$T_{12} T_{21} \Gamma_3 e^{-j\theta 2}$

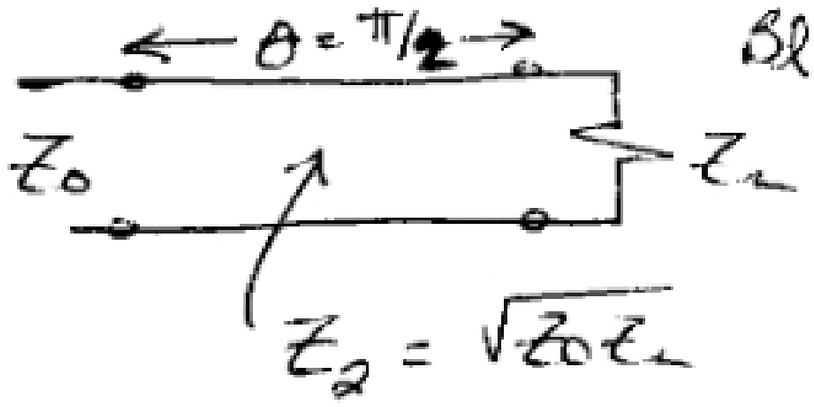
$+ T_{12} T_{21} \Gamma_3^2 \Gamma_2 e^{-j4\theta}$

$+ \ldots$

$$\Gamma = \Gamma_1 + T_{12}(T_{21}\Gamma_3)e^{-j2\theta} \sum_{n=0}^{\infty} \Gamma_2^n \Gamma_3^n e^{-jn\theta}$$

Use this to design optimal broadband matching

1. Quarter wave transformer



$\beta l = \left(\frac{2\pi}{\lambda}\right)\left(\frac{\lambda}{4}\right) = \pi/2$

$\Gamma = 0$ @ single frequency

2. Binomial Matching Network

Let $\Gamma(\theta) = A\left(1 + e^{-j2\theta}\right)^N = A \sum_{n=0}^{N} C_n^N e^{-2jn\theta}$

(N ← # of sections; C_n^N ← Binomial coefficient)

Produces flattest response of passband ~ best matching @ desired frequency some mismatch outside

Design process.

$$A = 2^{-N} \left| \frac{Z_L - Z_0}{Z_L + Z_0} \right|$$

← Use length of line to convert Z_L complex to Z_i real

N = # sections

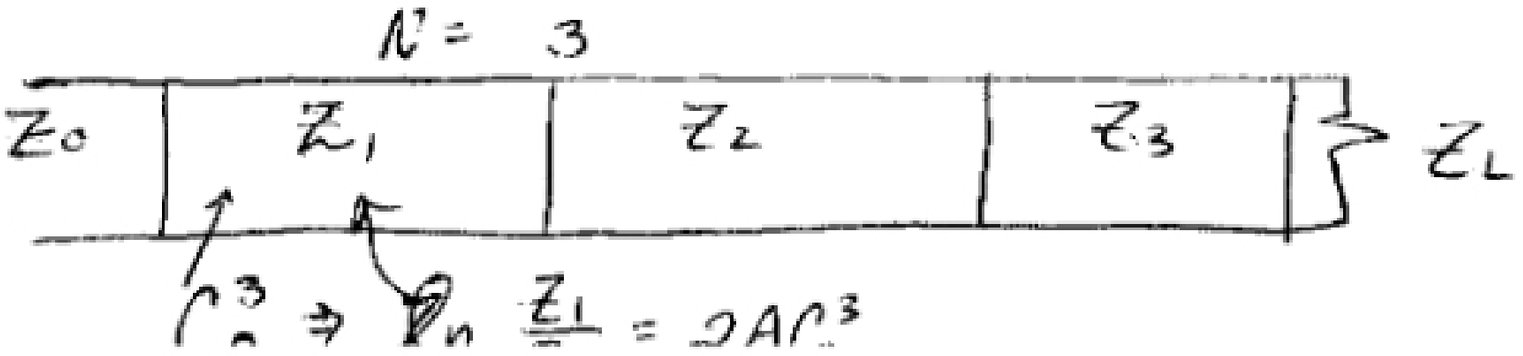
$BW = \frac{\Delta f}{f_0}$

$$C_n^N = \frac{N!}{(N-n)!\, n!} \quad \text{for} \quad n = 0 \text{ to } N-1$$

$$\ln \frac{Z_{n+1}}{Z_n} = 2 A C_n^N$$

Length: $\theta = 0$, $\beta L = 0, 360, \ldots$, $L = m\lambda$

$N = 3$



3. Chebyshev.
   Similar to binomial, but different calculation of Z_n
4. Tapered Lines

   If series (cascade) of lines provides good matching, why not a continuously-varying impedance (i.e.) a tapered line

   Many possibilities

Research Areas:

5. Optimal matching found using optimization theory on any of the above methods

   You provide a desired distribution, optimization provides a "closest fit" soln

   This is now commonly used for applications where optimal matching with minimal weights (# sections) is required & high power antenna systems.

   Addition of sections tend to increase noise in circuit, also, so they should be minimized

6. Use of PML theory may be applied to numerical work as well.

   Above theory is for normal incidence or TEM behavior. Non TEM is more complicated and can also be optimized.