Network Analysis and Synthesis
Unit-III

By

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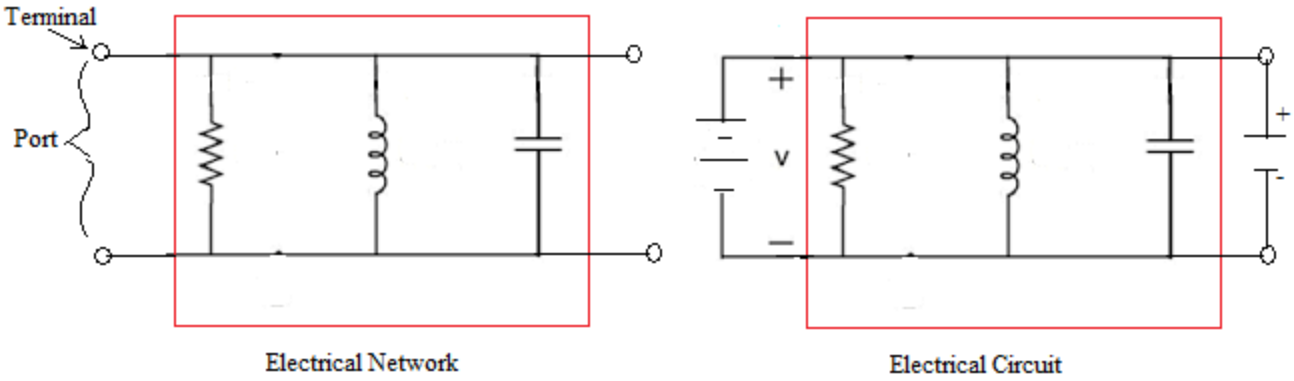
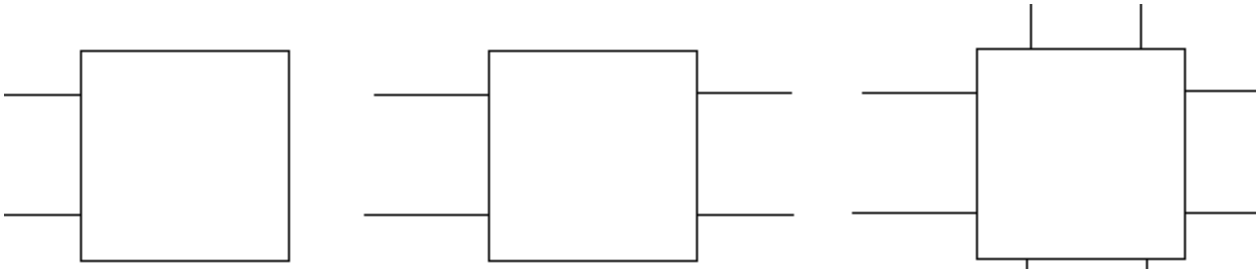
Introduction

- A network is an interconnection of basic electrical elements. A network is called an electric circuit when it has current and voltage sources connected to it. Thus an electric is a closed energized network. Figure below shows an electric network and an electrical circuit.
- A Terminal is an entry or exit point for a current, and a port is a two terminal contacts where current or potential sources are connected or measured. Terminals are used in pairs.



Electrical Network

Electrical Circuit



Single Port Network

Two Port Netwrk

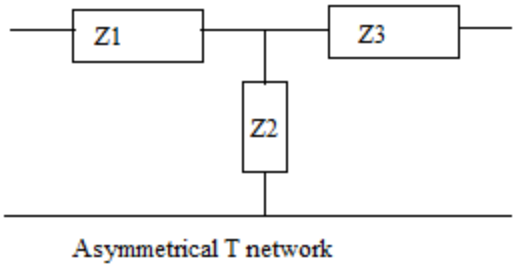
Multi-Port Network

Classification of Electrical Networks

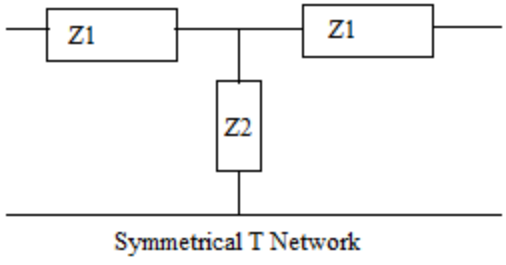
- Based on Terminals: One Port, Two-port or n-port network
- Unilateral or Bilateral
- Linear or Non-Linear
- Active or Passive
- Lumped or Distributed
- Symmetrical or Asymmetrical Network
- Balanced or Unbalanced

Classification based on Configuration

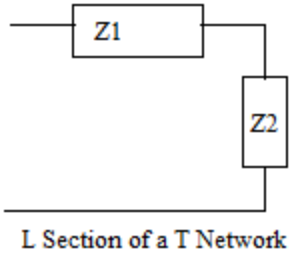
- T Type Network:
  - Symmetrical or Asymmetrical T Networks
  - Balanced or Unbalanced T Networks
  - Half T Section
  - L Section



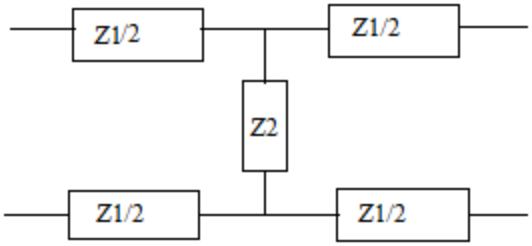
Asymmetrical T network



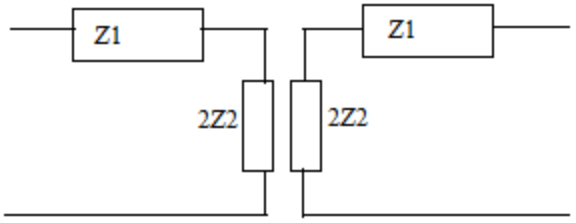
Symmetrical T Network



L Section of a T Network



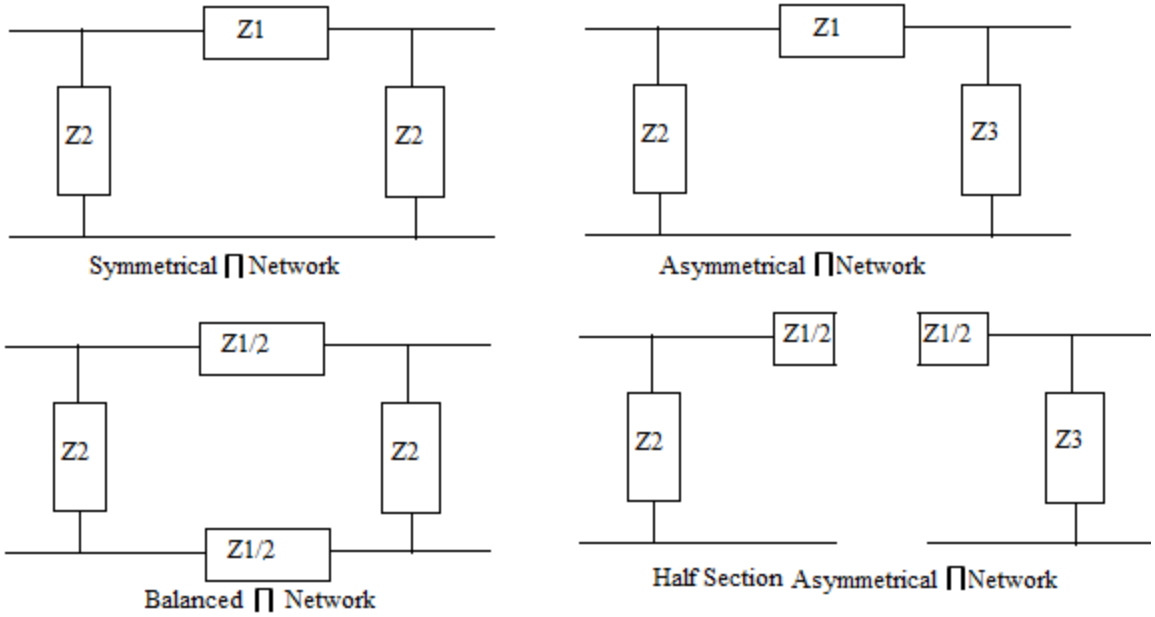
Balanced T Network



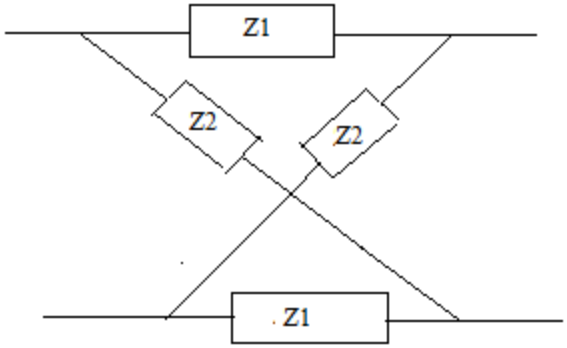
Half Section T Network

Π Network:

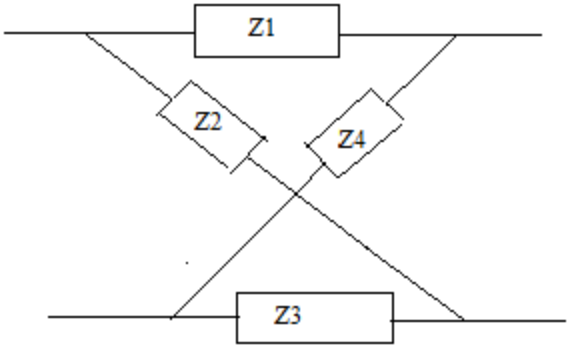
- Symmetrical or Asymmetrical Π networks
- Balanced or Unbalanced ⊓ networks
- Half T Section



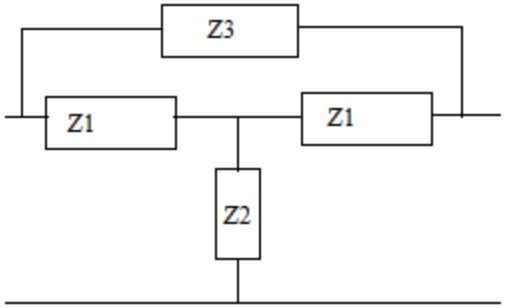
Lattice and Bridged Networks



Symmetrical Lattice Network



Asymmetrical Lattice Network



Bridged T Network

Network parameters (Based on I/O Voltage and Current)

Z, Y, h, ABCD pARAMETERS

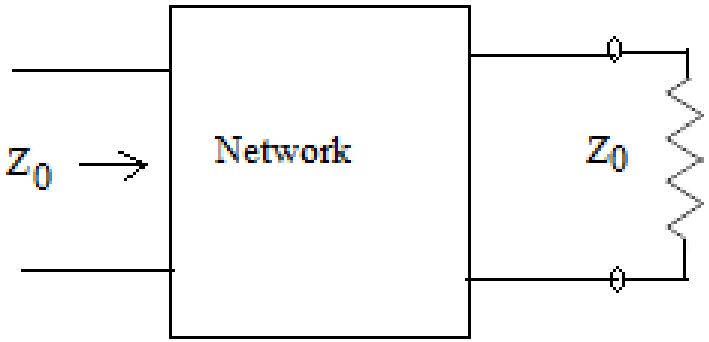
- Z Parameter (Open Circuit Impedance) $Z_{11}, Z_{12}, Z_{21}, Z_{22}$
  - This parameter is determined by first opening the output terminal and wrting the KVL equations, then opening the input terminal and writing the KVL equation for V2. We can then solve the equations by any method like Crammer's rule to determine the Y parameters.
- Y parameter (Short Circuit Admittance) $Y_{11}, Y_{12}, Y_{21}, Y_{22},$
  - This parameter is found by first shorting the output terminal and then writing the KVL equation for I1 and then shorting the input terminal and writing the KVL equation for I2. We can then solve the equations by any method like Crammer's rule to determine the Y parameters.
- Hybrid (h) Parameter $h_{11}, h_{12}, h_{21}, h_{22},$
  - The h parameter make use of the hybrid approach that is it uses both the open circuit and short circuit approach. First we short the output terminal and write the equation for V1, then we open the input terminal and write the equation for I2. We can then solve the equations by any method like Crammer's rule to determine the h parameters.
- Inverse hybrid (g) Parameter $g_{11}, g_{12}, g_{21}, g_{22},$
  - This is the dual of the h parameter representation and the equation is written as

(I1,V2) =f(V1,I2) where V1 and I2 are independent variables.

Transmission Parameters

- ABCD (Transmission) Parameter A, B, C, D
  - Transmission parameters are used in the analysis of power transmission lines, where they are also known as ‘general circuit parameters. They are also known as Chain parameters or ABCD parameters. The general equations are written as: (V1,I1) = f(V2,I2)
- Inverse Transmission Parameter A’, B’, C’, D’
  - This is the dual of the transmission parameters. The equation for this parameter is written as : (V2, I2) =f(V1,I1)

- Characteristics of Symmetrical Networks
  - Characteristic Impedance (Z_0): It is the impedance measured at the input port of a network when the infinite no. of network elements are connected



- Propagation Constant: It is defined as the ration of the current or voltage entering the network to the current or voltage leaving the network

Characteristics of Asymmetrical Networks

Iterative Impedance: It is the input impedance of a network with infinite sections at one port or the impedance measured at one port when other port is shunted with its input impedance with infinite network sections.

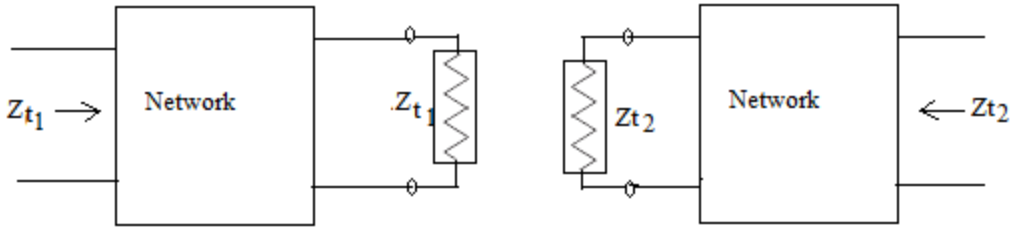
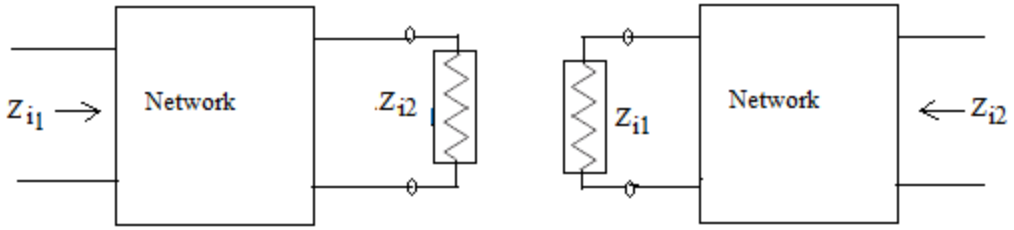


Image Impedance: Let Zi1 and Zi2 be two impedance such that Zi1 is the driving point impedance at port-1 with impedance Zi2 connected across Port-2 and Zi2 is the driving point impedance at prt-2 with Zi1 connected across port-1, then the impedances Zi1 and Zi2 are called image impedance of the network.



Iterative transfer Constant: If an asymmetrical network is terminated with iterative impedance, then the factors affecting the energy propagation are defined in terms of iterative transfer constant Qt. It is a complex number.

Image Transfer Constant: In asymmetrical networks, the factors affecting the propagation of energy is defined in terms of image transfer constant Qi if the network is terminated in image impedance.