

Network Analysis and Synthesis



Er. S.K. PANDEY

S. CHAND



As per new syllabus

Network Analysis and Synthesis

(SEMESTER IV)

**[For B.E./B.Tech. Students for Fourth Semester of all Engineering Colleges of
Maha Maya Technical University (Noida), Gautam Buddha Technical University
(Lucknow), Uttarakhand Technical University, Punjab Technical University and
also useful for other Technical Universities]**

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PREFACE TO THE FIRST EDITION

After 14 years of teaching experience, this textbook on Network Analysis and Synthesis is an endeavour towards providing students with a solid grounding in the foundations of this subject. It is suitable for use as a one - semester course material by undergraduate students of Electrical Engineering (EE) and Electrical & Electronics Engineering (EN).

The text book is organised into 8 chapters. The outline of the book is as follows :

Chapter 1 describes the basics of electric circuit theory.

Chapter 2 deals with laplace transform and its application for solving differential equation and also used for analysis of network.

Chapter 3 describes the graph theory approach of network analysis.

Chapter 4 In this chapter, in case of large network, if we are interested in the analysis of a part of the network, network theorems are more useful which are the subject of study in this chapter.

Chapter 5 deals with network functions. Driving point and transfer functions of various types of one and two - port networks have been discussed in this chapter. Complex frequency has been also described.

Chapter 6 two - port networks.

Chapter 7 deals with Bode plot.

Chapter 8 on passive network synthesis. Here elements fo realisability theory for such network have been presented and both Foster and Cauer forms of realisation have been explained

Chapter 9 deals with passive filters. Appendix includes some important mathematical portion which are useful in this book.

Er. S.K. Pandey
Asstt. Professor.

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I thank my publishers M/s S.Chand & Company for accepting to publish this book. My thanks in particular go to the publishing advisor Mr. R.S. Saxena for initiative of accepting of this book.

Finally, I am deeply indebted to my family. My mother (Bhagwani Pandey) and father (Mr. R.R.Pandey), who is the source of inspiration for this activity and without whose cooperation this work would not have been completed, my sons Vikash and Saurabh and my best friend Mr. P.P. Verma, Ms. Babita Tiwari, Vishal and Sachin for motivating and encouraging me constantly to undertake and complete this work.

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The author will gratefully acknowledge constructive criticism from both students and staff for further improvement of this book.

Er. S.K. Pandey
Asstt. Professor.

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&
GAUTAM BUDDHA TECHNICAL UNIVERSITY, LUCKNOW

B. Tech. IInd year (IV Semester) Electrical Engg. / Electrical & Electronics Engg.

EEE-402: NETWORK ANALYSIS AND SYNTHESIS

Unit-I:

Graph Theory : Graph of a Network, definitions, tree, co-tree, link, basic loop and basic cut set, Incidence matrix, cut-set matrix, Tie-set matrix Duality, Loop and Nodal methods of analysis.

(Refer to chapter-3)

Unit-II:

Network Theorems (Applications to a.c. networks) : Super-position theorem, Thevenin's theorem, Norton's theorem, maximum power transfer theorem, Reciprocity theorem. Millman's theorem, compensation theorem, Tellegen's theorem.

(Refer to chapter-4)

Unit-III:

Network Functions : Concept of Complex frequency, Transform Impedances, Network functions of one port and two port networks, concept of poles and zeroes, properties of driving point and transfer functions, time response and stability from pole zero plot.

(Refer to chapter-5)

Unit-IV:

Two Port Networks : Characterization of LTI two port networks ZY, ABCD and h -parameters, reciprocity and symmetry. Inter-relationships between the parameters, inter-connections of two port networks, Ladder and Lattice networks. T & Π Representation.

(Refer to chapter-6)

Unit-V:

(a) **Network Synthesis :** Positive real function; definition and properties; properties of LC , RC and RL driving point functions, synthesis of LC , RC and RL driving point immittance functions using Foster and Cauer first and second forms.

(Refer to chapter-8)

(b) **Filters:** Image parameters and characteristic impedance, passive and active filter fundamentals, low pass, highpass, (constant K -type) filters, and introduction to active filters.

(Refer to chapter-9)

UTTARAKHAND TECHNICAL UNIVERSITY

TEE – 301: NETWORK ANALYSIS AND SYNTHESIS

- 1. Graph Theory :** Graph of a Network, definitions, tree, co tree, link, basic loop and basic cut set, Incidence matrix, cut-set matrix, Tie-set matrix Duality, Loop and Node methods of analysis.
(Refer to chapter-3)
- 2. Network Theorems (Applications to a.c. networks) :** Super-position theorem, Thevenin's theorems Norton's theorem, maximum power transfer theorem, Reciprocity theorem, Millman's theorem, compensation theorem, Tellegen's theorem.
(Refer to chapter-4)
- 3. Network Functions :** Concept of Complex frequency, Transform Impedances, Network functions of one port and two port networks, concept of poles and zeroes, properties of driving point and transfer functions, time response and stability from pole zero plot, frequency response and Bode plots.
(Refer to chapters-5, 7)
- 4. Two Port Networks :** Characterization of LTI two port networks ZY, ABCD and h parameters, reciprocity and symmetry. Inter-relationships between the parameters, inter-connections of two port networks, Ladder and Lattice networks. T & Π Representation.(Refer to chapter-6)
- 5. Network Synthesis :** Positive real function; definition and properties; properties of LC , RC and RL driving point functions, synthesis of LC , RC and RL driving point immittance functions using Foster and Cauer first and second forms.
(Refer to chapter-8)

PUNJAB TECHNICAL UNIVERSITY

EE-201: NETWORK ANALYSIS AND SYNTHESIS

Circuits Concepts : Circuits elements,

Independent and dependent sources, signals and wave forms; periodic and singularity voltages, step, ramp, impulse, Doublet, Loop currents and loop equations, node voltage and node equations, Network Theorems, Superposition, Thevenin's, Norton's, Maximum Power Transfer, Reciprocity.

(Refer to chapters-1, 2, 4)

Time and Frequency Domain Analysis:

Representation of basic circuits in terms of generalised frequency & their response, Laplace transform of shifted functions, transient & steady response. Time domain behaviors from poles and zeros. Convolution Theorem.

(Refer to chapters-2, 5)

Network Synthesis:

Network functions, Impedance & Admittance function, Transfer functions, Relationship between transfer and impulse response, poles and zeroes and restrictions, Network function for two terminal pair network. Sinusoidal network in terms of poles & zeroes. Real liability condition for impedance synthesis of RL & RC circuits. Network synthesis techniques for 2-terminal network, Foster and Cauer forms.

(Refer to chapters-5, 6, 8)

Filters Synthesis:

Classification of filters, characteristics impedance and propagation constant of pure reactive network, Ladder network, T section, IT section, terminating half section. Pass bands and stop bands. Design of constant- K , m -derived filters, Composite filters.

(Refer to chapter-9)

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 - Theoretical questions.
 - Numerical questions.

Appendix-A : Cramer's Rule

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Appendix-B : Solution of quadratic equation.

Appendix-C : Some important Factors.

Appendix-D : Matrices.

Appendix-E : Laplace Transforms.

Appendix-F : Partial Fractions

Appendix-G : Complex and Polar forms

Appendix-H : Question paper of previous years.

1

CHAPTER

Basic of Electrical Circuit Theory

1.1 NETWORK TERMINOLOGY

Circuit: A circuit is a closed energized interconnection of electrical elements.

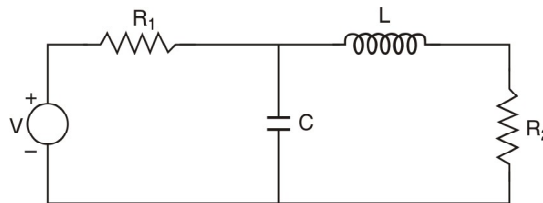


Fig 1.1

Network: A network is an interconnection of electrical elements.

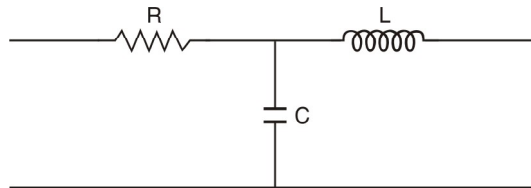


Fig 1.2

It is to be noted that all circuits are networks but reverse of it is not possible always.

Parameters: The various elements of an electric circuit are called its parameters like R , L and C . These parameters may be *lumped* or *distributed*.

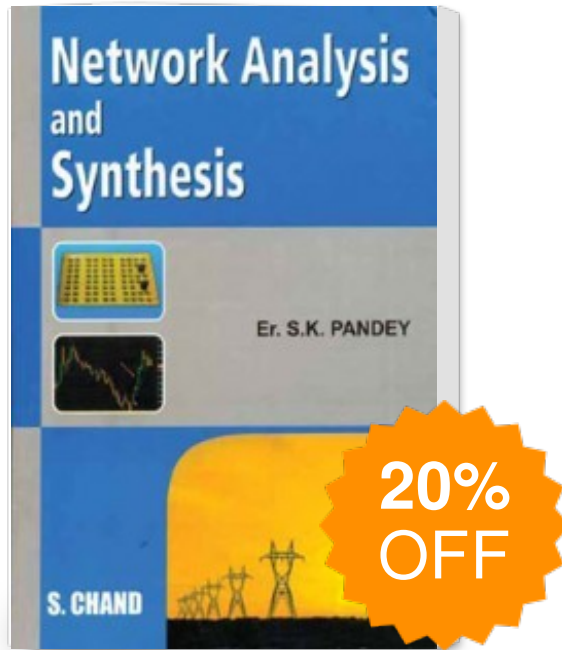
Linear Circuit: A linear circuit is one whose parameters are constant *i.e.* they do not change with voltage or current. The Ohm's law and super position theorems are applicable for such type of networks.

Non-Linear Circuit: It is that circuit whose parameters change with voltage or current. The Ohm's law and super position theorems are not applicable for such type of networks.

Bilateral Circuit: A bilateral circuit is one whose properties or characteristics are the same in either direction. The usual transmission line is bilateral, because it can be made to perform its function equally well in either direction.

Unilateral Circuit: It is that circuit whose properties or characteristics change with the direction of its operation. A diode rectifier is a unilateral circuit, because it cannot perform rectification in both directions. Then networks containing elements such as diodes, transistors etc. are unilateral networks.

Network Analysis Synthesis



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