are more extensively discussed later in the text.

Section 4 discusses some examples of unbalanced system conditions. It first discusses loads and then introduces symmetrical components. This section emphasizes a basic understanding of sequence networks and does not summarize zero sequence representations of transformers. The student needs to demonstrate that basic understanding in an exercise analyzing an unbalanced load, which appears at the end of the chapter.

Section 5 details the symmetrical component representation of transmission lines through detailed numerical examples of both single and double circuits. Electromagnetic and electrostatic unbalanced conditions are discussed for unbalanced lines.

Section 6 shows the symmetrical component representation of transformers. The section begins with a Y-Δ transformer, but it extensively explains a 90° positive sequence phase shift instead of the expected 30° one that is in common use. The section continues with zero sequence representations of various transformer connections, including grounding transformers and zig-zag transformers.

Section 7 demonstrates the sequence connections for various types of unbalanced faults. Because results are only briefly summarized, the interested student should review the basic transformation equations discussed in Section 4 to have a better understanding of their derivation.

Section 8 discusses the design of untransposed transmission lines and their representation with symmetrical components. Conversion of the "unsymmetrical" symmetrical component matrix to a "symmetrical" matrix using a transposition matrix is discussed.

Finally, Section 9 reviews Clarke components. It was refreshing to see these components explained in a text, but I would have like to see more examples and exercises.

A strong background in fields and waves and some basics of power engineering is required to fully understand this graduate-level book. Readers would be well served by fully understanding the material covered in the appendices prior to reading the main sections of the textbook. The appendices comprise approximately 1/3 of the book and cover the following:

- ✔ Principles of electricity and magnetism: reviews the basic electromagnetic concepts underlying the physical discussions presented in the book.
- ✔ Concept of flux-linkage and inductance: explains Faraday's law and inductance.
- ✔ Electromagnetic field above a perfectly conducting plane: examines the charge distribution on a perfectly conducting plane resulting from a perfectly charged line above it.
- ✔ Carson's earth-return correction factors: discusses wave propagation along a transmission line over a simplified model of the earth and formulas for calculating the inductive disturbances in neighboring transmission systems.
- ✔ Matrix algebra: concisely reviews concepts of matrix algebra.
- ✔ Magnetic energy in transformers: shows the total magnetic energy stored in power transformers on common closed magnetic cores.
- ✔ Exciting current in three-legged core-type transformer: discusses the fundamental frequency as well as the third- and fifth-harmonic magnetizing current.
- ✔ Hyperbolic functions: defines these functions, which are useful for the study of long transmission lines.
- ✔ Equivalent networks: discusses two-port, gamma and reverse gamma, and delta and wye networks; additional forms, operations, and theorems are reviewed.
- ✔ Y-Δ relationships: uses a matrix approach.
- ✔ Analysis of electromagnetic circuits: briefly reviews material that should have been covered in undergraduate courses.

The list of symbols and contexts at the end of the appendices is particularly helpful to all readers.

The writing style is clear but very heavily mathematical and sometimes without references to equations covered in previous sections. A more complete explanation of the equations would facilitate learning by students new to the subject. The exercises were relevant and facilitate understanding. Solutions to some of the exercises included with several of the sections would be beneficial to all students. Several sections mention topics of interest and then provide references without further explanation. It is my hope that future editions of the text more fully address these topics and expand discussions of other fundamentals, such as phase angle transformers and load tap changers. The figures were clear and helpful.

*Principles of Power Engineering Analysis* successfully presents graduate-level material on both transmission lines and transformer characteristics and a detailed treatment of symmetrical components. The book fills the need for a text with a physical approach to electric power engineering and is timely given the growth of electric transmission expansion and the crying need for personnel who understand both basics and some advanced concepts. As one of "Dr. Greenwood's boys" at RPI, I wish this text had been available to me then and am glad that I now have it as a reference. The book, however, is not for those who are new to the topics discussed.

*—Michael I. Henderson*

## Distribution System Modeling and Analysis

*By William H. Kersting, third edition, 2012, ISBN 13: 978-0849358067*

This new edition is very timely given the international attention on smart grids, including increased demand for better modeling and analysis methods to support planning and operations of smart distribution systems. The book

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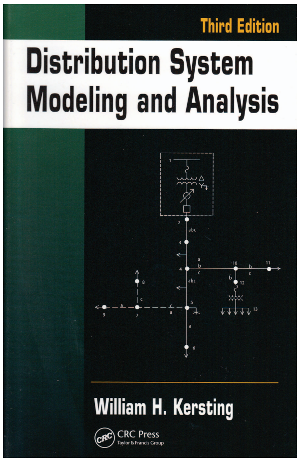
is an authoritative textbook on the subject of distribution system modeling and analysis. It develops models for each component in a distribution feeder using generalized matrices and develops the modified ladder technique to perform load flow analysis and a method in the phase domain to perform short-circuit analysis.

The book begins with an introductory chapter about the basic components of a distribution system and a practical overview of radial feeders. Then it leads into the second chapter with a thorough and real-world discussion about the nature of loads including the terminology for describing the changing load in a distribution system and an overview of how load is defined for individual customers as well as how the demand of the aggregated customer loads of a distribution transformer is computed. In Chapter 3, approximate methods are given for computing the voltage drop and power loss of line segments with uniformly distributed loads and for geometric areas with constant load densities. Chapters 4 and 5 present methods for computing the phase and sequence impedances and shunt admittances of overhead lines and underground cables using modified Carson's equations.




In Chapters 6–8, the phase frame models for the series components (distribution line segments, step-voltage regulators, and transformer banks) are developed. In Chapter 9, phase frame models for the shunt components (static loads, induction machines, and capacitor banks) are presented. Models for constant impedance (Z), constant current (I), and constant real and reactive power (P) loads are developed for wye connected or delta connected, three-phase, two-phase, or single-phase loads with any degree of unbalance. In addition, an extended model is developed for a three-phase induction machine operating as a motor or generator.

In Chapter 10, the modified ladder technique is derived and demonstrated through the analysis of a general radial distribution feeder under normal steady-state operating conditions (power-flow analysis) and under short-circuit conditions (short-circuit analysis). The phase frame models of the series and shunt components are used in the power flow analysis.

Further an unbalanced feeder is modeled for short-circuit calculations, and models for each type of short circuit are developed. In Chapter 11, models for the single-phase, center-tapped transformer and the three-phase transformer banks using the center-tapped transformer are developed and demonstrated.

I have used the earlier editions of this book multiple times over the last decade to teach a distribution systems analysis graduate course. The book is well written for use by professors teaching a senior-level or introductory graduate course in distribution systems analysis, as well as for students and practicing engineers looking for a reference textbook with theory and detailed examples on distribution component models and system analysis techniques. A detailed example follows the development of each new component model and analysis technique, which includes step-by-step explanations of the derivations and intermediate calculations. Further problems are included at the end of each chapter to study the component and feeder models and analysis techniques for various phasing and types of connections.

The new material in the third edition enhances the earlier editions by putting a greater emphasis on the implementation of the component models in a computer program for purposes of planning and for real-time analysis. According to the author, a major effort was made to demonstrate, through the use of several examples, computer programs that can be developed to assist the engineer in the planning and operation of present and future systems. The major additions are as follows:

- ✔ As new component models are introduced in the textbook, an example is included to demonstrate how a Mathcad program can simplify the analysis. Further, some homework assignments are recommended to be solved by writing a computer program in Mathcad or some other programming language. The inclusion of the Mathcad examples and problems in this new edition will provide many opportunities for students/engineers to develop skills in the implementation of the computer calculations for a simple feeder, which is critically important today. Practicing engineers are now expected to be able to write short programs to perform quick calculations to assist in making engineering decisions. MATLAB may have been a better choice for use in this textbook because it is a more commonly used computational tool of college students. However, students should be able to easily transfer the Mathcad examples into MATLAB code, if desired.
- ✔ Another major addition is the use of Milsoft Utility Solutions Inc.'s distribution analysis program Windmil. Milsoft has made available a student version of Windmil along with a user manual that can be downloaded from the company's Web site. Many of the examples in this textbook are included in the user manual. The new edition revised the problems from the earlier editions, which were to be solved using the Radial Distribution Analysis Package (RDAP), to be solved using Windmil. Also starting in Chapter 4, there is a Windmil assignment at the end of each chapter. Each assignment in Chapters 4–9 builds on the system studied in the previous chapter with the addition of the type of component model studied in that chapter. The Windmil assignments in Chapter 10 encompass the implementation of a 13-node feeder using given system data and the determination of settings of voltage regulators and capacitor bank. The Chapter 11 assignments expand the system developed in Chapter 10 with transformers and secondary loads. The inclusion of Windmil assignments demonstrates how a commercial program such as Windmil can be used for studying complex systems.
- ✔ In the earlier editions, the modified ladder technique was not introduced until Chapter 10. In this new edition, the modified iterative ladder technique is introduced in Chapter 6 to demonstrate the computation of load voltages and currents for a nonlinear system with distribution lines serving constant PQ loads. The modified ladder technique is demonstrated for the voltage regulators in Chapter 7, the various transformer connections in Chapter 8, and the load models in Chapter 9. The technique is fully developed in Chapter 10. When teaching my distribution analysis course with the earlier editions, after completing Chapter 6, I would skip to Chapter 10 and present the modified ladder technique. Then I would use the technique to present examples for each component model in Chapters 6–9. It is exciting to see that the author has now introduced the modified ladder technique in Chapter 6 and included examples and homework assignments in Chapters 6-9 that use the technique with each component model in a simple system. This change will greatly benefit students/engineers as it allows for more detailed discussion of the component models and their parameters in the chapter where the individual component model is introduced.

Overall this new edition includes additions that will make this textbook even more attractive for a distribution course or for students/engineers wishing to learn about the subject on their own. In addition to the detailed examples and problems, the Windmil assignments provide case studies for students/engineers to gain a more practical understanding of distribution system modeling and analysis.

*—Karen Butler-Purry*