Foreword

This is an ambitious book that deals with all major subjects comprising electric power engineering, including generation, transmission, distribution and consumption. The authors are well-recognized experts in this field. Their explanations of complex concepts are very clear, and are an especially attractive feature of this book. I have had the good fortune to be associated with them and their Institution in Grenoble for over a decade, and I have thoroughly enjoyed interacting with them on technical and other matters.

The organization and layout of the book is very pleasing. The figures are well thought out and are a great aid in understanding the concepts being discussed. The style of writing flows well, and it is clear that in their presentations the authors are constantly thinking of the reader – most likely a student who is being exposed to these ideas for the first time. The last part of the book, which presents worked out examples and exercises, will be particularly appreciated by students.

I am most familiar with the curricula in North American universities. A book such as this would best serve third or fourth year undergraduate students who wish to pursue a power engineering career. The viewpoint of the authors is naturally that of French academicians – and many of the power system examples they take are from the French technological environment. But clearly the

development of theory of power system engineering is applicable to power systems throughout the world. In particular, with the material on alternative generation resources, energy markets and deregulation of the electric power industry, the book has a universal appeal.

Part 1 of the book starts with a general discussion of the power system paradigm, which is central to the subject: generation, which is centralized, and loads, which are distributed. From this paradigm follows the need for transmission and distribution infrastructure. Major power equipment, such as transmission lines, transformers and cables, is discussed in detail in this part. Part 2 of the book is dedicated to the development of matrix formulation for load flow, short circuit and stability computations. The network matrices are given special attention. This part is mathematically the most demanding, and a careful study of the material will prepare the aspiring student for work in the field of electric power engineering. Part 3 deals with energy market developments. The effect of worldwide deregulation of power system operations are discussed in great detail. Congestion management is also given sufficient attention. In all chapters there are references to national and international technical literature, which will be useful to students pursuing studies in depth. As mentioned above, Part 4 of the book, which deals with problems and exercises for students, should be a particularly useful section of this four-part treatise.

In conclusion, this is a highly readable book that will be a welcome addition to the library of technical literature on electric power engineering. This book may well be the best modern introduction to our field. I have no doubt that it is well suited for use in the power engineering courses in North America as well as in other countries around the world.

A.G. Phadke

University Distinguished Professor Emeritus
Virginia Tech, Blacksburg, Virginia, USA
July 2009

Introduction

The development of electric power systems has been made through incremental innovations from the end of the 19th century and throughout the 20th century. The creation of deregulated electricity markets brings an emerging paradigm in which the relationships between producers, power systems operators and consumers have strongly changed as compared to the monopolistic case.

The scope of this book is to provide fundamental concepts of the physics and operation of transmission and distribution lines in Part 1:

– two paradigms of the world electrical power system;

– production of electrical energy;

– general information on electrical power grids;

– network architecture;

– operation of electric lines;

– high voltage direct current (HVDC) transmission;

– three-phase transmission lines;

– electrical transients in transmission.

This is followed in Part 2 by the models and tools for the description and simulation of large electrical grids for steady state and transient operations:

– functions of electrical energy systems;

– network representation;

– formation of the network matrices;

– load flow calculations**;**

– transient analysis methods;

– fault current calculations;

– stability analysis of power systems.

These advanced tools allow the physics and technology of power systems to be described and the algorithms of Y_{bus} and Z_{bus} matrices to be built for various studies, such as short-circuit studies and load flow or transient phenomena analysis.

Part 3 deals with the new organization concepts in the frame of deregulated markets:

– basic electrical system**;**

– liberalization of energy markets;

– description and models of energy markets;

– ancillary services**;**

– available transmission capability;

– congestion management;

– network access and charges.

In this part, restructuring of the power industry is presented where various parties interact together through market places or bilateral contracts.

In addition, the operation of power grids under this deregulated context is detailed and the relationships between power system operators and market stakeholders (energy producers and providers, traders…) is explained with several examples. Ancillary services, congestion management and grid access concepts are also described.

A large number of exercises and problems are disseminated throughout the book with solutions in Part 4, allowing the reader to check at any time his or her understanding of the content.

Nouredine HADJSAÏD and Jean-Claude SABONNADIÈRE