Preface

In the past two decades, modern power systems have evolved at a fast pace, growing from the traditional bundled-service infrastructure to a more deregulated and market-oriented environment. Generation resources are expanded from large centralized fossil-fueled power plants to smaller distributed generations from renewable sources. In light of the need to monitor and control power grids in real time, the intelligence of power system operation has evolved from the more human, experience-based classic information and communication technologies to the smart grid era to avoid cascaded blackouts and bring in the real-time control capabilities of the systems. Though the modern power systems are with increasing complexities, the requirements of reliable and efficient operation of the systems still remain the same.

This book is an adaptation of *Power System Analysis* and *Elements of Power System Analysis* written by Professor Emeritus John J. Grainger and the late Professor William D. Stevenson of North Carolina State University. The original contents have been revised with the inclusion of some new contents to keep up with the recent advances in electric power engineering. The revised work is intended to give the undergraduate or the first-semester graduate students who study power systems and need a comprehensive and fundamental knowledge to understand the major topics commonly encountered in the present day. The book also gives its readers a sound understanding of the underlying principles of the basic elements of the modern power system including generation, transmission, operation, and control with practical examples for the analysis of real-life problems.

The first chapter of this book briefly goes over the main subjects for the study of the modern power system. The introductory contents include a historical review of the evolution, key components and the control and operation of modern power systems. The electric utility deregulation and smart grid concepts are described as well.

Chapter 2 overviews the fundamentals of single-phase and three-phase AC circuit theories for the study of power system analysis. In Chapter 3, the steady-state operations of electric machinery including transformers and synchronous machines are addressed. Chapter 4 covers the derivations of transmission line parameters and Chapter 5 describes the equivalent circuit models of different

lengths of lines. Chapter 6 deals with the principles of network analysis to form the bus admittance and impedance matrices used for power-flow and short-circuit analyses. In Chapter 7, several commonly used power-flow methods are introduced. The fault analysis and symmetrical components are described in Chapters 8 through 10 to provide an understanding of the calculation of short-circuit currents and voltages during any abnormal states the power system may encounter. Chapter 11 emphasizes the protection principles and devices used for the protection of different power system components. The economic dispatch of generation units within a plant and between different plants is addressed in Chapter 12, where the issues of considering transmission line losses are also included. Modern automatic generation control for the power plants is then introduced. Chapter 13 focuses on the analysis of generator behaviors when the power system suffers different levels of disturbances. It begins with the classic two-machine problem and the numerical analysis methods for transient stability study are presented next.

In this book, examples and review questions are illustrated and homework problems are provided at the end of each chapter. MATLAB®† programs developed under GUIDE (Graphical User Interface Development Environment) are provided for most examples to facilitate the understanding of underlying concepts and learn skills of simulations with the software package. This educational tool will help the readers to calculate the power system problems easily and more quickly. The hand calculation results can also be validated by the solutions obtained by executing this software tool. MATLAB can be used to obtain power system problem solutions that involve different types of vector-matrix operations and numerical analysis methods. It is recommended that readers use MATLAB Release 2013a or a newer version for executing the program. The MATLAB-based educational tool is available at McGraw-Hill's Online Learning Center. To access the Online Learning Center, please visit www.mheducation.asia/olc/grainger.

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