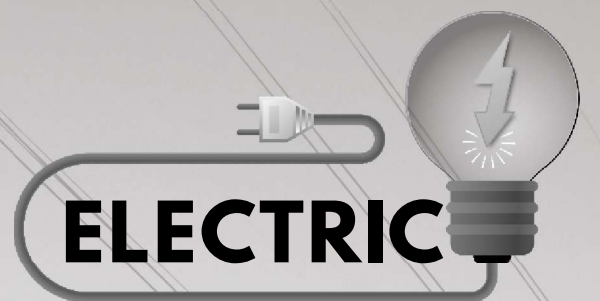






ELECTRIC

POWER DISTRIBUTION & Its Optimization Techniques

Editors
Norzanah Rosmin
Dalila Mat Said



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Editor Penyelaras/Acquisition Editor: **RASYIQAH ABDUL RANI**
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Diatur huruf oleh /Typeset by:
NORZANAH ROSMIN & DALILA MAT SAID
Faculty of Electrical Engineering
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CONTRIBUTORS

Dalila Mat Said *Centre of Electrical Energy Systems (CEES), Institute of Future Energy, Universiti Teknologi Malaysia, Johor Bahru*

Eric Rudolphe Chan Sai Hong *Faculty of Electrical Engineering, Universiti Teknologi Malaysia, Johor Bahru*

Felix Ericson David Hamonangan *Faculty of Electrical Engineering, Universiti Teknologi Malaysia, Johor Bahru*

Gobikumaran Jayaraman *GVM&E Engineering, Slim River, Perak*

Jasrul Jamani Jamian *Centre of Electrical Energy Systems (CEES), Institute of Future Energy, Universiti Teknologi Malaysia, Johor Bahru*

Khairul Huda Yusoff *Faculty of Information Science & Engineering Management and Science University, Selangor*

Madihah Md Rasid *Centre of Electrical Energy Systems (CEES), Institute of Future Energy, Universiti Teknologi Malaysia, Johor Bahru*

Mohd Hafizi Ahmad *Faculty of Electrical Engineering, Universiti Teknologi Malaysia, Johor Bahru*

Mona Riza Mohd Esa *Faculty of Electrical Engineering, Universiti Teknologi Malaysia, Johor Bahru*

Muhamad Ruzaini Abdul Rahim *Faculty of Electrical Engineering, Universiti Teknologi Malaysia, Johor Bahru*

Muhammad Haziq Mohd Wazir *Faculty of Electrical Engineering, Universiti Teknologi Malaysia, Johor Bahru*

Norazliani Md Sapari *Centre of Electrical Energy Systems (CEES), Institute of Future Energy, Universiti Teknologi Malaysia, Johor Bahru*

Norhafezaidi Mat Saman *Faculty of Electrical Engineering, Universiti Teknologi Malaysia, Johor Bahru*

Norzanah Rosmin *Centre of Electrical Energy Systems (CEES), Institute of Future Energy, Universiti Teknologi Malaysia, Johor Bahru*

Nur Ayeesha Qisteena Muzir *Centre of Electrical Energy Systems (CEES), Institute of Future Energy, Universiti Teknologi Malaysia, Johor Bahru*

Nurul Nadia Ibrahim *Centre of Electrical Energy Systems (CEES), Institute of Future Energy, Universiti Teknologi Malaysia, Johor Bahru*

Rasyidah Mohamad Idris *Centre of Electrical Energy Systems (CEES), Institute of Future Energy, Universiti Teknologi Malaysia, Johor Bahru*

Rizda Fitri Kurnia *Faculty of Electrical Engineering, Universiti Teknologi Malaysia, Johor Bahru*

Rozana Alik *Faculty of Electrical Engineering, Universiti Teknologi Malaysia, Johor Bahru*

Siti Maherah Hussin *Centre of Electrical Energy Systems (CEES), Institute of Future Energy, Universiti Teknologi Malaysia, Johor Bahru*

Wong Sui Jing *Faculty of Electrical Engineering, Universiti Teknologi Malaysia, Johor Bahru*

PREFACE

The purpose of this book is to provide readers with a comprehensive understanding of optimization techniques in electric power distribution systems, particularly in the context of today's rapidly evolving energy landscape. Our goal is to bridge the gap between theoretical concepts and practical applications, enabling students, engineers, and researchers to grasp both the fundamentals and advanced approaches needed to tackle real-world challenges in distribution networks.

The background of this book lies in the increasing complexity of modern grids, shaped by rising electricity demand, environmental concerns, and the growing penetration of distributed generation (DG), renewable energy sources, and smart grid technologies. These developments have introduced new opportunities but also significant challenges in maintaining efficiency, stability, reliability, and sustainability within distribution systems. Optimization has therefore emerged as a key enabler of progress in this field.

The scope of the book covers a wide range of optimization techniques and applications, including signal processing methods for voltage sag recognition, lightning protection design, nanocomposite-based insulation materials, passive power quality monitoring, economic dispatch optimization, harmonic mitigation, distribution network reconfiguration, voltage stability assessment, and hybrid microgrid optimization. While the book is broad in its coverage, it is not intended to replace specialized texts on transmission systems, advanced control theory, or pure materials science. Instead, it focuses on their application within the specific context of power distribution systems.

The target audience includes undergraduate and postgraduate students in electrical engineering, practicing engineers working in

utilities and industries, as well as researchers exploring new solutions in optimization, computational intelligence, and smart grids. For students, the book provides structured learning material; for engineers, it offers practical insights; and for researchers, it identifies future directions and open problems.

Our inspiration and motivation for writing this book stem from our teaching, research, and professional experiences in electric power systems. Over the years, we observed a lack of integrated resources that connect classical distribution challenges with modern optimization-driven solutions. This book is an effort to consolidate knowledge from different domains — Engineering, materials science, and computational methods into one cohesive resource.

We gratefully acknowledge the contributions of our colleagues, students, and research collaborators at Universiti Teknologi Malaysia (UTM) and other partner institutions. Special thanks are also extended to the Centre of Electrical Energy Systems (CEES), the Institute of Future Energy (IFE) and Faculty of Electrical Engineering (FKE), UTM for their encouragement, resources, and continuous support. Without their input and assistance, this book would not have been possible.

The structure of the book follows a logical progression: Chapter 1 introduces the background, challenges, and significance of optimization in power distribution. Chapters 2–4 focus on foundational aspects, including signal processing, lightning protection, and insulation materials. Chapters 5–7 then examine monitoring and optimization methods such as passive power quality monitoring, economic dispatch, and harmonic mitigation. Chapters 8–10 address system-level optimization challenges, including network reconfiguration, voltage stability, and hybrid microgrid planning. This progression allows readers to move from theoretical understanding to applied solutions.

As for usage tips, readers may approach the book sequentially for a comprehensive understanding, or selectively focus on specific chapters of interest. For example, utility engineers may find Chapters 5 to 9 particularly relevant, while students may begin with Chapters 1 and 2

for foundational knowledge. Researchers may prefer Chapters 6 to 10 for advanced optimization techniques and case studies.

The authors are academics and researchers with backgrounds in power distribution systems, optimization algorithms, materials engineering, and smart grids. Collectively, we bring experience from teaching, industry collaboration, and applied research, which shaped the practical and multidisciplinary approach of this book.

Finally, we encourage readers to not only absorb the content but to engage actively with the concepts presented. Apply the methods, question the assumptions, and explore new solutions for tomorrow's energy challenges. By doing so, you will help advance the development of resilient, sustainable, and intelligent power distribution systems.

Norzanah Rosmin

Dalila Mat Said

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