David Elmakias (Ed.)

New Computational Methods in Power System Reliability

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In memoriam of my lovely son Sharon Menachem Elmakias (*Oct. 9.1981-Jan.9.2005*)

"Sharon, I wanted to thank you.
Thank you for being with me in joyful times as well as sad.
Thank you for having such a big heart I am able to be a better person.
Thank you for respecting me even if you did not agree with me.
Thank you for worrying about me sleeping proper hours and having home leave.
Thank you for sacrificing your own comforts for the sake of others.
Thank you on behalf of tens of soldiers whom you helped.
Thank you for supporting me in times of trouble.
Thank you for making me smiling even when everything looked grey.
Thank you for being dependable and trusting all the time.
Thank you for forgiving and not angry every time I made mistakes.
Thank you for standing at my side every step of the way.
Thank you for letting me understand the meaning of the word "perfect".
Thank you for your contribution at complex and dangerous times.
Thank you for your infinite help with good word on everything.
Thank you for saying "yes" more than you sad "no".
Thank you for showing peace and self security.
Thank you for never ending ideas, concepts and improvements.
Thank you for proving what humility is.
Thank you for teaching me what the true friendship is".

Shai Siman Tov. From letter to Sharon's family.

Preface

Power system reliability is in the focus of intensive study due to its critical role in providing energy supply to the modern society. The basic methods of power system reliability assessment and improvement were presented in the following comprehensive books: Endrenyi J (1979) Reliability modeling in electric power systems, John Wiley & Sons, New York; Billinton R, Allan R, Salvaderi L (1991) Applied Reliability Assessment in Electric Power Systems. IEEE Press; Billinton R, Li W (1994) Reliability Assessment of Electrical Power Systems Using Monte Carlo Methods, Springer, New York; Billinton R. and Allan R (1996) Reliability evaluation of power systems. Plenum Press, Boston; Brown R (2002) Electric Power Distribution Reliability. Marcel Dekker, New York; Pansini A (2004) Transmission Line Reliability and Security. Marcel Dekker, New York. This book is not aimed at providing the overview of the state of the art in power system reliability. On the contrary, it describes application of some new specific techniques: universal generating function method and its combination with Monte Carlo simulation and with random processes methods, Semi-Markov and Markov reward models and genetic algorithm. The book can be considered as complementary to power system reliability textbooks. It is suitable for different types of readers. It primarily addresses practising reliability engineers and researchers who have an interest in reliability and performability analysis of power systems. It can also be used as a textbook for senior undergraduate or graduate courses in electrical engineering.

The book is divided into five chapters.

Chapter 1 presents a brief general description of power system structure. It describes basic concepts of reliability based planning and introduces the multi-state systems as an object of study.

Chapter 2 describes the basic mathematical tools used in this book for reliability analysis and optimization.

Chapter 3 presents several reliability assessment and optimization problems arising in power generation systems on power plant and power system levels.

Chapter 4 is devoted to reliability assessment of elements of transmission and transformation systems. It considers substation reliability evaluation based on overload capability of the transformers, reliability analysis of substation configurations and high voltage protections.

Chapter 5 considers methods of reliability enhancement in distribution systems and presents optimal sectionalizing and optimal insulation methodologies.

The book was written by the following authors: Dr. D. Elmakias (sections 1, 2.1, 3, 4, 5), Dr. H. Ben Haim (sections 1, 4.3), Eng. Sh. Frant (sections 1.3.2, 3.2), Dr. V. Gurevich (sections 2.3, 3.2), Dr. D. Laredo (section 4.3), Dr. G. Levitin (sections 1.5, 2.2, 2.3.3, 2.4, 3.4, 3.5, 5), Dr. A. Lisnianski (sections 2.1, 3.3, 4.3), Eng. Sh. Masal Tov (section 1.4, 5.1), Eng. D. Vishan (sections 4.1, 4.2). Sections 4.1 and 4.2 are based on joint research of Dr. Elmakias and Prof. Braunshtein. I thank the team of my co-authors for fruitful collaboration. I also thank Ms. R. Kalman and Mrs. T. Tarakanov for technical support.

I would like to express my sincere appreciation to Professor Janusz Kacprzyk, from Systems Research Institute (Polish Academy of Sciences), Editor-in-Chief of the Springer Series of Studies in Computational Intelligence, for providing me with the chance to include this book in the series.

It was a pleasure working with the Springer-Verlag editor Dr. Thomas Ditzinger.

Haifa, Israel David Elmakias

Contents

Preface vii
1. Basic Notions of Power System Reliability 1
1.1 Introduction 1
1.1.1 Three basic sub-systems 1
1.1.2 Fields of significant added-value of reliability tools 2
1.1.3 Concepts and methodologies 3
1.2 Structure of power system 5
1.3 Reliability based planning in power systems 12
1.3.1 Effect of failures on power system 14
1.3.2 Planning criteria 16
Generation expansion planning 16
Reliability criteria for generation expansion planning 19
Reliability criteria for transmission system planning 25
1.4 Risk analysis in power system planning 35
Risk index definition 35
1.5 Introduction to multi-state systems 38
1.5.1 Main definitions and models 39
Basic concepts of multi-state systems 39
Generic multi-state system model 40
Acceptability function 43
1.5.2 Simplest types of multi-state system 44
Series structure 44
Parallel structure 47
1.5.3 Measures of multi-state system performance 49
References 52
2. Basic Tools and Techniques 55
2.1 Modern random processes methods 55
2.1.1 General concepts 55
2.1.2 Markov models 59
Main definitions and properties 59
2.1.3 Markov reward models 72
Basic definition and model description 72
Computation of power system reliability measures by using Markov reward models 77

Combined capacity-demand model 79
Rewards determination for combined capacity-demand model 82
2.1.4 Semi-Markov models 91
Definition of semi-Markov process..... 92
Evaluation of reliability indices based on semi-Markov processes 97
2.2 The Universal Generating Function Method..... 105
2.2.1 Moment-generating function and z-transform 106
2.2.2 Mathematical fundamentals of the Universal Generating Function 110
Definition of the Universal Generating Function..... 110
Properties of composition operators..... 117
2.2.3 Obtaining the system reliability and performance indices using the UGF..... 119
2.2.4 UGF in analysis of series-parallel multi-state systems 125
Reliability block diagram method 125
2.2.5 Combination of random processes methods and the UGF technique..... 132
2.3 Monte Carlo simulation..... 141
2.3.1 Generation of random numbers 142
2.3.2 Continuous random variables 145
2.3.3 Combining the Monte Carlo simulation and UGF for estimating reliability confidence bounds of multi-state systems 146
2.4 Introduction to Genetic Algorithms 153
2.4.1 Structure of steady-state Genetic Algorithms 157
2.4.2 Adaptation of Genetic Algorithms to specific optimization problems 160
Parameter determination problems..... 161
Partition and Allocation Problems 162
2.4.3 Determination of solution fitness 165
2.4.4 Basic Genetic Algorithm procedures and parameters 166
References……..... 168
3. The Reliability of Generation Systems 171
3.1 Reliability indices of generation systems..... 174
3.1.1 Calculating reliability indices using the loss of load probability method..... 174
3.2 Evaluating generation system reliability with respect to unit commitment and operating constraints 182
3.2.1 Monte-Carlo sampling of the system availability states..... 187
3.2.2 Implementing unit commitment 189
3.3 Optimal reserve management for power generation systems 198
3.3.1 Multi-state system models 199
Problem formulation..... 201
UGF-based reliability evaluation..... 202

Implementing the Genetic Algorithm..... 205
3.4 Determination of the random generating capacity distribution for power plant..... 208
3.5 Power plant reliability optimization problems..... 213
3.5.1 Structure optimization problems 214
Optimal structure of systems with identical elements in each component..... 215
Optimal structure of system with different elements in each component..... 220
3.5.2 Optimal single-stage system expansion..... 223
3.5.3 Optimal multistage system expansion 225
3.5.4 Optimal multistage system modernization 230
References……..... 237
4. Reliability Assessment for Elements of Transmission and Transformation Systems 239
4.1 Calculating reliability indices of substations based on the overload capability of the transformers 239
4.1.1 The deterministic approach to study of the load capability of transformers..... 241
4.1.2 Calculating reliability indices based on the overload of the transformer using the Monte-Carlo method..... 242
Determining the time to failure by random number generator (RNG)..... 248
Determining the expected unsupplied energy by the Monte Carlo method..... 249
4.1.3 Analytical model for calculating reliability Indices for substations based on transformers overloading..... 250
The load model..... 251
The description of the analytical model..... 255
4.1.4 Probability $P(\theta_h > \theta_h^0)$..... 264
Calculation of the transformer temperature rise under failure conditions..... 264
Calculating the pdf of overlapping times..... 266
Calculating pdf of overlap time when the duration of load peak is deterministic..... 275
4.1.5 Estimation of instant of failure within a certain time interval..... 280
4.1.6 Determining the temperature rise..... 288
Hot-spot temperature calculation in case of an outage during peak load..... 290
Hot-spot temperature calculation in the case when an outage starts during an off-peak peak load 293
Hot-spot temperature calculation using a Monte-Carlo simulation 295
4.2 Reliability evaluation and analysis of substation configurations 307

4.2.1 Problem definition 307
4.2.2 Analytical models for evaluating the reliability parameters 309
4.2.3 The circuit breaker model 312
4.2.4 Failure mode and effect analysis 318
4.2.5 Logical algorithm for FMEA 318
Logical algorithm for single failure 324
Logical algorithm for two failures 330
Logical algorithm for the failure states of the circuit breaker 335
4.2.6 SharonSoft Reliability Software 336
Numerical examples 337
4.3 Reliability analysis of protection systems for high voltage transmission lines 350
4.3.1 Introduction 350
4.3.2 Description of protection system configurations 351
The configuration with two distance protections 351
The configuration with distance and differential protections 352
4.3.3 Failure definition and reliability block diagrams for protection systems 354
4.3.4 Markov models for protection systems reliability assessment 359
Computation results 365
4.4 Reliability assessment of high voltage transmission lines 367
4.4.1 Single circuit line model 367
4.4.2 Double circuit line model 368
References 372
5. Reliability of Distribution Systems 373
5.1 Methods of reliability enhancement in radial distribution systems 373
5.2 Optimal sectionalizing in single radial feeder networks 373
5.2.1 Mathematical formulation of the problem 375
Effect of sectionalizer operation failures 378
Effect of short-circuits caused by sectionalizer failures 379
5.2.2 Implementing the Genetic Algorithm 380
5.3 Optimal sectionalizing in interconnected radial networks 383
5.3.1 Effect of alternative supply on the unsupplied energy 385
5.3.2 Implementing the Genetic Algorithm 387
5.4 Optimal insulation in radial distribution networks 388
5.4.1 Effect of section insulation 390
5.4.2 Optimization problem 391
5.4.3 Implementing the Genetic Algorithm 391
5.5 Optimal replacement scheduling for distribution system equipment 394
5.5.1 Formulation of the problem 394

5.5.2 Model description 395
5.5.3 Estimating the total expected cost 397
Failures and replacement cost 397
Maintenance cost 400
References 404