Preface

The growing interest in the application of artificial intelligence (AI) techniques to power system engineering has introduced the potentials of using this state-of-the-art technology. AI techniques, unlike strict mathematical methods, have the apparent ability to adapt to nonlinearities and discontinuities commonly found in power systems. The best-known algorithms in this class include evolution programming, genetic algorithms, simulated annealing, tabu search, and neural networks.

In the last three decades many papers on these applications have been published. Nowadays only a few books are available and they are limited to certain applications. The power engineering community is in need of a book containing most of these applications.

This book is unique in its subject, where it presents the application of some artificial intelligence optimization techniques in electric power system operation and control.

We present, with practical applications and examples, the application of functional analysis, simulated annealing, tabu search, genetic algorithms, and fuzzy systems on the optimization of power system operation and control.

Chapter 2 briefly explains the mathematical background behind optimization techniques used in this book including the minimum norm theorem and how it could be used as an optimization algorithm; it introduces fuzzy systems, the simulated annealing algorithm, tabu search algorithm, genetic algorithm, and the particle swarm as optimization techniques.

Chapter 3 explains the problem of economic operation of electric power systems, where the problem of short-term operation of a hydrothermal–nuclear power system is formulated as an optimal problem and using the minimum norm theory to solve this problem. The problem of fuzzy economic dispatch of all thermal power systems is also formulated and the algorithm suitable for solution is explained.

Chapter 4 explains the economic dispatch (ED) and unit commitment problems (UCP). The solution of the UCP problem using artificial intelligence techniques requires three major steps: a problem statement or system modeling, rules for generating trial solutions, and an efficient algorithm for solving the EDP. This chapter explains in detail the different algorithms used to solve the ED and UCP problems.

Chapter 5, “Optimal Power Flow,” studies the load flow problem and presents the difference between the conventional load flow and the optimal load flow (OPF) problem and it introduces the different states used in formulating the OPF as a multiobjective problem. Furthermore this chapter introduces the particle swarm optimization algorithm as a tool to solve the optimal power flow problem.

Chapter 6, “Long-Term Operation of Hydroelectric Power Systems,” formulates the problem of long-term operation of a multireservoir power system connected in cascade (series). The minimum norm approach, the simulated annealing algorithm, and the tabu search approach are implemented to solve the formulated problem.

Finally, in Chap. 7, “Electric Power Quality Analysis,” presents applications of the simulated annealing optimization algorithm for measuring voltage flicker magnitude and frequency as well as the harmonic contents of the voltage signal. Furthermore, the implementation of SAA and tabu search to estimate the frequency, magnitude, and phase angle of a steady-state voltage signal, for a frequency relaying application is studied when the signal frequency is constant and is a variable with time. Two cases are studied: the linear variation of frequency with time and exponential variation. Effects of the critical parameters on the performance of these algorithms are studied in this book.

This book is useful for B. Sc. senior students in the electrical engineering discipline, MS and PhD students in the same discipline all over the world, electrical engineers working in utility companies, operation, control, and protection, as well as researchers working in operations research and water resources research.

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