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DISTRIBUTION SYSTEMS RESTORATION USING OPTIMIZATION TECHNIQUES

By

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To my guardian angel, my mother Hala El-Rabei

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Statement of Original Authorship

The work contained in this thesis has not been previously submitted to meet requirements for an award at this or any other higher education institution. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made.

Signature: _____

Date: _____

EXAMINERS' COMMITTEE

This thesis entitled “DISTRIBUTION SYSTEMS RESTORATION USING OPTIMIZATION TECHNIQUES” by Hossam El-Din Mohsen El-Dakroury meets the requirements for the award of Master of Science (M.Sc.) Degree in Electrical Engineering Ain Shams University, Faculty of Engineering, and it is approved for its contribution to knowledge and literary presentation.

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Abstract

Among the various components installed in the electrical distribution systems, main and lateral feeders are the most susceptible to temporary and permanent faults. Line faults are generally inevitable because they occur due to severe weather conditions and/or other natural events. The disconnection of customers from the utility grid affects the reliability indices of the distribution system and might cause several economic and technical problems. Due to such a problem, load restoration process takes place in order to restore the maximum number of disconnected loads due to line faults. Disconnected loads are restored by altering the statuses of sectionalizing (normally closed) and open-tie (normally open) switches. Load restoration operation is formulated as a mixed-integer nonlinear programming problem that aims at reaching a configuration which restores the maximum number of disconnected loads without violating topological or operational constraints.

Thesis consists of seven chapters. First chapter is an introduction of thesis topic. Second chapter discusses the importance of the electrical distribution system and its various components, focusing on the main component in thesis (the transmission lines) which are the most vulnerable to interruptions and the effect of these faults on the performance and reliability of electric system with a set of examples of faults that occurred in history in existing distribution systems and their impact on electrical systems, then the term "Restoration" is explained and how to apply it on electric system and the different types of functions that can be used to restore lost loads and methods of solution in cases of multi-functions. Also the different methods of optimizations methods used in restoration are explained, along with the advantages and disadvantages of each method, mentioning its application in various researches, along with presenting a survey of researches, systems, functions, and optimization methods used in literature. In chapter three, the electrical distribution system, its components, types, and the advantages and disadvantages of each type are explained, in addition to converting the electrical system to a set of mathematical equations expressing the system and its components, including the function to be optimized and the variables state to be found under different system constraints, with an explanation of the method of power flow in the electrical system and how to apply it in order to check system constraints. Chapter four, discusses the metaheuristic method used in thesis, binary particle swarm optimization, its equations, and how to apply them to the electrical system in order to restore lost loads, in addition to the term "load shedding", and how to use it into the function to be optimized, and how the programming deals with it as a method of solution in critical faults cases in order to achieve partial restoration. In chapter five, the proposed method is programmed, implemented and tested on a 118-bus distribution system by applying a variety of fault cases on feeder lines. Simulation results have also been compared with those published in previous research. In Chapter Six, load restoration by mathematical methods, including the required function, constraints, and approximation, illustrated theoretically. In chapter seven, Conclusions of Thesis are presented, as well as proposals for future work in this area.

Keywords

Load Restoration, Network Reconfiguration, Self-Healing, Radial Distribution System, Particle Swarm Optimization, BPSO, MINLP, MILP, Smart Grids, Neural Networks.

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