Abstract

In the recent years, there is an increased interest for research in the field of electrical power distribution systems. This is mainly, due to the facts that a major portion of the investment in the design of electrical power system is utilized for the distribution system and that a major share of the total losses in a power system occurs in the distribution system, as the voltage levels are low.

The present thesis is concerned with the optimization of operation and planning in radial distributions systems. The areas chosen for study are load flow, optimal capacitor location and placement, network reconfiguration, loss allocation and optimum planning of radial distribution systems.

First, a simple load flow algorithm for radial distribution systems is proposed. The algorithm is based on an algebraic voltage expression of the receiving end voltage magnitude of a branch in terms of the sending end voltage magnitude, resistance and reactance of the branch, total real and reactive power fed through the receiving end node of the branch. In distribution systems, the loads can be constant power, constant current, constant impedance, or a combination of constant power, constant current, and constant impedance, known as composite load. Hence, the proposed method is extended to the load flow solution of radial distribution systems with voltage dependent load models.

Next, capacitor location and sizing problem in radial distribution systems is studied. In order to select candidate locations of capacitors, two methods, i.e., fuzzy-min principle and fuzzy-product rule based methods are proposed. The effectiveness of these methods with three other existing methods, i.e., sensitivity based approach [1], method proposed by Chin and Lin [2], and the method proposed by Mekhamer et al. [3] are also studied. Two approaches for capacitor sizing using genetic algorithm are proposed. The first one is traditional objective function based

genetic algorithm (GA) and the second one is fuzzy satisfaction objective function based GA. The objective function tries to minimize the energy cost and effective capacitor cost (capacitor cost considering annual capital recovery factor (ACRF)) for the load duration curve considered.

After this, three approaches for multiobjective network reconfiguration are studied. In the deregulated environment, reliability of distribution systems are of great importance and hence only real power loss reduction is not the only objective to be considered. In the present study, multiple objectives are considered for minimization of the system power loss, deviations of the nodes voltage, branch current constraint violation and transformers loading imbalance, while subject to a radial network structure in which all the loads are energized. Heuristic rule is also incorporated in the algorithm for selecting the sequence of tie-switch operation. The three algorithms make use of classical weighted-sum, fuzzy max-min, and fuzzy satisfaction objective functions respectively. Different indices are defined in such a way that the network reconfiguration algorithm finds a configuration which reduces real power loss and at the same time, different objectives considered are satisfied simultaneously.

Deregulation of the power industry was aimed at enhancing competition and to bring down the prices. In the deregulated environment, the cost of power losses and energy losses are needed to be allocated to different consumers of the network. Three existing methods for loss allocation - pro rata method, quadratic loss allocation method, and proportional loss allocation method make use of assumptions to derive at losses to be allocated to different consumers in a radial distribution system. In the present study, an exact method for allocation of real power losses to consumers connected to radial distribution network is proposed. Energy loss allocation to different consumers connected to radial distribution network as well as impact of

network reconfiguration on loss allocation in radial distribution networks is also studied.

Finally, distribution system planning considering load growth, variable electricity charge, and variable load factor is studied. The algorithm determines radial feeder path to all load points using a minimum length algorithm, selects optimal sizes of the branch conductors, and optimal number of tie-switches so that the real power loss is minimum. Selection of location of substations using k-means algorithm is also proposed and studied.