PREFACE

The day by day increase in electrical power demand as load is has led the existing central generation and transmission network to operate under stressed condition. Thus, it has become quite challenging to operate the power system reliably, securely as well as economically. This issue may be addressed through power production of small generation units dispersed across the power grid or network known as Distributed Generation (DG).

One of the important tools in the planning and operation of a distribution system is network reconfiguration. Network reconfiguration is defined as altering the structural topology of distribution system by opening and closing the different set of switches associated with tie-lines and sectionalizer; however, keeping the radiality of the system intact under normal operating conditions. Network reconfiguration proves to be a viable solution for lowering distribution system losses and increasing system voltage stability margin as a consequence of improved system voltage profile.

Voltage stability is a critical factor that analyse the security level of a system. The increasing load growth in distribution network may lead to growing voltage instability and creates hindrance to load served by distribution utilities. Voltage instability in distribution systems could lead to voltage collapse and thus power blackouts in a certain or whole part of power system. One prime cause of this problem is the inability of the system to supply the reactive power demand. Additional power injection through integrated reactive power source and/ or renewable distributed generation (DG) in a small scale located near the load centres seems to be remedies to these challenges.

In traditional transmission and distribution systems, the presence of PV and PQ buses is very common. The concept of voltage control at PQV buses by remotely located P buses has been introduced. The dedicated P bus having pre-defined real power injection has variable reactive power source that controls the voltage of PQV bus. A PQV bus is defined as the bus with pre-specified quantities of active power, reactive power and voltage magnitude. Only the voltage angle of this bus is unknown. A P bus is defined as a reactive power generator bus which is maintaining the voltage magnitude at PQV bus constant at the required value. For a P bus, the quantity of active power is pre-specified. The quantities reactive power, voltage magnitude and voltage angle at this bus remain unknown and hence need to be calculated. Injection of regulated reactive power at generator bus P results in maintaining the desired value of the voltage magnitude of PQV bus located remotely. The PQV bus thus has pre-defined voltage magnitude in addition to predefined real and reactive power injections. Loss minimization under reconfigurable and optimally integrated DG environment has been performed in a system employed with remotely located PQV bus with its voltage magnitude being maintained by variation of reactive power injection at the selected P bus. The bus with minimum voltage magnitude has been chosen as PQV bus while P bus in the system is chosen with variable reactive power injection capable to control voltage magnitude of PQV bus. A Q bus is defined as a bus that has pre-defined reactive power injection with active power, voltage magnitude and angle as unknowns. Research on incorporation of set of P/Q and PQV buses seems to be limited to loss minimization. No attempt seems to be made in consideration of these buses in voltage stability enhancement.

In classical static analysis of power system loads at system buses are considered as constant real and reactive powers that are independent of frequency and voltage. However, it is not true for practical loads. Voltage dependent loads may be classified in three categories as constant current, constant impedance, constant power loads, or any combination of these three types of loads. The residential, commercial and Industrial loads are functions of system voltage, in general. Common static load models for active and reactive power are expressed in a polynomial or an exponential form. Moreover, load characteristics have significant effects on load flow solutions and convergence ability. This voltage dependency, if modelled properly, results in quite different power flow solutions.

From the limited literature survey carried out in this thesis, it seems that many researchers have considered loss minimization and voltage profile improvement through optimal placement of distributed generations. Meta-heuristic approaches seem to be simple and effective approaches in obtaining optimal location and size of DGs. Work may be carried out in finding a still better meta-heuristic approach in terms of its effectiveness and convergence rate as far as DG placement is considered. Optimal DG placement and network reconfiguration may be effectively utilized in loss reduction and voltage stability enhancement of distribution networks. Limited work has been reported regarding simultaneous reconfiguration and DG placement for loss minimization and no work seems to be made in voltage stability enhancement through simultaneous reconfiguration and DG placement. Very limited work seems to be made in loss minimization under presence of P, Q and PQV buses. No effort seems to be made in loss minimization and voltage stability enhancement through simultaneous DG placement and reconfiguration under presence of P, Q and PQV buses. Very few attempt seems to be made in loss minimization and voltage profile enhancement under time varying voltage dependent loads.

The main objective of this research is to maximize the voltage stability margin in terms of maximum loadability and/or to minimize the network losses of the distribution system under the system and operating constraints. The work carried out in this thesis has suggested simultaneous DG placement and network reconfiguration under presence of P/Q and PQV buses. DG placement has been proposed based on modified grey wolf optimization approach. Network has been reconfigured using rule based fundamental loop analysis. Voltage stability of the system has been examined in terms of maximum loadability. To enhance the system performance in terms of above objectives, novel set of P/Q and PQV buses have been introduced in distribution network. Firstly, a P/Q bus is identified and corresponding power injection has been calculated to enhance the system performances. Further, simultaneous optimal tie-switches as well as DG location with their optimum size have been evaluated to additionally enhance the system objectives. These approaches will help in the effective utilization of the existing distribution network, and additional load demand can be served without violating the maximum and minimum bus voltage limits and line capacity limits. The thesis also intends to examine the impact of DG and reconfiguration in distribution network performance under time varying voltage dependent loads. In order to achieve these, the following objectives have been defined:

- To propose a modified Gray wolf optimization algorithm for optimal placement of distributed generations.
- To solve DG allocation and network reconfiguration problem, simultaneously, considering multi-objective fitness function based on voltage stability margin enhancement and loss reduction.
- To propose a new multi-objective fitness function formulation based on real power loss reduction and voltage stability margin enhancement, and to consider simultaneous DG allocation and network reconfiguration

under remotely controllable PQV bus with its voltage magnitude controlled by P/Q bus.

- To propose a methodology to minimize network loss and improve voltage profile for time varying voltage dependent load model considering DG placement and reconfiguration, sequentially.